ESFS-NF 2024

ENABLING SUSTAINABLE FOOD SYSTEMS THROUGH NATURAL FARMING

INTERNATIONAL CONFERENCE

Extended Summaries-cum-Proceedings

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Enabling Sustainable Food Systems through Natural Farming (ESFS-NF)

Extended Summaries-cum-Proceedings of the International Conference

September 13-14, 2024
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Editors

Pramod Kumar, Sumit Vashisth, VGS Chandel, Rakesh Sharma, Sudhir Verma, Inder Dev, Ashu Chandel, Rajeshwar Singh Chandel

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FOREWORD

Sustainable Food Systems and Natural Farming are closely related concepts with common goals and principles, but different approaches, and practices. Natural Farming, as promoted by Padam Shri Awardee, Sh. Subhash Palekar, has been proving as a viable option to address the current farmers' distress, other related soil and water issues and to sustain farmers incomes. The farming practice has proven to be the most suitable paradigm and offers a solution to improve crop yields, increase farmers' income, ensure better health, environment conservation, reduce water consumption, minimize cost of production, eliminates usage of synthetic chemical inputs and rejuvenates soil health. Technological options however, need to explore scientifically through natural farm inputs for efficient soil carbon storage in agro-ecosystems, crop residue incorporation, mulch farming for conservation agriculture and intensification of agriculture. Dr YS Parmar University of Horticulture and Forestry (YSP UHF) is the pioneer in natural farming based planned principles research to establish the scientific logics behind the concept of Natural Farming. The University is actively involved in developing package of practices in Natural Farming in different farming systems across agro-climatic zones and crops. It has been furthering its attempt in this direction through the support of Govt. of Himachal Pradesh and Master's and Doctorate research.

The Himachal Chapter of the Indian Ecological Society was constituted during February 2017, based at YSPUHF, Nauni, Solan, Himachal Pradesh. With its inception, it joined hand with its parent society to carry forward various scientific events and emphasized to be one of the carriers of national agenda to enhance farmers' income. The international conference on **'Enabling Sustainable Food Systems through Natural Farming'** is a comprehensive two-day event dedicated to advancing sustainable agriculture, natural farming, and agroecological crop protection.

We thank all the participants who have taken the effort of coming to Nauni, a very small but beautiful place in the lap of Himalayan Mountains. Thanks are due to international and national advisory committee for their advice, conference organizing committee for their day and night efforts, the administration of YSP UHF for providing all logistics and other sponsors from the government, public and private organizations to support this international event in a wholehearted manner. The financial support rendered by National Bank for Agriculture and Rural Development (NABARD) for the publication of extended summaries-cum-proceedings of the congress is gratefully acknowledged.

Editors

Dated: 13th September, 2024
Solan, Himachal Pradesh

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Natural Resource Management through Agroecological Practices for Climate Resilience

ESFS-NF/APCR2024/1001

Judicious use of natural farming inputs through drip in apple based natural farming system in Spiti valley

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Keywords: Apple, Drip Irrigation, Intercropping, Natural Farming

Introduction

Spiti valley in Himachal Pradesh represents a true 'Cold desert' and has perennial problems of poor soil health (due to parent material) and availability of irrigation water (due to dependence on glacial water). As farmers' of the valley are shifting from traditional crops to commercial crops like apple, which has high demand for water and nutrients, fragile soil health and limited water supply are under huge stress. Natural farming (NF) is being perceived as only efficient farming system, which when adopted by farmers, can ward off inevitable ill impacts of chemical based food products and climate change besides meeting requirements of nutrition and good health. This farming system, adopted by farmers since ages is being reinvented for its advantages including improvement in soil health, quality produce and a cost-effective technology. However, labour and input shortage is being seen as major hurdle in its full scale adoption in the valley, as livestock and human population are scarce. Hence, judicious use of NF inputs and reducing labour, remains main issues. Krishi Vigyan Kendra at Tabo, therefore, is promoting automation in natural farming practices for more efficient resource use, reduced labour requirements and precise management of inputs.

Material and methods

Apple cultivar 'Royal Delicious was used grafted onto seedling rootstock, and planted at a spacing of 3m x 3m. The experiment was laid out in Randomized Block Design consisting of nine treatments *viz.,*T_1: Application of natural farming concoctions through drip irrigation system with pea as live mulch and intercrop, T_2: Application of natural farming concoctions through drip irrigation system with rajmash as live mulch and intercrop, T_3: Application of natural farming concoctions through drip irrigation system with dry mulch, T_4: Application of natural farming concoctions through drip irrigation system without mulch, T_5: T_1 + Foliar application of natural farming concoctions with pea as live mulch and intercrop, T_6: T_2 + Foliar application of natural farming concoctions with rajmash as live mulch and intercrop, T_7: T_3 + Foliar application of natural farming concoctions with dry mulch, T_8: T_4 + Foliar application of natural farming concoctions without mulch and T_9: Farmers' practice (basal application of jeevamrit without mulch) with each treatment replicated thrice. Ghanjeevamrit was applied @ 1t/ha in all treatments except T_9. Jeevamrit was applied through drip irrigation bi-weekly in treatments from $T_1$to T_8 while drenching of jeevamrit was done in treatment T_9 at an interval of 10 days.

Results and conclusion

The data presented depicts that mulching with dry grass recorded highest fruit parameters and maximum yield (164 q/ha) of apple using natural farming concoctions through drip irrigation and foliar application (T_7). This was followed by live mulches with intercropping of pea and rajmash which were statistically at par while treatment with no mulch (T_9) recorded lowest yield (134.47 q/ha). It may be due to better and timely supply of nutrients through drip as well as foliar application that produced large sized fruits with higher productivity. Mehta (2023) reported higher yields with intercrops under a integrated natural farming system. The study observed that intercrops such as peas and kidney beans can fix atmospheric nitrogen, thereby increasing the nitrogen availability in the soil. Additionally, these intercrops improve the utilization of soil moisture and nutrients, which enhances the physical and quality parameters of the fruit.

All the treatments, however, recorded significant benefit as the cost of cultivation was drastically reduced under natural farming practices. Maximum BC ratio of 4.48 was observed under T_5. Similar findings were reported by Chandel et al. (2024), net returns of apples under natural farming were better mainly due to sizable reduction in cultivation costs.

Table 1: Effect of NF treatments on fruit characteristics, yield and economics of apple

Treatments	Fruit Length (mm)	Fruit Breadth (mm)	Fruit Weight (g)	TSS (ºB)	Yield of Apple (q/ha)	Yield of Live mulches (q/ha)	Yield of intercrops (q/ha)	CEY (q/ha) (live mulches + intercrops)	Cost of Cultivation (Rs.)	Gross Returns (Rs.)	Net Returns (Rs.)	BC ratio (on Gross Returns)
T_1	72.29	75.93	247.84	13.10	155.63	12.26	26.84	193.75	347175	1550000	846875	4.46
T_2	71.29	76.29	248.54	13.30	153.92	1.98	5.10	180.48	392735	1443840	806430	3.67
T_3	73.65	76.98	248.81	13.53	157.56	-	-	-	382975	1260480	789305	3.29
T_4	71.63	74.96	245.63	14.00	146.90	-	-	-	334975	1175200	721885	3.51
T_5	74.07	78.92	255.47	13.90	163.73	12.87	27.13	202.73	361725	1621840	945643	4.48
T_6	74.74	79.48	256.18	14.07	163.97	2.03	5.22	191.16	407285	1529280	902870	3.75
T_7	75.20	79.18	258.98	14.27	164.00	-	-	-	397525	1312000	855825	3.30
T_8	72.65	75.89	249.26	13.03	159.51	-	-	-	349525	1276080	837765	3.65
T_9	69.38	71.22	240.95	12.87	134.47	-	-	-	322475	1075760	645505	3.36
$CD_{(0.05)}$	2.72	3.63	9.06	0.90	5.28	-	-	-	-	-	-	-

Market Price of Apple- Rs. 80/-; Market Price of Pea- Rs. 78/-; Market Price of Rajmash- Rs. 300/-

References

Chandel RS, Gupta M, Sharma S and Chandel A 2023. Economic analysis of natural farming based apple orchards in Himachal Pradesh. *Indian Journal of Ecology*, 50(1): 119-123.

Mehta H 2023. Impact assessment of natural integrated farming systems on apple production in dry temperate region. PhD thesis. Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan. pp. 60-61.

ESFS-NF/APCR2024/1002

Natural Farming: Sustainable farming system for apple production in cold deserts of Himachal Pradesh

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Key words: Apple, Live Mulch, Natural Farming, Cold Desert

Introduction

Spiti district in Himachal Pradesh with dry summers and long, freezing winters is a true representation of "cold desert" with only one cropping season. Amongst total population of 12,457 people, it has 2,583 farming families braving challenges of low soil fertility and dependence upon glacial water for irrigation for crop production. Recent shift from traditional, resilient crops to economically rewarding apple, combined with climate change, has further elevated this challenge. Also, there are fears of deterioration in soil health with increased use of chemical leading to sustainability issues in the near future. Thus, natural farming (NF), which uses natural formulations/methods for nutrient supplementation as well as improving soil health besides moisture conservation seems to be a holistic solution to the challenges being faced by Spiti farmers. Natural Farming, therefore, is imperative for employment generation through sustainable agriculture, all while protecting the fragile environment of higher Himalayas.

Material and methods

On-Farm Testing (OFT) on natural farming were conducted by the KrishiVigyan Kendra, Lahaul&Spiti-II at Tabo, Himachal Pradesh at research farm and 5 locations across Spiti valley. Treatments included T_1: Live mulch with pea; T_2: Live mulch with Kidney bean; T_3: Dry grass mulch and T_4: Control. The treatments were replicated thrice under Complete Randomized Block Design. Apple plants of royal delicious var. grafted on seedling rootstocks are spaced at 3x3m. Ghanjeewamrit @ 1t/ha was added into the soil before sowing of live mulches and intercrops. Jeewamrit @ 5% was applied after every 10 days as drenching and at weekly intervals as foliar spray on apple as well as intercrop. Intercropping was done with pea in between plants. Irrigation was given through flood system on biweekly basis.

Results and conclusion

Dry grass mulch recorded weed control efficiency of 92.36 per cent as compared to of control. Different mulches had significant effect on soil temperature and recorded 34.46 per cent higher moisture compared to conventional farming practice. Fruit characteristics (fruit length (75.44 mm), fruit breadth (81.44 mm) and fruit weight (259.38 g)) as well as yield (169.67 q/ha) were maximum under control which was a solo crop. Though, fruit parameters as well as yield of main crop under natural farming was significantly lower than control, however, Crop Equivalent Yield (CEY) of apple with intercrop under live much of pea and Kidney bean was 190.94 q/ha and 182.64 q/ha, respectively, while CEY with dry grass was 170.46 q/ha. Due to reduction in cost of cultivation under natural farming, 28% gain on net returns was recorded over control. All the results are in consonance with findings of Laishram et al. (2022). Consequently, maximum BC ratio of 4.59 was observed under treatment T_1 while treatment T_4 recorded BC ratio of 3.20. Most valuable contribution of natural farming inputs was observed in soil biological and physico-chemical properties. Soil organic carbon and beneficial microbial community showed observable increase in all treatments except control. Results support the findings of Lia et al (2019). Thus, it can be concluded that Natural farming must include intercrops as well as live mulches to override the yield deficit, if any, and keep the farmers' income northwards. This has greater benefit in cold deserts where the soil health is already precarious and further non-judicious use of chemicals can harm it irreversibly. Soil moisture and temperature moderation is also important factor in maintaining good soil health. Therefore, Natural farming, which uses only natural concoctions for supplementing nutrients to the plants can keep the soil healthy and sustainable for future use.

References

Laishram C, Vashishat R, Sharma S, Rajkumari B, Mishra N, Barwal P, Vaidya M, Sharma R, Chandel R, Chandel Ashu, Gupta R and Sharma N 2022. Impact of natural farming cropping system on rural households—Evidence from Solan district of HP. *Frontiers in Sustainable Food Systems* 6. 878015. 10.3389/fsufs.2022.878015.

Lia J, Xu O, Xu H and Huang D. 2019. Natural farming improves soil quality and alters microbial diversity in a cabbage field in Japan. *Sustainability*11(11): 3131.

ESFS-NF/APCR2024/1003

Climate resilient technologies adoption under NICRA in South Western Hill region of Rajasthan

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Keywords: Adoption, Climate Resilience, Farmers

Introduction

Climate change and global warming effects are reflecting on all sectors of human life. Dhanta village of Sirohi district, Rajasthan India was adopted due to climatic vulnerability and well known for its low, uneven and erratic rainfall. Impacts will be global, but much of the damage will be in developing countries, where, 11 percent of arable land could be affected by climate change, including a reduction of about 16 percent of agriculture GDP (Pathak *et al*. 2012). Farmer of selected village & nearby village under adverse climate situation such as early season drought (delayed onset), normal onset followed by 15-20 days dry spell, mid-season drought (long dry spell) & early withdrawal of monsoon were faced during past years.

Material and methods

The study was conducted at Dhanta village comes under Transitional plains of Luni Basin Zone II-b of Rajasthan, India. It is situated in the southern part of the Sirohi district and 20 km away from Krishi Vigyan Kendra, Sirohi. The village was purposively selected for the study with sample size 250 farmers under NICRA project. There are four modules with different interventions under study i.e. Natural Resources Management, Crop Production, Livestock Management and Institutional Intervention. The whole climate resilient location specific technologies are demonstrated in the stated village since 2022.

Results and conclusion

The study illustrated that out of 22 climate resilient technological intervention, all practices were adopted by farming community under different modules of CRT The data in table 1.0 revealed that area was increased to 128 hectares from 18 ha, cotton stalk and wheat straw was incorporated in about 238 ha area and 435 tons rich compost prepared from castor stalk and applied in the fields to increase organic matter in soil under NRM intervention. Similar finding has been reported by Sasanka *et al*. (2016). Data further showed that in different demonstrations viz., Bajra (MPMH-17) yield was increased by 21.9 per cent due to drought tolerant character of variety, chickpea (GNG-2144) yield by 14.28 per cent due to wilt resistance, and cumin (GC-4) yield by 17.80 per cent, over local varieties. This finding is line with result reported by Sasanka et al. (2016). The milk production of buffalos per lactation had increased by 14.0 per cent due to mineral mixture, deworming and vaccination interventions. Under capacity building programmes, 259 farmers and 130 farm women were participated and benefited in trainings on natural resources management, crop production, and livestock management.

It can be concluded that after NICRA project execution in the adopted village, farmers were benefited immensely due to the intervention broadly made on natural resources management, crop production, livestock management and use of custom hiring centre implements.

Table 1: Application of NRM technologies, Crop/Livestock yield and modules wise adoption of CRT in NICRA village adoption (n=250)

<table>
<tr><th rowspan="2">S. N.</th><th rowspan="2">NRM technologies</th><th colspan="2">Before NICRA</th><th colspan="2">After NICRA</th></tr>
<tr><th>No. of Farmers</th><th>Area (ha)/t</th><th>No. of Farmers</th><th>Area (ha)/t</th></tr>
<tr><td>1.</td><td>Dipping of community pond & check dam</td><td>16</td><td>18</td><td>130</td><td>128</td></tr>
<tr><td>2.</td><td>Summer deep ploughing</td><td>10</td><td>20</td><td>184</td><td>320</td></tr>
<tr><td>3.</td><td>Enrichment of soil by crop residue</td><td>20</td><td>30</td><td>158</td><td>238</td></tr>
<tr><td>4.</td><td>Recycling of organic waste</td><td>04</td><td>13 t</td><td>152</td><td>435 t</td></tr>
<tr><td>5.</td><td>Sprinkler irrigation</td><td>10</td><td>17</td><td>142</td><td>219</td></tr>
<tr><th colspan="2">Crop/ Livestock</th><th>Before NICRA Yield (q/ha)</th><th colspan="2">After NICRA Yield (q/ha)</th><th>% increase yield</th></tr>
<tr><td>1.</td><td>Bajra (MPMH-17)</td><td>8.20</td><td colspan="2">10.50</td><td>21.90</td></tr>
<tr><td>2.</td><td>Chickpea (GNG-2144)</td><td>17.5</td><td colspan="2">19.2</td><td>8.8</td></tr>
<tr><td>3.</td><td>Green gram (IPM-410-3)</td><td>7.5</td><td colspan="2">9.7</td><td>22.68</td></tr>
<tr><td>4.</td><td>Mustard (RH-0406)</td><td>14.2</td><td colspan="2">17.1</td><td>17.80</td></tr>
<tr><td>5.</td><td>Buffalo Milk</td><td>1489 l/Lactation</td><td colspan="2">1699 l/ lactation</td><td>14.00</td></tr>
<tr><td rowspan="2">6.</td><td rowspan="2">Capacity building programme</td><td>-</td><td colspan="2">259 farmers</td><td>-</td></tr>
<tr><td>-</td><td colspan="2">130 farm women</td><td>-</td></tr>
<tr><th colspan="2">CRT Modules</th><th colspan="2">No. of farmers adopted *CRT</th><th colspan="2">Percentage of adoption of CRT by farmers</th></tr>
<tr><td>1.</td><td>Natural Resources Management</td><td colspan="2">159</td><td colspan="2">63.80</td></tr>
<tr><td>2.</td><td>Crop Production</td><td colspan="2">205</td><td colspan="2">82.20</td></tr>
<tr><td>3.</td><td>Livestock Management</td><td colspan="2">195</td><td colspan="2">78.20</td></tr>
<tr><td>4.</td><td>Institutional Intervention</td><td colspan="2">139</td><td colspan="2">55.60</td></tr>
</table>

**CRT= Climate Resilient Technology*

References

Pathak H, Agraval PK and Singh SB 2012. Climate change impact, adaption and mitigation in agriculture, methodology for assessment and application. Indian Agricultural Research Institute, New Delhi.

Sasanka L, Kamalalkanta B and Sawagtika S 2016. Adaption of climate resilient technologies leading to sustainable food security. *International Journal of Agricultural Science Research,* 6 (6):183-188.

ESFS-NF/APCR2024/1004

Indigenous knowledge and traditional wisdoms in weather prediction for natural farming practices in Himalayas

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Keywords: Indicators, Indigenous knowledge, Weather forecast

Introduction

No doubt the development in science and technology enhanced the accuracy of weather prediction but it is not up to the mark especially in Himachal Himalayas may be due to orographic effects. Deep ITK knowledge and traditional wisdoms are exists among the old age farmers regarding estimation of coming weather its management and utilization. Integration of these two will definitely improve the weather forecast accuracy and agromet advisories in the state. Keeping this in view the present study was conducted on 185 respondents surveyed randomly from Solan, Sirmaur, Shimla, Mandi, Kangra and Kullu district of Himachal Pradesh. The main objective was to collect, document, conserve the vanishing out knowledge and integrate with available modern days weather forecast for the maximum benefits to farmers and to reduce the socio-economic losses related to the weather vagaries in the state.

Material and methods

In the present study the indigenous knowledge and traditional wisdom in weather prediction, management and its utilization were collected from 185 grown-ups farmers randomly from six district of Himachal Pradesh. A survey was conducted and the information was collected through a well designed questionnaire. The questionnaire was included the different approaches for weather prediction like astronomical approaches, biological approaches, pseudo-science approach, religious approach, social & cultural approach, Indigenous knowledge, traditional wisdom and prediction accuracy etc. The collected data was documented, analyzed and interpreted.

Results and conclusion

The results indicated that a deep ancestral knowledge of estimating the coming weather and doing agricultural and other operation based on it is exist among the grown-ups peoples. They were using different indicator to predict the weather like astronomical phenomena, birds' activities, animals activities, social & cultural beliefs, customs & rituals, prevailing folklores and many more which have passed through generation to generation. Among the respondents 100 % farmers relied on birds, astronomical, animals and plant indicators. All the respondents were using one or the others indicators along with the direction of their deities for the estimation of coming weather. The study revealed that this knowledge is vanishing out with time also less popular among the younger generation due lack of awareness & its availability. Introduction of intensive cropping systems at the cost of natural farming along with the information revolution is diminishing the importance of this deep indigenous ITK in weather prediction. We tried to collect, document and conserve it, otherwise losing, for the benefit of peoples in general and farming community in particular.

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An evaluation of Natural Farming Modules for *Kharif* Groundnut in Semi-Arid Gujarat Agroecosystems

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Keywords: Bijamrut, Ghanjivamrut, Jivamrut, Straw mulch

Introduction

Groundnut is one of the most important oil seed/cash crops of India. The worldwide groundnut is grown in 26.4 million hectares with a total production of 37.1 million metric tonnes and an average productivity of 1400 kg/ha.Conventional agriculture has made an adverse impact on soil and plant health. This eventually, leads to high demand for natural/organic farming to protect soil and plant health. Natural farming in recent years is gaining impetus due to realization of inherent advantages as it confers in sustaining crop production and in maintaining dynamic soil nutrient status and safe environment.

Material and methods

A field experiment was conducted at CNRM, S.D.A.U., S.K. Nagar during *Kharif* season.The experiment was conducted with two farming modules viz., natural farming (NF) and conventional farming (CF). Among the different modules under testing, natural farming input module which consists three crop residue mulching practices like No Mulching (M_0), Crop residue mulch @ 2.5 t/ha (M_1) and Crop residue mulch @ 5.0 t/ha (M_2) as a main plot treatment along with three organic manures levels as a sub-plot treatment *viz*., *Ghanjivamrut* @ 0.7t/ha (G_1), *Ghanjivamrut* @1.0 t/ha (G_2) and *Ghanjivamrut* @ 1.5 t/ha (G_3). Common application of seed treatment with *bijamrut* (200 ml/kg) with + *Jivamrut* foliar spray 500 L/ha at sowing, 30 and 60 DAS. In the case of conventional farming, chemical input is applied.

Results and conclusion

Majority of the yield attributes and yield of *kharif* groundnut were did not significantly influenced by different natural and chemical inputs modules (Table 1). No of pods/plant (32.75), pod yield (1822) and haulm yield (3028) were recorded higher with conventional farming compared to natural farming. The value of yield attributes and yield under natural farming namely, number of pods/plant (24.36), pod yield (1689 kg/ha) and haulm yield (1968 kg/ha) in T_9 (an application of1.5 t/ha *Ghanjivamrut*along with wheat straw mulch @ 5.0 t/ha) compared to other treatments. Minimum yields recorded with treatments T_2 (*Ghanjivamrut* @ 1.0 t/ha with no mulch applied).Yield reduction in natural farming is due to plant population reduction due to collar rot infestation after 30 DAS.

Amongst different modules, maximum net return of Rs 93692/ha with BCR 3.12 were obtained under conventional farming. In natural farming, farmers have use own resources (Cow inputs) result obtained higher net return of Rs 90964 with BCR 3.25 in T_9 (an application of1.5 t/ha *Ghanjivamrut* along with wheat straw mulch @ 5.0 t/ha) compared to other treatments.

Based on the results of present study, it is concluded that *kharif* groundnut grown under natural condition in loamy sand soils of North Gujarat with application of1.5 t/ha *Ghanjivamrut* + *Jivamrut* as a foliar spray @ 500 lit/ha atsowing, 30 and 60 DAS along with wheat straw mulch @ 5.0 t/ha recorded higher seed yield and economical realization.

Table 1: Effect of natural vs. chemical farming modules on *Kharif* groundnut

Treatments	No. of Pods/plant	Pod yield (kg/ha)	Haulm Yield (kg/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	BCR
T_1:No mulch + *Ghanjivamrut* @ 0.7 t/ha	20.06	1466	1586	113827	73380	2.81
T_2:No mulch + *Ghanjivamrut* @ 1.0 t/ha	18.66	1287	1512	100786	60339	2.49
T_3:No mulch + *Ghanjivamrut* @ 1.5 t/ha	21.56	1549	1792	121009	80562	2.99
T_4:Wheat straw mulch @ 2.5 t/ha +*Ghanjivamrut* @ 0.7 t/ha	23.16	1549	1597	119371	78924	2.95
T_5:Wheat straw mulch @ 2.5 t/ha + *Ghanjivamrut* @ 1.0 t/ha	23.51	1568	1842	122339	81892	3.02
T_6:Wheat straw mulch @ 2.5 t/ha + *Ghanjivamrut* @ 1.5 t/ha	23.81	1578	1853	123123	82676	3.04
T_7:Wheat straw mulch @ 5.0 t/ha + *Ghanjivamrut* @ 0.7 t/ha	24.06	1661	1885	128877	88430	3.19
T_8:Wheat straw mulch @ 5.0 t/ha + *Ghanjivamrut* @ 1.0 t/ha	24.31	1670	1912	129689	89242	3.21
T_9:Wheat straw mulch @ 5.0 t/ha + *Ghanjivamrut* @ 1.5 t/ha	24.36	1689	1968	131411	90964	3.25
S.Em ±	2.09	212.5	217.6	-	-	-
C.D. (p=0.05)	NS	NS	NS	-	-	-
C.V. %	18.45	27.29	24.57	-	-	-
Conventional Farming (CF)	32.75	1822	3028	137804	93692	3.12

References

Lokanath HM and Parameshwarappa KG. 2006. Effect of organics on the productivity of Spanish bunch groundnut under rainfed farming situation. *Proceeding of 18th World Congress of Soil Science, Philadelphia, Pannsylvania, USA,* p. 62-63.

Narayanaswamy S, Siddaraju R and Rajendraprasad S 2013. Influence of organic source of nutrients vs. conventional method of seed production on growth parameters and pod yield in groundnut (*Arachis hypogaea* L.). *Mysore Journal of Agricultural Science,* 47(2): 328-332.

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Nutrient management through bio-organics in groundnut

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Key words: Castorcake, FYM, Jivamrut, Panchgavya, Vermicompost

Introduction

The indiscriminate use of agrochemicals has had a negative impact on the environment, crop productivity, soil fertility and quality of the food. These problems have led to concentration on development and promotion of either organic or natural farming systems.Organic farming promotes the switch from a high volume to a high value production system. Groundnut (*Arachis hypogaea* L.) is an annual legume known as poor man's almond. It is the 13th most important food crop and 4th most important oilseeds crop of the world.Keeping these points in view, the present experiment was conducted.

Material and methods

A field experiment was conducted at Agronomy Instructional Farm, C.P.C.A., S.D.A.U, Sardarkrushinagar, Gujarat during the *kharif* seasons of 2021 and 2022 to study the effect of cow-based bio-enhancers and organic manure on *kharif* groundnut (*Arachis hypogaea* L.) grown under organic farming". The nine treatments (as per Table 1) consisted of nutrient management under organic farming replicated three times in Randomized Block Design. The seeds were sown manually at 45 cm row apart by maintaining the seed rate of 120 kg/ha and the seeds were sown in previously opened furrow at the depth of 5 to 6 cm and seeds were properly covered with soil and light irrigation was applied in each plot immediately after sowing.The observation on plant growth, yield attributes and yield were recorded as per standard procedure. Economics was worked out on the basis of prevailing market prices of inputs and output obtained from each treatment.

Results and conclusion

The data in Table 1 revealed that application of 100 % RDN through vermicompost + *panchgavya* @ 4% spray at 30 and 60 DAS (T_6) showed significantly higher plant height (44.93 cm), number of branches per plant (7.41) and pods per plant (12.68) during pooled study.Similarly Treatment T_6 being at par with T_5T_9 and T_4 registered maximum pod (1488 kg/ha) and haulm (2263 kg/ha) yield. These results are in confirmation with the findings of Choudhary *et al.* (2017) and Moinuddin and Kaleem, M. (2017). In case of economics, Treatment T_6, fetched the maximum gross and net return followed by T_5.

It is concluded that for securing higher pod yield and net profit from groundnut crop under organic farming, apply 100 % RDN either through vermicompost or castor cake along with either *panchgavya* @ 4% spray at 30 and 60 DAS or seed treatment with *bijamrut* @ 200 ml/kg seed + two spray of *jivamrut* @ 500 lit/ha at 30 and 60 DAS to groundnut.

Table 1: Effect of nutrient management on growth yield and economics of groundnut

Treatments	Plant height (cm)	No. of branches/ plant	No. of pods/ plant	Yield (kg/ha)		Gross returns (Rs./ha)	Net returns (Rs./ha)
				Pod	Haulm		
T_1:FYM	36.30	5.91	9.93	1145	1652	76960	34707
T_2:Castor cake	37.64	5.99	9.88	1163	1730	78430	35337
T_3:Vermicompost	39.42	6.17	10.30	1183	1797	79965	35131
T_4:FYM+*Panchgavya*	42.26	6.77	11.77	1342	2021	90625	43972
T_5:Castor cake+ *Panchgavya*	43.82	7.03	12.28	1448	2158	97670	50517
T_6:Vermicompost+*Pachgavya*	44.93	7.41	12.68	1488	2263	100595	53102
T_7:FYM+*Bijamrut*+*Jivamrut*	39.92	6.37	10.62	1231	1913	83425	36928
T_8:Castor cake+*Bijamrut*+*Jivamrut*	41.25	6.47	10.96	1269	1937	85825	36591
T_9:Vermicompost+*Bijamrut*+*Jivamrut*	43.54	6.90	11.89	1437	2075	96595	48473
S.Em.±	1.30	0.26	0.46	57.80	78.40		
C.D. (P=0.05)	3.75	0.76	1.33	166	226		

***Note:** 100% RDN applied through organic manureviz., FYM, Vermicompost, Castor cake in respective treatments, **2.** Panchgavya@4% spray at 30 and 60 DAS; **3.** Bijamrut seed treatment @200 ml/kg seed; **4.** Jivamrutdrenching @ 500 lit/ha at 30 and 60 DAS*

References

Choudhary GL, Sharma SK, Choudhary S, Singh KP, Kaushik MK and Bazaya BR 2017. Effect of *panchgavya* on quality, nutrient content and nutrient uptake of organic blackgram. *Journal of Pharmacognosy and Phytochemistry*. 6(5): 1572-1575.

Moinuddin and Kaleem M 2017. Yield and quality of groundnut(*Arachis hypogaea* L.) under different organic sources of nitrogen. *International Journal of Agricultural Science and Research*. 7(5): 295-298.

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Performance of tomato genotypes under natural environments in mid hill region of Himachal Pradesh

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Keywords: Climate resilient, Phenophase, Thermal indices, Genotypes

Introduction

The edifice of vibrant agriculture is premised on favourable natural environmental conditions during critical growth stages of plants. Vegetable cultivation is highly susceptible to the weather anomalies even a slight deviation from the cardinal temperature range can hampering crop growth performance. Moreover, changing cropping patterns, increased pest and diseases, seasonal fluctuations are the inevitable corollaries of rising temperature (Krishnan et al., 2020). Tomato is an herbaceous self-pollinated Peruvian origin second most important vegetable crop after potato over globe. Adjusting transplanting windows helps in averting the adverse effects of abiotic and biotic stress and ensures appropriate accumulation of heat units for crop growth and development.

Material and methods

The present investigation was carried out at the Experimental Farm of YSP UHF Nauni representing mid hill region of Himachal Pradesh. The study aimed to assess the pheno-thermal response of two tomato cultivars namely Heem Sohna and Solan Lalima to different natural environmental conditions created by transplanting the selected cultivars at an interval of 15 days before and after normal date of transplanting i.e., 10th March (early), 25th March (normal) and 09th April (late) under irrigated and rainfed conditions.

Results and conclusion

The study revealed that early transplanting of Heem Sohna cultivar under irrigated conditions experienced optimum meteorological conditions and took maximum number of days to attain different phenological stages viz. leaf development (23 days), inflorescence emergence (37 days), flowering (44 days), fruit development (66 days) and fruit maturity (88 days) followed by normal and late transplanting. The longer duration under optimum meteorological conditions provided ample time to complete its phenological stages efficiently and accumulate growing degree days (1037.5 ºC), photo-thermal units (14068.2), hydro-thermal units (52154.6 ºC) and helio-thermal units (8281.9 ºC). The proper completion of phenological stages, ample time and optimum conditions for uptake of nutrients and efficient accumulation of heat units resulted in higher morphological parameters coupled by higher biomass accumulation for early transplanted Heem Sohna cultivar under irrigated conditions followed by normal and late transplanting. Therefore, to bring tomato cultivation in line with the changing environmental conditions, transplanting in the first week of March, not later than 10th March, under irrigated conditions using Heem Sohna followed by Solan Lalima is recommended in mid hills of Himachal Pradesh for maximum return.

References

Krishnan R, Sanjay J, Gnanaseelan C, Mujumdar M, Kulkarni A and Chakraborty S. 2020. Assessment of climate change over the Indian region – a report of the Ministry of Earth Science, Government of India. Springer Nature. 266p.

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Natural farming and INM under loamy sand soil of north Gujarat agro-ecological conditions

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Key words: Groundnut equivalent yield, Integrated nutrient management, Natural farming

Introduction

Natural farming is a local low-input climate resilient farming system that advocates the complete elimination of synthetic chemical agro-inputs. Instead, it encourages farmers to use low-cost, locally sourced inputs and symbiotic intercropping to stimulate the soil's microbial activities. The lower cost of production by eliminating expensive external inputs is the main reason for natural farming's improved net returns. Natural farming is both a time-consuming and labour intensive system. Natural farming helps to improve organic matter and stimulate microbial activity in the soil.Keeping in mind with the view, the experiment was conducted with objectives to find out effect of natural farming practices crop productivity and soil fertility**.**

Material and methods

The experiment was conducted during 2022-2023 at Centre for Research on Integrated Farming Systems, SDAU, Sardarkrushinagar. The experimental site was very low in organic carbon (0.11%), available nitrogen (160.4 kg/ha), medium in available P (14.16 kg/ha) and K (105 kg/ha) having loamy sand soil structure. The experiment havingfive treatments,T_1: Control (only weeding), T_2: Complete NF (Use of jivamruit, ghanjivamrut, mulching, irrigation at wahpsa condition, intercropping and PMDS during fallow, T_3:AI-NPOF package (100% nutrients through organic with source of ½ FYM, ¼ vermicompost and ¼ neem cake + IOP (*Beejamrit* + *Ghanjeevamrit* @ 250 kg/ha + *Jeevamrit* @ 500 lit./ha/irrigation twice a month with irrigation), T_4: 50% organic:50% inorganic nutrient management with organic pests management and T_5: 50% organic:50% inorganic nutrient management with chemical pests management were tested in RBD with four replications. Groundnut and sesame were sown with the row ratio of 4:2, while, fennel and cabbage with the row ratio of 1:2, respectively. Fennel stover was used as mulching material during *kharif*, while in *rabi* season, groundnut seed shell, sesame stalk and cabbage green leaves king were used @5 t/ha.

Results and conclusion

The datapresented in table revealed that significantly higher GEY was recorded under treatment T_2 (2162 kg/ha), which was remained at par with T_4 and T_5.Groundnut increased pod yield in response to natural farming practices may be attributable to nutrients availability throughout crop growth, which was further ensured by improved microbial activity in the soil. The results confirm the findings of Sutar *et al*.,(2019).The significantly higher GEY in *rabi* season was recorded with application of 50% organic and 50% inorganic nutrient management along with organic pests management (2810 kg/ha), which was at par with treatment T_5(2667 kg/ha).This might be due to integrated use of organic and inorganic manures along with organic pests management which attributed to improve nutrients supply and soil health leading to higher nutrient uptake and increase in yield(Gore and Sreenivasa,2011). The application of integrated nutrient management (T_4) with need based botanical bio-pesticides for pest management followed bypre-monsoon dry sowing with multiple crops during fallow found significantly higher sequence groundnut equivalent yield (4665 kg/ha),which was at par with of integrated nutrient management (T_5).During *kharif*, the total gross return including intercrop (123348 Rs./ha) and net return (66274 Rs./ha) were recorded under treatment complete natural farming, which was found at par with treatment T_4 and T_5.In case of fennel+ cabbage cropping system, application of 50 % nutrient application through organic manures and 50 % nutrient application through inorganic sources (T_4)recorded significantly higher gross profit (160291 Rs./ha) and net profit (93214 Rs./ha), which was at par with T_5.The total sequences gross profit (266113 Rs./ha) and net profit was found significantly higher with T_4(143029 Rs./ha), while it was at par with T_5.

Considering the hazards of fertilizers and pesticides, farmers can employ these environmentally beneficial traditional agricultural outputs as a production alternative. Based on the results of one year data, it could be concluded that application of ghanjeevamrit + jeevamrit + mulching and intercropping system with alternate row (replacement series) under zero budget natural farming was proved productive in low nutrients requirement crops like groundnut and sesame, but under high nutrient requirement crops like fennel + cabbage integrated nutrient management is required.

Table 1: GEY and economics influenced by INM and natural farming practices during kharif, rabi as well as in crop sequence

S. N.	Kharif			Rabi			Crop sequence			
	Groundnut equivalent yield (kg/ha)	Gross profit*	Net profit*	Groundnut equivalent yield (kg/ha)	Gross profit*	Net profit*	GEY (kg/ha)	Gross profit*	CoC*	Net profit*
T_1	1241	70823	30711	1138	64936	41993	2380	135758	63055	72704
T_2	2162	123348	66274	1600	91292	52493	3762	214640	95873	118767
T_3	1738	99167	33884	2233	127415	27643	3972	226582	165056	61527
T_4	1855	105822	49815	2810	160291	93214	4665	266113	123084	143029
T_5	1849	105474	50199	2667	152157	71835	4516	257631	135596	122034
S.Em.±	88.54	5051	5051.1	64	3677	3677	101	5740	-	5740
CD (P=0.05)	348	19833	19833	253	14439	14439	395	22540	-	22540
CV %	10.01	10.01	21.9	6.17	6.17	12.81	5.22	5.22	-	11.08

**Rs./ha*

References

Gore N and Sreenivasa MN. 2011. Influence of liquid organic manures on growth, nutrient content and yield of tomato in the sterilized soil. *Karnataka Journal of AgriculturalSciences* 24(2): 153-157.

Sutar R, Sujith GM, Devakumar N. 2019. Growth and yield of Cowpea [*Vigna unguiculata* (L.) Walp] as influenced by jeevamrutha and panchagavya application. *Legume Research* 42 (6): 824-828.

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Enhancing growth, quality, and yield of pea (*Pisum sativum* L.) through natural farming practices

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Keywords: *Ghanjeevamrit, Jeevamrit,* Yield

Introduction

Organic agriculture is growing in popularity, particularly in regions like India's Northwestern Himalayas. Natural Farming, focuses on cooperating with nature to produce nutritious food without chemical fertilizers, herbicides, or pesticides (Ukale et al. 2016). Techniques like Jeevamrit and Ghan-jeevamrit enrich the soil with beneficial microorganisms, enhancing soil health, crop quality and yield. Organic amendments also improve soil physical, chemical, and biological properties, supporting sustainable crop productivity and biodiversity.

Material and methods

The present investigation was carried out during the rabi season of 2020-21 at the experimental farm of the Department of Soil Science and Water Management, Dr. YSPUHF, Solan, to study the effect of different natural farming practices on the growth and quality of pea. The experiment was laid out in a Randomized Block Design (RBD) on pea cv.PusaPragati, consisting of seven treatments with three replications. The different treatments involved various levels of Jeevamrit and Ghanjeevamrit.

Results and conclusion

This study showed Significant effects of different treatments were observed on plant height, protein content, ascorbic acid, and yield. Additionally, significant differences were noted in root length, pod length, and the total soluble solids (TSS) of pods. Maximum plant height (79.47 cm) was recorded under treatment T2, while the minimum (72.20 cm) was observed under T7. The highest root length (53.11 cm) was recorded in T6 and T7. Pod length was highest (8.47 cm) under T2 and lowest (8.37 cm) under T7. Maximum protein content (24.58%) was observed in T1, with the minimum (17.06%) recorded in T5. The highest ascorbic acid content (14.70 mg/100g) was found in T1, closely followed by T2 (14.13 mg/100g) and T3 (13.47 mg/100g), while the lowest (10.23 mg/100g) was in T5. The highest pod yield was recorded in T1 (106.37 q/ha), followed by T3 (99.20 q/ha) and T2 (96.53 q/ha), with the lowest yield (76.05 q/ha) observed in T7. There were no significant differences in total soluble solids, with T1 and T2 showing the highest values (17.5 °Brix) and T7 the lowest (17.0 °Brix).The study concludes that the use of Ghanjeevamrit and Jeevamrit, particularly in treatment T2, significantly enhances the growth and quality of peas, making it a viable alternative to conventional fertilizers.

References

Ukale DU, Bhagwat RV, Upadhyay SK, Cukkemane N and Cukkemane AA. 2016. Metabolic analysis of liquid formulations of organic manures and its influence on growth and yield of tomato (*Solanum lycopersicum* L.) crop in field. *Biocatalysis and Agricultural Biotechnology* 8: 50-54.

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Productivity analysis of pea var. *Matar Ageta* 7 under organic and natural farming practices

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Keywords: *Beejamrit*, *Ghanjeevamrit*, *Jeevamrit*, Mulching, Sustainability

Introduction

In recent decades, agriculture has faced various challenges related to environmental degradation, food safety and the sustainability of conventional farming practices. As a response to these concerns, organic and natural farming have emerged as prominent alternatives. Organic and natural farming plays significance in the context of sustainable agriculture. Pea (*Pisum sativum* L.) is a legume vegetable of the winter season with high nutritive value often called "poor man's meat" due to its high protein, vitamins, minerals, and low concentrations of detectable anti-nutritive factors. The main objective of this study was to assess the influence of organic and natural farming practices on productivity of early pea variety Matar Ageta 7.

Material and methods

The field experiment was conducted at research farm of the School of Organic Farming, Punjab Agricultural University, Ludhiana, Punjab, India. The experiment, laid out in Randomized Complete Block Design (RCBD) with four replications. Nutritional treatments were T1 (unfertilized control), T2 (RDF), T3 (Organic farming), T4 (Natural farming practices), T5 (ONF-I: recommended dose of N/ha through FYM + NF) and T6 (ONF-II: 50 % recommended dose of N/ha through FYM + NF). The seeds of Pea variety 'Matar Ageta 7 were treated with bio-fertilizer (*Rhizobium leguminosarum*) and talc based formulation of *Pseudomonas fluorescens* (15 g/Kg of seed) under organic farming treatments and with *beejamrit* in OF + NF and NF treatments. The sowing was done on first October 2022 with seed rate of 112.5 Kg/ha at 30 cm rows apart and 7.5 cm plant to plant spacing. The crop was cultivated as per the package of practices for cultivation of vegetables (Anonymous 2023).

Results and conclusion

Treatment T2 proved to be highly influential, yielding the maximum plant height (70.2 cm), which was statistically at par with T5 (67.5 cm) and T3 (65.8 cm). Pod characteristics, including length and width, are significantly influenced by different treatments. T2 demonstrated the longest pod length (10.2 cm) which was statistically at par with T5 (9.7 cm) and followed by T3 (9.2 cm). Treatment T5 yielded the maximum pod width (13.4 mm), which was statistically at par with T2 (13.2 mm) and T3 (13.1 mm), while T1 has the minimum pod width at 9.6 mm. The performance of overall productivity was measured by fresh pod yield per hectare, maximum fresh pod yield per hectare was recorded in T2 (75.6 q/ha) treatment which was statistically at par with T5 (69.9 q/ha) and T3 (65.5 q/ha) with T1 displaying the lowest yield at 39.4 q per hectare. Root studies at 30 and 45 days after sowing (DAS) revealed that T3 consistently displayed the longest root lengths and nodule count which was statistically at par with T5 and T6. Better root development under treatment T3 might be due to beneficial effects of decomposed organic matter, nutrition supplied by FYM as well as improved biological and physico-chemical properties of the soil (Kumari et al 2023).

From this study it has concluded that farmers who wants to adopt alternative agricultural practices for safe food production can practice recommended dose of N/ha through FYM or recommended dose of N/ha through FYM + NF practices which include seed treatment with *beejamrit* + basal application of *ghanjeevamrit* @ 250 kg//ha + FYM @ 250 kg/ha + *jeevamrit* + mulching + bio-pesticides prepared from locally available organic material.

Table 1: Growth and yield attributes of early pea variety Matar Ageta 7 as influenced by nutrient management practices

Treatments	Plant height (cm)	Pod length (cm)	Pod width (mm)	Fresh pod yield/ha (q/ha)	Root Length 30 DAS*	Root Length 45 DAS*	Nodule No 30 DAS*	Nodule No 45 DAS*
T1 (Control)	49.9[d]	7.6[d]	9.6[d]	39.4[c]	8.35[c]	10.5[c]	13[c]	18[d]
T2 (RDF*)	70.2[a]	10.2[a]	13.2[a]	75.6[a]	11.03[b]	17.5[a]	20[b]	32[b]
T3 (OF)	65.8[a]	9.2[bc]	13.1[a]	65.5[a]	11.93[a]	19.3[a]	30[a]	41[a]
T4 (NF*)	55.8[c]	8.3[cd]	11.9[c]	45.6[bc]	9.48[b]	13.6[b]	17[bc]	26[c]
T5 (ONF-I)	67.5[a]	9.7[ab]	13.4[a]	69.9[a]	11.55[a]	18.5[a]	28[a]	39[a]
T6 (ONF-II)	60.8[b]	8.6[c]	12.6[b]	53.5[b]	11.18[a]	17.9[a]	27[a]	38[c]
C.D.	4.60	0.85	0.43	11.97	1.07	2.90	3.63	3.12

** DAS: days after sowing, RDF: recommended dose of fertilizer, NF: Seed treatment with beejamrita + basal application of ghanjeevamrit @ 250 kg//ha + FYM @ 250 kg/ha + jeevamrit + mulching + pesticides/fungicides prepared from locally available organic material*

References

Anonymous. 2023. *Package of practices for cultivation of vegetables,* Punjab Agricultural University, Ludhiana, Punjab, 228 p.

Kumari S, Kumari R and Kumar A 2022. Effect of organic manures and biofertilizers on growth, yield and quality of pea (*Pisum sativum* L.). *International Journal of Bio-resource and Stress Management* 13: 1261-1268.

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Effect of manures and biofertilizers on growth and yield of radish under organic condition

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Introduction

Radish, known for its tender tuberous roots with a unique pungent flavor, is consumed raw in salads or cooked. Originating from Europe and Asia, it is a good source of vitamin C and minerals (Gamba *et al*., 2021). Cross-pollinated by bees and flies, radish varieties differ in shape, size, skin color, and crop duration. Temperate types are small and excellent for salads, while tropical types are larger and more pungent. Using biofertilizers enhances soil fertility, reduces dependency on chemical fertilizers, and promotes sustainable agriculture, making it crucial for improving radish growth and yield (Sarikhani *et al*., 2022).

Material and methods

The radish variety Punjab Safed was sown on 25 September 2023 using an RBD design with three replications, plot size of 4.5 x 4.0 m, and spacing of 60 x 10 cm. The study tested different combinations of organic manures and biofertilizers, with treatments including T_1 - 100% RDN through FYM, T_2 - 100% RDN through vermicompost, T_3 - 75% RDN through FYM, T_4 - 75% RDN through vermicompost, T_5 - T_1 + *Azotobacter* sp. and *Pseudomonas*, T_6 - T_2 + *Azotobacter* sp. and *Pseudomonas*, T_7 - T_3 + *Azotobacter* sp. and *Pseudomonas*, T_8 - T_4 + *Azotobacter* sp. and *Pseudomonas*, T_9 - Cow-based bio formulation, and T_{10} - Control. Initial soil status and microbial counts were also recorded during the experiment.

Results and conclusion

The experiment was conducted on sandy loam soil with a pH of 8.20 and EC of 0.76. The soil had a medium organic carbon content (0.62%) and calcium carbonate (0.61%). Available N, P, and K levels were 168.00, 12.78, and 240.55 kg ha-1, respectively. Initial DTPA extractable micronutrients were sufficient, with Zn at 1.95 mg kg-1, Mn at 7.85 mg kg-1, Fe at 7.69 mg kg-1, and Cu at 1.17 mg kg-1. The bacterial count was 64 x 10^5 CFU g-1 of soil. Significant differences among treatments were observed for growth and yield parameters. Maximum shoot length, root length, leaves per plant, root diameter, and yield (41.99 cm, 26.12 cm, 18.00, 33.11 mm, and 205.82 q/ha, respectively) were recorded with T_6 (100% RDN through vermicompost + *Azotobacter* sp. and *Pseudomonas*), which was significantly higher than all other treatments. The lowest root yield (141.00 q/ha) was recorded in T_9 (Cow-based bio formulation).

References

Gamba M, Asllanaj E, Raguindin PF, Glisic M, Franco OH, Minder B, ... and Muka T. 2021. Nutritional and phytochemical characterization of radish (*Raphanus sativus*): A systematic review. *Trends in Food Science and Technology* 113: 205-218.

Sarikhani MR and Amini R. 2020. Biofertilizer in sustainable agriculture: Review on the researches of biofertilizers in Iran. *Journal of Agricultural Science and Sustainable Production* 30(1): 329-365.

ESFS-NF/APCR2024/1012

Germination and seedling growth of papaya influenced by seed treatment with leaf extracts

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Key words: Leaf extracts, Seed Treatment, Growth

Introduction

Papaya (*Carica papaya* L.) is one of the globally important tropical fruit rich in different types of sugars, minerals, vitamins and antioxidants (Insanu *et al*. 2022). The fruit is commercially propagated by seeds and the germination as well as seedling growth depends on seed quality and the growing season. Most of the seed treatment research on papaya for better germination and seedling growth has been studies with different growth regulators and inorganic chemicals (Deb *et al*. 2010). There is very little report on seed invigoration with organic sources of stimulants for germination and seedling growth of papaya.

Material and methods

The present research was carried out to find out the effect of some leaf extracts on seed germination and seedling growth of papaya. In the present experiment leaves of neem, mango, jamun, custard apple, litchi and cashew nut were collected, dried and grinded to powder. The leaf powders aquatic extract were prepared by soaking the powders (3g each) into water for 24 hours followed by straining to get clear extract. The papaya seeds were then soaked in such different leaf extracts for 24 hours and sown in the polythene packets under poly tunnel.

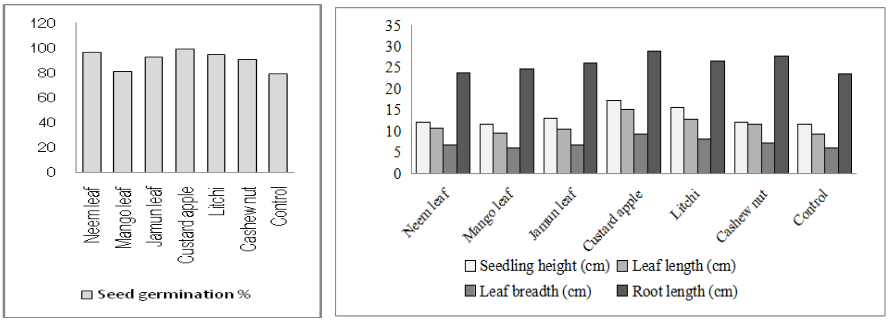
Results and conclusion

Maximum seed germination (98%) has been found in the seed lot treated with custard apple leaf extract followed by neem leaf extract (Figure 1a). Highest plant height (19.24 cm), stem girth (4.42 mm), root length (26.76 mm), leaf length, number of leaves have also been recorded in the seedlings under the treatment of custard apple leaf (Figure 1b). Root girth was maximum (8.31 mm) under mango leaf extract and longest root (26.76 mm) and maximum number of secondary roots (65.91) was recorded in litchi leaf extract treatment. All over the influence of custard apple leaf extract on germination and seedling growth of papaya was most significant.

References

Deb P, Das A, Ghosh SK and Suresh CP. 2010. Improvement of seed germination and seedling growth of papaya (*Carica papaya* L.) through different pre-sowing seed treatments, *Acta Horticulturae* 851: 313-316.

Insanu M, Nayaka NMDMW, Solihin L, Wirasutisna KR, Pramastya H and Fidrianny I. 2022. Antioxidant activities and phytochemicals of polar, semi-polar, and nonpolar extracts of used and unused parts of *Carica papaya* fruit. *Biocatalysis and Agricultural Biotechnology* 39: 102270.



(a) **(b)**

Fig. 1: (a) Seed germination (%); (b) seedling height, leaf length, leaf breadth and root length of papaya seedlings influenced by seed treatment with some leaf extracts

ESFS-NF/APCR2024/1013

Jeevamrit: An alternative to chemical fertilizers for marigold

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Keywords: Jeevamrit, Natural Farming, Soil Biology, Sustainable Agriculture

Introduction

Marigold (*Tagetes erecta*) flower cultivation has gained popularity among farmers due to its commercial value and benefits. The 'Siracole' variety, with its uniform flower size and bushy foliage, has proven highly productive and in demand. To develop sustainable cultivation practices, it is essential to explore the factors contributing to its growth and development. The present findings focuses on the effectiveness of Jeevamrit, a natural organic formulation, in marigold cultivation, examining its role in reducing chemical residues. This eco-friendly approach offers a promising solution for a more sustainable and environmentally responsible agricultural system.

Material and methods

The investigation was carried out at Department of Floriculture and Landscape Architecture, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India, during the summer and winter seasons of 2023-2024. The experiment employed a factorial randomized block design with two fertilizer treatments (Jeevamrit and RDF) and three harvesting flushes. Farmyard manure was applied uniformly to both treatments. Rooted cuttings of three sequential harvests were planted in summer and winter. Fertilizers were applied at the time of field preparation. The experiment was conducted at an altitude of 1276 m above mean sea level, with a latitude of 30◦52′02″ N and a longitude 70◦11′30″ E.

Results and conclusion

The results of the study showed that the cuttings of marigold cv. Siracole when planted during the summer season exhibited significant improvements in plant growth and yield, with increases in plant height (25.75%), plant spread (18.62%), chlorophyll content (28.17%), yield of marketable flower per square meter (21.38%), and flower size (46.46%). Furthermore, the use of Jeevamrit as a nutritional module resulted in enhanced uptake of nitrogen (13.00%), phosphorus (29.40%), and potassium (13.42%), leading to a substantial increase in marketable flower yield per square meter (3.97 %). In particular, the first flush of cuttings taken from the mother block yielded 7.27 kg of marketable flowers per square meter. The findings highlight the potential of Jeevamrit to replace chemical fertilizers in marigold cultivation, making it a better option for sustainable agriculture. Additionally, investigating the optimal formulation and application methods of Jeevamrit could maximize its impact on crop yields and environmental sustainability. By exploring these avenues, we can strengthen the evidence base for Jeevamrit's effectiveness in agriculture and promote its adoption among farmers.

References

Panda S, Grihalakshmi K, Barman S and Mishra PP. 2022. Production and marketing of marigold in Gajapati district, Odisha, India: Challenges and opportunities. *Plant Archives* 22(2): 292-296.

ESFS-NF/APCR2024/1014

Natural Farming: A sustainable approach for apple cultivation in Himachal Pradesh

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Keywords: Apple production, Natural farming, Soil health, Sustainable agriculture

Introduction

Apple cultivation in Himachal Pradesh is facing challenges due to declining yields, rising input costs, and environmental concerns. This study investigated the potential of Subhash Palekar Natural Farming (SPNF) as a sustainable alternative to conventional chemical-intensive practices in apple orchards. By emphasizing rhizosphere microbiome management, ecological pest control, and agroecosystem balance, SPNF aims to address prevailing orchard management challenges. The research aimed to evaluate SPNF's potential in enhancing soil health, promoting beneficial microbial populations, and reducing reliance on synthetic inputs, thereby providing a comprehensive solution to the multifaceted issues facing apple cultivation in the region.

Material and methods

The study was conducted at RHRTS, Mashobra, Shimla, HP during 2020 to 2023. The methodology employed in this study incorporated key principles of Subhash Palekar Natural Farming (SPNF). The approach focused on maintaining a healthy soil microbiome through the application of bio-stimulant formulations such as jeevamrit and ghanjeevamrit, derived from fermented cow dung, urine, and uncontaminated soil. Intercropping with leguminous crops and cultivating repellent plants were implemented to enhance soil fertility and manage pests naturally. Water conservation strategies included contouring, bund construction, and the WAPASA method. Mulching practices involved both dry grass and live mulch applications for moisture conservation. Plant trunks were protected with poudhlep applications four times a year. Natural nutrient management relied on jeevamrit drenching and ghanjeevamrit application, supplemented by nitrogen-fixing intercropped legumes. Pest and disease management utilized a range of natural preparations sprayed at regular intervals, including sonthastra, khatti lassi, ramban rognashi, darekastr, bhramastr, agniastr, and dashparni ark. Additionally, saptdhanya ankur spray was applied at specific growth stages to enhance fruit quality. Seed treatment employed Beejamrit. This comprehensive approach aimed to create a sustainable, ecologically balanced orchard system that could address the challenges faced by apple farmers in the region.

Results and conclusion

The study on Subhash Palekar Natural Farming (SPNF) in apple orchards yielded promising results across multiple parameters. Soil health improvements were significant, with SPNF soils demonstrating elevated organic carbon content (2.03%) and enhanced microbial load (295×10^5 cfu/ml). The substantial increase in Arbuscular Mycorrhizal Fungi (AMF) spore count (160 spores/ml) and earthworm population (80 per square feet) in SPNF soils further validated the positive impact on soil biota and fertility.

Fruit quality parameters were significantly enhanced under SPNF treatments. Apple varieties exhibited superior fruit firmness (7.82-9.03 Kg/cm^2) and increased ascorbic acid content

(15.55-21.08 mg/100g), indicative of improved nutritional value and post-harvest longevity. Fruits from SPNF plots maintained better quality under both laboratory and refrigerated storage conditions.

Plant growth was also positively influenced by SPNF, as evidenced by increased plant height and girth across different apple varieties. While the efficacy of SPNF in disease and pest management exhibited variability, the results suggest potential for further optimization of integrated pest management strategies within this framework. Seed treatment of intercrops with Beejamrit prior to sowing enhanced germination rates and controlled soil-borne diseases effectively.

Economic analysis revealed a significantly higher net return of Rs. 12,74,640.25/ha for SPNF compared to Rs. 8,30,840.01/ha for conventional chemical farming in 2023. This demonstrates the economic viability of SPNF as a sustainable alternative for apple cultivation in Himachal Pradesh. These findings collectively suggest that SPNF offers a promising, sustainable alternative for apple cultivation in Himachal Pradesh. By addressing both ecological and economic concerns, SPNF presents a viable pathway towards more resilient and sustainable apple production systems in the region.

References

Palekar S 2006. The principles of spiritual farming II, 2nd edn. Zero Budget Natural Farming Research, Development & Extension Movement, Amravati, Maharashtra, India.

Khadse A and Rosset M 2019. Zero Budget Natural Farming in India – from inception to institutionalization. *Agroecol Sustain Food Syst*. https://doi.org/10.1080/ 21683565. 2019.1608349

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Effect of plant bioformulations on quantitative and qualitative attributes of apple under high density plantation

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Keywords: High Density Plantation, TSS, Plant Bioformulation, Yield

Introduction

Apple is the prime fruit crop of Himalayan states of the country. In India, total area under apple cultivation is 0.32 million hectares yielding a production of 2.59 million tonnes of fruits, with a productivity rate of 8.2 t ha^{-1} (FAOSTAT, 2022). Apple farming has indeed been a cornerstone of the economy in many Himalayan states of India, particularly in Himachal Pradesh, Jammu & Kashmir, and Uttarakhand. The climate and terrain of these regions provide ideal conditions for apple cultivation. However, despite the economic benefits, farmers face significant challenges, with insect and pest infestations being among the most pressing issues. The economic losses due to pest infestations in apple orchards are substantial. It is estimated that the overall financial impact could reach hundreds of crores annually across the Himalayan region. In modern era, Plant based bioformulations contain bioactive compounds with insecticidal, antifungal and antimicrobial properties. When applied as foliar sprays or soil amendments, these compounds have the potential to reduce pests and disease incidence in crops. As natural protectants, these bioformulations can reduce the reliance on synthetic chemicals, thereby promoting a more sustainable and environmentally friendly approach to crop production.

Material and methods

The research was undertaken at Department of Fruit Science, Dr. Y S Parmar UHF, Nauni to evaluate the impact of these bioformulations on vegetative growth, yield-contributing traits and fruit quality attributes of apple trees. The objective was to identify specific formulations that enhance robust vegetative growth, which is essential for maintaining the overall health and maximizing the productivity of the trees. Six-year-old uniform trees of the Gala Schniga Schnico/EMLA9 apple variety, spaced at 2.0 x 1.5 meters were selected. The experiment included five different plant bioformulation (PB), namely, T_1: PB-1 + PB-5 + PB-2 + PB-6 + PB-3 (PB-2 + *Lantana camara* + *Eclipta elba*) + PB-7 (PB-2 + *Lantana camara*) + PB-9 (PB-6 + *Euphorbia hirata*) + PB-4 + PB-6 + PB-8, T_2: PB-5 + PB-6 + PB-3 (PB-2 + *Lantana camara* + *Eclipta elba*) + PB-7 (PB-2 + *Lantana camara*) + PB-4+ PB-6, T_3: PB-2 + PB-7 (PB-2 + *Lantana camara*) + PB-9 (PB-6 + Euphorbia hirata) + PB-6 + PB-8, T_4: PB-5 + PB-3 (PB-2 + *Lantana camara* + *Eclipta elba*) + PB-9 (PB-6 + *Euphorbia hirata*) + PB-4 + PB-8 and T_5: Control (water spray). Foliar applications were made at a rate of 50 ml per 200 liters of water for the following bioformulations: PB-1 (100–70 days before flowering), PB-5 (60–50 days before flowering), PB-2 (40–30 days before flowering), PB-6 (20–10 days before flowering), PB-7 (PB-2 + *Lantana camara*, after 100% flowering), PB-9 (PB-6 + *Euphorbia hirta*, at fruit set), PB-4 (at fruit set), PB-6 (at the pea stage), and PB-8 (at the walnut stage). Each treatment was replicated three times. Standard methods were employed to determine the qualitative and quantitative traits of apple.

Results and conclusion

Foliar application of plant bioformulation combinations exhibited significant effect on trunk girth, annual shoot growth, leaf area, fruit set and yield of apple (Table 1). However, yield efficiency (kg/leaf area) did not significantly affected by foliar application of different plant bioformulations. The trees treated with foliar application of treatment T_1 exhibited significant 29.02 per cent increase in trunk girth, 28.89 per cent increase in annual shoot growth, 11.07 per cent increase in leaf area, 15.96 per cent increase in fruit set and 89.95 per cent increase in yield over treatment T_5 (control). Similarly, fruit physico-chemical characteristics (Table 2) in terms of fruit weight, firmness, total soluble solids, sugars, ascorbic acid content and fruit colour (Greyed purple group 185 A). In conclusion, weed-based plant bioformulations hold great promise in broader horticultural research and apple production to improve quality growth attributes in sustainable manner.

Table 1: Impact of bio-formulations on growth and yield contributing traits of apple

Treatment	**Trunk girth (cm)**	**Shoot Growth (cm)**	**Leaf area (cm^2)**	**Fruit set (%)**	**Yield (kg $tree^{-1}$)**	**Yield efficiency (kg/LA)**
T_1	10.98a	25.32a	36.97a	55.84a	7.94a	0.22a
T_2	10.37ab	23.76b	35.81ab	52.37b	6.89b	0.19a
T_3	10.11ab	22.19c	34.65bc	51.93b	6.17c	0.18a
T_4	9.43bc	20.47d	33.86c	50.72b	5.19d	0.15a
T_5	8.51c	19.64d	33.29c	48.16c	4.18e	0.13a

The values followed by the same letter within each column are not significantly different from each other according to DMRT ($p \leq 0.05$).

Table 2: Effect of bio-formulations on fruit quality attributes of apple

Treatment	Fruit weight (mm)	Fruit firmness (kg cm^{-2})	TSS (°Brix)	Total sugars (%)	Ascorbic acid (mg 100 g^{-1})
T_1	138.23a	7.78a	13.50a	12.27a	5.86a
T_2	119.20b	7.27b	12.95b	11.77b	5.49b
T_3	116.39b	7.15b	12.70b	11.65bc	5.16c
T_4	111.99c	6.98bc	12.35c	11.37c	4.58d
T_5	105.71d	6.71c	11.90d	10.95d	4.12e

The values followed by the same letter within each column are not significantly different from each other according to DMRT ($p \leq 0.05$).

References

FAOSTAT 2022. Crops. Retrieved from Food and Agriculture Organization of the United Nations: https://www.fao.org/faostat/en/#data/QCL

ESFS-NF/APCR2024/1016

Resource use planning for commercial vegetable farms of Himachal Pradesh: A multi objective programming approach

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Keywords: Optimize land allocation, Multi-Objective Programming, Sustainability

Introduction

India is the second-largest global producer of fruits and vegetables, yet challenges persist in translating productivity into profitability, especially in vegetable farming. This study focuses on Himachal Pradesh, a region with unique agro-climatic conditions, aiming to optimize land allocation for vegetable farming through Multi-Objective Programming (MOP). The objectives include maximizing income and employment while minimizing the use of fertilizers and pesticides, thus balancing economic, social, and sustainable goals.

Material and methods

The study was conducted in Solan and Sirmaur districts of Himachal Pradesh using a multi-stage sampling design. Primary data were collected from 150 farmers using structured questionnaires. The MOP model was employed to optimize land allocation across three cropping seasons for marginal, small, and medium farmers. The model incorporated objectives of income maximization, employment generation, and reduction in the use of fertilizers and pesticides. Standard statistical procedures and Lingo 2.0 software were used to obtain the optimization results.

Results and conclusion

The optimization models showed significant improvements in productivity, profitability, and sustainability. For marginal farmers, income increased from Rs 229,359 to Rs 280,058 per hectare, with employment peaking at 252 man-days. Fertilizer and pesticide costs were reduced by Rs 1,760 and Rs 10,750 per hectare, respectively. Similar trends were observed for small and medium farmers, with income and employment rising significantly, and input costs decreasing. The MOP approach led to balanced allocations of crops like Chinese cabbage, beans, and peas, contributing to enhanced climate resilience through optimized resource use. These findings underscore the potential of MOP in achieving sustainable agricultural practices in the region.

Table 1: Comparative analysis under different optimization strategies among different size farms taking three vegetable crops a year

Farm Size	Objectives	Existing	Max Income	Max Employment	Min. Fertilizer	Min. Pesticide	MOP
Marginal	Income (Rs/Ha)	229359	280058	205155	232833	232833	255208
	Employment (Man-days/Ha)	190	224	252	136	136	171
	Fertilizer (Rs/Ha)	6180	6558	8852	4420	4420	4889
	Pesticide (Rs/Ha)	56479	55154	72113	45729	45729	53341
Medium	Income (Rs/Ha)	238095	296214	199751	237487	237487	282573
	Employment (Man-days/Ha)	217	173	263	139	139	166
	Fertilizer (Rs/Ha)	6686	5181	9173	3977	3977	4220
	Pesticide (Rs/Ha)	55370	46080	74106	37869	37869	39959
Large	Income (Rs/Ha)	256071	374673	210071	335567	335567	374673
	Employment (Man-days/Ha)	219	183	253	154	154	183
	Fertilizer (Rs/Ha)	7092	4622	9326	4428	4428	4622
	Pesticide (Rs/Ha)	57612	47836	73156	45172	45172	47836

References

Mahmoud RS, Elbehery R and Gheith M 2023. A Bi-Objective Mixed-Integer Linear Programming Model for a Sustainable Agro-Food Supply Chain with Product Perishability and Environmental Considerations. *Logistics* 7(3): 46.

Audsley E and Annetts J 2023. Multiple Objective Linear Programming for Environmental Farm Planning. *Journal of the Operational Research Society* 74(3): 933-943.

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Influence of growing media supplemented with liquid organic manure on growth, visual appeal and nutritional properties of ornamental kale

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Keywords: Jeevamrit, Ornamental, Cocopeat, Leaf mould

Introduction

Ornamental kale (*Brassica oleracea* var. *Acephala*) is a crop with untapped potential in the floral industry. Its striking appearance, with vibrant central leaves in shades of pink and red, and its ease of cultivation (Ren et al. 2015), make it a promising addition to the industry. Additionally, ornamental kale is rich in essential nutrients, offering significant health benefits as a good source of dietary carotenoids (Kurilich et al. 2002).

Material and methods

The study evaluated the effects of various growing media and application intervals of liquid organic manure (jeevamrit) on the vegetative growth, visual appeal and nutritional properties of Ornamental Kale (*Brassica oleracea* var. Acephala) genotype 'Kt OK-2'. The growing media tested includes a combination of leaf mould collected from ban oak soil and cocopeat in a 1:1 ratio (v/v), cocopeat alone, and leaf mould alone. Applying jeevamrit was drenched at weekly, fortnightly, and monthly intervals and compared with a control using RDF.

Results and conclusion

Results indicated that the growing medium of leaf mould and cocopeat (1:1, v/v) demonstrated superior qualitative and quantitative effects on plant growth compared to the other media, owing to its high nutritional content. Weekly drenching with jeevamrit further enhanced plant performance. This combination led to the highest measurements of plant height, spread, number of leaves, rosette diameter, percentage of green and coloured leaves per plant, pot display life, and early colour rosette formation. Additionally, the study assessed the total chlorophyll, anthocyanin, and carotenoid content of the plants, as well as the physico-chemical properties of the soil. In conclusion, the use of a balanced growing medium comprising leaf mould from ban oak soil and cocopeat in a 1:1 ratio, combined with weekly drenching of jeevamrit, proves to be an effective plant growth stimulant. This approach enhances biological efficiency and improves nutrient availability, fostering healthier plant growth.

References

Kurilich AC, Jeffery EH, Juvik JA, Wallig MA and Klein BP 2002. Antioxidant capacity of different broccoli (Brassica oleracea) genotypes using the oxygen radical absorbance capacity (ORAC) assay. *Journal of Agricultural and Food Chemistry* 50: 5053–5057.

Ren J, Liu Z, Niu R and Feng H. 2015. Mapping of Re, a gene conferring the red leaf trait in ornamental kale (*Brassica oleracea* L. var. acephala). *Plant Breed* 134(4): 494-500.

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Response of radish (*Raphanus sativus* L.) to natural farming practices under apple based agroforestry system

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Keywords: Ghanjeevamrit, Jeevamrit, Soil health, Sustainable agriculture

Introduction

Agroforestry is a deliberate land management approach that intentionally combines crops and crops without/with livestock on the same piece of land and establishes economic and ecological interactions among its components (Nair et al. 2021; Sharma et al., 2023). Natural farming practices in agroforestry systems offer an environmentally sustainable approach, enhancing biodiversity and food quality. The study investigates different natural farming techniques affect radish growth and soil properties within apple-based agroforestry system.

Material and methods

An experiment was conducted using a randomized block design (factorial). The study involved two factors: Jeevamrit (10%, 15% and 20%) and Ghanjeevamrit (1 t ha^{-1}, 2 t ha^{-1} and 3 t ha^{-1}) along with a control. Growth, yield, and quality of radish were assessed, along with soil properties.

Results and conclusion

Among the natural farming practices, Jeevamrit at 20% and Ghanjeevamrit at 3 tha^{-1} yielded the best results in radish growth and yield parameters, including root and shoot length, root-to-shoot ratio, root diameter, root weight, root yield, TSS content, and marketable maturity days. These treatments also improved soil physico-chemical properties such as organic carbon content, nutrient availability (nitrogen, phosphorus, potassium), and micronutrients (iron, copper, manganese, zinc), leading to better soil structure and reduced bulk density. Microbial counts (bacteria, fungi, actinomycetes) were highest in these treatments. The study concludes that Jeevamrit at 20% and Ghanjeevamrit at 3 t ha^{-1} are effective for sustainable radish production and soil health in apple-based agroforestry systems.

References

Nair PKR, Kumar BM and Nair VD. 2021. An introduction to agroforestry: Four decades of scientific developments. In *Global distribution of agroforestry systems* (pp. 45-58). Springer. https://doi.org/10.1007/978-3-030-35382-1_4

Sharma P, Bhardwaj DR, Singh MK, Nigam R, Pala NA, Kumar A and Thakur P. 2023. Geospatial technology in agroforestry: Status, prospects, and constraints. *Environmental Science and Pollution Research, 30*, 116459–116487.https://doi.org/10.1007/s11356-022-20305-y

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Effect of panchgavya and jeevamrit on growth and yield of *Stevia rebaudiana* Bertoni

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Keywords: Jeevamrit, Panchgavya, Yield, Harvesting schedules, Economic analysis

Introduction

Stevia rebaudiana Bertoni, a sweet herb of low calorie sweetener. Its leaves consist of two important secondary metabolites (steviol glycoside) namely stevioside and rebaudioside A and C which make it 30 times sweeter than cane sugar. The modern agriculture is dependent on heavily chemical fertilizer to meet the demands of ever-increasing population. Continuous use of inorganic fertilizers hazards the soil health. Therefore, it is necessary to minimize the application of inorganic fertilizers by substituting with organic inputs. The use of fermented liquid organic manure like panchagavya and jeevamrut are cheaper eco-friendly preparations made from cow products. It confers in sustaining crop production and maintaining dynamic soil nutrient status.

Material and methods

The experiment was carried out in the experimental field as well as in laboratory of the Department of Forest Products, College of Forestry, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during 2019-2020. The experiment was laid out in Randomized Block Design (factorial) with three replications. The measurements made on individual harvests were plant height, number of leaves/plant, number of shoots/plant, leaf and total foliage yield in fresh and dry basis. Jeevamrit was prepared by mixing cow dung and cow urine in water. Then add jaggery, gram flour and handful of field soil in a mixture. Keep the solution for 5-7 days for fermentation. For panchgavya, add fresh cow dung and cow ghee in a container. On the fourth day add cow urine, cow curd, cow milk, jaggery and water. On the nineteenth day, panchgavya mixture is ready for use.

Results and conclusion

In present studies the maximum plant height, number of branches, fresh and dry leaf weight per plant, fresh and dry foliage weight per plant and estimated fresh and dry foliage yield was recorded in the Panchgavya followed by jeevamrit as compared to control. Maximum plant height, number of shoots, fresh leaf weight per plant, dry leaf weight per plant, fresh foliage weight per plant, dry foliage weight per plant, estimated fresh and dry foliage yield was observed in second harvesting (H_2: 70-80 days after first harvest) as compared to first harvesting (H_1:50-60 days after transplanting). Treatments of different organic manures were found to have statistically significant impact on fresh leaf weight per plant. Maintaining soil fertility and use of plant nutrients in sufficient and balanced amounts is one of the key factors in increasing crop yield. Nitrogen plays a vital role in growth processes as it is an integral part of chlorophyll, protein and nucleic acid (Dharaiya *et al.,* 2018).

References

Dharaiya BK, Asodariya KB, Vaghela TD and Baladaniya BK. 2018. Effect of nutrient management on quality parameter, nutrient uptake, soil fertility and economics of Rabi sweet corn (*Zea mays* L. var. *saccharata* sturt). *International Journal of Chemical Studies* 6(3): 2101-2104.

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Response of Pea (*Pisum sativum* L.) to natural farming practices under high density apple-based agroforestry system

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Keywords: Natural Farming, Agroforestry, Jeevamrit, Ghanjeevamrit

Introduction

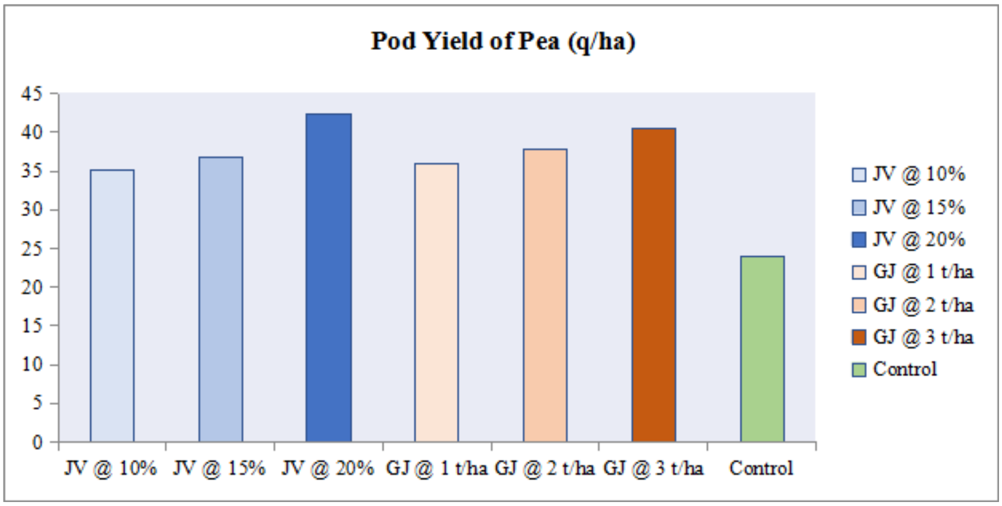
India, one of the world's oldest agrarian civilizations, derives about 20% of its GDP from agriculture and supports 58% of its population through this sector. The Green Revolution made India a food surplus nation but also brought environmental and health issues from the use of synthetic chemicals. This has prompted a shift towards non-chemical agriculture to restore ecological balance (Reddy and Menon, 2021). Natural Farming, a chemical-free method inspired by Japanese farmer Masanobu Fukuoka (Rosset and Martinez-Torres, 2012), was introduced in India by Subhash Palekar in 2006. Natural Farming aims to balance ecosystems and reduce production costs.Integrating Natural Farming with agroforestry by combining crops, trees, and livestock promises to enhance sustainability. In Himachal Pradesh, where apple-based agroforestry is common, this approach offers opportunities to grow nutrient-rich crops like pea and other vegetable crops. This study examines the effects of Natural Farming on pea growth within apple-based agroforestry system during the rabi season of 2022-2023.

Material and methods

The experiment was conducted at farmer field in Kandaghat region of Solan (HP) during October, 2022−March, 2023. The study consisted of an agri-horticulture system comprising of two structural components, viz., apple (*Malus × domestica* Borkh.) as tree component, pea var. arkel (*Pisum sativum* L.) and coriander (*Coriandrum sativum* L.) as vegetable crops. The coriander is intercropped between the pea rows. The experiment was designed as a RBD Factorial with additional treatment including two factors: Jeevamrit (10%, 15%, 20%) and Ghanjeevamrit (1 t ha^{-1}, 2 t ha^{-1}, 3 t ha^{-1}), each with three concentrations and a control (no manure) as an additional treatment. The effect of different natural farming treatments on growth and yield parameters of pea, soil properties and economics of agroforestry system were studied.

Results and conclusion

The highest plant height, leaf area index, shoot dry weight, number of pods, pod length, pod diameter, grains per pod, 100 grains weight, shelling percentage, pod yield per hectare, intercrop yield, and crop equivalent yield were exhibited by the application of Jeevamrit @ 20% and Ghanjevamrit @ 3 t/ha. These treatments also improved soil physico-chemical properties and biological properties. The economic parameters including gross returns, net returns, and B:Cratio were highest under Ghanjeevamrit @ 3 t ha^{-1} and Jeevamrit @ 20% concentration. The study concludes that natural farming practices significantly affect the crop growth and yield, while the intercropping of coriander between pea rows could also increase the productivity and efficient land use. Therefore, the use of Natural Farming practices holds promising potential for commercial cultivation of pea under apple-based agroforestry system in mid-hill conditions.



Refrences

Reddy AVV and Menon S. 2021. A study on the role of Jeevamruth in natural farming: A replacement for synthetic fertilizers. *Journal of Emerging Technologies and Innovative Research* 8(5): 89-90

Rosset PM and Martinez-Torres ME. 2012. Rural social movements and agroecology: Context, theory, and processes. *Ecology and Society* 17*(*3): 17.

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Effect of fermented organic manure on fruit quality and yield contributing traits of apple cv. Red Cap Valtod

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***Keywords**:* Organic manure, fruit quality, yield, sustainability

Introduction

Fermented Organic Manure (FOM) is a by-product of operational/compressed biogas plants, being used as it contains high contents of essential nutrient elements and beneficial microbes. It promotes overall plant growth, root development as well as stimulates the harmonic process of the plant, which leads to the complete development of the plants, fruits, and flowers. Additionally, converting biomass into manures offers an alternative method of bio-waste management with potential applications in agriculture (Huang et al., 2021). Sustainable development relies on maintaining good soil health which must be protected, conserved and improved. Keeping in view, the research was planned to evaluate the effect of conjoint use of fermented organic manure and chemical fertilizers on quality and yield contributing traits of apple.

Material and methods

The present studies on evaluation of the effect of conjoint use of fermented organic manure and chemical fertilizers on productivity parameters of apple cv. Red Cap Valtod was carried out during 2024-25 at Department of Soil Science and Water Management, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, (HP). Fertilizer inputs in the trial included were FOM and Conventional fertilizers. FOM was applied at 100, 70, 60, 50, 40, 30, 20 and 10 per cent on N equivalence basis along with chemical fertilizers at 100, 90, 80, 70, 60, 50, 40 and 30 per cent of RDF-NPK were evaluated in 10 treatment combinations. The experiment was laid in Randomized Block Design and replicated thrice. Observations on yield contributing characteristics and quality parameters were assessed.

Results and conclusion

Maximum number of flower, fruit set and fruit yield registered with application of 40 per cent RDF-NPK + 60% NPK through FOM with corresponding increase of 64, 45 and 88 per cent, respectively over absolute control. The treatment application of 40 reduced chemical fertilizers along with 60% of FOM also exhibited maximum leaf area (50.05 cm^2). The combination also found superior to improve fruit quality parameters in terms of total soluble solids (15.4 ˚B), firmness (5.94 kg cm^{-2}), fruit weight (147.72 g) and ascorbic acid (11.47%) compared to other treatments. Sugars content of fruit samples per cent in terms of total sugars, reducing sugars and non-reducing sugars showed a steady rise in concentration i.e. 8.13, 5.61 and 2.39 per cent, respectively. It can be concluded that the application of FOM in combination with chemical fertilizers registered a significant increase in fruit quality and yield contributing traits over the control treatment and thus, the integration of fermented organic manure along with chemical fertilizers or using it alone is advantageous for long term soil fertility for sustainable production of apple.

References

Huang S, Zheng X, Luo L, Ni Y, Yao L, and Ni W. 2021. Biostimulants in bioconversion compost of organic waste: A novel booster in sustainable agriculture. *Journal of Cleaner Production*. 319, 128704.

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Adaptive agroecological practices for sustaining rainfed agriculture in Himachal Pradesh

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Keywords: Rainfed ecosystems, Climate change, Smallholder farmers, Resilience

Introduction

Rainfed ecosystems in India, particularly in Himachal Pradesh, are increasingly vulnerable to water scarcity, land degradation, and declining agricultural productivity—challenges that are further intensified by climate change. Smallholder farmers, who rely heavily on rainfed agriculture, are especially at risk due to their limited adaptive capacity to cope with erratic weather patterns and extreme climatic events. The adoption of agroecological practices has emerged as a critical strategy to enhance climate resilience. These practices, which emphasize the sustainable management of essential resources such as soil, water, and biodiversity, are tailored to local conditions and incorporate both reactive and proactive measures. By integrating ecological principles into farming systems, agroecology not only mitigates the adverse effects of climate change but also improves resource use efficiency and supports sustainable agricultural productivity, thereby safeguarding the livelihoods of vulnerable farming communities in these regions.

Material and methods

Multistage random sampling technique was employed. In the first stage, three blocks were selected randomly out of the 10 blocks of the district. Three blocks were Rohru, Jubal Kotkhai and Theog. In the second stage of sampling, a list of the panchayat in each selected block was obtained and in the third stage, four panchayatsfrom each block were selected randomly and the list of households was prepared with the help of Patwari. In the final stage of sampling, twelve farmers using an equal allocation method were selected from each panchayat constituting a sample size of 144 in Shimla district. All the selected respondents were further divided into three classes according to the size of their land holdings, viz., marginal (<1 ha), small (1-2 ha), and medium (2-4 ha). Among the total 144 farmers, marginal farmers, who own less than 1 hectare, constitute the largest group with 60 farmers (41.67%) and an average landholding of 0.72 hectares. Small farmers, with landholdings between 1 to 2 hectares, constitute 50 farmers (34.72%) and have an average landholding of 1.49 hectares. Semi-medium farmers, holding between 2 to 4 hectares, represent the smallest group with 34 farmers (23.61%) and the largest average landholding of 2.15 hectares.

Results and conclusion

Adaptive agroecological practices for the climate change practiced by the sampled farmers are presented in Table 1. The data reveals that the adoption of various agricultural practices generally increases with farm size, with semi-medium farmers showing the highest adoption rates across most practices, followed by small and marginal farmers. Practices such as mulching, rainwater harvesting, and improved crop varieties were widely adopted by semi-medium farmers. Conversely, practices like early maturing and drought-resistant crops see lower adoption, particularly among marginal farmers, likely due to limited resources or higher perceived risksas noted by Umar (2024). This trend suggests that larger farmers have better access to resources, technology, and information, enabling them to adopt a broader range of sustainable and productivity-enhancing practices.

Table 1: Adoption of adaptive agroecological practices for climate change among different farmer categories

Farmer Category (FC)	Marginal (%)		Small (%)		Semi medium (%)	
	Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Minimum tillage system (zero/minimum)	31.67	68.33	42.00	58.00	58.82	41.18
Mulching	53.33	46.67	66.00	34.00	70.59	29.41
Agroforestry (Agri+Horti)	41.67	58.33	64.00	36.00	61.76	38.24
Rainwater Harvesting Tanks	40.00	60.00	54.00	46.00	73.53	26.47
Drip Irrigation	30.00	70.00	44.00	56.00	61.76	38.24
Sprinkler	45.00	55.00	48.00	52.00	55.88	44.12
Crop diversification	58.33	41.67	62.00	38.00	67.65	32.35
Improved crop varieties	51.67	48.33	56.00	44.00	76.47	23.53
Plant early maturing crops	26.67	73.33	32.00	68.00	38.24	61.76
Plant drought-resistant crops	28.33	71.67	34.00	66.00	50.00	50.00
Crop Insurance	40.00	60.00	52.00	48.00	61.76	38.24
Soil Test	35.00	65.00	40.00	60.00	50.00	50.00
Compost and FYM	40.00	60.00	56.00	44.00	64.71	35.29
Improved livestock feed and feeding practices	33.33	66.67	56.00	44.00	61.76	38.24
Early-warning weather information	45.00	55.00	58.00	42.00	67.65	32.35

References

Begum MEA, Rashid MA, Hossain MI, Hossain MA, Rashid MH, Shahadat MK, and Mainuddin M 2024. Farmers' choices and factors driving adoption of climate change adaptation strategies in saline coastal area of Bangladesh. *African Journal of Science, Technology, Innovation and Development* 16(1): 113-127.

Umar MB. 2024. Climate Change Awareness, Perception, and Adaptation Strategies for Small and Marginal Farmers in Yobe State, Nigeria. In *Sustainability of Natural Resources* (pp. 148-163). CRC Press.

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Evaluation of natural farming on production and economics of rice–potato cropping system

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Introduction

Conventional agriculture practices arehighly dependent on greater inputs whereas, natural farming is a chemical-free farming system with on-farm resource optimization. Rice-potato cropping system is important for generating income and produce more food per unit of land to meet the rapidly growing population. Nutrient management on cropping system basis is more efficient and judicious than sole crop basis, because the residual effect of fertilizers applied to one crop are exploited by the succeeding crop (Singh *et al.* 2022). Mulch is a material placed on or spread over the soil surface to protect the soil from erosion, conserve soil moisture and suppress weed growth. Therefore, the present investigation was conducted to evaluate natural farming with modern practices in rice-potato cropping system under Gwalior region of Madhya Pradesh.

Material and methods

The experimental soil was silty-clayloam in texture, with neutral pH. The experimental design was a randomised block design with three replications for rice-potato cropping system. Treatments consisted of two factors as mulch and nutrient management practices. The details of mulch and nutrient management practices are Mulches – 02 (No mulch and Paddy straw mulch @5 t/ha), Nutrient management practices – 04 (100% RDF (NPK), Compost @25 t/ha + Azotobacter @1.25 litre/ha + PSB @1.25 litre/ha + Jeevamrut @500 litre/ha, FYM @25 t/ha + Jeevamrut @500 litre/ha and Control). Rice variety "Sharbati" and potato variety "Kufri Chandramukhi" were grown as test crop. Both the crops were grown as per recommended package of practices. The organic manures and bio-fertilizers were applied in the experimental plots before sowing as per the treatments and Jeevamrut was applied as foliar application at weekly intervals after 30 days after sowing (DAS) in rice crop and 25 DAP in potato crop.Tuber yield was multiplied with market sailing rate (rice inorganic @ Rs. 23.9/kg,rice organic @ Rs. 35.8/kg, potato inorganic @ Rs. 10/kg and potato organic @ Rs. 15/kg) to get gross return.

Results and conclusion

Application of paddy straw mulch did not show any significant effect on rice grain and straw yields. There was significant effect of nutrient application on rice yield. Highest Rice grain yield of 2827 kg/ha was recorded with 100% RDF NPK which was followed by FYM @ 25 t/ha + Jeevamrut @ 500 litre/ha (2529 kg/ha). Interaction of mulching x nutrient application was found to be significant which was highest (2840 kg/ha) with no mulch x 100%RDF NPK. There was significant effect of paddy straw mulch on haulm yield of potato. Highest fresh harm yield (90.2 q/ha) was recorded with mulching which was significantly higher than no mulching treatment. Highest haulm yield (100.1 q/ha) was recorded with 100% RDF NPK which was significantly higher than all other treatments. Interaction of straw mulch and nutrient management practices on haulm yield was found to be significant and highest haulm yield (110.1 q/ha) was recorded with mulching x 100% RDF NPK.Highest total tuber yield (216.3 q/ha) was recorded with mulching treatment which was significantly higher than no mulching treatment. Highest organic carbon content (0.34%) was recorded with paddy straw mulch which was significantly higher than no mulch treatment. Highest organic carbon content 0.4% was recorded with FYM @ 25 t/ha + Jeevamrut @ 500 litre/ha which was significantly higher than 100% RDF NPK. Interaction of mulching x nutrient application was found to be non- significant. It is concluded that there was 10.5% reduction in rice yield and 7.74% reduction in potato tuber yield under FYM @ 25t/ha + Jeevamrut @ 500 litre/ha (natural farming) over 100% RDF NPK. It can be compensated by 1.5 times enhancing sale rate being chemical free. There was 8.8% increase in soil organic carbon after three years of experimentation.

Table1: Effect of mulch and natural farming on production and economics of rice-potato sequence

Treatments	Rice yield (kg/ha)		Potato yield (q/ha)		REY*(q /ha) of system	Economics (Rs. /ha) of sequence			OC (%)
	Grain	Straw	Haulm	Tuber		Cost of cultivation	Net return	B:C	
A. Mulches									
No mulch	2,352	2,943	60.6	200.6	107.2	211,455	1,52,302	1.71	0.31
Paddy straw mulch @ 5 t/ha	2,326	3,008	90.2	216.3	114.0	214,655	1,68,165	1.78	0.34
SEm±	26.8	24	0.8	2.0	0.8	81	1,258	0.01	0.004
CD (P=0.05)	NS	NS	5.3	13.3	5.4	531	8,239	0.06	0.012
B. Nutrient management									
100% RDF (NPK)	2,827	3875	100.1	232.5	125.6	210,123	1,22,834	1.57	0.29
Decomposed crop residue + natural farming	2,307	2806	76.2	209.0	110.5	223,443	1,81,204	1.81	0.37
FYM @25 t/ha + natural farming	2,529	3059	67.1	214.5	115.0	223,443	1,98,108	1.88	0.40
Control	1,692	2162	58.2	177.9	91.4	195,210	1,38,787	1.71	0.24
SEm±	56	44	1.3	2.5	1.3	1,641	3,793	0.02	0.006
CD (P=0.05)	174	138	4.1	7.7	4.1	5,112	11,817	0.07	0.017
Interaction mulching x Nutrient management									
SEm±	54	49	1.6	5.1	1.7	162	2,515	0.02	0.008
CD (P=0.05)	74	NS	7.1	15.9	7.1	NS	17,970	NS	0.02

**REY-Rice equivalent yield (q/ha)*

References

Singh V, Sasode DS, Singh SP, Patel R, Sharma J, Bagri PK, Bagri US, Sahu MP, MishraY K, Malgaya G and Parmar B. 2023. Interactive response of organic mulch and different nutrient sources on productivity and profitability of rice - potato cropping system. *Agricultural Mechanization in Asia* 54(10): 16071-79.

Singh V, Singh SP, Sasode DS, Joshi E, Sharma SK, Patel R, Sadawarti MJ, Rawal S and Dua VK. 2022. Effect of paddy straw mulch and different nutrient sources on yield and economics of rice - potato sequence. *The Pharma Innovation Journal* 11(10): 383-387.

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Impact of bio-organic nutrients on yield and quality attributes of tomato

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Keywords: Balanced diet, Nutrition, Sustainable**,** Tomato

Introduction

Tomato is the largest grown vegetable crop and is known as a protective food. India is the second largest producer of tomato after China with an area of 864 thousand hectares and annual production of 20.336 million tonnes (NHB, 2022). It is important commercial and dietary vegetable crop after potato and sweat potato. Tomato, and its derivatives have not only a high nutritional value but also antioxidant, anti-inflammatory and anticancer properties. Additionally, they are essential for a healthy and balanced diet due to their functional compounds, such as lycopene, vitamins, minerals, and proteins. For enhancing high yield in vegetable crops excessive amounts of inorganic fertilizers are applied and these chemical fertilizers cause harmful effects on environment, human and animal health. Crop production also become uneconomical livelihood for small and marginal farmers because of the over use of expensive commercial fertilizers. Therefore, bioorganic nutrient management is one of the most important factors for sustainable production and also for enhancing nutritional content. Additionally, given their wide range of uses and benefits, the organic cultivation of tomatoes holds significant promise in both domestic and export markets.

Material and methods

The experiment was carried out at Regional Horticultural Research and Training Station, Jachh, Kangra, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during 2022-2023 and 2023-2024. Experiment comprised of eleven treatments which were combination of different bioorganic nutrient sources (FYM, Biofertilizers and natural farming components) and laid out in Randomized Block Design with three replications. Each plot size was 3.6 m × 1.8 m and transplanting weredone at the spacing of 90 cm × 30 cm. The tomato (cv Solan Lalima) was grown as the main crop, while French bean (cv Falguni) was grown as intercrop as per treatment combinations.The observations were recorded on following characters: Crop equivalent yield (q/ha), Total soluble solids (˚Brix), Ascorbic acid (mg/100 g fresh weight), Lycopene content (mg per 100 g of fruit weight) and Phenol content(GAE mg/100ml).

Results and conclusion

On the basis of two-year experiment**,** treatment T_7 (seed/ Seedling treatment with *Beejamrit* + *Ghanjivamrit* (1t/ha) as basal dose at the time of field preparation + *Jeevamrit* @ 10% at 14 days interval) was found superior for yield (359.88q/ha) and most of the quality (TSS- 4.09 ºB, Lycopene- 2.68mg and Phenol content- 7.09mg) characters followed by T_4 and T_6 whereas for ascorbic acid treatment T_4(Farmer Practice + Jeevamrit @ 5% at 21 days interval) was recorded highest. Hence, it can be concluded that French bean can be intercropped with tomato under natural farming practices for getting more number of crops per unit area along with higher yield and also improves the nutritional quality of tomato.

Table 1: Effect of different nutrient sources on yield and quality attributes of tomato

Treatments		CEY (q/ha)	Ascorbic acid (mg/100g)	Lycopene (mg/100 g)
T_1	Absolute control	192.66	21.28	2.46
T_2	Farmer Practice (250q/ha)	276.48	23.73	2.53
T_3	Farmer Practice + Biofertilizer (*Azotobacter*)	318.20	26.69	2.62
T_4	Farmer Practice + *Jeevamrit* @ 5%	341.23	30.64	2.67
T_5	*Jeevamrit* @ 5% at 21 days interval	243.65	23.54	2.53
T_6	*Beejamrit* + *Ghanjivamrit* (1t/ha) + *Jeevamrit* @ 5% + French bean	350.52 (47.13)	29.91	2.67
T_7	*Beejamrit* + *Ghanjivamrit* (1t/ha) + *Jeevamrit* @ 10% + French bean	359.88 (48.89)	30.51	2.68
T_8	*Beejamrit* + *Ghanjivamrit* (1t/ha) + *Jeevamrit* @ 5% + French bean	326.84 (45.43)	29.65	2.61
T_9	*Beejamrit* + *Ghanjivamrit* (1t/ha) + *Jeevamrit* @ 10% + French bean	333.67 (44.26)	29.48	2.62
T_{10}	*Ghanjivamrit* (1t/ha) as basal dose at the time of field preparation +*Jeevamrit* @ 5% + French bean	347.10 (47.06)	29.68	2.65
T_{11}	*Ghanjivamrit* (1t/ha) +*Jeevamrit* @ 5% + French bean	321.39 (43.68)	29.44	2.60
	Mean	310.15	27.69	2.60
	$CD_{0.05}$	-	0.85	0.08

Figures in parentheses are total yield (q/ha) of French bean.

References

Gao F, Li H, Mu X, Gao H, Zhang Y, Li R, Cao K and YL. 2023. Effects of organic fertilizers application on tomato yield and quality: A meta-analysis. *Applied Sciences* 13: 2184.

NHB 2022. Area and production of tomato in India. National Horticulture Board, Ministry of Agriculture & Farmers Welfare. 2022-23 (2nd Adv. Estimate).

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Impact of bio-organic nutrients on sustainable production of pea

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Keywords: FYM, *Jeevamrit*, Nutrients, Pea, Sustainable

Introduction

Pea (Pisum sativum L.), a member of "Fabaceae" family and is one of the most important grain legumes as it is extensively used for both human nutrition and livestock feed. Himachal Pradesh is 5th largest pea producing state of India with area coverage of 21.72 thousand hectares and annual production of 292.85 thousand metric tonnes (NHB, 2022-23). For the effective cultivation of legume vegetables, appropriate quantities of nutrients are essential otherwise their growth and development can be affected by various physiological symptoms. For enhancing high yield in vegetable crops excessive amount of inorganic fertilizers are applied, but due to heavy and continues use of inorganic fertilizer soil fertility and crop productivity both are deteriorates.Therefore, nutrient management is one of the most important factors for sustainable production.

Material and methods

The experiment was carried out at Regional Horticultural Research and Training Station, Jachh, Kangra, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during 2021-2022 and 2022-2023. Experiment comprised of eleven treatments in which different combination of FYM, bio fertilizer and natural farming components were used and laid out in Randomized Block Design with three replications. Each plot size was 3.6 m × 1.8 m and seeds were sown at the spacing of 60 cm × 7.5 cm. Pea (cv. Pusa Pragati) was grown as the main crop, while, spinach (cv Pusa Harit) was grown as intercrop as per treatment combinations.

Table 1: Effect of different nutrient sources on growth and yield parameters of pea

Treatment		PY (q/ha)	CEY (q/ha)	NI (Rs./ha)	B:C
T_1	Absolute Control	53.05	53.05	152765	2.18
T_2	Farmer Practice (250q/ha)	74.41	74.41	166885	1.34
T_3	Farmer Practice + Biofertilizer (*Azotobacter*)	87.85	87.85	217165	1.73
T_4	Farmer Practice + *Jeevamrit* @ 5%	82.79	82.79	184400	1.32
T_5	*Jeevamrit* @ 5%	63.43	63.43	168040	1.96
T_6	*Beejamrit* + *Ghanjivamrit* (1t/ha) + *Jeevamrit* @ 5% + French bean	76.24 (25.65)*	95.47	262585	2.20
T_7	*Beejamrit* + *Ghanjivamrit* (1t/ha) + *Jeevamrit* @ 10% + French bean	78.96 (30.37)	101.74	282565	2.27
T_8	*Beejamrit* + *Ghanjivamrit* (1t/ha) + *Jeevamrit* @ 5% + French bean	74.89 (22.96)	92.11	252460	2.18
T_9	*Beejamrit* + *Ghanjivamrit* (1t/ha) + *Jeevamrit* @ 10% + French bean	75.83 (23.88)	93.75	254895	2.12
T_{10}	*Ghanjivamrit* (1t/ha) +*Jeevamrit* @ 5% + French bean	77.48 (24.75)	96.04	266065	2.25
T_{11}	*Ghanjivamrit* (1t/ha) +*Jeevamrit* @ 5% + French bean	74.92 (22.03)	91.44	250980	2.19
	Mean	74.53	84.73		
	$CD_{0.05}$	5.80			

Figures in parentheses are total yield of spinach; PY, Pod yield, CEY, Crop equivalent yield, NI, Net income

Results and conclusion

On the basis of two year study**,** treatment T_3 [Farmer Practice + Biofertilizers (RZB)] was found superior for most of growth and yield contributing characters followed by T_4 and T_7 whereas highest equivalent yield (101.74 q/ha), net income (282565) and B:C ratio (2.27) was observed in treatment T_7 (seed/ Seedling treatment with *Beejamrit* + *Ghanjivamrit* (1t/ha) as basal dose at the time of field preparation + *Jeevamrit@* 10% at 14 days interval) in which spinach cv. *Pusa Harit* was inter cropped. Thus, it can be concluded that spinach can be inter cropped with pea under natural farming practices for getting more number of crops per unit area along with higher economic returns.

References

NHB. 2022. Indian Horticulture Database. National Horticulture Board. Haryana 1-3p.

Thakur V, Sharma P, Kumar P, Sharma P, Bhat SA, Sharma S, Rehan and Thakur S. 2024. Quantifying the impact of fermented liquid bio formulations, bio fertilizers and organic amendments on horticultural and soil nutrient traits of garden pea (*Pisum sativum* L.) *International Journal of Recycling Organic Waste in Agriculture* 13: 1-17

ESFS-NF/APCR2024/1026

Biogenic K fertilization modulates yield and quality attributes of apple

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Keywords: Biogenic nano K, Potash derived from molasses, fruit quality

Introduction

Apple (*Malus* x *domestica* Borkh.) is one of the prime fruit crops grown in temperate regions of the world. Commercial cultivation of apple extended between 31.07 °N and 77.44 °E (Palmer et al., 2003). Potassium nutrition plays an indispensable role in growth and development of fruit crops. Application of chemically processed fertilizer sources as murate of potash releases K^+ at fast rate in soil, and thereby results in huge loss due to leaching and its fixation with clay particles causes in nutrient imbalance. However, very small fraction of K^+ is bio-available to plants. In modern time, slow release fertilizers have gained quantum in production system including biogenic and mineral fertilizers that are more readily absorbed by plants. Nano bio-fertilizers are based on organic matter and are made from minimally processed materials, such as plant and animal waste and use of nano bio-fertilizers can reduce environmental damage and contribute to agricultural sustainability. In the current study, the biogenic nano K and mineral fertilizers were assessed to improve qualitative traits of apple.

Materials and method

Apple cv. Jeromine (3 years old) was maintained in high density, spaced at 2.5×1.5 m apart. K nutrient sources including, biogenic nano K, Potash derived from molasses (PDM) along with mineral fertilizer Organo dehydrate polyhalite (ODP) were supplemented in 8 different combinations along with a control. Nano K at 0.25%+ 100% of K through PDM (T1), Nano K at 0.25%+ 80% of K through PDM (T2), Nano K at 0.50%+ 100% of K through PDM (T3), Nano K at 0.50%+ 80% of K through PDM (T4), Nano K at 0.25%+ 100% of K through ODP (T5), Nano K at 0.25%+ 80% of K through ODP (T6), Nano K at 0.50%+ 100% of K through ODP (T7), Nano K at 0.50%+ 80% of K through ODP (T8). Standard methods were followed to determine the quality parameters of apple fruit samples (A.O.A.C., 1980).

Results and conclusion

The data depicted that application of nano K @ 0.25 per cent+100 per cent K ODP exhibited maximum spur density, fruit set and fruit yield with 72.22, 14.48 and 76.84 per cent increase over the control. TSS, total sugars and anthocyanins content was also increased by 1.2, 1.3 and 1.5 times through nano K @ 0.25 per cent+100 per cent K ODP. Soil application mineral fertilizer in combination with foliar application of biogenic nano potassium had positive and significant effect on yield as well as physiochemical characteristics of apple under HDP. Among the different treatment combinations, nano K @ 0.25 per cent+100 per cent K ODP proved to be most effective treatment for obtaining higher yields of better-quality fruits.

Table 1: Effect of biogenic nano K and mineral fertilizers on yield and quality of apple

Treatment	Spur density	Fruit set (%)	Yield (kg/tree)	Fruit weight (g)	Firmness (kg/cm^2)	TSS °B	Sugars (%)	Anthocyanins (mg/100g)
T_1	0.25	48.65	2.37	184.87	6.06	10.20	9.03	18.16
T_2	0.20	46.38	3.36	171.42	6.43	9.40	8.11	15.61
T_3	0.19	45.21	2.03	163.95	6.63	8.70	7.43	13.38
T_4	0.25	48.01	2.89	182.66	6.20	9.90	8.43	16.72
T_5	0.31	51.76	3.59	188.11	5.34	10.73	9.25	18.43
T_6	0.21	47.18	2.69	176.38	6.41	9.47	8.26	16.54
T_7	0.19	45.71	2.37	166.45	6.51	9.07	7.91	14.43
T_8	0.28	50.34	3.36	187.35	5.96	10.30	9.12	18.40
T_9	0.18	44.26	2.03	156.15	7.22	8.32	7.09	11.63
CD (0.05)	0.04	1.71	0.50	9.15	0.27	0.52	0.34	0.59

References

AOAC 1980. Official method of analysis of association of analytical chemists, 13th ed. (W. Horowitzed.). Benjamin Franklin Station, Washington, DC, 1018 p.

Palmer JW, Prive JP, Tustin DS. 2003. Temperature. In: Ferree, DC, Warrington, IJ (Eds) Apples: Botany, Production and Uses. Cabi Publishing. Pp. 217-236.

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Effect of incorporation of organic amendments on growth and yield of chilli

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Keywords: Chilli, improved quality, organic amendments, sustainability, yield.

Introduction

Extensive use of industrial fertilizers in agriculture is under debate due to environmental distress and doubts for consumer health. Therefore, possibility for the use of soil micro-organisms as bio-fertilizers or Plant-growth-promoting rhizobacteria (PGPR) and also adoption of natural farming system, are considered as eco-friendly, non-hazardous, non-bulky and economically suitable options. These systems increase the nutrient uptake capacity and maintain the soil fertility. PGPR facilitate the growth and production of vegetable crops by producing phyto-hormones, increasing root growth, nutrient uptake, plant hormone stimulation, suppression of pathogenic activity, and restoration of soil health through the mineralization of organic pollutants and protecting them from various detrimental effects. Thus, PGPR are emerging as organic fertilizers suitable for many plant species, which could reduce chemical fertilizer application while enhancing soil quality and plant yield.

Material and methods

The study was carried out on chilli as pot culture trial with 8 treatments in a Completely Randomized Design and replicated thrice. The effect of incorporation of organic amendments on growth and yield of chilli was evaluated. The treatments comprised of T1: Absolute Control, T2: PGPR, T3: 100% RDN through NPK+ PGPR, T4: 100% RDN through FYM (on N equivalence basis) + PGPR, T5: Natural Farming Practices (jeevamrit + ghanjeevamrit as per recommendations), T6: 75% RDN through NPK+ PGPR. T7: 75% RDN through FYM (on N equivalence basis)+PGPR, T8: 100% RDN+ PGPR.

Results and conclusion

Application of 75% RD through PGPR consortia+ chemical fertilizers registered maximum number of flower, fruit set and number of fruits per plant. Similarly, the maximum number of branches per plant (7.67) was also observed in the treatment (T_6) along with the maximum number of fruits (88.00). The fruit length (9.33 cm) and fruit breadth (1.20 cm) was also maximum over the other treatments. This treatment also recorded the maximum plant height (96.00 cm), followed by the treatment T_3 (90.67 cm) which comprised of 100% RDN through NPK + PGPR. The variation in ascorbic acid content of chilli at green stage was from 80.67 mg per 100 g to 120.33 mg per 100 g with maximum value being in treatment 75% RDN through NPK + PGPR.

It is concluded that the incorporation of organic amendments registered a significant increase in plant growth parameters, flowering and fruit set over the control treatment. It is thus inferred that this sustainable approach of incorporating organic amendments, especially PGPRs along with chemical fertilizers or using it alone is advantageous in going towards the sustainable farming and reducing the dependence and injudicious use of chemical fertilizers.

Table 1: Effect of growth regulators, fertilizers and natural farming practices on growth and yield of chilli

Treatment	Number of branches/ plant	Fruit length (cm)	Fruit breadth (cm)	Number of fruits / plant (g)	Plant height (cm)	Yield per pot (g)	Ascorbic acid content (mg/100g)
T_1	2.67	3.67	0.43	45.67	50.67	66.67	80.67
T_2	3.67	4.33	0.60	55.33	70.00	97.67	88.67
T_3	6.33	8.00	0.96	85.00	90.67	182.00	116.33
T_4	5.00	5.33	0.92	64.33	79.67	113.67	98.00
T_5	4.67	4.67	0.73	58.67	73.33	99.67	94.33
T_6	7.67	9.33	1.20	88.00	96.00	183.00	120.33
T_7	5.33	5.33	0.79	68.00	77.00	116.00	103.33
T_8	5.00	5.00	0.75	59.00	77.00	121.33	103.67

References

Hasan A, Tabassum B, Hashim M and Nagma K. 2024. Role of plant growth promoting rhizobacteria (PGPR) as a plant growth enhancer for sustainable agriculture: A Review. *Bacteria. 3*(2), 59-75

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Impact of plant based potassium formulations on yield contributing and biochemical characteristics of apple

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Keywords: Foliar feeding, Biostimulants, Fruit color

Introduction

Apple is the most premier temperate fruit of north-west Himalayas of India which accounts for over 90 per cent of the nation's total apple production (Sharma, 2018). In recent times, the researchers have focused to increase both productivity and quality of fruits along with reduced fertilizer costs and or environmental pollution. The improvement of the skin coloration and the overall nutritional value of fruits are the most important attributes for apple consumers including colour intensity which is related to biosynthesis of anthocyanins and its accumulation in skin tissue. Potassium is a crucial mineral nutrient for growth and development besides enhancing fruit size and quality. Biostimulants have been found to modulate and improve final coloration of different fruit crops. Bio stimulants serve as an environment friendly product in sustainable horticulture, which help to reduce the consumption of synthetic fertilizers. In addition, bio stimulants especially, protein hydrolysate and phosphites can be a vital approach to enhance nutrient availability, absorption and efficiency. The objective of the study is to expand further use of bio-organic and eco-friendly practices for sustainable and bio-fortified crop production.

Material and methods

Biostimulants namely, plant based protein hydrolysate (PH) and K-phosphite (K_p) were applied as foliar (0.5, 1 and 1.5 %) at pea stage and one month before harvesting on apple cv. Gala Schniga Schnico. Total eleven treatment combinations were included, PH (0.5%) + K-Phosphite (0.5%) (T_1), PH (0.5%) + K-Phosphite (1%) (T_2), PH (0.5%) + K-Phosphite (1.5%) (T_3), PH (1%) + K-Phosphite (0.5%) (T_4), PH (1%) + K-Phosphite (1%) (T_5), PH (1%) + K-Phosphite (1.5%) (T_6), PH (1.5%) + K-Phosphite (0.5%) (T_7), PH (1.5%) + K-Phosphite (1%) (T_8), PH (1.5%) + K-Phosphite (1.5%) (T_9), 100% RDF-NPK (35:17.5:35) (T_{10}) along with control (T_{11}). Biochemical analyses of fruit samples were determined according to the standard methods.

Results and conclusion

Foliar fertilization with Protein hydrolysate (PH) and K- phosphite (K_p) significantly affected the yield and biochemical traits of apple. Maximum fruit set and fruit yield was exhibited in foliar feeding of PH (1.5 %) + K-Phosphite (1%). This superior treatment also recorded improved quality traits in terms of fruit weight, fruit TSS, total phenols and anthocyanins content in fruit samples. The elevated final red colour of apples might be endorsed to a modulation of the metabolism of plant endogenous growth regulators obtained with the application of plant base bio-stimulant formulations which led to anthocyanins biosynthesis and further its accumulation in fruit skin prior to harvest.

Biostimulants mode of action involves the up-regulation of a number of genes responsible for the secondary metabolism of plants leading to the synthesis and accumulation of phenols. These biostimulants had a positive effect in promoting the secondary metabolism of treated plants, leading to an improvement of fruit quality and appearance.

Table 1: Foliar application of PH and K-phosphite affected bio-chemical traits of apple

Treatment	Fruit set (%)	Fruit yield (kg/tree)	Fruit weight (g)	TSS (°B)	Total phenols (mg/100 g)	Anthocyanins (mg/100 g)
T_1	22.64	3.63	119.94	12.13	59.22	7.95
T_2	24.83	4.20	120.83	12.50	61.48	8.08
T_3	27.03	3.37	121.97	12.17	65.33	8.82
T_4	29.23	3.82	122.62	13.03	73.41	8.33
T_5	28.71	4.17	121.92	12.40	65.29	7.88
T_6	24.42	4.21	123.81	13.20	71.36	8.68
T_7	30.63	4.57	130.41	13.27	77.92	8.79
T_8	35.49	6.40	134.81	13.67	83.33	9.20
T_9	31.59	5.92	129.92	12.80	80.70	8.94
T_{10}	23.03	3.45	119.96	11.93	60.57	7.50
T_{11}	20.40	3.06	116.73	11.73	56.12	7.15
CD (0.05)	5.92	1.16	8.36	0.96	7.22	0.88

References

Colla G, Nardi S, Cardarelli M, Ertani A, Lucini L, Canaguier R and Rouphael Y. 2015. Protein hydrolysates as biostimulants in horticulture. *Scientia Horticulturae* 196: 28–38

Sharma SK. 2018. Apple High Density Orcharding: Performance reckoning studies in respect of the agro ecological challenges of Kinnaur. *International Journal of Science and Research* 8(4): 636-643.

ESFS-NF/APCR2024/1029

Comparative assessment of soil chemical properties under SPNF practice and chemical farming

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***Keywords**:* Chemical farming, Nutrient availability, SPNF, Soil Chemical Properties,

Introduction

Natural farming, also referred to as zero budget natural farming, is a breakthrough farming technique. In this farming practice, all the inputs (insecticides, fungicides, and pesticides) are made from natural herbs and locally available inputs. The natural farming is a low input based, climate resilient, and low-cost agricultural method. This excludes the usage of synthetic fertilisers and industrial pesticides. Smallholder farmers in Himachal Pradesh of India are starting to favour it more and more. This study assesses the soil nutrient status under SPNF practices and chemical farming.

Material and methods

The field experiment comprises of four SPNF cropping systems *viz*., Tomato+ Brinjal+ Frenchbean, Cucumber + Okra + Frenchbean, Apple + Soyabean + Urd , Turmeric + Urad which were compared with the chemical farming under sole crops (tomato, cucumber, apple, turmeric). Soil properties such as organic carbon, available macronutrients (N, P, K), micronutrients (Fe, Zn) were analysed as per standard procedure.

Results and conclusion

The study showed that SPNF practice under different cropping system significantly improves the soil chemical properties. Soil pH and EC under SPNF ranged from 7.15-7.80 and 0.176- 0.259 ds m^{-1} where, as under chemical farming pH and EC range from 6.83-7.37 and 0.202- 0.432 ds m^{-1}. Similarly, SPNF Practice significantly improve the soil OC content However available NPK contents were maximum under chemical farming. Highest soil organic content (1.80%) was recorded under SPNF cropping system (Tomato +Brinjal+ Frenchbean) followed by 1.64 per cent in SPNF (Cucumber + Okra + Frenchbean), 1.56 per cent in SPNF (Apple + soybean + Urd) and lowest under SPNF-Tumeric + Urad (1.46%). The medium to high nutrient availability status was recorded under SPNF practices.

These findings highlight the effectiveness of SPNF Practice in boosting soil fertility. Also underscore the potential of sustainable agroecological practices to improve soil fertility and contribute to long-term agricultural resilience.

Table 1: Effect on soil chemical characteristics of different farming systems

S N	Cropping systems	pH (1:2.5)	EC (dsm^{-1})	OC (%)	Available Macro-nutrients ($kg\ ha^{-1}$)		
					N	P	K
1.	SPNF (Tomato+ Brinjal+ Frenchbean)	7.63	0.215	1.80	383.0	34.1	452.0
	Chemical Farming (Tomato)	7.37	0.243	1.56	333.4	38.6	390.4
	t- value	2.820	1.389	3.00784	12.222	33.3595	22.0544
	P- value (<0.05)	0.0239	0.1186	0.019817	0.00013	0.00001	0.000013
2.	SPNF (Cucumber+ Okra+ Frenchbean)	7.80	0.259	1.64	383.0	26.9	262.0
	Chemical Farming (Cucumber)	7.02	0.372	1.15	410.2	32.4	294.0
	t- value	9.8001	4.0916	4.3301	18.4190	31.6954	77.2913
	P- value (<0.05)	0.00030	0.00748	0.00617	0.000026	0.00001	0.00001
3.	SPNF (Apple+ Soyabean+ Urd)	7.44	0.212	1.56	301.0	22.2	358.0
	Chemical Farming (Apple)	7.00	0.432	1.12	338.5	35.5	388.2
	t- value	5.514	3.1053	10.18402	7.3908	4.58803	13.07547
	P- value (<0.05)	0.00263	0.01802	0.000262	0.00089	0.005061	0.000099
4.	SPNF (Turmeric + Urad)	7.15	0.176	1.46	326.0	19.7	191.0
	Chemical Farming (Turmeric)	6.83	0.202	1.02	365.6	23.5	215.2
	t- value	4.6512	3.94	8.62911	9.92	6.11	6.20
	P- value (<0.05)	0.004826	0.00852	0.000496	0.00029	0.001815	0.001725

References

Jackson ML. 1973. *Soil Chemical Analysis.* Prentice Hall of India Pvt. Ltd., New Delhi.

ESFS-NF/APCR2024/1030

Apple Orchard Resilience: Effect of summer pruning on apple under high density plantation

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Keywords: High-density plantation, Return bloom, Productivity

Introduction

In high-density apple orchards, managing vegetative growth is crucial for optimizing fruit production and ensuring long-term sustainability. Summer pruning, conducted during the growing season, influences tree vigour, return bloom, and yield. This study examines the effects of different timings and intensities of summer pruning on apple (*Malus x domestica* Borkh.) under high-density planting, focusing on vegetative growth, return bloom and fruit productivity as key parameters for sustainable orchard management.

Material and methods

Five pruning timings (T) (15, 30, 45, 60 and 75 days after fruit set) and three pruning intensities (B) (keeping 2, 4 and 6 buds) were evaluated. Each treatment was applied to a randomized block design with three replications. Return bloom was assessed in the following spring, fruit productivity and fruit weight were measured at harvest, whereas, tree spread at the end of the growing season.

Results and conclusion

This study evaluated the impact of summer pruning on critical parameters in high-density apple orchards, including tree spread, fruit weight, return bloom, and productivity. Pruning 30 days after fruit set (T_2) resulted in the smallest increase in tree spread, measuring 11.37%, which was statistically comparable to pruning 15 days after fruit set (T_1). Conversely, the highest fruit weight was achieved with pruning 45 days after fruit set (T_3), recording an average weight of 145.30 g. Maximum return bloom was observed with pruning 75 days after fruit set (T_5), while the highest productivity was realized with pruning 45 days after fruit set (T_3), yielding 40.52 MT/ha.

Among bud intensities, the 2-bud intensity (B_1) demonstrated superior performance in return bloom and productivity, indicating its effectiveness. The interaction between pruning timing and intensity revealed that pruning 45 days after fruit set with a 2-bud intensity resulted in the lowest increase in tree spread (7.36%). Fruit weight was maximized with pruning 45 days after fruit set combined with a 6-bud intensity. However, the greatest return bloom and productivity were achieved with pruning 45 days after fruit set combined with a 2-bud intensity. These findings suggest that summer pruning performed 45 days after fruit set with a 2-bud intensity ($T_3 \times B_1$) optimizes tree spread, enhances productivity, and stimulates return bloom in high-density apple orchards.

Table 1: Effects of timing and intensity of summer pruning on plant spread, fruit weight, return bloom, and productivity in apple

Treatment	Tree spread (% increase)	Fruit weight (g)	Return Bloom (no. of flowers/cm^2 of TCSA)	Productivity (MT /Ha)
T_1 (15 Days after fruit set)	14.94(22.44)	130.53	48.82	38.19
T_2(30 Days after fruit set)	11.37(19.47)	131.61	48.02	40.03
T_3 (45 Days after fruit set)	20.59(26.00)	145.30	54.77	40.52
T_4 (60 Days after fruit set)	26.38(30.77)	118.63	50.52	31.99
T_5 (75 Days after fruit set)	16.13(23.04)	121.47	56.54	30.49
B_1 (2 Buds)	11.49(19.04)	123.46	58.99	38.41
B_2 (4 Buds)	18.91(25.46)	128.62	50.80	34.22
B_3 (6 Buds)	23.24(28.54)	136.46	45.41	36.12
C.D $_{(0.05)}$	Time - 3.34 Bud - 2.58	Time - 10.02 Bud -7.76	Time - 1.02 Bud- 0.79	Time - 1.13 Bud - 0.87

References

Atucha A. 2020. Mechanical Summer Pruning in Apples. *Acta Scientiarum Polonorum 15*: 113-121

Lakso AN, Li K T, Piccioni R and Robinson T. 2003. Summer pruning reduces whole-canopy carbon fixation and transpiration in apple trees. *The Journal of Horticultural Science and Biotechnology*: 749-754.

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Quality nursery production of broccoli using bioresource based seed treatments

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Introduction

Use of bioresource based plant protection measures including natural farming concoctions, biocontrol agents, botanicals along with physical measures like hot water treatments are becoming popular amongst farmers because of no use of chemical pesticides in their farms. Broccoli is an important crop in this area and is very sensitive to various diseases of which most of the pathogens are carried through the nursery to the main field. So, the present investigation was aimed to produce a healthy nursery based on seed treatment/ soil application/ foliar sprays of various non chemical, bio resource based component.

Material and methods

The study included two experiments using broccoli cv. Palam Samridhi. In the initial screening the effect of 42 seed priming treatments under various categories comprising of beejamrit @ 5% and 10% each for 30, 45 and 60 mins, formulations of different plant extracts viz., *Allium sativum*, *Melia azedarach*, *Roylea elegans*, *Murraya koenigii* with water @ 5% and 10% and cow urine @ 25%, hot water treatments at 49, 50, 51 and 52°C for durations of 30, 45 and 60 mins and six bioagents viz., *Trichoderma harzianum*, *T. viride, T. atroviride ta001, Bacillus pumilus, B. subtilis and Pseudomonas fluorescens* @ 5% and 10% along with control on seed quality parameters in broccoli. In the second experiment, two best treatment combinations were chosen from each category of various treatments, alongside control the second experiment was laid out under nursery conditions to study the effect of seed treatments, soil application of jeevamrit @10% at 15 days interval and foliar application of saunthastra and buttermilk @ 3% alternatively at weekly interval on seedling quality and health parameters in broccoli.

Results and conclusion

Out of 11 treatments, the maximum value for total emergence (81.00%) was observed in the treatment (T_7) Beejamrit @ 5% for 60 min followed by (T_3) *Trichoderma harzianum* (5%) and (T_6) Drek + cow urine (10%) having total emergence of 78.67% and 78.33% respectively. The maximum speed of germination (24.09), seedling height (21.39 cm) and minimum incidence of damping off (3.00%) was recorded in (T_7) Beejamrit @ 5% for 60 min followed by (T_3) *Trichoderma harzianum* (5%) which had speed of germination of 23.47, seedling height of 20.68 cm and damping off of 3.67%. It can be concluded from the study that seed treatment with (T_7) Beejamrit @ 5% for 60 min and soil application of jeevamrit @10% at 15 days interval and foliar spray of saunthastra and buttermilk @ 3% alternatively at weekly interval significantly improved emergence, growth parameters, vigour of seedlings and reduced damping off in broccoli cv. Palam Samridhi.

Table 1: Effect of seed priming with bioresource based seed treatments on growth parameters and disease incidence (%) in broccoli under nursery conditions

S.N.	Treatments	Total emergence (%)	Speed of germination	Seedling height (cm)	Damping off (%)
T_1	Hot water treatment at 49°C for 30 min	75.67 (8.76)	16.44	15.38	6.33 (2.51)
T_2	Hot water treatment at 49°C for 45 min	77.33 (8.85)	21.21	18.50	4.67 (2.16)
T_3	*Trichoderma harzianum* (5%)	78.67 (8.93)	23.47	20.68	3.67 (1.91)
T_4	*Pseudomonas fluorescens* (5%)	77.67 (8.87)	21.42	19.11	4.33 (2.08)
T_5	Karu + water (25%)	76.33 (8.79)	19.75	16.55	5.67 (2.38)
T_6	Drek + cow urine (10%)	78.33 (8.91)	22.67	19.77	4.00 (2.00)
T_7	Beejamrit @ 5% for 60 min	81.00 (9.06)	24.09	21.39	3.00 (1.72)
T_8	Beejamrit @ 10% for 30 min	76.33 (8.79)	20.37	17.61	5.33 (2.30)
T_9	Control (Untreated)	71.00 (8.49)	15.48	14.99	9.33 (3.05)
$CD_{0.05}$		0.17	0.57	0.91	0.29

Figures in the parentheses are square root transformed

ESFS-NF/APCR2024/1032

Performance of indigenous honeybee, *Apis cerana* under conventional and natural farming conditions in apple

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Keywords: Biodiversity, Conventional farming, Honeybees, Natural farming,

Introduction

Modern agricultural practices have been questioned because of its effect on public health, climate change and biodiversity. Decline in biodiversity leads to losses of ecosystem functions, such as biological pest control and insect pollination (Thompson *et al*., 2014). Among the insect pollinators, honeybees play a vital role in conserving biodiversity. During the past decades and in recent years, decline of honey bees was reported that might be due to intensive use of pesticides, which posed a serious threat to food security and productivity. Pesticides contaminate nectar and pollen which directly effects the overall performance of honeybees. Organic farming increases biodiversity, bee species, abundance and pollination rate (Wintermantel *et al*., 2019). In view of this, a study was planned to evaluate how indigenous honeybee respond to the natural farming practices.

Material and methods

The study was conducted in the farmers field of Shong (natural farming field) and Sungra (conventional farming field) village of Kinnaur District of Himachal Pradesh to evaluate the performance of *Apis cerana* under conventional and natural farming conditions during 2023 in apple bloom. The three queen right colonies of *Apis cerana* similar to one another was introduced in both the fields (conventional and natural farming) at 10 per cent flowering stage of apple. The foraging activity was assessed by counting number of bees/1m2 /5 minute one day before and day 2 after introduction of colonies in conventional and natural farming fields. Total brood area was assessed one day before introduction of colonies of *Apis cerana* in conventional and natural farming fields of apple with the help of measuring scale (cm^2) and on 7^{th}, 14^{th}, 21^{st} and 28^{th} days after introduction.

Results and conclusion

The results showed significant variation in foraging activity of *A cerana* under conventional and natural farming practice on apple bloom. The average foraging activity of *A. cerana* under natural farming practice before the introduction of *A. cerana* colonies found statistically higher (10.78 ± 1.39 bees/m^2/5 min) as compared to conventional farming (7.78 ± 1.71 bees/m^2/5 min). After the introduction of *A. cerana* colonies under both the crop management practices revealed more foraging activity from day 2 to day 6 (15-15.33 bees/m^2/5 min) under natural farming practice, whereas, it was statistically lower ranging from 11.11 to 11.67 bees/m^2/5 min under conventional farming practice. Fruit set was also statistically more (34%) under natural farming practice.

Based on one year preliminary data it is concluded that natural farming practice have positive impact on overall performance of *A.cerana* and fruit set in apple. However, there is need of further investigation for its validation.

Table 1: Effect of conventional and natural farming practice on foraging activity of indigenous honeybees, *Apis cerana* on apple bloom

Crop management practice	Before introduction (pre count)	Day 2 after introduction	Day 4 after introduction	Day 6 after introduction	Fruit set (%)
	Bees/m^2/5 min				
Conventional Farming	7.78±1.71	11.11±2.14	11.33±1.73	11.67±0.88	30.67±1.16
Natural Farming	10.78±1.39	15.00±1.20	15.00±0.33	15.33 ± 1.21	34.00±0.00
t- value	-5.63*	-2.24*	-3.61*	-4.26*	-5.00*
p-value	0.005	0.041	0.023	0.013	0.007

**Significant at P<0.05*

References

Thompson ID, Okabe K, Parrotta JA, Brockerhoff E, Jactel H, Forrester DI and Taki H. 2014. Biodiversity and ecosystem services: Lessons from nature to improve management of planted forests for REDD-plus. *Biodiversity and Conservation* 23(10): 2613–2635.

Wintermantel D, Odoux JF, Chadoef J and Bretagnolle V. 2019. Effects of organic farming on seasonal dynamics of honeybee colony performance. *Journal of Applied Ecology* 56: 1960–1969.

ESFS-NF/APCR2024/1033

Comparative analysis of natural, organic and conventional farming systems for soil health

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Introduction

Excessive use of chemical fertilizers and pesticides following the Green Revolution has led to significant degradation of soil health and environmental quality. In response, the increasing awareness of sustainable agriculture has driven the exploration of alternative farming practices that enhance soil health and crop yield while minimizing environmental impact. Natural farming (NF) is one such approach that emphasizes the use of natural inputs and regenerative practices. A key component of natural farming is *Ghanjeevamrit*, a preparation made from locally sourced organic materials, which improves soil fertility and boosts crop productivity.

Material and methods

The present investigation was carried out during 2023-2024 at the SPNF model farm, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni - Solan, Himachal Pradesh. The experiment consisted of five treatments with different levels of *Ghanjeevamrit*: T_1 (NF without *Ghanjeevamrit*, Control), T_2 (NF with 1.0 Mg ha^{-1} *Ghanjeevamrit*), T_3 (NF with 1.5 Mg ha^{-1} *Ghanjeevamrit*), T_4 (NF with 2.0 Mg ha^{-1} *Ghanjeevamrit*), and T_5 (NF with 2.5 Mg ha^{-1} *Ghanjeevamrit*). Additional treatments included Organic Farming (OF) and Conventional Farming (CF) practices for comparative analysis. The best treatment among T_1-T_5 was compared with OF and CF. Data on soil properties was recorded and compared across NF, OF and CF systems.

Results and conclusion

Highest soil moisture was observed in NF, ranging from 21.10 to 26.83%. Minimum soil temperature was lowest under CF (5.40- 13.70°C) and highest under NF (6.10 -15.50°C). Maximum soil temperature was lowest under NF (9.15 to 18.95°C) and highest under CF (10.70 to 20.90°C). Bulk density was significantly lower in NF (1.37 Mg m^{-3}) and OF (1.34 Mg m^{-3}) compared to CF (1.48 Mg m^{-3}). Maximum water holding capacity was significantly higher in NF (45.97%) and OF (46.31%) compared to CF (41.39%), with no significant difference between NF and OF. Water-stable aggregates (WSA > 0.25 mm) were higher in NF (58.87%) and OF (62.20%) compared to CF (55.46%). Soil organic carbon (SOC) in NF (17.78 g kg^{-1}) was statistically at par with OF (18.75 g kg^{-1}) but significantly higher than CF (14.63 g kg^{-1}).

Similarly, OF had significantly higher SOC than CF (Das et el. 2023). The results indicate that both NF and OF significantly improved soil properties compared to CF, likely due to the reduced reliance on chemical inputs and the enhancement of soil organic matter and microbial activity.

References

Das SK, Kumar A, Yadav A, Laha R and Mishra VK. 2023. Zero budget natural farming practices on yield of crops (Maize + soybean and Pea + coriander) in mid hill of Sikkim Himalayas. *Journal of Agriculture and Ecology* 16: 37-42

ESFS-NF/APCR2024/1034

Response of cauliflower to biostimulant vis-a-vis organic manures under *Morus alba* based agroforestry system

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Keywords: Agroforestry, Biostimulants, Jeevamrut

Introduction

Agroforestry merges agriculture and forestry to enhance land use, security, and environmental health. Agri-silviculture, a common practice, integrates trees with crops, optimizing interactions and minimizing competition. Mulberry (*Morus alba*) is a fast-growing, adaptable tree offering environmental benefits and valuable compounds. Cauliflowers (*Brassica oleracea* var. botrytis) are vital crops in the Himalayas, rich in nutrients and cultivated for their high yield. Natural farming practices, including biochar, farmyard manure, and vermicompost, improve soil health and sustainability. Bio-stimulants, such as plant hormones and algal extracts, enhance plant growth and stress tolerance. This study investigates the impact of biostimulants and biofertilizers on pea and cauliflower under a Morus alba agroforestry system.

Material and methods

This study evaluates the effects of mulberry as a tree component alongside *Brassica oleracea* (cauliflower) as intercrops within an agroforestry system. It investigates how fertilizers and biostimulants impact crop performance both with and without tree canopy, focusing on soil properties and economic aspects. Key treatments include biochar, vermicompost, farmyard manure, and natural farming practices. The study also assesses the preparation of Jeevamrit and Ghanjeevamrit, field preparation, crop protection, and various crop and soil parameters. Observations include plant growth metrics, yield, soil health, and economic returns. Statistical analysis will be performed using ANOVA in R-studio to compare treatment effects.

Results and conclusion

The correlation matrix for the cauliflower crop was created using R-Studio (Posit Team, 2024) with the PerformanceAnalytics package (Fig.1) revealed linear relationships among crop and soil variables, with coefficients ranging from -1 to +1 at significance levels of α = 0.05, 0.01, and 0.001. Text size indicates correlation strength—larger text for stronger correlations and asterisks for significance. Yield parameters were positively correlated with most soil parameters, except bulk density, which was negatively correlated. Growth parameters and soil attributes also showed strong positive correlations. The highest positive correlation was between fungi and bacterial counts (0.99***), followed by fungal and actinomycetes counts (0.98***) and gross and net curd weights (0.98***). The strongest negative correlation was between bulk density and organic carbon (-0.92***). *Morus alba* L. based agroforestry enhanced cauliflower yields, with RDF + humic acid and FYM treatments improving soil nutrients and health. Vermicompost increased soil organic carbon and nitrogen, while RDF + humic acid optimized nutrient levels for crops.

GCW (Gross curd weight), NCW (Net curd weight), BD (Bulk density), Ba.C. (Bacterial count), F.C. (Fungi count), A.C. (Actinomycetes count). Significance (α): * <0.05, ** <0.01, * <0.001*

Fig. 1: Correlation matrix (Karl Pearson's) depicting linear relationship between growth with physico-chemical and microbial characteristics of cauliflower

References

Abdel Naby HM, Fathy ELE, El-Gamily EL and Salem NM. 2016. Effect of organic, mineral fertilization and foliar spraying with some biostimulants on growth, yield and chemical composition of Pea. *Journal of Plant Production* 7(9): 925-933.

Al-Falahi MN, Al-Dulaimi KH, Ghani ETA, Al-Taey DK and Farhan KJ. 2022. Effect of humic acids and the amount of mineral fertilizer on some characteristics of saline soil, growth and yield of broccoli plant under salt stress conditions. *Journal of Agricultural Science* 80. 10.15159/jas.22.24

ESFS-NF/APCR2024/1035

Relative influence of graded doses of natural farming formulation on soil properties of apple (*Malus x domestica* Borkh.) based agroforestry system

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Keywords: Apple farming, Jeevamrit, Ghanjeevamrit, Soil health

Introduction

Apple has emerged as a suitable tree species for agri-horticulture system due the space between alleys that can be utilized for cultivating vegetable crops. Nevertheless, the extensive use of agrochemicals and chemical fertilizers in agriculture has led to various environmental issues. There has been a growing emphasis on nature-based solutions such as natural farming practices that aim to improve soil health and sustain the yield (Selvan et al. 2023). However, there is a dearth of systematic investigation that precisely analyse how varying levels of natural farming formulations affect the soil attributes.

Material and methods

The experiment involved three-year-old apple plants-based agroforestry system (3m × 1m; planted in the east–west direction) and Radish (*Raphanus sativus* L.) var. Japanese white (spacing 30cm × 10cm) as the main crop, while pea (Pisum sativum L.) var. PB-89 (since intercropping is one of the essential components of NF) was grown as an intercrop (spacing 60cm × 7.5cm) in a 2:1 ratio between apple tree alleys. the experiment was established using a two-factor factorial randomized block design with additional treatment, each replicated thrice. Factor-I consisted of different concentrations of jeevamrit, i.e., 10%, 15% and 20%, whereas factor-II contained three graded doses of ghanjeevamrit, i.e., 1 $t.ha^{-1}$, 2 $t.ha^{-1}$ and 3 $t.ha^{-1}$, and control (no jeevamrit and no ghanjeevamrit) as additional treatment.

Results and conclusion

The findings of the current investigation indicated that compared to control treatment, the natural application treatment also had a notable effect on the soil properties, leading to increased organic carbon (9.71%), nitrogen (8.00-10.47%), phosphorus (30.23-32.49%), and potassium (11.57-13.73%) availability, as well as increased micronutrient (12.48-91.84%) and microbial counts. Particularly, soil physicochemical and biological properties were appreciably ($p<0.05$) impacted by graded doses of jeevamrit and ghanjeevamrit, except for the pH (7.08-7.16) and electrical conductivity (0.24 - 0.27 dS m^{-1}) of soil. The application of jeevamrit@20% enhanced the organic carbon content (1.31%) and macronutrients availability such as available N (363.04 kg ha^{-1}), P (60.15 kg ha^{-1}), available K (259.53 kg ha^{-1}) and micronutrients such as available Fe (51.89 mg kg^{-1}), Cu (3.65 mg kg^{-1}), Mn (5.64 mg kg^{-1}), and Zn (4.32 mg kg^{-1}) compared to the other concentrations of jeevamrit. Similarly, with the application of 20% jeevamrit@, the soil had a greater soil viable bacterial count (124.16×10^6 cfu g^{-1} soil), fungal count (18.65×10^2 cfu g^{-1} soil), and actinomycete count (19.36×10^2 cfu g^{-1} soil). Among the ghanjeevamrit treatments, the soil properties substantially ($p<0.05$) improved in response to the application of 3 t ha-1 ghanjeevamrit. Conversely, the soil bulk density decreased with rising the levels of jeevamrit and ghanjeevamrit. Overall, the the study concluded that incorporating natural farming practices, especially using jeevamrit@20% and ghanjeevamrit@3 t.ha^{-1} had positive effect on the soil health of apple-based agroforestry systems, contributing to sustainability.

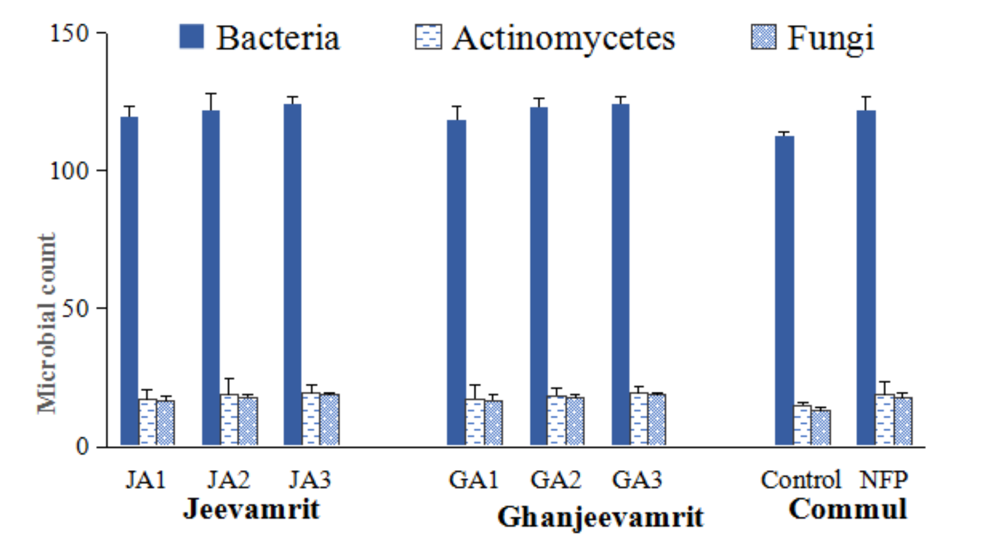

Fig 1: Biological properties of the topsoil

References

Selvan T, Panmei L, Murasing KK, Guleria V, Ramesh KR, Bhardwaj DR and Deshmukh HK. 2023. Circular economy in agriculture: Unleashing the potential of integrated organic farming for food security and sustainable development. *Front Sustain Food Syst* 7: 1170380.

ESFS-NF/APCR2024/1036

Effect of microbial enriched bioformulations on different agronomic traits of replanted apple rootstocks

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***Keywords*:** Apple, soil pathogens, amendments, endophytes, bio formulations

Introduction

Apple replant problem is major issue in all apple growing areas of world. Due to small land holdings and difficult land terrains in Himachal Pradesh, its impossible for apple orchardists to shift the plantation sites. Most of the apple orchards have completed their life span and facing a lot of problems in terms of establishment, poor growth, and sensitivity towards different soil borne pathogens and reduction in fruit yield. The main causes are soil pathogenic fungi, nematodes, nutrient exhaustion, pH imbalances and toxic root exudates. Chemical pesticides are used against soil pathogenic microbes but they sometimes target the plant beneficial microbes. Therefore, integrated sustainable land management strategies were used in the present study to overcome apple replant issue.

Material and methods

The study was conducted in 2020 in senile apple orchards situated at an elevation of 2086 m above sea level in Rohroo block of Shimla district (Himachal Pradesh). Orchard soil health management practices includes application of freshly chopped brassicaceae crops and Brassica seed meal rich in glucosinolate have microcidal effect on the soil pathogenic flora of ARD sites (Mayton et al., 1996; Kirkegaard et al., 1993). Apple replant disease (ARD) resistant rootstocks (M-9 and M-111) were selected for new plantation. Four plant growth promoting bacterial root endophytes *i.e*., *Bacillus megaterium* EA_3, *Stenotrophomonas maltophilia* EK_6, *Acinetobacter seifertii* ES_2 and *Pseudomonas aeruginosa* ES_8 with treatment combination of seven were selected for field experiments. The effects of cyclic application of consortial formulations were studied for 9 months from February 2020 to October 2020. Different agronomic traits of replanted apple rootstocks were recorded for two years in terms of per cent survival, plant height, number of shoots and rhizosphere colonization.

Results and conclusion

Orchard health management practices have negative impact on soil pathogenic fungi due to natural isothiocynate production. After molecular identification, the two dominant fungal pathogens were identified as *Fusarium annulatum* and *Ceratobasidium ramicola*. An increase in the total bacterial population is one of the indicators of successful establishment of the newly planted apple root stocks. Root and rhizosphere colonization is an important characteristic of indigenous plant growth-promoting bacteria. The percentage of surviving plants in the treatment T7 was 96.7% (83.85), which was significantly lower than that in the treatments T4, T5, and T6 while the lowest percentage of surviving plants was recorded in treatment T1. Similarly, plants in treatment T7 had the greatest plant height, which was at par with that in treatment T4, while the lowest plant height was recorded in treatment T1, which was statistically on a par with that in treatment T3. The number of shoots was greatest under treatment T7, which was on a par with treatments T3, T4, T5, T6, and T7.

ESFS-NF/APCR2024/1037

Assessing the influence of natural farm inputs on chemical and biological properties of soil in pea (*Pisum sativum* L.)

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Keywords: Ghanjeevamrit, Jeevamrit, Natural Farming, Nutrient management

Introduction

Natural farming is a holistic approach in agriculture which has gained renewed attention in recent years as both a sustainable and economically viable method of crop cultivation. This approach eschews synthetic chemicals and fertilizers and instead emphasizes natural processes and ecological balance to enhance soil health, promote plant growth and improve yield quality.

Material and methods

The study included pea cultivar Pusa Pragati, with seven distinct treatments and three replications: T_1 (100% RDF), T_2 (3 t ha^{-1} ghanjeevamrit + 5% jeevamrit @ 15 days interval), T_3 (2 t ha^{-1} ghanjeevamrit + 10% jeevamrit @ 15 days interval), T_4 (1 t ha^{-1} ghanjeevamrit + 15% jeevamrit @ 15 days interval), T_5 (3 t ha-1 ghanjeevamrit + 5% jeevamrit @ 30 days interval), T_6 (2 t ha^{-1} ghanjeevamrit + 10% jeevamrit @ 30 days interval) and T_7 (1 t ha^{-1} ghanjeevamrit + 15% jeevamrit @ 30 days interval) and absolute control. Soil properties such as organic carbon, available macro nutrients (NPK) and microbial count were measured as per standard methods.

Results and conclusion

Maximum organic carbon content was recorded in T_2 (1.46%) which was statistically at par with T_5 (1.46%), T_3 (1.44%) and T_6 (1.39%). There were significant effect among different treatments in primary nutrient content that maximum nitrogen content was recorded under T_1 (335.53 kg ha^{-1}) which was statistically at par with T_2 (329.27 kg ha^{-1}), T_3 (327.17 kg ha^{-1}) and T_4 (325.10 kg ha^{-1}). Maximum P content was recorded under T_1 (39.57 kg ha^{-1}) which was statistically at par with T_2 (37.33 kg ha^{-1}), T_4 (36.57 kg ha^{-1}) and T_3 (35.83 kg ha^{-1}). Maximum available K content was recorded under T_1 (381.53 kg ha^{-1}) which was statistically at par with T_2 (378.57 kg ha^{-1}), T_3 (374.83 kg ha^{-1}) and T_4 (370.33 kg ha^{-1}). Maximum microbial count varies with maximum bacterial count recorded under T_2 (14.67 x 10^6 cfu g^{-1} soil) which was statistically at par with T_5 (13.63 x 10^6 cfu g^{-1} soil) and T_3 (13.33 x 10^6 cfu g^{-1} soil) and maximum fungal count was recorded under T_2 (32.27 x 102 cfu g^{-1} soil) which was statistically at par with T_5 (30.70 x 10^2 cfu g^{-1} soil) and T_3 (28.67 x 10^2 cfu g^{-1} soil) and maximum actinomycetes count was recorded under T_2 (3.77 x 10^2 cfu g^{-1} soil) which was statistically at par with T_5 (3.57 x 10^2 cfu g^{-1} soil), T_3 (3.37 x 10^2 cfu g^{-1} soil) and T_6 (3.13 x 10^2 cfu g^{-1} soil).

The effect of natural farming practices on the soil properties were found significant with respect to organic carbon and viable microbial count was recorded maximum in 3 t ha^{-1} ghanjeevamrit + 5% jeevamrit drenching @ 15 days interval statistically at par with 2 t ha^{-1} ghanjeevamrit + 10% jeevamrit drenching at 15 days interval was reported as a most effective nutrient module for pea cultivation on sustainable basis.

Table 1: Effect of NF inputs on chemical and biological properties of soil in pea

Treatments		Soil properties				Microbiological properties		
		N	**P**	**K**	**OC**	**BC**	**FC**	**AC**
T_1	100% RDF	335.53	39.57	381.53	1.35	11.07	23.70	2.57
T_2	3t ha^{-1} Ghanjeevamrit + 5% Jeevamrit @ 15 days interval	329.27	37.33	378.57	1.46	14.67	32.27	3.77
T_3	2t ha^{-1} Ghanjeevamrit + 10% Jeevamrit @ 15 days interval	327.17	35.83	374.83	1.44	13.33	28.67	3.37
T_4	1t ha^{-1} Ghanjeevamrit + 15% Jeevamrit @ 15 days interval	325.10	36.57	370.33	1.37	12.23	26.83	2.87
T_5	3t ha^{-1} Ghanjeevamrit + 5% Jeevamrit @ 30 days interval	316.73	32.87	335.97	1.46	13.63	30.70	3.57
T_6	2t ha^{-1} Ghanjeevamrit + 10% Jeevamrit @ 30 days interval	313.60	31.37	326.63	1.39	12.83	27.33	3.13
T_7	1t ha^{-1} Ghanjeevamrit + 15% Jeevamrit @ 30 days interval	309.40	32.10	334.50	1.36	11.83	25.00	2.63
Mean		322.40	35.09	357.48	1.40	12.80	27.79	3.13
C.D (0.05)		12.87	4.42	15.27	0.08	1.44	4.36	0.64

BC, Bacterial count (10^6 cfu g^{-1}); FC, Fungal Count (10^2 cfu g^{-1}); AC, Actinomycetes Count(10^2 cfu g^{-1})

References

Jackson ML. 1973. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi.

Subba Rao NS. 1999. Soil microorganism and plant growth. Oxford & IBH publishing Company, New Delhi. 252p.

ESFS-NF/APCR2024/1038

Effect of natural farming formulations on yield and quality of strawberry (*Fragaria × ananassa* Duch.) cv. Camarosa

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Keywords: Ghanjeevamrit, Jeevamrit, Natural farming, Strawberry.

Introduction

Strawberry (*Fragaria× ananassa* Duch.) is an octaploid fruit crop belonging to the Rosaceae family. It is a hybrid of *Fragaria virginiana* and *Fragaria chiloensis*, cultivated under diverse agro-climatic conditions (Maher et al., 2020). Natural farming is a low-cost, climate-resilient system that uses natural inputs and avoids chemical fertilizers, promoting soil health through methods like multi-cropping, soil coverage, and natural formulations like Jeevamrit and cow dung mixtures to enhance soil microbes for nutrient fixation (Anahu and Chaddha, 2021).

Material and methods

The experiment was conducted at Horticulture Research & Training Station and KrishiVigyan Kendra Kandaghat, Solan under polyhouse conditions to study the 'Effect of different components of natural farming formulations on yield and quality of strawberry (*Fragaria × ananassa* Duch.) cv. Camarosa. The experiment consisting of thirteen treatments replicated thrice. Natural farming formulations, including *Jeevamrit* and *Ghanjeevamrit* were prepared. *Jeevamrit* was made by fermenting a mixture of cow dung, cow urine, jaggery, and gram flour for 7-10 days, stirred daily, and then diluted for application. *Ghanjeevamrit* was prepared similarly, dried under shade, and applied near the plant base.

Results and conclusion

This study determined the effects of Ghanjeevamrit and Jeevamrit applied at various intervals, in comparison to recommended dose of fertilizer (RDF) and the results obtained in the current study have been presented and discussed below. Maximum number of flowers per plant was observed under treatment T6 (29.67). Highest number of fruits (26.01) was observed in T13 which was followed by T6 (24.67). Maximum fruit yield was recorded in T13 (350.10 g/plant) which was closely followed by T6 (339.16 g/plant). Fruit Length and breadth was maximum in T13 (35.15 mm and 27.25mm, respectively) followed by T6 (34.57 mm and 27.19 mm, respectively). Maximum fruit weight was recorded in T6 (13.75g). Total soluble solids was maximum in T6 (10.35 ˚Brix), whereas, there was no significant difference in titratable aciditywith T7 showed maximum titratable acidity.

The trial concluded that while the maximum yield was achieved with the recommended fertilizer dose, the treatment with Jeevamrit 20 per cent + Ghanjeevamrit 1.5 t/ha (T6) provided a competitive yield. Jeevamrit and Ghanjeevamrit enhance soil microorganisms, improving plant growth, resistance therefore, increases fruit yield and quality. Thus, applying Jeevamrit 20% + Ghanjeevamrit 1.5 t/ha at 10-day intervals is recommended for strawberry cultivation under natural farming.

Table 1: Effect of natural farming inputs on yield and quality of strawberry

Treatment	No.of flowers /plant	No. of fruits /plant	Fruit Length (mm)	Fruit Breadth (mm)	Fruit weigh t (g)	Fruit Yield (g/plant)	TSS (˚Brix)	TA (%)
T1: Ghanjeevamrit (1.0 t/ha.) + Jeevamrit 10% at 10 days	25.60	19.00	29.62	24.82	11.70	221.19	7.90	0.64
T2: Ghanjeevamrit (1.0 t/ha.) + Jeevamrit 15% at 10 days	26.03	20.33	30.84	25.79	11.93	242.64	8.27	0.65
T3: Ghanjeevamrit (1.0 t/ha.) + Jeevamrit 20 % at 10 days	26.41	21.33	31.81	26.42	12.56	267.86	8.80	0.63
T4: Ghanjeevamrit (1.5 t/ha.) + Jeevamrit 10% at 10 days	27.07	21.70	32.56	26.94	12.86	278.92	9.27	0.62
T5: Ghanjeevamrit (1.5 t/ha.) + Jeevamrit 15% at 10 days	28.33	23.43	32.77	27.07	13.06	306.08	10.20	0.59
T6: Ghanjeevamrit (1.5 t/ha.) + Jeevamrit 20 % at 10 days	29.67	24.67	34.57	27.19	13.75	339.16	10.35	0.57
T7: Ghanjeevamrit (1.0 t/ha.) + Jeevamrit 10% at 20 days	22.57	16.33	26.52	21.20	10.41	170.18	6.43	0.69
T8: Ghanjeevamrit (1.0 t/ha.) + Jeevamrit 15% at 20 days	22.83	16.36	26.55	22.68	10.42	170.25	6.87	0.68
T9: Ghanjeevamrit (1.0 t/ha.) + Jeevamrit 20 % at 20 days	23.80	17.00	27.17	23.32	10.52	181.45	7.03	0.68
T10: Ghanjeevamrit (1.5 t/ha.) + Jeevamrit 10% at 20 days	23.90	17.34	27.85	23.42	10.67	193.68	7.50	0.67
T11: Ghanjeevamrit (1.5 t/ha.) + Jeevamrit 15% at 20 days	24.57	18.40	28.13	24.10	11.64	202.04	7.70	0.65
T12: Ghanjeevamrit (1.5 t/ha.) + Jeevamrit 20 % at 20 days	25.00	18.83	28.75	24.66	11.65	220.37	7.73	0.60
T13: Recommended dose of fertilizer(FYM and N, P, K)	29.42	26.01	35.15	27.25	13.46	350.10	9.87	0.59
Mean	25.78	20.60	30.18	24.99	11.89	241.91	8.30	0.64
CD (0.05)	0.68	1.49	0.88	0.69	0.55	17.86	0.67	NS

References

Anshu and Chaddha S. 2021. Subash Palekar Natural Farming: A way to heal the chemical degraded soils. *Just Agriculture* 2(3).

Maher MM, Shylla B, Sharma DD, Sharma U and Kuchay MA. 2020 .Yield and quality of polyhouse grown strawberries as affected by soilless media and jeevamrit. *International Journal of Chemical Studies* 8(3): 585-589.

ESFS-NF/APCR2024/1039

Biological and physico-chemical properties of soils under natural and chemical farming systems of apple

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Keywords: fungal and bacterial count, macro nutrients, micro nutrients

Introduction

'Natural farming' means farming with nature and without chemicals. This new emerging method of farming has many advantages including an increase in soil fertility, diversity, yield and quality of the produce as well as protection from the negative effects of chemical methods on environment (Bishnoi and Bhati, 2017). The biological and chemical properties of soil changes significantly when conventional farming is replaced by natural farming. With the aim to study these changes, this study was conducted to compare the microbiome and phsico-chemical status of soils under natural and chemical farming systems of apple production in the Shimla district of HP.

Material and methods

The present study was focused on commercial apple orchards in three different blocks (Theog, Jubbal, Rohru) of Shimla district of Himachal Pradesh. The experiment took place in adjacent commercial, irrigated apple orchards, one natural and one conventional, each approximately 1.0 ha in size, to avoid any pedoclimatic impact. In total, five orchards under natural farming system (NFS) and five orchards under chemical farming system (CFS) of apple production were selected for comparison. The variety used was "Starking Delicious" grafted onto seedling rootstock. All the sampled trees were of uniform age (more than 10 yrs) and size. Soil physico-chemical properties (pH, EC, organic carbon), primary (N, P, K), secondary (Ca, Mg) macronutrients and micronutrients (Cu, Fe, Mn, Zn) status were determined by standard methods.Fungal and bacterial count was determined by serial dilution method(Aguilera et al., 1999) to compare the microbiome status under both the farming systems.

Results and conclusion

Soil pH and EC were recorded to be higher (6.12 and 0.48 dS m^{-1}) in CFS than NFS (5.77 and 0.38 dS m^{-1}), while OC was reported to be higher (2.03 %)in NFS than CFS (1.78 %). However, only OC was found to be significant. Significant difference was found between the primary (N, P, K) and secondary (Ca, Mg) macro nutrient status of soils in natural and chemical farming systems of apple (Table 1). Mean N, P, K, Ca and Mg were reported to be higher (397 kg ha^{-1}, 73 kg ha^{-1}, 428 kg ha^{-1}, 4.53 [cmol(p^+) kg^{-1}] and 2.57 [cmol(p^+) kg^{-1}] in CFS than in NFS (368 kg ha^{-1}, 64.28 kg ha^{-1}, 355.80 kg ha^{-1}, 3.53 [cmol(p^+) kg^{-1}] and 1.74 [cmol(p^+) kg^{-1}]. Among micro nutrient status of soils, Cu and Zn were reported to be significantly different in both the farming systems whereas, Fe and Mn were reported to be non-significant. Fungal and bacterial count determined from collected soil samples were recorded to be higher in NFS (34.45, 33.45 cfu/g of soil) as compared to CFS (26.80, 25.25 cfu/g of soil). Overall, per cent increase of fungal and bacterial count over CFS was found to be 34.69 and 40.91 per cent. However, application of jeevamrit and panchgavya increases the microbial diversity under NFS, the nutrient status of soils was reported to be higher in CFS. This may be due to small sample size studied and also the orchardists selected were practicing natural farming from only four years.

Table 1. Comparison of primary and secondary macronutrient status of soils under natural and chemical farming systems of apple production

Parameter / Location	NFS					CFS				
	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	Ca [cmol(p^{+}) kg^{-1}]	Mg [cmol(p^{+}) kg^{-1}]	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	Ca [cmol(p^{+}) kg^{-1}]	Mg [cmol(p^{+}) kg^{-1}]
LG	349.00	66.02	343.00	3.51	1.76	379.00	76.10	377.00	4.72	2.36
SR	342.00	63.67	339.00	3.11	1.95	390.00	72.30	399.00	4.32	3.07
HM	377.00	67.78	312.00	3.44	1.85	398.00	81.70	523.00	4.62	2.62
MD	381.00	64.13	418.00	3.67	1.47	404.00	73.10	438.00	4.11	2.03
SJ	391.00	59.80	367.00	3.92	1.69	414.00	61.80	403.00	4.92	2.77
Range	342-391	59.8-67.7	312-418	3.11-3.92	1.47-1.95	379-414	61.8-81.7	377-523	4.11-4.92	2.03-3.07
Mean	368.00	64.28	355.80	3.53	1.74	397.00	73.00	428.00	4.53	2.57
CV	5.79	4.65	11.21	8.46	10.41	3.36	9.95	13.42	7.11	15.42
SE	9.53	1.34	17.83	0.13	0.08	5.97	3.25	25.68	0.14	0.18
t	2.57	2.48	2.3	5.12	4.23					
P	0.032	0.038	0.049	0.0008	0.002					

References

Aguilera LE, Gutiérrez JR and Meserve PL. 1999. Variation in soil micro-organisms and nutrients underneath and outside the canopy of *Adesmia bedwellii* (Papilionaceae) shrubs in arid coastal Chile following drought and above average rainfall. *Journal of Arid Environments* 42(1): 61-70.

Bishnoi R and Bhati A. 2017. An overview: Zero budget natural farming. *Trends in Biosciences* 10(46): 9314-9316.

ESFS-NF/APCR2024/1040

Impact of Zero Budget Natural Farming vis-à-vis conventional farming on soil biological properties and yield of pea

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Keywords: ZBNF, Soil microbes, yield

Introduction

Food safety, environmental deterioration and the need to mitigate dangers to human health have sparked interest in the development and use of sustainable alternative agricultural systems around the world (Carter et al., 1993). Chemical-intensive conventional agriculture resulted in a quantum leap in food production, but it also resulted in irreversible ecological catastrophes, such as global warming, widespread soil erosion, salinization, decline ground water tables, deterioration of soil fertility, nutrient imbalance, damage to soil health, land degradation, desertification, loss of biodiversity and pesticide pollution, in addition to a reduction in food production. Judicious application of nutrient especially organic manures not only improves the productivity but also make cultivation sustainable (Tiwari et al., 2002) because it is the basic source of soil organic matter.

Material and methods

Study areas were identified with the help of Department of Agriculture, Government of Himachal Pradesh, Solan. For Zero Budget Natural Farming, only those farmers were selected who were practising ZBNF for last at least four years while for conventional farming system farmers involved in growing pea as a commercial crop for last four or more years selected. The study area was positioned between ZBNF and Conventional Farming System as per GPS which consisted of three blocks of Solan district i.e. Solan, Kandaghat and Kunihar. A total of 15 farmers each for ZBNF and conventional farming system were selected. Soil samples at 0-15 cm depth were taken before sowing of the crop and after harvesting of the crop i.e. in November and April, respectively (following standard operating procedure).

Results and conclusion

Bacterial population was lower under conventional farming system (8.65×10^5 cfu g^{-1}) as compared to ZBNF farming system (9.28×10^5 cfu g^{-1}). Population of fungi under conventional farming system ranged from 6.1 to 6.88×10^3 cfu g^{-1} while in ZBNF practice, it ranged from 6.21-7.31×10^3 cfu g^{-1}. ZBNF farming system had higher fungi population (6.73×10^3 cfu g^{-1}) as compared to conventional farming system (6.42×10^3 cfu g^{-1}). Similarly, the population of actinomycetes were recorded in ZBNF (9.28×10^3 cfu g^{-1}). Higher yield was recorded under conventional farming system (109.67 q/ha) as compared to ZBNF (92.07 q/ha) farming system.

The results concluded that beneficial microorganisms were recorded higher under ZBNF compared to conventional farming system. Yield of pea was significantly higher under conventional farming system as compared to ZBNF. However due to lesser cost of cultivation, ZBNF farming system was more economical as compared to conventional farming system. The study concluded that ZBNF helps in improving the soil health, especially biological properties of the soil which, however, is compensated by lower cost of cultivation and hence, being more economical.

Table 1: Viable microbial count in ZBNF and conventional farm practices in pea

Block/ Farmer		Conventional			ZBNF		
		Bacteria ($x10^5$ cfu g^{-1})	Fungi (x 10^3 cfu g^{-1})	Actinomycetes (x 10^3 cfu g^{-1})	Bacteria (x 10^5 cfu g^{-1})	Fungi (x 10^3 cfu g^{-1})	Actinomycetes (x 10^3 cfu g^{-1})
Solan	F_1	49.50	6.11	9.13	53.70	7.23	9.64
	F_2	48.90	6.55	8.32	51.48	7.12	9.45
	F_3	38.60	6.85	9.15	47.32	6.91	9.26
	F_4	41.40	6.12	9.25	45.60	6.23	9.32
	F_5	40.20	6.32	8.38	42.60	6.43	8.48
Kandaghat	F_6	38.70	6.18	9.56	41.70	6.43	9.78
	F_7	38.42	6.42	9.34	42.57	6.54	9.51
	F_8	36.20	6.88	9.23	43.72	6.94	9.87
	F_9	38.20	6.18	8.43	43.76	6.33	8.85
	F_{10}	38.10	6.76	8.92	47.42	7.31	9.21
Kunihar	F_{11}	42.80	6.34	8.67	41.26	6.48	8.87
	F_{12}	43.52	6.13	9.24	52.80	7.12	9.32
	F_{13}	40.50	6.84	9.32	47.65	7.23	9.55
	F_{14}	40.49	6.41	6.27	42.54	6.49	9.15
	F_{15}	30.52	6.24	6.56	41.70	6.21	8.88
Range		30.52-49.50	6.11-6.88	6.27-9.56	41.26-53.70	6.21-7.31	8.48-9.87
Mean		40.40	6.42	8.65	45.72	6.73	9.28
SE		1.21	0.07	0.25	1.08	0.10	0.10
T		3.28	2.46	2.29			
P		0.0028	0.0212	0.0345			

References

Carter ME, Gamez R and Gliessman S. 1993. *Sustainable Agriculture and the Environment in the Humid Tropics,* National Academy Press, Washington DC, pp 1– 191.

Tiwari A, Dwivedi AK and Dikshit PR. 2002. Long term influence of organic and inorganic fertilization on soil fertility and productivity of soybean-wheat system in a Vertisol. *Journal of Indian Society of Soil Science* 50: 472-475.

ESFS-NF/APCR2024/1041

Boosting soil microbial vitality: Organic weed management in acid Alfisols

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Keywords: Organic farming, Soil microbial health, Weed management

Introduction

Agriculture plays a vital role in India's economy, contributing approximately 20.2% to the nation's GDP and employing over 60% of the population. The Green Revolution of the 1960s, driven by chemical-based technological advancements, greatly enhanced production capacity and ensured the country's food security (Swami, 2020). The current agricultural system is heavily production-focused, relying primarily on inorganic inputs like herbicides for weed control (Sadeghi et al., 2010) and fertilizers to enhance crop output. The excessive use of chemical fertilizers and plant protection chemicals has led to numerous adverse effects, including the adverse effect on soil microbial population. Considering the harmful effects of herbicides on soil and the growing demand for organic products, there is an urgent need to develop eco-friendly weed control methods. Therefore, this study was conducted with the aim of minimizing economic losses and preserving soil microbial health by implementing effective organic weed management practices in the maize-pea cropping system.

Material and methods

The prese study was carried out under All India Coordinated Research Project on Weed Management (AICRP-WM) at Department of Agronomy, Forages and Grassland Management, CSKHPKV, Palampur (H.P.). The experimental farm is located at 32°6′ N latitude, 76°3′ E longitude and 1290 m above mean sea level. The experiment consisted of 10 treatments *viz.,* T1-Hoeing, T2-Stale seed bed + Hoeing, T3-Raised stale seed bed + Hoeing, T4-Mulch, T5-Stale seed bed (SSB) + Mulch, T6-Raised stale seed bed (RSSB) + Mulch, T7-Intercropping, T8-Crop rotation, T9-Intensive cropping and T10-Chemical check. Soil microbial parameters were estimated using standard method of analysis.

Results and conclusion

The results indicated significant effect of weed management practices on soil microbial parameters. Microbial parameters were significantly higher in the treatment RSSB + mulch (T_6) followed by SSB + mulch (T_5) while chemical check (T_{10}) recorded the lowest values. Mulch treatment in combination with RSSB and SSB (T_6 and T_5) recorded the higher soil microbial biomass nitrogen which might be due to better plant growth in RSSB and SSB as compared to normal seed bed which resulted in extensive root growth of plant thus adding more organic material thus increasing soil microbial biomass nitrogen.

Application of mulch increase amount of organic C and soil moisture. Among different cropping systems, the highest soil microbial biomass nitrogen was recorded in intercropping system due to addition of organic residues whereas the intensive cropping resulted in depletion of organic carbon from soil thus recorded lower soil microbial biomass nitrogen. The lowest soil microbial biomass nitrogen was recorded in chemical check which might be due to release of toxic compounds in the soil with the addition of chemical fertilizers and herbicides which result in low organic C content which in turn affect growth of soil microorganisms. Considering the hazards of fertilizers and pesticides, farmers can employ environmentally beneficial organic weed management practices as compared to chemical herbicides. The present study revealed that lantana mulch alone or along with Raised Stale Seed Bed and Stale Seed bed have beneficial effect in enhancing soil microbial parameters which ultimately improves the soil health and aids in sustainable crop production.

Table 1: Effect of weed management practices on soil microbial parameters

Treatment	Microbial Biomass C (µg g^{-1} soil)		Microbial Biomass N (µg g^{-1} soil)		Dehydrogenase (µg TPF/g soil)		Urease activity (µg $g^{-1}h^{-1}$)		Phosphatase (µg g^{-1} h^{-1})	
	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
T_1 : Hoeing	270	272	13.1	13.3	3.55	3.8	10.35	10.65	4	4.2
T_2 : SSB + hoeing	271.75	273.15	13.4	13.65	4.05	4.4	10.8	11.05	4.15	4.45
T_3 : RSSB + hoeing	274.35	276.3	13.9	14.1	4.4	4.8	11.35	11.55	4.4	4.85
T_4 : Mulch	281.7	283.8	14.8	15	6.75	7	12.3	12.65	5.35	5.55
T_5 : SSB + mulch	285	287.15	15.7	15.95	7.3	7.7	12.65	13.05	6	6.25
T_6 : RSSB + mulch	294	297.2	16.25	16.55	7.75	8.05	13.55	13.75	6.4	6.5
T_7 : Intercropping	282	284.5	15.3	15.6	8.25	8.4	13.9	14.1	6.75	6.85
T_8 : Crop rotation	275.35	277	13.55	14	7.55	7.8	12.55	12.65	6.15	6.2
T_9 : Intensive cropping	272.8	271.15	14.4	14.55	7.15	7.3	12.4	12.6	6	6.3
T_{10} : Chemical check	255	262.5	11.35	11.5	3.1	3.25	9.05	9.35	3.5	3.8
SE(m±)	2.6	2.45	0.35	0.35	0.35	0.3	0.55	0.45	0.2	0.2
LSD (P=0.05)	7.75	7.2	1	1.1	1	0.9	1.55	1.35	0.7	0.7

References

Sadeghi S, Rahnavard A and Ashrafi ZY. 2010. Response of wheat (*Triticum aestivum*) germination and growth of seedling to allelopathic potential of sunflower (*Helianthus annuus*) and barley (*Hordeum vulgare* L.) extracts. *Journal of Agriculture Technology* 6: 573–577

Swami S. 2020. Soil health management under organic production system. *International Journal of Chemical Studies* 8(2): 330-339.

ESFS-NF/APCR2024/1042

Effect of natural farming inputs and salicylic acid on seed quality of sweet pea (*Lathyrus odoratus* L.)

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Keywords: Natural farming, Subhash Palekar, Salicylic acid.

Introduction

Sweet pea (*Lathyrus odoratus* L.) is an important annual flower crop of temperate regions belongs to the family fabaceae and can climb up to 6-8 ft with various flower colours. Salicylic acid is an important growth regulator for inducing the resistance against diseases and pests whereas beejamrit is an ancient organic formulation commonly used as a pre-sowing seed treatment for improving the seed germination and quality attributes.

Material and methods

Seeds of sweet pea were treated with salicylic acid @ 100 ppm a quick dip @ 100 ppm for 12 hours @ 100 ppm for 24 hours and beejamrit (100%) a quick dip, for 12 hours, for 24 hours along with control. Treatments included T1: Salicylic acid @ 100 ppm a quick dip; T2: Salicylic acid @ 100 ppm for 12 hours; T3: Salicylic acid @ 100ppm for 24 hours; T4: Beejamrit (100%) a quick dip; T5: Beejamrit (100%) for 12 hours; T6: Beejamrit (100%) for 24 hours; T7: Absolute Control. The quality attributes of seed, i.e., 100 seed weight, speed of germination, germination percentage, seedling length (cm), seedling dry weight (mg), seed vigour index-I and seed vigour index-II was recorded.

Results and conclusion

Seeds treated withT_5 (Beejamrit @100% for 12 hours) showed the better results w.r.t. seed quality parameters which was found statistically at par with the treatment T_3 i.e., (150 ppm of salicylic acid for 24 hours). Salicylic acid had significantly improved the initial growth of seedling. Natural formulation *beejamrit* was also equally good in boosting the seedling emergence as well as its physical characters. These treatment combinations can invigorate or enhance the seed quality thus boosting crop production of sweet pea in the long run in the temperate regions.

Table 1: Effect of salicylic acid and beejamrit on seed quality of sweet pea

Treatment			100 seed weight (g)	Germination (%)	Seedling dry weight (mg)	Seed vigour index-I	Seed vigour index-II
Salicylic Acid	Quick dilution	T_1	5.81	78.5 (62.39)*	13.5	1,833.42	983.88
	Dilution for 12 h	T_2	6.05	77.75 (61.94)*	12.09	1941.99	1038.03
	Dilution for 24 h	T_3	6.53	80.25 (63.62)*	14.39	2072.65	1172.58
Beejamrit	Quick dilution	T_4	6.51	74.5 (59.67)*	13.26	1835.42	1045.36
	Dilution for 12 h	T_5	6.91	81.5 (64.56)*	14.71	1724.28	1253.85
	Dilution for 24 h	T_6	6.43	75.5 (60.36)*	13.89	1870.74	1039.23
Control		T_7	0.21	3.64	0.3	124.5	79.98

References

Patel M, Shaikhul I, Bernard RG, Choudhary N, Yadav VK, Bagatharia S, Sahoo DK and Patel A. 2024. Zero budget natural farming components Jeevamrit and Beejamrit augment *Spinacia oleracea* L. (spinach) growth by ameliorating the negative impacts of the salt and drought stress. *Frontiers in Microbiology* 15: 1326390.

ESFS-NF/APCR2024/1043

Plant beneficial bacteria from liquid Jeevamrit bioformulation

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Keywords**:** Plant growth promoting bacteria, phosphate solubilization, antifungal activity

Introduction

Jeevamrit formulation is renowned for its potential to boost crop production, largely due to the diverse microorganisms as it contains. These beneficial bacteria play a significant role in promoting plant health through various mechanisms. They can directly enhance plant growth by solubilizing of nutrients. Indirectly, these microbes improve soil health by suppressing harmful pathogens and enhancing soil structure, which supports better root growth and nutrient uptake. Additionally, the microbial diversity in *jeevamrit* contributes to the decomposition of organic matter, enriching the soil with nutrients. Understanding the specific roles and functions of these bacteria can lead to optimized formulations and application methods, maximizing jeevamrit's effectiveness as a plant probiotic.

Material and methods

Jeevamrit samples were processed to isolate and identify beneficial bacteria. The screening focused on several key plant growth-promoting traits, including phosphate and potassium solubilization, dinitrogen fixation, and the production of siderophores and ammonia. Additionally, the bacteria were assessed for their lytic enzyme activity and ability to inhibit plant pathogens. Promising bacterial isolates were further evaluated through seed germination and growth studies using a filter paper assay to determine their effectiveness in promoting plant growth and enhancing crop productivity.

Results and conclusion

Preliminary screening indicates that 66.96% of the isolates were phosphate solubiler, 16.96% for K-solubiler and 66.96% N_2 fixers. Additionally, 8.93% of the isolates produced siderophores, and 7.14% produced ammonia. The isolates also showed significant potential in inhibiting several phytopathogens, including *Alternaria, Fusarium, Sclerotium, Sclerotinia* and *Colletotrichum* sp. Phosphate solubilization capabilities ranged from 50.25 to 476.50 µg/ml, while, IAA production varied between 0.15 and 27.40 µg/ml.

Sixteen isolates effectively inhibited all tested phytopathogens, with inhibition percentages ranging from 43.75% to 61.44%. The isolates also demonstrated lytic enzyme activities: amylase (16.67%), gelatinase (44.44%), protease (38.89%), cellulase (5.56%), and lipase (50%). The four most effective bacterial isolates—*Bacillus subtilis* (NJA13, Acc. No. OK036919), *Levilactobacillus brevis* (HJA21, Acc. No. OK036950), *Paucilactobacillus vaccinostercus* (JJA8, Acc. No. OK036952), and *Bacillus safensis* (CJV10, Acc. No. OK036956) demonstrated exceptional plant growth-promoting properties.

References

Ardeep K, Pandey ST, Negi MS, Kumar A and Gautam P. 2022. Innovation in traditional organic nutrient management practices for better soil health and higher productivity of brahmi (*Bacopa monnieri* L.). *Indian Journal of Traditional Knowledge* 21(3): 670-676

ESFS-NF/APCR2024/1044

Optimizing soil health, productivity and economics through natural farming practices for year round lettuce cultivation

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Introduction

Intensive use of synthetic inputs has led to adverse effects, including soil degradation, eutrophication, biodiversity lossand rising cultivation costs. Natural Farming emerges as a promising solution, offering a "triple-win" by enhancing crop productivity, reducing input costs, and fostering climate-resilient agriculture. Healthy soils, teeming with mycorrhizal fungi and other microbes, regenerate and provide essential nutrients to crops, reducing reliance on purchased inputs and improving farmers' income, health, and well-being.

Material and methods

Lettuce commercial cultivar 'Solan Kriti' was used in present study. Three treatments had application of *Ghanjeevamrit* @ 0.5 t/ha with three different concentartions of Jeevamrit (5, 10, 15%). The other three treatments had application of *Ghanjeevamrit* @ 1.0 t/ha with three different concentartions of *Jeevamrit*. All the treatments were supplemented with Saptadhanyakur (3%) along with sour butter milk (3%) except for control. Before sowing, seeds were treated with beejamrit. Drenching with Jeevamrit was done as per treatments at fortnightly intervals, started 15 days after sowing. The observations were recorded for different agro-morphological, biochemical, soil characteristics, microbial counts and socio-economic parameters.

Results and conclusion

The results revealed that application of Ghanjeevamrit @ 1 t/ha + Jeevamrit (drenching @ 15%) + Saptadhanyakur (spray @ 3%) + Sour butter milk (spray @ 3%) recorded superior results for majority of characters namely, plant height (36.37 cm), leaf length (27.74 cm), yield (32.27 t/ha), calcium (128.37 mg/100g), iron content (3.70 mg/100g), available NPK (332.87, 38.12, 246.22 kg/ha, respectively) in soil. Highest bacterial, fungal and actinomycetes population was also recorded.
Maximum gross income, net returns and B:C ratio were recorded by application of same treatment under February transplanted crop. Therefore, natural farming practices can be recommended to the farmers on long term basis for getting more yield, better growth, better soil fertility and year-round commercial and sustainable production of lettuce.

Refrences

Boraiah B, Devakumar N and Palanna KB. 2018. Yield and quality parameters of capsicum (*Capsicum annuum* L. var. *grossum*) as influenced by organic liquid formulation. *International Journal of Pure and Applied Bioscience* 6:333-38.

ESFS-NF/APCR2024/1045

Cumulative impact of nutrient management strategies on the micronutrient content of soil under apricot cultivation

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Introduction

The Subhash Palekar Natural Farming (SPNF), which uses indigenous cow-based farming system for nutrients, pest and disease control with its four pillars being; 1) Beejamrit, 2) Jeevamrit, 3) Acchadana and 4) Waapasha (Soil moisture). This new concept of SPNF needs to be compared to both chemical & organic farming in apricot (*Prunus armeniaca* L.) being the most important fruit crops of sub-tropical regions in India. Organic manures & bio-fertilizers along with inorganic fertilizers are effective means for improving soil aggregation, structure & fertility, increasing microbial diversity, improving moisture holding capacity of soils, increasing cation exchange capacity & consequently crop yields.

Material and methods

The experiment was laid out in experimental orchard of Horticultural Research and Training Station and Krishi Vigyan Kendra (HRTS & KVK), Kandaghat, Solan (H.P.) Present studies were conducted during 2019-2021 in the experimental orchard of apricot cv. New Castle on bearing apricot trees with an age of more than 20 years and planted at a distance of 5×5 m. The experiment comprised of 11 treatments and 3 replications. The treatments consisted of different doses of Jeevamrit (JA), ghanjeevamrit (GJA), PGPR, biofertilizers (BF) and recommended dose of fertilizers being urea, SSP, MOP and FYM. For the estimation of micronutrient cations, 10 grams of soil sample was shaken with 20 ml of diethylenetriaminepenta acetic acid (DTPA of pH 7.3) for 2 hours and filtered through Whatman No. 42 filter paper (Lindsay and Norvell, 1978). Available Zn, Cu, Fe and Mn in the extract were determined on Atomic Absorption Spectrophotometer and were expressed in ppm.

Results and conclusion

Maximum DTPA extractable Zinc, copper, iron and manganese were reported under organically amended soils as well as soils receiving natural farming treatments like Jeevamrit and Ghanjeevamrit. The higher Zn content in treatments receiving various organic inputs is due to the mineralization of organically bound Zn which forms stable chelate and subsequently decrease its fixation, absorption or precipitation (Das, 2007). The increase in copper can be attributed to the mineralization of organically bound forms and formation of stable water soluble complexes or organic chelates of higher stability, which decreases their susceptibility to absorption, fixation and/ or precipitation. Higher availability of micro nutrients in jeevamrit treated trees might be because of its capacity to add good amount of organic carbon content to soil which hastens process of mineralization of organically bound micronutrients in soil. The increase in iron content from its initial status may be due to contribution of substantial amount of iron from FYM and Jeevamrit which contain variable amount of iron depending upon the preparation procedure, age of cattle and fortification. Higher availability of Mn in this study by combined application of organic based fertilizers and inorganic fertilizers may be ascribed to the enhanced microbial activity in soil and consequent release of organic substances (chelating agent) which could have prevented micronutrients from precipitation, fixation, oxidation and leaching. From these results it can be concluded that the systems of nutrient management had a significant and visible effect on soil micronutrients under apricot cultivation.

Table 1: Effect of different nutrient management practices on DTPA-extractable zinc, copper, iron and manganese (mg kg^{-1}) in soil

Treatment / Year	Zn		Cu		Fe		Mn	
	2020	2021	2020	2021	2020	2021	2020	2021
T_1:JA +GJA @ 40 kg/bigha each	2.84	2.80	2.34	2.45	63.67	65.80	27.63	29.70
T_2:JA +GJA @ 60 kg/bigha each	3.01	3.14	2.26	2.37	67.33	70.00	30.03	33.47
T_3:JA +GJA @ 80 kg/bigha each	3.14	3.16	2.33	2.43	75.50	80.17	32.27	34.87
T_4:FYM + JA + PGPR (RD of N by FYM)	2.92	2.80	2.25	2.37	83.50	85.93	37.23	41.43
T_5:FYM + BF + PGPR (RD of N by FYM)	3.08	2.89	2.46	2.69	85.60	90.67	39.83	42.13
T_6:80% RD+ JA	2.55	2.55	2.11	2.29	87.53	86.13	34.57	35.17
T_7:80% RD+ GJA	2.57	2.51	1.95	2.12	75.07	79.73	35.67	39.00
T_8:80% RD+ BF	2.31	2.44	1.80	2.00	68.67	66.50	40.27	43.73
T_9:80% RD+ PGPR	1.92	2.00	1.84	1.90	70.43	79.23	30.90	34.43
T_{10}:100% FYM + RD of N, P and K	1.48	1.57	1.88	1.87	79.20	85.13	37.93	42.17
T_{11}:Control (no application)	0.85	0.96	1.23	1.37	32.43	42.40	20.23	27.57
Mean	2.42	2.44	2.04	2.17	71.72	75.61	33.32	36.70
$CD_{0.05}$	0.18	0.45	0.28	0.29	14.52	13.69	7.27	9.60
Treatment (T) Year (Y)	0.24 NS		0.19 NS		9.69 NS		5.76 NS	

References

Das DK. 2007. *Micronutrients: Their behaviour in soils and plants*, 2nd revised New Delhi.

Lindsay W H and Norvell W A. 1978. Development of DTPA soil test for Zn, Fe, Mn and Cu. *Soil Science Society of American Journal* 42: 420-428.

ESFS-NF/APCR2024/1046

Comparative analysis of soil properties in natural and chemical farming systems for vegetable crops

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Introduction

Current farming trends are focusing on reducing the use of chemical pesticides and inorganic fertilizers, necessitating the search for environment friendly alternatives. Overuse of chemical fertilizers not only depletes soil nutrients but also poisons the whole ecosystem (Li et al, 2020). Natural farming is a holistic agricultural practice in which soil is supplemented with microbial consortiums to accelerate the proliferation of soil microflora which is beneficial to soil enrichment. It uses a variety of methods including crop diversification, crop rotation and intercropping to improve soil fertility which is one of the most important components for nutrient management.

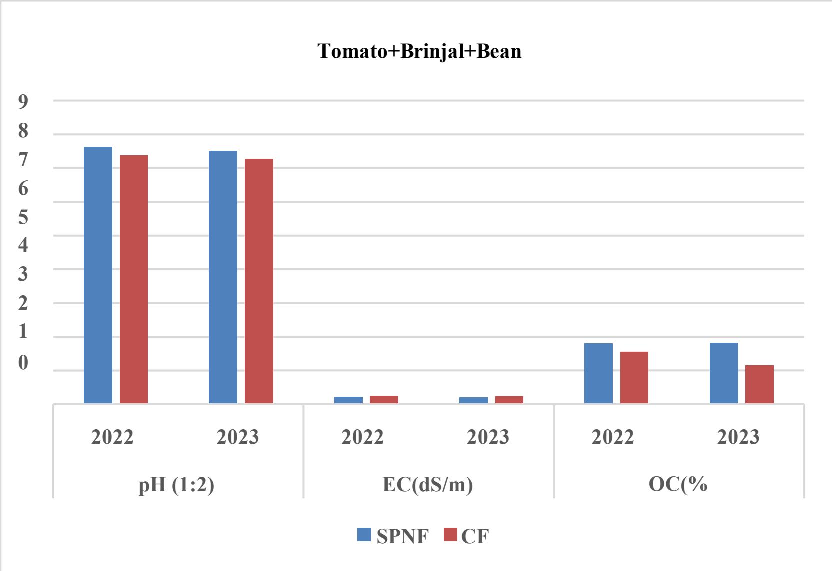
Material and methods

The investigation was conducted during kharif seasons of the year 2022 and 2023 at an experimental field of SPNF, Nauni, Solan and experimental farm (CF) of Department of Entomology, UHF, Nauni, Solan. Two cultivation systems were examined in this study: (1) conventional practice with chemical fertilizers (CF) and (2) Subhash Palekar Natural Farming (SPNF). Intercropping of brinjal and bean was done in SPNF system, considered tomato as the main crop (Tomato+Brinjal+Bean). On the other hand, in the CF system, the Tomato was cultivated as solo crop. Representative soil samples from 0-15 cm depth were collected from the respective field. Soil pH was determined by the procedure as described by Jackson (2005). EC of the soil was estimated using the electrical conductivity meter in supernatant solution obtained from 1:2 soil to water suspension by keeping it overnight. Soil organic carbon was determined by wet digestion method of Walkley and Black.

Results and conclusion

Soil pH, EC and organic carbon were analyzed after harvesting each crop and the results were presented in graphical form. The soil pH was slightly alkaline in SPNF cropping system which might be due to alkaline nature of cow urine present in jeevamrit. On the other hand, the soil pH was near neutral in CF system of farming. The value of EC of the SPNF system was found lower as compared to the CF system of cropping. An increase in EC in conventionally managed soils could be due to the higher input of salts in the form of chemical fertilizers. The maximum organic matter content was recorded in SPNF system when compared with the CF system of cropping.

Higher organic carbon under SPNF system might be due to the addition of jeevamrit, ghanjeevamrit and the presence of partially decomposed or undecomposed fraction of organic matter present in ghanjeevamrit which increases the microbial population and enzymatic activity and ultimately increased soil organic carbon content. Soil management practices also influence soil organic carbon concentration. Compared to monocropping, intercropping practices enhancing the soil organic carbon content. It alters the decomposition rate through changes in abiotic and biotic attributes of the ecosystem. Intercropping systems promote balance and prevent competition between the main crop and the intercrops for light, moisture and nutrients (Munkholm and Hansen, 2016). From the above results, it can be concluded that natural farming practices has positive and significant effect on soil properties which helps in the improvement of soil fertility status.



References

Li R, Pang Z, Zhou Y, Fallah N, Hu C, Lin W and Yuan Z. 2020. Metagenomic analysis exploring taxonomic and functional diversity of soil microbial communities in sugarcane fields applied with organic fertilizer. *International Journal of Bioremediation Research* 93:81-86.

Munkholm LJ and Hansen EM. 2012.Catch crop biomass production, nitrogen uptake and root development under different tillage systems. *Soil Use Management* 28: 517–529.

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Effect of farming practices on growth of *Matricaria chamomilla* Linn. under wild pomegranate based agroforestry system

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Keywords: Jeevamrith, plant height, number of flower, agroforestry system and FYM

Introduction

Agroforestry systems have been practiced traditionally for centuries, providing environmental and economical productivity. The interest in agroforestry systems has significantly increased in recent years because these systems are sustainable in terms of productivity and are more environmentally friendly. To grow healthy plants, natural systems should be disturbed as little as possible. Jeevamrutha and Panchagavya have the potential to play the role of promoting growth and providing immunity in the plant system. Organic fertilizers in comparison to chemical fertilizers have lower nutrient content and are slow releasers but they are as effective as chemical fertilizers over longer periods of use (Naguib, 2011). If bio-organics are used, growing medicinal and aromatic plants beneath wild pomegranate trees may be a financially sound solution with few expenses.

Material and methods

The study comprises structural and functional components *viz*, wild pomegranate as woody perennial and aromatic herb (*Matricaria chamommila*) as intercrop. The treatment combination included T_1: Recommended dose of fertlizers (NPK- 60:45:30 kg ha^{-1}), T_2: Natural farming (Jeevamrith),T_3: FYM (2t ha^{-1}),T_4: Vermicompost (2t ha^{-1}), T_5: FYM (2.5 t ha^{-1}) and T_6: Control. In addition, the impact of manures on the growth of *Matricaria chamommila* growing with and without pomegranate trees was studied.

Results and conclusion

Maximum plant height (48.49 cm) was recorded under (S_1) i.e., tree canopy and minimum (44.03 cm) was recorded in (S_2) i.e., open planting condition. Among different doses of manures, maximum plant height (49.81cm) was recorded in T_1 and minimum (40.61 cm) was recorded in T_6. Among different doses of manures maximum (61.82 cm) plant spread was recorded in T_1 and minimum (53.05 cm) was recorded in T_6. Planting conditions have significant effect on flowering initiation period, longest (81.05 days) flowering initiation period was recorded under (S_1) i.e., tree canopy, and shortest (79.06 days) flowering initiation period was recorded in (S_2) i.e., open condition. Among different doses of manures, longest (82.42 days) flowering initiation period was recorded in T_4 and shortest (76.67 days) was recorded in T_6.

Planting conditions and manures have significant effect on number of flowers per plant of *Matricaria chamomilla*, maximum (285.91) number of flowers per plant was recorded under (S_1) i.e., tree canopy, and minimum (268.09) was recorded in (S_2) i.e., open condition. Maximum number of flowers (320.09) was recorded in T_1 and minimum (231.63) was recorded in T_6. *Matricaria chamomilla* showed better growth parameters when grown as intercrop with wild pomegranate compared to sole cropping. Application of Recommended Dose of fertilizers (NPK @ 60:45:30) attributed to the highest growth parameters.

References

Naguib NYM. 2011. Organic vs chemical fertilization of medicinal plants: a concise review of researches. *Advances in Environmental Biology* 5: 394-400.

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Intensification of vegetable crop production using climate-resilient natural farming practices

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Introduction

Vegetable cultivation holds immense importance for small-scale farmers as it plays a vital role in generating income and livelihood opportunities. However, challenges such as low yields from a lack of scientific methods and environmental degradation due to heavy use of chemical inputs have prompted a shift to eco-friendly farming practices like Subhash Palekar Natural Farming (SPNF) system. Subhash Palekar identifies four key principles of natural farming: *beejamrit, jeevamrit*, *acchadan* (mulching), and *whapasa* and offers a cost-effective, eco-friendly alternative using locally made botanical pesticides and microbial enrichments to manage soil health and pests naturally. Another alternative, intercropping, involves growing multiple crops together, which enriches soil, reduces risk of complete crop failure and diversifies income.

Material and methods

The present investigation was conducted on crop intensification of vegetables by following natural farming practices at the Subhash Palekar Model Farm, Department of Entomology, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during *Kharif* season of 2023. The experiment was laid out in Randomized Complete Block Design (RCBD) Factorial with three replications comprising of twelve treatment combinations of three levels of *ghanjeevamrit* (G_0 : No *Ghanjeevamrit*; G_1 : *Ghanjeevamrit@* 1 t/ha; G_2 : *Ghanjeevamrit @* 1.5 t/ha) and four levels of *jeevamrit* (J_0 : No *Jeevamrit;* J_1 : *Jeevamrit* spray @ 10 %; J_2 : *Jeevamrit* spray @ 15 %; J_3 : *Jeevamrit* spray @ 20 %). The tomato cv. (Solan Lalima) was grown as the main crop, while brinjal (cv. Pusa Purple Long) and French bean (cv. Contender) were grown as intercrops. In each plot, a similar planting arrangement was maintained, where within the five lines of tomato plants four lines of intercrops (brinjal and French bean) were planted.

Results and conclusion

Growth, yield and quality characters such as plant height, harvest duration, fruit weight, number of fruits per cluster, number of fruits per plant, fruit yield per plant, yield per plot and per hectare (kg/plot and q/ha) were recorded maximum with the application of *ghanjeevamrit* @1.5 t/ha (G_2) among different doses of *ghanjeevamrit*. Among different levels of *jeevamrit*, application of *jeevamrit* spray @ 20 per cent (J_3) was found best for plant height, harvest duration, fruit weight, number of fruits per plant fruit, yield per plant. However, application of *jeevamrit* spray @ 15 per cent (J_2) also performed best in parameters like, number of fruits per cluster, yield per plot and per hectare (kg/plot and q/ha). Regarding interaction effect, maximum plant height, harvest duration, number of fruits per cluster, number of fruits per plant, fruit yield per plant, yield per plot (kg) and per hectare (q) was recorded in the treatment having an application of *ghanjeevamrit @* 1.5 t/ha + *jeevamrit* spray @ 15 per cent (G_2J_2).The incidence of tomato fruit borer was lowest in the plots which were treated with *ghanjeevamrit* @1.5 t/ha (G_2). The plots treated with *jeevamrit* spray @ 20 per cent (J_3) resulted in minimum incidence of tomato fruit borer. However, application of *ghanjeevamrit* @ 1.0 t/ha + *jeevamrit* @ 20 per cent drenching (G_1J_3) resulted in lowest fruit borer incidence. Regarding economics of treatments, highest net returns (Rs. 19,07,348/ha) were recorded in G_2J_2 followed by G_2J_3 (Rs. 17,34,788/ha), whereas lowest net returns (Rs. 8,17,098 /ha) were recorded in G_2J_2. Treatment G_2J_2 (7.79) recorded highest B: C followed by G_2J_3 (7.06) and G_1J_3 (3.60).

Table 1: Effect of crop intensification on vegetative, yield, quality traits and incidence of fruit borer (%) of tomato grown under natural farming system

Particular	Plant height (cm)	Days to 50% flowering	No. of fruits per cluster	Fruit weight (g)	No. of fruits per plant	Fruit yield per plant (g)	Harvest duration	Yield per plot (kg)	Yield per hectare (q)	TSS (°Brix)	Ascorbic acid(mg)	Incidence of fruit borer (%)
Ghanjeevamrit												
G_0	146.73	39.25	5.28	56.06	19.85	894.59	41.92	17.86	264.63	3.98	27.51	2.94
G_1	153.25	35.58	5.48	60.21	23.63	1055.51	43.92	21.21	314.27	3.97	27.50	2.79
G_2	159.19	39.50	5.94	61.95	25.19	1155.54	45.25	23.22	344.03	3.86	28.88	2.71
$CD_{0.05}$ (G)	**4.54**	**3.32**	**0.23**	**1.35**	**0.72**	**51.29**	**1.70**	**1.02**	**15.09**	**NS**	**NS**	**0.13**
Jeevamrit												
J_0	144.96	37.22	5.19	55.78	18.58	776.91	39.22	15.58	230.79	3.81	27.89	3.24
J_1	148.11	38.78	5.58	58.64	21.59	1011.27	44.44	20.34	301.33	4.03	29.25	2.97
J_2	157.99	38.33	5.82	61.33	25.27	1163.19	45.11	23.41	346.80	3.97	27.95	2.62
J_3	161.18	38.11	5.68	61.88	26.12	1189.49	46.00	23.74	351.66	3.93	26.77	2.41
$CD_{0.05}$ (J)	**5.24**	**NS**	**0.26**	**1.56**	**0.72**	**59.23**	**1.97**	**1.18**	**17.43**	**NS**	**NS**	**0.15**
Interaction (G×J)												
G_0J_0	137.07	40.33	4.73	51.72	16.00	655.37	38.33	12.98	192.30	3.54	27.16	3.34
G_0J_1	145.79	41.33	5.37	53.10	19.90	823.12	42.00	16.68	247.15	4.25	30.28	2.99
G_0J_2	151.10	38.33	5.53	59.92	21.20	975.89	43.00	19.56	289.82	4.00	28.02	2.80
G_0J_3	152.96	37.00	5.47	59.51	22.30	1123.97	44.33	22.22	329.25	4.12	24.56	2.59
G_1J_0	148.14	34.33	5.17	56.91	19.80	786.78	39.00	15.72	232.86	3.97	28.49	3.21
G_1J_1	144.41	36.33	5.67	59.87	21.00	1064.12	45.00	21.24	314.61	3.99	27.24	2.97
G_1J_2	153.34	36.33	5.43	60.62	25.83	1174.24	45.00	23.60	349.65	4.15	26.57	2.70
G_1J_3	167.13	35.33	5.67	63.44	27.87	1196.91	46.67	24.30	359.96	3.75	27.71	2.29
G_2J_0	149.66	37.00	5.67	58.72	19.93	888.58	40.33	18.04	267.23	3.91	28.02	3.15
G_2J_1	154.13	38.67	5.70	62.94	23.87	1146.58	46.33	23.10	342.21	3.85	30.22	2.95
G_2J_2	169.53	40.33	6.50	63.46	28.77	1339.44	47.33	27.06	400.91	3.77	29.25	2.34
G_2J_3	163.44	42.00	5.90	62.70	28.20	1247.58	47.00	24.69	365.78	3.92	28.03	2.36
$CD_{0.05}$ (G×J)	**9.08**	**NS**	**0.45**	**2.71**	**1.45**	**102.59**	**NS**	**2.04**	**30.19**	**NS**	**NS**	**NS**

References

Palekar S. 2006. Shoonya bando valadanai sargika krushi, published by *Swamy Anand, Agri Prakashana*, Banglore, India.

ESFS-NF/APCR2024/1049

Natural farming practices for sustaining soil health under different agroecology in Bihar

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Keywords: Agroecology, natural farming, soil health.

Introduction

Green revolution increased crop yields but resulted in negative environmental health (e.g. soil degradation, greenhouse gas emissions, biodiversity losses) and economic impacts (Agoramoorthy, 2008 and Duddigan et al., 2023). There has been huge growth in alternative farming systems in India and globally, including agroecology, organic farming, sustainable intensification, conservation agriculture, and minimum tillage or no-till systems (Fitzpatrick et al., 2022). The largest alternative farming movement in India i.e. Natural Farming (NF), began as a grassroot social movement, is one such low-input, climate-resilient type of farming that encourages farmers to use low cost locally-sourced inputs, eliminating the use of artificial fertilizers, and industrial pesticides. Thus, the current studies conducted to evaluate the status of soil health by adopting natural farming practices by the farmers under different agroecology in Bihar.

Material and methods

Thirty surface soil samples (0-15 cm) were collected from 15 famers' fields of five district of Bihar during April-May, 2024. Out of 30 samples, 15 samples were collected from the fields being treated with natural farming inputs and another 15 from conventional fields of the same farmer. The collected soil samples were processed and analyzed for physico-chemical properties following standard procedure.

Results and conclusion

The different physico-chemical properties and DHA (Dehydogenase activity) of soils were found enhanced/improved due to adoption of natural farming practices over conventional methods by the farmers. The average pH, OC (%), available N(kg/ha), available P (mg/kg), available K (mg/kg), available S (mg/kg), available Zn (mg/kg), Zn (mg/kg) and Dehydrogenase (µg TPF /g soil/ 24 hr) in natural farming and conventional farming were found as 7.58 & 7.72; 0.75 & 0.68; 248.3 & 220.3; 23.2 & 19.9; 64.6 & 52.2; 18.2 & 15.6; 21.5 & 20.6; 1.24 & 1.06 and 116.0 & 84.7 respectively. The variability in different properties was due to different management practices and variability in natural farming inputs being followed by the farmers.

The changes in microbial properties were more pronounced than the chemical changes. Also the pH under natural farming practices was found decreased towards normal range over the conventional practices. Among different nutrients, maximum increase was recorded for K (23.8%) under natural farming over conventional practices (Fig 1) that might be due to addition of crop residue and cow dung/urine. The present study indicates that adoption of natural inputs enhances the soil health and makes the soil more resilient towards changing climate and thus, improves the nutrient supply for sustainable crop production.

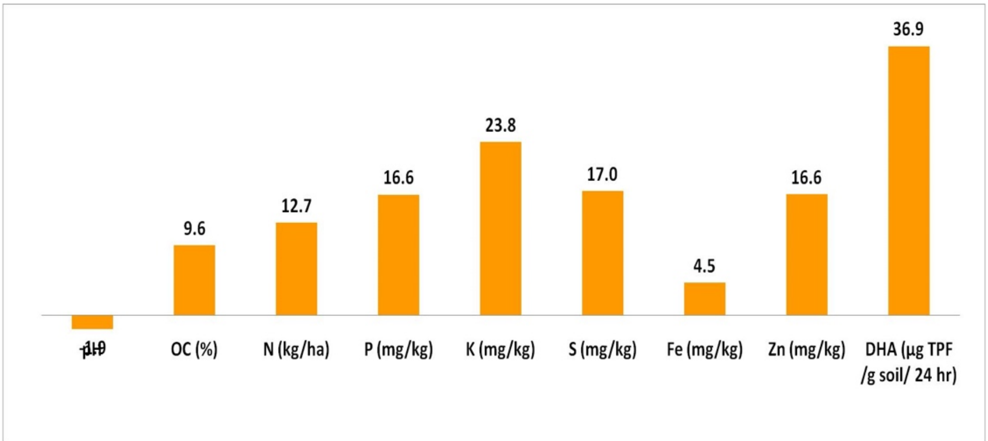

Fig 1. Status of soil under natural over conventional farming

References

Agoramoorthy G. 2008. Can India meet the increasing food demand by 2020? *Futures* 40: 503–506.

Duddigan Sarah, Shaw Liz J, Sizmur Tom, Gogu Dharmendar, Hussain Zakir, Jirra Kiranmai, Hamika Kaliki, Rahul Sanka, Mohammad Sohail, Reshma Soma, Vijay Thallam, Haripriya Vattikuti, Chris D. Collins. 2023. Natural farming improves crop yield in SE India when compared to conventional or organic systems by enhancing soil quality. *Agronomy for Sustainable Development*. 43:31

Fitzpatrick Ian Carlos, Naomi Millner, Franklin Ginn. 2022. Governing the soil: natural farming and bionationalism in India. *Agriculture and Human Values*. 39: 1391–1406.

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Influence of varied levels of ghanjeevamrit and jeevamrit on pea yield and soil nutrient status

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***Keywords*: Conventional farming, Natural Farming, Soil health, Sustainability**

Introduction

Approximately 58% of Indians rely on agriculture as their primary source of income. The country's exceptional agricultural expansion was realized in the 1960s following the advent of the Green Revolution. The input-intensive "Green Revolution," while successful, has obscured significant externalities in recent decades that have harmed human health, natural resources, and agriculture itself (Koner and Laha 2021). As a result, there was widespread misery in the farming sector and many farmers fell into the debt trap. The novel agricultural technique known as "natural farming" (NF) has the potential to achieve both environmental preservation and global food security (Duddigan et al. 2023). With the foregoing background information in mind, the purpose of this study was to assess how NF practices affected the yield of pea crop and soil health.

Material and methods

Field experiment was conducted at Krishi Vigyan Kendra Shimla, Rohru, during *rabi* 2022-23 and2023-24. Soil was sandy loam in texture in texture (pH 5.74, organic C 0.81 %, N (226.4 kg ha-1), P(39.7 kg ha-1) and K (442.9 kg ha-1) before the start of the experiment. The research design used randomized block design arranged in factorial (RBD) with 2 factors. Factor one comprises of three Ghanjeevamrit application rates, viz. 0 t ha^{-1}, 1.5 t ha^{-1} and 2.0 t ha^{-1} and other factor comprises of three jeevamrit foliar spray rates, viz. 0, 10, and 20 % along with one control (conventional farming).

Results and conclusion

The results showed that the highest pea equivalent yield was obtained with application of ghanjeevamrit @ 2.0 t ha^{-1}, which was however statistically at par with plots receiving ghanjeevamrit @ 1.5 t ha^{-1}. Comparing plots under conventional farming approach to those under natural farming practice, the latter showed a marginally non-significant increase in pea equivalent yield. The available soil nutrients and the pH of the soil also displayed comparable outcomes. On the other hand, jeevamrit foliar sprays had no discernible effect on the investigated soil parameters; instead, application of ghanjeevamrit at a rate of 2.0 t ha^{-1} produced the highest results. In conclusion, natural farming outperformed conventional farming in terms of pea equivalent yield, indicating an improvement in and/or sustaining the soil quality parameters under investigation in the present study.

Table 1: Effect of Ghanjeevamrit and Jeevamrit on equivalent yield (PEY) and soil chemical properties of pea

Treatment	pH	OC (%)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})	PEY (t ha^{-1})
Ghanjeevamrit (t/ha)						
0	5.75	0.90	229.9	39.9	440.2	105.0
1.5	5.77	0.94	234.4	40.7	442.6	111.9
2	5.81	0.97	235.8	41.0	444.1	116.2
F value	2.34	4.09	4.25	3.78	0.21	7.38
P value	0.129	0.037	0.033	0.045	0.81	0.005
Jeevamrit (%)						
0	5.77	0.93	232.3	40.4	441.3	109.9
10	5.77	0.94	233.8	40.7	442.4	110.4
20	5.79	0.94	234.1	40.7	443.2	112.8
F value	0.28	0.17	0.43	0.27	0.05	0.55
P value	0.758	0.845	0.659	0.765	0.95	0.589
Natural Farming vs Conventional Farming						
Natural Farming	5.78	0.94	233.4	40.6	442.3	111.0
Conventional Farming	5.71	0.87	231.7	42.3	448.6	110.8
F value	3.71	4.48	0.36	8.99	0.68	0.00
P value	0.070	0.048	0.557	0.008	0.42	0.954
Initial value	5.74	0.86	226.4	39.7	443.0	-

References

Duddigan S, Shaw LJ, Sizmur T, Gogu D, Hussain Z, Jirra K, Kaliki H, Sanka R Sohail M, Soma R and Collins CD. 2023. Natural farming improves crop yield in SE India when compared to conventional or organic systems by enhancing soil quality. *Agronomy for Sustainable Development* 43(2): 1-15.

Koner N and Laha A. 2021. Economics of alternative models of organic farming: empirical evidences from zero budget natural farming and scientific organic farming in West Bengal, India. *International Journal of Agricultural Sustainability* 19(3-4): 255-268.

ESFS-NF/APCR2024/1051

Response of okra to natural farming practices under sub-tropical low hill conditions

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Keywords: BC ratio, Ghanjeevamrit, Jeevamrit, Soybean, Yield.

Introduction

Okra (*Abelmoschus esculentus* L.) is an economically important vegetable crop belongs to family Malvaceae and grown throughout the tropics, subtropics and warm temperate regions. Okra is a rich source of iodine; 100 g fresh fruit contain calcium 66 mg, phosphorus 56 mg, 1.9 % protein, 6.4 % carbohydrate, 1.2 % fibre, 13 mg vitamin C etc. As the demand for healthy and residue free quality food is increasing all over the world, alternative farming approaches like natural farming is the option. Natural cultivation methods, which avoid synthetic chemicals and prioritize eco-friendly practices, are gaining traction for their role in sustainable development. This approach supports the production of quality and healthy foods while minimizing environmental impact. Therefore, in the present study an attempt has been made to study the effect of various natural farming practices on okra yield and growth parameters.

Material and methods

The present study was undertaken at RHRTS, Jachh during April-Mid August in the year 2024. The seeds of Okra *cv. P-8* were sown at a spacing of 60 x 20 cm on raised beds of size 9 m^2 with two rows on each bed and one intercrop. Natural farming practices were evaluated in a randomized block design with three replications. Straw mulching @ 10 t/ha was done in between the beds and Soybean was used as an intercrop and green mulch. Alternate spray of neemashtra, brahmashtra and khatti lassi @ 3% was followed at 15 days interval in all the treatments. The treatments were comprised of different levels of jeevamrit spray @ 10 and 20 % at 15 days interval and ghanjeevamrit @ 2 t/ha as basal dose. Observations were recorded on 10 randomly marked plants in each bed on number of fruits per plant, fruit length, average fruit weight, number of branches, plant height, fruit yield per plant.

Results and conclusion

Okra cultivation under natural practices exhibit variability with respect to various growth and yield parameters (Table 1). The results revealed that treatment T_5 (Okra + Soybean + ghanjeevamrit @ 2 t/ha + jeevamrit spray @ 10 % at 15 days interval) significantly resulted in maximum plant height (126.0 cm), no. of fruits/plant (26.44) and yield (23.84 t/ha), which was significantly at par with T_3 (Okra + Soybean + Jeevamrit spray @ 10%). Meena *et al.* 2021 studied performance of different okra varieties and reported 21.07 no. of fruits per plant, 117.40 cm plant height, 11.08 gm fruit weight, 224.09 gm/plant fruit yield of okra *cv P-8.* In terms of economics benefit-cost ratio (3.01) was also recorded highest under T_5 followed by T_3 and T_8. Sharma *et al.* 2020 reported 3.43 benefit-cost ratio under natural farming practice and 2.94 under organic farming.

Table 1: Effect of natural farming on yield, growth parameters and economics of okra

Treatment	Plant height (cm)	No. of fruits/plant	Yield (gm/plant)	Yield (t/ha)	B:C ratio
T_1 (Okra + Jeevamrit spray @ 10%)	109.33	22.11	235.50	18.84	2.35
T_2 (Okra + Jeevamrit spray @ 20%)	107.44	17.89	182.53	14.60	1.68
T_3 (Okra + Soybean + Jeevamrit spray @ 10%)	111.83	24.67	260.13	20.81	2.56
T_4 (Okra + Soybean + Jeevamrit spray @ 20%)	109.00	19.89	205.90	16.47	1.92
T_5 (Okra + Soybean + Ghanjeevamrit @ 2t/ha + Jeevamrit spray @ 10%)	126.00	26.44	298.00	23.84	3.01
T_6 (Okra + Soybean + Ghanjeevamrit @ 2t/ha + Jeevamrit spray @ 20%)	120.00	24.00	245.97	19.68	2.17
T_7 (Okra + Ghanjeevamrit @ 2 t/ha)	118.11	17.12	171.07	13.68	1.91
T_8 (Control)	110.13	17.11	171.37	13.71	2.40
CD (0.05)	10.88	3.73	46.84	3.746	

References

Sharma Anchal. 2020. Performance of okra (*Abelmoschus esculentus*) varieties under organic, natural and conventional farming practices. M.Sc. Thesis.

Meena MK, Moond SK, Devkaran, Meena M and Khardu S. 2021. Performance studies on different okra varieties and hybrids under arid climatic conditions of Rajasthan. *Journal of Agriculture and Ecology* 11: 37-43.

ESFS-NF/APCR2024/1052

Harnessing potential of natural farming inputs on wheat yield and soil properties in Eastern India

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Introduction

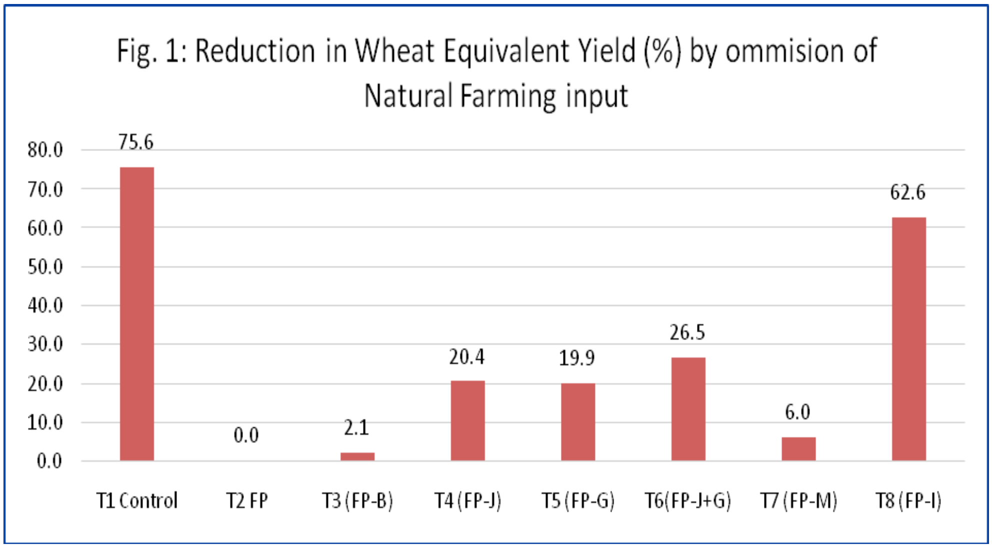
Natural farming, is an agroecology- based farming system and popularly known as low-cost farming system. It is an innovative and noble farming approach as the inputs prepared in farmers premise using cow-dung, cow-urine and locally available natural herbs, thereby reducing the use of synthetic inputs. This practice is gaining popularity among farmers across the country due to quality produce, soil health improvement and cost reduction approach (Kumar *et al.* 2023). Natural farming system emphasized on poly-crop cultivation on the same land, including legumes to ensure proper land utilization, soil fertility maintenance, better income and overall health.

Material and methods

A field experiment was conducted at Natural Farming Demonstration Unit, RPCAU, Pusa, Bihar during *Rabi* 2023-24 to study the potential of natural farming inputs on growth and yield attributes of wheat (var. *Sharbati)* and soil properties in eastern India by adopting omission plot techniques.The experiment constituted of eight treatments i.e. Control (No any input), Full package (FP) of natural farming (Beejamrita + Jeevamrita + Ghanjeevamrita + Mulching + Intercropping with faba bean), FP excluding Beejamrita, FP excluding Jeevamrita, FP excluding Ghanjeevamrita, FP excluding Jeevamrita & Ghanjeevamrita, FP excluding Mulching and FP excluding Intercropping; replicated thrice in calcareous, non-saline, alkaline soil with medium soil organic carbon. Desi cowdung/urine and locally available natural herbs were used for input preparations. Jeevamrita (500 l /ha) with irrigation water and Ghanjeevamrita (500kg/ha) were applied at the time of field preparations. Previous rice crop residue was used for mulching (4-5 cm).

Results and conclusion

Result revealed that full package of natural farming (T_2) was found to produce significantly highest plant height (93.39 cm), number of effective tillers/m^2 area (155.63), dry matter accumulation (471.64 g), length of spike (14.20 cm), grains/spike (42.33) and wheat equivalent yield (3981.17 kg/ha). Omission of natural farming inputs substantially decreased the wheat equivalent yield. The wheat equivalent yield obtained in treatments with omission of Beejamrita (3897.77 kg/ha) oromission of Mulching (3740.95 kg/ha)were statistically at par with full package of natural farming. Further, an omission of natural input such as Jeevamrita, Ghanjeevamrita and Intercropping significantly decreased the growth, yield attributes of wheat and wheat equivalent yield (Fig.1).



B:C ratio was found highest with full package treatment (2.18) and it was 0.48 with treatment having omission of legume as intercrop. Under the influence of omission of natural inputs, soil characteristics such as organic carbon, available phosphorus, available potassium, available sulphur significantly decreased except in full package treatment and treatment with omission of Beejamrita. The soil biological properties as observed in terms of microbial population and enzymatic activities, were significantly affected by natural farming practices. From this study it can be inferred that each natural farming inputs have a great role in achieving yield of crops and soil fertility maintenance. Intercropping with legume specially in wheat, play a very crucial role in achieving the potential yield in natural farming.

References

Kumar R, Kumar S, Yashavanth BS, Venu Nakeertha, Meena PC, Dhandapani A and Kumar Alok. 2023. Natural Farming Practices for Chemical-Free Agriculture: Implications for Crop Yield and Profitability. *Agriculture* 13(3): 647

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Ameliorating potentials of natural bio-formulations and *Azolla* in fenugreek-coriander based intercropped strawberry

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Keywords: Bio-formulations, Fruit yield, Sustainability

Introduction

Natural farming is recognised as a practical and affordable solution to farmers in order to improve soil health, lower production costs, and use less water. This type of agro-ecological farming excludes all synthetic chemical inputs and recycles biomass on the farm. Innovative nutri-sensitive farming practices can be an affordable way to advance wellbeing and health. The potential influence of natural farm inputs on high-quality and sustainable strawberry production is highlighted in the current study.

Material and methods

Biological modifications namely, *Ghan-Jeevamrit* and *Jeevamrit* have been used. Ghan-Jeevamrit contained 4-5 days air dried indigenous cow dung (100 kg), raw sugar (1 kg), pulse flour (1 kg), cow urine (3 L) and undisturbed bunds/ forest soil (250 g). Natural farm inputs were applied at growth stages namely, transplanting, crown formation and fruit set. The trial included, T_1: *Ghan-Jeevamrit* @ 750 g/m^2 (3 times each at 250 g/m^2)+ *Jeevamrit* @ 1L; T_2: *Ghan-Jeevamrit* @ 500 g/m^2 (2 times each at 250 g/m^2)+ *Jeevamrit* @ 1L+*Azolla*; T_3: *Ghan-Jeevamrit* @ 1500 g/m^2 (3 times each at 500 g/m^2)+ *Jeevamrit* @ 1L; T_4: *Ghan-Jeevamrit* @ 1000g /m^2 (2 times each at 500 g/m^2)+ *Jeevamrit*@ 1L+ Azolla; T_5: *Ghan-Jeevamrit* @ 2250 g/m^2 (3 times each at 750 g/m^2)+ *Jeevamrit*@ 1L; T_6: *Ghan-Jeevamrit* @ 1500g/m^2 (2 times each at 750 g/m^2) + *Jeevamrit*@ 1L+ *Azolla*; T_7: *Ghan-Jeevamrit* @1500 g/m^2 (250+500+750 g/m^2)+ *Jeevamrit*@ 1L; T_8: *Ghan-Jeevamrit* @1000 g/m^2 (250 Stage-I+750 g/m^2)+ *Jeevamrit*@ 1L+ *Azolla*; T_9: *Ghan-Jeevamrit* @1500 g/m^2 (750+500+250 g/m^2)+ Jeevamrit@ 1L; T_{10}: Ghan-Jeevamrit @ 1250 g/m^2 (750 Stage-I+500 g/m^2)+ Jeevamrit@ 1L+ *Azolla*.

Results and conclusion

Application of *Ghan-Jeevamrit* @ 1500 g/m^2 + Jeevamrit@ 1L+ *Azolla* had a significant impact on production, quality metrics of strawberry fruits. Leaf area was also exhibited maximum (81.1 cm) in treatment T_6, whereas, it was minimum (63.6 cm) in T_5. Similarly, number of crowns (6.5 cm) was noted maximum in treatment T_6; however, statistically similar effects were displayed for all the applied treatments. This combination also registered maximum yield (271.5 g/plant). The study concluded that bio-mobilization and recycling of native nutrients encouraged dehydrogenases and acid phosphatase enzymatic activity to maintain soil health and productivity for sustainable strawberry production.

References

Kumar, P., Sharma, N., Sharma, S. and Gupta R. 2020. Rhizosphere stochiometry, fruit yield, quality attributes and growth response to PGPR transplant amendments in strawberry growing on solarized soils. *Scientia Hortic*. 265: 108-121.

Saini S, Kumar P, Sharma NC, Sharma N and Balachandar D. 2021. Nano-enabled Zn fertilization against conventional Zn analogues in strawberry. *Scientia Hortic*. 282, 110016.

ESFS-NF/APCR2024/1054

Evaluation of different genotypes of carnation on application of jeevamrit and recommended doze of fertilization

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Keywords: Carnation, genotype evaluation, jeevamrit, organic farming

Introduction

Carnation (*Dianthus caryophyllus* L.), a member of the Caryophyllaceae family, is a highly sought-after flower in global trade. The thriving cut flower industry heavily relies on chemical fertilizers, causing several issues such as soil and water pollution, escalating fertilizer prices, and scarcity. This necessitates exploring, testing and advocating for eco-friendly alternatives and supplements. Hence, the study focused on the objectives to find out the possibility of organic cultivation of carnation and to identify suitable genotype(s) for organic and inorganic cultivation.

Material and methods

The experiment comprised of fourteen genotypes of carnation and two fertilization treatments: 1) RDF i.e., 10-10-10 g/m^2 NPK (as basal dose) + 100 ppm N + 140 ppm K (as fertigation- twice a week) which was incorporated in the form of 87 mg of urea, 311 mg of multi-K and 129 mg of calcium nitrate in 1 litre of water (Momin, 2012) and ii) Jeevamrit @ 20 ml/plant as drenching at 30 days interval, which was prepared by mixing cow dung- 1 kg, cow urine- 1 litre, jaggery- 200 g, pulse flour- 200 g and a handful soil and water was added to make up to a volume of 20 litres which was then allowed to ferment for four days (Palekar, 2006). On the fifth day of fermentation, drenching was done at 20 ml per plant at 1:4 dilutions. The experiment was laid out replicated thrice in spacing of 20 x 20 cm with 24 plants/m^2. Treatments were started at 30 days after transplanting.

Results and conclusion

Among the genotypes, longest stem length was recorded in genotype 'Bizet' (84.95 cm), all the genotypes under study attained stem length of more than 45 cm hence all the genotypes fall under 'A' grade. All the genotypes recorded stem sturdiness of less than 15°, hence all genotypes fall under 'A' grade. Maximum flower size was recorded in genotype 'Raggio-de-Sole' (6.37 cm). The genotype 'Bizet' also recorded maximum number of flowers per square metre (144.80), maximum duration of flowering (78.00 days) and maximum vase life (8.10 days). Longer stem length was obtained in treatment with Jeevamrit (74.36 cm) as compared to RDF (73.35 cm). Jeevamrit (8.59°) recorded lesser deviation of the stem as compared to RDF (8.85°) which mean both the treatments fall under 'A' grade as both the treatments recorded stem sturdiness of less than 15°. Larger flower size was recorded with Jeevamrit (5.93 cm) as compared to RDF (5.87 cm). More number of flowers per square metre was also obtained in Jeevamrit (133.20) while RDF recorded 129.22. Longer duration of flowering was observed Jeevamrit (72.20 days) as compared to RDF (66.37 days). The vase life was same in both the treatment i.e., RDF and Jeevmrit which was 7.27 days.

References

Palekar S. 2006. *Text book on Shoonya Bandovalada Naisargika Krushi*, Swamy Anand, Agri Prakashana, Bangalore, India, 154p.

Momin KC. 2012. Effect of nutrient management on cutting production, storage and rooting of carnation (*Dianthus caryophyllus* L.). PhD Thesis. Department of Floriculture and Landscape Architecture, YSPUHF, Nauni, Solan (H.P), India. 119p.

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Effect of cow based and chemical based fertilizer on quality production and soil nutrition of annual chrysanthemum

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Keywords: *Glebionis coronaria*, Jeevamrit, Production

Introduction

Despite the crucial role floricultural crops play in agriculture, particularly in industries like cosmetics, pharmaceuticals, nutraceuticals, poultry and perfumery, there remains a significant research gap in natural farming for these crops (Pathania et al 2024). Therefore, sustainable cultivation of floricultural crops, especially loose and cut flowers as well as superior seed production through natural farming, presents a promising alternative to farming systems reliant on chemical fertilizers.

Material and methods

The study was determined the best treatments for boosting growth, flowering and quality seed production in *Glebionis coronaria* L. Spach,. The experiment included 9 treatments: T_1 (jeevamrit @ 5%), T_2 (jeevamrit @ 10%), T_3 (jeevamrit @15%), T_4 (jeevamrit @ 20%), T_5 (jeevamrit @ 25%), T_6 (jeevamrit @ 30%) and T_7 (jeevamrit @ 35%) applied every 15 days interval, T_8 (RDF) and T_9 (Absolute control) and was arranged in a randomized block design with three replications.

Results and conclusion

The results revealed that T_8 yielded the best results in terms of vegetative growth, flowering and seed yield, but these were statistically comparable to those obtained with T_7 (jeevamrit @ 35%), followed by T_6 (jeevamrit @ 30%). Additionally, the use of natural farming treatments (T_6 and T_7) significantly enhanced the soil's population of beneficial microorganisms (bacteria, fungi, and actinomycetes) and gave comparable results for soil macro-nutrient levels. This approach not only enhances plant growth and flowering but also fosters a healthy soil microbiome, promoting long-term productivity and sustainable, eco-friendly agriculture.

Table 1: Effect of natural farming on performance of chrysanthemum

Treatment	Days taken to first flowering	Duration of flowering (days)	No. of flower heads / plant	Diameter of flower heads (cm)	No. of seeds / head	Seed yield (g)
T_1	86.91	39.71	246.93	3.58	228.21	8.8
T_2	87.13	41.58	249.73	3.72	231.85	8.92
T_3	87.89	43.16	255.07	3.72	233.2	9.07
T_4	88.04	43.94	256.03	4.07	234.67	9.17
T_5	90.39	45.25	256.4	4.18	235.3	9.27
T_6	95.7	47.89	259.67	4.25	237.93	9.41
T_7	96.72	48.76	261.77	4.32	238.29	9.74
T_8	97.53	49.33	263.1	4.06	238.51	9.88
T_9	86.11	35.94	210.48	3.35	220.63	8.37
$CD_{0.05}$	2.35	1.83	3.47	0.26	2.32	0.18

References

Pathania S, Dhiman SR, Kashyap B, Kumar A, Kaushal R, Gupta RK, Saleh IA, Okla MK and Elshikh MS. 2024. Influence of planting dates and fertilizer modules on yield of chrysanthemum and soil health. *BMC Plant Biology* 24: 510.

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Optimizing agro-ecological fertilization in agroforestry systems of north-western Himalayas

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Introduction

Natural resource management through agroecological practices is vital for enhancing climate resilience in agricultural systems. The integration of organic fertilizers such as Farmyard Manure (FYM), Vermicompost (VC), and bio-inputs like Jeevamrut into crop management strategies can significantly influence plant growth, yield, and economic returns. This study aimed to evaluate the effects of different fertilizers on key agronomic parameters and provide valuable insights into how sustainable fertilization practices can elevate productivity and foster long-term soil health. These practices not only optimize agricultural output but also strengthen the resilience of farming systems against climate variability, promoting a more sustainable and robust agricultural future.

Material and methods

The experiment included six treatments: Control (T_0), Farmyard Manure (FYM, T_1), Vermicompost (VC, T_2), Jeevamrut (T_3), a combination of FYM and VC (T_4), and Recommended Dose of Fertilizers (RDF, T_5). Data collection focused on key agronomic parameters viz. plant height, number of pods per plant, yield per hectare to evaluate the effectiveness of each fertilization practice. The economic viability of each treatment was also analyzed by calculating net returns and the BC ratio, providing a comprehensive assessment of both agronomic and economic outcomes. This approach aimed to identify the most effective fertilization practices that can be integrated into agroforestry systems.

Results and conclusion

Application of FYM (T_1) led to the best overall performance across all parameters, with the tallest plants (55.29 cm), the highest number of pods per plant (22.17), the greatest yield per hectare (6.04 t ha^{-1}), and the highest net returns (Rs. 130724) along with a BC ratio of 2.21. In comparison, the control treatment (T_0) resulted in the shortest plants (48.23 cm), the fewest pods per plant (15.40), and a lower yield (4.47 t ha^{-1}), though it still had a relatively high BC ratio of 2.01. Other treatments, including VC (T_2), Jeevamrut (T_3), FYM+VC (T_4), and RDF (T_5), showed varying degrees of improvement over the control.

The study highlights the effectiveness of FYM as the most beneficial treatment for enhancing crop productivity and economic returns, suggesting its potential as a key component in sustainable agroecological practices. The superiority of organic fertilizers, such as FYM, can be linked to the beneficial influence of organic manure in providing nutrients for a longer duration, particularly during the crucial stages of plant growth (Paramesh et al. 2023). The findings underscore the importance of integrating organic inputs into natural resource management strategies to build resilient agricultural systems capable of withstanding climate-related challenges.

Table 1: Agro-ecological fertilization in agroforestry systems

Treatment	Plant height (cm)	No. of pods plant^{-1}	Yield /hectare (t ha^{-1})	Net returns (Rs)	B:C
T_0 (Control)	48.23	15.40	4.47	96599.95	2.01
T_1 (FYM)	55.29	22.17	6.04	130724.2	2.21
T_2 (VC)	51.33	17.93	5.21	93418.85	1.77
T_3 (Jeevamrut)	48.29	17.55	4.60	98960.84	2.02
T_4 (FYM+VC)	49.02	19.93	5.25	101767.1	1.89
T_5(RDF)	49.04	16.45	5.23	58824.29	1.22

References

Paramesh V, Kumar P, Bhagat T, Nath AJ, Manohara KK, Das B, Desai BF, Jha PK and Prasad PVV 2023. Integrated nutrient management enhances yield, improves soil quality, and conserves energy under the lowland rice–rice cropping system. *Agronomy* 13(6): 1557.

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Development biology of *Helicoverpa armigera*: An emerging threat to sustainable apple production

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Keywords: Development biology, *Helicoverpa armigera*

Introduction

Apple (*Malus* x *domestica* Borkh.), a member of family Rosaceae is primarily grown in Jammu-Kashmir, Himachal Pradesh and Uttarakhand. It has an output of 481.06000 MT and the area under apple cultivation in Himachal Pradesh is 114.65000 ha. The plants are attacked by various insect pests but in the recent years, *H. armigera* has been found feeding on immature stages (pea and walnut) of apples. This might be due to change in the climate, inclement use of pesticides etc. which has resulted the *H. armigera* to shift its host preference to apple fruit. Therefore, the present study evaluated the feeding preference of *H. armigera* in different varieties during immature stages by studying the biological parameters of *H. armigera*.

Material and methods

Developmental biology of *H. armigera* was studied on different apple varieties *viz.,* Super chief and Redlum gala under laboratory conditions. A cohort of 50 eggs were taken and apple leaves were provided as food for first instar larvae. The larvae was then shifted to Helico rearing trays on moulting and reared on immaturestages of apple fruits (pea stage). Food and oviposition substrate were changed daily till the last adult died. The biology parameters were determined using 100,000 bootstrap replicates to obtain stable SE estimates.

Results and conclusion

The results of the study revealed that the mean duration of incubation and larval period of 1st, 2nd ,3rd 4th and 5th instars was 3.03, 2.83, 2.93, 3, 5.32 and 10.93 in Super Chief as compared to 2.9, 3.5 3.14, 3.7,4.19 and 7.72 in Gala Redlum. The pupal period of Gala Redlum was 14.2 as compared to 10.93 in Super Chief . Whereas, the pre-adult period was lesser in case of Super Chief 31.44 as compared to Gala Redlum 39.28. The total pre-oviposition period of Super Chief was 32.69as compared to 41.92 in Gala Redlum.

The present study showcased that *H. armigera* completed its life cycle in both the varieties but in case of super chief it was able to complete the life cycle more faster than the Gala Redlum which shows that it can be a threat to sustainable apple production in Himachal Pradesh. Thus more comprehensive studies on other commercial varieties (immature stage) and role of different secondary metabolites are required to find the host preference of *H. armigera*.

Table 1: Development biology of *Helicoverpa armigera* on pea stage of apple

Parameters	Estimate ± SE	
	Super Chief	Gala Redlum
Egg period	3.03±0.121	2.9±0.121
1st instar	2.83±0.157	3.5±0.157
2nd instar	2.93±0.138	3.14±0.138
3rd instar	3±0.176	3.7±0.176
4th instar	5.32±0.262	4.19±0.262
5th instar	10.93±0.248	7.72±0.248
Pupal period	10.93±0.563	14.2±0.563
Pre adult	31.44±0.404	39.28±0.404
Male longevity	13.16±0.352	11.26±0.752
Female longevity	12.05±0.217	13.65±0.517
Adult Pre- oviposition period	1.94±0.14	2.69±0.24
Total Pre-oviposition period	32.69±0.84	41.92±1.02
Oviposition days	7.44±0.33	8.46±0.29

References

Huang YB and Chi H. 2012. Age-stage, two-sex life tables of *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae) with a discussion on the problem of applying female age-specific life tables to insect populations. *In.Sci.*19(2):263-273.

ESFS-NF/APCR2024/1058

Response of rhizosphere microbial community influencing soil properties, under natural farming system

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Introduction

Understanding the rhizosphere soil microbial community is critical for maintaining soil health and fertility. The health of rhizosphere soil micro-organisms is an important indicator to evaluate soil quality. Therefore, understanding the response of rhizosphere soil microorganisms to natural farming and conventional farming system is crucial for promoting the sustainable development of agriculture.

Material and methods

The viable microbial diversity and total bacterial community structure of rhizosphere soil collected from farming system developed under CF and NF were analysed by culture based (Plate assay) and non-culture based techniques (Illumina platform) using metagenomic approach.

Results and conclusion

Continuous cropping cause rhizosphere soil acidification and reduction in alkaline nitrogen (AN) and soil organic matter (SOM). It is universally accepted fact that the continuous cropping over the years in the same farm reduces the diversity of rhizosphere soil microbial communities, increasing harmful functional microorganisms and declining beneficial ones (Rao et al. 2022). The abundance of bacteria that perform nitrification and saprophytic fungi in the rhizosphere soil of continuous cropping areas under CF system decreases, inhibiting carbon and nitrogen cycling processes (Jacoby et al. 2017). The present finding revealed that the rhizosphere soil under NF system showed higher contents of organic matter, soil nutrients, soil enzymes and diverse microbial community structure in comparison to rhizosphere soil under CF system. Maximum viable bacteria, actinomycetes and fungal count was observed from the rhizosphere soil of NF system $192.00 \pm 1.73 \times 10^6$ cfu/g, $74.33 \pm 0.33 \times 10^3$ cfu/g and $16.67 \pm 0.33 \times 10^3$ cfu/g), whereas minimum bacteria, actinomycetes and fungal count was observed for the rhizosphere soil under CF ($103.67 \pm 1.20 \times 10^6$cfu/g, $42.00 \pm 1.15 \times 10^3$cfu/g and $11.33 \pm 0.33 \times 10^3$cfu/g), respectively. Total bacterial community structure in rhizosphere soil of NF system showed an impressive range of taxa, including phyla, classes, orders, families, genera, and species. The dominant phyla in all rhizosphere soil samples were Proteobacteria, Acidobacteria, Actinobacteria, which in combination reached 80%–85%. The observed microbial diversity, community structure, and individual taxon bring novel insights into the potential of managing the microbial community for sustainable agricultural productivity.

References

Jacoby R, Peukert M, Succurro A, Koprivova A, Kopriva S. 2017. The role of soil microorganisms in plant mineral nutrition-current knowledge and future directions. *Front Plant Sci* 8.

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Higher cellular membrane stability and leaf greenness delay senescence in garden pea under natural farming

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***Keywords*:** Greenness, Leaf area duration, Senescence

Introduction

Maintaining extended duration of green leaf area during the grain-filling stage is vital for crop productivity. A higher leaf area index (LAI) enhances light capture, supporting photosynthesis and grain development. The leaf greenness index, reflecting chlorophyll content, indicates the leaf's ability to intercept sunlight. A slower decline in greenness extends leaf activity, contributing to longer light interception. Prolonged leaf area duration (LAD) sustains photosynthesis, ensuring continuous assimilate supply for grain maturation. Stable cell membranes during this period aid nutrient and water transport, keeping leaves functional, extending grain filling, and enhancing stress resilience, leading to improved crop productivity.

Material and methods

This study was conducted during the rabi season of 2023-24 at the Department of Entomology's farm (conventional farming) and the Subhash Palekar Natural Farming farm. The garden pea crop (Cultivar - Punjab 89) was sown on November 4, 2023, following recommended crop production practices for both conventional and natural farming systems to investigate the post-flowering senescence process. Physiological parameters were measured in fully developed leaves at 15-day intervals post-flowering. Leaf greenness was measured using a chlorophyll meter. LAI was determined based on the exponential decrease in irradiance through the canopy, following the Lambert-Beer law as modified by Monsi-Saeki (Hirose, 2005). Light interception percentage was calculated by comparing irradiance below and above the canopy using a luxmeter. Leaf area duration was calculated as the average LAI multiplied by the time interval. Relative water content was measured following Sade et al. (2015). Duncan's multiple range test was used to compare means.

Results and conclusion

Reproductive phase of the pea crop sown on November 4, 2023, was extended by 16 days under the natural farming system, with flowering beginning on January 19, 2024, and the final harvest on April 29, 2024, spanning 102 days. In contrast, under the conventional farming system, flowering started on January 16, 2024, and the final harvest occurred on April 10, 2024, lasting 86 days. Additionally, a more pronounced decline in leaf greenness index (from 67.76 to 16.36), relative water content (from 92.94% to 67.65%), and green leaf area index (from 2.77 to 0.17) was observed from the first to the seventh fortnight post-flowering in conventional farming, leading to reduced leaf light interception. Moreover, higher cellular membrane stability (ranging from 19% to 200%) in the natural farming system contributed to maintaining leaf functionality throughout the post-flowering period and the slower decline in leaf greenness, extended leaf area duration (Table 1) resulted in prolonged green leaf area by 16 days compared to conventional farming practices.

Table 1: Leaf greenness index, Relative water content, Leaf light interception, Green leaf area index, Green leaf area duration and Cellular membrane stability index under conventional and natural farming system.

FPFI	Leaf greenness index		Relative water content (%)		Green leaf area index		Cellular membrane stability index
	CF	NF	CF	NF	CF	NF	NF over CF
1	67.76±0.77[a]	67.16±1.45[a]	92.94±1.01[ab]	94.75±1.53[a]	2.77±0.11[a]	2.87±0.21[a]	19.22±7.41[c]
2	64.60±1.16[ab]	65.00±1.26[ab]	91.09±1.71[abc]	92.24±156[ab]	2.46±0.19[b]	2.64±0.02[ab]	38.07±8.89[c]
3	57.73±0.77[c]	61.56±0.47[b]	90.09±1.12[abc]	92.15±2.76[ab]	2.09±0.06[c]	2.17±0.11[c]	36.03±5.56[c]
4	48.63±0.87[d]	57.47±1.11[c]	88.62±0.80[bc]	90.76±1.57[abc]	1.49±0.08[e]	1.77±0.05[d]	80.82±5.62[bc]
5	39.11±1.51[f]	54.83±2.26[c]	83.37±1.71[d]	88.92±0.71[bc]	0.98±0.03[f]	1.34±0.06[e]	83.33±8.74[bc]
6	29.27±1.01[g]	44.75±0.92[e]	78.35±0.67[e]	85.84±1.63[cd]	0.54±0.03[g]	0.83±0.03[f]	128.22±29.57[ab]
7	16.37±0.81[h]	27.63±1.14[g]	67.65±3.42[f]	78.12±1.52[e]	0.17±0.02[h]	0.45±0.03[g]	199.98±54.57[a]

FPFI: Fortnight post flowering initiation, CF: Conventional farming, NF: Natural farming Means with same letter at superscript are not significantly different at significance level of 5%.

References

Hirose T. 2005. Development of the Monsi-Saeki theory on canopy structure and function. *Annals of Botany 95*(3): 483-494.

Sade N, Galkin E and Moshelion M. 2015. Measuring Arabidopsis, tomato and barley leaf relative water content (RWC). *Bio-protocol* 5(8), e1451-e1451.

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Bio-organic nutrient sources and their effect on growth and yield of French bean

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***Keywords*: Bio-organic nutrient sources, Ghanjeevamrit, Jeevamrit**

Introduction

Modern agriculture has decreased soil fertility leading to environmental and health risks from excessive synthetic fertilizer use. To combat this, bio-organic nutrient sources like fermented formulations (beejamrit, jeevamrit) and organic manures (vermicompost, farmyard manure) are essential for improving soil health, boosting crop productivity, and minimizing ecological impact. Integrated use of these organic inputs is gaining popularity, especially with rising demand for chemical-free food. Off-season vegetable cultivation, particularly for French bean offers profitable opportunity for sustainable nutrient management practices.

Material and methods

Field experiment on French bean cv. contender was conducted at the Department of Soil Science, College of Horticulture and Forestry, Neri, Himachal Pradesh. The study evaluated bioorganic nutrient sources (vermicompost, FYM, *jeevamrit, ghanjeevamrit*) and inorganic fertilizers for sustainable French bean production and soil health improvement. The randomized block design included three replications. Beans were sown at 75 kg/ha with 45 cm row spacing and 15 cm seed spacing. Irrigation occurred every 10-15 days, depending on crop stage and soil conditions. Beejamrit was used for seed treatment, while jeevamrit and ghanjeevamrit were applied as per treatment schedules. Growth parameters recorded included days to 50% flowering, plant height, number of branches, pod length, and yield per hectare. No major pest or disease issues were observed, and green pods were harvested at edible maturity.

Results and conclusion

Data presented in the table indicate that the days to 50 per cent flowering, plant height and number of primary branches, length of green pods, and yield per hectare were significantly influenced by the treatment combinations of bioorganic nutrient sources *viz*., vermicompost, farmyard manure, jeevamrit, ghanjeevamrit and inorganic fertilizers, compared to the control. The improved growth in terms of plant height, number of primary branches per plant and length of green pod in treatment T_6 {Vermicompost + Beejamrit + Jeevamrit @ 5% at weekly interval + Acchadana (GM)} can be attributed to the accelerated proliferation of beneficial soil microbes and better availability of nutrients through rapid mineralization and increased solubilisation of native soil nutrients and cumulative effect of continuous supply of nutrients and growth promoting substances present in vermicompost and jeevamrit lead to better absorption of nutrients resulted into synthesis of nucleic acid, amino acid, amide substances in growing region and meristematic tissue ultimately enhancing cell division and differentiation (Jidhu and Jeyakumar, 2016). Also, cow urine present in jeevamrit provides nitrogen which is constituent of protein and protoplasm, vigorously induces the vegetative development of the plant.

Jeevamrit is well thought-out to be a gifted source of natural carbon, N, P, K and lot of other micro nutrients required for the crops (Somdutt *et al.,* 2021). The results indicate that jeevamrit @ 5% at weekly interval with vermicompost can be used as a cost-effective bioorganic nutrient module for sustainable yield.

Table 1: Effect of bioorganic nutrient sources on growth, and yield of French bean

Treatment	Days to 50 % flowering	Plant height (cm)			Number of primary branches			Length of green pod (cm)	Yield per hectare (t/ha)
		30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS		
T_1	42.00	25.46	41.69	44.57	3.65	4.31	5.87	12.31	8.85
T_2	39.33	26.17	43.01	47.82	3.66	4.15	5.11	11.33	10.07
T_3	40.33	25.55	41.12	48.76	3.33	4.67	5.94	11.16	11.47
T_4	41.00	25.14	42.38	43.83	3.77	4.33	5.87	11.68	9.93
T_5	41.33	24.03	40.24	45.77	3.23	3.76	5.00	11.20	7.04
T_6	39.00	27.49	47.73	52.64	4.02	5.31	6.18	12.72	12.52
T_7	42.00	27.37	43.62	46.43	3.60	4.04	5.71	11.34	10.32
T_8	41.33	26.46	41.16	44.58	3.59	4.68	5.54	12.29	10.98
T_9	41.66	24.87	42.64	43.98	3.38	4.48	5.50	12.35	6.61
CD (0.05)	2.06	1.35	N/A	N/A	0.33	0.12	N/A	0.86	1.28

References

Jidhu VS and Jeyakumar P. 2016. Growth and yield response of cowpea to multi location bio-inoculants. *Legume Research* 39: 962-969.

Somdutt KB, Rathore RS and Shekhawat PS. 2021. Jeevamrut and panchagavya's consequences on growth, quality and productivity of organically grown crops: A review. *Agric. Rev.* Article Id: R-2239.

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Variation of soil chemical characteristics among different forest types of western Himalayas

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Keywords: Chemical properties, Forest soil, Organic carbon, Protected Forest

Introduction

Soil is a crucial element of forest and woodland ecosystems, integral to the regulation of essential processes such as nutrient cycling, decomposition, water availability, and species regeneration. Additionally, forest soils contribute significantly to habitat heterogeneity, thereby influencing the structural diversity of plant communities. The impact of different land management practices on soil indicators is profound, necessitating continuous monitoring and assessment to detect changes. Evaluating soil quality is a key component of sustainable forest management. In light of this, a study was undertaken to assess the variations in soil characteristics across different forest types.

Material and methods

The present study was carried out in Palampur and Dharamshala forest divisions in district Kangra of Himachal Pradesh (India) during the year 2021-2022. Kangra district is situated in Western Himalayas between 30° 22' 40" to 33° 12' 40" North and 75° 45' 55" to 79° 04' 20" East. Composite soil samples from main plot area of 0.1 ha were collected from 0 - 15 and 15 - 30 cm soil depths in all the different forest types. Afterwards, soil samples were air dried and mixed well before they were grinded with pestles mortar and sieved through a 2 mm mesh sieve. Analysis of soil pH and EC was done by the methods suggested by Jackson (1973) and OC was determined by using Walkley and Black (1934) method.

Results and conclusion

Soil pH in different forest types ranged from acidic to strongly acidic in reaction. Maximum values of pH 5.33 at 0 - 15 cm and 5.73 at 15 - 30 cm soil depths were recorded under Un-demarcated protected Forests (UPF) followed by corresponding values of 5.24 and 5.69 in Demarcated Protected Forests (DPF). Whereas, minimum values were recorded as 4.61 and 5.15 in Reserve Forest (RF), respectively. Soil EC found in safer limits i.e., < 0.8 dSm^{-1} indicating no accretion of soluble salts. Soil organic carbon content is generally medium to high and maximum values of SOC 2.18 and 1.71 % were observed under RF at 0 - 15 cm and 15 - 30 cm followed by respective values of 1.96 and 1.63 % in DPF.

Reference

Jackson ML. 1973. Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi, 498p.

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Transitioning towards sustainability: Nutrient management with fermented concoctions in broccoli

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Keywords: Beejamrit, Broccoli, Ghana Jeevamrit, Jeevamrit

Introduction

Overuse of chemical fertilizers result in soil and environment degradation. Nitrate from synthetic fertilizers accumulates in broccoli that is harmful for human consumption and can be minimized with the use of fermented organic concoctions. Farm-based products like Jeevamrit, beejamrit, and ghanajeevamrit enrich soil with microbes. Jeevamrit is utilized to accelerate the mineralization process and Beejamrit has antibacterial and antifungal capabilities which protects the crop against soil and seed-borne diseases during germination and establishment. These fermented liquid organic manures are inexpensive and increases soil fertility and crop vigour (Shraddha et al., 2023).

Material and methods

The experiment was conducted at Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India, during 2018-2019 and 2019-2020 with ten treatments that is, T_1 - RDN {(125N: 75P:52K kg ha^{-1}) + FYM 20 t ha^{-1}}; T_2 - T_1 + Beejamrit; T_3 - 90% RDN + 5% Jeevamrit (0.5Lm^{-2}); T_4 - 90% RDN + 5% Jeevamrit (1.0Lm^{-2}); T_5 - 90% RDN + 5% Jeevamrit (1.5Lm^{-2}); T_6 - 90% RDN + 5% Jeevamrit (0.5Lm^{-2}) + Jeevamrit FS; T_7 - 90% RDN + 5% Jeevamrit (1.0Lm^{-2}) + Jeevamrit FS; T_8 - 90% RDN + 5% Jeevamrit (1.5Lm^{-2}) + Jeevamrit FS; T_9 - 90% RDN + Ghana Jeevamrit @ 200 kgha^{-1}; T_{10} - 90% RDN + Ghana Jeevamrit @ 200 kgha^{-1} + Jeevamrit 5 % FS.

Results and conclusion

Treatment T_8 (90 % RDN (125N: 75P: 52K kg/ha) + FYM 20 @ t/ha) + 5 % Jeevamrit @ 1.5 L/m^2 at fortnightly interval + 5 % Jeevamrit foliar spray at an interval of 20 days) improved plant height (58.58 cm), number of leaves (17.86), days to 50 % maturity of marketable heads (86.00), number of secondary heads per plant (12.93), weight of central head (417.55 g), head size (130.88 cm^2), harvest duration (41.17 days), marketable yield per plot (12.61 kg) and economics (1.93). All these growth and yield characteristics are improved with the application of Jeevamrit as drench and foliar spray because of consistent provision of nutrients at regular intervals during all crop growth stages. The protoplasmic contents are increased and cell division and elongation are promoted by the supply of nutrients provided by these organics. These liquid manures could have increased growth and yield-contributing characteristics if combined with chemical fertilisers (Shraddha et al., 2023). Similar were the opinion of Rathore et al. (2022) that with the use of organic manures and fermented liquid bioformulations, there were a greater number of fruits per plant in brinjal, which may have been caused by improved nutrition and photosynthesis transfer and subsequent improved plant in growth and yield. Pooled data disclosed that the maximum net income of Rs 2,45,840 was obtained in treatment T_8 with net income of Rs 2,34,757.

Treatment	Plant height (cm)	Number of leaves	Days to 50 per cent marketable heads	Number of secondary heads per plant	Weight of central head (g)	Head size (cm^2)	Harvest duration (days)	Marketable yield per plot (kg)	B:C
T_1	51.45	14.37	90.67	10.80	336.29	116.77	33.00	10.21	1.71
T_2	53.24	15.41	88.17	11.37	346.80	118.40	34.00	10.28	1.72
T_3	56.62	15.38	89.17	11.73	376.58	123.08	36.00	10.62	1.77
T_4	55.45	15.67	88.83	11.83	390.20	123.97	37.00	11.09	1.78
T_5	53.30	15.71	87.83	11.90	394.65	125.02	37.33	11.55	1.81
T_6	56.06	15.81	87.33	12.00	401.95	125.62	37.67	11.67	1.89
T_7	57.34	16.09	87.00	12.27	409.98	126.88	39.67	12.10	1.90
T_8	58.58	17.86	86.00	12.93	417.55	130.88	41.17	12.61	1.93
T_9	54.57	14.71	90.83	11.50	355.33	119.84	34.67	10.37	1.83
T_{10}	51.21	15.38	89.83	11.67	369.61	121.95	35.17	10.56	1.74
Mean	54.48	15.61	88.57	11.80	379.89	123.24	36.57	11.11	
Y	0.56	NS	0.88	0.17	4.04	0.97	0.88	0.18	
T	1.25	1.05	1.97	0.72	9.04	2.17	1.97	0.41	
Y × T	NS	NS	NS	0.56	NS	NS	NS	NS	

References

Rathore G, Kaushal R, Sharma, V and Lalkhumliana F. 2022. Quantifying the effect of fermented liquid bio formulations and organic amendments on yield and quality of eggplant (*Solanum melongena* L.). *Journal of Plant Nutrition*, 46: 1-13.

Shukla S, Thakur Y R, Vashishat RK, Sharma S, Chandel RS, Dhingra S, Alam T, Khargotra R and Jyoti, K. 2023. Impact of fermented organic formulations combined with inorganic fertilizers on broccoli. *Heliyon*, 9(9), e20321.

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Impact of tree-based agroforestry systems in improving soil properties of Eastern India

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Introduction

Tree-based agroforestry systems play a crucial role in enhancing soil properties, offering a sustainable alternative to conventional monocropping (treeless).Treesnaturally contribute to soil fertility through leaf litter decomposition and nitrogen fixation reducing the need for synthetic fertilizers. Tree roots naturally improve soil structure, thereby maintaining soil moisture and reducing the need for irrigation.Trees in fields also act as carbon sinks.Tree-based agroforestry systems align well with the principles of natural farming, promoting sustainability, ecological balance, and economic stability.Thus, the study was carried out to understand the impact of tree-based agroforestry practices on the soil properties.

Material and methods

Six agroforestry systems *viz*., 1. *Bombax ceiba*; 2. *Swietenia mahogany* + *Citrus limon*; 3. *Litchi chinensis;*4. *Khaya senegalensis*; 5. *Swietenia mahogany* + *Citrus limetta;* 6. *Mangifera indica* to study various soil properties and nutrient status which are prominentin Pusa Block of Samastipur District, Bihar were identified during 2021-23.Soil samplesfrom the different tree-based systems and a treeless system was collected at the two depths *viz.,* 0-15 cm and 15-30 cm. Physical and chemical properties of soil such as pH, EC, bulk density, Organic carbon, Available nitrogen, Available phosphorus and Available potassium were measured. Soil organic carbon stock (t ha^{-1}) of the different systems under study was also computed for comparison.

Results and conclusion

The performance of tree-based systems in improving soil physio-chemical properties such as bulk density, soil pH, EC, soil organic carbon and stock, available N, P and K was excellent than that of open crop field without trees (indicated in Table 1). Among the systems recorded, Litchi and Mahogany + Mausmi tree-based systems were found to be superior in 0-15 cm and 15-30 cm soil depths in terms of improving soil physio-chemical properties to those that of other systems. The results indicate that tree-based agroforestry practices have naturally impactedsoil physical, chemical and biological properties positively.

Trees add organic matter to the soil through leaf litter, root biomass, and decaying wood which act as primary source of soil carbon, enriching the soil and improving its structure.Carbon Sequestration in tree-based systems aids in reducing greenhouse gases and mitigating climate change.

Table 1: Physico-chemical properties of soil in tree-based agroforestry

Tree-based Agroforestry System Types	Soil Depth 0-15 cm								Soil Depth 15-30 cm							
	BD g cm^{-3}	pH	EC dS m^{-1}	OC (%)	SOC t ha^{-1}	N t ha^{-1}	P t ha^{-1}	K t ha^{-1}	BD g cm^{-3}	pH	EC dS m^{-1}	OC (%)	SOC t ha^{-1}	N t ha^{-1}	P t ha^{-1}	K t ha^{-1}
Semal	1.08^{cd}	7.72^{c}	0.34^{b}	1.42^{a}	4.76^{a}	166.21^{c}	54.48^{bc}	127.68^{b}	1.20^{cd}	7.84^{b}	0.38^{b}	1.32^{a}	2.31^{b}	164.12^{c}	48.85^{bc}	124.69^{b}
Mahogany+ Lemon	1.13^{bc}	8.01^{b}	0.28^{bc}	0.63^{cd}	2.14^{bc}	186.07^{b}	62.56^{ab}	170.24^{a}	1.19^{d}	7.83^{b}	0.29^{c}	0.6^{c}	1.07^{c}	180.84^{b}	50.35^{b}	144.85^{a}
Litchi	1.26^{a}	7.94^{bc}	0.34^{b}	1.20^{b}	4.19^{a}	195.48^{ab}	54.97^{bc}	177.33^{a}	1.30^{b}	7.91^{b}	0.39^{b}	1.08^{ab}	2.28^{b}	191.30^{ab}	45.29^{c}	110.51^{b}
African Mahogany	1.06^{d}	8.97^{a}	0.27^{c}	0.58^{d}	1.94^{c}	149.48^{cd}	42.87^{cd}	99.68^{c}	1.17^{d}	9.01^{a}	0.28^{c}	0.56^{c}	0.92^{c}	144.26^{d}	31.96^{e}	81.76^{c}
Mahogany+ Mausmi	1.28^{a}	8.86^{a}	0.43^{a}	1.15^{b}	4.59^{a}	212.20^{a}	74.79^{a}	128.43^{b}	1.38^{a}	8.85^{a}	0.48^{a}	1.11^{ab}	2.19^{b}	203.84^{a}	65.04^{a}	116.85^{b}
Mango	1.19^{b}	8.86^{a}	0.23^{c}	0.88^{c}	1.57^{b}	146.35^{d}	49.85^{bc}	96.32^{c}	1.26^{bc}	8.96^{a}	0.25^{c}	0.78^{b}	1.48^{a}	140.07^{d}	38.54^{d}	81.01^{c}
Open treeless	1.28^{a}	8.78^{a}	0.27^{c}	0.60^{d}	1.49^{c}	119.17^{e}	33.00^{d}	80.64^{c}	1.39^{a}	8.88^{a}	0.27^{c}	0.36^{c}	1.15^{c}	106.62^{e}	30.76^{e}	72.80^{c}

References

Das DK and Chaturvedi OP. 2005. Structure and function of *Populus deltoides* agroforestry systems in eastern India: 2. Nutrient dynamics. *Agroforestry Systems* 65: 223-230.

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RPCAU steps toward natural farming for socio-economic sustenance

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Keywords: Microbial population, Natural Farming component, soil health.

Introduction

We are reimagining the scenario of Indian agriculture with increased farmers' income, reduced fertilizer and water usages, increased renewable energy use, and reduced greenhouse gas emissions, restoration of degraded soil. Unlike modern agriculture, Natural Farming (NF) is a distinctive chemical-free agricultural technique that is thought to be an agroecology-based diversified farming system that integrates crops, trees, and livestock, allowing functional biodiversity.However, there are many concerns for this natural farming like its feasibility in different agro-ecologies, sustainability in yield, development of suitable package of practices for different crops etc. Scientific methodology for the inputs formulations and practices of natural farming needs to be standardised and documented, while simultaneously ensuring their dissemination to farmers at affordable cost for sustainable crop production and soil health improvement.

The national goal of guaranteeing food and nutritional security may face major difficulties if any farming practices or production technologies are adopted on a broad scale that are not supported by science and/or that could have a negative impact on crop productivity. Under such circumstances, there is a need to scientifically validate document and upscale NF practices for crop production, nutrient management and plant protection measures. Keeping in view of the above facts we have initiated the programmes like: i. Establishment of School of Natural Farming, ii. To identify suitable package of practice for natural farming iii. To assess the comparative effectiveness of natural farming and organic farming on crop productivity vis-a-vis quality and soil health, and iv. To estimate the economics of natural farming and organic farming.

Material and methods

To achieve the above said targets and disseminate this noble science a group of trained human capital will be in demand in coming decades hence, four-year undergraduate programm on Natural Farming. To validate the technologies behind this noble science several university funded as well as post graduate and doctoral research programmes are formulated for knowing the science behind natural farming. The university has developed demonstration unit (2 ha) of natural farming, shelter beds for desi cows (08) with provision of cow dung and urine collection, inputpreparation laboratory and initiated assessment of different cultivars of cereals, millets and spices for their suitability under Natural Farming as well as activities like monetization of cow dung through installation 2 cubic meter capacity biogas plant and making cow dung lamp *(Gobar ka Diya)* were also initiated.

Results and conclusion

In an on-farm experiment with nine treatments constituting of Control, Natural Farming packages, Organic Farming, INM and modern agricultural practices in three replications in RBD is under testing with Rice-Wheat-Greengram cropping system at initial phase of experimentation,In rice and wheat crop the natural farming treatments exhibit at par with

organic treatment and resulted significantly lower yield than RDF/INM packages. Non-significant change in soil organic carbon, available phosphorus and available potash was observed in post-harvest rice soil, whereas addition of organic matter showed nitrogen build-up. Yield attributes and yield of greengram was significantly affected by treatment. Highest pod yield (2.6 t/ha) was recorded in Natural Farming treatment with irrigation at critical stages (T_3 & T_4) which was at par with T_6 (Organic Farming) & T_8 (100% N through organic sources). The full package of natural farming practices (T5) was at par with organic farming practices (T6) with respect to soil organic carbon, available phosphorus and available potash in post-harvest wheat soil, whereas addition of organic matter (T7), INM (T8) and RDF (T9) showed their significant superiority over Natural Farming practices (T2 to T5) with respect to soil organic carbon, available phosphorus and available potash in post-harvest wheat soil.Variation in microbial population among different treatments in pre sowing and post-harvest wheat conditions recorded a great variation and was found for total microbial population in pre sowing and post harvest wheat soil.
In general, a higher microbial population was recorded after crops with a standard package of Natural farming. This is beginning and hopes that these efforts will result soil health and higher-quality produce, a foundation for the scientific validation of natural farming and a strengthening of the GOI's flagship programme.

ESFS-NF/APCR2024/1065

Geospatial analysis of land use dynamics using machine learning algorithms in coal mined landscape

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Keywords: Random Forest, Support Vector Machine, SDGs

Introduction

Approximately 24 per cent of the global land area, constituting 3,500 million hectares, is suffering from diverse forms of land degradation across various regions, while over 90 million hectares of India's landmass is adversely affected by anthropogenic disturbances including coal mining. Coal is the primary source of energy in India mainly harnessed for thermal power generation, meeting 70% of the energy needs in industrial and domestic sectors. Despite the growing evidence of detrimental impacts, the intensification of coal mining has resulted in abrupt changes in land use and vegetation, contamination by pollutants, biological invasion, and soil erosion, proliferating wastelands. Geospatial techniques, including satellite remote sensing (RS), geographic information systems (GIS), and global positioning systems (GPS), have proven indispensable, cost-effective, and viable for modelling and assessing land use dynamics in coal-mined landscapes.. The Artificial Intelligence (AI)-based Machine Learning (ML) algorithms, which offer robust solutions for the classification of high-dimensional, large, nonlinear, spatial, and complex remote sensing datasets with spectral limitations of classification. Therefore, the present study was undertaken with the following objectives: 1) To evaluate ML algorithms in analysing land use and vegetation 2) To evolve strategies for reclaiming degraded landscapes.

Material and methods

The study was conducted in the coal mining industrial belt of Katghora-Korba, located between 22° 01′ to 23° 01′ N latitudes and 82° 07′ to 83° 07′ E longitudes in Central India. The cloud-free Sentinel-2 and Landsat TM satellite data of the study area corresponding to 2023 and 1993 were utilized to characterize land use, vegetation and change detection. Digital image and terrain analysis (DEM, FCC) were conducted using ERDAS Imagine 2015 version 15.1 and ArcGIS version 10.4 platforms. Various Machine Learning (ML) algorithms, such as Support Vector Machine (SVM), Random Forest (RF), and Maximum Likelihood Classifier (MLC), were utilized in supervised classification to analyze the land use and vegetation on sentinel 2 satellite data. The accuracy of a classified image was assessed using the confusion matrix union tool. The accuracy metrics, including producer's accuracy, user's accuracy, overall accuracy, and the kappa coefficient, were calculated. Change detection analysis was conducted by applying the post-classification comparison technique with the matrix union tool.

Results and conclusion

Six types of land use classes were identified: 1) Agriculture and fallow, 2) Forest and plantation, 3) Built-up areas, 4) Water bodies, 5) Mining land, and 6) Degraded lands (Table 1). The Support Vector Machine (SVM) algorithm performed better than the Random Forest and Maximum Likelihood Classifier (MLC) in precisely classifying land cover and vegetation. The user accuracy levels for different classes ranged from 95.2% to 98.8%, and the producer accuracy ranged from 95.4% to 98.9%, with an overall classification accuracy of 97.73% and kappa accuracy of 98.21% under the SVM classifierThe largest area was

covered under Agriculture and fallow land, encompassing 223.67 km², followed by degraded land (98.41 km²), built-up land (64.88 km²), forest and plantations (48.8 km²), and mining areas (29.9 km²). In contrast, water bodies covered the least area, accounting for 478.06 km². Of the total area, agriculture, degraded land, built-up land, forest and plantations, mining areas, and water bodies occupied 46.8, 20.6, 13.6, 10.2, 6.3, and 2.6 per cent, respectively. Cross-tabulation matrices shows that out of 287.8 km² and 94.32 km² area under agriculture and forest in 1993, only 223.67 km² and 48.76 km² were retained in these categories in 2023, resulting in a net loss of 22.2 and 48.3 per cent of the areas, respectively. Mining land expanded from 13.56 km² to 29.94 km², while degraded wasteland exponentially increased from 43.45 km² to 98.41 km², accounting for a net increase of 2.2 and 2.25 times, respectively, between 1993 and 2023.
The agriculture and forests are converted into mining and degraded lands with an increase anthropogenic destruction. The barren areas and overburdens within a 5 km radius of mining sites are serious threats to be rehabilitated with afforestation/reforestation along with soil conservation practices.

Table 1: Spatio-temporal variations in land cover dynamics between 1993 and 2023

Year	**1993**								
2023	**LULC classes**	**AG&FL**	**BU**	**DL**	**FR&PL**	**MA**	**WB**	**UC**	**Total**
	AG&FL	182.2	9.91	5.93	21.56	0.32	3.7	0.05	223.67
	BU	49.4	12.51	2.82	29.54	0.86	3.15	0.13	98.41
	DL	32.7	7.2	5.32	14.37	1.91	3.23	0.15	64.88
	FR&PL	10.1	7.78	2.97	21.58	4.18	2.1	0.05	48.76
	MA	10.4	4.4	1.33	4.96	5.57	3.16	0.12	29.94
	WB	2.8	1.53	0.47	2.21	0.72	4.65	0.02	12.4
	UC	0.19	0.12		0.1		0.11		**0.52**
	Total	287.79	43.45	18.84	94.32	13.56	20.1	0.52	**478.58**

AG&FL-Agriculture crop & Fallow land; BU-Built-up area; DL-Degraded land; FR&PL- Forest and Plantation; MA-Mining area; WB-Water body; UC-Unclassified area

ESFS-NF/APCR2024/1066

Combined application of biochar and AMF improves drought stress tolerance in plants

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Keywords: Biochar, common bean, drought stress, okra, soybean

Introduction

Drought negatively affects plant growth, yield and physiological properties such as photosynthesis relative water content and photosynthetic rate in many plants[1-2]. However, the impact of biochar and AMF on drought stress adaptive responses in soybean, common bean and okra plants during drought stress remains unexplored. This study aims to check biochar and AMF-mediated modulation of growth, physiological responses and nutrient uptake in soybean, common bean and okra to cope with drought stress. Besides, variation in soil enzymatic activities and microbial biomass related to the combined application of biochar and AMF in the presence of drought stress was also explored.

Material and methods

Four treatments used for the experiments included control (only soil), biochar, AMF, and combined treatment with biochar and AMF. Mixing the soil with 1.0 per cent biochar used a pot experiment. Seed of soybean and common bean was cultivated into plastic pots, including soil (5 kg). Within 40 days of plant growth in drought conditions were maintained. After 40 days, plant growth parameters, physiological traits and soil properties were measured.Root morphological traits such as total root length, projected area, root surface area, root volume, and root diameter were evaluated. All roots were spread out and detected using a scanning system with a blue board as a background.

Results and conclusion

Drought stress negatively affected growth, root morphological traits and physiological properties in soybean, common bean and okra.The biochar exhibited a significant positive impact onthe root morphological traits such as total root length,projected area, root surface area, root volume, and root diameter of soybean, common bean and okra. However, AMF and biochar significantly developed root morphological parameters under drought conditions. The maximum values of total root length were observed in dual applications with AMF and biochar in drought stress. Dual applications of AMF and biochar significantly enhanced total chlorophyll, and nitrogen contents in plantscompared to the control. Combined with biochar and AMF positively affects AMF spores' number, microbial biomass, and soil enzyme activities under drought stress conditions. Combined with AMF and biochar improved plant growth, root morphological traits, and microbial biomass in drought conditions.

Dual applications with biochar and AMF can decrease the effects of drought stress, helping to improve okra, common bean and soybean growth, yield, and soil enzyme activities under drought conditions.

References

Hashem A, Kumar, A, Al-Dbass AM, Alqarawi AA, Al-Arjani ABF, Singh G and Abd Allah EF. 2019. Arbuscular mycorrhizal fungi and biochar improves drought tolerance in chickpea. *Saudi Journal of Biological Sciences* 26(3): 614-624.

ESFS-NF/APCR2024/1067

Validation of natural farming practices in pea for sustainable plant health management

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Keywords: Leaf miner, natural farming, powdery mildew, wilt

Introduction

Pea (*Pisum sativum*) is an important rabi season vegetable crop grown in the mid hills of Himachal Pradesh. In the state, it covers an area of 21,720 hectares with annual production of 2,92,850 metric tonnes while, in Solan district, the crop is grown over an area of 1670 ha with annual production of 16,780 MT. For increased production, farmers use chemical fertilizers and pesticides non-judiciously which has detrimental effects over soil health and also increases production cost significantly. Hence, need of the hour is to shift from chemical based farming to natural farming which is a low-input and climate-resilient farming system that encourages farmers to use low-cost locally-sourced inputs, eliminating the use of artificial fertilizers and industrial pesticides.

Material and methods

The study validated the natural farming (NF) practices in pea. Before sowing, seeds of pea, oat and fenugreek were treated with beejamrit to avoid seed borne infection and for better germination. Ghanjeevamrit was applied @ 1.5 tonnes/ha. Jeevamrit drenching @ 20% was given at an interval of 15 days starting from 15 days after sowing. WAPSA were prepared (1 ft. width, 4 inch deep) and dry grass mulch (3 inch) was applied in the plot. For the management of diseases and insect pests, need based sprays of natural formulations @ 5% were given at 7 days intervals. In conventional farming, standard recommended practices were followed. Samples were taken to assess physico-chemical properties and microbial load of the soil and diseases and insect pests incidence/severity in pea.

Results and conclusion

NF in pea has shown promising results in organic carbon, porosity, available nitrogen and potash contents of soil which increased to 14.2g/kg, 47.88%, 393.1Kg/ha and 381.89 Kg/ha, respectively. Higher bacterial (26.3×10^7 cfu/g), fungal (7.4×10^4 cfu/g) and actinomycetes (5.6×10^4 cfu/g) count and enhanced earthworm activity ($27.8/m^2$) were observed in the Natural farming (NF) soil as compared to conventional farming (CF) soil. Due to additional yield of fenugreek (grown as intercrop), equivalent yield was higher in NF (183.5 q/ha) as compared to yield obtained in CF (173.8 q/ha) system. Higher net returns (Rs. 4,91,610) and B:C ratio (3.91) were recorded in NF compared to CF system (Rs. 4,77,940 and 3.61, resp.). No incidence of wilt was observed in NF plots while, only 10.3% disease severity of powdery mildew and 5.8 per cent leaf miner infestation was recorded in crop raised through natural farming practices. The study concluded that NF in pea intercropped with fenugreek was better than conventional farming system to improve soil health and net returns.

References

Palekar S 2006. The principles of spiritual farming II, 2nd edn. Zero budget natural farming Research, Development & Extension Movement, Amravati, Maharashtra, India. http://www.vedicbooks.net/principles-spiritual-farming-volume-p-14779.html.

ESFS-NF/APCR2024/1068

Natural farming practices for improved soil health, yield and profitability in capsicum

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Keywords: Capsicum, intercropping, soil quality, yield

Introduction

Bell pepper (*Capsicum annuum* L.), is a high value cash crop grown as an off-season vegetable (April-October) in various agro climatic zones of Himachal Pradesh which covers an area of 2,854 hectares with annual production of 56,011.7 metric tonnes. Himachal Pradesh ranks fifth in the production of capsicum, with the maximum production in Solan district (27,440 MT) followed by Sirmaur, Kangra, Mandi and Shimla (Directorate of Agriculture, 2021-22). The present socio economic situation of farmers is not good being trapped in a vicious cycle of high cost agriculture and uncertain returns. Hence, need of the hour is to shift from chemical based farming to natural farming which is a low-input and climate-resilient farming system that encourages farmers to use low-cost locally-sourced inputs, eliminating the use of artificial fertilizers and industrial pesticides.

Material and methods

The study validated the natural farming (NF) practices in capsicum. Before sowing, seeds of capsicum and French bean (Intercrop) were treated with beejamrit. Nursery of capsicum was raised using natural farming practices where, ghanjeevamrit was applied in nursery bed @15g /m2 and Jeevamrit was drenched @10% at weekly intervals. Beds of size 2.5x2.5 m were prepared and at the time of land preparation, ghanjeevamrit was applied @1.5 t/ha and thereafter, on 22.4.2024, healthy nursery was transplanted in the field at a planting distance of 75 cm x 45 cm (Row to row and plant to plant). In between two rows of capsicum, French bean was sown at a planting distance of 15 cm. Finger millet was sown as the border crop.

Results and conclusion

The results revealed that natural farming practices in capsicum have shown promising results, indicating the potential of natural farming as a sustainable and economically feasible alternative to conventional farming practices. There have been noticeable changes in soil physico-chemical properties before and after the experiment particularly organic carbon contents, porosity and available nitrogen contents. Higher microbial load and enhanced earthworm activity was observed in the NF soil as compared to conventional farming soil. This could be ascribed to the regular use of Jeevamrit and ghanjeevamrit which besides providing nutrition to the plants has led to increase in soil porosity, reduced bulk density, higher population of beneficial microbes that helped in better uptake of the nutrients from soil. Dry grass mulching has resulted in decreased soil temperature, increases in moisture content, humus and organic carbon contents and also increased earthworm population in the soil. Capsicum raised through natural farming practices, achieved equivalent yield of 463.8 q/ha due to additional yield of French beans (Table 1). Moreover, higher gross, net returns and B:C ratio were obtained as compared to conventional farming system. This may be due to increased availability of nutrients due to build-up of soil micro flora resulting from increased bacteria, fungi, actinomycetes, P solubilizers and N fixers population in the soil which resulted in high nutrient uptake, better growth and yield (Chaudhary et al., 2022). As far as major diseases and insect pests in capsicum are concerned, no insect was observed to cause any significant damage to the crop in NF plots due to antifeedant activity of all the astra. It can be concluded that NF system in capsicum intercropped with French bean outperformed compared to conventional farming system.

Table 1: Impact of natural farming on yield and profitability in capsicum

System	MCY	IY	EY	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C
NF*	365.8	78.4	463.8	3,12,500	14,84,160	11,71,660	4.74
CF*	347.6	-	-	3,68,750	11,12,320	7,43,570	3.01

**NF-Natural farming, CF-Conventional farming; EY, Equivalent yield; IY, Intercrop yield; MCY, Main crop yield*

References

Choudhary R, Kumar R, Sharma GD, Sharma RP, Rana N and Dev P. 2022. Effect of natural farming on yield performances, soil health and nutrient uptake in wheat + gram inter cropping system in sub-temperate regions of Himachal Pradesh. *Journal of Crop and Weed* 18(2): 01-08.

ESFS-NF/APCR2024/1069

Impact of natural farming trainings on farmer's adoption

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Keywords: Impact, natural farming, training, farmers

Introduction

The primary goal of natural farming is to reduce the cost of cultivation and improvement in the quality of farm produce and also in enhancing the income of farmers. All the inputs (insecticides, pesticides and fungicides) are made up of natural herbs from locally available inputs, thereby reducing the use of fertilizers and cost of cultivation. Numerous extension organizations are working on to raise the farmers awareness about natural farming, Government Institutes, NGOs etc., are playing a major role in extension of natural farming through training, exhibitions, Kisan Melas, Sanghosthi and other programs. Directorate of Extension Education, YSPUHF works with the farmers and farm women for increasing the production of crops. Different trainings were organized to motivate farmers to adopt new technologies. To find out the success of any training programme a periodic appraisal and evaluation is essential, so that suitable changes can be made to make the training programme more effective. This creates a need to do some serious evaluation of the Impact of trainings on adoption of natural farming organized. Keeping these facts in mind this study was conducted to assess the perception of natural farming trainings among the trained farmers and to study the constraints perceived by the farmers during adoption of natural farming.

Material and methods

The investigation attempted the impact of natural farming trainings on its adoption by the farmers. The study was conducted to know the impact of trainings/ workshops/camps on the farmers of HP, Uttarakhand and Gujarat. The data was collected through a well structured and pre-tested interview schedule. 17 trainings/ workshops/ camps were organized. Out of 600 farmers, 250 male and 350 female farmers participated. Feedback from the trained farmers on natural farming based through interview schedules and face to face talk were collected before and after the completion of trainings/ Workshops/ camps. The collected data were analyzed with the help of suitable statistical techniques and methods. Data were divided according to size of their landholdings in to three categories namely: Marginal (<1 ha.), Small (1-2 ha.) and medium (2-4 ha.).

Table 1: Farmer's distribution according to their land holdings

Category	No. of farmers	Farmers (%)
Marginal (< 1 ha.)	342	57
Small (1-2 ha.)	180	30
Medium (2-4 ha.)	78	13
Total	600	100

Results and conclusion

Majority of farmers had high (53.33%) to medium (40%) perception with respect to the use of Ghanjeevamrit only a few (6.67%) trained farmers had low perception to use of Ghanjeevamrit. In terms of the use of Jeevamrit, most (49%) of the trained farmers had medium perception, followed by (26.67%) of trained farmers had low perception and

(24.33%) trained farmers had high perception about use of Jeevamrit. Regarding the use of Beejamrit, majority of the trained farmers (46.33%) had medium perception, followed by (30.67%) of trained farmers who had high perception and (23%) trained farmers had low perception about use of Beejamrit. In case of use of Mulching, most of the trained farmers (45.17%) had medium perception, followed by (30.33%) of trained farmers had high perception and (24.50%) of trained farmers had low perception about use of mulching. In case of use of Whapasa, majority (52%) of the trained farmers had medium perception, followed by (28.33%) of trained farmers who had high perception and (19.67%) trained farmers had low perception about use of whapasa.

Neemastra, Brahmastra, and Agniastra s farmers are using in fields to control and protect the crops from insects, pests and diseases. Most of the trained farmers (53.50%) had medium perception about Neemastra use, followed by (28.17%) the trained farmers who had high perception and (18.3%) trained farmers had low perception about use of Neemastra. With regards to use of Brahmastra, majority of trained farmers (50.83%) had medium perception, followed by (28.5 %) trained farmers had high perception and 20.67% trained farmers had low perception about the use of Brahmastra. In case of use of Agniastra, most of trained farmers (52.5%) had medium perception, followed by (27.17%) trained farmers who had low perception and (20.33%) trained farmers had high perception about use of Agniastra. Concerning use of cow milk and curd which is effective to control the fungus, majority of the trained farmers had medium perception, while (26%) of trained farmers had high perception, (24.5%) of trained farmers had a low perception of use of fungicides.The correlation coefficient of attributes of trained farmers observed that correlation coefficients in respect of Education (0.632), Social participation (0.368), Credit availability (0.364), Annual Income (0.517), Source of Information (0.283), Contact with Extension Personnel (0.454), Innovativeness((0.273), Knowledge about Natural farming (0.487) were found positive and significant relationship with perception of trained farmers about Natural Farming at 5 % level of probability, while Age (0.039), Caste (0.074), Size of family (0.038) were found to having no significant relationship with the perception of trained farmers about Natural Faming.

This study concluded that only (14.16%) of the respondents had high perception in Natural Farming before participation of Natural Farming Trainings and after the participation of Natural Farming trainings this figure is increased up to (25.83%). In this study High cost inputs and Marketing of Natural Farming Produce were identified as the major problems experienced by the farmers during adoption of Natural Farming.

References

Badodiya SK, Daipuria OP, Jaulkar MA and Dhakad U. 2009. Management of eco-friendly practices by winter vegetable groers. National Seminar on Organic Farming. RVSKVV, Gwalior.

Eliazer NARL, Ravichandran K and Antony U. 2019. The impact of the Green Revolution on indigenous crops of India. *J. Ethn. Food*. 6: 1-11 doi: 10.1186/s42779-019-0011-9.

ESFS-NF/APCR2024/1070

Enhancing soil health through organic manures and bio-stimulants in pea-capsicum cropping sequence

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Keywords: Organic farming, Soil properties, PGPR, Humic acid

Introduction

The shift towards sustainable agricultural practices has intensified the focus on improving soil health through organic farming. This study explores the impact of organic manures, including Farm Yard Manure (FYM), vermicompost, Plant Growth-Promoting Rhizobacteria (PGPR), and Humic Acid (HA), on the soil properties within a pea-capsicum cropping sequence under organic farming conditions.

Material and methods

The study employed a randomized block design with eight treatments and three replications. The treatments included varying combinations of 75 and 100% Recommended Dose of Nutrients (RDN) through FYM, vermicompost with Plant Growth-Promoting Rhizobacteria (PGPR), and Humic Acid (HA): T1: 100% RDN through FYM + Vermicompost (50:50); T2-T4**:** 75% RDN + PGPR 1 + HA foliar and soil application; T5-T7: 75% RDN + PGPR 2 + HA foliar and soil application; T8**:** Absolute control.Soil properties such as organic carbon, available macronutrients (N, P, K), micronutrients (Fe, Zn), and microbial countwere measured as per standard methods.

Results and conclusion

The study showed that treatment T7 led to increases of 39% in nitrogen, 37 % in phosphorus, and 36 % in potassium over initial values, while T4 resulted in increases of 16, 25 and 23% for these same nutrients. Organic carbon levels rose by 20 % in T7 and 15 % in T4, with bacterial counts increased by 58% in T7 and 38% in T4. For micronutrients, T7 significantly enchanced iron and zinc by 34% and 28%, respectively, and T4 by 25% and 24 %. In contrast, the control treatment T8 showed slight decreases of 0.2% for nitrogen, 0.1% for phosphorus, 0.2% for potassium, 0.6% for iron, and 0.4% for zinc. These findings highlight the effectiveness of organic manures and bio-stimulants in boosting soil fertility.

The experiment demonstrated that integrating organic manures with bio-stimulants like PGPR and humic acid significantly enhanced soil health, surpassing both initial soil conditions and the 100% RDN treatment. Treatments T4 and T7 led to substantial increases in essential soil nutrients—nitrogen, phosphorus, potassium—as well as organic carbon and micronutrients.

These findings underscore the potential of sustainable agroecological practices to improve soil fertility and contribute to long-term agricultural resilience.

References

Jackson ML. 1973. *Soil Chemical Analysis.* Prentice Hall of India Pvt. Ltd., New Delhi.

Vance ED, Brookes PC and Jenkinson DS. 1987. An extraction method for measuring soil microbial biomass C. *Soil Biology and Biochemistry* 19(6): 703-707.

ESFS-NF/APCR2024/1071

Enhancing Biodiversity in Mountain Ecosystems through Agroecological Practices

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Keywords: Agro-ecology, Biodiversity, Diversification

Introduction

Mountains host about half of the world's biodiversity hotspots and 30% of Key Biodiversity Areas, offering essential services like food, medicine, and climate regulation. In regions like Shimla, agroecological practices are vital for enhancing biodiversity and ecological balance. Strategies such as diversifying fruit tree species beyond monoculture apple orchards and using organic farming methods can bolster local biodiversity and ecosystem resilience, supporting both native species and environmental health.

Material and methods

This approach focuses on applying agroecological practices to boost biodiversity in Shimla's mountainous areas. Key practices include:

Avoiding Monoculture of Apples: Transitioning from monoculture apple orchards to a diverse mix of fruit trees, such as pear, plum, and persimmon. This diversification helps prevent soil depletion, reduces the likelihood of pest outbreaks, and supports a wider range of pollinators.

Organic Apple Farming: Implementing organic farming techniques for apple cultivation, including natural pest control and organic fertilizers. This practice minimizes chemical inputs, enhances soil health, and supports sustainable farming.

Plantation of Native Species: Incorporating native tree species such as Deodar (*Cedrus deodara*), Blue Pine (*Pinus wallichiana*), Himalayan Oak (*Quercus leucotrichophora*), Rhododendron (*Rhododendron arboreum*), Walnut (*Juglans regia*), Alder (*Alnus nepalensis*), and Cherry (*Prunus serrulata*). These trees contribute to local ecosystem health by supporting flora and fauna, enhancing forest cover, and improving soil stability.

Results and conclusion

Adopting agroecological practices in Shimla greatly benefits biodiversity and ecosystem health. Shifting from single-crop apple orchards to a mix of fruit trees like pear, plum, and persimmon improves soil health, mitigates pest issues, and supports diverse pollinators. Using organic farming techniques reduces chemical inputs and enhances soil fertility. Planting native species such as Deodar, Blue Pine, and Himalayan Oak strengthens forest cover, provides wildlife habitats, and helps control erosion. Adding Rhododendron and Cherry enriches floral diversity and habitat quality, while Walnut and Alder offer essential resources and stabilize soil. These practices collectively maintain ecological balance, boost resilience to climate change, and promote the long-term sustainability of Shimla's mountainous ecosystems, preserving its rich biodiversity and ecological integrity (Altieri, 1999).

References

Altieri MA. 1999. The ecological role of biodiversity in agroecosystems. *Agriculture, Ecosystems & Environment,* 74(1), 19–31.

Theme 2

Nature based Solutions for Crop Protection

ESFS-NF/NBSCP2024/2001

Adoption of Vedic Principles & Practices in Modern Day Farming

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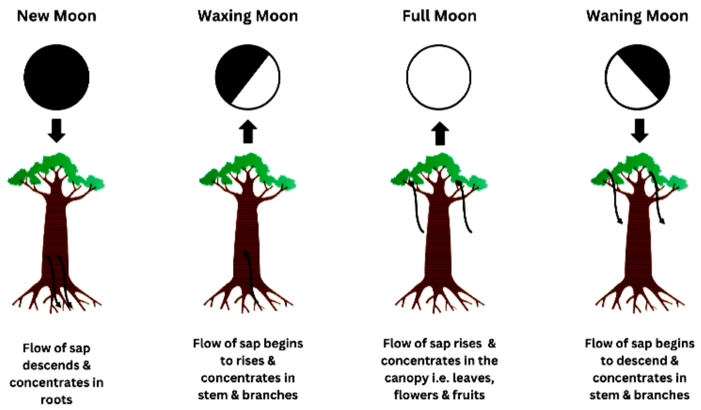
Keywords: Almanac, Climate, Herbs, Season, Zodiac

Introduction
Modern agriculture science aims for high yield, while suppressing & disregarding the importance nature's own *'check & balance'* i.e., parameters for equilibrium in native ecosystem of flora and fauna. A faulty cropping pattern contributes negatively in the *Universal System of the Mother Nature.* Ignorance of deep relationship between season - climate and co-existence of plant – animal in the food chain. *Life Force* in all the living organisms come from the cosmic forces. Continuous correction process is happening in nature, which was experienced and observed globally during lock-down period in COVID pandemic. Vedic Mantra is '*Harmony with Mother Nature'.*

Materials and methods
Nine planets have been considered important in Vedas for agriculture, rituals & festivals. Vedic Agriculture Almanac is based on Moon's transit in Zodiac & Constellation and at times, specific position of Moon vis-à-vis other planets during Lunar months. Agronomy of crop cultivation needs to be tuned according to the lunar month. There is deep relation between type of pest & disease with lunar phase.
Seasonal change happens due to half-yearly transit of Sun between tropics of Capricorn & Cancer. Crop cultivation is decided as per Solar seasons. El Nino and La Nina climate patterns determine various biotic factors (pollinators, pests, disease) & abiotic factors (soil moisture, fertility, atmospheric temperature, humidity, photoperiod) which are responsible for crop performance. Pest and disease control medicines are available in native vegetation. Weeds are indicators of soil properties & biotic factors. Companion planting &crop rotation maintains equilibrium in ecosystem of biotic & abiotic factors.

Results and conclusion
Vedic Agriculture Almanac is based on the resultant force of cosmic energies emanated from nine planets namely Sun, Moon, Mars, Mercury, Jupiter, Venus & Saturn in solar system along with two imaginary planets Rahu and Ketu, twelve zodiac signs &twenty-seven constellation. Earth receives cosmic energies as 'Sun Rays' during day time & as 'Moon Light' during night time. Gravitational forces working between various cosmic objects, including Earth, also work directly on living organism in Earth's Biosphere.
Various crops are cultivated for specific parts as the *produce*. Accordingly, all crops have been categorized into four elemental groups of Zodiac signs: *Fire* for Fruit & seed crops, Earth for Root crops, Air/light for Flower crops & Water for Leafy crops.Zodiac signs respectiveelement does influence positively on the *produce* of the crop, simultaneously enhance immunity against biotic and abiotic stress conditions by strengthening sustainabilityin the native ecosystem. Formative forces of specific planets influence different plant parts. For example, Moon's influence on sap movement in plants is tuned with Moon phases as depicted in the above picture.



Incidence of sucking pests & airborne fungal & bacterial disease increases around *Full Moon* when sap is concentrated in leaves, flowers & fruits. However, incidence of chewing pests, soil borne pests, fungal and bacterial disease increase, sap is concentrated in roots around *New Moon*. Scheduling crop protection measures using native herbs in tuned with above rule of nature help in saving unnecessary efforts & expenses, while getting healthier crop and yield.

References

Vedic agriculture almanac

ESFS-NF/NBSCP2024/2002

Efficacy of natural products against *Helicoverpa armigera* (Hubner) under laboratory conditions

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Keywords: *Helicoverpa armigera*, fruit borer, natural products

Introduction

Helicoverpa armigera (Lepidoptera: Noctuidae) is a polyphagous insect that feeds on more than 181 cultivated and wild plant species. In India, considerable economical losses of about 50-60 per cent have been reported by various workers due to *H. armigera* in tomato. High biotic potential, superior climate adaptation and ability to withstand, metabolize and avoid toxic chemicals has resulted in successive invasions of the pest at different locations. Traditional pest management with synthetic pesticides has led to resistance and other challenges, increasing the need for alternative methods.

Material and methods

Efficacy of natural products (*Agniastra, Brahmastra* and *Neemastra*) against 2nd instar larvae of *H. armigera* by leaf dip bioassay was evaluated. The solution of each natural product was considered as 100 per cent standard stock solution and various working concentrations were prepared in distilled water by serial dilution. Preliminary range tests were conducted with a number of concentrations, and those concentrations that resulted in mortality rates ranging between 20 to 80 per cent were determined. The leaves were dipped in the solution and were dried under shade for 30 minutes and then ten 2nd instar larvae were released on the treated leaves. The data on larval mortality were recorded at 24, 48 and 72 hours after treatment and moribund insects were treated as dead.

Results and conclusion

The relative toxicity of natural products evaluated against 2nd instar larvae of *H. armigera* ranged from LC_{50} values of 8.81 to 14.10 per cent, with the minimum and maximum values corresponding to *Brahmastra* and *Neemastra*, respectively (Table 1). The ascending order of LC_{50} values for the natural products was found to be *Brahmastra* (8.81%) > *Agniastra* (12.19%), >*Neemastra* (14.10%). When compared to *Neemastra*, *Brahmastra* was 1.60 times more toxic to 2nd instar larvae followed by *Agniastra* (1.16 times). Natural products have potential to cause mortality of *H. armigera* larvae. Among these, *Brahmastra* was observed to be the most effective treatment against the test insect, suggesting promising alternatives to synthetic pesticides and the need for further research to optimize their use.

Table 1: Efficacy of natural products against *Helicoverpa armigera*

Insecticide	Heterogeneity χ^2	Regression equation (Y)	LC_{50} (%)	Fiducial limits (%)		Relative toxicity
				Lower limit	Upper limit	
Agniastra	1.06	3.37+1.51X	12.19	7.16	17.22	1.16
Brahmastra	0.08	3.64+1.43X	8.81	5.04	12.57	1.60
Neemastra	3.18	2.99+1.76X	14.10	9.54	18.67	1

References

Singh SP and Dwivedi K 2021. To study the bio-efficacy of natural compounds against *Helicoverpa armigera* in tomato. *The Pharma Innovation Journal* 10(10): 1952-1958.

ESFS-NF/NBSCP2024/2003

Evaluation of biocontrol agents against *Colletotrichum truncatum* causing Anthracnose rot of tomato

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Keywords: Tomato, *Colletotrichum truncatum*, *Trichoderma, Pseudomonas*

Introduction

Tomato (*Solanum lycopersicum* L.), a member of the *Solanaceae* family is a widely grown warm season crop worldwide. In India, tomato is considered as a major cash crop and known as 'Functional food' as it reduces the risk of cancer and cardiovascular diseases. Among various fungal disease of tomato, anthracnose fruit rot caused by *Colletotrichum* species is a devastating fungal disease affecting tomatoes mainly after harvest.The disease is important as it affects fresh market, home garden and processing tomatoes which ultimately reduces their market value. Management through repeated spraying of synthetic fungicides results in adverse effect and various problems. Keeping the above aspects in view, an investigation was carried out to evaluate the biocontrol agents against *Colletotrichum truncatum*.

Material and methods

Tomato fruit samples showing symptoms of anthracnose fruit rot were collected and isolation of pathogen was done by following standard procedure for isolation. The isolated fungus was identified on the basis of cultural, morphological and molecular characteristics. The management efficacy of various species of *Trichoderma* and *Pseudomonas* were evaluated under*in vitro* against the mycelial growth of pathogen causing anthracnose fruit rot of tomato using dual culture method (Morton and Stroube, 1955). Per cent inhibition in mycelial growth was calculated by using formula given by Vincent (1947). The biocontrol agents were also evaluated on tomato fruits. The spray spore suspension at 1×10^5 conidia/ml of fungal and 10^5 cfu/ml bacterial biocontrol agents was done on fruits and pathogen inoculation was done by pin prick method after 2 days of spraying. The disease incidence, disease severity and per cent disease index (PDI) were calculated.

Results and conclusion

On the basis of cultural, morphological and molecular basis the pathogen was identified as *Colletotrichum truncatum.* Further, four strains of *Trichoderma viz.*, *T. viride*, *T. harzianum* TH5 strain, *T. koningii* JA strain, *T. koningii* MA strain and two strains of *Pseudomonas viz., P. fluor*escens NE-32 strain and *Pseudomonas* sp. LL1-20 strain were evaluated against the mycelial growth of *C. truncatum.* Colony diameter of *C. truncatum* in dual culture plate was observed and compared with control (Table 1).
Dual culture assay for the evaluation of antagonistic properties of four species of *Trichoderma* and two species of P*seudomonas* revealed that, maximum inhibition in mycelial growth of 77.77 percent was observed by using *T. harzianum* TH5 strain followed by *T. koningii* MA strain with 72.22 mm mycelial growth inhibition. *Pseudomonas* sp. LL1-20 strain resulted in 57.77 per cent of mycelia growth inhibition of *C. truncatum* while least mycelia growth inhibition of 54.07 per cent was recorded in *P. fluorescens* NE-32 strain.However, in fruit spray of biocontrol agents, *T. harzianum* TH5 strain was found most effective with minimum percent disease index (8.48%) in comparison to 86.66 per cent disease index in control. Maximum disease index was observed with *P. fluorescens* NE32

strain. Hence, the study concluded that all biocontrol agents proved to be effective in inhibiting the growth of pathogen under *in vitro* conditions as compared to the control. Also, when these antagonists were evaluated on tomato fruits against the disease, minimum disease incidence as well as percent disease index was observed when compared to control. However, this study and its results are notably useful for identifying potential biocontrol agents and for hypothesizing the mechanisms through which they reduce pathogen damage.

Table 1: Effect of biocontrol agents on mycelia growth of *Colletotrichum truncatum*

Biocontrol agents	Radial growth (mm)	Inhibition in mycelia growth (%)
Trichoderm aviride	30.66[d]	65.92(54.29)[d]
T.harzianum TH5 strain	20.00[a]	77.77(61.96)[a]
T. koningii JA strain	27.66[c]	69.26(56.42)[c]
T.koningii MA strain	25.00[b]	72.22(58.24)[b]
Pseudomonas fluorescens NE-32	41.33[f]	54.07(47.33)[f]
Pseudomonas sp. LL1-20 strai	38.00[e]	57.77(49.46)[e]
Control	90.00[g]	-
$CD_{(0.05)}$	8.40	(6.43)
SE(d)	3.87	(2.91)

**Figures in parentheses are angular transformed values; Figures denoted by same letter do not differ significantly*

References

Morton DJ and Stroube WH 1955. Antagonistic and stimulating effects of soil microorganisms upon *Sclerotium. Phytopathology* 45: 417-20.

Vincent JM 1947. Distortion of fungal hyphae in the presence of certain inhibitors. *Nature* 159: 850.

ESFS-NF/NBSCP2024/2004

Efficacy of natural products against hoppers in rice grown under natural farming

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Keywords: Hoppers, natural farming, natural products, rice, virus

Introduction

Hoppers pose a significant threat to rice crops, impacting productivity through direct feeding and virus transmission. The green leafhopper reduces yield and spreads the rice dwarf virus, while the brown planthopper transmits the rice grassy stunt and rice ragged stunt viruses, leading to over 10 per cent yield loss. The white-backed planthopper has been linked to the southern rice black-streaked dwarf virus, causing severe plant stunting. Traditional pest management with synthetic pesticides has led to resistance and other challenges, increasing the need for alternative methods. Therefore, this study evaluates natural plant products for managing these hoppers in natural farming systems.

Material and methods

HPR 2880 variety was transplanted at 20 × 15 cm spacing in July, following natural farming practices. Natural farming components, including *Beejamrit* (200 mL/kg seed), *Jeevamrit* (10% concentration every 15 days), and *Ghanjeevamrit* (40 kg/bigha at transplanting), were used. The study employed a randomized block design with six treatments, each replicated four times, including an untreated control (UTC). Natural products were applied starting 60 days after transplanting (DAT) and repeated every 10 days for three sprays. Hopper populations' *viz.*, green leafhopper (GLH), white leaf hopper (WLH), and white-backed planthopper (WBPH) were monitored by counting hoppers /5 sweeps from 60 to 100 DAT. Mean populations were calculated, and per cent reductions were determined over the UTC (Table 1).

Results and conclusion

Efficacy of natural products against rice hoppers was evident, with significant reductions in population counts. *Brahmastra* (10%) was the most effective for WLH and GLH, resulting in mean counts of 2.30 and 0.88 hoppers /5 sweeps, with population reductions of 48.89 and 55.83 per cent, respectively. *Agniastra* (10%) followed closely, achieving reductions of 44.22 per cent for WLH and 52.50 per cent for GLH.

Table 1: Efficacy of natural products against hoppers associated with rice

Treatment	Application rate	Mean hopper count/ 5 sweeps		
		WLH	WBPH	GLH
Agniastra	10%	2.51 (1.87)a	0.97 (1.40)a	0.95 (1.40)a
Brahmastra	10%	2.30 (1.82)a	1.00 (1.41)abc	0.88 (1.37)a
Darekastra	80%	3.63 (2.15)bc	1.50 (1.58)bc	1.18 (1.48)ab
Dashparni ark	5%	2.99 (1.99)ab	1.12 (1.45)ab	0.97 (1.40)a
Neemastra	10%	3.85 (2.20)bc	1.79 (1.67)c	1.59 (1.61)b
Untreated control		4.50 (2.42)d	2.22 (1.79)d	2.00 (1.78)c
CD (0.05)		0.21	0.16	0.16

Figures in parentheses are the square root transformed values

In case of WBPH, *Agniastra* (10%) proved most effective, reducing the population by 56.24 per cent with an average of 0.97 hoppers /5 sweeps, and *Brahmastra (10.0%)* followed closely, with a mean population of 1.00 hopper /5 sweeps. *Dashparni ark* (5%) and *Darekastra* (80%) were less effective, while *Neemastra* (10%) resulted in the highest hopper counts. Hopper populations in rice were effectively managed through holistic natural farming principles and natural products like *Brahmastra* (10%) and *Agniastra* (10.0%), suggesting promising alternatives to synthetic pesticides and the need for further research to optimize their use.

References

Adhikari B, Padhi J and Sthitapragyan S. 2019. Efficacy of new molecules against green leafhopper in rice. *Journal of Entomology and Zoology Studies* 7(2): 194-197.

Sharma SK, Ghosh A, Gupta N, Singh AK, Diksha D, Thapa P, Jangra S and Baranwal VK. 2022. Evidence for association of southern rice black-streaked dwarf virus with the recently emerged stunting disease of rice in North-West India. *Indian Journal of Genetics and Plant Breeding* 82(4): 1-5.

ESFS-NF/NBSCP2024/2005

Influence of natural farming practices on microbial population and management of diseases in pea

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Keywords: Pea, *Pisum sativum*, Natural farming, disease management

Introduction

Pea (*Pisum sativum* L.) also known as garden pea is one of the major winter season vegetable crops grown in Himachal Pradesh, India. The crop is grown throughout the year in this hilly state, during summers in high hills and during winter in mid and foot hills. The crop is vulnerable to a number of diseases, out of which Bacterial blight, Powdery mildew, Rust and Fusarium wilt are amongst the most common in all the pea growing areas. Chemical fungicides have been recommended from time to time to check these biotic stresses but due to the rising public concern over the adverse effects of synthetic chemicals on environment and living beings, a shift has been observed on adoption of natural farming practices by the farmers. Natural farming offers avaluable, alternate approach crop cultivation without the use of chemical pesticides and fertilizers. The research trial was conducted during Rabi Season 2022-23 and 2023-24 to observe the effect of different plant protection formulations on the incidence and severity of different diseases of garden pea cv. Punjab-89 under different cropping systems.

Material and methods

Garden Pea cv. Punjab-89 was grown under different cropping systems. Thirteen treatments *viz*., Sole crop (Pea)+4 sprays of buttermilk @ 3% (T1), Pea intercropped with Fenugreek + 4 sprays of buttermilk @ 3% (T2), Pea intercropped with Coriander + 4 sprays of buttermilk @ 3% (T3), Pea intercropped with Spinach + 4 sprays of buttermilk @ 3% (T4), Sole Crop (Pea) + 4 sprays of *Sounthaster* @ 3% (T5), Pea intercropped with Fenugreek + 4 sprays of Sounthaster @ 3% (T6), Pea intercropped with Coriander + 4 sprays of Sounthaster @ 3% (T7), Pea intercropped with Spinach + 4 sprays of Sounthaster @ 3% (T8), Sole crop (Pea)+ alternate Sprays of Buttermilk (2) and *Sounthaster* (2) @ 3% (T9), Pea intercropped with Fenugreek + alternate sprays of *buttermilk* (2) and *Sounthaster* (2) @ 3% (T10), Pea intercropped with Coriander + alternate spray of Buttermilk (2) and Sounthaster (2) @ 3% (T11), Pea intercropped with Spinach + alternate spray of Buttermilk (2) and Sounthaster(2) @ 3% (T12) and Sole Crop (Pea) grown under conventional/chemical Framing (T13) was taken as Control. The data on disease incidence and severity, yield, population of soil microflora were recorded in the field periodically.

Results and conclusion

The results showed that amongst various natural farming based treatments, minimum incidence and severity of bacterial blight 13.32% and 2.66%; powdery mildew 20% and 6.80%; fusarium wilt 7.78% and 1.84%, respectively were recorded with T6 (Pea intercropped with Fenugreek + 4 sprays of *Sounthaster* @ 3%) which was statistically at par with that recorded in T13 (Sole Crop of Pea under Conventional/Chemical Framing). Almost similar results were recorded *w.r.t.* rust and downy mildew, however, the incidence of these diseases was less as compared to other diseases. While analyzing the data on the crop yield it was found that treatment comprising of pea intercropped with fenugreek with 4 spray of buttermilk @ 3% (T_2) performed better in terms of pod yield (5.85 kg/bed) amongst all the combinations and was significantly superior to treatment T_{13} (Pea sole crop in conventional/ chemical farming) with pod yield of 3.20 kg/bed). The analysis of the data pertaining to the number of root nodules per plant indicated that treatment comprising of sole pea crop with 4 spray of *Sounthaster* @ 3% (T_5) recorded maximum nodules per plant (18.47) and (11.67) at the stage of 50% flowering and pod filling stage, respectively amongst all the combinations and was significantly superior to treatment T_{13} (Pea sole crop in conventional/ chemical farming) which recorded nodules (10.53) and (6.2) at the stage of 50% flowering and pod filling stage, respectively.

Mycorrhizal root colonization (50.93%) was observed maximum under treatment comprising of pea intercropped with coriander with 4 spray of Sounthaster @ 3% (T_7)and was significantly superior to treatment T_{13} (Pea sole crop in conventional/ chemical farming) with 12.47% mycorrhizal root colonization per plant. Pea intercropped with fenugreek with 4 spray of buttermilk @ 3% (T_2) recorded maximum bacterial population per plant (142.67×10^7 cfu), fungal population per plant (27.33×10^2 cfu) and actinomyces population per plant (22.33×10^2cfu) which were at par with T6 (Pea intercropped with Fenugreek + 4 sprays of *Sounthaster* @ 3%) and significantly higher as compared to treatment T_{13} (Pea sole crop in conventional/ chemical farming). It can be concluded from the present investigation that pea crop grown under natural farming especially when intercropped with Fenugreek and applied with 4 sprays of Sounthaster @ 3%, a field formulated fungicide (based on dried ginger and milk) was found a prominent and effective treatment combination in checking the incidence of major diseases. The treatment also registered superiority over conventional/ chemical farming *w.r.t.* green pod yield, number of rhizobia root nodules, population of microflora and root colonization with mycorrhizal fungi.

ESFS-NF/NBSCP2024/2006

Insect-Pests–Natural enemy complex of tomato in natural farming and chemical farming and their management

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Keywords: Natural Farming, Insect-pests, Agroecology, Natural enemy

Introduction

India is the second largest tomato (*Solanum lycopersicum* L.) producer in the world. The production of tomato is hampered due to attack of insect-pests viz. *Helicoverpa armigera* (Hubner), *Macrosiphum euphorbae, Tuta absoluta* (Meyrick), *Liriomyza trifolii* (Burgess), *Trialeurodes vaporariorum* (Westwood), *Bactrocera tau* etc. To control these insect-pests insecticides are used which leads to development of resistance in insect-pests and harmful to humans, non-target organisms and environment. Subhash Palekar Natural Farming (SPNF) is an agro-ecological farming approach, improves soil fertility through many agro-ecological principles. The main aim is to study the diversity and abundance of insect-pests and natural enemies, under SPNF and Conventional Farming (CF) systems.

Material and methods

The study was carried out at the Subhash Palekar Natural Farming Farm of Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. The tomato crop (cv. Solan Lalima) was grown during rainy (kharif) of 2021 under two systems, viz. natural farming (NF) and chemical farming (CF). The tomato seedlings raised under different farming systems were transplanted in the month of April , 2022 at 90 cm × 30 cm spacing in plots of 1.2 m × 30 m.Brinjal cv.Pusa purple long anf French bean cv. Contender was grown as companion crop with tomato under NF. Sole tomato crop was cultivated in CF. NF system was implemented as per Palekar (2013). The cow urine, dung and butter milk of indigenous cows (Sahiwal breed), maintained at the university dairy were used. Under CF crop was grown following standard package of practices of the University. Insect-pests of tomato were recorded as per standard procedure.

Results and conclusion

Data contained in Table 1 reveal that infestation of serpentine leaf miner (*L. trifolli*) (40 mines /plant)was first observed on 22nd standard week i.e. second week of June,2021 which differed non-significantly with CF (0.20 mnes/plant). The first incidence of greenhouse whitefly (*T. vaporariorum*) was noticed on 24th standard week i.e. last week of June, 2021 under both the farming systems. The greenhouse whitefly recorded under SPNF on 25th standard week (1.13 nymphs/plant) was statistically different from CF system (0.10 nymphs/plant). In NF system eight natural enemies were recorded whereas under CF system only six natural enemies of the insect-pests were recorded.

Table 1: Incidence of insect-pests of tomato under SPNF (Tomato+French bean+ Brinjal) and CF systems

Standard Week	Serpentine leaf miner (no./plant)		t-value	P<0.05
	SPNF	CF		
22	0.40±0.13	0.20±0.07	1.3191	0.1923
23	0.60±0.18	0.17±0.07	2.2127	0.0386
24	0.77±0.23	0.23±0.11	2.0186	0.0481
25	0.37±0.13	0.00±0.00	2.7956	0.0070
Greenhouse whitefly (no./plant)				
24	1.20±0.27	0.63±0.18	1.6904	0.0962
25	1.13±0.23	0.10±0.05	4.2199	0.0008
26	1.10±0.21	0.17±0.08	4.1099	0.0001
27	1.28±0.27	0.07±0.05	4.3937	0.0004
	Natural Enemies of Tomato insect-pests			
	Coccinella septempunctata	*Coccinella septempunctata*		
	Hippodamia variegata	*Hippodamia variegata*		
	Cheilomenes sexmaculata	-		
	Episyrphus balteatus	*Episyrphus balteatus*		
	Melanostoma orientale	*Melanostoma orientale*		
	Eupeodes confrater	*Eupeodes confrater*		
	Ischiodon scutellaris	*Ischiodon scutellaris*		
	Chrysoperla zastrowi sillemii	-		

Agroecological based pest management approaches specifically natural Farming practices which utilizes locally available farm inputs and plant protection decoctions are effective in managing the insect-pests of tomato. NF system attracted more natural enemies in comparison to CF system. This system can therefore, be a viable option for the management of insect-pests and conservation of natural enemies, after having further systematic validation studies.

References

Palekar S 2013. Subhash Palekar Krishi- Vegetable Crops Part-I Zero Budget Spiritual Farming Research Development & Extension Movement, Amravati, Maharashtra, India, 216p

ESFS-NF/ NBSCP2024/2007

Diversity of plant parasitic nematode associated with guava and mango nurseries in Himachal Pradesh

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Keywords: Diversity, plant parasitic nematode, predominant, survey

Introduction

Himachal Pradesh is a hilly state primarily relant on its horticulture sector with fruit nurseries being the prime focus. The low and mid-hill zones are known to produce tropical and subtropical fruit nurseries. Mango and guava are among the two most important fruit crops whose nurseries are predominant in the state Himachal Pradesh. However, underground pests like plant parasitic nematodes severely affect nursery production, causing weak seedlings, stunted growth, and gall formation. The main issue is the lack of awareness among nurserymen and orchardists about nematode infection in planting materials.

Material and methods

Soil samples were collected from the rhizosphere of ten mango and guava fruit nurseries growing locations in districts of Bilaspur, Hamirpur and Kangra. Total 42 composite soil samples were collected from the rhizosphere of different fruit nurseries across the state consisting of 200cc soil. The samples were brought back to the nematology lab and samples were stored at 4^0C for further processing. The samples were processed through Cobb's sieving and decanting technique (Cobb, 1918) followed by Schilnder modification. The occurrence (%) of plant parasitic nematodes per 200cc soil was determined.

Results and conclusion

Six genera of plant parasitic nematodes were prevalent in the rhizosphere of the guava and mango fruit nurseries surveyed namely, *Meloidogyne incognita, Helicotylenchus dihystera, Hoplolaimus indicus, Mesocriconema xenoplax, Xiphinema* spp., *Mesodorylaimus* spp. *Meloidogyne incognita* and *Helicotylenchus dihystera* were the most frequent with the maximum incidence in the surveyed fruit nurseries. The occurrence (%) of the plant parasitic nematodes followed, *Meloidogyne incognita* (90.48%), *Helicotylenchus dihystera* (90.48%), *Mesocriconema xenoplax* (71.43%), *Xiphinema* spp. (28.57%), *Hoplolaimus indicus* (23.81%) and *Mesodorylaimus* spp. (14.29%) (Figure 1).

The results of the current findings revealed that root knot nematode and spiral nematode were the most prevalent plant-parasitic nematodes, causing significant harm to the guava and mango seedlings at the nursery stage leading to unhealthy diseased fruit nursery seedlings. The phytonematodes have proliferated throughout India as a result of nurserymen's ignorance of plant parasitic nematodes infection in planting materials. Plants that are afflicted frequently have stunted growth and eventually succumb to nematode infection on their roots, which is exacerbated by secondary fungal pathogen attacks (Poornima et al. 2016). This study suggests strategies to control nematode infection in fruit nurseries and manage it from spreading through affected planting material to healthy new orchards.

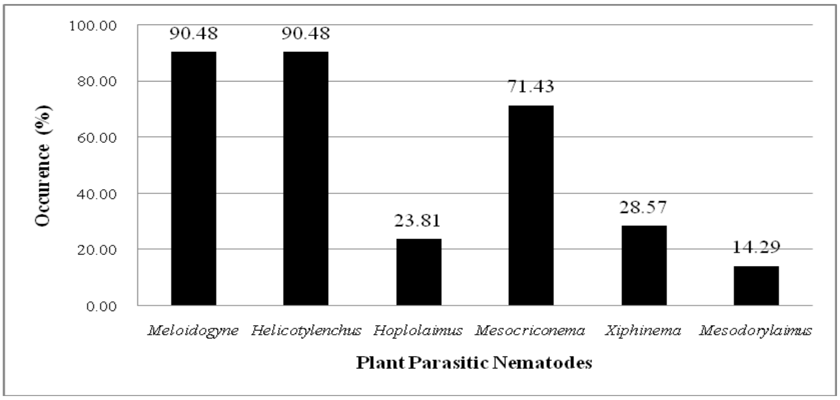

Fig 1: Diversity of plant parasitic nematodes in guava and mango nurseries

References

Cobb NA. 1918. Estimating the nema population of soil. Agricultural Techmology Circular 1, Bureau of plant industry, USDA, Washington, DC.

Poornima K, Suresh P, Kalaiarsan P, Subramanian S and Ramaraju K. 2016. Root knot nematode, *Meloidogyne enterolobii* in guava (*Psidium guajava* L.) – a new record from India. *Madras Agricultural Journal* 103: 359–365.

ESFS-NF/NBSCP2024/2008

Impact of natural farming practices on crop and soil health: Insights from bio-concoction formulations

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Introduction

Soils are being depleted due to he widespread misuse and improper application of chemical fertilizers; simultaneously, large-scale pesticide, spraying has put eco-systems in a vulnerable position. Natural farming is the ancient practice of farming duly re-conceptualized to fit to the present day's agriculture. The basic component of this newly framed natural farming is cow-based bio-concoctions, which have immense impact on crop growth (Ghosal and Sahu 2022). Evidence from the literature suggests that natural farming promotes soil carbon regeneration, symbiotic relationship between crops and microbes and increases the population of native soil arthropods and earthworms (Goshal, 2024). Therefore, it is the need of the hour to study the impact of natural farming on crop and soil health from the insight of the role of bio-concoction based formulation.

Material and methods

The study was conducted under the ICAR-sponsored project "Outscaling of Natural Farming through KVKs, aimed to investigate the fundamental science behind natural farming. The study included on-site demonstrations of natural farming practices at Sasya Shyamala Krishi Vigyan Kendra to assess their impact on crop and soil health, with a focus on bio-concoction-based formulations: *Jeevamrit, Ghanjeevamrit, Neemastra* and *Agniastra*. The study also intricated the physico-chemical and microbial properties (using the pour plate method on selective media) of four key bio-concoctions mentioned duly analysed in laboratory to draw conclusions.

Results and conclusion

The study showed encouraging results in knol khol, greengram, paddy, tomato, spinach, coriander, and guava in natural farming compared to conventional practices. While all crops demonstrated promising vegetative growth, the reproductive growth of cole crops like cabbage and cauliflower was less satisfactory despite good vegetative development. The findings also revealed that the pH levels of Jeevamrit, Ghanjeevamrit, Neemastra, and Agniyastra, measured 15 days after preparation, were 4.64, 5.82, 8.77, and 8.95, respectively. All the bio-concoctions were the potent sources of micro-nutrients specifically zinc, copper, iron & manganese. Additionally, total N-fixers were significantly higher ($P<0.05$) in *Ghanjeevamrit*, followed by *Jeevamrit, Neemastra* and *Agniastra*. On the contrary, the total count of bacterial population was found to be higher ($P<0.05$) in Agniyastra as compared to other formulations.

Natural farming increased the abundance of both micro- and macro-arthropods and enhanced the activities of enchytraeids. A total of 247 individuals of macro- and micro-arthropods, along with enchytraeids, were recorded from 250 grams of soil under straw mulch conditions. The performance of *Agniastra* (5%) and *Neemastra* (5%) in reducing seed damage in pulses under laboratory conditions was also promising, resulting in only 0.88% seed damage compared to 25.76 per cent in untreated seeds. Therefore, it can be concluded that natural farming has a positive effect on crop and soil health, particularly by influencing the microbial and arthropod activity in the soil. As natural farming is a relatively new field, there is a huge scope for further research to unveil its scientific background.

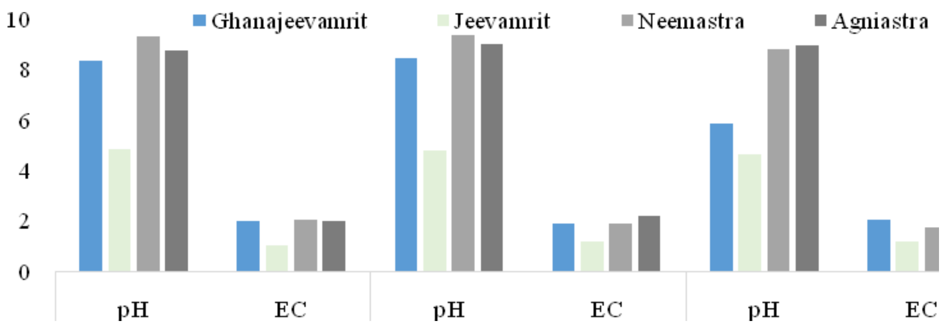

Fig. 1: pH & EC of different bio-concoctions

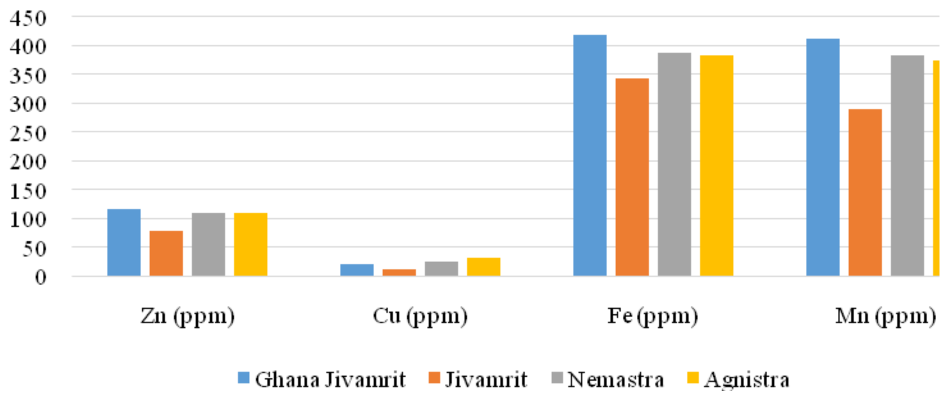

Fig. 2: Micro-nutrient concentration of different bio-concoctions

References

Ghosal A. 2024. Natural farming: time to go back to our roots, *The Agricultural Magazine* 3(8): 543-547.

Ghosal A and Sahu NC. 2022. Impact of crop-specific technologies and organic growth stimulants on mustard, blackgram and greengram in Sundarban area of West Bengal. *Journal of Indian Society of Coastal Agricultural Research* 40(2): 90-98.

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Eucalyptus Oil: A potent antifungal agent against nursery pathogens

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Introduction

Nursery diseases such as root-rot, stem decay and damping-off pose significant threats to crop health and yield. *Fusarium oxysporum* is linked to root-rot and stem decay, while *Rhizoctonia solani* is responsible for root-rot and post-emergence damping-off, resulting in crop losses of up to 50-60%. Such losses severely impact global food security (Savary et al., 2019). This study investigates the antifungal efficacy of Eucalyptus oil against these pathogens.

Material and methods

The study evaluates the antifungal properties of *Eucalyptus tereticornis* oil against *Fusarium oxysporum* and *Rhizoctonia solani*. Various clones (C-7, C-83, C-288, and C-413) and concentrations (5, 10, 20, and 40 mg/ml) were tested for their growth inhibition potential. Fungal growth inhibition was measured at after 7 days of incubation. The results were analyzed to determine the variation in antifungal efficacy across different clones and concentrations.

Results and conclusion

Eucalyptus oil demonstrated significant antifungal properties against both *Fusarium oxysporum* and *Rhizoctonia solani* (Table 1). For *Fusarium oxysporum*, clone C-83 exhibited 100% growth inhibition at all tested concentrations after seven days, followed closely by clones C-288 and C-413. Similarly, *R. solani* was significantly inhibited by all clones, with clone C-83 showing the highest average inhibition of 97.78%. These findings indicate that *Eucalyptus* oil, particularly from clone C-83, holds considerable promise as an effective natural fungicide against major nursery pathogens (Poonia et al., 2015).

Table 1: Growth inhibition of Eucalyptus oil against *Fusarium oxysporum* and *Rhizoctonia solani* after 7 days of incubation

Clone	Concentration (mg/ml)	Growth inhibition (%)	
		Fusarium oxysporum	***Rhizoctonia solani***
C-7	5	84.44	80.00
	10	95.56	91.11
	20	100.00	100.00
	40	100.00	100.00
Mean		95.00	92.78
C-83	5	100.00	91.11
	10	100.00	100.00
	20	100.00	100.00
	40	100.00	100.00
Mean		100.00	97.78
C-288	5	91.11	86.67
	10	100.00	100.00
	20	100.00	100.00

	40	100.00	100.00
Mean		97.78	96.67
C-413	5	88.89	62.22
	10	100.00	80.00
	20	100.00	100.00
	40	100.00	100.00
Mean		97.22	85.56
Overall Mean		97.50	93.20

References

Poonia PK, Devi LA, Tripathi S 2015. The efficacy of methanolic extract of *Eucalyptus tereticornis* Sm. leaves against wood decaying fungi. *Indian Forester* 141 (8): 869-872.

Savary S, Willocquet L, Pethybridge SJ, Esker P, McRoberts N, Nelson A. 2019. The global burden of pathogens and pests on major food crops. *Nature Ecology and Evolution* 3(3): 430-439.

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Biofumigation potential of mustard seed extracts against potential insect pests

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Keywords: Allelo-chemicals, Bio-fumigation, Mustard seeds

Introduction

The aqueous extracts from black, brown and white mustard were utilized for *in vitro* anti-feedant activity against *Spilosoma obliqua* larvae. The oil extracts were utilized to assess the *in vitro* insecticidal activity against *S. obliqua*. Meanwhile, myrosinase activity and potential allele-chemicals were assessed against *Lipaphis erysimi* in three mustard types in field conditions. GC-MS deciphered the involvement of chemical compounds. The study published in 2024 in South African Journal of Botany. In another study, the comparative assessment of bio-fumigation potential of allylisothiocyanate & mustard oil seed extracts against pumpkin red beetle, *Aulocophora foveicollis* and tobacco cutworm, *Spodoptera littura* has also been done.

Material and methods

Spilosoma obliqua collected from castor leaves, experimented for anti-feedant activity with aqueous extracts and same organism was experimented for insecticidal activity with oil extracts from black, brown and white mustard seed extracts. *L. erysimi* infestation was co-related with change in myrosinase and allelo-chemicals activity in open field conditions in three mustard plants used here. GC-MS showed relative involvement of chemical compounds. The assessment of anti-feedant and insecticidal activities of three distinct mustard seed extracts were noted individually against *A. foveicollis* and *S. littura* and comparison in bio-efficacy was drawn. Sinigrin and allylisothiocyanate were obtained from Sigma Aldrich. Probit analysis and SPSS software were used for statistical analysis.

Results and conclusion

Research analysis done here demonstrates the importance of mustard allelo-chemicals in managing serious pest infestations and deciphers how the allelo-chemicals vary according to the content of key secondary metabolites concerning change in enzymatic activity in response to pest infestation. Since the brown mustard holds the maximum values of glucosinolates, resulting in highest anti-feedant activity (%), feeding inhibition (%) and highest range of mortality, as glucosinolates are known to deter insect pests. Even the LT_{50} values of brown were found to be much more effective than other two mustards analyzed here because of higher concentration of glucosinolates and N-hexadecanoic acid present in the brown mustard oil. The content of total phenols and ortho-dihydric phenols was also noticed to be highest in brown as compared to black and white. The fatty acids and unique to mustard type sterol compounds (Table 1) present in varying amounts in mustard oils are responsible for insecticidal effects and the presence of same compounds in mustard oil used here has been illustrated through GC-MS analysis and their presence can be directly linked to their performance of action observed in insecticidal assay. In near future, the utilization of different types of mustard seed extracts (oil & water) against insect pest invasion may reduce the crop yield losses, prevent from diseases and also, at the same time is environmentally safe.

Table 1: Key biochemicals responsible for insecticidal effects in mustard seeds oil

%Peak Area in Mustard Types	Diethyl Phthalate / its derivative (1, 2-benzene dicarboxylic acid)	N-Hexadecanoic Acid	Decanoic Acid	Octadecanoic Acid	Cholestan-3-one / Stigmasta-3,5-diene / 1h-indole-3-ethanamine
Black Mustard	12.71%	23.41%	6.02%	6.93%	1h-indole-3-ethanamine (1.82%)
Brown Mustard	3.71%	34.87%	1.79%	8.85%	Stigmasta-3,5-diene (0.44%)
White Mustard	0.34%	1.05%	0.37%	0.20%	Cholestan-3-one (15.42%)

References

Garg S, Nain P, Joshi R, Punetha H, Srivastava RM. 2024. Bio-efficacy of mustard seed extracts against Bihar Hairy Caterpillar *Spilosoma obliqua* & assessment of mustard allele-chemicals in response to mustard aphid *Lipaphis erysimi* (Aphididae: Hemiptera) infestation. *South African Journal of Botany* 171: 156-163.

Lietzow J. 2021. Biologically active compounds in mustard seeds: A toxicological perspective. *Foods* 10(9): 20-89.

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Diversity of natural enemies of *Trialeurodes vaporariorum* in vegetable growing areas under different agro-climatic zones of Himachal Pradesh

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Keywords: Diversity, Greenhouse Whitefly, Natural Enemy, Vegetable

Introduction

The greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood) (Homoptera: Alyerodidae) is a polyphagous and key pest of many crops in the tropical and subtropical areas. It is a serious pest in protected as well as in field conditions which transmits many viral diseases and produces honeydew on which sooty mould grows. Greenhouse whiteflies can reduce crop production by 50 per cent. In Himachal Pradesh. Sood and Sood (2002) recorded greenhouse whitefly on 44 plant species comprised of ornamnetals (29 species), vegetable crops (6 species), field crops (2 species), medicinal plants (3 species) and weed hosts (4 species).

Material and methods

A survey was conducted in different locations under three different agro-climatic zones of Himachal Pradesh for collection of natural enemies of *T. vaporariorum*. Specimens were collected and identified using the checklists and keys available in the literature. Diversity indices were calculated according to standard procedures.

Results and conclusion

In Zone-I, a total of 8 natural enemies of *T. vaporariorum* were recorded, out of which *Chrysoperla zastrowi sillemii* was the most dominant (49.11%). The next dominant natural enemy was *Encarsia sophia* which contributed to 18.85 per cent followed by *Coccinella septempunctata* (11.81%), *Cheilomenes sexmaculata* (11.49%), *Harmonia dimidiata* (3.36 %), *Encarsia formosa* (2.60%), *Hippodamia variegata* (2.14%) and *Phrynocaria perrotteti* (0.65%).

In zone- II, a total of 9 natural enemies were recorded. Among the natural enemies the most prevailing was *E. sophia* which accounted for 44.15 per cent of the total relative proportion of the natural enemy followed by *E. formosa* (41.52%), *C. zastrowi sillemi* (7.68%), *C. septumpunctata* (2.76%), *H. variegata* (1.88%). Whereas the rest of the natural enemy contributed less than 1 per cent (*Nesidiocoris tenuis*: 0.65; *Oenopia sauzeti*: 0.59; *Propylea dissecta*: 0.59; *Phrynocaria perrotteti*: 0.34). Similarly, in zone-III only five natural enemies viz. *E. sophia, C. zastrowi sillemi*, *C. septumpuctata, Hippodamia variegata* and *H. dimidata*, were recorded. Among these natural enemies *E. sophia* was dominant with 71.14 per cent of the total followed by *C. zastrowi sillemi* (9.23%), *C. septumpunctata* (7.20%), *H. dimidata* (6.83%) and *H. variegate* (5.60%).

In zone-I, the Simpson and Shannon diversity indices were 0.31 and 1.40, respectively. Maximum diversity was 2.08, while, the species evenness was 0.51, species dominance was 0.49 and Marglef index was 1.18. Similarly, Zone-II, the values of Simpson and Shannon diversity indices were 0.39 and 0.61, respectively. Maximum diversity was 2.20, while the species evenness was 0.35, species dominance was 0.65 and Marglef index was 1.01. The diversity indices *viz.,* Simpson diversity index, Shannon index, species richness, species evenness, dominance and Marglef index were 0.53, 0.99, 1.61, 0.54, 0.46 and 0.59, respectively for the agro-climatic zone-III. A total of 11 natural enemies *viz. C. zastrowi sillemii, C. septempunctata, H. variegata, H. dimidiata, N. tenuis*, *P. perrotteti, O. sauzeti, P. dissecta*, *C. sexmaculata, E. formosa and E. sophia* were recorded on *T. vaporariorum* infesting tomato under different agroclimatic zones (Zone-I, Zone- II and Zone- III).

Table 1: Relative proportion of natural enemies of *T. vaporariorum* infesting vegetable crops

Zone- I		**Zone-II**		**Zone-III**	
Species	**RP (%)**	**Species**	**RP (%)**	**Species**	**RP (%)**
C. zastrowi sillemi	49.11	*C. zastrowi sillemi*	7.68	*C. zastrowi sillemi*	9.23
C. septumpuctata	11.81	*H. variegata*	1.88	*C. septumpuctata*	7.20
C. sexmaculata	11.49	*C. septumpuctata*	2.76	*H. variegata*	5.60
H. dimidata	3.36	*N tenius*	0.65	*H. dimidata*	6.83
H. variegata	2.14	*O. sauzetti*	0.59	*E.sophia*	71.14
P. perrotteti	0.65	*P. dissecta*	0.59		
E. sophia	18.85	*P. perrotteti*	0.34		
E. formosa	2.60	*E. sophia*	44.15		
		E. formosa	41.52		
Total	100		100		100

References

Sood S and Sood AK. 2002. Incidence and record of host plants of the greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood) from Himachal Pradesh. *Pest Management and Economic Zoology* 10: 81-86.

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Assessment of pesticide residues in cucurbits: A comparative study of conventional and natural farming

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Keywords: Conventional farming, Cucurbits, Natural farming, Pesticide residues

Introduction

Agricultural practices have evolved significantly, driven by the need to enhance crop yield and ensure food security for a growing global population. Among the emerging techniques, natural farming, or Zero Budget Natural Farming (ZBNF), has gained attention as a sustainable approach that minimizes human intervention and relies on natural processes, avoiding synthetic chemicals and fertilizers (Laishram et al., 2022).

Cucurbits, including cucumber, bottle gourd, and bitter gourd, are important vegetables known for their nutritional value and high demand. However, the extensive use of pesticides in conventional farming has raised concerns about the safety of these crops. To address these concerns, this study assesses pesticide residues in cucurbits from four different farming systems: natural farming, polyhouse farming, market samples, and farmgate samples. The objective is to provide a comparative analysis of pesticide contamination in cucurbits grown under various agricultural practices, with a focus on the relatively new and sustainable approach of natural farming.

Material and methods

Sample collection and preparation: A 1 kg sample of cucumber, bottle gourd, and bitter gourd was collected from each of the four different growing systems. The samples were finely chopped and thoroughly homogenized.

Extraction and cleanup of pesticide residues: The quick, easy, cheap, effective, rugged, and safe (QuEChERS) analytical technique, validated for residue estimation (Sharma et al., 2013), was used. A 15-gram sample was placed in a 50 mL centrifuge tube, and 30 mL of acetonitrile was added. The sample was homogenized for 3 minutes at 15,000 rpm, followed by the addition of 3 grams of anhydrous NaCl. After shaking for 5 minutes, the sample was centrifuged at 3,000 rpm for 3 minutes. An 18 mL aliquot was transferred to another tube containing 9 grams of anhydrous Na_2SO_4 and shaken for 5 minutes. An 11 mL aliquot was then transferred to a new tube containing 1.15 grams of anhydrous $MgSO_4$ and 0.4 grams of PSA, shaken, and centrifuged for 5 minutes at 5,000 rpm. For Gas Chromatography-Mass Spectrometry (GC-MS/MS), 6 mL of the extract was transferred to a test tube, evaporated to dryness at 40°C under a nitrogen stream, and reconstituted in 3 mL of n-hexane. For Liquid Chromatography-Mass Spectrometry (LC-MS/MS), a 1 mL aliquot was filtered and placed in an injection vial. The cucurbit samples were analysed for the presence of more than 200 pesticides using GC-MS/MS and LC-MS/MS.

Results and conclusion

The results revealed that none of the cucumber, bottlegourd, and bittergourd samples from natural farming practices contained pesticide residues, highlighting the effectiveness of these methods in producing clean, residue-free crops. In contrast, farmgate samples exhibited the highest levels of contamination, emphasizing the stark difference between conventional and natural farming methods.For cucumber, farmgate samples were the most affected, with 30%

showing pesticide residues. This was followed by 26.66% of market samples and 25% of polyhouse samples (Figure 1). Farmgate cucumber samples contained residues of Chlorpyrifos, Chlorothalonil, Profenofos, Cypermethrin, Clothianidin, and Lambda-cyhalothrin, while market samples had Profenofos, Metalaxyl, Fluopyram, Monocrotophos, and Novaluron.In bottlegourd, 40% of farmgate samples were contaminated with Profenofos, compared to 25% of market samples, which contained Lambda-cyhalothrin, Trifloxystrobin, and Profenofos. For bittergourd, 33% of farmgate samples were contaminated with Fenazaquin, Chlorpyrifos, and Lambda-cyhalothrin. Additionally, 12.5% of market samples were contaminated with Chlorantraniliprole.

The study clearly demonstrates that natural farming practices are highly effective in producing pesticide-free cucumber, bottlegourd, and bittergourd, with none of the samples from these methods showing any contamination. Conversely, conventional farming methods, particularly those reflected in farmgate samples, resulted in significant pesticide residue presence, with cucumber being the most affected. This stark contrast underscores the potential benefits of adopting natural farming techniques to reduce pesticide contamination in crops and promote safer, cleaner produce for consumers.

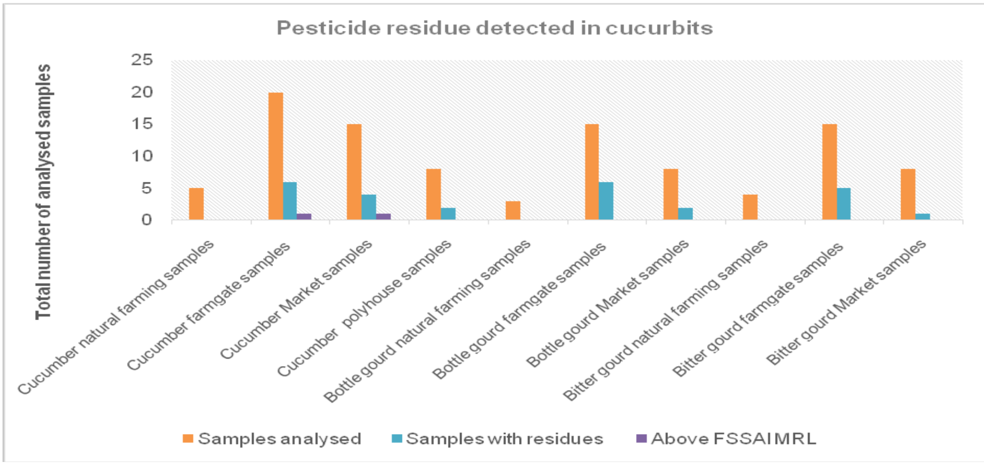

Fig 1. Cucurbits samples contaminated with pesticide residues

References

Laishram C, Vashishat RK, Sharma S, Rajkumari B, Mishra N, Barwal P, Vaidya MK, Sharma R, Chandel RS, Chandel A, Gupta RK and Sharma N 2022. Impact of Natural Farming Cropping System on Rural Households—Evidence From Solan District of Himachal Pradesh, India. *Frontiers in Sustainable Food Systems* 6:878015. doi: 10.3389/fsufs.2022.878015

Sharma KK 2013. Pesticide residue analysis manual (2nd ed.). Indian Council of Agricultural Research.

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Monitoring of pesticide residues in pome fruits cultivated under natural farming and conventional farming in Himachal Pradesh

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Keywords: Apple, Natural farming, Pear, Pesticide residues

Introduction

The rapid deterioration of natural environment and agricultural products has become a matter of great concern for many people in the world (Stockdale et al., 2001). Nowadays natural farming, or Zero Budget Natural Farming (ZBNF), has gained attention as a sustainable approach that minimizes human intervention and relies on natural processes, avoiding synthetic chemicals and fertilizers (Laishram et al., 2022). Pome fruits such as apple and pear mainly grown in Himachal Pradesh are of commercial importance and thus lure the farmers to use pesticides on these crops. Indiscriminate use of pesticides in these crops has raised concerns about the safety of consumers as well as environment. To address these concerns, monitoring study has been carried out in apple and pear. The samples for pesticide residue study were collected from natural farming, market and farmers field. The objective was to study comparative analysis of pesticide contamination in these fruits under varying agricultural practices, including the relatively new and sustainable approach of natural farming.

Material and methods

Sample collection and preparation: 1 kg sample of each Apple and Pear were collected from natural farming, market and farmers field from different locations. The samples were finely chopped and grind well. A representative sample of 15 g was taken for residue analysis.

Extraction and cleanup: The samples were analysed as per the modified QuEChERS (Quick, easy, cheap, effective, rugged and safe) method for fruits and vegetables. Fruit samples were homogenized and a representative sample (15 g) drawn in 50 mL centrifuge tube containing 30 mL acetonitrile. The contents were homogenized at 15000 rpm for 3 min in high speed homogenizer. Thereafter, 3 g sodium chloride was added into the tube, shaken at 50 rpm for 2 min in a Rotospin and then, centrifuged at 3000 rpm for 3 min. Finally,18 mL of the upper organic phase was transferred to a new anhydrous sodium sulphate for removal of the moisture. After removing moisture contents, 11 ml extract was transferred into a 15 ml centrifuge tube and cleaned up with dispersive solid phase by using magnesium sulfate anhydrous (900 mg) and PSA (150 mg). Capped tube was centrifuged at 3,000 rpm for 5 min. For GC analysis, transferred 6 mL extract to the test tube and evaporated to dryness at 40°C in the presence of nitrogen current and reconstitute in 3mL n-hexane. For LC, filter 1mL extract into injection vial.

Analysis, Quantification and Confirmation on the instrument: The sample after extraction and clean-up was analysed on the Gas Chromatograph-Mass Spectrometry (GC- MS/MS) and Liquid Chromatograph- Mass Spectrometry (LC-MS/MS) for the qualitative and quantitative determination of more than 200 pesticide residues.

Results and conclusion

The results revealed that none of the apple fruit samples from natural farming contain pesticide residues whereas 40% of market sample and 30% of farmgate samples found contaminated with residues. Mainly encountered pesticides in apple were trifloxystrobin, tebuconazole, spiromesifen, lambda cyhalothrin, difenoconazole, fluopyram and fenazaquin. Out of the total, two apple samples were found to be contaminated with residues of spiromesifen and difenconazole above FSSAI MRL (Maximum Residue Limit). None of the pear samples from natural and conventional farms were found to have pesticide residues only one sample of market was contaminated with difenoconazole. The study clearly demonstrates that natural farming practices are highly effective in producing pesticide-free pome fruits, with none of the samples from these methods showing any contamination. Conversely, conventional farming methods, particularly those reflected in market samples, resulted in significant pesticide residue presence. This stark contrast underscores the potential benefits of adopting natural farming techniques to reduce pesticide contamination in fruits and promote safer, cleaner produce for consumers.

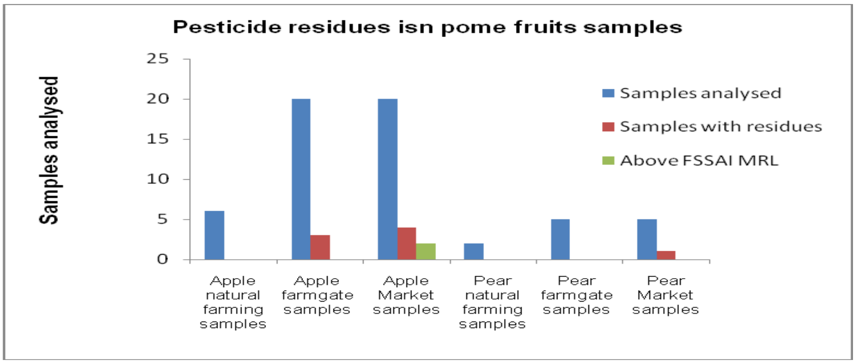

Fig 1. Pesticide residues in pome fruit samples

References

Laishram C, Vashishat RK, Sharma S, Rajkumari B, Mishra N, Barwal P, Vaidya MK, Sharma R, Chandel RS, Chandel A, Gupta RK and Sharma N. 2022. Impact of natural farming cropping system on rural households—Evidence from Solan district of Himachal Pradesh, India. *Frontiers in Sustainable Food Systems*. 6:878015.

Stockdale EA, Lampkin NH, Hovo M, Keatingge R, Lennartsson EKM, Mc Donald DW, Padel S, Tatterall, FH, Wolfe MS and Watson CA. 2001. Agronomic and environmental implications of organic farming systems. *Advances in Agronomy*. 70:261-327.

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Comparative analysis of pesticide residues in chilli peppers from natural versus conventional farming

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Keywords: Capsicum, Chilli, Conventional farming, Pesticide residue

Introduction

To address food production and security challenges, proponents of chemical agriculture advocate for the continued or increased use of chemical fertilizers and synthetic pesticides. Yet, persistent reliance on these inputs can lead to decreased crop productivity and harm natural resources and ecosystems. In contrast, Zero Budget Natural Farming (ZBNF) presents a sustainable alternative that protects both agricultural growth and the environment (Kumar et al., 2020; Laishram et al., 2022). In Himachal Pradesh, peppers are popular off-season crops, but excessive pesticide use in these crops has raised concerns about consumer safety and ecological impact. This study monitors pesticide residues in green chilli and capsicum, comparing those from natural and conventional farming practices. The aim is to evaluate the levels of pesticide contamination associated with each farming method, providing valuable insights into their safety and environmental impacts.

Material and methods

Samples of 0.5 kg green chilli and 1 kg capsicum were collected from natural farming systems, markets, farmers fields, and protected cultivation. The analysis followed the modified QuEChERS (Quick, Easy, Cheap, Effective, Rugged, and Safe) for fruits and vegetables. For Gas Chromatography (GC), 6 mL of the extract was transferred to a test tube, evaporated to dryness at 40°C under a nitrogen stream, and reconstituted in 3 mL of n-hexane. For Liquid Chromatography (LC), 1 mL of the extract was filtered into an injection vial. The final samples were analyzed for pesticide residues using Gas Chromatograph-Mass Spectrometry (GC-MS/MS) and Liquid Chromatograph-Mass Spectrometry (LC-MS/MS) to determine both the presence and concentration of pesticide residues.

Results and conclusion

The results indicate that samples of green chilli and capsicum from natural farming were completely free from pesticide residues, showcasing the effectiveness of this farming system in avoiding contamination. In contrast, conventional farming systems revealed notable pesticide contamination. Specifically, 40% of farmgate, 30% of market, and 60% of polyhouse capsicum samples contained residues of multiple pesticides, including cypermethrin, profenofos, chlorantraniliprole, hexaconazole, carbendazim, spiromesifen, flubendiamide, lambda cyhalothrin, bifenthrin, acephate and thiamethoxam (Figure 1). For green chillies, 26.67% of farmgate and 20% of market samples showed contamination with pesticides such as fluopyram, carbendazim, chlorantraniliprole, novaluron, monocrotophos, trifloxystrobin, tebuconazole, fipronil, spiromesifen and difenoconazole. One farmgate sample of green chilli and one market sample exceeded the FSSAI's Maximum Residue Limits (MRL) with residues of fipronil and novaluron, respectively. This significant discrepancy highlights that natural farming methods effectively eliminate pesticide residues, ensuring cleaner produce. Conversely, conventional farming practices, particularly those observed at farmgate levels, show high levels of contamination, with capsicum being the most affected. This comparison underscores the advantages of natural farming for reducing pesticide residues and promoting healthier, safer food for consumers.

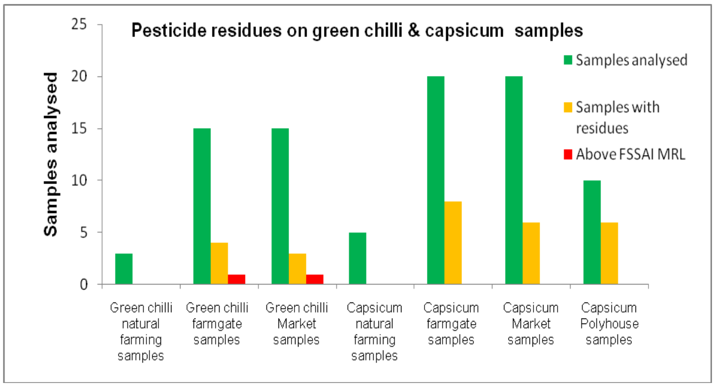

Fig 1. Pesticide residues on green chilli & capsicum fruit samples

References

Kumar R, Kumar S, Yashavanth BS, Meena PC, Indoria AK, Kundu S and Manjunath M. 2020. Adoption of Natural Farming and its Effect on Crop Yield and Farmers' Livelihood in India. ICAR-National Academy of Agricultural Research Management, Hyderabad, India.

Laishram C, Vashishat RK, Sharma S, Rajkumari B, Mishra N, Barwal P, Vaidya MK, Sharma R, Chandel RS, Chandel A, Gupta RK and Sharma N. 2022. Impact of Natural Farming Cropping System on Rural Households-Evidence From Solan District of Himachal Pradesh, India. *Frontiers in Sustainable Food Systems* 6:878015. doi: 10.3389/fsufs.2022.878015

ESFS-NF/NBSCP2024/2015

Comparative overview of pesticide residue in pomegranate: Natural vs. conventional farming

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Keywords: Pomegranate, Natural farming, Pesticides Residue, LC-MS/MS, GC-MS/MS

Introduction

Conventional farming often refers to high input modern agriculture systems that include the frequent applications of synthetic chemical fertilizers, fungicides, insecticides, herbicides, high yielding cultivars and monoculture (Le Campion et al., 2020). In the last decade where the concern about food safety, environmental sustainability and human health has increased, alternative sustainable agricultural practices like natural farming have got significant attention. These approaches underline ecological balance, soil health and reduction in the reliance on synthetic alternatives (Laishram et al., 2022). Nowadays, consumers have plenty of options depending on their priorities and beliefs, and they are more curious than ever about the food they eat. These decisions frequently come from the farming practices that are employed to create the ingredients: Natural and conventional farming. Pomegranate attacked by various pests throughout the cropping season and to control these pests excessive pesticide use has raised concerns about their impact on consumer and environmental health. The study was undertaken to monitor pesticide residues in pomegranate collected from different farmers who are practicing conventional farming and natural farming. The goal is to evaluate the pesticide contamination levels in each system, provide information on their safety and impacts on the environment, and eventually advise stakeholders and customers about the advantages and disadvantages of each farming strategy.

Material and methods

Two kg of pomegranate fruit samples were collected from natural farming systems, markets and farmers fields. Modified QuEChERS (Quick, Easy, Cheap, Effective, Rugged, and Safe) is used for pesticide residue extraction and cleanup. For Liquid Chromatography (LC), 1 mL of the extract was filtered into an injection vial and for Gas Chromatography (GC) analysis 6 mL evaporated to dryness at 40°C under zero air stream and the final volume was made up with 3 mL of n-hexane. The final samples were analyzed for pesticide residues using Liquid Chromatography-Mass Spectrometry (LC-MS/MS) and Gas Chromatograph-Mass Spectrometry (GC-MS/MS).

Results and conclusion

Pomegranate samples from natural farming were fully free of pesticide residues (Fig. 1), demonstrating the efficiency of these approaches in preventing contamination. In contrast, conventional farming methods revealed notable pesticide contamination. One sample out of total 6 farmgate and three out of 10 market collected samples were found contaminated with pesticide residues of multiple pesticides, including propargite, carbendazim, monocrotophos, imidacloprid, lambda cyhalothrin and novaluron. In one farmgate sample the residue of fenazaquin and in market samples fenazaquin and novaluron were found above FSSAI's Maximum Residue Limits (MRL). This considerable disparity demonstrates how natural farming practices successfully get rid of pesticide residues, guaranteeing cleaner product. This comparison highlights the benefits of natural farming in terms of lower pesticide residue levels and better, safer food for customers.

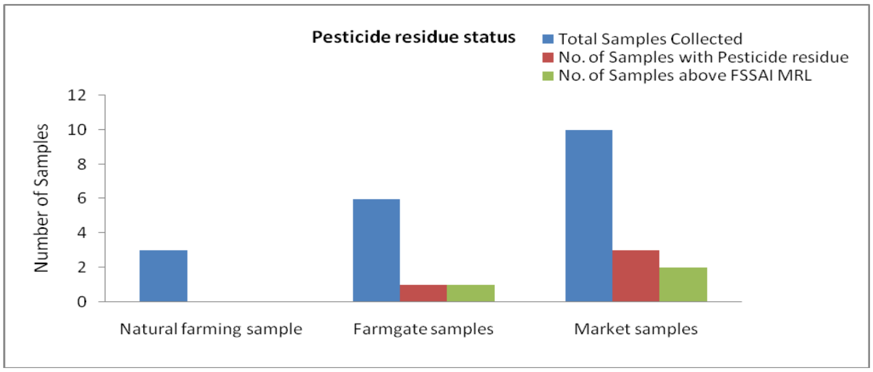

Fig 1. Pesticide residues on pomegranate fruit samples

References

Le AC, Oury FX, Heumez E and Rolland B 2020. Conventional versus organic farming systems: dissecting comparisons to improve cereal organic breeding strategies. Org. Agr. 10, 63–74.

Laishram C, Vashishat RK, Sharma S, Rajkumari B, Mishra N, Barwal P, Vaidya MK, Sharma R, Chandel RS, Chandel A, Gupta RK and Sharma N 2022. Impact of natural farming cropping system on rural households-Evidence from Solan fistrict of Himachal Pradesh, India. *Frontiers in Sustainable Food Systems*. 6:878015.

ESFS-NF/NBSCP2024/2016

Diversity of insect- pests and beneficial insects under the natural farming and conventional farming systems

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Introduction

Owing to the adverse effects of agrochemicals on human and environmental health; globally, the current focus is on development of sustainable food systems which are environmentally safe and free from insecticide residues. This condition has stimulated are consideration of Natural Farming systems, such as Subhash Palekar Natural Farming (SPNF), This cropping system is based on four major principles *viz.* Jeevamrit, Beejamrit,Waphasa and Acchadan (Palekar2016). The present investigation was undertaken to study the diversity of insect-pests and predators/pollinators in the sole cropped in the Chemical Farming system and intercropped in the SPNF system and intercropped and border cropped fields in the multi-layered SPNF systems.

Material and methods

The study was carried out at three experimental farms i.e.Subhash Palekar natural farming (SPNF) farm, multi-layered Subhash Palekar natural farming (MLSPNF) farm and chemical farming (CF) during 2021-22. In chemical farming, cucumber was raised as the sole crop, in SPNF farm, the main crop, cucumber was intercropped with French bean and okra and in Multi-layered SPNF system included five different types of fruit trees apple, pomegranate, peach, guava with grasses and fodder plants and the main vegetable crop was cucumber whereas French bean and okra were companion crops. In all the three farms, the data on the number of species of pests and their predators along with the density of each species were observed at the peak time of the cropping season and were identified using binocular microscope.The diversity of insect pests, predators and pollinators were analyzed through Simpson Index (Simpson1949) and Shannon-Wiener Index (Shannon1948).

Results and conclusion

In the present study, the numbers of different pests observed in CF farm were less as compared to SPNF and MLSPNF farms. But the number of different species of predators/ pollinators were observed higher in SPNF and MLSPNF farms as compared to CF farms. Relatively higher diversity of insect-pests was observed in MLSPNF system followed by SPNF system and CFsystem (Table 1). Simpson index (D') 1.00 was observed highest in fruit plants (pomegranate, apple and peach) in the MLSPNF farm. Shannon's index indicates both abundance and evenness of the species occurring in the community. Shannon diversity index (H) was observed highest (1.80) in cucumber crop in MLSPNF farm followed by the SPNF farm in the same crop (1.75). Similarly, maximum diversity (H_{max}) of pests was observed highest (1.95) in the cucumber crop of both the farms. Species evenness (j) was maximum 0.93 in the cucumber and bean crop of the MLSPNF farm, whereas species dominance (D) was observed minimum (0.06 and 0.07) in the bean and cucumber, respectively in the same farm (MLSPNF) and maximum (1.00) was recorded in the fruit plants of the MLSPNF farm, where the species evenness (j) value was zero. Margalef index was maximum 1.28 in the cucumber crop of the SPNF farm and 1.20 in the same crop of the

MLSPNF farm. Relative higher diversity of beneficial insects was observed in the MLSPNF ecosystem followed by SPNF system and CF farm (Table 2) . In these three farms the Simpson index (D') was highest 0.86 in pomegranate in the MLSPNF ecosystem and Shannon index (H) was highest (1.93) in cucumber crop in the SPNF farm and in same crop of MLSPNF farm its value was 1.78. Similarly, maximum diversity (H_{maxi}) of predators and pollinators was observed highest (2.20) in the cucumber crop of both the farms. Species evenness (j) was maximum 0.89 in peach plants under MLSPNF farm, whereas species dominance (D) was observed minimum (0.11) in the same crop of the same farm and maximum (0.61) was recorded in the pomegranate in the MLSPNF farm, whereas Margalef index was maximum (1.91) in the cucumber crop of the SPNF farm. The result of the study confirmed intercropping, traditional agricultural methods and insect biodiversity in an agro-ecosystem have important consequences for the conservation of biodiversity, contributing to the efficient biological control programme, there cycling the nutrients, increasing the productivity, crop health and soil productivity.

Table 1: Diversity indices of pests and predators/ pollinators in Subhash Palekar Natural Farming (SPNF), multi-layered SPNF and chemical farming (CF)

	Fields	**Crops**	**Simpson Index**		**Shannon Index (H)**	**Max. diversity (H_{max})**	**Evenness (j)**	**Species Dominance (D=1-J)**	**Margalef Index**
			(D')	**1-D'**					
Diversity Indices of pests	**SPNF**	Cucumber	0.19	0.80	1.75	1.95	0.89	0.10	1.28
		Okra	0.37	0.63	1.21	1.61	0.75	0.25	0.97
		Bean	0.47	0.53	0.86	1.09	0.78	0.22	0.53
	ML-SPNF	Cucumber	0.19	0.81	1.80	1.95	0.93	0.07	1.20
		Okra	0.25	0.75	1.45	1.61	0.90	0.09	0.84
		Bean	0.38	0.62	1.03	1.09	0.93	0.06	0.49
		Pomegranate	1.00	0	0	0	0	1	0
		Apple	1.00	0	0	0	0	1	0
		Peach	1.00	0	0	0	0	1	0
	CF	Cucumber	0.25	0.75	1.47	1.70	0.86	0.14	1.08
Diversity Indices of predators and pollinators	**SPNF**	Cucumber	0.17	0.83	1.93	2.20	0.88	0.12	1.91
		Okra	0.35	0.65	1.19	1.39	0.86	0.14	1.04
		Bean	0.35	0.65	1.19	1.39	0.86	0.14	1.04
	ML-SPNF	Cucumber	0.20	0.80	1.78	2.20	0.81	0.19	1.65
		Okra	0.48	0.52	0.99	1.39	0.71	0.29	0.78
		Bean	0.48	0.52	0.99	1.39	0.71	0.29	0.78
		Pomegranate	0.86	0.14	0.27	0.69	0.39	0.61	0
		Apple	0.47	0.52	0.91	1.09	0.83	0.17	0
		Peach	0.32	0.68	1.24	1.39	0.89	0.11	0
	CF	Cucumber	0.31	0.69	1.44	1.82	0.79	0.21	1.00

References

Palekar S 2016. Vegetable crops in zero budget spiritual farming. *Zero budget spiritual agriculture system research, development and extension movement, Amaravati, MH*.

Shannon C E 1948. A mathematical theory of communication. *The Bell system Technical Journal* 27(3): 379-423.

Simpson EH. 1949. Measurement of diversity. *Nature* 163(4148): 688-688.

ESFS-NF/NBSCP2024/2017

Comparative study on the diversity and abundance of insect pests infesting broccoli in conventional and natural farming systems

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Keywords: Abundance, Conventional farming, Diversity, Natural farming

Introduction

Broccoli (*Brassica oleracea* var. *italica*) is a highly nutritious vegetable valued for its health benefits. However, its cultivation is often challenged by a variety of insect pests that can significantly reduce yield and quality (Sharma & Singh, 2020). In recent years, there has been a growing interest in sustainable farming practices, such as SubhashPalekar Natural Farming (SPNF), which emphasize minimal external inputs and promote ecological balance. This study aims to compare the diversity and abundance of insect pests infesting broccoli crops under two farming systems: SPNF and Conventional Farming (CF). Understanding these differences can guide the development of pest management strategies that are more sustainable and environmentally friendly.

Material and methods

The study was conducted over two consecutive growing seasons (2021-22 and 2022-23), where broccoli crops were cultivated using both conventional and natural farming methods. Conventional farming involved the use of synthetic pesticides and fertilizers, while natural farming was based on natural practices, excluding synthetic inputs. Insect pests were monitored and identified weekly. Data on pest abundance was collected and was measured as the number of pests per plant, and diversity indices were calculated to assess pest diversity to compare the two farming systems.

Results and conclusion

The results revealed a significant difference in the diversity and abundance of insect pests between the two farming systems. Broccoli crop in conventional farming was infested by three major pests: cabbage aphid, diamondback moth and flea beetle. In contrast, natural farming systems only experienced infestation by the cabbage aphid (Table 1). The Shannon-Wiener Index (H') and Simpson's Diversity Index (D) were calculated for each system and year. The results showed that the CF system had a higher Shannon-Wiener Index (0.974 in 2021-2022 and 1.009 in 2022-2023) compared to the SPNF system (0.365 in 2021-2022 and 0.363 in 2022-2023), indicating greater pest diversity in CF. Similarly, the Simpson's Diversity Index was lower in CF (0.387 in 2021-2022 and 0.517 in 2022-2023) than in SPNF (0.897 in 2021-2022 and 0.905 in 2022-2023), reflecting a higher probability of encountering different pest species in CF. The results indicate that the CF system supports a more diverse pest population than the SPNF system, which may create conditions conducive to a broader range of insect pests (Altieri & Nicholls, 2004). In contrast, the SPNF system, with its emphasis on natural inputs and ecological balance, appears to suppress pest diversity, possibly due to enhanced pest resistance or natural pest control mechanisms. This lower diversity in SPNF could reduce the need for chemical pest control, aligning with sustainable agricultural goals. The study concludes that natural farming can be an effective strategy for managing pest infestations in broccoli crop, offering a sustainable alternative to conventional farming practices.

Table 1: Abundance and pest status of insect pests infesting broccoli crops under SPNF and conventional farming (CF) systems

Insect pest	Pest status		Abundance			
	SPNF	CF	SPNF		CF	
			2021-2022	2022-23	2021-2022	2022-23
Cabbage aphid	Present	Present	34.79-44.41 aphids/ plant	30.90-45.32 aphids/ plant	21.06-25.32 aphids / plant	19.85-25.45 aphids per plant
Diamondback moth	Absent	Present	-	-	1.67-1.89 larvae/ plant	0.96-1.33 larvae per plant
Flea beetle	Absent	Present	-	-	0.82-0.94 beetle / plant	0.98-1.12 beetle per plant

References

Altieri MA and Nicholls CI. 2004. *Biodiversity and pest management in agroecosystems*. CRC Press.

Sharma P and Singh R 2020. Management of insect pests in cruciferous vegetables: A review. *Journal of Entomology and Zoology Studies* 8(3): 123–129.

ESFS-NF/NBSCP2024/2018

Comparative effect of SPNF and chemical treatments on foraging activity of honey bees in apple (*Malus x domestica Borkh.*)

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Keywords: Chemical, Honey bees, Foraging, SPNF

Introduction
Pollination is the basic pillar of agricultural sector and play significant role in crop production at global level (Potts et al 2016). Bees play a vital role in pollination of various crops, Apple is one crop which is mostly self-incompatible and rely on agents to transfer polllen, of which honey bees are the most important. Pollination is mostly affected by the use of pesticides at time of flowering which reduces the foraging rate of the honey bees, thus directly affecting fruit set. Therefore, the present study was conducted to observe the comparative effect of SPNF and chemical treatments on foraging activity of honey bees.

Material and methods
In the preset study, comparative data on foraging rate of honey bees in Gala and Delicious varieties of apple under SPNF, chemical (neonecotinoids) and control plots (without any management options) was studied. Apple trees were selected randomly, each, from SPNF, chemical control and control plots (with no management tactics). Apple flowers in plot area of 1 meter square were selected from apple tree with 10 replications per treatment. Honey bee activity was recorded after 10 % bloom at one day interval for a period of 15 days. The data on foraging activity of honey bees was observed 3 times a day i.e. 9:00-10:00 AM, 12:00- 1:00 PM and 4:00 to 5:00 PM.

Results and conclusion
Honey bee activity was significantly higher in SPNF treatment followed by control treatment in both the varieties, while lowest was recorded in chemical treatment. Highest bee activity was recorded on ninth day of observation in SPNF treatment (15.30 and 17.10 bees/m^2/minute, respectively, in Delicious and Gala varieties) over control (13.10 and 13.20 bees/m^2/minute, respectively, in Delicious and Gala varieties) and chemical treatment (10.40 and 9.70 bees/m^2/minute, respectively, in Delicious and Gala varieties). Lowest bee activity 4.40, 3.20; 2.50, 4.50 and 3.70, 3.10 bees/m^2/minute, respectively, in Delicious and Gala varieties was recorded on seventh day of observation in SPNF, control and chemical treatments, respectively, this was due to unfavourable weather conditions. Signifcant difference in mean bee activity in all the three treatments was observed, with maximum mean foraging activity recorded in SPNF (10.83 and 11.89 bees/m^2/minute, respectively, in Delicious and Gala varieties), followed by control (9.10 and 9.69 bees/m^2/minute respectively, in Delicious and Gala varieties) and least in chemical treated apple plants (7.14 and 7.63 bees/m^2/minute, respectively, in Delicious and Gala varieties).
The results in the present study revealed higher honey bee activity in SPNF treatments, which indicates its comparative safety towards pollinators and thus can serve as an eco-friendly alternative to pesticides.

Table 1: Effect of different treatments on foraging activity of honey bees in apple

Days after 10% bloom	Bee count (bees/m²/min) in Delicious Strains				Bee count (bees/m²/min) in Gala strains			
	SPNF	Control	Chemical	Mean	SPNF	Control	Chemical	Mean
1	10.60 (18.96)	9.00 (17.37)	7.40 (15.69)	9.00 (17.34)	12.60 (20.76)	10.10 (18.44)	8.30 (16.67)	10.33 (18.62)
3	11.10 (19.40)	9.90 (18.26)	8.50 (16.88)	9.83 (18.18)	13.40 (21.43)	11.10 (19.42)	8.70 (17.07)	11.07 (19.31)
5	13.50 (21.49)	10.70 (19.05)	8.80 (17.18)	11.00 (19.24)	14.00 (21.92)	11.50 (19.79)	9.30 (17.63)	11.60 (19.78)
7	4.40 (12.04)	3.20 (10.08)	2.50 (8.84)	3.37 (10.32)	4.50 (12.12)	3.70 (11.00)	3.10 (10.02)	3.77 (11.05)
9	15.30 (22.96)	13.10 (21.10)	10.40 (18.72)	12.93 (20.93)	17.10 (24.34)	13.20 (21.25)	9.70 (18.05)	13.33 (21.21)
11	14.60 (22.38)	12.30 (20.39)	8.30 (16.68)	11.73 (19.82)	15.50 (23.09)	12.20 (20.25)	9.60 (17.99)	12.43 (20.45)
13	10.90 (19.17)	8.70 (17.05)	6.70 (14.89)	8.77 (17.04)	10.90 (19.21)	9.30 (17.65)	7.80 (16.17)	9.33 (17.67)
15	6.20 (14.29)	5.90 (13.97)	4.50 (12.11)	5.53 (13.45)	7.10 (15.29)	6.40 (14.49)	4.50 (12.16)	6.00 (13.99)
Mean	10.83 (18.84)	9.10 (17.16)	7.14 (15.12)		11.89 (19.77)	9.69 (17.79)	7.63 (15.72)	
$CD_{0.05}$ Factor 1 (Day) 0.99 Factor 2 (Treatment) 0.60 Factor (Day x Treatment) ns					$CD_{0.05}$ Factor 1 (A) 0.94 Factor 2 (B) 0.57 Factor (A x B) ns			

**Figures in parenthesis are angular transformed values; Data are mean of observations recorded 3 times a day.*

References

Potts SG, Imperatriz- Fonseca V, Ngo H.T. Aizen M A, Biesmeijer JC, Breeze TD, Dicks LV, Garibaldi LA, Hill R, Settele J, Vanbergen AJ. 2016. Safeguarding pollinators and their values to human well-being. *Nature* 540(7632): 220-229.

ESFS-NF/NBSCP2024/2019

Antifeedant activity of different solvent extracts of *Artemisia roxburghiana* against cabbage butterfly *Pieris brassicae* L.

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Keywords: Antifeedant, *Artemisia roxburghiana*, Cow urine, Hexane, Methanol

Introduction

Cabbage butterfly, *Pieris brassicae L* is a significant pest of cruciferous crops, causing substantial economic losses due to its voracious feeding habits. Indiscriminate use of chemical pesticides for pest management has raised problem of resistance development and contamination of food and environment with pesticide residues. The botanicals and plant based extracts have emerged as viable alternatives to synthetic pesticides for protecting crops from insect pests and enhance ecological balance. This abstract explores the efficacy of different solvent extracts of *Artemisia roxburghiana* in mitigating the feeding activity of cabbage butterfly, highlighting their potential role in integrated pest management.

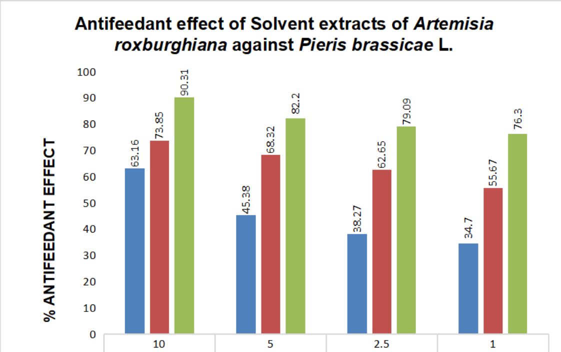
Material and methods

The culture of *Pieris brassicae* was raised on cabbage leaves under laboratory conditions. The sample of *Artemisia roxburghiana* was washed, air dried and powdered. Methanol and hexane solvent extract (10%) was prepared using soxhlet extraction while cow urine extract was prepared as per Gahukar (1996). Working solutions of desired concentration were prepared by serial dilution method. Leaves of cabbage were dip treated in test concentrations for 30 seconds, dried in shade and provided to pre starved 3rd instar larvae. Leaf area consumed was recorded after 24 hours to find antifeedant effect. All treatments were replicated thrice. Data obtained was subjected to statistical analysis for interpretation of results. The preference index was worked out as per the scale by Sharma and Bisht (2008) according to which preference index values between 0.1-0.25 denote extremely antifeedant, 0.26-0.50 are strongly antifeedant, 0.51-0.75 are moderately and 0.76-0.99 slightly antifeedant. Values >1 indicate preferred plant extract

Results and conclusion

The observations on leaf area consumed were used for calculations of the antifeedant activity (%) and Preference Index. Among the solvent extracts evaluated, the lowest per cent feeding (5.64%) was recorded in methanol extract of Artemisia at 10%, followed by hexane extract (14.56%) and cow urine extract (19.56%) at similar concentration while the highest per cent feeding was recorded in control (56.66%).The observations indicated that maximum antifeedant activity i.e. 90.30% was found when the leaves were treated with methanol extract i.e A+M (T3) at 10%, followed by hexane A+H (T2) and cow urine extract A+U (T1), with 73.85% and 63.16% effect, respectively at same concentration against 3rd instar larvae of *P. brassicae*. Minimum antifeedant effect was found to be 34.7 % when the larvae were fed on T1 (A+U) at 1% concentration.

As per the preference index scale, the methanol extract (T3) at 10% was found to be extremely antifeedant (0.17) while methanol extract at 5% (0.28), 2.5% (0.34), 1% (0.38) and hexane extract at 10% (0.41), 5% (0.48) were observed to fall under strong antifeedant category.



	10	5	2.5	1
T1(A+U)	63.16	45.38	38.27	34.7
T2(A+H)	73.85	68.32	62.65	55.67
T3(A+M)	90.31	82.2	79.09	76.3

Hexane extract at 2.5% (0.54), 1% (0.61) and cow urine extract at 10% (0.53), 5% (0.70) showed moderate antifeedant activity. However, cow urine extract at 2.5% and 1% was found to be slightly antifeedant with the preference index value of 0.76 and 0.79, respectively.

References

Gahukar RT. 1996. Formulations of neem based products/pesticides. *Pestology* 20(9):44-55

Sharma RK and Bisht RS. 2008. Antifeedant activity of indigenous plant extracts against *Spodoptera litura* Fabricius. *Journal of insect Science* 21: 56-60.

ESFS-NF/NBSCP2024/2020

Evaluation of pesticide residues in solanaceous crops grown under natural and conventional farming in Himachal Pradesh

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Keywords: Brinjal, Natural Farming, Pesticide residues, Tomato

Introduction

Quality and quantity of agricultural crops are affected by hundreds of pests found in agro-ecosystem. The main method of pest control adopted by the majority of farmers is often the erroneous and abusive application of pesticides. Thus, causing serious ill effects on human health. Foreseeing the challenges posed by the indiscriminate use of pesticides, an alternative for the same is need of the hour and one such alternative is natural farming (Laishram et al., 2022). It increases long time fertility of soil and produces the food of high quality. Solanaceous crops like tomato and brinjal are commercially important crops, which are mainly grown in mid hills of HP, indiscriminate use of pesticides for control of pests in these crops have raised concerns about the safety of consumers. To address these concerns, this study assesses pesticide residues in tomato and brinjal crops taken from different farming systems: Natural farming, Farm gate samples & Market samples.

Material and methods

One kg sample of each crop *i.e.* tomato and brinjal were collected from different locations under natural farming, farmgate and market samples. These samples were grinded well. 15 gm of representative sample was taken for residue analysis. The QuEChERS analytical technique, validated for residue estimation (Sharma, 2013) was used. A 15-gm sample was placed in a centrifuge tube and 30mL of acetonitrile was added. The mixture was homogenized for 3 min at 15,000 rpm, followed by the addition of 3 gm of anhydrous NaCl. Then sample was centrifuged at 3,000 rpm for 3 min. An 18mL aliquot was transferred to another tube with 9 gm of anhydrous Na_2SO_4. An 11mL aliquot was then transferred to a new tube with 1.15 gm of anhydrous $MgSO_4$ and 0.4 gm of PSA and centrifuged for 5 min at 3,000 rpm. Then 6mL extract was transferred to the test tube and evaporated to dryness, filtered and reconstituted in 3mL of n-hexane for GC analysis. For LC, filtered 1 mL extract was injected into vial for residue analysis. Analysis of pesticide residues was conducted by gas chromatography and liquid chromatography with mass spectrometry. Qualitative and quantitative analysis was based on internal standards and standard curves.

Results and conclusion

The results revealed that none of the tomato and brinjal samples from natural farming practices contained pesticide residues, highlighting the effectiveness of natural farming in producing clean, residue-free crops. In contrast, farmgate samples of tomato exhibited the highest levels of contamination, with 60% samples showing pesticide residues. Whereas 40% of market samples exhibited pesticide residues (Figure 1). Further, the samples of brinjal collected from natural farming and farmgate locations revealed no pesticide residues. Whereas, only two samples collected from the market exhibited the pesticide residues. The main pesticides detected in tomato samples were chlorantraniliprole, chlorpyrifos, lambda-cyhalothrin, profenofos, difenoconazole, fenazaquin, imidacloprid and propargite. The two farmgate samples of tomato were found to be contaminated with residues of fenazaquin above FSSAI MRL. While in brinjal main pesticides detected were profenofos, lambda cyhalothrin and trifloxystrobin and none were above FSSAI MRL. It is concluded that natural farming practices are highly effective in producing pesticide free vegetables such as tomato and brinjal in comparison to the conventional farming methods. Hence, this study underlines the importance of adopting natural farming as an alternative to the conventional farming practices.

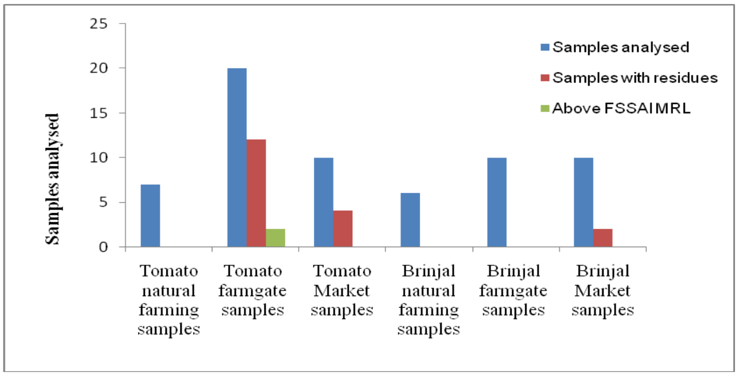

Fig 1. Pesticide residues in tomato and brinjal samples

References

Laishram C, Vashishat RK, Sharma S, Rajkumari B, Mishra N, Barwal P, Vaidya MK, Sharma R, Chandel RS, Chandel A, Gupta RK and Sharma N. 2022. Impact of natural farming cropping system on rural households—Evidence from Solan district of HP. Frontiers in Sustainable Food Systems. 6:878015.

Sharma KK. 2013. Pesticides Residue Analysis Manual. IARI, New Delhi. 251p.

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Antifeedant activity of cow urine extracts of indigenous plants against cabbage butterfly *Pieris brassicae* L.

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Keywords: Antifeedant, *Azadirachta indica*, Cow urine, Preference index

Introduction

The indiscriminate use of synthetic insecticides has led to the accumulation of toxic residues in the food and environment along with the development of resistant pest population. The integration of natural plant extracts as an alternative to chemical pesticides into farming practices represents a promising approach in integrated pest management. In the present investigation, the cow urine extracts of plants with known insecticidal properties were evaluated for their antifeedant activity against cabbage butterfly, *Pierisbrassicae L.* a major pest of cole crops. This study focuses on assessing impact of these extracts on the feeding behaviour of cabbage butterfly.

Material and methods

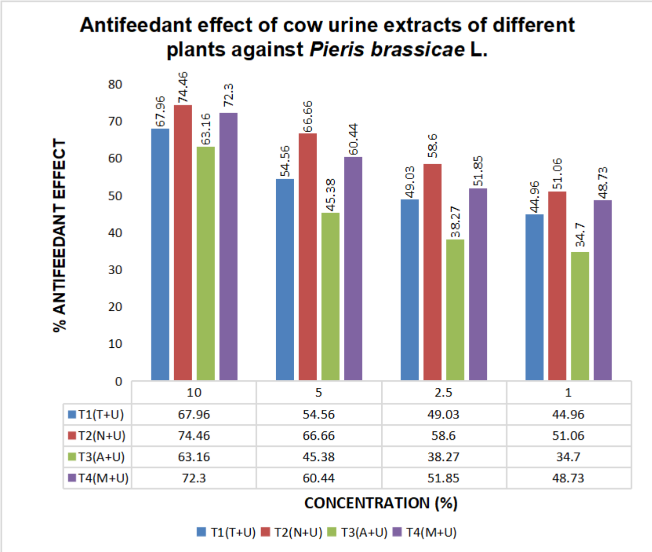
The culture of *P.brassicae*was maintained on cabbage leaves under laboratory conditions. Leaf samples of the test plants under investigation i.e*Azadiractaindica, Artemisia roxburghiana* and *Tagetes minuta* were air dried for 6-7 days and then dried in an oven at 30°C for 24 hours.The well-dried leaves were powdered and the stock solution (10%) of the cow urine extract of plant material was prepared as per the method of Gahukar (1996). The desired working concentrations were obtained by serial dilution.The antifeedant activity was evaluated against 3rd instar larvae by leaf disc method under laboratory conditions. Leaves of cabbage were dip treated in test concentrations for 30 seconds, dried in shade and provided to pre starved larva. Leaf area consumed was recorded after 24 hours to find the antifeedant effect. All treatments were replicated thrice along with control. The data obtained was subjected to statistical analysis for interpretation of results.

Results and conclusion

In the present investigations, all the plant extracts prepared in cow urine had a significant effect on feeding behavior of *P. brassicae*. Antifeedant effect was found to increase with the increasing concentration (1 to 10%) for all the plant extract tested. Cow urine extract of the neem of test plants,T2 (N+U) was found to be the most effective in reducing feeding of the *P. brassicae* at all the concentrations tested followed by mixture of cow urine extract, T4(M+U) followed by the cow urine extract of Tagetes, T1(T+U) and cow urine extract of Artemisia, T3(A+U). Maximum antifeedant activity of 74.46% was found when the leaves were treated with T2 at 10%, followed by T4 (72.30%), T1(67.96 %)and T3 (63.16%) respectively, against 3rd instar larvae of *P. brassicae* at the similar concentration. The antifeedant activity of each extract was categorized on the basis of preference index as per the following scale (Sharma and Bisht, 2008).

C value	Antifeedant category
0.1-0.25	Extremely
0.26-0.50	Strongly
0.51-0.75	Moderately
0.76-0.99	Slightly
>1	Preferred plant extract

T2 (N+U) at 10% (0.40), 5% (0.49); T4 (M+U) at 10% (0.43) and T1 (T+U) at 10% (0.48) fall under strong antifeedant category. T2 (N+U) at 2.5% (0.58), 1% (0.65), T4 (M+U) at 5% (0.56) and 2.5% (0.65) and 1% (0.67) along with T1 (T+U) extract at 5% (0.62), 2.5% (0.67), 1% (0.71) T3 (A+U) at 10% (0.53), 5% (0.70) showed moderate antifeedant activity while artemisia + urine extract at 2.5% (0.76), 1% (0.79) was slightly antifeedant.



References

Gahukar RT. 1996. Formulations of neem based products/pesticides. *Pestology* 20 (9):44-45.

Sharma RK and Bisht RS. 2008. Antifeedant activity of indigenous plant extracts against *Spodoptera litura* Fabricius. *Journal of insect Science* 21: 56-60.

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Ecological interactions between phytophagous mites and predator populations in apple agro-ecosystem

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Keywords: Phytophagous mites, interaction, predatory complex, abundance

Introduction

Apple is an important temperate crop of Western Himalayan region of India. Among phytophagous mites, European red mite, *Panonychus ulmi* (Koch) and two-spotted spider mite, *Tetranychus utricae* (Koch) are the predominant mite species infesting apple orchards in Himachal Pradesh (Bhardwaj et al., 2010). This paper provides an overview on the current status of predatory complex associated with phytophagous mites throughout the apple growing season.

Material and methods

Interaction of spider mite populations with predatory mites was studied in i) orchards with pesticide applications and ii) orchard with earlier pesticide application history. The abundance, predatory potential and diversity of natural enemy complex associated with spider mites in apple orchard was studied on five randomly selected apple trees. A sample of 20 leaves was taken from each tree and thus total of 100 leaves were brought to acarology laboratory to determine the number of predators and prey per leaf under the Stereozoom binocular microscope.

Results and conclusion

During sampling five different predators were recorded feeding on spider mite on apple. Among different predators recorded feeding on spider mite, predatory mite (*Neoseiulus longispinosus* and *Euseius* sp.) was the most abundant predators which remained associated with the spider mites throughout the season. In orchard where the applications of pesticides have stopped the populations of predatory mites made their appearance late in May with a peak in July-August and again in October-November. Predatory mites constituted 76.43 to 83.55% of the total predator population. Anthocorid bug (*Orius insidiosus*) was the next predominant species (5.23-7.62%) found associated with the mite populations late in the season from July-December. The predatory thrips (*Haplothrips* spp.) was the third most frequent predator (9.16-13.78%) found associated with the mite populations throughout the season irrespective of mite population.

The Chrysopids (*Chrysopa* spp.) was the fourth most frequent predator (2.06-2.18%) found in the apple orchard, while other predator population was variable and went down with that of the spider mites. While, in orchards where pesticides were used regularly, the predatory mites were present for very-very short period in very low numbers and therefore, the spider mite populations increased sharply to damaging level without any biological barrier.

References

Bhardwaj S and Sharma S 2010. Diversity of predatory mite fauna associated with various agroclimatic zones of Himachal Pradesh. *Indian Journal of Entomology*, 83(4):655-659.

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Efficacy of different biocontrol agents and bioproducts for management of leaf spot and blight disease of *Lilium* sp.

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Keywords: Biocontrol agents, Bioproducts, Blight, Leaf spot

Introduction

Leaf spot and blight disease of lilium caused by *Alternaria alternata* is a disease of increasing significance in lily growing areas of Himachal Pradesh. Severe blightening of leaves of oriental lilies have been seen in district Solan. The oriental lilies and hybrids (LA) were found to be more susceptible to the disease as compared to Asiatic lilies. The leaves developed small circular, brownish–black spots which later coalesced to cover the larger area on the leaves and buds. Lilium being a commercial ornamental flower, effective management of leaf spot and blight is necessary.

Material and methods

The research trial was carried out under *in vitro* conditions. *Trichoderma atroviride, Trichoderma atroviride* isolate TMEX01, *Trichoderma lixii* TH-05, *Trichoderma* sp. isolate Rh_324_2, *Trichoderma lixii* isolate NBAII-Th30, *Trichoderma* sp. Strain Cranberry, *Aspergillus costaricensis* isolate KS1, *Bacillus subtilis* (AFC-9), *Pseudomonas chloraphis* (*Ps*), *Bacillus subtilis* (*Bs*), Consortium of *Ps* + *Bs* were examined on the mycelial inhibition of isolated *Alternaria alternata* by dual culture method (Huang and Hoes, 1976) for fungal antagonists and streak plate method (Utkhede and Rahe, 1983) for bacterial antagonists. On the other hand, bioproducts viz. neem based fungicide, sauthastra, buttermilk, jeevamrit were tested using poison food technique at 500 ppm.

Results and conclusion

Among fungal antagonists, *Aspergillus costaricensis* isolate KS1 resulted in the highest inhibition of pathogen radial growth by 54.95 per cent followed by *Trichoderma lixii* isolate NBAII-Th30 (52.41%) and these were statistically at par with each other and in bacterial antagonist consortium of *P. chloraphis* + *B. subtilis* showed the highest inhibition of pathogen radial growth by 40.07 per cent followed by *B. subtilis* (35.76%) and both were statistically at par with each other.

Among the bioproducts maximum growth inhibition was found by sauthastra followed by neem based fungicide with per cent mycelial inhibition of 65.01 and 37.32 per cent at 500 ppm respectively. So, from above results this was concluded that all the biocontrol agents and bioproducts used were effective in managing the pathogen. But, among these sauthastra and *Aspergillus costaricensis* isolate KS1 were best in managing the disease.

Table 1: Mycelial inhibition of *Alternaria alternata* by different biocontrol agents

S.N.	Treatments	Mycelial inhibition (%)
1.	*Pseudomonas chloraphis*	15.87 (23.46)
2.	*Bacillus subtilis*	34.22 (35.76)
3.	Consortium of *P. chloraphis* + *B.subtilis*	41.48 (40.07)
4.	*Trichoderma atroviride*	50.38 (45.21)
5.	*Trichoderma atroviride* isolate TMEX01	59.65 (50.55)
6.	*Trichoderma lixii* TH-05	57.58 (49.35)
7.	*Trichoderma* sp. isolate Rh_324_2	61.35 (51.55)
8.	*Trichoderma lixii* isolate NBAII-Th30	62.81 (52.41)
9.	*Trichoderma* sp. Strain Cranberry	58.07 (49.63)
10.	*Aspergillus costaricensis* isolate KS1	66.96 (54.95)
11.	*Bacillus subtilis* (AFC-9)	33.09 (35.08)
12.	Neem based fungicide (Neem Vati)	36.78 (37.32)
13.	Jeevamrit	0.00 (0.00)
14.	Buttermilk	0.00 (0.00)
15.	Sauthastra	82.18 (65.01)
16.	Control	0.00 (0.00)
	CD (0.05)	2.56

**Figures in parentheses are arc sine transformed values*

References

Hung HC and Hoes, JA. 1976. Penetration and infection of *Sclerotinia sclerotiorum* by *Coniothyrium minitans*. *Canadian Journal of Botany* 54: 406-410.

Utkhede RS and Rahe JE. 1979. Evaluation of chemical fungicides for the control of onion white rot. *Pesticide Science* 10: 414-418.

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Cow urine based *Sapindus* extracts as alternate for insect-pest management in natural farming

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***Keywords*:** Botanicals, Diamondback moth, local resources, *Sapindus mukorossi,* Natural Farming

Introduction

Cole crops constitute a major portion of the diets of people all around the continents. Serious economic losses are caused by the attack of *Plutella xylostella* (L.) i.e. diamondback moth (DBM), a major insect pest of crucifers, and the problem is aggravated by the overuse of chemical insecticides which has led to serious issues pertaining to environment, human health, loss of non-target insects and an imbalance in the ecosystem. All these issues have helped in acclaiming the importance of plant-based insecticides or botanicals for the control of insect pests (Isman 2020). These are harmless to non-target organisms, preserve the natural elements, and utilize local resources.

Materials and methods

The study analysed the cow urine extract of fruits of *Sapindus mukorossi* (commonly called soapnut tree) for its insecticidal properties. The fruits of the soapnut tree were collected. The fruits were air dried and ground to powder. An extract was prepared with cow urine as solvent by Simple Extraction Method. The filtered extract was then used for bioassay studies. Different concentrations (0.25, 0.5, 1, 1.5, 2, and 2.5%) of the extract were used to study the repellent, antifeedant, and toxic effects on the second instar larvae of *P. xylostella*.

Results and conclusion

In the present study the cow urine extract of *S. mukorossi* showed repellent, antifeedant, and toxic effects against *Plutella xylostella* at all the concentrations (0.25, 0.5, 1, 1.5, 2, and 2.5%) used in the study, except the control (Table 1). Maximum repellent action was found at 2.5% (93.33% larvae), followed by 2% (76.67% larvae), and no repellent action (0% larvae) was observed in the control. A similar trend was followed in antifeedant action where 4.98% leaf area was consumed followed by 18.60% and 94.52% at 2.5%, 2%, and control, respectively. The LC_{50} calculated is 0.98% with fiducial limits of 0.59–1.42%, and LC_{90} is 3.29% with fiducial limits of 2.12-5.11%. So, it is evident from the current study that *S. mukorossi* shows strong repellent, antifeedant, as well as high toxicity to *P. xylostella* larvae and hence, it can be used for managing DBM population.

Table 1: Biological activities of cow urine extract of *Sapindus mukorossi* on 2nd instar larvae of diamondback moth (*Plutella xylostella*)

Concentration (%)	**Repellant (% larvae repelled)**	**Antifeedant (% leaf area consumed)**
Control (0)	0.00 ± 0.00	94.52 ± 0.78
0.25	16.67 ± 3.33	82.62 ± 1.09
0.5	36.67 ± 3.33	59.29 ± 1.45
1	46.67 ± 3.33	40.65 ± 1.74
1.5	63.33 ± 3.33	25.92 ± 1.57
2	76.67 ± 3.33	18.60 ± 0.96
2.5	93.33 ± 3.33	4.98 ± 0.83
CD (0.05)	9.451	3.84

References

Isman MB. 2020. Botanical insecticides in the twenty-first century-fulfilling their promise? *Annual Review of Entomology 65*(1): 233-249.

ESFS-NF/NBSCP2024/2025

Cow urine based *Artemisia* extracts as alternate for insect-pest management in natural farming

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***Keywords*:** Botanicals, Diamondback moth, insecticide resistance, Natural Farming

Introduction

Diamondback moth (DBM), *Plutella xylostella* (L.) is a major insect pest of vegetables in the family Brassicaceae, leading to serious economic losses all over the globe. The overuse of chemical insecticides to control DBM has been on the rise, which has not only led to environmental degradation and health hazards but has also caused insecticide resistance in the pest. With the initiative of Govt., Natural Farming is on its spree and farmers being benefitted. The plant based insecticides has long been tested and tried on various insect pests (Khan et al., 2017) however Artemisia spp. are still under explored. An attempt was made to devise Artemisia extract with cow urine and astonishing findings were observed.

Materials and methods

The study analysed two plants, *Artemisia roxburghiana* and *Artemisia brevifolia,* for their insecticidal properties. Plants were collected from the mid hills of Solan and high hills of Kinnaur district of Himachal Pradesh. The arial parts of the plant were air dried and powdered. An extract was prepared with cow urine as a solvent by Simple Extraction Method. The filtered extract was then used for bioassay studies. Different concentrations (2, 5, 10, 15, and 18%) of the extract were used to study the repellent, antifeedant, and toxic effects on the 2nd instar larvae of DBM by feeding them with treated leaves.

Results and conclusion

Both species of *Artemisia* showed repellent, antifeedant, and toxic effects against *P. xylostella* at all the concentrations (2, 5, 10, 15, and 18%) used in the study, except the control (Table 1). Maximum repellent action was found in *A. brevifolia* at 18% (82.50% larvae), followed by 15% (75% larvae), and no repellent action (0% larvae) was observed in the control. A similar trend was followed in antifeedant action (% leaf area consumed) of *A. brevifolia,* i.e., 4.78%, followed by 17.00% and 98.56% at 18%, 15%, and control, respectively. Whereas, in the case of *A. roxburghiana,* maximum number of repelled larvae were observed at 18% (80% larvae), followed by 15% (62.5% larvae), and no repellent action (0% larvae) was observed in control. A similar trend was followed in antifeedant action of *A. roxburghiana,* i.e., *area consumed was* 8.05%, followed by 23.20% and 93.87% at 18%, 15%, and control, respectively. The LC_{50} calculated for *A. brevifolia* extract is 12.59% with fiducial limits of 8.84–17.93%, and LC_{90} is 42.73% with fiducial limits of 30.00–60.85%. Similarly the LC_{50} calculated is 13.83% with fiducial limits of 9.91–19.31% and LC_{90} is 42.54% with fiducial limits of 30.48-59.39% in case of *A. roxburghiana*. So, it is evident from the current study that both *Artemisia* species are showing repellent, antifeedant, as well as toxic effects against *P. xylostella*. Hence, it can be used for the eco-friendly management of DBM under Natural Farming system.

Table 1: Biological activities of cow urine extract of *Artemisia* spp. on 2nd instar larvae of diamondback moth (*Plutella xylostella*)

Conc. (%)	*Artemisia roxburghiana*		*Artemisia brevifolia*	
	Repellant (% larvae repelled)	**Antifeedant** (% leaf area consumed)	**Repellent** (% larvae repelled)	**Antifeedant** (% leaf area consumed)
Control	0.00 ± 0.00	93.87 ± 0.00	0.00 ± 0.00	98.56 ± 0.00
2	12.50 ± 2.50	89.16 ± 0.98	10.00 ± 4.10	92.30 ± 1.47
5	20.00 ± 4.08	74.23 ± 2.20	22.50 ± 4.79	64.77 ± 1.30
10	47.50 ± 0.48	42.56 ± 1.27	52.50 ± 4.79	32.97 ± 2.37
15	62.50 ± 6.29	23.20 ± 2.41	75.00 ± 2.89	17.00 ± 1.27
18	80.00 ± 4.08	8.05 ± 1.20	82.50 ± 4.79	4.78 ± 1.33
CD (0.05)	12.35	4.68	11.84	4.38

References

Khan S, Taning CNT, Bonneure E, Mangelinckx S, Smagghe G and Shah MM. 2017. Insecticidal activity of plant-derived extracts against different economically important pest insects. *Phytoparasitica 45*: 113-124.

ESFS-NF/NBSCP2024/2026

Root knot nematode management in tomato through natural and conventional farming practices under protected cultivation

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Keywords: Root knot nematode, tomato, protected cultivation, natural farming

Introduction

Protected cultivation is a new-age farming technique that is highly productive, conserves water and land, and also protects the environment (Jensen 2001).At present 223.18 ha of area is reported to be under the crops being raised under greenhouses in Himachal Pradesh. Such protected environment provides suitable and congenial microclimate for the multiplication of various biotic stresses such as nematodes, insects, diseases etc. Three species of plant parasitic nematode i.e. *Meloidogyne incognita, Helicotylenchus dihystera* and *Pratylenchus* spp. were recorded to be predominant under protected cultivation in Himachal Pradesh. Out of these three nematode species, the crops were observed to be severely infested with root knot nematode (*Meloidogyne incognita*) (Sharma *et al*. 2009). Root knot nematode parasitism on host plants considered to be of paramount importance in facilitating hosts for the entry of soil borne pathogen like *Fusarium, Pythium* and *Phytophthora* etc. which further aggravate the losses. Preventing nematode problem is far better than trying to treat after it is established.

Material and methods

The effect of amendments on the tomato plants under the protected cultivation was studied in root-knot nematode (RKN)-infested soil. A total of seven treatments were used, including T1: Neem @ 2 tons/ha + African Marigold; T2: Castor @2 tonns/ha + African Marigold; T3: Flupyram 400 SC @ 0.625 lt/ha (0-10 days before transplanting) + African Marigold; T4: Fluensulfone 2% GR @ 4kg/ha (0-7 days before transplanting) + African Marigold; T5: Ghanjeevamrit @ 250 kg/ha (0-10 days before transplanting) + Brahmastra @ 800 ml/10 l water (500 ml solution as drenching per plant near root zone area) + African Marigold; T6: Ghanjeevamrit @ 500 kg/ha (0-10 days before transplanting) + Brahmastra @ 1200 ml/10 l water (500 ml solution as drenching per plant near root zone area) + African Marigold; T7: Untreated Check . The treatments T5 and T6 were applied at the time of transplanting and repeated after 15, 30, 45 and 60 days after transplanting. Each treatment was replicated three times. For the estimation of the initial and final soil nematode population, the soil was thoroughly mixed and three composite samples were drawn. Each composite sample was made by mixing five sub-samples. Nematode extraction was achieved by washing the soil using the modified Cobb's sieving and decanting method.

Results and conclusion

Natural farming practices resulted in comparatively lower nematode populations (soil & root), root-knot index, egg masses per root system and number of eggs per egg mass and higher fruit yields as compared to untreated check (Table 1). The soil population (J2 per 200 g soil) was significantly lower in treatments with natural farming practices (Ghanjeevamrit @ 500 kg/ha (0-10 days before transplanting) + Brahmastra @ 1200 ml/10 l water (500 ml solution as drenching per plant near root zone area at time of transplanting and repeated after 15, 30, 45 and 60 days after transplanting) + African Marigold were applied and was at par with chemical (T3 and T4 where the nematicides (Flupyram 400 SC @ 0.625 lt/ha (0-10 days before transplanting) + African Marigold; Fluensulfone 2% GR @ 4kg/ha (0-7 days before transplanting). The root population (no. of nematodes per 5 g root) was also found significantly lower in natural farming practices than untreated check. The root knot index was also found lower in treated plots as compared to untreated check except T2 and T5 where castor and less concentration of Brahmastra were applied. However, the number of egg masses per root system and number of eggs per egg mass was found lower in treatments with nematicides (T3 and T4). The tomato yield was increased from 35 to 49 per cent in different natural farming treatments with maximum increase (61%) in nematicides treated plots (T3 and T4). The present study revealed a significant decrease in the final soil nematode populations and root gall index in the natural farming practices in comparison to all other treatments. The decrease in the population of nematodes could be due to the presence of nematicidal compounds released from the natural farming products applied throughout the crop season.

The present study concludes that the integrated application of natural farming practices, along with farmyard manure, is highly effective in managing rot knot nematode infestation in tomato grown in polyhouses. The additional incentive of soil nutrient enrichment, in addition to its suppressive effect on nematodes, offers a double advantage to the farmers by increasing crop yield. For effective management strategies, calculating the site- and soil-specific dosages of these amendments could prove them to be a sustainable asset for eco-compatible *M. incognita* management in tomato.

Table 1: Efficacy of different chemical and natural farming inputs against *Meloidogyne* sp. infecting tomato under protected cultivation (INP-118.4 J2/200 cc soil)

Treatment	Final nematode population		RKI	No. of egg masses	No. of eggs/egg mass	Yield (kg /plot)	Yield (q/ha)
	200 cc soil	5 g roots					
T1: Neem + Marigold	198.33 (13.91)*[bc]	12.33 (3.49)[cd]	1.56[c]	4.33[de]	100.20[c]	14.33	358.33
T2: Castor + Marigold	221.67 (14.87)[b]	21.22 (4.60)[b]	2.33[b]	11.56[b]	268.31[b]	12.83	320.83
T3: Flupyram + Marigold	186.67 (13.64)[bc]	11.22 (3.34)[cd]	1.44[c]	2.77[e]	69.27[c]	17.20	430.00
T4: Fluensulfone + Marigold	194.44 (13.93)[bc]	9.00 (3.00)[d]	1.67[c]	3.06e	65.91[c]	17.27	431.67
T5: Ghanjeevamrit + Brahmastra + Marigold	248.89 (15.73)[b]	22.00 (4.68)[b]	2.33[b]	10.28[bc]	269.68[b]	14.48	362.08
T6: Ghanjeevamrit + Brahmastra + Marigold	136.11 (11.61)[c]	14.89 (3.80)[c]	1.78[bc]	7.11[cd]	171.52[bc]	15.97	399.17
T7: Untreated Check	381.11 (19.48)[a]	30.33 (5.51)[a]	3.67[a]	21.28[a]	491.59[a]	10.67	266.67
C.D (0.05)	2.701	0.756	0.665	3.625	113.65	3.159	

**Figures in parentheses are square root transformed values; RKI = Root Knot Index*

References

Jensen MH. 2001. Controlled Environment agriculture in deserts, tropics and temperate regions-A World Review. In *International Symposium on Design and Environmental Control of Tropical and Subtropical Greenhouses* 578 (pp. 19-25).

Sharma HK, Pankaj and Singh B. 2009. Protected cultivation and nematode problem. *Journal of Nematology* 39: 1–8.

ESFS-NF/NBSCP2024/2027

Agroecology harbouring a diverse range of natural enemies against *Eriosoma lanigerum* (Hausmann)

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Keywords: Agroecology, Conservation, Diversity, Parasitoid, Predators, Woolly apple aphid

Introduction

Apple is responsible for an economy of around Rs.5000 crore in Himachal Pradesh. The state has four types of agroclimatic zones and Chamba district have all these four different agroclimatic zones. Agroecology is responsible for the diversity and abundance of flora and fauna at a place. Therefore, these four types of agroclimatic zones provides habitat to a diverse range of natural enemies like predators and parasitoids of various pests. Woolly apple aphid, *Eriosoma lanigerum* (Hausmann) is a major pest of apple worldwide as well as in Himachal Pradesh causing the economic losses to the farmers. Currently this pest is managed using various insecticides which are very harmful to the environment and also to the humans. Present study was conducted to access the diversity of natural enemies against *E. lanigerum*. So, the efforts should be made to conserve them and manage this pest naturally without using insecticides and enriching the biodiversity (Snyder, 2019).

Material and methods

A roving survey was conducted in year 2023 to access the diversity of natural enemies against *E. lanigerum* in different locations of Chamba district of Himachal Pradesh *viz*. Chamba, Salooni, Tissa, Holi and Bharmour. In each location three orchards were visited and in each orhard five plants were randomly selected for observation. In each plant four branches in four directions were selected and total number of various natural enemies in each branch associated with *E. lanigerum* were calculated and then added to form the total number of natural enemies per species per plant. This data was then converted into percentage to find out relative proportion of each species in each location. Also for each location various diversity indices were calculated (Simpson, 1949). The specimens were collected and brought to Biological Control Laboratory of Department of Entomology, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni for identification.

Results and conclusion

In the current study various natural enemies like predatory coccinellids *viz. Coccinella septempunctata* (Linnaeus), *Hippodamia variegata* (Goeze), *Harmonia dimidiata* (Fabricius), *Cheilomenes sexmaculata* (Fabricius) and *Chilocorus infernalis* Mulsant; predatory syrphids *viz*. *Episyrphus balteatus* (De Geer), *Eupeodes corollae* (Fabricius), *Eupeodes confrator* (Wiedemann); predatory neuropteran *viz. Chrysoperla zastrowi sillemi* (Esben-Petersen) and an aphelinid parasitoid, *Aphelinus mali* Haldeman were found attacking the population of *E. lanigerum* in different locations of Chamba district naturally (Fig. 1). Also various diversity indices like Shannon and Simpson indexs, Margalef's index, species evenness, species dominance etc. were also calculated to further check the distribution of these natural enemies in different locations of Chamba district.

The study reveals the presence of a diverse range of natural enemies against *E. lanigerum* yet, farmers spray various insecticides for management of *E. lanigerum* and sometimes keep spraying unnecessary due to lack of knowledge. This is very harmful for environment as well as to the humans as it led to reduction in number of natural enemies and also various health hazards. So focus should be on educating farmers and conserving this diverse range of natural enemies so that population of *E. lanigerum* can be managed naturally.

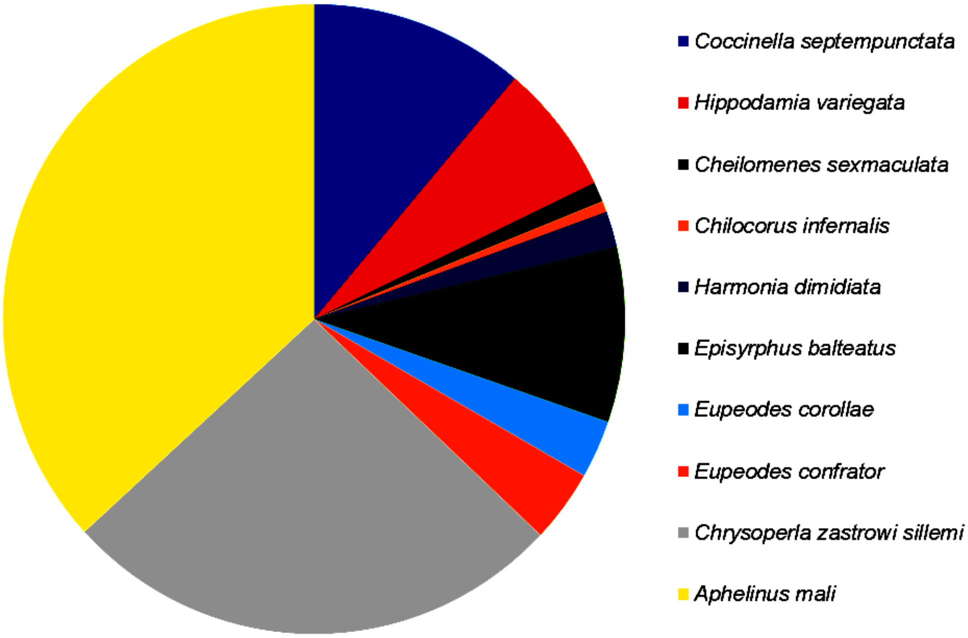

Fig.1 Diversity of natural enemies against *E. lanigerum* in Chamba district of Himachal Pradesh.

References

Simpson EH. 1949. Measurement of diversity. *Nature*, 163: 688p.

Snyder WE. 2019. Give predators a complement: Conserving natural enemy biodiversity to improve biocontrol. *Biological Control*. 135: 73-82

ESFS-NF/NBSCP2024/2028

Marigold: An alternative to conventional chemical pesticides for sustainable crop protection

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Keywords: Natural crop protectant, Nematodes, Sustainable agriculture

Introduction

Marigold (*Tagetes* spp) which is considered to be a traditional medicinal plant, has significant therapeutic value and is used in treatment of a number of ailments. It acts as biopesticides especially as insecticide, mosquitocide, nematicide, bactericide and fungicide. The essential oils obtained from the aerial part of Tagetes mainly contain monoterpene hydrocarbons (ocimenes, limonene, terpinene etc) and acyclic monoterpene ketones (tagetones, dihydrotagetone and tagetenone) in addition to lower amount of sesquiterpene and oxygenated compounds. These components are mainly responsible for insecticidal, larvicidal and mosquitocidal property (Bakshi and Ghosh, 2022). Marigold has multifaceted role in safeguarding crops from various pests and diseases have been documented.

Materials and methods

The intercropping of African marigold (*Tagetes erecta* L.) with vegetable crops (cowpea, tomato) will encourage an abundance of beneficial arthropods and increase cultural and biological control against various key pests. Also, the use of marigold extract both as aqueous and methanolic can be done. Plant extracts are widely used as insecticides as they are eco-friendly and safe to the environment. Unlike chemical insecticides, plant extracts as alternative insecticides are non-toxic to human and animals and do not cause environmental contaminations. Application method of plant extract was foliar application of plant extract (aqueous and methanolic).

Results and conclusion

Significant control of whitefly (*Trialeurodes vaporariorum*) was achieved when french marigolds were intercropped amongst tomatoes from the beginning of the growth period. Similarly, it was observed that *M. incognita* did not form galls on soybean plants when intercropped with marigold species *T. erecta* and *T. patula.* Also, similar kind of results were obtained when aqueous foliar extracts of *T. patula* was applied in management of western tarnished bug *Lygus Hesperus*. Highest mortality was observed with the lowest concentration of the methanolic extract. Thus marigold crop as intercropping as well as in extract form affects the key insect pests by significantly reducing their populations and consequently improve yields. Further research is warranted to fully elucidate the mechanisms underlying marigold's crop protection benefits and to optimize its utilization in diverse agricultural settings (Lopez and Liburd, 2023). Nevertheless, the available evidence strongly supports the potential of marigold as a valuable tool in the arsenal of organic and sustainable farming practices.

References

Bakshi L and Ghosh R. 2022. Marigold biopesticide as an alternative to conventional chemical pesticides. *Journal of Advanced Scientific Research* 13 (5): 26-33.

Lopez M and Liburd OA. 2023. Effects of intercropping marigold, cowpea and an insecticidal soap on whiteflies and aphids in organic squash. *Journal of Applied Entomology* 147 (7): 452-463

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Impact of natural farming practices on the diversity of insect visitors in sunflower

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Keywords: Diversity indices, insect visitors, SPNF, pollinators

Introduction

Sunflower is the world's fourth important oilseed crop that improves the human diet, prevents malnutrition. It is an allogamous and protandric species i.e., it reproduces mainly through cross-fertilization and produces both nectar and pollen that encourages bee visits and other pollinators numerously. A variety of insect-pests attack the sunflower crop, causing significant crop loss. Farmers have relied heavily on chemical pesticides to manage sunflower insect pests, resulting in higher production costs and environmental pollution. Recently, Subhash Palekar Natural Farming system has emerged as an alternative technique which is not only cheap but is chemical free and based on agro-ecology (Palekar, 2016). This farming system boosts production without the use of chemicals by utilizing locally made botanical pesticides and innovative cultivation methods. As a result, this farming system is becoming increasingly popular among farmers. With this in mind, it became necessary to investigate the impact of conventional and natural farming practices on the diversity of insect visitors in sunflower. Hence the investigation was carried out to study the impact of conventional and natural farming practices on the diversity of insect visitors on sunflower.

Material and methods

The studies were conducted in the experimental farm of Department of Entomology and experimental farm of SPNF during 2023-24. The observations were recorded for total number of species present and population density of each species per sampling unit. The diversity of insect visitors was calculated using different indices viz., Margalef's richness index, Simpson index and Shannon- Wiener index.

Results and conclusion

The number of insect visitors on sunflower crop in SPNF and conventional farming systems is presented in Table 1. Among the hymenopteran visitors, there were *A. mellifera*, *A. dorsata*L. *A. cerana*, *Bombus haemorrhoidalis, Vespa* spp., *Ceratina* spp and *Halictus* species (sweat bees). Additionally, Lepidoptera, hemipetrans and coleopteran visitors have also been observed. In SPNF, maximum numbers was of *B. Haemorrhoidalis* and minimum number was of hemipetrans whereas, in conventional farming system maximum numbers was of *A. mellifera* L. and minimum number was of Lepidoptera. The diversity indices were calculated to compare the diversity of insect visitors in two farming systems. The comparison of the diversity indices of both farming systems (Table 2) revealed that the SPNF system had more insect visitor's diversity in sunflower than the CF system.

For SPNF system, Margalef's index, Simpson index, Shannon index (H), maximum diversity (H_{max}.), species evenness (J), species dominance and Margalef's index, were 0.14, 2.01, 7.14, 0.28, 0.72 and1.26 respectively, whereas in CF system, the values of these indices were 0.15, 2.03, 6.63, 0.30, 0.7 and 1.35, respectively. The results of the study concluded that the number of insect visitors were higher in SPNF system than CF system. In SPNF maximum numbers was of *B. Haemorrhoidalis* and minimum number was of hemipetrans whereas, in conventional farming system maximum numbers was of *A. mellifera* L. and minimum number was of Lepidoptera. The analysis of diversity indices revealed that the SPNF system had a greater diversity of insect visitors than the CF system. The study concluded that number of insect visitors were higher in SPNF system than CF system. In SPNF maximum numbers was of *B. Haemorrhoidalis* and minimum number was of hemipetrans whereas, in conventional farming system maximum numbers was of *A. mellifera* L. and minimum number was of Lepidoptera.

Table 1:Number of insect visitors and diversity indices of insect visitors on sunflower crop in natural and conventional farming systems

S.N.	Insect visitors	SPNF	CF
1	*A. mellifera* L.	250	225
2	*A. dorsata* L.	110	54
3	*A. cerana* L.	166	115
4	*B. haemorrhoidalis*	285	120
5	*Halictus* spp.	180	76
6	*Vespa* spp.	48	38
7	*Ceratina* spp.	56	29
8	hemipetrans	30	34
9	Coleopterans	95	44
10	Lepidoptera	45	28
	Total	1265	763
Diversity indices of insect visitors			
Diversity indices			
Simpson index(D)		0.14	0.15
Simpson (1-D) index of diversity		0.86	0.85
Shannon_H		2.01	2.03
Maximum diversity (H_{max})		7.14	6.63
Evenness (J)		0.28	0.30
Dominance(D)		0.72	0.7
Margalef index		0.14	0.15

References

Palekar S. 2016. Vegetable crops in Zero Budget Spiritual Farming. Zero Budget Spiritual Agriculture System Research, Development and Extension Movement, Amaravati, Maharashtra.

Simpson EH. 1949. Measurement of diversity. *Nature* 33:163:688

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Management of cauliflower insect pests through bio-ecological interventions

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Keywords: BIPM, Trap-Cropping, Biocontrol,

Introduction

Cauliflower (*Brassica oleracea* L. var. *botrytis*) is an important winter season vegetable crop grown in the Himalayan region. There are many insect pests that affect the production and quality of this crop viz., *Brevicoryne brassicae, Bagrada cruciferarum, Plutella xylostella, Pieris brassicae*, and other lepidopterans (Gaikwad et al., 2018). The non-judicious utilization of insecticides for the management of insect pests in vegetable crops may deteriorate the ecosystem processes and eventually deleterious to the human health. The increasing demand for the chemical free food commodities has given an impetus to eco-friendly pest management through the use of biological organisms and habitat manipulation in agroecosystems. Hence the present investigation focussed on studying the effect of biointensive pest management practices including cultural and mechanical techniques along with biocontrol strategies for the management of insect pests of cauliflower.

Material and methods

Cauliflower cultivar PSBK-1 was transplanted in the field at a spacing of 30 x 60 cm and mustard was grown as trap crop around the bunds. Evaluation of biointensive pest management (BIPM) module comprising of spray of azadirachtin 1500ppm (2ml/litre), release of *Chrysoperla zastrowii sillemi* (4 larvae/plant), mechanical destruction of egg masses and early gregarious larval instars of *Pieris brassicae* and two sprays of *Bacillus thuringiensis* NBAIR BTG4 (10ml/L) was carried out and compared with application of Spinosad 2.50 % SC along with untreated control. Each treatment was replicated seven times and the data on aphid and caterpillar counts were recorded at weekly interval starting from the first appearance of the pest until harvest.

Results and conclusion

Cabbage aphids (*B. brassicae*) began to appear on Standard Meteorological Week (SMW)-2 and their population grew unabated in the absence of any treatment. However, the aphid population kept on fluctuating throughout the cropping period under BIPM and chemical intervention. Minimum population of aphid was observed in Spinosad 2.50% SC (9.14 aphids/3 leaves) followed by BIPM (12.10 aphids/3 leaves) which were significantly lower than the control (46.31 aphids/3 leaves). The per cent reduction of aphids over untreated control in BIPM and Spinosad 2.50 % SC was 73.87 and 80.26 per cent, respectively. Infestation of diamondback moth (*P. xylostella*) was recorded in the 9^{th} and 10^{th} SMW.

Mean population of DBM larvae recorded under BIPM was 0.38 larvae/plant which was significantly at par with chemical treatment (0.43 larvae/plant). Both treatments showed significantly lower population of DBM as compared to untreated control. In the end of the cropping season few eggs clusters of cabbage butterfly (*P. brassicae*) were also noticed in all the treatment. Miniscule populations of other insect pests *viz*., *Spodoptera litura*, *Hellula undalis* and *Bagrada cruciferarum* were also observed. Cauliflower yield under BIPM was 185.71 q/ha which was statistically at par with chemical treatment (192.86 q/ha).

Table 1: Comparative analysis of biointensive pest management and chemical applications on aphid and diamondback moth population in cauliflower

Treatment	Mean Aphids/ three leaves	Reduction in aphid over Control (%)	Mean no. of DBM larvae/plant	Yield (q/ha)	B:C ratio
T1 (BIPM)	12.10 (3.62)	73.87	0.38 (1.18)	185.71	1.88
T2 (Spinosad)	9.14 (3.18)	80.26	0.43 (1.19)	192.86	2.06
T3 (Control)	46.31 (6.88)	-	3.93 (2.20)	158.86	1.76
$CD_{0.05}$	0.19	-	0.26	21.00	-

**Figures in parenthesis are square root transformation values*

References

Gaikwad AD, Bhede BV, Bokan SC and Bhosle BB. 2018. Seasonal incidence of major insect pests, natural enemies on cauliflower and their correlation with weather parameters. *Journal of Entomology and Zoology Studies* 6(5): 952-956.

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Species composition and elevation distribution of bumblebees in Jammu region

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Keywords: Cabbage bio-enzyme, Citrus bio-enzyme

Introduction

Bumblebees are cold adapted and high-elevation insects that serve a crucial ecological and economic role by serving as pollinators of both wild and domestic floral plants and crops. They play a crucial role in the smooth functioning of both natural as well as agricultural ecosystem due to their behaviour of 'Buzz pollination' (Goulson, 2010). These buzz bees are ideal to explain the distribution at higher altitudes as because they are cold-adapted and are widely distributed from an altitude of 1000m to 5500m above mean sea level in the north western Himalayas where Jammu and Kashmir confers wide range of habitats for bumblebees because of greater diversity in different altitudinal range.

Material and methods

Survey and identification of the host plants and bumblebee species were carried out at different elevations ranging from 260 m to 3200 m amsl of Jammu region from the month of April to September in the consecutive time period of two years i.e., 2021 and 2022. The survey sites were divided into four altitudinal gradients. The bumblebees were collected mainly by "Direct search method" by using sweeping hand nets. Identification of bumblebees on morphological differences up to genus/species was done by using the key provided by Williams, 2022. Species diversity index of bumblebees was calculated with Shannon-weiner function *viz*. Shannon diversity index (H), Maximum diversity ($H_{max.}$) and Species evenness (J)

Results and conclusion

During the survey period of two years, a total of six species of bumblebees were collected from different altitudes of Jammu region viz. *B. haemorrhoidalis, B. albopleuralis, B. trifasciatus, B. tunicatus*, *B. simillimus* and *B. eurythorax*. These collected six species belonged to four different subgenus. Out of all the species, *B. eurythorax* is the only species found at the altitude of 1800-2500 m amsl. Species diversity index were found to be highest at the altitudinal ranges of 1800-2500 m. Species evenness were found to be maximum at 1200-1800m altitudinal range. This shows that the temperate areas were richer in diversity and were more suitable habitat for bumblebees. The results concluded that six bumblebee species of four different subgenera were found in Jammu region with highest species diversity index at the altitude of 1800-2500 m.

Table 1: Species diversity index, richness and evenness of bumblebee species

Altitude (m amsl)	No. of species collected	No. of individuals in all species	Species diversity index (H)	Species evenness (j)
0-600	2	30	0.640	2.12636
600-1200	3	90	1.058	2.21808
1200-1800	5	102	1.569	2.24477
1800-2500	6	150	1.635	2.10221

References

Williams PH. 2022. *The Bumblebees of the Himalaya: An Identification Guide*. Royal Belgian Institute of Natural Sciences.

ESFS-NF/NBSCP2024/2032

Natural enemy diversity for integrated pest management of cole crops in temperate zone of Himachal Pradesh

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Keywords: Biological control, Predator, Parasitoid, Pest

Introduction

Cole crops such as cabbage, cauliflower, and knol-khol are vital to the diets of millions in India, offering both nutritional and economic benefits. Nationally, these crops cover around 369,000 hectares, with an annual yield of 7.949 million tonnes (Kumar and Sharma 2021). In Himachal Pradesh, particularly in the temperate zones of Kinnaur and Lahaul Spiti, agriculture has shifted from cereal-based subsistence farming to a commercial, vegetable-focused model. This shift has significantly increased the area under vegetable cultivation and overall production (Barwal et al.,2023). However, the quality and yield of cole crops in these regions face serious threats from pests like the diamondback moth (*Plutella xylostella* L.), aphids (*Lipaphis erysimi* Kalt. and *Brevicoryne brassicae* L.), and the cabbage butterfly (*Pieris brassicae* L.). Pesticide overuse has led to pest resistance, highlighting the need for biological control agents as a sustainable alternative. Due to the low pesticide use in Kinnaur and Lahaul Spiti, these areas boast a rich biodiversity of biocontrol agents, such as Syrphid flies, Ladybird beetles, Green lacewing bugs, and parasitoids like *Diaeretiella rapae* and *Cotesia glomerata*, which help manage pests while promoting a sustainable agricultural system.

Material and methods

In 2023, an extensive survey was carried out across various sites in the Kinnaur, Lahul, and Spiti districts of Himachal Pradesh, specifically in Kalpa, Sangla, Nako, Spiti and Kaza, to evaluate the diversity of natural enemies targeting the pest complex associated with cole crops-*P. brassicae* L., *P. xylostella* L., *L. erysimi* Kalt., and *B. brassicae* L. In each location, 10 orchards were surveyed, with 20 to 25 plants randomly selected within each orchard for detailed observation. For every plant, the inner, middle, and outer leaves were examined to assess the total pest population and the presence of natural enemies. In the case of parasitoids, pests were reared under controlled conditions to determine the total number of parasitoids. This data was subsequently converted into percentages to ascertain the relative proportion of each species in each location. Additionally, various diversity indices were calculated for each site to provide a comprehensive understanding of the ecological dynamics at play.

Results and conclusion

In this study, the population of various natural enemies, including the predatory Syrphid flies *Episyrphus balteatus*, *Eupeodes corollae*, *Ischiodon scutellaris* (Fabricius), *Melanostoma orientale*, the ladybird beetles *Coccinella septempunctata*, *Hippodamia variegata*, *Chilomenus sexmaculata*, and the green lacewing *Chrysoperla zastrowi sillemi* (Esben-Petersen) parasitoid like *Diaeretiella rapae* was found to be associated with cabbage aphid (*Brevicoryne brassicae* L.). Additionally, the gregarious feeder larvae of *Pieris brassicae* were observed in the same areas. After rearing the 2nd and 3rd instar larvae, the emergence of the larval parasitoid *Cotesia glomerata* from the 5th instar larvae was noted.

Furthermore, various diversity indices such as Shannon and Simpson indices, Margalef's index, species evenness, and species dominance were calculated to assess the distribution of these natural enemies across different locations in the Kinnaur, Lahaul, and Spiti districts. The findings of this study underscore the critical role of natural enemies in regulating pest populations in cole crops within the temperate zones of Kinnaur, Lahaul, and Spiti districts. The observed diversity of predatory Syrphid flies, ladybird beetles, green lacewing, and larval parasitoids, along with the calculated diversity indices, indicate a robust and balanced ecosystem.

The results highlight the potential of biological control agents in sustainably managing pest populations, reducing the reliance on chemical pesticides, and promoting ecological resilience in these agriculturally significant regions. Further research should explore the interactions between these natural enemies and pest species to enhance the effectiveness of integrated pest management strategies.

Table 1: Relative proportion of natural enemies in associated with cole crops

Natural enemy species	**Relative proportion of natural enemies (%)**				
	Spiti	**Kalpa**	**Sangla**	**Nako**	**Lahul**
Episyrphus balteatus	18.38	14.41	9.79	18.12	18.18
Eupeodes corollae	7.35	9.91	4.90	8.05	3.25
Ischiodon scutellaris	11.03	7.66	6.29	2.68	5.84
Melanostoma orientale	7.35	5.41	8.39	4.70	9.09
Coccinella septempunctata	18.38	24.77	27.27	32.89	29.22
Hippodamia variegata	7.35	3.15	3.50	2.01	5.84
Chilomenus sexmaculata	3.68	4.05	4.90	2.68	4.55
Chrysoperla zastrowi sillemi	12.50	12.16	9.09	10.07	9.09
Diaeretiella rapae	13.97	18.47	25.87	18.79	14.94

References

Barwal P, Sharma S, Bali D and Kaur E. 2023. Profitability and resource use efficiency of cabbage production in temperate zone (High- Hills) of Himachal Pradesh. Economic Affairs (New Delhi), 68(2), 1075–1080. https://doi.org/10.46852/0424-2513.2.2023.11

Kumar R and Sharma SK. 2021. Effect of integrated nutrient management on cabbage production in dry temperate region. *Journal of Krishi Vigyan* 9(2): 46–48.

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Efficacy of natural and organic products against *Trialeurodes vaporariorum* infesting cucumber under protected environment

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***Keywords*:** Cucumber, Natural and organic products, Protected environment, *Trialeurodes vaporariorum*

Introduction

Trialeurodes vaporariorum (Westwood) is a key pest and one of the most important limiting factor in cucumber production under protected conditions (Sood et al. 2018). Both nymphs and adults feed on phloem sap, leading to considerable yield losses. Plant protection measures against this pest, especially under commercial cultivation has been based upon the use of chemical insecticides, which pose prospective ill-effects. Thus, it is imperative to replace these insecticides with sustainable alternatives such as cattle and plant-based products. In this context, the study was aimed to evaluate the effectiveness of natural and organic products against *T. vaporariorum* infesting cucumber under protected environment.

Material and methods

The effectiveness of natural and organic products against greenhouse whitefly on parthenocarpic cucumber F_1 hybrid "Mini Angel" was assessed under two naturally ventilated polyhouses (105 m^2) as preventive and curative measures. In preventive measures, whitefly population was allowed to buildup naturally and the application of treatments began 15 days after transplanting (DAT) whereas in curative measures, plants were artificially infested with whiteflies at 10 DAT and insecticidal applications were started at 30 DAT. In all, ten natural and biopesticide products along with two chemical checks were evaluated as detailed in Table 1. The experiment was conducted in randomized block design and replicated thrice. All the treatments except for chemical insecticides were applied at 10 days interval. Observations were recorded on number of whitefly adults on terminal three fully opened leaves of five randomly selected plants in each treatment and the mean whitefly population per three leaves was worked out. Also, the yield data on different dates of harvesting was recorded to work out cumulative yield.

Results and conclusion

The results revealed that the natural and organic products affected the whitefly adult population significantly when used as preventive and curative measures. Preventive whitefly management measures resulted in mean population levels of 0.01 to 0.07 adults/leaf with a population of 0.08 adults per leaf in untreated check, the minimum and maximum corresponding to *Tamarlassi* (0.02 adults/leaf) and *Beauveria bassiana* (0.07 adults/ leaf), respectively among natural and biopesticide products. Under curative measures treatments, mean population of 2.17 to 12.40 adults/leaf with 19.23 adults/leaf in untreated check was observed. *Tamarlassi* (6.11 adults/leaf) and *Darekastra* (12.40 adults/leaf) recorded the minimum and maximum adult population among the natural and organic products. The chemical insecticide and biopesticide treatments namely, soil application of imidacloprid, alternate foliar application of spiromesifen and thiamethoxam and foliar application of azadirachtin proved significantly superior to natural products in curative measures whereas, were at par in preventive measures. Cumulative mean fruit yield varied from 2134 to 2476 g/plant in different insecticidal treatments, while a yield of 2092 g/plant was evident in untreated check. A significantly high yield was recorded in soil application of imidacloprid which was at par to *Tamarlassi* and foliar application of azadirachtin. Alternate foliar application of spiromesifen and thiamethoxam followed them and was at par to alternate foliar application of vermiwash and *Tamarlassi* and foliar application of fermented cow urine. Foliar application of *Darekastra* resulted in minimum fruit yield and was at par to foliar application of *Beauveria bassiana.*

The study concludes that the natural and organic products are more effective as preventive measures and can be incorporated in integrated whitefly management programme under protected cultivation.

Table 1: Effect of natural and organic products on greenhouse whitefly population and fruit yield of cucumber

Treatment	Method of application	Application Rate	Seasonal mean population/leaf		Cumulative yield (g/plant)
			Preventive measures	Curative measures	
Azadirachtin	Foliar application	0.00045%	0.01 (1.01)	4.52 (2.33)	2433 (49.33)
Beauveria bassiana	Foliar application	5 g/lt	0.07 (1.03)	11.62 (3.49)	2145 (46.30)
Darekastra	Foliar application	10%	0.07 (1.03)	12.40 (3.60)	2134 (46.18)
Darekastra & Fermented buttermilk	Alternate foliar application	10 %	0.02 (1.01)	9.73 (3.21)	2275 (47.69)
Dashparni	Foliar application	10%	0.03 (1.01)	10.24 (3.33)	2185 (46.73)
Fermented buttermilk	Foliar application	10%	0.02 (1.01)	7.56 (2.87)	2360 (48.56)
Fermented cow urine	Foliar application	5%	0.02 (1.01)	6.84 (2.76)	2375 (48.73)
Tamarlassi	Foliar application	10%	0.02 (1.01)	6.11 (2.65)	2442 (49.42)
Vermiwash	Foliar application	10%	0.05 (1.02)	10.81 (3.41)	2238 (47.29)
Vermiwash & *Tamarlassi*	Alternate foliar application	10%	0.03 (1.01)	7.16 (2.81)	2382 (48.81)
Imidacloprid	Soil application at 5 and 50 DAT	0.009%	0.01 (1.01)	3.31 (2.06)	2476 (49.76)
Spiromesifen	foliar application	0.02%	0.06 (1.03)	2.17 (1.76)	2420 (49.17)
Untreated Check	-	-	0.08 (1.04)	19.23 (4.47)	2092 (45.73)
C.D. (0.05)	-	-	(0.02)	(0.06)	(0.92)

References

Sood AK, Singh V and Mehta PK. 2018. Current status and management strategies of insect-pests of vegetable crops under protected cultivation in Himachal Pradesh. In: S Kumar, NB Patel, SN Saravaiya and BN Patel (Eds.), *Technologies and Sustainability of Protected Cultivation for Hi-Valued Vegetable Crops* (pp. 339-354). Navsari Agricultural University, Navsari, Gujarat, India.

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Effect of bioresources against wheat (*Triticum aestivum* L.) leaf blight

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Keywords: Wheat, Foliar blight, *Alternaria triticina*, Bioresources

Introduction

Wheat (*Triticum aestivum* L.) is one of the world's major cereal crops and staple food crop grown under irrigated and rain-fed conditions. *Alternaria triticina* is a significant cause of economically important diseases in tropical, subtropical, and temperate regions, and its variability complicates host range and resistance screening. Effective disease management strategies are crucial, as chemical control is costly and unsustainable. Biofertilizers offer a sustainable alternative by reducing the use of chemical fertilizers while enhancing yields.

Material and methods

The study was conducted in rabi season on wheat crop to record the occurrence and distribution of leaf blight. The survey of various regions in the Prayagraj district to record disease severity in different wheat-growing areas. Additionally, the study involved collecting diseased samples to examine the cultural and morphological characteristics of the isolates under in-vitro conditions from these different areas (Chaudhary *et al.* 2011). The scale for disease assessment of Alternaria leaf blight caused by *Alternaria triticina* was calculated.

Results and conclusion

Minimum disease intensity (%) at 50 days after sowing (DAS) was recorded in the treatment T7 Microalgae + Phosphate Rich Organic Manure (7.13). Minimum disease intensity (%) at 70 DAS was recorded in the treatment T7 Microalgae + Phosphate Rich Organic Manure (9.84). Minimum disease intensity (%) at 90 DAS was recorded in treatment T7 Microalgae + Phosphate Rich Organic Manure (10.94) (Table 1). Microalgae + Phosphate rich organic manure (3 kg/ha + 25 kg/ha), were found as best to minimize leaf blight disease of wheat.

Table 1: Effect of bioresources on disease intensity of wheat

Treatment		Disease intensity (%)		
		50 DAS	70 DAS	90 DAS
T_0	Control	10.86	12.31	18.50
T_1	Microalgae	9.39	10.33	12.05
T_2	Mycorrhiza	8.92	10.79	12.67
T_3	Deoiled Seed Cake	9.93	11.99	15.88
T_4	Phosphate Rich Organic Manure	9.18	11.46	13.75
T_5	Microalgae + Mycorrhiza	8.22	10.02	11.55
T_6	Microalgae + Deoiled Seed Cake	9.65	10.21	11.64
T_7	Microalgae + Phosphate Organic Manure	7.13	9.84	10.94
CD (0.05)		0.89	1.20	1.69

References

Chaudhary B, Kumar S, Sharma RL and Jakhar SR. 2011. Effect of different media, pH and temperature on growth and sporulation of *Fusarium udum* causing wilt of pigeon pea. *International Journal of Current Microbiology and Applied Sciences* 6(5): 2005-11.

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Biology and predatory potential of *Blaptostethus pallescens* Popp. against *Tetranychus urticae* Koch

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Keywords: Anthocorids, Biological control, Preying potential

Introduction

Tetranychus urticae due to its polyphagous nature causes serious threat to various crops. It feeds on plant tissue and suck the cell content, as a result photosynthesis process is hampered. Use of pesticides to control this pest leads to various environmental consequences, therefore there is a need to develop safe and sustainable methods. Biological control based pest management could be a viable option. Anthocorids are potential predators of several pests. *B. pallescens* is reported to prey upon mites, thrips and lepidopterans (Ballal *et al*. 2018). However, there are some discrepancies regarding its development and preying potential on mites. It is therefore, pertinent to evaluate predatory potential of *B. pallescens* on *T. urticae*.

Material and methods

Developmental biology of *B. pallescens* was studied on *T. urticae*. Tender bean pods were introduced into the adult bug rearing containers for egg laying. The bean pods containing eggs were kept in glass tubes for hatching. After emergence, the predatory nymphs were reared individually on *T. urticae* in Petri plates on bean leaves until adult emergence. Data on the duration of each developmental stage of the predatory bug, adult longevity, fecundity and sex ratio were recorded. Feeding potential of the predator was recorded daily for 18h on mite and for 6h on *C. cephalonica.* In another set, the predator was allowed to feed on the mite and rice moth eggs for 12h each. A third set where the predator was reared exclusively on rice moth eggs. Data thus obtained were used to calculate the prey consumed during the life stage and the entire life time.

Results and conclusion

In the present study, the immature development of the predatory bug was fastest (21.3 days) on *C. cephalonica* eggs followed by *T. urticae*+*C. cephalonica* (12+12 h feeding) (25 days) and *T. urticae*+*C. cephalonica* (18+6 h feeding) (25.4 days). Male longevity was 26.9 days on *C. cephalonica* eggs, 20.4 days on *T. urticae*+*C. cephalonica* (12+12 h) and 17 days on *T. urticae*+*C. cephalonica* (18+6 h). Likewise, the females reared on *C. cephalonica* eggs alone survived for 37.8 days, while those developed on *T. urticae*+*C. cephalonica* (12+12 h) or *T. urticae*+*C. cephalonica* (18+6 h) lived for 29.5 or 24.5 days, respectively (Table 1). Fecundity was highest (190.4 eggs/female) in females reared on *C. cephalonica* eggs followed by *T. urticae* + *C. cephalonica* (12+12 h) (117.8 eggs/female) and *T. urticae* + *C. cephalonica* 18+6 h (98 eggs/female).

Sex ratio was female biased (1:1.1 to 1:1.2) in each case. The consumption rate of adult male and female predators was 251.8 and 410.8 on *C. cephalonica* eggs, which was higher than recorded for the predator feeding on *T. urticae*+*C. cephalonica* (12+12 h) (170.3 and 246.4, respectively) and *T. urticae*+*C. cephalonica* (18+6 h) (126.3 and 186.8, respectively). Females consumed higher number of preys than males in each case. The biological and feeding potential of the bug were highest on *C. cephalonica* eggs followed by *T. urticae* + *C. cephalonica* (12+12 h) and *T. urticae* + *C. cephalonica* (18+6 h).

This indicates that the predatory bug can be used against the mite, but repeated applications may be required, as it will not be able to increase its population exclusively on the mite.

Table 1: Developmental biology of *Blaptostethus pallescens* on prey combinations

Developmental stage		Mean duration (days ± SE) on indicated food		
		***T. urticae* + *C. cephalonica* (18+6 h)**	***T. urticae* + *C. cephalonica* (12+12 h)**	***C. cephalonica* (24 h)**
Eggs		4.6a ± 0.1	4.5a ± 0.1	4.4a ± 0.1
1st instar		2.9a ± 0.1	2.9a ± 0.2	2.7a ± 0.2
2nd instar		2.9a ± 0.2	3.2a ± 0.1	2.5b ± 0.1
3rd instar		3.9a± 0.1	3.4b± 0.1	2.6c ± 0.1
4th instar		4.5a ± 0.1	4.6a ± 0.2	3.7b ± 0.1
5th instar		6.6a± 0.2	6.4a ± 0.1	5.4b ± 0.1
Adult longevity	Male	17.0c ± 0.9	20.4b ± 1.2	26.9a ± 1.7
	Female	24.9b ± 1.8	29.5b ± 2.1	37.8a ± 2.2

References

Ballal CR, Akbar SA, Yamada K, Wachkoo AA and Varshney R. 2018. Annotated catalogue of the flower bugs from India (Heteroptera: Anthocoridae; Lasiochilidae). *Acta Entomologica Musei Nationalis Pragae* 58: 207-226.

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Impact of natural farming practices on the diversity of insect visitors in onion

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***Keywords*:** Diversity indices, Onion, Pollinators, SPNF

Introduction

Onion, *Allium cepa* L. (family: Alliaceae) is one of the most important vegetable crop grown worldwide. Pollination by insects is vital for the production of hybrid onion seed. Around 40 percent of India's onion seed demand is fulfilled by the organized sector, with farmers meeting the remaining requirement through their own seeds. The quality of onion seed material relies on pollination, which is influenced by the abundance and diversity of insect visitors. Hence, conservation of the insect visitors is crucial for ensuring the quantity and quality of onion seeds. (Munawar et al., 2011). Onion crop is attacked by several insect pests. Natural farming methods which utilize locally available natural herb-based inputs as insect repellents, pesticides and fungicides can reduce the need for artificial fertilizers and industrial pesticides (Laishram et al. 2022). Considering this, it became essential to examine how conventional and natural farming practices affect the diversity of insect visitors in onion crops. Hence the investigations were carried out to study the impact of conventional and natural farming practices on the diversity of insect visitors in onion.

Material and methods

The study was conducted in onion in conventional farming (CF) and natural farming (NF) practices. Observations were recorded for total number of species present and population density of each species per sampling unit. The diversity of insect visitors was calculated using different indices *viz.,* Margalef's richness index, Simpson index and Shannon- Wiener index.

Results and conclusion

The results revealed that total 1655 and 1251 numbers of insect visitors were counted in natural and conventional farming system, respectively. In natural farming, highest number was for *Episryphus balteatus (*130), whereas lowest for *Ischiodon scutellaris* (27), whereas, in conventional farming highest number was for *A. mellifera* (102) and lowest for *Ischiodon scutellaris* (16). The second highest number (119) was for *Carpocoris fuscispinus*, whereas, *Sphaerophoria indiana* and *Protophormia terraenova* were counted as 111, both being third highest in number. In conventional farming system, the number of various insect visitor species varied from 16-102. *Carpocoris fuscispinus* was second (95) in number after *A. mellifera*.

The sryphid flies *E. balteatus* and *S. indiana* were (92) being third highest. *A. dorsata* number was also low (29), wheras, *Chrysocoris stolii* and *Liorhyssus hyalinus* were not recorded in conventional farming system. The comparison of the diversity indices of both farming systems revealed that the The Simpson index (D) and Simpson (1-D) index of diversity, respectively were same for both natural and conventional farming systems i.e. 0.06 and 0.94. Whereas, Shannon H, Maximum diversity (Hmax) and Margalef index, respectively were high in natural farming systems i.e 2.92, 3.00 and 4.23 than conventional farming system 2.80, 2.89 and 3.77. The dominance (D) and evenness (J) were same for both the farming systems (0.07).

In total 1655 and 1251 numbers of insect visitors were recorded in natural and conventional farming system, respectively. In natural farming, the highest number was recorded for *E. balteatus* (130), while the lowest was for *Ischiodon scutellaris* (27). In the conventional farming system, the highest number was recorded for *A. mellifera* (102) and the lowest for *Ischiodon scutellaris* (16). SPNF system had a greater diversity of insect visitors than CF.

Table 1: Number of insect visitors on onion crop in natural and conventional farming

Insect	Number of nsect visitors	
	NF	CF
Apis mellifera L	122	102
Apis dorsata L	45	29
Apis cerana F	89	72
Bombus haemorrhoidalis	30	26
Halictus spp.	94	73
Vespa spp.	48	34
Episyrphus balteatus	130	92
Sphaerophoria Indiana	111	92
Episryphus virdaureus	105	99
Ischiodon scutellaris	27	16
Eristalis tenax	68	70
Eupeodes spp	95	83
Eristalode taeniops	95	90
Musca spp.	93	72
Protophormia terraenova	111	88
Chrysocoris stolii	67	-
Liorhyssus hyalinus	53	-
Carpocoris fuscispinus	119	95
Minor Coleopterans	99	81
Minor Lepidopterans	54	37
Total	**1655**	**1251**
Diversity indices of insect visitors		
Simpson index (D)	0.06	0.06
Simpson (1-D) index of	0.94	0.94
Shannon H	2.92	2.80
Maximum diversity (H max)	3.00	2.89
Evenness (J)	0.93	0.93
Dominance (D)	0.07	0.07
Margalef index	4.23	3.77

References

Laishram C, Vashishat RK, Sharma S, Rajkumari B, Mishra N, Barwal P and Vaidya MK. 2022. Impact of natural farming cropping system on rural households-evidence from Solan district of Himachal Pradesh, India. *Frontiers in Sustainable Food Systems* 6:870-882.

Munawar MS, Raja S, Niaz S and Sarwar G. 2011. Comparative performance of honeybees (*Apis mellifera* L.) and blow flies (*Phormia terronovae*) in onion (*Allium cepa* L.) seed setting. *Journal of Agricultural Research* 49 (1):49-56.

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Effect of natural farming formulations on seed yield, germination, disease incidence and severity in onion

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***Keywords*:** Onion, Natural Farming, Diseases management

Introduction

Onion (*Allium cepa* L.) is one of the most essential vegetable crop grown and consumed world wide. During seed production of onion different types off diseases occur of which purple blotch and stemphylium blight are one of the main crop.These diseases not only affect the yield but also reduce the quality of seed. For managment of diseases various chemical pesticides are used but use of chemical pesticides has raised concern towards these adverse effect on environment and public health (Rani et al., 2021) Natural farming provides answer to these issues as it is low input based, climate resilient farming system as all the inputs like pesticides and fungicides are made up of cow dung, cow urine and natural herbs and locally available inputs, thereby reducing the use of artifical fertilizers and pesticides. Currently no package of pratices to manage these through natural farming system, so a research trial was conducted to study the effect of natural farming based plant protection formulation on seed yield (Kg/ha), germination (%), diseases incidence, severity (%) on Onion cv. Palam Lohit under different cropping system.

Material and methods

Onion cv. *Palam Lohit* was grown different cropping system. There were 13 treatment combination *viz*, T_1-Onion+Pea with 4 sprays of Butter milk,T_2-Onion+Pea with 4 sprays of Sounthaster, T_3-Onion+Pea with 2 sprays of Butter milk and 2 sprays of Sounthaster, T_4 - Onion+Fenugreek with 4 sprays of Butter milk, T_5-Onion+Fenugreek with 4 sprays of *Sounthaster*, T_6 - Onion+Fenugreek with 2 sprays of Butter milk and 2 sprays of *Sounthaster*, T_7-Onion+Pea+Fenugreek with 4 sprays of Butter milk, T_8-Onion+Pea+Fenugreek with 4 sprays of *Sounthaster*, T_9-Onion+Pea+Fenugreek with 2 sprays of Butter milk and 2 sprays of *Sounthaster*, T_{10}-Onion sole crop with 4 sprays of Butter milk, T_{11}-Onion sole crop with 4 sprays of *Sounthaster*, T_{12}-Onion sole crop with 2 sprays of Butter milk and 2 sprays of Sounthaster and T_{13}-Control. The data on diseases incidence, severity (%), seed yield, germination (%) were recorded periodically.

Results and conclusion

Data showed that amomg various natural farming based treatment, in first year of research trial maximum seed yield was recorded in T_5 which was stastically at par with T_{13}, and similar trend was reported in second year of research trial (Table 1). Maximum germination (%) was recorded in treatent T_5 and T_1 which was at par with T_{13}. In first year of research trial minimum diseases incidence and severity of purple blotch was reported in T_5 which was stastically at par with T_4, T_3 and T_{13} and in second year of research trial minimum diseases incidence and severity was recorded in T_5 which was stastically at par with T_6 and T_{13}. Similar trend was reported in case of *stemphhylium* blight. It can be concluded from the present research that onion crop treated with beejamrit @ 10% before sowing, applied with under natural farming especially when intercropped with fenugreek and applied with 4 sprays of *Sounthaster* @3% was found effective combination in checking the incidence of major diseases and increasing the seed yield and germination (%) of onion cv. Palam Lohit.

Table 1: Effect of natural farming based plant protection formulation on seed yield and germination in onion

Trt	Seed yield (kg/ha)			Germination (%)		
	I	II	Pooled	I	II	Pooled
T_1	631.47	356.978	494.22	82.67 (9.14)	83.33 (9.18)	83.00 (9.11)
T_2	494.93	278.756	386.84	74.00 (8.66)	75.00 (8.71)	74.50 (8.63)
T_3	526.22	314.311	420.27	77.00 (8.83)	77.33 (8.85)	77.17 (8.78)
T_4	603.02	344.178	473.60	81.00 (9.05)	81.00 (9.05)	81.00 (9.00)
T_5	694.04	366.933	530.49	83.00 (9.16)	84.67 (9.23)	83.83 (9.15)
T_6	530.49	248.889	389.69	72.00 (8.54)	71.00 (8.48)	71.50 (8.45)
T_7	453.69	265.956	359.82	73.33 (8.62)	73.33 (8.62)	73.33 (8.56)
T_8	521.96	310.044	416.00	76.67 (8.81)	76.67 (8.81)	76.67 (8.75)
T_9	566.04	318.578	442.31	79.67 (8.98)	79.00 (8.94)	79.33 (8.90)
T_{10}	590.22	329.956	460.09	82.33 (9.12)	79.33 (8.96)	80.83 (8.98)
T_{11}	574.58	311.467	443.02	79.33 (8.96)	78.67 (8.92)	79.00 (8.88)
T_{12}	465.07	292.978	379.02	76.00 (8.77)	75.33 (8.73)	75.67 (8.69)
T_{13}	742.40	539.022	640.71	85.67 (9.30)	86.00 (9.32)	85.83 (9.26)
Mean	568.78	329.080	448.93	78.67 (8.87)	78.51 (8.86)	78.59 (8.87)
$CD_{0.05}$	120.77	136.02		0.24	0.18	

References

Rani L, Thapa K, Kanojia N, Sharma N, Singh S, Grewal AS, …... and Kaushal J. 2021. An extensive review on the consequences of chemical pesticides on human health and environment. *Journal of cleaner production* 283: 124657.

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Evaluation of plant extracts against *Colletotrichum capsici* causing anthracnose disease of chilli

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***Keywords*:** Poisoned food technique, botanicals, anthracnose

Introduction

Chilli (*Capsicum annuum*) is an important commercial spice crop with export potential but suffer from many diseases of which anthracnose caused by *Colletotrichum capsici* is one of the major diseases. Pathogen is responsible for causing the disease in tropical and sub-tropical regions of the world including India. The disease cause pre and post-harvest damage to chilli causing lesions on fruits and reduces the market value. The indiscriminate use of the chemicals for crop protection is leading to their accumulation of residues in soil, water and plants, and also causing the ecological imbalance. Hence, efforts should also be made to use some eco-friendly disease control measures to maintain the ecological balance. The present investigation includes the *in vitro* evaluation of eight plant extracts *viz.* Garlic (*Allium sativum),* Marigold (*Tagetes* sp.), Neem (*Azadirachta indica)*, Ginger (*Zingiber officinale)*, Milkweed (*Calotropis* sp*.)*, Ashwagandha (*Withania somnifera)*, Lantana (*Lantana camara)* and Tulsi (*Ocimum tenuiflorum)* by poisoned food technique.

Material and methods

In vitro evaluation of eight plant extracts was done at three different concentrations i.e. 5%, 10% and 20%. The efficacy of plant extracts were tested by using Poisoned Food Technique described by Nene and Thapliyal (1993) on potato dextrose agar (PDA) medium. The PDA medium amended with plant extract was poured @ 20 ml per Petri plate. After solidification of poisoned medium, the plates were inoculated with 0.5 mm mycelium disc of *C. capsici* obtained from seven days old culture of pathogen. Plates containing um-amended medium served as control and inoculated plates were incubated in B.O.D incubator at 26±2˚C. The colony diameter of culture was recorded when plates under control were fully covered. The efficacy of plant extracts was expressed as per cent inhibition of mycelial growth over control.

Results and conclusion

Among all plant extracts tested neem at 20% was found to be the most effective with maximum mycellial growth inhibition of 43.37 per cent and the minimum radial growth of mycelium 42.46 mm followed by Tulsi with 42.22 per cent growth inhibition and 43.33 mm of radial growth. Similarly, at 10 per cent concentration neem leaf extract showed maximum per cent growth inhibition of 41.77 per cent and minimum radial growth of 43.66 mm and 38.22 per cent growth inhibition with 46.33 mm radial growth at 5 per cent concentration respectively followed by Tulsi leaf extract.

In Tulsi leaf extract, the per cent growth inhibition was 34.22 and 25.77 per cent at 10 per cent and 5 per cent concentration of plant extract with radial growth of 49.33 mm and 55.66 mm, respectively. Neem as compared to other botanicals was found to be most effective at all concentrations. But, at 20 per cent concentration it was highly effective as compared to 5 and 10 per cent followed by Tulsi at 20 per cent concentration was found to be effective against the pathogen among other concentrations.

Table 1: Effect of plant extracts on mycellial radial growth of *Colletotrichum capsici*

Trt.	Botanicals	Concentration (%) / Radial growth (mm)			Concentration (%)/ Per cent Growth inhibition (%)		
		5%	10%	20%	5%	10%	20%
T1	Garlic (*Allium sativum*)	54.33	53.83	50.66	27.55	28.22	32.44
T2	Marigold (*Tagetes* sp.)	61.33	58.50	52.33	18.22	22	30.22
T3	Neem (*Azadirachta indica)*	46.33	43.66	42.46	38.22	41.77	43.37
T4	Ginger (*Zingiber officinale*)	54.33	53.33	50.00	27.55	28.88	33.33
T5	Ashwagandha (*Withania somnifera*)	66.00	61.66	59.66	12.00	17.77	20.44
T6	Milk weed (*Calotropis*)	66.66	63.66	62.33	11.11	15.11	16.88
T7	*Lantana camara*	59.66	57.00	55.00	20.44	24.00	26.66
T8	Tulsi (*Ocimum tenuiflorum*)	55.66	49.33	43.33	25.77	34.22	42.22
T9	Control	75.00	75.00	75.00	0	0	0
S.E(m)±		0.67	0.76	0.76	0.83	1.17	1.23
CD (0.05)		2.00	2.28	2.29	2.66	3.77	3.95

Refrences

Vincent JM. 1947. Distortion of fungal hyphae in the presence of certain inhibitors. *Nature* 159 (4051): 850.

Nene YL and Thapliyal PN. 1993. Fungicides in plant disease control. Oxford and IBH publishing Co. Pvt. Ltd., New Delhi. 325p.

ESFS-NF/NBSCP2024/2039

Effect of seed biopriming on cucumber seed quality and health

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***Keywords* :** Bioagents, Seed, *Bacillus, Pseudomonas, Trichoderma*

Introduction

Farmers have become increasingly more dependent on agrochemicals for crop protection and economic stability of their operations. But due to environmental and health hazards, the utilization of agrochemicals is becoming more restrictive. Advanced are entirely focused on protecting natural resources for future generations. Bioagents may be used as suitable alternative to protect plants from indigenous pathogen populations and reduce the usage of synthetic chemicals (Lugtenberg et al., 2001). The aim of this study is to highlight the bio-efficacy of different strains of biological control agents on seed quality, health parameters in cucumber and therefore results in sustainable agriculture development.

Material and methods

Apparently healthy seeds with no cracks or other visible deformities were selected and surface sterilized with 1.0% sodium hypochlorite solution for 3-5 minutes. Seeds were than rinsed three times with sterilized distilled water and dried under laminar air flow chamber on sterilized blotting paper. The surface sterilized seeds were then soaked in the spore/cell suspensions of bacterial bioagents and *Trichoderma* spp. (10^8 and 10^6 cfu per ml, respectively) for 6-8 hours, separately. Ten indigenous isolates of bioagents including five bacterial bioagents (*Bacillus licheniformis* strain B6, *B. pumilus* strain MK5, *B. subtilis* strain RDO10, *Pseudomonas aeruginosa* strain N2S6, *P. fluorescens* strain HB-13) and five fungal bioagents (*Trichoderma atroviride* ta001, *T. atroviride* ta002, *T. atroviride* ta003, *T. atroviride* ta004, *T. atroviride* ta005 were screened for their bio-efficacy as seed treatment under laboratory conditions following standard methods of seed quality and health testing as prescribed by International Seed Testing Association.

Results and conclusion

Maximum germination percent, speed of germination, seedling length as well as lowest seed microflora percent and seed infection percent were found in seeds bioprimed with *B. pumilus* strain MK5 and *T. atroviride* ta001 among their respective isolates (Table 1). The increase in germination and speed of germination might be due to an increased synthesis of the phytohormones like gibberellins, which might have appreciably stimulated the activity of germination specific enzymes like α-amylase, proteases and nucleases involved in hydrolysis and assimilation of the starch in bioagents treated seeds. Also variations in seedling length may be associated to the stimulation of plant growth by bioagents that may produce growth-regulating substances like hormones upon seed imbibitions. The increase in seedling length might be due to establishment of endophytic population in rhizoplane and interior of roots which have adaptability to niche. Occurrence of minimum seed microflora (%) and percent seed infection in bioagent treated seeds might be due to production of microbially active compounds, such as lytic enzymes, toxins, biocidal volatiles, and siderophores that chelate iron and antibiotics. It can be concluded from the findings of present study that treatment comprised of seed priming with bioagents viz. *Trichoderma atroviride* (ta001) and *Bacillus pumilus* strain MK5 was found superior treatment for increasing seed quality parameters. This treatment also provided the control of seed infection as well as seed microflora.

Table 1: Effect of biopriming with different microbial strains of biological control agents on seed quality and health of cucumber

Treatment	Germination (%)	Speed of germination	Seed infection (%)	Microflora (%)
Bacillus licheniformis B6	82.67 (9.09)	18.83	1.00 (1.00)	3.33 (1.82)
B. pumilus MK5	87.33 (9.34)	19.94	0.67 (0.67)	1.67 (1.28)
B. subtilis strain RDO10	81.00 (8.99)	18.18	2.33 (1.47)	4.00 (1.99)
Pseudomonas aeruginosa N2S6	84.33 (9.18)	17.87	2.67 (1.61)	4.33 (2.06)
P. fluorescens HB-13	82.00 (9.06)	17.88	1.33 (1.14)	3.00 (1.73)
Trichoderma atroviride ta001	86.00 (9.27)	18.10	0.33 (0.33)	2.67 (1.63)
T. atroviride ta002	81.00 (9.00)	16.28	2.00 (1.41)	5.33 (2.29)
T. atroviride ta003	81.33 (9.02)	16.98	1.67 (1.24)	3.67 (1.88)
T. atroviride ta004	82.00 (9.05)	16.99	2.00 (1.41)	5.00 (2.20)
T. atroviride ta005	79.33 (8.91)	16.46	3.00 (1.66)	3.67 (1.91)
Untreated Control	74.67 (8.64)	14.07	5.33 (2.31)	6.67 (2.54)
CD (0.05)	0.25	2.06	0.56	0.47

Reference

Lugtenberg BJJ, Dekkers L and Bloemberg GV. 2001. Molecular determinants of rhizosphere colonization by *Pseudomonas. Annual Review of Phytopathology* 39: 461-490.

ESFS-NF/NBSCP2024/2040

Studies on pre-harvest foliar application of bio-resources in managing post-harvest losses in garlic

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Keywords: *Allium sativum, Alternaria,* Bio-resources, *Fusarium, Stemphylium*

Introduction

Garlic (*Allium sativum* L.) is a perennial herbaceous plant. It is used as a spice, condiment and is utilized for culinary purpose. The crop suffers from major field diseases such as: Basal rot, Purple blotch and Stemphylium blight which further adds for post- harvest losses during handling and storage making the crop susceptible to a number of physiological as well as pathological disorders (Tripathi and Lawande, 2006). The present study was emphasized on standardization of foliar applications of bio-resources in minimizing the post-harvest losses due to storage rots in garlic.

Material and methods

In vitro evaluation of bio-resources against *Fusarium oxysporum* f. sp. *cepae*, *Alternaria porri* and *Stemphylium vesicarium*: Six botanicals and four bio-formulations were tested for their efficacy using poison bait technique by Falck (1907). Impact of all bio-resources tested *in vitro* was further evaluated at 10% concentration in field conditions by foliar applications. In all, total of 7 sprays were given from the appearance of the disease till the date of harvesting. The treated bulbs were further evaluated under storage for 90 days and following parameters were recorded; storage rot, frequency of storage rot, deformed bulbs, fresh weight, dry weight, total weight loss, disintegration of bulbs, garlic sprouting, hollow bulbs.

Results and conclusion

The results indicated that cow urine recorded maximum mycelial inhibition of 63.01%, 93.20% and 92.22% against *Fusarium oxysporum* f. sp. *cepae*, *Alternaria porri* and *Stemphylium vesicarium*, respectively. *In vivo* studies revealed that pre-harvest foliar applications of bio-resources against basal rot of garlic recorded minimum disease incidence by cow urine (15.83%). The fungus *A. porri* was considerably managed by cow urine (22%) which showed least disease severity on the plants. The fungus *Stemphylium vesicarium* was controlled by vermiwash (4.37%) and cow urine (5.73%). Harvested bulbs when kept under 3 months of storage conditions, recorded the minimum pathological losses in case of cow urine (13.89%) and darek (14.92%). Frequency of *Aspergillus niger* was recorded to be least in treatments, darek and cow urine (2.59 and 3.25%) and was followed by lemon grass (3.43%). The frequency of disease blue mould was found minimum in case of nirgundi (1.01%) while bacterial rot was reported least within range of 5.56 and 6.17% by cow urine and darek. Physiological losses were restricted in most of the bio-resources. Deformed bulbs formation was observed after harvesting was negligible.

References

Falck R. 1907. Wachstum agesetse, wachstum faktore hund temperature werte der holzzerstorenden. *Mycelien* 3*:* 38-39.

Tripathi PC and Lawande KE. 2006. Cold Storage of Onion and Garlic. Technical Bulletin No. 15. National Research Center for Onion and Garlic, Pune, Maharashtra. pp. 2-8.

ESFS-NF/NBSCP2024/2041

Management of *Colletotrichum circinans* using botanicals

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Keywords: *Colletotrichum circinans*, diameter, growth, onion smudge

Introduction

Chemicals are known to have adverse effect when used continuously and inappropriately. Such outcomes result in persistent toxicity, resistance, environmental contamination and risks to human health. Currently, the use of botenicals with toxic effects against the phytopathogen is being investigated. Because of lack of environmental pollution, lack of residual toxicity and phytotoxic properties, they are being evaluated for controlling the phytopathogens (Kumar and Singh, 2012).

Material and methods

Aqueous extracts of five different plant extracts viz. *Azadirachta indica* (neem), *Ocimum* sp. (tulsi), *Datura* sp. (datura), *Murraya* sp. (curry leaves) and *Lantana* sp. (lantana) were evaluated *in vitro* at four concentrations (5, 10, 15 and 20 %) each for their efficacy against *C. circinans* by poisoned food technique. Data were recorded in terms of diametric growth (mm) further converted into per cent inhibition w.r.t. control.

Results and conclusion

All plant extracts showed inhibition on growth of fungus. Maximum inhibition was recorded in *Datura* (97.22%) followed by *Lantana* sp., *Ocimum* sp., *Murraya* sp. and *Azadirachta indica* resulted in 86.62, 82.91, 79.53 and 61.94 per cent growth inhibition, respectively. Onion smudge is an important disease which occurs in mild to severe form in non-pigmented onion bulbs, while, pigmented bulbs are resistant to disease. *In-vitro* evaluation of plant extracts against pathogen revealed maximum inhibition (97.22%) with *Datura* sp. thus proving it to be an effective botanical against onion.

Table 1: *In-vitro* evaluation of plant extracts against *Colletotrichum circinans*

Treatment	Diametric growth (mm) at concentration (%)				Overall mean	Inhibition (%)				Overall mean
	5	10	15	20		5	10	15	20	
Azadirachta indica	51.66 (46.00)	36.00 (36.85)	30.33 (33.40)	19.00 (25.82)	34.25 (35.50)	42.60	60.00	66.30	78.88	61.94
Ocimum sp.	36.00 (36.85)	25.50 (30.31)	0.00 (4.05)	0.00 (4.05)	15.37 (18.81)	60	71.66	100	100	82.91
Datura sp.	10.00 (18.41)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	2.50 (7.64)	88.88	100	100	100	97.22
Murraya sp.	34.33 (35.85)	26.00 (30.64)	13.33 (21.38)	0.00 (4.05)	18.41 (22.98)	61.85	71.11	85.18	100	79.53
Lantana sp.	32.66 (34.84)	11.00 (19.35)	4.50 (12.23)	0.00 (4.05)	12.16 (17.61)	63.71	87.77	95.00	100	86.62
Control	90.00 (71.53)	90.00 (71.53)	90.00 (71.53)	90.00 (71.53)	90.00 (71.53)					
Mean	42.44 (40.57)	31.50 (32.12)	23.19 (24.44)	18.50 (18.92)		63.40	78.10	83.89	95.77	

Factors	$CD_{P\geq0.05}$	$SE_{(d)}$
Treatment (T)	0.48	0.24
Conc. (C)	0.39	0.19
T x C	0.96	0.40

References

Kumar B and Singh KP. 2012. Botanical pesticides in plant disease management. *Eco-friendly innovative approaches in plant disease management* 71: 94.

ESFS-NF/NBSCP2024/2042

Record of natural enemies of Fall armyworm, *Spodopetra frugiperda* (JE Smith) in maize

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***Keywords*:** Fall armyworm, natural enemies

Introduction

Fall armyworm, *Spodoptera frugiperda* (J.E.Smith) (Lepidoptera: Noctuidae) is one of the most destructive pests worldwide which is extended to the tropical regions of the western hemisphere from the United States to Argentina (Nagoshi, 2009). The fall armyworm is a polyphagous pest and it attacks more than 350 plant species, causing major economic damage to important cultivated crops such as rice, wheat, sorghum, sugarcane, cotton and other vegetable crops. In India, the incidence of this pest was first observed in Shivamogga district of Karnataka on maize crop in 2018.

Material and methods

Twenty larvae at weekly interval collected from the field were brought to the laboratory and reared in separate vials on maize leaves, stem and artificial diet. Number of parasitised larvae during the process of rearing in the laboratory was recorded. During the process of rearing, the parasitoids which emerged from the larvae were preserved in 70 per cent ethanol and got identified from ICAR-National Bureau of Agricultural Insect Resources (NBAIR).

Results and conclusion

A total of four species of natural enemies belonging to four families namely, Braconidae, Ichneumonidae, Tachinidae and Mermithidae representing three orders *viz*., Hymenoptera, Diptera and Nematoda were recorded (Table 1) with *Cotesia ruficrus, Campoletis*sp.,*Exorista* sp. (Tachnid fly) being the parasitoids and one entomopathogenic nematode (mermithid).The study identified various natural enemies of *S. frugiperda* which can contribute to the management of the pest.The integration of these natural enemies into pest management strategies is part of an Integrated Pest Management (IPM), which seeks to control pests like the fall armyworm sustainably.Natural enemies provide ongoing pest control without the need for repeated chemical applications.

Table 1: Associated natural enemies with *Spodoptera frugiperda*

Category	Common name	Scientific name	Order	Family
Parasitoids	-	*Cotesia ruficrus*	Hymenoptera	Braconidae
	-	*Campoletis* sp.	Hymenoptera	Ichneumonidae
	Tachnid fly	*Exorista* sp.	Diptera	Tachinidae
Entomo-pathogenic nematode	Mermithid nematode	-	Nematoda	Mermithidae

References

Nagoshi RN, Fleischer S and Meagher RL. 2009. Texas is the overwintering source of fall armyworm in central Pennsylvania: Implications for migration into the Northeastern United States. *Environmental Entomology* 38(6): 1546-1554.

Sisay B, Simiyu J, Malusi P, Likhayo P, Mendesil E, Elibariki N, Wakgari M, Ayalew G and Tefera T. 2018. First report of the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae), natural enemies from Africa. *Journal of Applied Entomology* 142: 800-804.

ESFS-NF/NBSCP2024/2043

Preliminary studies on effect of farming systems on diversity of insect pests in cauliflower

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Keywords: cauliflower, conventional farming, insect pest, Natural farming

Introduction

Seraj Valley is an ideal location for growing vegetable, especially Cole crops which cater to the needs of farmers of the temperate zone of the country. Cauliflower is the predominant crop of the area and is attacked by various insect pests. A large number of insecticides have been recommended and used to control these pests. These insecticides have their own harmful effects, including their negative impacts on natural enemies. Farming systems have great impact on insect pests and natural enemies, and organic practices increase the natural enemies. Hence, the current study to study the effects of SPNF in comparison to conventional farming (CF) in cauliflower.

Material and methods

After survey, farmer practicing both the Subhash Palekar Natural Farming (SPNF) and conventional farming (CF) were selected. The primary data were collected from the farmers (50 No.) practicing both the natural farming and conventional farming systems by random survey. The seasonal occurrence of major insect pests on the cauliflower crop was monitored at weekly intervals starting with the pest's emergence and continuing until standard harvesting, i.e standard meteorological weeks (SMW) 15 through SMW 28. Data on insect diversity were merged in order and statistically analyzed to generate diversity indices, species richness, and evenness in each sampling method separately. The Shannon diversity index was calculated (Shannon, 1948) using the following formula:

A) Diversity index (H) = -Σ (pi ln (pi)), where,
pi =proportion of I^{th} species
ln= natural logarithm

B) Richness (H max)= log of total number of groups/ species

C) Eveness (J) = H/H max

D) Dominance (D) = 1-J

The Simpson diversity index was calculated using the following formula

$$\text{Diversity index (D)} = \frac{1}{-\Sigma\, pi^2}$$

p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), Σ is still the sum of the calculations, and s is the number of species.

Results and conclusion

Major insect pest recorded on cauliflower from SPNF and CF systems were cabbage butterfly *Pieris brassicae*, the cabbage aphid *Brevicoryne brassicae*, diamond back moth *Plutella xylostella,* cabbage head borer *Hellula undalis*, tobacco leaf eating caterpillar *Helicoverpa armigera* and, cabbage semilooper *Thysanoplusia orichalcea*. And minor pest recorded were flea beetle, mustard saw fly and cutworms. To evaluate species diversity and relative abundance, four diversity indices were calculated: richness, evenness, Shannon-

Weiner index, and Simpson index (Table 1). The diversity indices calculated for two different methods of farming differed. Natural farming had higher insect pest diversity (0.98) than conventional farming (0.61). SPNF had a higher level of evenness (0.45) among the nine most dominant insect species of insect pest than CF (0.34). Approximately 55% of insect pest were dominant among all insects pest observed in NF. CF methods dominated by 0.66 per cent of insects. The Simpson index is a dominance index since it prioritizes common or dominant species. In this situation, a few uncommon species with a small number of representatives have effect on diversity. Simpson's Index (D) is calculated using the number of species and their relative dominance. The determined Simpson index values for the NF and CF sampling methods were 0.59 and 0.73, respectively. The results indicate that SPNF have a positive effect on the population of natural enemies as compared to CF system

Table 1: Shannon- Weiner Diversity Index, Simpson's Diversity Index computed for insect collected in different methods of farming

Biodiversity Component	Result of Shannon- Weiner Diversity Index	
	Natural Farming	**CF**
Number of individuals	5220	5004
Average Population Size	580.00	834.00
Richness	9.00	6.00
Diversity(H)	0.98	0.61
Maximum Diversity(H max)	2.20	1.79
Eveness (j)	0.45	0.34
Dominance (D)	0.55	0.66
Simpson's Diversity Index		
Simpson's Diversity Index (D)	0.59	0.73
Dominance Index (1 – D)	0.41	0.27
Simpson's Reciprocal Index (1 / D)	1.69	1.37

References

Barakzi, AW, Chandel RS, Sharma PL, Verma SC, Singh MP and Yankit P. 2022. Effect of farming systems on diversity and seasonal abundance of Insect pests and their natural enemies in cauliflower. *Indian Journal of Entomology* 84(3): 535-540

Rana A. 2019. Insect-pests, natural enemies and soil micro-flora in cabbage under zero budget natural farming and conventional farming systems. M. Sc. Thesis. Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan

ESFS-NF/NBSCP2024/2044

Efficacy of locally available natural concoctions in management of Alternaria blotch and powdery mildew of apple

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Keywords: Alternaria blotch, Powdery mildew, Jivamrit

Introduction

As per a report, it is estimated that about ten thousand people lost their lives annually worldwide due to haphazard usage of pesticides (Horrigan et al., 2002).Therefore, in India which is largest producer of pesticides in Asia, farming population was regularly exposing toward temporary acute to chronic diseases even developmental disorders.Application of chemical pesticides for the management of various diseases of apple that contributes for over five per cent share of Himachal Pradesh gross domestic product (GDP), have raised public concern toward its adverse effects on environment and public health. Hence an alternative focus is relied on adoption of natural farming practices.

Material and methods

Present study was conducted at apple orchard located at village Jarol of tehsil Janjehli at2115 meters altitude and latitude 31.55542^0 N and 77.22465^0 E on average 12 years old apple cultivar "Royal Delicious" at spacing of 5.5 x 5.5 m. The experiment were laid out in randomized block design with six treatments viz., T1: Gaumautra, T2: Jivamrit, T3: Khatti lassi, T4: Jivamrit+ Khatti lassi, T5: Saunth Astra, at different concentrations, including 2.5, 5.0, 7.5 and 10 per cent respectively along with untreated control.Six foliar sprays of all natural concoctionswas done for the management of foliar diseases. However, each spray was performed at interval of 14 days w.e.f. petal fall upto fruit development stage (20 days before harvest of fruit).

Results and conclusion

Results of field evaluation of all these treatments revealed that Maximum PDC (Per cent disease control) was recorded with 10 per cent foliar spray of Jivamrit+ Khatti lassi (54.3 %) followed by 10 per cent foliar spray Saunth Astra (50.8%) against Alternaria leaf spot disease of apple caused by *Alternaria mali*. In another experiment, among all of above treatments, foliar sprays of Khatti lassi (10%) exhibited maximum per cent disease control (59.1%) followed by Jivamrit+ Khatti lassi (10%) and Saunthastra (10%) with 56.7 and 52.3 Per cent disease control, respectively against powdery mildew caused by *Podospheria leucotricha*. Pandia et al (2019) also supported the research as they found field efficacy of jivamrit against Alternaria leaf spot diseaseof Mungbean with 75.22 per cent diseases control.

It can be concluded that rigorous foliar spray of natural farming concoctions like *Jivamrit+ Khatti lassi, Khatti lassi* and *Saunthastra* provided inhibitory effects against important foliar diseases of apple.

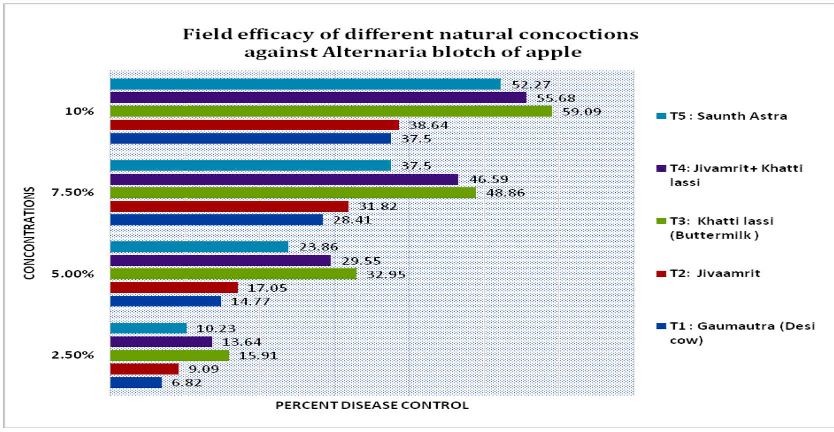

Fig.1

Effect of natural concoctions against Alternaria blotch of apple

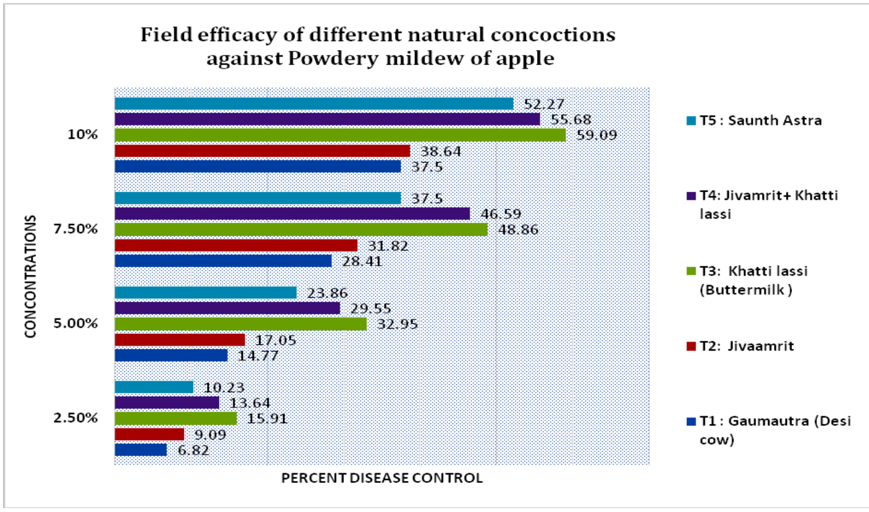

Fig.2 Effect of natural concoctions against Powdery mildew of apple

References

Horrigan L, Lawrence RS and Walker P 2002. How sustainable agriculture can address the environmental and human health harms of industrial agriculture. environmental health perspectives 110: 445-456.

Pandia S, Trivedi A, Sharma SK and Yadav S. 2019. Evaluation of Jeevamrut and its Constituents against Alternaria Leaf spot of mungbean in-vitro and under cage house condition in Rajasthan. International J Current Microbio and App Sci 8(09): 2240-225.

ESFS-NF/NBSCP2024/2045

Functional response of *Chrysoperla zastrowi sillemi* to green-peach aphid, *Myzus persicae* Sulzer infesting capsicum

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Keywords: Pest, Predator, Instar, *Chrysoperla zastrowi sillemi, Myzus persicae*, capsicum

Introduction
Myzus persicae (Sulzer) (Hemiptera: Aphididae) is a cosmopolitan and polyphagous pest infesting many host plants of economic importance. The pest reduces the yield and quality of produce through direct feeding and contamination of the foliage by honeydew on which sooty mould grows to inhibit photosynthesis, in addition to transmits more than 150 viral diseases. Rapid growth rate, wide host range and high insecticide resistance make this pest more difficult to control with insecticides. *Chrysoperla zastrowi sillemi* is an important predator of many soft bodied insects *M. persicae*. In this study, the density responsiveness (functional response) of the predator to the pest was assessed.

Material and methods
Functional responses of each larval stage of *C. zastrowi sillemi* was studied at 25± 1^0C, and 70± 5 per cent RH and 14L:10D photoperiod to 3rd nymphal stage of *Myzus persicae* in a Petri plate on capsicum leaf disk. Six prey densities (10 times) were provided to the individual predator on capsicum leaves in petri plates separately. After 24 h, the number of aphids consumed by the larva was recorded. Roger's random predator equation (Rogers et al.1972) for a type II response was used to estimate the functional response parameters.

Results and conclusion
The predation efficiency of all the larval stages of *C. zastrowi sillemi* against *M. persicae* is numerically demonstrated by parameters namely attack rate (a) and handling time (Th). Attack rate of the predator increased with the advancement of the predator stage. Attack rate was lowest (0.060 h^{-1}) for first instar and highest for third instar (0.111 h^{-1}). Handling time of thirdinstar (0.219 h^{-1}) was lowest as compared to the other stages. Maximum predation rates of first, second and third instar were 21.16, 111.46 and 175.15 aphids, respectively in 24 h period. The advancement of growing stages caused higher attack rate and lower handling time which may be due to the increase in size, voracity, hunger level and walking speed of the predator. The results concluded that *C. zastrowi sillemi* exhibit type II functional response to *M. persicae* which suggests that the predator could be more effective at low pest densities.

Table 1: Functional response parameters of *C. zastrowi sillemi* to *Myzus persicae*

Predator stage	Attack rate (a)	Handling time (Th)	Theoretical max predation rate (K=T/ Th)
1st instar	0.060±0.004	1.248±0.104	21.16±2.729
2nd instar	0.065±0.003	0.601±0.457	111.46±30.251
3rd instar	0.111±0.005	0.219±0.009	175.15±4.741

References
Rogers D. 1972. Random search and insect population models. *Journal of Animal Ecology* 41: 369-383.

ESFS-NF/NBSCP2024/2046

Diversity of natural enemies of *Spodoptera frugiperda* on maize

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Keywords: Natural enemies, Insecticides, Fall armyworm.

Introduction

Spodoptera frugiperda (J.E. Smith), commonly known as fall armyworm which have got a global attention owing to its catastrophic and cosmopolitan nature. Fall armyworm larvae attack maize plants starting from seedling to maturity stage. Recently, this pest has become a serious threat to maize all over the country and is being managed by using insecticides which result in various environmental impacts (Akinyemi, 2021). The present study assessed the diversity of native natural enemies associated with this pest in Himachal Pradesh. The study also identified effective natural enemies to utilise them to develop IPM strategies.

Material and methods

Survey study assessed the diversity of natural enemies of *S. frugiperda* infesting maize in different locations of Una, Bilaspur, Hamirpur, Kangra, Mandi and Solan districts of Himachal Pradesh. In each location five fields were visited and in each field 40 plants were randomly observed to record the number of the pest and its natural enemies.

Results and conclusion

Natural enemies like *Compoletis chloridae*, *Trichogramma chilonis*, *Cotesia sp.*, *Microplitis sp.*, *Temelucha sp.,Charops bicolor*, unidentified tachinid fly (all parasitoids) and rove beetle (predator) of *S. frugiperda* were found.

Table1: Infestation of fall armyworm and its natural enemies complex

District	Location	Natural enemies
Kangra	Nurpur	*Compoletis chlorideae, Microplitis sp.*Tachnid fly
	Indora	*C. chlorideae, Microplitis sp.,* Tachnid fly
	Fatehpur	*C. chlorideae, Microplitis sp.*
	Dhera	*C. chlorideae, Microplitis sp.,* Tachnid fly
Hamirpur	Hamirpur	Tachnid fly, *Microplitis sp.,* Rove beetle
	Nadaun	Tachnid fly, *Microplitis sp.,* Rove beetle
	Sujanpur	Tachnid fly, *Microplitis sp.,* Rove beetle
	Galore	Tachnid fly,*Microplitis sp.,* Rove beetle
Una	Una	*C. chlorideae, Microplitis sp.*Tachnid fly
	Amb, Gagret	*C. chlorideae*
	Bangana	*Microplitis sp.*
	Haroli	*C. chlorideae, Microplitis sp.*Tachnid fly
Bilaspur	Ghumarwin	*C. chlorideae, Microplitis sp.*Tachnid fly
	Swarghat	*Microplitis sp.*
Mandi	Sundarnagar	*Microplitis sp.*
Solan	Nalagarh	*Microplitis sp.,* Tachnid fly, Cotesia sp. *and C. chlorideae*
	Solan	*Microplitis sp.,* Tachnid fly and Cotesia sp.

References

Akinyemi AO. 2021. Exploring integrated pest management strategies in the control of the fall armyworm in smallholder organic agriculture farms in Africa. *Agro-Science* 20(3): 65-70.

ESFS-NF/NBSCP2024/2047

Response of bio-enzyme and ecofriendly practices on soil health and production of ginger

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Keywords: Bio-enzyme, Citrus, bio-enzyme, Ginger

Introduction

Bio enzymes are the types of organic solutions that are obtained from fermentation of various organic materials such as fruits, vegetable peels and flowers. Bio enzymes provide a residue free environment. They are eco-friendly, nontoxic, non-chemical soil supplements for improving soil quality and plant health (Saramanda and Kaparapu, 2017). Natural farming is a system where the laws of nature are applied to agricultural practices. In this farming system neither chemicals nor organic fertilizers are added to the soil. Thus, the natural farming shows the synergistic effects of both animal and plant products on increasing soil fertility, crops establishment and better environment.

Material and methods

Two types of bioenzymes (B_1 cabbage bioenzyme and B_2 Citrus bioenzyme) were used in this experiment in combination with natural farming practices. Experiment was laid out in randomized complete block design with 8 treatments. The crop was used during experimentation was ginger variety Solan Giriganga at spacing of 30cm x 20cm. Foliar applications of bioenzymes were given after 30 days of sowing and total of 8 treatments were given at an interval of 21 days. Soil, growth, rhizome, yield and quality parameters of ginger were studied.

Results and conclusion

Soil pH ranged from 7.13-7.57 with mean value of 7.36. The electrical conductivity of soil ranged from 0.30 - 0.40 with mean value of 0.33dS/m. The soil organic carbon ranged from 1.24 – 1.90 % with mean value of 1.62 %. The available nitrogen content was observed in between 348.47 – 376.61 kg/ha. The available phosphorus content was observed in between 34.32 – 43.61 kg/ha. The available potassium content was observed in between 218.13 – 228.93 kg/ha. Microbial biomass carbon ranged from 13.40 – 30.20 µg/g with mean value of 21.68 µg/g. Maximum pH, EC, organic carbon, NPK, Microbial biomass carbon was observed in T_3: FYM (600q/ha) + NF (*Beejamrit* + *Ghanjeevamrit* + *Jeevamrit*) + B_1 (Cabbage bio-enzyme). Whereas, the minimum pH, EC, Organic carbon, NPK, Microbial biomass carbon was observed in T_7: FYM (300q/ha) + NF (*Beejamrit* + *Ghanjeevamrit* + *Jeevamrit*).

Application of cabbage and citrus bioenzymes in conjugation with natural farming practices proved to be effective in enhancing soil health, yield and quality of ginger including B:C ratio. Cabbage bioenzymes gave superior results as compared to citrus bioenzymes. Treatment of ginger with FYM (600 q/ha) + NF (*Beejamrit* + *Ghanjeevamrit* + *Jeevamrit*) + B_1 (Cabbage bio-enzyme) gave maximum yield of 252.70 q/ha with B:C ratio of 1.31.

Table 1: Effect of bioenzymes and NF practices in ginger

Trt	No. of tillers per plant	Leaf area (cm^2)	Projected yield (q/ha)	Gross Return/ha @ ₹ 60/kg (₹)	Cost of Cultivation/ ha (₹)	Net Returns/ ha (₹)	B:C ratio
T_1	6.33	46.98	222.48	13,34,900	5,97,081	7,37,819	1.24
T_2	7.00	48.38	236.83	14,209,80	6,27,081	7,93,899	1.27
T_3	7.40	53.39	252.70	15,16,180	6,57,081	8,59,099	1.31
T_4	5.67	45.78	211.39	12,68,320	5,97,081	6,71,239	1.12
T_5	6.33	45.03	216.50	12,99,020	6,27,081	6,71,939	1.07
T_6	6.67	47.52	230.70	13,84,220	6,57,081	7,27,139	1.11
T_7	6.00	39.88	189.94	11,39,660	5,90,675	5,48,985	0.93
T_8	6.00	40.87	192.92	11,57,500	5,76,830	5,80,670	1.01
Mean	6.43	45.98	219.18	13,15,097	6,16,249	6,98,848	1.13
CD (0.05)	**NS**	**3.18**	**3.40**				**0.02**

References

Mali S, Bafna A, Rangwala T, Vyas N, Gupta, R, Ansari S and Yadav N. 2023. Effect of foliar spray of bioenzyme and fruit pulp extract on growth, photosynthetic pigments, and oxidative stress parameters in tomato (*Solanum lycopersicum*). *International Journal of Creative and Thoughts* 11: 139-148

Saramanda G and Kaparapu J. 2017. Antimicrobial activity of fermented citrus fruit peel extract. *Journal of Engineering Research and Application 7* (11)

ESFS-NF/NBSCP2024/2048

Natural farming boosts insect diversity and production in onion

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Keywords: Diversity indices, Pollinators, Fluorescent pan traps

Introduction

Conventional agricultural practices impact directly or indirectly pollinator populations due to increased use of agrochemicals. The transformation of agriculture in the past to conventional farming (CF) has triggered a decline in bees and other insect pollinators. There is an urgent need now to adopt farming systems which would take into consideration the health of pollinators, soil and human besides appropriate management of pests. The individual species and aggregate community contributions of native pollinators to crop pollination on organic versus conventional farms is well documented. On organic farms, native pollinator communities could provide full pollination services even for a crop with heavy pollination requirements, without the intervention of managed honey bees whereas conventional farms experienced greatly reduced diversity and abundance of native insect species, resulting in insufficient pollination services from native bees alone. Onion (*Allium cepa* L.) seed production relies heavily on insect pollination due to its protandrous nature, making abundance and diversity of pollinators a crucial factor in ensuring successful seed production and productivity. Onion is susceptible to numerous insect pests so effective pest management is essential for maximizing crop yield. Natural farming (NF) utilizing cost-effective, locally prepared inputs viz., *jeevamrit, beejamrit, ghanjivamrit, darekaster, brahmaster* and *agniaster* as plant protectants are evaluated for management of pests in onion crop (Palekar, 2006).

Material and methods

Diversity of insect visitors using fluorescent coloured PAN traps was studied as per method given by Campbell and Hanula (2007). Fluorescent coloured pan traps were prepared by painting plastic bowls manually using fluorescent yellow and blue aerosol paint. Pan traps of fluorescent yellow, blue and white colour were used. These traps were filled with water (three-fourth) and few drops of detergent were added to diminish surface tension so that the trapped insects sank into it. Twenty four bowls, eight of each colour were placed in three lines and the colours alternated throughout the transect. Bowls were placed 2m apart on the ground so that each individual bowl was not hidden by vegetation and insects could easily spot it. Traps were placed prior to 0900 h in the morning and removed after 1500 h. Observations were recorded at early, full and end of crop bloom during three sunny days.

Results and conclusion

In fluorescent coloured pan traps, maximum number of insects trapped were 2.61/trap of *A. mellifera* and *Sphaerophoria Indiana* each and minimum number of insects trapped were of *Liorhyssus hyalinus* (0.56/trap). Significantly, maximum number were trapped during full bloom stage of onion (2.23/trap) and in natural farming system (1.73/trap). Maximum number of insect visitors trapped were *Apis mellifera* (3.00/trap) in natural farming and minimum number of insect visitors 0.56/trap were *A.dorsata* and *Ischiodon scutellaris* in conventional farming system. *Chrysocoris stolii* and *Liorhyssus hyalinus* were recorded in natural farming system only. The interaction effect of insect visitors and farming systems on insect visitor diversity in fluorescent pan trap was non -significant (Table 1).

Table 1: Diversity of insect visitors trapped in fluorescent pan trap in NF and CF systems

Insect visitor	Number of insects / traps		Mean
	Farming systems		
	NF	CF	
Apis mellifera L.	3.00	2.22	2.61
Apis dorsata L.	0.89	0.56	0.72
Apis cerana L.	2.11	1.67	1.89
Bombus haemorrhoidalis	1.11	0.78	0.94
Halictus spp.	2.22	1.33	1.78
Vespa spp.	0.89	0.67	0.78
Episyrphus balteatus	2.78	1.89	2.33
Sphaerophoria indiana	2.89	2.33	2.61
Episryphus virdaureus	2.00	1.56	1.78
Ischiodon scutellaris	1.00	0.56	0.78
Eristalis tenax	1.33	1.11	1.22
Eupeodes spp.	1.67	1.22	1.44
Eristalode taeniops	1.44	1.44	1.44
Musca spp.	1.56	1.11	1.33
Protophormia terraenova	2.00	1.89	1.94
Chrysocoris stolii	1.22	0.00	0.61
Liorhyssus hyalinus	1.11	0.00	0.56
Carpocoris fuscispinus	2.33	1.67	2.00
Minor Coleopterans	2.00	1.67	1.83
Minor Lepidopterans	1.11	0.67	0.89
Mean	1.73	1.22	
CD$_{(0.05)}$	Farming system - 0.13, Insect visitors - 0.43, Farming system x Insect visitors- NS		

Irrespective of farming systems, maximum number (2.61 /trap) of insects trapped were *A. mellifera* and *Sphaerophoria indiana* being statistically at par with *E. balteatus* (2.33 /trap) followed by *Carpocoris fuscispinus* (2.00/trap) which was statistically at par with *Protophormia terraenova* (1.94/trap), *A. cerana* (1.89/trap), minor Coleopterans (1.83/trap), *Halictus spp.* and *Episryphus virdaureus* both being 1.78/trap. However, minimum number of insect visitors trapped were *Liorhyssu shyalinus* (0.56/trap) though statistically at par with *Chrysocoris stolii* (0.61/trap), *A.dorsata* and *Vespa spp.* both being 0.78/trap, minor lepidoptera(0.89/trap) and *Bombus haemorrhoidalis* (0.94/trap). The number of insects trapped for *Eristalis tenax*, *Musca spp.*, *Eupeodes spp.* and *Eristalodetaeniops* were 1.22 /trap,1.33/trap, 1.44/trap,1.44/trap, respectively. It is evident from this study that the natural farming practices enhance the bee and other insect visitors in onion crop.

References

Campbell JW and Hanula JL. 2007. Efficiency of malaise traps and colored pan traps for collecting flower visiting insects from three forested ecosystems. *Journal of Insect Conservation* 11:399-408.

Palekar S. 2006. *Shoonya Bandovalada Naisargika Krushi*. Swamy Anand, Agri Prakashana, Bangalore, India. 201p.

ESFS-NF/NBSCP2024/2049

Impact of conventional and natural farming practices on the foraging activity of *Apis mellifera* L. on sunflower

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Keywords: SPNF, *Apis mellifera*, foraging activity, conventional farming

Introduction

Honey bees contribute towards 35 per cent of global crop production and are important for sustainable crop production. For the past few decades the decline of honey bee has been a major concern globally which is a serious threat to food security and agriculture productivity. The most important cause of direct bee mortality is the use of various kinds of pesticides in agro-horticulture crops to ensure production and to meet the world food demand. Sunflower (*Helianthus annuus* L) is grown as monoculture in many parts of the country. The neonicotenoid, Imidacloprid is approved for use on Sunflower for the control of sucking insect pests. It is categorized as highly toxic to bees having lethal and sub lethal effects, affecting the behavior and navigation of honey bees. To protect the honey bees and other pollinators from pesticide toxicity, the focus currently is on natural and organic farming of agriculture and horticulture crops. This includes application of various indigenous farm and plant products to meet the nutrient requirements, as well as protection of plants from various pest and diseases. Keeping this in view, the study was conducted to investigate the impact of conventional and natural farming practices on the foraging activity of *Apis mellifera* L. on sunflower.

Material and methods

The studies were conducted in the experimental farm of Department of Entomology and experimental farm of SPNF of the university during the year 2023-2024. *Apis mellifera* colonies of 3-4 frames were placed in sunflower fields treated with imidacloprid (0.2ml/l) at 10% flowering stage of the crop and natural inputs at 15 days interval. The observations on activity of the adult bees in the field were recorded and analyzed (Gomez and Gomez 1984). Bee activity was monitored each day from the setup of the beehives in the conventional and natural farming fields under open conditions. The foraging activity was assessed by counting the number of bee/ m^2/2 minutes for 14 days.

Results and conclusion

The observations on the foraging activity of *A. mellifera* (number of bee/ m^2/2 minutes) recorded for 14 days in imidacloprid and natural input applied fields is presented in Table 1. The bee count (number of bees/m^2/2min) did not differ statistically in pre-count under the conventional and SPNF farming systems i.e. 21.33 and 20.33, respectively. On day of application of imidacloprid (conventional treatment) the bee count sharply declined to 9.11 bees/ m^2/2min with further decrease and later increase and recovery of bee activity on 13th day (21.77 bees/ m^2/2min) after spray. Whereas, under SPNF system the bee activity was almost uniform maximum being on 14th day (28.22 bees/ m^2/2min), except on day 6 (11.44 bees/ m^2/2min), when the low activity could be due to weather conditions (rainfall). Application of imidacloprid adversely affected the bee activity and much pronounced effect could be seen in the first 5 days after spray, with recovery of bee activity on 14th day.

Table 1: Effect of conventional and SPNF farming system on foraging activity of *Apis mellifera* L. on sunflower

DAS	Bees count (number/m^2/2min)	
	Conventional Farming (Imidacloprid)	**SPNF Farming**
Pre-count	21.33	20.88
Day of Spray	9.11	19.00
1	3.66	18.22
2	4.55	18.66
3	6.88	18.66
4	8.00	20.88
5	9.33	18.66
6	11.00	11.44
7	13.00	19.66
8	15.44	13.77
9	16.66	21.77
10	17.66	23.66
11	17.88	25.22
12	20.44	25.44
13	21.77	27.88
14	23.44	28.22
Mean	13.76	20.75
(CD=0.05)	Treatment (0.39), Treatment×Days (1.58)	

References

Gomez KA and Gomez AA. 1984. Statistical procedure for agricultural research. 2nd ed. Willey and Sons, Inc., New York. 680p.

Theme 3

Natural Farming for Socio-Economic Transformation

ESFS-NF/NFSET2024/3001

Effect of intercropping on nutrient content and microflora of the soil grown under natural farming system

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Keywords: Crop intensification, Natural farming, Soil microflora

Introduction

Today, feeding population has become one of the most fundamental challenges. The natural farming practices which focuses on developing sustainable and equitable farming practices. There are four most popular pillars of natural farming coined by Subhash Palekar, an eminent natural farming expert and Padma Shree awardee *i.e.* beejamrit, jeevamrit, acchadan (mulching) and whapasa. Intercropped legumes under natural farming provide wide range of extra benefits, including enhanced soil fertility, increased soil nitrogen status, weed control, reduced soil erosion, and higher yields than a single crop. It also adds value to the cropping system including output, better resource utilization and monetary benefits.

Material and methods

The present investigation evaluated the effect of intercropping under natural farming (NF). The main crop variety was 'Pb-89'. The intercrops were radish cv. 'Japanese White', spinach cv. 'Pusa Harit', coriander cv. 'Solan Selection' and fenugreek cv. 'IC-74'. The trial included, T_1: Sole crop of pea (recommended dose of fertilizers @ Urea 55 kg ha^{-1} + SSP 375 kg ha^{-1} + MOP 100 kg ha^{-1} + FYM @ 200 q ha^{-1}); T_2: Sole crop (pea) under natural farming; T_3: Pea intercropped with radish; T_4: Pea intercropped with coriander; T_5: Pea intercropped with spinach; T_6: Pea intercropped with fenugreek; T_7: Pea intercropped with radish + coriander; T_8: Pea intercropped with radish + spinach; T_9: Pea intercropped with radish + fenugreek; T_{10}: Pea intercropped with coriander + spinach; T_{11}: Pea intercropped with coriander + fenugreek; T_{12}: Pea intercropped with spinach + fenugreek; T_{13}: Pea intercropped with (Radish, Coriander, Fenugreek, Spinach) in alternate rows .

Results and conclusion

Pea intercropped with fenugreek recorded maximum available N (330.3 kg ha^{-1}) in soil. Maximum iron (55.28 mg kg^{-1}), copper (2.29 mg kg^{-1}), zinc (4.31 mg kg^{-1}) and manganese content (4.18 mg kg^{-1}) in the soil were recorded under treatment T_{11}. T_6 has maximum bacterial (137.61 × 10^7 cfu g^{-1} soil), fungal (20.30 × 10^2 cfu g^{-1} soil) and actinomycetes (22.21× 10^2 cfu g^{-1} soil) population in soil. While in the pea rhizosphere T_6 had highest bacterial (142.67 × 10^7 cfu g^{-1} soil) and fungi (24.15 × 10^2 cfu g^{-1} soil), while, T_7 had the highest actinomycetes count (24.60 × 10^2 cfu g^{-1} soil). There were no significant differences recorded in available iron, copper, zinc and manganese content of soil before sowing and after harvest of crop.

References

Palekar S. 2006. Shoonya bando valadanai sargika krushi, published by *Swamy Anand, Agri Prakashana*, Banglore, India.

ESFS-NF/NFSET2024/3002

Understanding farmers' perception toward natural farming as a sustainable food system: A Road map

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Keywords: Perception, Sustainable Food Systems, Multistage sampling

Introduction

Natural Farming is an eco-friendly approach and some of its features make it useful to the farmers and environment. Features of natural farming are that there is no use of Pesticides, Chemical Fertilizers, or Herbicides, and there is no Pollution. Moreover, Subhash Palekar Natural Farming involves the use of low-cost and locally sourced available inputs as compared to Organic and Conventional farming. The two main axes of Natural Farming are structural and agronomic, respectively. On the one hand, it entails enhancing soil fertility using a variety of agroecological concepts, such as diversification, nutrient recycling, and promoting advantageous biological interactions, among others (Palekar 2006). The benefits of "Natural Farming", a branch of agroecology that has emerged in India would be very much beneficial for the farmers (Dorin 2021).

Material and methods

The study was conducted in three districts of Himachal Pradesh viz., Mandi, Kangra and Kullu. Multistage random sampling was used for the selection of farmers practicing and not practicing natural farming. At the first stage, one block was selected from each district where the proportion of farmers practicing Natural Farming was highest, and in those locations we also identified farmers who have not adopted natural farming. At the second stage, in each block, the highest villages were selected based on the highest numbers of Natural farmers. At the third stage, in each village, farmers were selected randomly from selected panchayats for the collection of primary data.

Results and conclusion

List of panchayats from each district with highest number of farmers who have adopted Natural farming is presented in Table 1. From district Mandi 56 farmers were selected, from Kangra 46 farmers were selected and from Kullu 42 farmers were selected who were practicing Natural farming. Farmers in Himachal Pradesh, they are adopting Natural Farming practices and are satisfied with the yield and productivity. Through our survey, it was found that farmers in Mandi, Kangra, and Kullu were satisfied and many were selling their produce at prime prices in the market. But, one of the major issues they were facing is that there are few dedicated retail outlets for selling their Natural Farming Produce in the market. Currently, there are three established outlets located in Solan, Bilaspur, and Shimla, which serve as major distribution centers for Natural Farming produce. Recently, Dr. Yashwant singh Parmar University of Horticulture and Forestry in Nauni has joined hands with the government to open a new outlet within the university campus.

Table 1: List of the blocks with the highest number of Natural Farming farmers

District	Name of the Block	Total no. of Farmers	Panchayat (Highest Number of farmers adopting NF)	Panchayat (Population)	Sample Size
Mandi	Karsog	3197	Kandi Sapnot	166	56
Kangra	Bhawarna	2603	Saloh	174	46
Kullu	Kullu	2392	Mangarh	165	42

In conclusion, Natural farming has emerged as a promising agricultural paradigm in India, including the state of Himachal Pradesh, offering a sustainable and environmentally friendly alternative to conventional farming practices. Natural farming is a great substitute for conventional farming and its produce is chemical which is one of its best advantages. Consumers can have healthy and chemical-free produce. The government should promote Natural Farming in Himachal Pradesh.

References

Dorin B. 2021. Theory, practice and challenges of agroecology in India. *International Journal of Agricultural Sustainability*. *20*(2): 153-167.

Palekar S 2016. Zero budget spiritual farming, doi: http://bit.ly/1Pk3a8p.

ESFS-NF/NFSET2024/3003

Pea based natural farming for diversification and sustainable livelihood in Chamba district of Himachal Pradesh

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***Key words*: Diversification, Ghanjeevamrit, Jeevamrit, Net Return, traditional farming

Introduction

"Natural Farming is a chemical-free traditional farming method. It is considered as an agroecology based diversified farming system which integrates crops, trees and livestock with functional biodiversity"-Niti Ayog. Natural farming is a system where the laws of nature are applied to agricultural practices. Natural Farming builds on natural or ecological processes that exist in or around farms. There are several states practicing Natural Farming. Prominent among them are Andhra Pradesh, Chhattisgarh, Kerala, Gujarat, Himachal Pradesh, Jharkhand, Odisha, Madhya Pradesh, Rajasthan, Uttar Pradesh and Tamil Nadu. Till now 6.5 lakh ha area is covered under natural farming in India. Himachal Pradesh practices Natural Farming under the Prakritik Kheti Khushhal Kissan (PK3) Yojana. The scheme aims to reduce the cost of cultivation and enhance farmers' income. The scheme went beyond its target of covering 500 farmers to 2669 in 2018– 19. By 2019–20, 54,914 farmers were practicing Natural Farming on 2,451 hectares of land. The scheme has now targeted to bring more farmers under its ambit and cover 20,000 hectares.

Material and methods

A study on Pea Based Natural Farming for Diversification and Sustainable Livelihood at Different Locations of District Chamba (Himachal Pradesh) Cultivars: Pea cv PB-89; Capsicum cv Solan Bharpur has been carried out at different locations of district Chamba with objectives as average fruit weight (g), yield per hectare (t) and Economics (Net Return/ha) in Rs. The study was conducted during Kharif Season having Plot size: 2.4 m X 1.35 m (3.24 m^2), 4 numbers of replications, 9 treatments, 36 plots were selected and Capsicum–Solan Bharpur, Rajmash-Baspa (intercrop) and Fingermillet-Kodo (border crop) were sown. Ghanjeevamrit (at the time of field preparation), Jeevamrit (Fortnightly starting from 15 days after sowing) and production and protection practices will be followed as per SPNF.

Results and conclusion

It has been observed that average pea seed yield (q/ha) was found highest under treatment G2J2 (T5) 31.5 (q/ha) which was closely followed by chemical control 29.9 (q/ha) and least by G3J3 (T9) 20.1 (q/ha). It has been reported that number of pods per plant were found highest under treatment G2J2 (T5) *i.e.* 9.71 which was closely followed by G2J1 (T4) 9.64 where as lowest were found in G3J3 (T9) 9.46. It has been observed that economics (Net Return/ha) in Rs was found highest under treatment G2J2 (T5) *i.e.* Rs 202440 which was closely followed by G2J1 (T4) Rs 189620 and least by G3J3 (T9) Rs 127660. However, net returns under chemical control were Rs 178700. Similarly B:C ratio was found highest under treatment G2J2 (T5) *i.e.* 4.4 which was closely followed by G2J1 (T4) 4.1 and least by G3J3 (T9) 2.8. However, B:C ratio under chemical control was 2.31.

ESFS-NF/NFSET2024/3004

Status of organic farming in Haryana *vis-à-vis* India

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Introduction

Organic farming is a method of agriculture that involves the cultivation of crops without the use of chemical fertilizers and pesticides, with an emphasis on environmental and social responsibility. This is an agricultural method that operates at the grass roots, ensuring that the reproductive and regenerative capacity of the soil, excellent plant nutrition, and solid soil management are preserved. This approach results in the production of nutritious food that is abundant in vitality and resistant to diseases. India is the second largest producer of organic agricultural land in the world and the first in terms of the total number of producers (Willer et al., 2024).

Material and methods

To fulfil the objective secondary data was used for the study. Itwas subjected to analysis using tabular examination and basic statistical methods like measures of central tendency and percentages.

Results and conclusion

The entire area under the organic certification procedure (registered under the National Programme for Organic Production) is 7.3 million ha (2023-24). This encompasses 4.5 million hectares of cultivable land and an additional 2.8 million hectares designated for wild harvest collection. Madhya Pradesh has the most area under organic certification, followed by Maharashtra, Rajasthan, Gujarat, Odisha, Sikkim, Uttar Pradesh, Uttarakhand, Kerala, Karnataka, and Andhra Pradesh. The area under Haryana was 2.9 thousand ha. In 2023-24, India produced approximately 3.6 million metric tons of certified organic products, which encompasses a wide range of food items, including oil seeds, fibre, sugar cane, cereals and millets, cotton, pulses, aromatic and medicinal plants, tea, coffee, fruits, spices, dry fruits, vegetables, and processed foods.

The production of organic produce in Haryana was 3 thousand metric tons. The production is not restricted to the edible sector; it also includes the production of organic cotton fibre and functional food products. Maharashtra is the most significant producer among the various states, with Madhya Pradesh, Rajasthan, Karnataka, and Gujarat following in that order. Fiber crops are the most significant category of commodities, followed by Oil Seeds, Sugar Crops, Cereals and Millets, Medicinal/Herbal and Aromatic plants, Spices & Condiments, Fresh Fruit Vegetables, Pulses, Tea & Coffee.

References

Willer H, Trávníček J and Schlatter B. 2024. *The World of Organic Agriculture: Statistics and Emerging Trends 2024*. Research Institute of Organic Agriculture FiBL National Programme for Organic Production (NPOP).

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Effect of bio-inoculants and bio-organic nutrient sources on residual soil fertility in Okra

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Keywords: Bio-inoculants, Jeevamrit, Residual soil fertility

Introduction

Organic nutrient sources play an important role in maintenance of soil physical, chemical and biological properties for sustaining better growth of plants(Anim et al 2006).Okra responds very well to organic manure application and is an efficient in fertilizer use which is the key to its higher growth and yield. A number of plant growth promoting rhizobacteria enhance emergence of seed, plant growth and improve crop production by residing in the rhizosphere of plants (Ali et al., 2020).

Material and methods

The experiment was laid out in Randomized Complete Block Design with three replications at spacing of 60 cm ×20 cm in a plot size of 1.8 m × 1.0 m accommodating 15 plants per plot. Cow urine and beejamrit were used for the treatment of seeds; seeds were soaked overnight @ 10% solution of cowurine and @ 10 % solution of beejamrit as per treatments and planted on next day. For the treatment with bio-inoculants, seeds were soaked in water overnight and dried under shade and thereafter, these seeds were coated with *Pseudomonas fluorescens* and *Pseudomonas lactis* culture @ 8 g/kg as per treatments.

Results and conclusion

Maximum fruit yield per plant (0.37 kg) and fruit yield per plot (2.74 kg)) were recorded by the treatment T_{16} [FYM (50 q/ha) + vermicompost (25 q/ha) + Jeevamrit + *Pseudomonas fluorescens*]. Minimum soil pH (6.96), maximum soil organic carbon (0.76%), available nitrogen (259.36 kg/ha) and available phosphorus (26.98 kg/ha) were obtained with treatment T_{16} [FYM (50 q/ha) + Vermicompost (25 q/ha) + Jeevamrit + *Pseudomonas fluorescens*]. The maximum soil electrical conductivity (0.208 dSm^{-1}) and available potassium (174.65 kg/ha) were obtained in treatment T_{17} [Recommended Dose of Fertilizer (78N:50P:54K kg/ha)]. Maximum gross income (₹ 2,58,760 /ha) and net income (₹ 1,60,620 /ha) were obtained by treatment T_{16} [FYM (50 q/ha) + Vermicompost (25 q/ha) + Jeevamrit + *Pseudomonas fluorescens*]. Highest B:C ratio (1.69) was recorded by the treatment T_{10} [Jeevamrit + *Pseudomonas fluorescens*]. This study concluded that growth and yield of okra can be enhanced by the application of FYM, vermicompost, jeevamrit and *Pseudomonas fluorescens* which will further improve the soil health and productivity.

References

Ali N, Khan MN, Ashraf M, Izaz S, Saeed HR, Abdullah M, Ahmad N, Akram HM and Farooq M 2020. Influence of different organic manures and their combinations on productivity and quality of bread wheat. *Journal of Soil Science and Plant Nutrition* 20:1949–1960.

Anim JO, Blay ET and Frempong ME 2006. Effects of organic manure on okra production. *Journal of Applied Horticulture* 8: 155-158.

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Comparative analysis of natural and conventional farming: Impacts on cost, yield and sustainability

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Keywords: Cost-effectiveness, Productivity, Soil Health, Sustainability

Introduction

The debate between natural and conventional farming encompasses various aspects such as yield, soil fertility and sustainability. Natural farming enhances ecological balance, improves soil quality, and promotes microbial diversity, offering long-term benefits over conventional methods that, while often achieving higher short-term yields, contribute to environmental degradation. This paper reviews recent literature to compare these methods, focusing on natural farming's strengths in sustainability and long-term productivity, alongside the immediate efficiency of conventional farming.

Material and methods

A structured literature review was conducted using Google Scholar and Dimensions, focusing on studies published between 2023-2024. Keywords included "Natural Farming," "ZBNF," "Conventional Farming," and related economic and agronomic metrics. Initial searches retrieved 682 studies from Google Scholar and 543 from Dimensions, which were narrowed to 77 studies meeting UGC Journal List Group II criteria. After screening titles, abstracts, and full texts, 23 studies were selected for analysis. Data on production costs, market demand, yield, nutrient content, and profitability were extracted and synthesized.

Results and conclusion

Natural farming demonstrates cost-effectiveness, with cultivation costs reduced by Rs. 15,520 per hectare on average. Significant cost savings are observed in cotton and intercropped tomatoes. Despite conventional farming yielding higher gross returns by Rs. 11,633.96 per hectare, natural farming remains competitive for specific crops. Net returns often exceed those of conventional methods by Rs. 767.68 per hectare, with notable advantages for cotton and lemon. Yield data indicates higher outputs for paddy and lemon under natural farming, though conventional methods excel in crops like wheat. Benefit-cost ratio analysis shows natural farming's profitability for paddy and cotton, while conventional farming remains advantageous for crops like rice and maize. Challenges in implementation and resource requirements for natural farming are acknowledged, with supportive policies potentially addressing these barriers.

Table 1: Cost of Cultivation

Crop	Natural Farming (Rs/ha)	Conventional Farming (Rs/ha)	Cost Difference (Rs/ha)
Cotton	37,296	90,262	-52,966
Tomato (Intercropped)	95,684	136,788	-41,104

References

Duddigan S, Shaw LJ, Sizmur T, Gogu D, Hussain Z, Jirra K, ... Collins CD. 2023. Natural farming improves crop yield in SE India when compared to conventional or organic systems by enhancing soil quality. *Agronomy for Sustainable Development* 43(31).

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Systematic exploration of natural farming: Perception, adoption and challenges in agribusiness perspectives

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Keywords: Adoption, Barriers, Perceptions, Sustainability

Introduction

Indian agriculture, while significantly boosted by the Green Revolution, faces challenges like environmental degradation and economic pressures on farmers (Kumar et al., 2019). Natural Farming, emphasizing traditional practices such as *Jivamrita* and *Bijamrita*, promises improved soil health and sustainability (Choudhary et al., 2022). However, concerns regarding input availability, cultural biases, and mixed crop yield results slow down its widespread adoption (Biswas, 2020). This study examines farmers' perceptions and the factors influencing Natural Farming adoption in India, highlighting its potential as a sustainable agricultural practice.

Material and methods

Systematic search was conducted using the string "Farmers Perception" OR "Farmers Adoption" AND "Attitude" OR "Barriers" OR "Challenges" AND "Natural Farming" OR "ZBNF" OR "Subash Palekar ZBNF." The search, limited to secondary sources, yielded 256 results. After applying filters for publication date (2019-2024), geographical focus on India, and open access, the pool was narrowed to 166 studies. Only peer-reviewed, English-language articles with empirical research methods were included, resulting in 139 open access papers. Further screening of titles and abstracts reduced the selection to 45 studies, and after a thorough full-text review, 13 studies meeting the inclusion criteria were finalized for analysis.

Results and conclusion

Natural farming is gaining attention for its economic, environmental, and health benefits, but faces adoption challenges (Table 1). Farmers perceive economic benefits from cost savings and increased production quality through Natural Farming. Many also acknowledge the environmental and health advantages, such as improved soil health and residue-free food. However, labor intensity and marketing challenges, including the lack of demand for Natural farming produce, complicate adoption. Effective government support, peer influence, and educational programs are critical to overcoming these barriers.

Table 1: Key Factors Influencing perception, adoption, and challenges in natural farming

Key Areas	Perceptions/Adoption	Challenges
Economic	Cost savings, income generation	High input costs, lack of market demand
Environmental	Improved soil health, sustainability benefits	Limited scientific validation
Labor	Labor-intensive, workforce demographics	High labor requirements
Market	Mixed views on market access	Marketing challenges, low demand
Policy & Support	Need for strong government support	Inconsistent policies, weak support
Knowledge & Training	Knowledge gaps, need for training	Lack of technical expertise

(Source: Primary Probe, 2024)

Sustainable adoption also depends on addressing social and cultural factors, such as gender disparity and community influence, while enhancing training, policy, and market infrastructure. The findings highlight the need for a multi-dimensional approach to promote Natural Farming adoption. Continuous farmer training, financial incentives like subsidies, and low-interest credit can ease the transition. Strengthening market infrastructure and raising awareness about the environmental and health benefits will improve product marketability and returns. Direct marketing, cooperatives, better access to bio-inputs, and peer networks can address key challenges and enhance adoption.

References

Biswas S 2020. Zero Budget Natural Farming in India: Aiming back to the basics. *International Journal of Environment and Climate Change*, 10(9), 38-52.

Choudhary SK, Kumar R, Seema and Kumar A. 2023. General overview of zero budget natural farming (ZBNF). *Agricultural Reviews* 44(3): 328–335.

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Suitability of winter annuals for cut flower production under natural and chemical farming

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Keywords: Winter annuals, Natural farming, Jeevamrit

Introduction

Annuals are the plants that go through their whole life cycle, from seed to blossom to seed again, in a single growing season (Kashyap *et al*. 2020). Among annuals, winter flowering annuals have a wide variety of blooms, well-liked garden attraction and they are crucial elements in any landscape design.The quality of crop is maintained whileusing organic manures which provide the necessary nutrients.Jeevamrit also has huge microbiological load. It increases soil microbial activity, ensuring that nutrients are available for the crops.

Material and methods

The present investigation was carried out in the experimental farm of the Department of Floriculture and Landscape Architecture, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during 2022-23. Six winter flowering annuals namely; annual chrysanthemum (*Glebionis coronaria*), dog flower (*Antirrhinum majus*), larkspur (*Delphinium ajacis*), lupin (*Lupinus polyphyllus*), paper flower (*Helichrysum bracteatum*) and sweet william (*Dianthus barbatus*) were selected for the study. The experiment was laid out in Randomized Block Design (factorial) with two treatments viz. Jeevamrit @ 500 ml/m^2 (drenching) in natural farming and recommended dose of fertilizer NPK 20:20:20 for inorganic and FYM @ 5 kg/m^2 Full doses of phosphorus and potassium and half doseof nitrogen were applied as basal dose at the time bed preparation. Remaining half dose of nitrogen was applied after 30 days of transplanting.

Results and conclusion

Observations recorded were based on vegetative, flowering and longevity of different winter season annuals.The results revealed that among two cultivation system maximum plant height (75.72 cm), minimum number of days taken for flower bud formation (86.30 days), maximum number of cut stems per plant (10.42) and maximum vase life (10.20 days) were observed in natural farming system. Interaction between winter season annuals and cultivation system revealed that maximum vase life (16.87 days) was recorded in *Helichrysum bracteatum* under the natural farming system, whereas, minimum vase life (5.67 days) was observed in *Delphinium ajacis* under the conventional system.

Due to the availability of superior food reserves, nutrients, and growth-promoting compounds (gibberlic acid and indole-3- acetic acid) in jeevamrit all these enhanced vase life. The results are similar with findings of Vanlalhruaii (2019) in boston fern.

Table 1: Influence of cultivation systems on vase life (days) of different winter season flowering annuals

Winter season annuals	Cultivation systems		Mean
	Natural	**Conventional**	
Annual chrysanthemum (*Glebionis coronaria*)	9.60	9.20	9.40
Dogflower (*Antirrhinum majus)*	6.60	6.20	6.40
Larkspur (*Delphinium ajacis)*	5.80	5.67	5.73
Lupin (*Lupinus polyphyllus*)	8.13	7.60	7.87
Paper flower (*Helichrysum bracteatum*)	16.87	15.93	16.40
Sweet William (*Dianthus barbatus*)	14.73	14.53	14.63
Mean	10.20	9.86	
$CD_{0.05}$			
Winter season annuals	0.32		
Cultivation system	0.19		
Winter season annuals × Cultivation system	0.46		

References

Kashyap B, Thakur AK and Bassi SK. 2020. Gardening and Floriculture. S. Dinesh & Co., Jhalandhar.108p.

Vanlalhruaii R. 2019. Studies on the effect of jeevamrit application on frond production and longevity of boston fern (*Nephrolepis exaltata* (L.) Schott). M. Sc. Thesis. Department of Floriculture and Landscape Architecture, YSP University of Horticulture and Forestry, Solan. 73p.

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Challenges faced by farming community in adoption of organic farming in India

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Keywords: Certification, Challenges, Climate change, Organic farming, Policy support

Introduction

Organic farming in India is deeply rooted in traditional agricultural practices but has only recently been re-emphasized as a modern agricultural method. With growing concerns over the environmental and health impacts of conventional farming, organic farming has been promoted as a viable alternative. Indian government and various non-governmental organizations (NGOs) have introduced several initiatives to encourage organic farming. However, the farming community faces a myriad of challenges that hinder the widespread adoption of organic practices.

Material and methods

This study on the challenges faced by the farming community in adopting organic farming in India was conducted using a combination of primary and secondary data collection methods. The results from primary data collection were compared with secondary data to identify any discrepancies and to strengthen the overall conclusions.

Results and conclusion

Despite the growing interest in organic farming in India, the farming community faces substantial challenges that hinder its widespread adoption and practice (Table 1). Addressing these challenges requires a multi-faceted approach, including increased awareness and education, financial and institutional support, streamlined certification processes, and improved market access. Additionally, tailored research and development initiatives are necessary to equip farmers with the tools and knowledge needed to transition to and sustain organic farming practices. Only through such concerted efforts can organic farming realize its full potential as a sustainable and profitable agricultural practice in India.

Table 1: **Key Challenges in Organic Farming in India**

Challenge	Key Findings
Lack of Awareness and Knowledge	Only 27% of farmers are fully aware of organic farming practices.
Economic Barriers	Transition costs are 30% higher; break-even in 3-5 years.
Certification and Market Access	Certification costs Rs.15,000 to Rs. 40,000/ farm; limited market access.
Soil Health and Fertility Management	20% yield reduction during the transition years.
Pest and Disease Management	25% higher incidence of pest attacks in organic farms.
Policy and Institutional Support	60% of allocated funds reach beneficiaries; inconsistent program execution.
Climate Change and Environmental Factors	Up to 40% yield loss in organic farms during drought years.

References

Sahu RS, Tiwari M and Deka N. 2024. The role of organic farming in creating food security and sustainable livelihoods for India's smallholder farmers: a systematic review using PRISMA. *Organic Agriculture* 14(2): 95–121.

ESFS-NF/NFSET2024/3010

Growth and yield response of flaxseed (*Linum usitatissimum* L.) to organic and natural farm inputs

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Keywords: Flaxseed, Jeevamrit, Organic manures

Introduction

Natural farming practices are gaining prominence for their role in fostering agricultural sustainability and socio-economic development. By reducing reliance on synthetic inputs, organic and natural farming enhance soil health, biodiversity, and environmental resilience. This study focuses on flaxseed (*Linum usitatissimum* L.), an economically important oilseed known for its rich nutritional profile and diverse industrial applications. This study investigated the impact of various organic manures- Farmyard manure (FYM), vermicompost, and JeevamriTon growth and yield. The research aimed to identify the most effective method for maximizing flaxseed productivity and economic returns, offering valuable insights into optimizing flaxseed cultivation while promoting sustainable farming practices.

Material and methods

The experimental area falls within the subtropical, sub-humid agro-climatic zone of Himachal Pradesh, India. In this experiment, random block design was used with three replications and five representative plants were selected from each replication and the growth and yield parameters were recorded. Considering all variables and fixed inputs, the cost of each treatment was assessed to identify the most cost-effective option for profitable flaxseed cultivation. The benefit-cost (B:C) ratio was determined by dividing the gross return by the total cost of cultivation.

Results and conclusion

Data showed notable differences across the various organic manure applications. The control had the lowest performance metrics, with an average plant height of 49.92 cm, 38.97 capsules per plant, and a seed yield of 1.05 g per plant, resulting in a seed yield of 5.95 q/ha and a benefit: cost ratio of 0.81. Among the treatments, vermicompost yielded the highest plant height (64.71 cm) and number of capsules per plant (87.52), with the highest seed yield per plant (3.47 g), translating to the highest seed yield per hectare (17.34 q) and a benefit: cost ratio of 1.13. Farmyard manure (FYM) also showed significant improvement in growth and yield with a plant height of 61.27 cm, 81.90 capsules per plant, and a seed yield of 3.15 g per plant, equating to a seed yield of 15.75 q/ha and thebenefit: cost ratio of 1.61. Jeevamrit exhibited intermediate results, with a plant height of 60.16 cm, 72.64 capsules per plant, and a seed yield of 2.80 g per plant, resulting in a seed yield of 14.00 q/ha and highest benefit: cost ratio of 1.65. Application of organic fertilizers significantly improved flaxseed plant growth and yield compared to the control. Among the organic treatments, vermicompost led to the highest seed yield per hectare, while jeevamrit provided the best benefit: cost ratio, indicating superior economic efficiency. Although, jeevamrit was less effective than vermicompost and FYM in terms of yield, still performed better than the control and demonstrated a high benefit: cost ratio. Overall, these results suggest that organic manures are highly effective in enhancing flaxseed productivity, with Jeevamrit offering the best economic return.

Table 1: Growth and yield response of flaxseed to organic and natural farm inputs

Treatments	Plant height (cm)	Number of capsules/plant	Seed yield/plant (g)	Seed yield (q/ha)	B:C
Control	49.92	38.97	1.05	5.95	0.81
FYM (5 t/ha)	61.27	81.90	3.15	15.75	1.61
Vermicompost (5 t/ha)	64.71	87.52	3.47	17.34	1.13
Jeevamrit*	60.16	72.64	2.80	14.00	1.65

**(3 applications- as a basal dose + at the time of flowering + at the time of capsule formation)*

References

Jhala AJ and Hall LM. 2010. Flax (*Linum usitatissimum* L.): current uses and future applications. *Aust. J. Basic Appl. Sci* 4(9): 4304-4312.

Selvan T, Panmei L, Murasing KK, Guleria V, Ramesh KR, Bhardwaj DR., ... and Deshmukh HK. 2023. Circular economy in agriculture: unleashing the potential of integrated organic farming for food security and sustainable development. *Frontiers in Sustainable Food Systems* 7: 1170380.

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Promoting Socio-Economic Development through Sustainable Agriculture: Integrating Crop diversification and Natural farming

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***Keywords**:* Crop diversification, Natural farming, Socio economic development

Introduction

Sustainable agriculture stands as a fundamental pillar for achieving socio-economic developmentin agricultural dominated societies. This abstract explores the dual approach of integrating crop diversification through vegetables and natural farming to encourage both environmental sustainability and economic resilience. Integration of both enhances biodiversity, reduces dependency on monoculture, improves food and nutritional security by diversifying the agricultural portfolio, eliminateor reducesthe use of chemicalsin favour of ecological balance, and encouraging stable soil health.This study shows how the fusion of these approaches can result in increased agricultural production, improved living standards for farmers, and more resilient rural financial systems.

Material and methods

Keeping in view the importance of crop diversification and natural farming for nutritional and socioeconomic transformation of the tribal community. KVK Kinnaur has focused its efforts for socio economic transformation of the tribal community through crop diversification and natural farming. KVK initiated with raising nursery of different vegetables viz. tomato, cabbage, red cabbage, cauliflower, broccoli, knolkhol, kale, lettuce, brussels sprout, summer squash, etc. under protected structures at KVK farm, and motivating the farmers of surrounding villages to cultivate these in the kitchen gardens. Farmers showed keen interest in kitchen gardening and natural farming and other technical support from the scientists of KVK. They started diversification through vegetables provided by KVK, Kinnaur on their nutri-garden of 100 m^2 in 2023. KVK has demonstrated comprehensive components of the nutritional garden and natural farming model, accompanied by consistent follow-up visits, demonstrations at KVK farm as well as farmer field, awareness and training camps.

Result and conclusion

Crop diversification through vegetables has positive and significant impact on production and farmer income (Table 1). It was observed that crop diversification through vegetables resulted higher production (141.50 q/ha) compare to monoculture 95.5 (q/ha).The main probable options for improvement in crop productivity with diversification is that, crop mixtures are more likely to be effective in suppressing diseases and pests, increasing soil fertility and improving the efficiency of local agroecological systems. It also evident in our findings that crop diversification along with natural farming significantly improves income from agricultural activities. Increased production and production stability from diversified cropping system and Table 1 shows the comparison between crop diversification through vegetable vs monoculture w.r.t. crop production and income reduction in input cost (fertilizer and chemicals) are the probable explanations for improved income. It was observed that crop diversification through vegetables having more benefit cost ratio (2.61) than monoculture (1.91).Crop diversification gives more return than monoculture.Today, because of increasing input costs and decreasing commodity prices, the farmers are looking for new ways to increase efficiency and cut costs.These interventions significantly increased the farmer's income by reducing input costand maximizing production& quality which indirectly reflected in the change of their lifestyle, nutritional statusand increase in economic status.

Table 1: Comparison between crop diversification through vegetable *vs.* monoculture

Yield (q/ha)			Economics of demo (Rs/ha)			Economics of check (Rs/ha)		
Demo	**Check**	**Change**	**Cost of cultivation**	**Net return**	**B:C**	**Cost of cultivation**	**Net return**	**B:C**
141.50	95.5	48.16	148650	389050	2.61	160450	307480	1.91

References

Gummagolmath KC, Bhawar S, Lakshmi SBR and Patra P. 2020. Impact of Crop diversification on farmers socio-economic conditions of the farmers: A case of Himachal Pradesh. *Research Journal of Agricultural Sciences* 11(1): 137-143.

Makate C, Wang R, Makate M and Mango N. 2016. Crop diversification and livelihoods of smallholder farmers in Zimbabwe: adaptive management for environmental change. *Springer Plus* 5. https://doi.org/10.1186/s40064-016-2802-4

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Effect of different crop management practices on performance of rabi maize (*Zea Mays L.*)

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Introduction

There is a challenge for agriculture over the coming decades to meet the world's increasing demand for food in a sustainable way. One of the reasons of the challenges is the changes in soil quality that have already led to a reduction in crop productivity with lower yield and higher cost of production (Gruhn *et al.,* 2000) in conventional agriculture. Therefore, to understand the methods of sustainable approach, an experiment was conducted to evaluate effect of varied crop management practices on the performance of maize in rabi season.

Material and methods

The experiment was conducted at the experimental farm of AICRP on Soybean, SAS, Nagaland University, Medziphema campus, during the *rabi* season of 2023. The treatments comprised of two *rabi* maize varieties *viz.,*RCM 76 and VLQMH 45 as main plot treatment and three different crop management practices *viz.,*Organic Farming (well decomposed FYM @ 10 t ha^{-1}), Natural Farming (Beejamritha @ 50-100ml/kg seed treatment and Jeevamritha @ 200 liter/acre at 15, 30 and 45 DAS) and Integrated Crop Management as sub plot treatment (50% recommended dose of nitrogen through urea + 50% recommended dose of nitrogen through FYM).

Results and conclusion

Among the *rabi* maize varieties, plant growth parameters *viz.*, plant height, dry weight and number of green leaves, recorded at 60 DAS revealed that between the two *rabi* maize varieties *viz.,*RCM 76 and VLQMH 45, VLQMH 45 performed significantly better than RCM 76. Similarly yield and yield attributes *viz*., number of cobs $plant^{-1}$, number of grains cob^{-1}, grain yield and harvest index were also found to be significantly superior in VLQMH 45 variety as compared to RCM 76 (Table1). Table 1 also depicts that the different crop management practices recorded significant effect on all the plant growth parameters and also yield and yield attributed. The data showed that Integrated Crop Management practice produced more grain yield than organic farming and natural farming by 67% and 83% respectively. Ghasal*et al*., (2021) reported that integrated crop management provided balanced and continuous supply of the nutrient that resulted in higher productivity and profitability of basmati rice-wheat system. It can be concluded that Integrated crop management practice proved better than organic and natural farming.

Table 1: Effect of crop management practices on growth parameters of maize

Treatments	Plant height $plant^{-1}$ (cm)	Dry weight $plant^{-1}$ (g)	No. of green leaves $plant^{-1}$	No. of cob $plant^{-1}$	No. of grains cob^{-1} (g)	Grains yield (kg ha^{-1})	Stover Yield (kg ha^{-1})	Harvest Index %
Variety								
RCM 76	31 .77	2.52	6.33	0.66	63.11	187.64	1201.82	11.51
VQMH 45	33.55	3.22	7.60	0.81	99.11	392.55	1389.23	28.56
Sem±	0.35	0.18	0.10	0.02	4.89	21.40	46.17	0.87
CD at 5%	1.59	NS	0.45	0.08	22.00	96.32	NS	3.92
Crop Management Practices								
Organic Farming	29.77	2.02	6.30	0.63	68.93	191.76	1377.88	15.09
Natural Farming	**23.25**	**1.27**	**6.73**	**0.37**	**45.00**	**94.63**	**702.83**	**12.17**
Integrated Crop Management	44.96	5.33	7.87	0.87	129.40	583.89	1808.86	32.84
Sem±	0.49	0.21	0.19	0.05	4.88	34.18	62.11	2.22
CD at 5%	1.50	0.64	0.58	0.15	15.05	105.31	191.37	6.84

References

Ghasal PC, Mishra RP, Choudhary J, Dutta D, Bhanu C, Meena AL, Ravisankar N, Kumar A, and Panwar AS. 2023. Evaluation of integrated crop management, organic management and natural farming in basmati rice-wheat system under Upper Indo-Gangetic Plains. *Journal of Plant Nutrition*.

Gruhn P, Goletti F and Yudelman M. 2000. Integrated Nutrient Management, Soil Fertility, and Sustainable Agriculture: Current Issues and Future Challenges. Food, Agriculture, and the Environment Discussion Paper 32.

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Impact of natural farming practices on maize (*Zea mays*) and rajmash (*Phaseolus vulgaris*) intercropping in Kullu

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Keywords: Natural Farming, maize, rajmash, intercropping

Introduction

Intercropping or mixed cropping of two or more crops is a common practice followed among the farmers which is very popular which can not only conserve soil but also provide two or more crops at a same time and enhances the production of the crop. Intercropping can not only enhance soil fertility but also improves the nutrient use efficiency of the soil (Dhima *et al.* 2007; Chen et al. 2004). The main advantage of intercropping is increasing production per unit area compare to a single cultivation due to the better use of environmental factors such as light, water and nutrients in the soil. It tends to give higher yield than sole crops, greater yield stability and efficient use of nutrients (Kumar *et al.,* 2018). Hence, the present study was undertaken to evaluate maize + rajmash intercropping under the natural farming practices:

Material and methods

Recommended practice (RP) was compared with Natural farming practices (NF) during kharif 20019 and 2020. In total, 14 trials were laid in the Chanon, Sharan and Goshal villages of the Kullu district on the farmer's field each year. The gross plot size of the frontline demonstrations was 400 m^2 each. The complete recommended practices (RP) were followed in one plot and the complete Natural Farming (NF) practices were followed in other plot. The soil samples were taken at the initiation and harvest of the demonstrations from all the fourteen plots. The data from RP plots and NF plots on growth, yield and soil parameters were recorded and analysed to draw the inferences. The detail of recommended practice (RP) and natural farming practices (NF) are given in Table 1.

Results and conclusion

Plant height, cobs length, cob girth and grains per cob (212.21 cm , 15.17 cm, 15.39 cm and 307.40) were recorded the significant improvement with the adoption of RP over the NF (191.43 cm, 12.54 cm, 12.62 cm and 274.20). The maize yield of 33.19 q/ha was recorded in RP over the NF (24.51 q/ha) with the increase of 35.41 %. The pods per plant, pod length and grains per pod recorded the significant increase in the RP (12.36, 11.31 cm & 5.33) over the NF (10.25, 10.21 cm & 4.52). The yield of 4.61 q/ha was recorded in rajmash in RP over the 3.87 q/ha in the NF practice with percent increase of 19.12. The crop equivalent yield (CEY) of 25.61 q/ha (Table 4) was recorded in RP over 21.50 q/ha in the NF practice. The application of the RP improved the net returns viz. Rs. 57952/- the line sowing as compared to the NF (Rs. 53268/-). The significantly higher BC ratio was recorded in the NF (2.80) over RP (2.21) in the mean data of both the years (Table 4). The non significant increase in the soil properties were recorded but the available N, P and K enhanced significantly. The RP enhanced the growth and yield parameters as compared to NF during both the years. The increase in the net returns was recorded in the RP as compared to the NF. Unlikely, high values of BC ratio were recorded from NF plots as compared the RP.

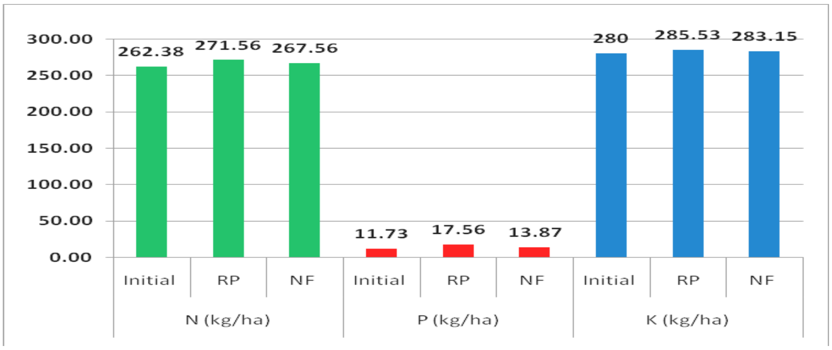

Fig. 1: Effect of natural farming practices on available N, P and K content of soil

References

Chen C, Westcott M, Neill K, Wichman D and Knox M. 2004. Row configuration and nitrogen application for barley–pea intercropping in Montana. *Agronomy Journal* 96: 1730-1738.

Kumar S, Singh SP, Sharma R and Sharma RR. 2018. Resource Use Efficiency of Sustainable Farming Practice: A study of Maize and Rajmash Intercropping under North-Western Himalayan Region of J & K. *International Journal of Pure and Applied Biosciences* 6(3): 798-802.

ESFS-NF/NFSET2024/3014

Evaluation of a combined topical herbal treatment and oral supplementation regimen for therapeutic management of subclinical mastitis in dairy cows

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Keywords: Mastitis, Herbal Treatment, dairy Cows, CMT

Introduction

Mastitis represents a major concern in dairy farming due to its insidious impact on milk yield, quality, and overall herd health. Traditional antibiotic treatments, while effective, often lead to issues such as antibiotic resistance and milk contamination. This study investigates the clinical efficacy of a holistic approach involving a topical herbal treatment and oral supplementation in managing subclinical mastitis in dairy cows. The topical treatment consists of *Aloe vera* (250 g), turmeric (50 g), and quick lime (20 g), while the oral supplementation includes lime juice (200 ml) and turmeric (50 g). The therapeutic efficacy was evaluated based on the return to normal milk yield, improvement in taste and keeping quality, and California Mastitis Test (CMT) scores, with a participatory survey conducted to gather insights from dairy farmers.

Material and methods

The study was conducted on dairy cows diagnosed with subclinical mastitis through CMT. The cows received the topical herbal mixture applied to the udder twice daily for two weeks, along with the specified oral supplementation. Milk samples were collected before treatment, immediately after treatment, and during a follow-up period of one month. These samples were assessed for yield, taste, keeping quality, and CMT scores. Additionally, a participatory survey was conducted to capture farmers' perceptions of the treatment's effectiveness and practical applicability.

Results and conclusion

Results demonstrated a significant improvement in all evaluated parameters. Treated cows showed a marked return to normal milk yield, indicating effective infection management. Taste and keeping quality of the milk were notably enhanced, attributed to the antimicrobial and antioxidant properties of the herbal ingredients. CMT scores significantly decreased, reflecting a reduction in somatic cell count and improved udder health. The participatory survey underscored positive farmer feedback regarding the treatment's practicality and effectiveness. This combined topical and oral herbal treatment offers a natural, cost-effective, and sustainable alternative to conventional antibiotics for managing subclinical mastitis. The promising results advocate for broader adoption of this regimen in dairy farming, emphasizing the potential of herbal remedies in enhancing dairy cow health and milk quality.

References

Mokhtar B, Abdelhanine A and Wessam M. 2019. Intramammary honey preparation for treatment of subclinical bovine mastitis: A preliminary study. *Organic Agriculture* 1-8.

ESFS-NF/NFSET2024/3015

Economics of pea (*Pisum sativum* L.) improved through natural farm inputs in spinach and coriander based crop sequencing

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Keywords: *Ghanjeevamrit, Jeevamrit,* Natural Farming, Pea

Introduction

Increased demand for diverse, resource-intensive diets, alongside the heavy use of chemical fertilizers, threatens soil health and disrupts soil ecosystems, making the use of natural fertilizers essential for sustainable agriculture. Natural farming is an eco-friendly agricultural approach that emphasizes the use of organic inputs, minimal soil disturbance, and biodiversity to enhance soil health and crop productivity. Natural farming reduces input costs for farmers by eliminating the need for chemical fertilizers and pesticides, leading to higher profit margins. Additionally, it promotes sustainable agricultural practices, which can enhance long-term economic resilience.

Material and methods

The present investigation was carried out evaluate the effect of natural farming practices on economics of pea when grown with spinach and coriander. Pea cv. PB-89, Spinach cv. Pusa Harit and Coriander cv. Solan selection were used. There were 10 treatments comprising of varied doses of *Jeevamrit* and *Ghanjeevamrit*. Seeds were treated with *Beejamrit* prior sowing. Crop Equivalent Yield (CEY) and Land Equivalent Ratio (LER) were calculated as per standard methods.

Results and conclusion

The results indicated that the treatments with natural inputs achieved the highest land equivalent ratio, pea equivalent yield, cost of cultivation, gross returns, net returns, and benefit-cost ratio compared to the control (Table 1). Highest Pea Equivalent Yield (109.01 q/ha) and gross returns (3,27,019 Rs/ha) were achieved under treatment T_9, with the highest net returns (2,41,244 Rs/ha) and benefit-cost ratio (2.84) in treatment T_8. The lowest values for these metrics were observed in the control (T_{10}).

Application of organic liquid manures and bio-formulations, particularly *Jeevamrit*, in natural farming systems significantly reduced cultivation costs and improved yields, net returns, and benefit-cost ratio. Based on the computed B:C ratio, treatment T_8 (1.5 t/ha Ghanjeevamrit + Jeevamrit @ 20% + JM) was found to be the best, with a maximum B:C ratio of 2.84. Therefore, considering yield, quality parameters, soil health, and benefit-cost ratio, the application of 1.5 t/ha Ghanjeevamrit + Jeevamrit @ 20% + JM at 14-day intervals was identified as the most effective nutrient module for pea cultivation.

Table 1: Effect of natural farm inputs on economics of pea

Treatment	LER	Equivalent Yield (q/ha)	Cost of Cultivation (Rs/ha)	Gross Return (Rs/ha)	Net Returns (Rs/ha)	B:C Ratio
T_1- 0.5t/ha *Ghanjeevamrit* + *Jeevamrit* @10%	1.01	73.71	60110	221130	161020	2.68
T_2- 0.5 t/ha *Ghanjeevamrit* + *Jeevamrit* @20%	1.15	84.41	65510	241231	175721	2.68
T_3- 0.5 t/ha *Ghanjeevamrit* + *Jeevamrit* @30%	1.22	86.84	72110	260509	188399	2.61
T_4- 1.0 t/ha *Ghanjeevamrit* + *Jeevamrit* @10%	1.16	77.39	67475	232159	164684	2.44
T_5- 1.0 t/ha *Ghanjeevamrit* + *Jeevamrit* @20%	1.51	87.69	72875	263063	190188	2.61
T_6- 1.0 t/ha *Ghanjeevamrit* + *Jeevamrit* @30%	1.56	92.79	78275	278362	200086	2.56
T_7- 1.5 t/ha *Ghanjeevamrit* + *Jeevamrit* @10%	1.40	92.98	74975	278940	203965	2.72
T_8- 1.5 t/ha *Ghanjeevamrit* + *Jeevamrit* @20%	1.80	106.4	83075	319379	236304	2.84
T_9- 1.5 t/ha *Ghanjeevamrit* + *Jeevamrit* @30%	1.94	109.0	85775	327019	241244	2.81
T_{10}- Absolute Control	0.52	34.86	35750	104580	68830	1.92

LER, Land Equivalent Ratio

References

Chandel RS, Gupta M, Sharma S and Chandel A. 2023. Economic analysis of natural farming based apple orchards in Himachal Pradesh. *Indian Journal of Ecology* 50(1): 119-123.

Kumar R, Kumar S, Yashavanth BS, Venu N, Meena PC, Dhandapani A and Kumar A. 2023. Natural farming practices for chemical-free agriculture: implications for crop yield and profitability. *Agriculture* 13(3): 1-16.

ESFS-NF/NFSET2024/3016

Endophytic plant growth promoting bacteria enhance growth in tomato (*Solanum lycopersicum* L.)

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Keywords**:** Biofertilizers, Endophytic bacteria, Growth, Tomato

Introduction

Tomato (*Solanum lycopersicum* L.) is cultivated globally for its adaptability and high yield, providing essential nutrients like potassium, folate, and antioxidants (Amr and Raie, 2022). Agro-chemicals boost production but harm ecosystems, including soil and water. A sustainable approach to reduce the use of agro-chemicals is integrated bio-fertilizer technology using bacterial endophytes, which colonize plant tissues. These microorganisms enhance tomato growth by producing hormones, fixing nutrients, and inhibiting pathogens (Glick 1995). Haryana's tomato productivity is 21.5 per cent below the national average, highlighting the need for sustainable approaches. Hence, this research was focused on enhancement of tomato growth by bacterial endophytes.

Material and methods

Endophytic bacterial isolates were screened for plant growth-promoting traits and seedling characteristics. Best-performing bacterial endophytes, individually and in combination, were applied to tomato (var. Hisar Arun) seedlings at transplanting. Treatment includes, T_1- Absolute control, T_2- Control + Recommended dose of fertilizers (RDF), T_3- RDF + Bacterial isolate 1, T_4- RDF + Bacterial isolate 2, T_5- RDF + Bacterial isolate 3, T_6- RDF + Bacterial isolate 1 + Bacterial isolate 2, T_7- RDF + Bacterial isolate 1 + Bacterial isolate 3, T_8- RDF + Bacterial isolate 2 + Bacterial isolate 3, T_9- RDF + Bacterial isolate 1 + Bacterial isolate 2 + Bacterial isolate 3 and T_{10}- Reference PGPR (Providencia spp.). Wherein, Bacterial isolate 1- L-6, Bacterial isolate 2- S-4, Bacterial isolate 3- TMG-5.

Results and conclusion

Twenty bacterial endophytes from different tissues of tomato plants were screened for plant growth-promoting traits and seedling characteristics in vitro. Among them, isolates S-4, L-6, and TMG-5 showed the highest phosphate solubilization activity, siderophore production, and IAA production, respectively. These isolates were the most effective to enhance seed germination, radicle length, and plumule length compared to all tested isolates, including the control. The results showed that plants treated with these bacteria exhibited increased plant height, stem girth, leaf area, root length, root fresh weight, root dry weight, shoot fresh weight, and shoot dry weight compared to untreated control plants. T_9 (RDF + Bacterial isolate 1 + Bacterial isolate 2 + Bacterial isolate 3) resulted in the greatest plant height (88.37 cm), stem girth (7.59 cm), leaf area (158.83 cm^2) at 120 days after transplanting; root length, root fresh weight, root dry weight, shoot fresh weight, and shoot dry weightat final harvest. This study concludes that endophytic bacteria can be commercialized as biofertilizers to enhance tomato plant growth in tomato.

References

Amr A and Raie W 2022. Tomato components and quality parameters. A review. *Jordan Journal of Agricultural Sciences* 18(3): 199-220.

ESFS-NF/NFSET2024/3017

Economic analysis of natural farming in Bilaspur district of Himachal Pradesh

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***Keywords*:** Conventional farming, Crop Equivalent Yield, Natural farming, ZBNF

Introduction

Farmers have been heavily dependent on agrochemicals which results in loss of soil fertility, contamination of water and degradation of environment. Due to its harmful effects, the need for alternative agro-ecological farming practices is emerging and Natural farming is one such agroecological practice. Himachal Pradesh has adopted Subhash Palekar Natural Farming (SPNF) in the year 2018 under the scheme "Prakritik Kheti Kushhal Kisan Yojna"(PKKY). It aims at reducing cost of cultivation and enhance farm income for long-term welfare of farmers." The present study is aimed at assessing the economic impact of Natural farming on the farmers in the state.

Material and methods

Bilaspur district was selected purposively for the study. Multistage random sampling design was opted to select of farmers. Both primary and secondary data were used to carry out the study. Primary data were collected by survey method using well-structured and pre-tested schedule. Secondary data were collected in terms of number of registered farmers practicing natural farming. A list of farmers practicing natural farming was procured from the Project Director of ATMA, Bilaspur. Two blocks i.e., Bilapsur Sadar and Ghumarwin were selected. 50 farmers each from two blocks were selected randomly and a sample of 100 farmers was selected for the study. Standard cost and return concepts were used for the cost and return analysis.

Results and conclusion

The major results of the study are presented in the following table. Yield under natural farming systems was almost at par with conventional farming systems. In Kharif season, the percentage reduction in costs under natural farming over conventional farming varied from 0.04 per cent to 30.19 per cent and during Rabi season, it varied from 1.87 per cent to 25.96 per cent. Percentage increase in net returns under natural farming over conventional farming in Kharif season varied from 10.78 per cent to 56.45 per cent and from 0.05 per cent to 73.23 per cent in Rabi season. Similar findings were reported by Reddy et. al., 2019. Therefore, it can be seen that natural farming has lower cost of cultivation and higher net returns than conventional farming. Lower cost of cultivation by complete elimination of expensive external agro-inputs is the main reason for farmer's improved income under natural farming. Non-dependency on agro-chemicals helps the farmers in maintaining the soil health by enhanced soil biological activity thus making it more environmental friendly farming practice. Diversified cropping pattern ensured a more steady and regular income to the farmers. From the study, it was observed that most of the farmers practicing natural farming were marginal and small so natural farming may enhance the socio-economic status of marginal and small farmers by increasing their income mainly through reduced cost of cultivation. So, economic analysis using cost and returns shows that natural farming was proven to be better agroecological farming system in the long run.

Table 1: Comparison of crop equivalent yield, costs and net returns under natural farming and conventional farming systems

Crop Combinations	CEY (Q/ha)	Cost (Rs./ha)	Net Returns (Rs./ha)
Natural Farming			
Kharif Season			
Cereal-Vegetable-Pulse	39.42	52,938 (-1.81)*	25,902 (22.83)
Cereal-Vegetable-Oil seed crop	43.43	53,890 (-0.04)	32,970 (56.34)
Cereal-Pulses	39.93	46,867 (-13.07)	32,993 (56.45)
Cereal-Vegetables	40.28	54,047 (0.25)	26,513 (25.73)
Vegetables	51.06	55,013 (-30.19)	72,637 (10.78)
Rabi Season			
Cereal-Vegetable-Pulse	35.23	55,404 (-1.87)	18,576 (11.38)
Cereal-Vegetable-Oil seed crop	33.89	54,563 (-3.36)	16,690 (0.05)
Cereal-Pulses	35.21	49,674 (-12.02)	24,267 (45.48)
Cereal-Vegetables	36.25	47,229 (-16.35)	28,896 (73.23)
Vegetables	35.02	49,260 (-25.96)	38,290 (40.69)
Conventional Farming			
Kharif Season			
Maize	37.50	53,912	21,088
Tomato	57.75	78,807	65,568
Rabi Season			
Wheat	34.83	56,462	16,681
Pea	37.50	66,535	27,215

[*]Figures in parentheses are percentage change of natural farming over conventional farming costs and returns.

References

Reddy BG, Reddy VR and Reddy MS. 2019. Potential and constraints of zero budgeted natural farming (ZBNF): A study of Andhra Pradesh. *Indian Journal of Agricultural Economics* 74(3): 321-332.

ESFS-NF/NFSET2024/3018

Natural farming uplifted the socio-economic status of farmers in Mandi district of Himachal Pradesh

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***Keywords**:* Cost-effective farming, Eco-friendly, Profitable farming

Introduction

India is predominantly an agrarian country where 47 per cent of the Indian population directly or indirectly depends on agriculture for their livelihood (Anonymous, 2023). After the Green Revolution period, India witnessed an increased dependency on market-based chemical inputs which forced capital-less farmers to fall into the vicious circle of debt traps. Himachal Pradesh is a hilly state situated in the North-Western region of the Himalayas where the majority of the population lives in the rural area and depends upon agriculture and allied activities. The division of land holdings and inherited land increases the number of marginal and small farmers in the state.

Material and methods

To upscale their income and reduce the cost of cultivation, these farmers are transitioning towards natural farming implemented by the state government. Therefore, the present study was conducted to study the impact of Natural farming in uplifted the socio-economic status of farmers in Mandi district of Himachal Pradesh. A list of farmers practising Subhash Palekar Natural Farming first was procured from the Project Director ATMA, Mandi, Himachal Pradesh. A sample of 80 farmers was selected from 2 dominant blocks of Mandi district i.e., Balh and Gopalpur through simple random sampling design.

Results and conclusion

The findings of the study revealed that the average family size was 5.35 persons with approx. balanced gender distribution with a high literacy rate of 94.18%. The average no. of workers was 4.10 with a dependency ratio of 0.31, highlighting the pressure on the working population. The average landholding is 0.80 hectares, with 63.75 per cent under cultivation, out of which 64.83 per cent of the cultivated area is under natural farming, which demonstrates a cropping intensity of 193.55%, indicating efficient land use. Livestock plays a crucial role, with an average of 1.82 animals per farm, predominantly local cows. The primary income source is agriculture, accounting for 51.31 per cent of household income under natural farming practices. Overall, the findings suggest that natural farming is a sustainable farming system that significantly contributes to the fulfilment of the present generation's demands in economic upliftment by optimizing land use, enhancing productivity, and supporting diversified income sources (Walker et al, 2021)

References

Anonymous 2023. Economic survey highlights thrust on rural development: Aims to improve quality of life in rural areas for more equitable and inclusive development.

Walker G, Osbahr H and Cardy S. 2021. Thematic collages in participatory photography: A process for understanding the adoption of Zero Budget Natural Farming in India. *International Journal of Qualitative Methods* 20: 1-13.

ESFS-NF/NFSET2024/3019

Economic outcomes of apple grown under natural farming System and conventional farming system in Shimla district of Himachal Pradesh

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Keywords: Natural farming, Conventional farming, Crop combinations

Introduction

The transition from conventional to sustainable agricultural practices has gained global attention as a response to environmental degradation and the need for resilient farming systems. In Himachal Pradesh's Shimla district, apple farming is a crucial livelihood, yet it faces challenges like rising input costs and soil depletion. Natural Farming (NF) offers a promising alternative, aiming to enhance economic viability and social well-being while preserving ecological balance. This study delves into the economic and social outcomes of NF adoption among apple farmers, building on existing research that underscores the system's potential to revolutionize agriculture (FAO, 2020; Sharma & Singh, 2021).

Material and methods

The study was conducted in Shimla district, Himachal Pradesh, focusing on apple growers using natural and conventional farming practices. A simple random sampling design was employed to select 60 farmers, with 30 practicing Subhash Palekar Natural Farming (SPNF) and 30 using conventional methods from Shimla. The list of SPNF farmers was obtained from the Project Director, ATMA. Primary data were collected through a structured and pretested survey. The data was analyzed using the concepts of variable and fixed costs.The economic worth was assessed through Benefit-cost ratio. Additionally, a Likert scale was employed to evaluate farmers' perceptions toward natural farming.

Results and conclusion

NF shows a significant reduction in cost of cultivation, up to 40.66 per cent with apples + vegetables crop combination. Despite these lower costs; NF generally yields more, with apple + vegetable crop combination achieving a 13.47 per cent increase in yield. Net returns also improve, notably by 18.46 per cent with apples + pulses + vegetables crop combination. NF's Benefit-Cost Ratio (BCR) ranges from 2.29 to 2.64, indicating better returns on investment compared to CF, which has a lower BCR of 1.71 to 1.78, reflecting less efficiency in cost-to-return generation. These findings imply that Natural farming is more cost-effective and profitable, enhancing economic outcomes of apple growers. The reduced costs and higher returns under Natural farming not only improves the financial stability but also offer a more sustainable approach to increase farm income and to reduce the financial risk for farming communities, thereby contributing positively to their socioeconomic conditions.

Table 1: Economic analysis of different crop combinations under natural and conventional farming systems

Farming system	Crop combinations	% change in Cost of Cultivation under NF w.r.t. CF	% change in Yield under NF w.r.t. CF	% change in Net returns under NF w.r.t. CF	B:C
Natural farming (NF)	Apple+Pea	-26.99	6.21	12.20	2.45
	Apple+Pea+ Vegetables	-32.51	21.58	31.34	2.42
	Apple + Pulses	-13.88	11.05	13.35	2.29
	Apple+Pulses+ Vegetables	-5.46	16.56	18.46	2.64
	Apple+Vegetables	-40.66	13.47	23.23	2.39
Conventional Farming (CF)	Apple+Pea	-	-	-	1.71
	Apple+Rajmah	-	-	-	1.78

References

FAO. 2020. The state of food and agriculture: Overcoming water challenges in agriculture. FAO.

Sharma A and Singh R. 2021. The impact of natural farming on sustainable agriculture: A case study of Himachal Pradesh. Journal of Agricultural Science and Technology, 23(4): 123-135.

ESFS-NF/NFSET2024/3020

Unveiling the growth and yield potential of *Andrographis paniculata*: The king of bitters

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Introduction

Nutrient management underscores the use of manures, chemical fertilizers and biological agents to achieve sustainable crop production and improved soil health. Natural farming practices avoiduse of synthetic fertilizers and pesticides which offers several benefits for cultivating medicinal and aromatic plants in Himachal Pradesh. By nurturing soil health these techniques enhance the yield of active ingredients in medicinal plants and ensuring a final product that is free from harmful chemical residues with superior medicinal properties. *Andrographis paniculata* commonly known as Kalmegh also known as "King of Bitters" is an annual herb belonging to family Acanthaceae. It possesses immunological, antibacterial and anti-inflammatory, hepatoprotective properties and is in high demand in the pharmaceutical industries for preparation of ayurvedic medicines (Sule*et al*., 2010 :Akbar ,2011.). The National Medicinal Plants Board (NMPB) and the Food and Agriculture Organization recommended that all the medicinal and aromatic plants (MAP's) are to be cultivated organically. Organically grown MAP's are not only readily acceptable in global market but also fetch premium prices than those grown through conventional farming. The NMPB has proposed 32 prioritized list of medicinal plant for cultivation and among them *Andrographis paniculata* (Kalmegh) is at 17th position. Due to its wide pharmacological properties and economic value the wild collection is not sufficient to meet the growing demand and at the same time the quality of the raw material cannot be guaranteed. Thus, keeping in view the medicinal importance of *Andrographispaniculata*and its very high demand in pharmaceutical industries the present studies were conducted.

Material and methods

The experiment was laid out in Randomized Block Design (RBD) Factorial under field conditions with 8 treatments and three replications. T_1 - Control (without fertilizers), T_2 - NPK (60:45:30) T_3 - FYM 9.6 t/ha (N content equivalent to fertilizer dose) kg/ha), T_4 - Vermicompost 3.3 t/ha (N content equivalent to fertilizer dose), T_5 - Jeevamrit (Two splits), T_6 - FYM (9.6 t) + PK (45:30 kg/ha),T_7 -Vermicompost (3.3 t) + PK (45:30 kg/ha) and T_8 - Jeevamrit + PK (45:30 kg/ha).The sowing of seeds was done in the month of May 2021 and nursery transplanted during July month with spacing of 45 × 30 cm between rows and plants. Growth and yield parameters were recorded at three harvesting stages (pre-flowering, flowering and pod setting stage)

Results and conclusion

Among various combinations, treatment T_2 (NPK @ 60:45:30 kg/ha) excelled over other treatments for all the growth and yield parameters i.e. plant height (46.98 cm), plant spread (30.07 cm^2), number of branches per plant (19.89), number of leaves per plant (92.39), fresh stem weight per plant (20.30 g), dry stem weight per plant (12.90 g), fresh leaf weight per plant (13.87 g), dry leaf weight per plant (7.47 g), fresh above ground biomass per plant

(35.29 g), dry above ground biomass per plant (20.70 g), estimated fresh above ground biomass (26.12 q/ha) and estimated dry above ground biomass (15.32 q/ha) which was followed by T_7 and minimum values were recorded in control i.e. (T_1). Among different harvesting stages, maximum value for all the growth and yield parameters was recorded when plants were harvested at full flowering stage. Economic analysis revealed that NPK (60:45:30 kg/ha) had the highest benefit cost ratio which was followed by Jeevamrit + PK (45:30 kg/ha) and minimum was recorded in control.

Table 1: Effect of different organic manures, fertilizers and time of harvesting on estimated dry above ground biomass (q/ha) in *Andrographis paniculata* (Burm.f.) Wall. exNees

Treatments	H^*_1	H_2	H_3	Mean
T1 (Control)	4.55	10.52	8.45	7.84
T2 (NPK (60:45:30 kg/ha)	9.61	18.95	17.40	15.32
T3 (FYM 9.6 t/ha)	6.08	15.81	13.43	11.77
T4 (Vermicompost 3.3 t/ha)	6.32	16.70	13.50	12.17
T5 (Jeevamrit)	5.41	13.74	11.25	10.13
T6 (FYM 9.6 t +PK (45:30 kg/ha)	7.78	18.05	15.38	13.74
T7 (Vermicompost 3.3 t + PK (45:30 kg/ha)	9.04	18.90	16.30	14.75
T8 (Jeevamrit + PK (45:30 kg/ha)	7.22	16.81	13.80	12.61
Mean	7.00	16.18	13.69	

*H = harvesting stages

	SE(m)	SE(d)	C.D(0.05)
Treatment	0.472	0.668	1.342
Harvesting	0.289	0.409	0.822
T×H	0.818	1.156	2.324

References

Akbar S. 2011. *Andrographis paniculata*: a review of pharmacological activities and clinical effects. *Alternative Medicine Review* 16**:**66-77.

Sule A, Ahmed QU, Samah OA and Omar MN. 2010. Screening for antibacterial activity of *Andrographis paniculata* used in Malaysian folkloric medicine: A possible alternative for the treatment of skin infections. *Ethnobotanical Leaflets* 14: 445-456.

ESFS-NF/NFSET2024/3021

Economic analysis of natural farming in Shimla and Kullu districts of Himachal Pradesh

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Keywords: Conventional, Natural, Crop Equivalent Yield, Net Returns

Introduction

Himachal Pradesh implemented Zero Budget Natural farming (ZBNF) in 2018, with plans to convert the entire state to natural farming by 2022 (Kumar and Kumari, 2020). The non-chemical, low-cost Subhash Palekar Natural Farming (SPNF) technique was promoted in the hill State as part of the Prakritik Kheti Khushhal Kisan Yojana (PK3Y), launched by the State government in 2018. It is a significant practice to prevent environment from harmful effects of conventional farming but this practice also needs to be economically feasible. The present study was carried out to analyze the economic viability of natural farming.

Material and methods

District Shimla and Kullu were selected purposively for the research study. Simple Random Sampling was used for the selection of sample of farmers. 40 farmers from four blocks each *viz.,* Rohru, Theog, Naggar and Banjar were selected to form a total sample size of 160 farmers. Data pertaining to number of farmers registered under natural farming was collected from Project Director, ATMA, Shimla and Project director, ATMA, Kullu. Data was collected by from the farmers by survey method using a well- structured and pretested schedule. Standard cost concepts and Crop equivalent yield (CEY) given by Francis (1986) were calculated to compare the cost and returns of Natural farming and Conventional farming approaches.

Results and conclusion

In Shimla, CEY for Kharif season combinations (apple + vegetables) and (apple + pulses + vegetables) were 65.23 and 62.81 q/100 plants, respectively, compared to 60.15 q/100 plants under conventional farming. Similarly, in Kullu, Kharif season combinations (apple + vegetables), (apple + pulses + vegetables) and (apple + pulses) produced 62.67, 64.08 and 63.45 qtls/100 plants, respectively, exceeding the 60.12 q/100 plants observed in conventional farming (apple + vegetables + pulses). Rabi season crop combinations under natural farming also exhibited higher CEY in both the districts. Cost analysis revealed significant reductions in cost of cultivation for natural farming, with Shimla's Kharif combination (apple + pulses + vegetables) and Rabi combination (apple + pea) showing reductions of -15.66 and -15.49%, respectively, while Kullu's Kharif combination (apple + vegetables) and Rabi combination (apple + pea) demonstrated reductions of -14.20% and -20.79%, respectively. Highest net returns in Shimla during the Kharif season were observed for crop combination (apple + vegetables) under natural farming. Kullu's Kharif season crop combination (apple + pulses + vegetables) under natural farming yielded the highest net returns. All natural farming combinations outperformed conventional farming in net returns across both districts. The economic analysis shows natural farming, besides being ecologically efficient, is also a more lucrative system for apple growers in the state. Therefore, it should be encouraged on a wider scale among more farmers.

Table 1: Comparison of Crop Equivalent Yield (CEY), Costs and Returns under Natural Farming and Conventional Farming Systems in Kullu and Shimla

Crop Combinations	Shimla			Kullu		
	CEY (Qt)	Cost of cultivation (Rs)	Net Returns (Rs)	CEY (Qt)	Cost of cultivation (Rs)	Net Returns (Rs)
Natural Farming						
Kharif Season						
Crop Combinationa1 (apple + vegetables)	65.23	49628.30 (-14.53)	409961.22	62.67	54994.82 (-14.20)	383703.00
Crop Combination 2 (apple + pulses + vegetables)	62.81	48976.41 (-15.66)	393280.20	64.08	55418.68 (-13.53)	393124.51
Crop Combination 3 (apple + pulses)	-	-	-	63.45	55243.61 (-13.81)	388912.01
Rabi Season						
Crop Combination 4 (apple + pea)	2.23	30984.42 (-15.49)	540.16	5.18	34151.69 (-20.79)	2099.51
Crop Combination 5 (apple + vegetables+ pulses)	2.94	32728.53 (-10.73)	144.71	-	-	-
Crop Combination 6 (apple + vegetables)	2.67	34265.05 (-6.54)	1380.60	-	-	-
Crop Combination 7 (apple + pea + vegetables)	-	-	-	5.62	34211.99 (-20.65)	5136.28
Conventional Farming						
Kharif Season						
Apple + Vegetables + Pulses	60.15	58067.83	364703.28	60.12	64093.02	356725.31
Rabi Season						
Apple + Vegetables	1.65	36663.29	-3911.64	-		
Apple + Pea	-	-	-	4.76	43116.72	-9783.38

Figures in parentheses are percentage decrease from conventional farming costs.

References

Francis CA. 1986. Distribution and importance of multiple cropping. *Agricultural systems* 25: 238-240.

Kumar A and Kumari S. 2020. A review on zero budget natural farming: a path towards sustainable agriculture. *The Pharma Innovation Journal* 9: 236-239.

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Effect of natural farm inputs on performance of Strawberry cv. Camarosa under garlic and fenugreek crop sequencing

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Keywords: Strawberry, Natural Farming, Performance, Garlic, Fenugreek

Introduction

Strawberry is the most remunerative crop confined to 44 hectares of area expanding from sub-temperate to sub-tropical climate of Himachal Pradesh. The crop is commercially adopted by the farmers in Dhaulakuan-Puruwala and Rajgarh areas of Sirmour and some parts of Solan district. Strawberries are mainly grown under open field conditions which left significant bare area between the rows. Intercropping is one of the possibilities for increasing the usage of the cultivated land and is considered as one of the cropping systems to increase productivity and sustainability. Legume crops play an important role in fixation of the atmospheric nitrogen and have potential of improving soil fertility. Natural farming, an agro-ecological farming technique aimed at developing crop production and soil fertility conservation solutions using a variety of locally available components while maintaining environmental balance. By improving soil health and boosting nutrient and water use efficiency crop productivity can be enhanced.With the use of natural farm inputs and intercropping chemical free strawberry fruits can be produced. In light of the afore-mentioned information, the study investigated the effect of natural farm inputs on legume intercropped strawberry cv. Camarosa.

Material and methods

Strawberry runners were planted in plots of 2x 2 m at the spacing of 30 x 45 cm in the last week of September. Garlic cv. Large Segmented and fenugreek cv. IC-74 was sown in the month of October between the rows of strawberry (1 row of strawberry and 1 row of intercrop).The experiment included 7 treatments *viz*., T1 Jeevamrit @10% in strawberry-garlic-strawberry cropping system, T2 Jeevamrit @10% in strawberry-fenugreek-strawberry, T3 Ghan-Jeevamrit @2.5 t/ha in strawberry-garlic-strawberry, T4 Ghan-Jeevamrit @2.5 t/ha in strawberry- fenugreek –strawberry, T5 Jeevamrit @10% + Ghan-Jeevamrit @ 2.5 t/ha in strawberry-garlic-strawberry,T6 Jeevamrit @10% + Ghan-Jeevamrit @ 2.5 t/ha in strawberry- fenugreek –strawberry and T7 Strawberry monoculture supplemented with FYM only .

Results and conclusion

The data depicts that maximum number of flowers were recorded in Jeevamrit +Ghan-Jeevamrit and Strawberry–fenugreek cropping system (T5) which was at par with T6,T1and T2 while number of crowns were statistically non-significant. Maximum runner production was also observed in T5 which was at par with T6 and T4. Maximum fruit set and yield was recorded in T5. Maximum fruit weight was recorded in T6 and was at par with T1 and T5. Highest soil microbial properties and enzymatic activity was recorded in T6 followed by T5. The findings are in line with Verma et al (2024) who also observed significant higher yield and total microbial count by natural farm bioformualtions. Also Ragab et al (2014) conducted study on strawberry intercropping with garlic, pepper and snap bean and found that strawberry grown in association with garlic utilized the resources more aggressively than the respective intercrops while pepper proved to be more competitive.

Intercropping garlic in strawberry fields has been found to reduce the incidence of arthropod pests, twospotted spider mite. From the study it can be concluded that application of Jeevamrit @10% + Ghan-Jeevamrit @ 2.5 ton/ha and strawberry intercropping with garlic and fenugreek can optimize resource utilization and can improve strawberry growth and yield as compared to strawberry monoculture. Moreover, additional income can be generated through the intercrops.

Table 1: Yield contributing traits, microbial and enzymatic activity of strawberry cv. Camarosa influenced by natural farm inputs under garlic-fenugreek sequencing

Treatment	No. of flowers/ plant	No.of runners	Fruit set (%)	Yield (g/plant)	Bacterial count (x 10^6 cfu)	Soil fungi (x 10^3 cfu)	AMF count/ 50 g of soil	DHA*	Acid-Phosphatase
T_1	32.33	20.33	82.67	639.33	26.97	15.23	233.17	67.93	198.57
T_2	28.00	24.00	82.67	587.33	27.67	15.70	227.40	71.57	210.53
T_3	32.00	24.67	82.00	610.67	26.23	14.93	262.57	67.60	216.67
T_4	29.33	26.00	82.00	603.33	27.90	16.27	239.83	66.30	221.57
T_5	32.67	31.00	84.67	650.00	28.70	17.23	281.30	74.07	234.37
T_6	32.33	26.67	82.00	631.33	29.63	17.40	288.57	75.30	236.47
Control	23.00	19.33	80.00	533.00	14.63	9.87	98.80	48.67	180.63
$CD_{0.05}$	3.86	5.54	1.62	55.95	0.94	0.41	6.77	1.59	1.65
CV (%)	7.16	12.53	1.09	5.12	2.02	1.48	1.62	1.31	0.43

**DHA: Dehydrogenase*

References

Verma P, Chauhan JK and Bodh S. 2024. Improvement of soil health and leaf nutrient status in strawberry (Fragaria x ananassa) using bioorganic formulations. Journal of Plant Nutrition, DOI: 10.1080/01904167.2024.2377820.

Attallah S, Badawy I, Abdalla RM. 2022. Yield, Quality, Land Equivalent Ratio, and Economic viability of Intercropping Combinations of Summer Squash, Faba Bean andStrawberry. Assiut Journal of Agricultural Sciences.

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Effect of natural farming practices on crop intensification in bell pepper

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Keywords: Bell pepper, *Ghanjeevamrit*, Intercropping, *Jeevamrit*, Natural farming

Introduction

Natural farming (NF) is essential for sustainable agriculture. It minimizes the use of chemical inputs, enhancing soil health and promoting biodiversity (Das et al. 2023). Natural farming approach is based on four fundamental elements: *beejamrit*, *jeevamrit*, *waaphasa* and *acchadana*. By promoting the use of organic practices like composting, crop rotation and intercropping, natural farming aims to create sustainable agriculture system. Intercropping involves growing multiple crops together, which improves soil fertility, controls pests naturally and reduces the risk of crop failure. Crop intensification also increases yield by optimizing resource utilization and reducing competition for light, water and nutrients (Mousavi and Eskandari 2011).

Material and methods

Main crop was bell pepper (cv. Solan Bharpur). The intercrops were French bean (cv. Contender) and brinjal (cv. Pusa Purple Cluster). The seedlings of bell pepper (cv. Solan Bharpur) and brinjal (cv. Pusa Purple Cluster) were transplanted on 1st May, 2023. The seeds of French bean (cv. Contender) were sown on 4th May, 2023. The plot size was 1.2 m × 3 m and a spacing of 60 cm × 30 cm was followed. The experiment was set up in a Randomized Complete Block Design (RCBD) Factorial with three replications and twelve treatment combinations i.e., T_1**:** No Ghanjeevamrit + No Jeevamrit; T_2: No Ghanjeevamrit + Jeevamrit @ 10 %; T_3: No Ghanjeevamrit + Jeevamrit @ 20 %; T_4: Ghanjeevamrit @ 0.5 t/ha + No Jeevamrit; T_5: Ghanjeevamrit @ 0.5 t/ha + Jeevamrit @ 10%; T_6: Ghanjeevamrit @ 0.5 t/ha + Jeevamrit @ 20 %; T_7: Ghanjeevamrit @ 1.0 t/ha + No Jeevamrit; T_8: Ghanjeevamrit @ 1.0 t/ha + Jeevamrit @ 10%; T_9: Ghanjeevamrit @ 1.0 t/ha + Jeevamrit @ 20%; T_{10}: Ghanjeevamrit @ 1.5 t/ha + No Jeevamrit; T_{11}: Ghanjeevamrit @ 1.5 t/ha + Jeevamrit @ 10%; T_{12}: Ghanjeevamrit @ 1.5 t/ha + Jeevamrit @ 20 %

Results and conclusion

Maximum fruit weight (51.72 g), number of fruits per plant (19.23), fruit yield per plot (12.07 kg) and per hectare (268.18 q) were recorded in the treatment T_9 (*Ghanjeevamrit* @ 1.0 t/ha + *Jeevamrit* @ 20 %). The maximum bell pepper equivalent yield (315.90 q/ha) was recorded in the treatment T_9 i.e. G_2J_2 (*Ghanjeevamrit* @ 1.0 t/ha + *Jeevamrit* @ 20 %). Treatment T_{12} (*Ghanjeevamrit* @ 1.5 t/ha + *Jeevamrit* @ 20 %) resulted in the highest cost of cultivation (Rs. 2,07,846/ha) among the various treatment combinations. Treatment T_9 (*Ghanjeevamrit* @ 1.0 t/ha + *Jeevamrit* @ 20 %) resulted in maximum gross income (Rs. 12,63,600/ha), highest net returns (Rs. 10,60,754/ha) and maximum B:C ratio (5.23). Hence, based on natural farming practices, the application of *ghanjeevamrit* @ 1.0 t/ha + *jeevamrit* @ 20% was determined to be the most effective treatment for crop intensification in bell pepper.

Table 1: Effect of NF practices on yield and economic parameters of bell pepper

Treatment	Fruit weight (g)	Number of fruits per plant	Yield (kg/plot)	Yield (q/ha)	Bell pepper equivalent yield (q/ha)	Gross Income (Rs./ha)	Cost of Cultivation (Rs./ha)	Net Income (Rs./ha)	B:C
T_1	40.80	11.53	5.23	116.19	139.37	5,57,480	1,89,246	3,68,234	1.95
T_2	43.31	13.37	6.57	146.05	177.61	7,10,440	1,91,046	5,19,394	2.72
T_3	45.05	14.43	7.17	159.28	201.70	8,06,800	1,92,846	6,13,954	3.18
T_4	42.91	12.83	6.33	140.59	169.40	6,77,600	1,94,246	4,83,354	2.49
T_5	48.14	15.27	9.71	215.73	252.26	10,09,040	1,96,046	8,12,994	4.15
T_6	49.39	16.27	10.12	224.77	277.00	11,08,000	1,97,846	9,10,154	4.60
T_7	47.42	14.93	8.47	188.31	237.08	9,48,320	1,99,246	7,49,074	3.76
T_8	48.51	15.83	9.84	218.64	265.56	10,62,240	2,01,046	8,61,194	4.28
T_9	51.72	19.23	12.07	268.18	315.90	12,63,600	2,02,846	10,60,754	5.23
T_{10}	48.29	15.43	9.78	217.35	260.90	10,43,600	2,04,246	8,39,354	4.11
T_{11}	50.71	18.33	11.52	256.04	305.37	12,21,480	2,06,046	10,15,434	4.93
T_{12}	50.57	17.17	10.72	238.20	284.40	11,37,600	2,07,846	9,29,754	4.47
Mean	47.24	15.39	8.96	199.11	-	-	-	-	-
$CD_{(0.05)}$	1.97	1.65	1.57	34.97	-	-	-	-	-

References

Das SK, Kumar A, Yadav A, Laha R and Mishra VK. 2023. Zero budget natural farming practices on yield of crops (maize + soybean and pea + coriander) in mid hill of Sikkim Himalayas. *Journal of Agriculture and Ecology* 16(16):37-42.

Mousavi SR and Eskandari H. 2011. A general overview on intercropping and its advantages in sustainable agriculture. *Journal of Applied Environmental and Biological Sciences* 1(11):482-486.

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System productivity and profitability of soybean-wheat cropping system under natural farming

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Keywords: Natural farming, soil health, system productivity, wheat equivalent yield

Introduction

Intensive agrochemical based conventional farming after post green revolution has not only posed serious threat to environment and sustainability but also increased cultivation costs many folds (Yadav, 2011). Maize/paddy-wheat is predominant cropping systems in Himachal Pradesh in general and Mandi district in particular. This prevalent cropping system is highly input intensive deteriorating soil health and also not so remunerative for small holders; hence a systematic and holistic shift towards natural farming is the best options and need of the hour to make such systems more profitable and environmentally benign. Legumes are less input intensive and considered the best option for cereal based cropping systems under natural farming however, legume based profitable cropping system particularly under natural farming conditions are still lacking. Hence, in the present study performance of soybean-wheat cropping system was assessed under natural farming and compared with the conventional farming.

Material and methods

The demonstration trials on soybean-wheat cropping system under conventional and natural farming were conducted under rainfed conditions at KVK Mandi. Soybean – wheat cropping system under conventional farming was compared with soybean-wheat + pea under natural farming. Harit Soya and HPW 368 varieties of soybean and wheat respectively were grown both under conventional/ natural farming conditions. Complete package and practices were followed for raising crops under conventional farming and all principles were adopted for the cultivation of crops under natural farming. In order to compare the productivity and profitability final crop yield were recorded and gross return (Rs ha^{-1}) were calculated on the basis of prevailing market price of the produce. For comparison between crop sequences, the yield of all crops was converted into wheat-equivalent yield (WEY) on price basis. Soil samples were analyzed after four years for physico-chemical properties and microbial count using standard analytical methods.

Results and conclusion

Total system productivity wheat equivalent yield was found higher (67.61q ha^{-1}) under natural farming compared to conventional farming (60.10 q ha^{-1}). Total net returns were also found higher in soybean-wheat + pea cropping sequence under natural farming plot. The study recorded lower soil pH (6.68) and EC (0.17 dS/m), improvement in soil organic carbon status, increased build up of soil available major nutrients N, P, K, soil microbial count of bacteria, fungi and actinomycetes under natural farming plot as compared to conventional farming (Table 1). The total system productivity, profitability and soil health status was higher in soybean – wheat + pea cropping system under natural farming. Therefore concerted efforts need to be made for further scaling up of this cropping system under natural farming in the state.

Table 1: System productivity, profitability and soil properties of soybean-wheat based cropping systems

Parameter		Soybean-wheat (CF)	Soybean – wheat + pea (NF)
System productivity WEY (q ha^{-1})	*Kharif*	38.97	41.95
	Rabi	21.13	25.66
	Total	60.10	67.61
Cost of Cultivation (Rs ha^{-1})		96455	106556
Gross return (Rs ha^{-1})		147137	167930
Net return (Rs ha^{-1})		50682	61374
B:C ratio		1.53	1.58
pH		7.20	6.68
EC (dS/m)		0.22	0.17
Available N (kg ha^{-1})		156.80	164.64
Available P (kg ha^{-1})		19.93	22.47
Available K (kg ha^{-1})		189.75	201.53
OC (%)		0.48	0.61
Bacterial count (cfu $x10^4$)		2.35	5.65
Actinomycetes count (cfu $x10^3$)		5.05	5.78
Fungal count (cfu $x10^2$)		2.50	2.63

**Value of crop yields are average of three year; NF:- Natural farming; CF:- Conventional farming*

References

Yadav AK. 2011. Restoring soil health, fertility and sustainability in Indian agricultural soils. In: National symposium cum brainstorming workshop on organic agriculture, CSKHPKV, Palampur, India held on April, 19-20, 2011. *Souvenir & Abstracts*: 8-11.

ESFS-NF/NFSET2024/3025

Determinants of sustainable agriculture in Himachal Pradesh: Insights from the success stories of local farming communities

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Keywords: Sustainable agriculture; food security; agricultural practices

Introduction

Sustainable agriculture is increasingly recognized as essential for ensuring food security, environmental health, and economic stability, particularly in regions with challenging terrains like Himachal Pradesh. This study explores the critical factors that contribute to sustainable agricultural practices in Himachal Pradesh, drawing insights from the success stories of local farming communities. Through qualitative analysis of case studies, this research identifies key determinants such as the adoption of organic farming techniques, effective water management practices, community-led initiatives, government support, and the integration of traditional knowledge with modern agricultural practices. These success stories highlight the resilience and adaptability of the local farmers, demonstrating how tailored agricultural strategies can lead to enhanced productivity, environmental conservation, and socio-economic growth. By understanding these factors, the study offers valuable lessons for policymakers, researchers, and farmers aiming to promote sustainable agriculture in similar mountainous regions, and also underscore community engagement, resource management, and innovation in achieving long-term agricultural sustainability.

Material and methods

The descriptive research design was adopted for the concerned research study. Further a random sampling design was used for the collection of data. The research study has purposively conducted at Four districts of Himachal Pradesh. The sample size of about 245 farmers were selected for the study, the farmers were randomly selected and interviewed with the self structured questionnaire in response to objectives of the study. The secondary data for the present study was collected from various established and government journals, magazines, research articles, newspapers, and websites. The data further was analyzed through appropriate statistical and analytical tools in accordance with the nature of data considering the objectives of the research study.

Results and conclusion

Ongoing market dynamics of sustainable agriculture practices adopted throughout the nation is concerned, its practice in Himachal Pradesh has witnessed in a most structured and growing impetus in its adoption with enhanced knowledge and institutional training instruments. Considering this fact, this study has enlarged the interest of farming community at large and would also paved an area of development with consistent efforts among the community of agricultural policy makers and researchers in the field of sustainable agriculture worldwide. It is imperative that respondents (farming community) were inclined to seek information and attempts to get the updated awareness regarding the sustainable farming system and various developments. Hence, paves a potential scope to lead a larger expansion of sustainable farming practices through out the state with adequate institutional and physical infrastructure and developing better coordination all the stakeholders engaged in managing the sustainable farming system.

Table 1: Awareness Level among the farming community regarding various sustainable agriculture practices across Himachal Pradesh

Agro Climatic zones	Awareness Level Frequency of Respondents (Weightage)			Mean Weightage Score (N=327)	S.D.	CoV	p- value
	High (III)	Moderate (II)	Low (I)				
Sub Tropical/ Low Hills	154	105	92	552	2.10	34.8	0.001
Sub-Humid/ Mid Hills	162	108	87	688	2.8	54.8	0.001
Wet Temperate/ High Hills	184	118	32	746	4.21	46.9	0.001
Dry Temperate	216	116	24	885	3.22	37.5	0.001

Source: Field Survey reports, 2023-24

References

Bhullar GS and Bhullar NK. 2013. Agricultural sustainability: Progress and prospects in crop research. Academic Press. 14(7): 56-69.

Hulsmann S and Doll P. 2007. Water management for sustainable agriculture. Cambridge University Press 4(24): 321-345.

Prasad MNV. 2021. Traditional knowledge systems in agriculture: A global perspective. CRC Press 4(12): 52-74.

Uphoff N. 2000. Community development and local governance in agricultural projects. Cornell University Press. 4(11): 78-82.

ESFS-NF/NFSET2024/3026

A Study of adoption of natural farming in apple orchards of Chaupal Block

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Keywords: Adoption, Conventional farming, Natural farming, UTAUT

Introduction

Natural Farming is an agro ecological approach wherein no chemicals are used. As a sustainable agricultural method; zero budget natural farming (ZBNF) is an alternative to high-input, chemical fertilizer-reliant farming. It exemplifies agro ecological concepts, which places emphasis on enhancing biological interactions, diversity of genetic resources, greater biomass recycling, management of organic matter and soil biological activity, and improved soil conditions. Efforts have been made since 2016 to popularise natural farming in Chaupal. This study was conducted to adoption of natural farming.

Material and methods

The study was conducted in Chaupal block of Shimla district of Himachal Pradesh. Sampling Design comprises of Multistage sampling in which three stage sampling processes was used. In first stage Chaupal block of Shimla district was selected purposively as it known to have a good number of adopters of natural farming. A sample size of 100 farmer families was considered adequate. In the second stage 5 panchayat from the block were be selected on the basis of highest adoption of natural farming of apples. In the third stage 20 farmers were selected randomly from the list of farmers with each Panchayat.

Results and conclusion

The data showed that the adopters have an ambivalent view regarding the stated benefits (performance expectancy) of natural farming (Table 1). They opine that adoption of natural farming takes mental efforts (effort expectancy), even though it does not require scientific knowledge. There was minimal social influence for adoption of natural farming. It was also found that good facilitating conditions like access to cow dung, cow urine etc. are aiding the adoption of Natural Farming. Scientific research is required to enhance performance expectancy and lower effort expectancy. Better rating on Performance Expectancy and Effort Expectancy is likely to enhance social influence in favour of Natural Farming.

Table 1: UTAUT dimensions of natural farming in apple

UTAUT Dimension	Mean
Performance Expectancy	3.31
Effort Expectancy	2.20
Social Influence	1.74
Facilitating Conditions	4.84

References

Gupta N, Tripathi S and Dholakia HH. 2022. Can zero budget natural farming save input costs and fertiliser subsidies. *The Council on Energy, Environment and Water*: 1-30.

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SWOT analysis of retail outlet of Solan Natural Farmer Producer Company of Himachal Pradesh

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Keywords: FPC, Green Grocery, Natural Farming, Retail, SWOT

Introduction

Natural farming is a chemical free and agro ecology based diversified farming system that integrates crops, trees and livestock with functional biodiversity. This system is based on exclusion of all synthetic chemical inputs. Solan Natural FPC is supporting 71 farmers from six panchayats in Solan by focusing on marketing of natural farming products. For this purpose, it has a retail outlet on Solan bypass, opposite to the APMC where produce of natural farming is sold. The study aims to carry SWOT analysis of retail outlet of the FPC.

Material and methods

The SWOT analysis was conducted through a two-stage process: *Stage 1:* Data Collection, used systematic observations of the retail outlet at different times and days of the week, complemented by semi-structured interviews with stakeholders to obtain a broad spectrum of information.The marketing practices were analyzed through document review and observation of promotion and merchandising. Sales reports were analyzed with statistical tools to identify performance trends.The retail environment was examined for customer-friendliness through observation. *Stage 2:* Analysis, involved the evaluation and classification of the collected data into the four SWOT categories.

Results and conclusion

Strengths: The outlet has lower operational cost due to government support and in-house packaging. The strategic location near APMC and government's endorsement foster consumer trust and facilitate cost-effective direct sales by farmers contributing to increased profits.
Weaknesses: Government administrative requirements restrict the FPC from adapting to change. This FPC's financial limitations hinder its capacity to attract and retain customers due to inadequate marketing. The outlet location on highway, away from central market, limits customer reach. Insufficient storage facilities, unappealing packaging and the inability to consistently offer a diverse product range exacerbate customer dissatisfaction.
Opportunities: The high traffic on the Solan highway presents a potential customer base and the regular visits by retailers to APMC offer a strategic chance to attract them.
Threats: Possible entry of large private firms having stronger competencies, innovative marketing and superior customer service. Additionally, there is a threat that government support could be withdrawn, which could undermine the FPC's operational and financial capabilities. Environmental changes affecting crop yields could impact product availability and quality.

References

Ministry of Agriculture & Farmers Welfare, Press Information Bureau 2022. Data of registered FPO's. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1806232.

ESFS-NF/NFSET2024/3028

Examining determinants of institutional finance utilization among adopters of sustainable agricultural practices

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Keywords: Constraints, Determinants, Sustainable agriculture

Introduction

India's economy hinges predominantly on agriculture, providing sustenance for two-thirds of its population and serving as the cornerstone of economic stability. The enduring significance of agriculture is underscored by its integral role in shaping India's economic landscape, with its performance impacting the trajectory of various sectors (Sudhakar and Kumari, 2023). Access to financial resources catalyses empowering farmers and promoting broader social and economic inclusion (Kaur and Kapuria, 2020). Agricultural finance in tribal districts of Himachal Pradesh is over riding, being the primary catalyst for economic empowerment, augmented income, poverty reduction, and financial inclusivity. Access to agricultural finance significantly contributes to food security as the availability of finance fortifies tribal farmers against the diverse challenges posed by climate change. Furthermore, it serves as a conduit for investing in agricultural inputs and types of equipment, accessing broader markets and infrastructure, and amplifying their competitiveness. The study identifies the factors responsible for using institutional finance among farmers residing in tribal regions.

Material and methods

The study was conducted in tribal districts of Himachal Pradesh namely, Kinnaur, Lahaul & Spiti and Chamba (Bharmour)**.** Multi-stage sampling technique was employed. A comprehensive dataset was meticulously compiled from both primary and secondary sources. Primary data were systematically gathered through a well-designed questionnaire administered via personal interviews. The binary logit model was employed to analyse the factors influencing the increased use of institutional finance in tribal areas. Kendall's Coefficient of Concordance was employed to investigate the constraints concerning farmers in accessing institutional sources of finance for agricultural needs.

Results and conclusion

The results of the study indicate that income, farming experience, education qualification, and attendance of financial inclusion programs show a positive and statistically significant relationship with the utilisation of institutional finance. In particular, 'farm income' emerges as a powerful predictor, exhibiting a highly significant and positive impact on the probability of utilising institutional finance ($p<0.001$). The findings highlighted the significant influence of demographic determinants on utilising institutional finance in the study area. Demographic variables such as age, gender, land ownership, income, farming experience, family type, occupation, and education qualification play significant roles in determining farmers' propensity to access institutional finance.

To enhance financial inclusion and supporting economic development among farmers in tribal regions, several strategic measures should be implemented. Financial institutions must establish more rural branches and promote digital banking services to improve accessibility for remote populations.

Table 1: Binary logistic regression on demographic variables (Independent) and usage of institutional finance (Dependent variable)

Odds (use of institutional finance)	Odds ratio	Std. error	z	P>|z|	95% conf. interval	
Age	2.586	1.289	1.91	0.057	.238	6.870
Gender	1.125	.893	0.15	0.881	.973	5.329
Land	1.451	.719	0.75	0.452	.549	3.837
Income	22.079	17.452	3.92	0.000	4.690	103.944
Farming experience	3.775	1.729	2.90	0.004	1.538	9.266
Type of Family	.180	.147	-2.09	0.037	.036	0.900
Occupation	.691	.256	-0.99	0.320	.334	1.430
Education Qualification	7.600	2.956	5.21	0.000	3.546	16.291
Livestock	.806	.650	-4.87	0.000	.166	3.918
Financial inclusion programmes organised by the Government	433.490	843.17	3.12	0.002	9.579	19617.1
_cons	9.86e-10	4.02e-09	-5.09	0.000	3.34e-13	2.91e-06
Number of obs	300					
LR chi2(10)	360.99					
Prob > chi2	0.000					
Pseudo R2	0.868					
Log-likelihood	-27.391					

References

Sudhakar V and Kumari YA. 2023. A qualitative analysis of agricultural products marketing in India: A case study of Telangana Sona/RNR-15048 marketing and promotion strategies through mass media. *Juni Khyat* 13(2): 9–16.

Kaur S and Kapuria C. 2020. Determinants of financial inclusion in rural India: Does gender matter? *International Journal of Social Economics* 47(6): 747–767.

ESFS-NF/NFSET2024/3029

Economics of Prakritik Kheti Khushhal Kisan Yojna in Sirmaur district of Himachal Pradesh: Is it economically practical?

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Keywords: Agro-climatic conditions, Crop yield, PK3Y

Introduction

Agriculture has long been central to the Indian economy, with over half the population depending on it for their livelihoods (Tripathi et al., 2018). The Green Revolution shifted Indian agriculture from subsistence to commercial farming but brought hidden costs affecting natural resources and health. Recent policy changes, such as reduced subsidies and privatization, have impacted peasants negatively. The 2018-19 Economic Survey and 2019 budget highlighted the promotion of Zero Budget Natural Farming (ZBNF) to cut costs and double farmers' income (Bhosle, 2019; GOI, 2019). This study evaluates the economic viability of Prakritik Kheti Khushhal Kisan Yojna (PK3Y), with detailed analysis and policy implications.

Material and methods

The study was conducted on farmers practicing natural farming and conventional farming in the Sirmour district of Himachal Pradesh. Three blocks along with five panchayats in each block, were chosen, and within each panchayat, six farmers were randomly selected. Largely, 115 farmers were considered as the respondents under the given study to assess the economics of Prakritik Kheti Khushhal Kisan Yojna (PK3Y) versus non-PK3Y methods. Cost was calculated using the A2+FL method. This includes various cost components computed following standard methodologies (CSO, 2008; CACP, 2012; Miglani, 2016). The total income for each of the farmer households under study is calculated as follows: $TI = (Y \times P) + S - TC$ (where, TI = Total Income, INR/ha; Y = Yield, kg/ha; P = Price, INR/Qt; S = Subsidy, INR/ha; TC = Total Cost of production, INR/ha).

Results and conclusion

The study has evaluated the performance of the Prakritik Kheti Khushhal Kisan Yojna (PK3Y) model in terms of three important parameters: cost of cultivation, yield, and income. Evidence suggests that farmers shifting into PK3Y have experienced a reduction in production costs in the post-conversion period compared to their non-PK3Y counterparts. Contrary to earlier concerns about yield loss, the data shows that farmers practicing PK3Y have achieved higher yields compared to their conventional counterparts in the same regions. Although the magnitude of yield improvement varies, the evidence indicates that PK3Y performs better in terms of yield and income.

Empirical evidence strongly suggests that PK3Y can play an important role in income generation of the farmers in Sirmour. Additionally, government interventions are needed to connect PK3Y farmers with markets, implement a price support mechanism, and provide other forms of assistance. This includes offering subsidies, technical support for both the operation and certification processes for natural farming, and supplying fertilizers and pesticides to facilitate a smoother transition to PK3Y.

Table 1: Comparative Production Scenario (Vegetables)

Type of farming	Cost of cultivation (Rs. / Hec.)	Avg. Yield (Qtls/ Hec)	Income (Rs. / Hec.)
Peas, Tomato, Potato, Frenchbeans, Capsicum, cabbage, Cauliflower			
PK3Y	Rs. 1452/-	302.56	2,05,618/-
Conventional	Rs. 3947/-	257.28	1,36,712/-
Apple, Peach, Pear, Plum, Mango, Kinnow, Apricot			
PK3Y	Rs. 1302/-	457.62	3,84,612/-
Conventional	Rs. 2489/-	319.45	2,91,563/-
Grains and Cereal crops			
PK3Y	Rs. 1067/-	289.76	3,14,589/-
Conventional	Rs. 2106/-	254.45	2,89,692/-

References

CACP 2012. Price policy for kharif crops the marketing season 2012-13. New Delhi: Ministry of Agriculture, Government of India.

Tripathi S, Shahidi T, Nagbhushan S and Gupta N. 2018. Zero Budget Natural Farming for the Sustainable Development Goals. Council on Energy, Environment and Water. Andhra Pradesh, India.

ESFS-NF/NFSET2024/3030

Impact assessment of natural farm practices in agronomic crops of Sirmaur district of Himachal Pradesh

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Keywords: Conventional Farming, Natural Farming, Crop Equivalent Yield

Introduction

Natural Farming (NF), that is originally Zero Budget Natural Farming (ZBNF), is indeed a holistic approach to agriculture that focuses on reducing costs and enhancing soil health through ecological practices. Zero Budget Natural Farming (ZNBF) is the practice of growing crops without the use of any external inputs, such as pesticides and fertilizers. The phrase "Zero Budget" refers to all crops with zero production costs. The farmers' revenue is increased as a result of ZBNF's guidance towards sustainable farming methods that help to maintain soil fertility, assure chemical-free agriculture, and ensure a cheap cost of production (zero cost). It depends on four pillars i.e., Jeevamrita, Beejamrita, Acchadana and Whapasa.

Material and methods

The primary data were collected from 100 farmers practicing Natural Farming of Rajgarh and Pachhad block of Sirmaur district in Himachal Pradesh of India by applying simple random sampling chosen by purposive sampling Techniques. To analyse the data, all respondents were separated into three groups based on the size of their land holding: marginal (less than 1 ha), small (between 1 and 2 ha), and medium (between 2 and 4 ha). The data collected showed the cropping patterns, income patterns along with quantity of input use compared to prices under NF and CF system.

Crop Equivalent Yield (CEY): A variety of crops were grown in a multiple or mixed cropping system in NF. Therefore, comparing the economics of multiple crops with a single crop was very challenging. Crop equivalent yield is the total of equivalent major and intercrop yields. To compare different cropping sequences and economic returns, crop equivalent yields (CEY) were used

$$\text{CEY} = C_y + [C_{1_y} \times \frac{P_{C_1}}{P_C}] + [C_{2_y} \times \frac{P_{C_2}}{P_C}] + \ldots\ldots + [C_{n_y} \times \frac{P_{C_n}}{P_C}]$$

Results and conclusion

Under natural farming system the yield per hectare in all crop combinations were higher from conventional farming crops. In CEY, percentage increase yield in NF Over CF varied between 15.37 – 107.77 percent. Maximum increase in yield was of wheat+ vegetables+ pulses system (107.77 %) and minimum in wheat+ vegetables (15.37%). percentage increase net returns in NF over CF varied between -15.18 - 289.63 percent. Maximum increase in net returns was of Sugarcane+ Vegetables+ French bean (289.63) and minimum in Wheat+ Vegetables+ Oilseed crops (-15.18). The net returns of natural farming was higher as compare conventional farming due to the high number of crops were grown together under natural farming. Percentage increase Benefit Cost Ratio in NF over CF varied between -39.13 – 428.04 percent. The sampled households were grown 30 diverse crops annually i.e 17 in kharif and 13 in rabi season under natural farming and 7 crops under conventional farming.

Table 1: Comparison of Crop equivalent yield (CEY), net returns and benefit cost ratio between natural farming and conventional farming (CF)

NF		CF		Yield difference (qtl/ha)	Increase change in yield of NF over CF (%)
Crops+	CEY (q/ha)	Crops	Yield q/ha		
Maize-Vegetables-Pulses (1)	80.45	Maize	69.04	11.41	16.52
Maize-Vegetables (2)	86.65	French Bean	68.85	17.8	25.85
Tomato-Other Vegetables (3)	162.23	Tomato	95.77	66.46	69.39
Sugarcane-Vegetables-Turmeric (4)	1508.29	Sugarcane	978.54	529.75	54.13
Wheat-Vegetables-Pulses (5)	73.99	Wheat	35.61	38.38	107.77
Wheat-Vegetables (6)	76.46	Pea	66.27	10.19	15.37
Wheat-vegetable & oil seed crop (7)	50.51	Mustard	28.76	21.75	75.62

Net Returns

NF	Net Returns (Rs.)	CF	Net Returns (Rs.)	Increase change in net returns of NF over CF (%)
Maize-Vegetables-Pulses	108241.90	Maize	84731.39	27.74
Maize-Vegetables	101893.19	Tomato	72185.19	41.15
Tomato-other Vegetables	189505.49	French bean	94896.49	99.69
Sugarcane, vegetable & French Bean	302684.55	Sugarcane	77684.55	289.63
Wheat-Vegetables-Pulses	100423.39	Wheat	58157.87	72.67
Wheat-Vegetables	100605.05	Pea	75672.05	32.94
Wheat, vegetable & oil seed crop	55839.72	Mustard	65839.72	-15.18

NF	B:C	CF	B:C	Increase change of NF over CF (%)
Maize, vegetable & pulse	1.75	Maize	1.51	15.89
Maize & vegetable	1.51	Tomato	1.28	17.96
Tomato & other Vegetable	1.79	French bean	1.53	16.99
Sugarcane, vegetable & turmeric	4.33	Sugarcane	0.82	428.04
Wheat- Vegetables- pulses	1.68	Wheat	1.38	21.73
Wheat- Vegetables	1.83	Pea	1.42	28.87
Wheat-Vegetables- Oil seed crop	1.12	Mustard	1.84	-39.13

References

Galab S, Reddy PP, Raju SR, Ravi C and Rajani A. 2019. Impact assessment of Zero Budget NF in Andhra Pradesh – *Kharif* 2018-19, Centre for Economic and Social Studies, Nizamiah Observatory Campus, Begumpet, Telangan. 60p.

Mahajan A and Dev K. 2022. Resource use efficiency of NF systems in low hills of Himachal Pradesh. *Indian Journal of Economics and Development* 18: 239-42.

ESFS-NF/NFSET2024/3031

Effect of natural farming on quality seed production of intercropped *Tagetes* varieties

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Keywords: *Tagetes*, Intercropping, Natural Farming

Introduction

Marigold is considered as one of the most important annual flower crops. There is a constant demand for flowers throughout the year for various functions, festivals, marriages, and floral decorations. Natural farming practices including intercropping has now become a focus for study by a range of agri-ecological and environmental scientists with broad research interests. Natural farming system with intercropping of french bean and soybean, where legumes fix the atmospheric nitrogen, release in the soil. Growing of millets has many advantages since millets are a power house of nutrients.

Material and methods

The study evaluated varieties of marigold for seed production based on intercrops such as pulses, vegetables and millets under natural farming system. The study was conducted in RCBD with 10 treatments replicated thrice. Observations were recorded at regular intervals according to standard methods.

Results and conclusion

The results documented that T_1 [Punjab Gainda No. 1 (V_1)] recorded maximum number of branches per plant (35.66), followed by the treatment T_4 [Punjab Gainda No. 1 (V_1) (34.33) + Soybean (11.33)] is different significantly. Number of capitula (82), number of seeds per capitula (349) and seed yield per plant (75) were recorded maximum in T_2 [Sole crop (V_2)], followed by T_8 [Pusa Deep (V_2)+ Soybean].

Table 1: Effect of natural farming on seed production of *Tagetes* varieties

Treatment	Marigold (Main Crop)				French bean, Soybean, Chilli, Kodo Millet (Intercrops)			
	No of branches/ plant	No of capitula	No of seeds/ capitula	Seed yield (g).	No of branches/ plant	No of pods/Fruits/ panicles	No of seeds/ pod/Fruits/ panicle	Seed yield (g).
T_1-Sole crop (V_1)	35.66	57	236	36	-	-	-	-
T_2 -Sole crop(V_2)	28.33	82	349	75	-	-	-	-
T_3-V_1 + French bean	30.00	51	224	35	6.60	37.7	4.16	161.05
T_4-V_1+ Soybean	34.33	55	246	38	11.33	24.22	3.5	168.3
T_5 -V_1 + Chilli	30.88	49	223	35	5.63	35.63	23.05	23.98
T_6-V_1 + Kodo millet	24.55	46	220	36	4.88	5.2	220.23	6.5
T_7 V_2 + French bean	22.25	78	340	72	8.31	35.92	4.14	166.41
T_8-V_2 + Soybean	25.32	85	348	75	11.62	38.23	3.16	175.8
T_9-V_2 + Chilli	24.43	82	342	66	6.96	25.76	23.54	25.3
T_{10}-V_2+ Kodo millet	23.20	84	340	65	6.59	5.33	235.42	7
Mean	27.89	67.2	286.8	53.3	7.74	25.99	64.65	91.79
CD $_{0.05}$	0.97	0.28	4.10	0.23	1.11	1.50	2.46	4.75

References

Vashishat RK, Laishram C and Sharma S. 2021. Problems and factors affecting adoption of natural farming in Sirmaur district of Himachal Pradesh. *Indian J Ecology* 48: 944–949.

ESFS-NF/NFSET2024/3032

Breakthrough of natural farming in Himachal Pradesh: A Case study of Indora block in Kangra

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Keywords: Conventional Farming, Crop Equivalent Yield, Cropping Systems

Introduction

Natural Farming (NF) is a farming method that addresses farmers' top concerns about the rising expense of production. It essentially envisions ecological or regenerative farming practices that forbid applying any form of pesticides to soil biosystem.Its focus on soil health, biodiversity and reduced input costs can lead to increased agricultural yields and returns.The method emphasizes the application of natural mixtures created from cow dung, cow urine, jaggery, pulse flour etc., mulching practices, and symbiotic intercropping instead of using synthetic chemical inputs (fertilizer and insecticides) at all. It depends on four pillars i.e., *Jeevamrita, Beejamrita, Acchadana* and *Whapasa*.

Material and methods

The primary data were collected from 100 Natural farmers of Indora block of Kangra district in Himachal Pradesh. All respondents were separated into three groups based on the size of their land holding: marginal (less than 1 ha), small (between 1 and 2 ha), and medium (between 2 and 4 ha). The Socio-economic analysis was done for sampled natural farming house hold.The data collected showed the cropping patterns, income patterns along with quantity of input use compared to prices under NF and CF system. The comparison between NF and CF with respect to Production cost, net return and crop equivalent yield.

Crop Equivalent Yield (CEY): A variety of crops were grown in a multiple or mixed cropping system in NF. Therefore, comparing the economics of multiple crops with a single crop was very challenging. Crop equivalent yield is the total of equivalent major and intercrop yields. To compare different cropping sequences, economic returns and crop equivalent yields (CEY) were used

$$\text{CEY} = C_y + [C_{1_y} \times \frac{P_{C_1}}{P_C}] + [C_{2_y} \times \frac{P_{C_2}}{P_C}] + \ldots\ldots + [C_{n_y} \times \frac{P_{C_n}}{P_C}]$$

Results and conclusion

The yield was more in all crop combination under NF over CF systems. Percentage increase yield in NF over CF in kharif season is varied between 1.37-5.98 per cent and in rabi season it was varied between 2.98 – 4.64 percent. Maximum increase in yield was of Vegetables-pulses system (5.98%) in kharif season followed by cereal-pulses (4.42%) in rabi season. The cost of cultivation was lower in all crop combination under NF over CF systems. The percentage decrease cost in NF over CF varied between 3.50 – 9.079 per cent in kharif and 0.13-15.60 per cent in rabi season. Maximum reduction of cereal- vegetable (15.60%) in rabi season followed by vegetable-pulses (9.07%) in kharif season. The sampled household were grown 21 diverse crops annually i.e 10 in kharif and 11 in rabi season under natural farming and 3 crops under conventional farming.

The relative economic efficiency (ECC) of NF was higher compared to CF in both rabi and Kharif seasons. This means that NF is more economically efficient in terms of less cost of cultivation and also generating net returns.

Table 1: Comparison of crop equivalent yield (CEY), cost of cultivation and net return between natural farming (NF) and conventional farming (CF)

Crop Combination	CEY (q/ha)					
	Kharif			Rabi		
	NF	CF	% increase in NF over CF	NF	CF	% increase in NF over CF
Cereal + Pulses	38.81	38.29	1.37	38.41	36.84	4.25
Cereal + Vegetable	33.35	32.15	3.73	38.03	36.93	2.98
Vegetable+ Pulses	29.38	27.73	5.98	34.94	33.38	4.64
Crop Combination	Cost of cultivation (Rs/ha)					
	Kharif			Rabi		
	NF	CF	% increase in CF over NF	NF	CF	% increase in CF over NF
Cereal + Pulses	47162.69	48873.79	3.50	51885.62	51954.12	0.13
Cereal + Vegetable	55076.34	58827.88	6.37	48781.41	57802.61	15.6
Vegetable+ Pulses	55749.88	61316.85	9.07	54488.81	53448.62	1.94
Crop Combination	Net Returns (Rs/ha)					
	Kharif			Rabi		
	NF	CF	ECC of NF Over CF	NF	CF	ECC of NF Over CF
Cereal + Pulses	14001.35	10787.26	29.80	29239.88	24982.26	17.04
Cereal + Vegetable	20548.64	17002.17	20.86	37279.5	30135.89	23.70
Vegetable+ Pulses	28494.43	25004.2	13.96	146869.75	134698.01	9.04

Referencs

Babalad H B and Navali GV. 2021. Comparative Economics of Zero Budget NF and CF systems in northern dry zone (Zone-3) of Karnataka. *Economic Affairs* 66: 355-61.

Chandel RS, Gupta M, Sharma S, Sharma PL, Verma S and Chandel A. 2021. Impact of Palekar's NF on Farmers; Economy in Himachal Pradesh. *Indian Journal of Ecology* 48:872-77.

ESFS-NF/NFSET2024/3033

Land use patterns and challenges in natural and organic farming practices across Kangra district of Himachal Pradesh

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Keywords: cultivation practices, natural farming, Organic, land use, sustainable agriculture

Introduction

The study explores land use patterns, cultivation practices, and the challenges faced by farmers under CETARA-Natural Farming (NF), Organic PGS, and Third-Party Certification systems in Kangra district, Himachal Pradesh. This region was selected due to its high concentration of certified farmers practicing sustainable agriculture. The research aims to fill gaps in the literature regarding the specific challenges faced by farmers under different certification systems, particularly in adopting natural farming practices that avoid synthetic inputs and promote ecological balance.

Material and methods

Kangra district, representing 10.31% of Himachal Pradesh's total area, was chosen for its significant number of farmers engaged in natural and organic farming. A multistage random sampling design selected 120 farmers across five blocks—Dehra Gopipur, Paragpur, NagrotaBagwan, Palampur, and Bhawarna—categorized into CETARA-NF, Organic PGS, and Third-Party Certification systems. Data on total land holdings, cultivated areas, and challenges faced were collected. The Chi-square test was employed to analyze problems associated with adopting each certification system.

Results and conclusion

Average total land holding was 0.40 ha, with 0.30 ha under cultivation. Natural farming was prominent, particularly among CETARA-NF farmers, who dedicated an average of 0.17 ha to such practices. Chi-square analysis revealed significant differences in challenges faced by farmers under different certification systems.

Highest Chi-square value (11.67) was observed for resource availability issues, indicating that access to resources is a major problem for farmers, especially under TPC. Other significant challenges included positive health reviews (10.25), response in generating certificates (9.03), and market demand/consumer preference (7.05), all significant at the 5% level. These findings suggest that resource management, certification processes, and market dynamics are critical areas for intervention to support sustainable farming practices.

References

Laishram C, Vashishat RK, Sharma S, Rajkumari B, Mishra N, Barwal P, Vaidya MK, Sharma R, Chandel RS, Chandel A, Gupta RK and Sharma N. 2022. Impact of natural farming cropping system on rural households—Evidence from Solan district of Himachal Pradesh, India. *Frontiers in Sustainable Food Systems* 6: 878015.

Malik DP. (2020). Organic farming in India: Production, export, certification, and policy support. *Indian Journal of Agricultural Sciences* 90(1): 230-232.

ESFS-NF/NFSET2024/3034

Success Story of Natural Farming in Himachal Pradesh

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Keywords: Multilayer Cropping, Natural Farming, Net Returns, Marginal Farmers

Introduction

Agriculture is exposed to three of the greatest challenges of the 21st century- sustainable food and nutritional security, adaptation and mitigation of climate change and sustainable use of critical resources. This situation is posing a big question about the future of agriculture, rural youth and food production more severely in Himachal Pradesh situated in Himalayaswhere agriculture is main occupation with more marginal farmers. Natural farming can be a holistic alternative to the present paradigm of high-cost chemical inputs-based agriculture and to address the negative and uncertain impacts of climate change. It promotes sustainable multilayer crops production hence ensure nutritional and health security of farmers and society as a whole.

Material and methods

The study is based upon the primary data collected from 100 natural farmers each from four different zones *viz*., Dry temperate zone (Kinnaur), Temperate zone (Shimla), subtropical zone (Sirmaur) and tropical zone (Kangra) of Himachal Pradesh. All farmers were separated into three groups based on the size of their land holding: marginal (less than 1 ha), small (between 1 and 2 ha), and medium (between 2 and 4 ha). The data collected showed the socio-economic status, cropping patterns, income patterns along with quantity of input use compared to prices under NF and CF systems. The comparative analysis between NF and CF was conducted with respect to Crop equivalent yield, net returns and benefit cost ratio.
In addition, multilayer cropping Pattern is an optimal agricultural practice which optimizes space, water, light and nutrients resulting in increased productivity and sustainability. Hence very useful in case of marginal farmers; Crop equivalent Yield (CEY): in natural farming system comparing the economic viability of multilayer crop against a single crop become challenging. The varying yields of intercrop are converted into equivalent yield based on the market value of each crop. So, it is profitability indicator used in cost benefit analysis.

Results and conclusion

Natural farming significantly boosted crop equivalent yields across all four zones of Himachal Pradesh ranged from 3.81-93.13 per cent. Lowest yield improvement was observed in the temperate zone (Shimla), while the highest was in dry temperate zone (Kinnaur). Net returns also increased with natural farming, varying between 5.5% and 81.26%, with Shimla at the low end and Sirmour at the high end. Benefit-cost (B:C) showed similar positive trends, ranging from 36.92-97.33% compared to conventional methods.Moreover, natural farmers had followed multilayer cropping system by growing 2 to 5 crops simultaneously while conventional farmers had opted 1 to 2 crops only. On natural farms, 16 to 30 different crops were cultivated, in contrast to 4-9 in conventional farms. This study underscored that natural farming addressed key 21st century challenges, ensuring sustainable food and nutritional security, enhancing farmer livelihoods, and promoting sustainable resource use. It emphasized the need for ongoing collaboration among farmers, researchers, policymakers, and stakeholders to ensure the broad adoption and success of natural farming practices.

Table 1: Comparison of CEY, Net returns and benefit:cost between NF and CF

Dry Temperate Zone (Kinnaur)				
CEY				
	NF	CF		
Crop combination	Net returns Rs / 100 plants	Net returns Rs / 100 plants	Difference	% increase in yield
	31.55 Apple+(Rajmah + pea+ millet + veg + cereal)	16.34 Apple + Vegetables	15.21	93.13
Net returns				
	2,00,832	1,92,161	16171	8.42
BCR				
	NF	CF		
	2.91	1.72	1.19	69.18
No. of crops	16	09		
Temperate (Shimla)				
CEY				
	19.98 (Apple+pea +veg + pulses)	20.74 (Apple+pea+ veg+pulse)	0.76	3.81
Net Returns				
	157160	148907	8253	5.5
BCR				
	NF	CF		
	2.34	1.26	1.08	85.71
No. of crops	18	04		
Sub- Tropical (Sirmaur)				
CEY				
	291.22 (Maize +Veg +Pulses+ Sugarcane+Turmeric)	191.83 (Maize+ Frenchbean+Tomato+S cane)	99.39	51.81
Net returns				
	1,37,027	75,595	61432	81.26
BCR				
	NF	CF		
	1.48	0.75	0.73	97.33
No. of crops	30	07		
Tropical (Kangra)				
CEY				
	64.65 (Cereal+ pulses + veg)	41.22 (Cereal + pulses+veg)	23.43	56.84
Net returns				
	92143	80869	11274	13.94
BCR				
	NF	CF		
	0.89	0.65	0.24	
No. of crops	21	06		

References

Bharucha Z P, Mitjans S B and Pretty J. 2020. Towards redesign at scale through zerobudget natural farming in Andhra Pradesh, India. *International Journal of Agricultural sustainability* 18: 1-20.

ESFS-NF/ NFSET2024/3035

Natural Farming: Concerns and farmers perspectives

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***Keywords*: Natural farming, soil health, farmers' concerns**

Introduction

Agriculture is the backbone of the Indian economy, however intensive agro chemical based farming has posed serious environmental and health hazards. Apart increasing cultivation costs is a big challenge for small holders especially in the hilly states, hence reducing input costs for profit maximization is the need of the hour and Natural Farming (NF) is potential alternative to achieve this aim for sustainable agriculture production by improving soil health through soil biological activity. In Himachal Pradesh, a preponderant majority (89.96 percent of total population) lives in rural areas who rely on Agriculture is the main livelihood occupation. Agriculture provides direct employment to about 58 per cent of total workers of the state in spite of 80 per cent rainfed farming. State government has hence initiated a flagship programme to popularize natural farming; consequently, the area under NF has increased substantially in the state. However, still there are some concerns of the farmers which need due consideration in future endeavours to promote this noble technology.

Material and methods

A field based survey was conducted in six districts *viz*. Kangra, Bilaspur, Mandi, Lahaul & Spiti, Kullu and Hamirpur representing all agro-climatic zones of the state. A total 58 farmers practicing natural farming from 20 blocks of these districts were surveyed for assessing the adoption level of natural farming practices. Personal interview coupled with Focused Group Discussions (FGD) and visit to the fields of the identified individual farmer in presence of ATMA officials was organized for collecting the information and the collected data were analyzed to draw inferences. Soil samples from the KVK natural farming demonstration plots were analyzed after four years for physico-chemical properties and microbial count using standard analytical methods.

Results and conclusion

The results concluded that NF practices *viz., jeevamrit, beejamrit, ghanajeevamrit* and bio-formulations have been adopted by majority of the respondents in the state to the tune of 94.83, 91.38, 75.86 and 74.14 per cent, respectively.

Table 1: Adoption level of respondents about use of natural farming practices

SPNF Practice	Adoption (%)						Mean (n=58)
	Kangra (n=17)	Bilaspur (n=10)	Mandi (n=11)	Lahaul & Spiti (n=3)	Kullu (n=4)	Hamirpur (n=13)	
Beejamrit	100	70	81.81	100	100	100	91.38
Jeevamrit	100	90	81.81	100	100	100	94.83
Mulching	29.41	40	72.72	66.67	0.0	15.38	36.21
Wapasa	5.89	30	54.54	0.0	0.0	0.0	17.24
Ghanjeevamrit	64.70	70	81.81	100	100	76.92	75.86
Legumes	29.41	70	72.72	66.67	50	62.54	58.62
Bio-formulations	76.47	40	72.72	100	100	84.61	74.14

The study also revealed a substantial reduction in input costs in NF as compared to non-NF due to non-use of expensive agro-chemicals and better profitability (B:C). Studies revealed that the percent organic carbon, dehydrogenase activity and microbial biomass carbon in soil were higher under natural farming system as compared to conventional system. The yield of various crops particularly pulses outscored the conventional farming system resulting in higher net returns and profitability owing especially due to low costs of cultivation. Regarding management of pests and diseases, it was observed that some bioformulations like *tamarlassi, darekastra, dashparni, Brahamastra* etc. showed some promising results to check the populations of pests and diseases as prophylactic measures both under open and protected environment.

The benefits perceived by NF farmers range from less cost of cultivation, better quality and taste, etc, but the premium price benefit is not experienced by most of the farmers probably due to lack of certification, branding and marketing infrastructure. Hence it is pertinent to have a more focused approach for adoption of all four pillars of natural farming with emphasis on strong market linkages to draw maximum benefit/ impact of this technology.

ESFS-NF/ NFSET2024/3036

Impact of low-cost climate resilient Subhash Palekar Natural Farming in Kinnaur district of Himachal Pradesh

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Keywords: Natural Farming, Benefit cost ratio, Crop Equivalent Yield

Introduction

In an era where industrial agriculture is often criticized for its environmental impact and reliance on chemical inputs, Subhash Palekar Natural Farming (SPNF) presents a compelling alternative rooted in sustainability and self-sufficiency.SPNF promotes farming in harmony with nature, drastically cutting production costs by eliminating dependence on synthetic inputs and external financing. It emphasizes using homegrown seeds, locally sourced natural fertilizers, and practices that enhance soil fertility and biodiversity. SPNF's four pillars—*Jeevamrita, Beejamrita, Acchadana,* and *Whapasa*—focus on enriching the soil, protecting crops naturally, and optimizing water use.

Material and methods

Kinnaur is the hilly district of Himachal Pradesh situated in northern part of India was selected for the present study. Multi-stage random sampling was opted to select the ultimate sample of 100 farmers practicing natural farming. The major crop grown in Kinnaur is Apple and all the analysis is done on per 100 plants basis. The BCR is a profitability indicator used in cost-benefit analysis. It helps determine the viability of cash flows generated from an asset or project. It was used to measure returns per rupee of investment in apple cultivation.

Results and conclusion

The comparison of CEY, total cost and net-returns for various crop combinations under natural and conventional farming practices, focusing on different apple tree categories (non-bearing, initial fruiting, main fruiting, and above 30 years) is summarized in table 1. Myth was that yield decreases in NF but the study is showing that CEY was 35.72% and 529.58% higher in NF across both Kharif and Rabi seasons. Total decrease in total cost of Cultivation of 13.94% for kharif season and 18.62 % for rabi season is noticed in Natural Farming (NF) over CF. Total increase in Net returns of 49.78 per cent for kharif season is noticed in Natural Farming over Conventional Farming. Maximum BCR of apple cultivation was 2.91 which was under Natural Farming system as compared to Conventional Farming system was 1.72. Non availability of specialized market, unfair prices of produce and labour intensive were the main problems faced by the natural farmers.

References

Chandel RS, Gupta M, Sharma S, Sharma PL, Verma S and Chandel A. 2021. Impact of Palekar's Natural farming on Farmers; Economy in Himachal Pradesh. *Indian Journal of Ecology* 48: 872-77.

Vashishat RK, Laishram C and Sharma S. 2021. Problems and factors affecting adoption of natural farming in Sirmaur district of Himachal Pradesh. *Indian Journal of Ecology* 48: 944-49.

Table 1: Comparison of crop equivalent yield (CEY), total cost of cultivation, net return and benefit cost ratio (BC) between natural and conventional farming

<table>
<tr><th colspan="7">CEY (Qtl/ 100 plants)</th></tr>
<tr><th>Crop Combinations</th><th>Non – Bearing (0-7)</th><th>Initial fruiting year (8-12)</th><th>Main fruiting year (13-30)</th><th>Above 30 years</th><th>Difference between NF & CF</th><th>% increase of NF /CF</th></tr>
<tr><th colspan="7">Natural Farming</th></tr>
<tr><td>Kharif</td><td colspan="4"></td><td></td><td></td></tr>
<tr><td>Crop Combination 1 (Apple + Rajma + Millet)</td><td>10.18</td><td>20.09</td><td>41.19</td><td>89.01</td><td rowspan="2">11.076</td><td rowspan="2">35.72</td></tr>
<tr><td>Crop Combination 2 (Apple+ Rajma + Vegetables+ Maize)</td><td>15.4</td><td>26.29</td><td>46.11</td><td>88.38</td></tr>
<tr><td>Rabi</td><td colspan="4"></td><td></td><td></td></tr>
<tr><td>Crop Combination 3 (Apple + Pea + Cereals + Vegetables)</td><td>10.73</td><td>10.34</td><td>9.56</td><td>11.3</td><td rowspan="4">8.82</td><td rowspan="4">529.58</td></tr>
<tr><th colspan="5">Conventional Farming</th></tr>
<tr><td>Apple + Vegetables (Kharif)</td><td>1.96</td><td>12.04</td><td>32.74</td><td>77.28</td></tr>
<tr><td>Apple + Vegetables (Rabi)</td><td>1.44</td><td>1.51</td><td>2.03</td><td>1.68</td></tr>
<tr><th colspan="7">Total cost of cultivation (Rs/100 plants)</th></tr>
<tr><th colspan="7">Natural Farming</th></tr>
<tr><td>Kharif</td><td colspan="4"></td><td></td><td></td></tr>
<tr><td>Apple + Rajma + Millet</td><td>35,821.40</td><td>44,069.82</td><td>52,399.63</td><td>51,725.11</td><td rowspan="2">-7,786.72</td><td rowspan="2">-13.94</td></tr>
<tr><td>Apple+ Rajma + Vegetables+ Maize</td><td>39,990.60</td><td>49,392.71</td><td>58,268.12</td><td>52,950.57</td></tr>
<tr><td>Rabi Season</td><td colspan="4"></td><td></td><td></td></tr>
<tr><td>Apple + Pea + Cereals + Vegetables</td><td>30,054.12</td><td>32,640.66</td><td>37,352.33</td><td>37,996.06</td><td rowspan="4">-7,897.09</td><td rowspan="4">-18.62</td></tr>
<tr><th colspan="5">Conventional Farming</th></tr>
<tr><td>Apple + Vegetables (Kharif)</td><td>35,745.62</td><td>51,875.63</td><td>73,327.53</td><td>62,507.09</td></tr>
<tr><td>Apple + Vegetables (Rabi)</td><td>30,124.17</td><td>37,832.71</td><td>53,321.11</td><td>48,353.55</td></tr>
<tr><th colspan="7">Net Returns (Rs. 100/plants)</th></tr>
<tr><th colspan="7">Natural Farming</th></tr>
<tr><td>Kharif</td><td colspan="4"></td><td></td><td></td></tr>
<tr><td>Apple + Rajma + Millet</td><td>45,647.80</td><td>1,16,631.54</td><td>2,77,113.94</td><td>6,60,372.23</td><td rowspan="2">95,660.25</td><td rowspan="2">49.78</td></tr>
<tr><td>Apple+ Rajma + Vegetables+ Maize</td><td>83,111.22</td><td>1,59,184.59</td><td>3,08,361.83</td><td>6,52,153.12</td></tr>
<tr><td>Rabi</td><td colspan="4"></td><td></td><td></td></tr>
<tr><td>Apple + Pea + Cereals + Vegetables</td><td>55,767.51</td><td>50,102.57</td><td>39,125.76</td><td>52,421.75</td><td rowspan="4">78,434.83</td><td rowspan="4">269.72</td></tr>
<tr><th colspan="5">Conventional Farming</th></tr>
<tr><td>Apple + Vegetables (Kharif)</td><td>-20,099.57</td><td>44,409.11</td><td>1,88,617.82</td><td>5,55,719.77</td></tr>
<tr><td>Apple + Vegetables (Rabi)</td><td>-18,574.96</td><td>-25,736.41</td><td>-37,101.05</td><td>-34,909.32</td></tr>
<tr><th colspan="7">Benefit Cost Ratio</th></tr>
<tr><th>Farming System</th><th colspan="2">Natural Farming</th><th colspan="2">Conventional Farming</th><th></th><th></th></tr>
<tr><td>Benefit Cost Ratio (BCR)</td><td colspan="2">2.91</td><td colspan="2">1.72</td><td>1.19</td><td>69.19</td></tr>
</table>

ESFS-NF/ NFSET2024/3037

Comparison of socio-economic aspects of Natural farming vs Conventional Farming

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Keywords: Conservation, Mixed cropping, Natural farming (NF), Sustainability.

Introduction

Natural farming in Himachal Pradesh emphasizes sustainable agricultural practices that align with the natural environment. It involves no use of chemical fertilizers and pesticides, focusing instead on natural inputs like compost, cow dung, and urine, khatti lassi, jaggery, pulse flour etc. The practice supports biodiversity, enhances soil fertility, and promotes water conservation, which is crucial in the hilly terrain of Himachal Pradesh. This approach not only helps in producing healthier crops but also ensures long-term environmental sustainability, making it an increasingly popular choice among farmers in the region. It depends on four pillars i.e., Jeevamrita, Beejamrita, Acchadana and Whapasa.

Material and methods

The study was conducted in Indian sub-continent where primary data were collected from 60 farmers practicing natural farming in Chopal and Jubbal Kotkhai blocks of shimla district of Himachal Pradesh. A simple random sampling method was used for the survey. To analyze the data, respondents were categorized into three groups based on their landholding size: marginal (less than 1 ha), small (above 2 ha), and medium (between 2 and 4 ha). The data revealed cropping patterns, Yield cost and return trends, and the quantity of input use compared to prices under both the natural farming (NF) and conventional farming (CF) systems.

Results and conclusion

The study revealed that the natural farming system outperforms the conventional farming system in terms of Crop Equivalent Yield (CEY), cost efficiency, and net returns. CEY was 7.01 and 147.73 per cent higher in natural farming across both Kharif and Rabi seasons. The table presents a comparison of costs and returns for various crop combinations under natural and conventional farming practices, focusing on different growth stages (non-bearing, initial fruiting, main fruiting, and above 30 years).

In natural farming, the kharif season combinations show favorable returns, with 4.30 per cent more increase and in rabi 207.07 per cent increase over conventional farming. Conventional farming shows a stark contrast, with significantly higher 48.30 and 31.69 per cent costs of cultivation compared to natural farming. Overall, natural farming practices offer more consistent and favorable returns with lower cultivation costs, especially for the kharif season and certain crop combinations. Overall, natural farming proves to be a more economically viable and sustainable approach compared to conventional methods.

References

Dev P, Paliyal SS and Rana N. 2022. Subhash Palekar natural farming-scope, efficacy and critics. *Environment Conservation Journal* 23: 99-106.

Kumar A and Kumari S. 2020. A review on Zero Budget Natural Farming: a path towards sustainable agriculture. *The Pharma Innovation Journal* 9: 236-239.

Table 1. Comparison of socio-economic aspects of Natural farming vs Conventional farming; crop equivalent yield, cost of cultivation and net returns

Crop Combinations	Non – Bearing (0-7)	Initial fruiting year (8-12)	Main fruiting year (13-30)	Above 30 years	Diff between NF & CF	Increase of NF /CF (%)
CEY (Qtl/Ha)						
Natural Farming						
Kharif Season						
Crop Combination 1 (Apple + Bean+Other Vegetables)	6.34	36.06	60.06	56.06		
Crop Combination 2 (Apple + Pulses + Vegetables)	6.42	41.02	66.62	64.62	**2.76**	**7.01%**
Rabi Season						
Crop Combination 3 (Apple + Pea)	5.34	4.98	3.95	3.89	**3.10**	**147.73**
Crop Combination 4 (Apple + Pulses + Vegetables)	6.34	5.23	4.95	4.65		
Crop Combination 5 (Apple +Pea+ Other Vegetables)	6.4	5.98	5.45	5.27		
Conventional Farming						
Apple+pulses+bean+ vegetables (kharif)	2.6	42.56	58.18	54.21		
Apple+pulses+bean+ vegetables (rabi)	2.8	2.4	1.8	1.4		
Total cost of cultivation (Rs/100 plants)						
Natural Farming						
Kharif Season						
Apple + Bean+Other Vegetables	28415.99	42504.3	62902.	60972.	**-45970**	**48.72**
Apple + Pulses + Vegetables	29917.4	41261.9	61758.8	59322.7		
Rabi Season					**Rabi Season**	
Apple + Pea	28868.0	27276.4	43791.0	45889.4	**-16807.9**	**31.69**
Apple + Pulses + Vegetables	29412.1	23545.1	40515.8	42893.2		
Apple +Pea+ Other Vegetables	29987.1	32587.0	45322.9	44594.3		
CF Kharif and Rabi						
Apple+pea+pulses+ vegetables	34724.4	68452.7	133639.	140592.		
Apple+pea+pulses+ vegetables	32561.2	35684.2	68457.2	75423.1		
Net Returns (Rs/100plants)						
Natural Farming						
Kharif Season						
Apple + Bean+Other Vegetables	17205.0	215571.	581866.	547475	**14152.88**	**4.30%**
Apple + Pulses + Vegetables	17251.7	204352.	583918.	576292.		
Rabi Season						
Apple + Pea	46735.2	51276.8	22042.1	32664.7	**64296.15**	**207.07%**
Apple + Pulses + Vegetables	35991.1	40659.0	21926.4	22509.9		
Apple +Pea+ Other Vegetables	48460.0	33016.1	20140.3	23852.8		
Conventional Farming kharif and Rabi						
Apple+pea +pulses + vegetables	-22161.4	288029.	544816.	504670.		
Apple+pea +pulses + vegetables	-14235.1	-26451.1	-42153.2	-41253.1		

ESFS-NF/ NFSET2024/3038

Comparative efficacy of jeevamrit, organic manures and inorganic fertilizers in *Eclipta alba* L.

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***Keywords*:** Jeevamrit, Annual, Pharmaceutical, B:C

Introduction

Jeevamrit is one of the major inputs of SPNF. It is made up of cow dung, cow urine, gram flour, jiggery and water. It supplies adequate nutrients required for the plant growth. The growth, yield and economic analysis shows Jeevamrit can be used as n alternative to the chemical fertilizer and other organic manures and can be adopted by the farmers to increase the overall crop yield and income. Continuous use of chemical fertilizers has been reported to cause various detrimental effects on physical and chemical properties of soil. Use of organics (FYM, Vermicompost), naturals (Jeemarit, ghanjeevamrit) is eco- friendly and also sustains the productivity (Mandla and Sharma. 2022). *Eclipta alba* possesses wide range of pharmacological properties, therapeutic application and therefore, has a great economic value (Mukopadhyay et al. 2018). Due to huge demand of this plant by pharmaceutical and cosmetics industries, the wild collection is not sufficient to meet the growing pressure. The present study was carried out to study the effect of various manures on growth and yield of *E. alba.*

Material and methods

A field experiment was conducted during the year 2020- 2021 from May- September at experimental farm of the Department of Forest Products, College of Forestry, UHF Nauni, Solan (HP) situated at 30°25' N latitude and 76°11'E longitude at an elevation of 1270m in the N-W Himalayas. The experiment was laid out in Randomized Block Design with three replications and five treatments. The treatments included T_1-Absolute control, T_2-NPK (90:60:30 kg/ha), T_3– FYM (14.5t/ha), T_4- Vermicompost (5t/ha), T_5- Jeevamrit (three doses). Since, *Eclipta alba* is an annual herb, the nursery was raised in May and the seedlings were transplanted in the last fortnight of June at a spacing of 45×30 cm. The plants were harvested in the last fortnight of September. The data was recorded for various growth parameters (plant height, no. of branches and leaves) and yield parameters (plant biomass and estimated fresh yield) and benefit cost ratio.

Results and conclusion

The data presented in the table revealed that the maximum plant height (49.77 cm), no. of branches/ plant (14.44), no. of leaves/ plant (202.67), fresh above ground biomass (109.00) and estimated fresh yield (91.87 q/ha) was recorded maximum in T2 followed by treatment T4, T5 and T3. The lowest values for all the growth and yield parameters were recorded in T1 plant height (33.56 cm), no. of branches/ plant (7.00), no. of leaves/ plant (145.44), fresh above ground biomass (55.40) and estimated fresh yield (46.23 q/ha). The maximum benefit cost ratio was recorded in T2 (2.01) followed by T5 (1.76), T4 (1.12) and T3 (1.10). The minimum BC ratio was recorded in T1 (1.04). The BC ratio ranged from 1.04 to 2.01.

Table 1: Effect of various manures on growth and yield of *E. alba*

Treatment	Plant height (cm)	Number of branches/ plant	Number of leaves/ plant	Fresh above ground biomass (g)	Estimated fresh yield (q/ha)	B:C
T_1	33.56	7.00	145.44	55.40	46.23	1.04
T_2	49.77	14.44	202.67	109.00	91.87	2.01
T_3	42.84	9.33	158.67	68.77	58.22	1.10
T_4	46.88	12.11	183.33	91.06	77.60	1.12
T_5	44.62	10.33	169.33	76.84	65.74	1.76
C.D(0.05)	0.95	0.88	3.26	2.92	2.36	
SE(m)	0.31	0.29	1.08	0.961	0.78	
SE(d)	0.44	0.41	1.53	1.36	1.11	
C.V (%)	1.08	3.83	0.92	1.58	1.51	

References

Mandla I and Sharma S. 2022. Subhash Palekar Natural Farming: Introduction and its four pillars. *Just Agriculture* 3 (1): 1- 5.

Mukopadhyay G, Kandu S, Sarkar A, Sarkar P, Sengupta R and Kumar C. 2018. A review on physico-chemical and pharmacological activity of *Eclipta alba*. *The Pharma Innovation Journal* 7: 78-83.

ESFS-NF/ NFSET2024/3039

Sustainable growth and yield enhancement in *Origanum vulgare* L. through natural farming

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Keywords: Biomass Production, Chemical-Free Farming, Benefit cost ratio

Introduction

Natural farming is a holistic approach that emphasizes sustainability by leveraging nature's wisdom and minimizing external inputs. It focuses on soil health, biodiversity, and harmony with local ecosystems, avoiding synthetic fertilizers and pesticides to produce pure, chemical-free crops while maintaining ecological balance (Gerami et al. 2016). *Origanum vulgare* L. is a prime example of such cultivation that exemplifies these principles. Renowned for adding an "Italian taste" to Mediterranean dishes like pizza and pasta, Oregano thrives without synthetic aids, highlighting how farming practices can yield flavorful, nutritious ingredients while supporting long-term agricultural productivity and environmental health.

Material and methods

The present study explored the impact of organic manures, fertilizer on oregano's growth and yield. The research carried out at an altitude of 1270 m using a randomized block design with three replications and five treatments aligned with natural farming principles. The treatments included Control, NPK (90:45:30 kg/ha), FYM (4t/ha), Vermicompost (2t/ha) and Jeevamrit (three splits). The study emphasized sustainable agricultural practices, highlighting the role of organic amendments like FYM, Vermicompost, and Jeevamrit in promoting growth, yield, and the quality of oregano in natural farming systems. These practices reduced dependency on chemical inputs (Gokdogan O. 2016) by enhancing soil health and contributing to environmentally friendly cultivation methods aligning with the principles of natural farming.

Results and conclusion

The data presented in the table revealed that the plant height was maximized in the T_2 treatment (55.67 cm) *i.e.* Vermicompost at 2 t/ha. The number of branches and leaves per plant were both found maximum in the T_2 treatment NPK i.e. 6.06 and 212.11 respectively, which was applied at rate of 90:45:30 kg/ha. Regarding biomass, the estimated fresh aerial biomass was found maximum in the T_2 treatment (19.64 q/ha) with NPK (5.62 q/ ha) at 90:45:30 kg/ha, while the estimated dry aerial biomass was found maximum in the T_2 treatment with NPK.

These results highlight the effectiveness of vermicompost for enhancing plant height and fresh biomass, and NPK for increasing branch count, leaf number and dry biomass. Vermicompost and FYM enhance *Origanum vulgare* L. (oregano) growth by providing essential nutrients, improving soil structure, and boosting microbial activity. These organic amendments support better plant health, higher yields, and sustainable soil fertility.

Table 1. Effect of bio-organic sources on growth, yield and quality of oregano

Treatment	Plant height (cm)	Number of branches per plant	Estimated Fresh aerial biomass (q/ha)	Estimated dry aerial biomass (q/ha)	B:C ratio
T_1: Control	35.66	3.56	10.99	3.15	0.83
T_2 : NPK (90:45:30) kg/ha	55.67	6.06	19.64	5.62	1.27
T_3: FYM (4t/ha)	47.29	5.06	17.77	4.68	1.12
T_4: Vermicompost (2t/ha)	53.78	5.33	17.91	5.02	1.2
T_5: Jeevamrit	50.17	4.89	15.51	3.99	1.02
Mean	50.04	55.61	4.83	6.89	
Factors	$CD_{0.05}$	$CD_{0.05}$	$CD_{0.05}$	$CD_{0.05.}$	
Treatment (T)	3.65	0.57	0.29	0.08	
Harvesting (H)	1.96	0.30	0.15	0.04	
T x H	NS	NS	0.40	0.11	

References

Gerami F, Moghaddam PR, Ghorbani R and Hassani A. 2016. Effects of irrigation intervals and organic manure on morphological traits, essential oil content and yield of oregano (*Origanum vulgare* L.). *Anais da Academia Brasileira de Ciencias* 88: 2375-2385.

Gokdogan O. 2016. Determination of input-output energy and economic analysis of lavender production in Turkey. *International Journal of Agricultural and Biological Engineering* 9: 154-161.

ESFS-NF/ NFSET2024/3040

Enhancing productivity of cauliflower-lentil based intercropping system under mid hills of Western Himalayas

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Keywords: Agroforestry, Intercropping, Jeevamrit, Legumes

Introduction

Cultivating trees and agricultural crops in intimate combination with one another is an ancient practice that farmers have used throughout the world. Inclusion of legumes as intercrop, not only provides nitrogen to the base crop but also increases the amount of humus in the soil due to decaying crop remains (Kheroar and Patra, 2013). Quantifying the beneficial and competitive effects of nutrient use in intercropping systems is important as well as necessary. The use of organic liquid products such as *Jeevamrit* and Panchagavya results in higher growth, yield and quality of crops (Palekar, 2006).

Material and methods

A field experiment was laid out in RBD (Factorial) Design having crops *Brassica oleracea* L.*var. botrytis* [Cauliflower (CF)] :*Lens culinaris* [Lentil (L)] in *Rabi* season with three factors viz., two planting condition (*Grewia* based Agroforestry system and open condition), six intercropping patterns (I_1 1:1 row system i.e.one row of cauliflower and onerow of lentil, I_2 1:2 row system i.e. one row of cauliflower and tworows of lentil, I_3 2:1 row system i.e. two rows of cauliflower and onerow of lentil, I_4 2:2 row system i.e. two rows of cauliflower and tworows of lentil, I_5 0:1 row system i.e. Sole lentil and I_6 1:0 row system i.e. sole cauliflower) and 3 nutrient sources (T_1: RDF with FYM, T_2: Jeevamrit @500 l/ha and T_3: No manure). The study optimizes cauliflower production in mixture, lentil as intercrop and evaluate the sustainability of intercropping systems based on Cauliflower on the basis of yield, LER and economic net income.

Results and conclusion

The results revealed that maximum yield parameters of both crops were recorded under *Grewia* based Agroforestry systems.Among the intercropping patterns, the yield parameters of cauliflower and Lentil performs better in sole cropping. Among the nutrient sources the maximum yield of both the crops were recorded on application of Recommended Dose of Fertilizer with FYMfollowed by Jeevamrit whereas, minimum were recorded in control where no manure was applied.From the economic point of view, 1:1 intercropping pattern provide higher net returns(433645.14 Rs ha^{-1})under Grewia based Agroforestry system.Among the different intercropping patterns of Cauliflower-Lentil, the comparatively higher(1.55) LER was recorded in I_1 i.e. 1:1 row system (indicating yield advantage) followed by 1.54, 1.39 and 1.32 for 1:2, 2:2 and 2:1 row system, respectively. The percentage land saved was significantly higher (34.21 %) in I_1 whereas minimum (23.12) was recorded in I_3 i.e. 2:1 row system of Cauliflower-Lentil intercropping system which was statistically at par with the I_4. In both cropping years, for the vegetable crop values of competitive ratio were greater than one while, it was less than one were recorded for legumes. The maximum (2.17) value of competitive ratio for Cauliflower was recorded in I_2 and followed the decreasing precedence in other intercropping patterns as $I_2>I_1>I_4>I_3$ with the minimum value of CR (1.09) recorded in I_3 (Table 1).Hence, it is concluded that 1:1 row system of *Cauliflower*-Lentil with application of RDF along with FYM under Grewia based Agroforestry system is eluded as most cost effective combination.

Table 1: Effect of different intercropping patterns on Land equivalent ratio, percentage land saved and Competitive ratio under Cauliflower- Lentil *max* intercropping system

Intercropping Patterns	**LER Cauliflower- Lentil**			**Percentage land Saved**		
	2020	**2021**	**Pooled**	**2020**	**2021**	**Pooled**
I_1 1:1 row system	1.54	1.56	1.55	31.13	37.29	34.21
I_2 1:2 row system	1.48	1.60	1.54	31.74	34.97	33.35
I_3 2:1 row system	1.30	1.34	1.32	21.09	25.14	23.12
I_4 2:2 row system	1.28	1.49	1.39	18.20	32.09	25.14
I_5 Sole	1.00	1.00	1.00	-	-	
$CD_{0.05}$	0.19	0.10	0.11	10.45	32.09	25.14
	Competitive ratio Cauliflower			Competitive ratio Lentil		
I_1 1:1 row system	1.60	1.62	1.61	0.72	0.64	0.68
I_2 1:2 row system	2.03	2.31	2.17	0.56	0.45	0.51
I_3 2:1 row system	1.05	1.12	1.09	0.96	0.92	0.94
I_4 2:2 row system	1.25	1.51	1.38	0.92	0.70	0.81
$CD_{0.05}$	0.42	0.24	0.28	0.19	0.10	0.12

References

Kheroar S and Patra BC. 2013. Advantages of maize-legume intercropping systems. *Journal of Agricultural Science and Technology.B* 3(10B): 733.

Palekar S. 2006. Text book on shoonya bandovalada naisargika krushi, published by swamyanand Agri Prakashan, Bangalore, 67.

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Intercropping systems under natural farming module impacts yield and economics in mid-hills of Chamba district

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***Keywords**:* Capsicum, Cucumber, Intercropping, Natural Farming, Tomato

Introduction

India is facing population crisis and per capita land holding is decreasing. To sustain, small and marginal farmers are focusing more on vegetable cultivation, which is demanding more input and offers less returns. The concept of natural farming is now gaining popularity among farmers as input is bare minimum and output is on higher side. However farmers are more focussed on sole cropping of vegetables of same family. To reduce the dependency of farmers on single crop an experiment was designed to study the effect of intercropping on yield and economics under mid hills conditions of Chamba district.

Material and methods

In total there were six treatments viz. T1: Tomato sole crop, T2: Tomato + French Bean, T3: Capsicum sole crop, T4: Capsicum + French Bean T5: Cucumber sole crop, T6: Cucumber + French Bean. The experiment was laid out in RBD with each treatment replicated thrice. Standard application of ghanjeevamrit, jeeveamrit was done and for control of foliar diseases application of khatti lassi was done. The parameters recorded were plant height, average fruit weight, number of fruits/pods per plant, equivalent yield and cost benefit ratio.

Results and conclusion

Results indicated that there was 5.9 per cent increase in tomato, 2.39% in capsicum and 9% increase in cucumber plant height when planted with bean as intercrop. Similarly when bean was planted as intercrop, it resulted in 5, 7 and 8% increase in average fruit weight of tomato, capsicum and cucumber when compared with sole crops. Number of fruits per plants was also altered when bean was planted as intercrop however the increase was non-significant in comparison to sole crop. Results indicated that equivalent yield was significantly affected by intercropping and there was 14, 8 and 16 per cent increase in equivalent yield of tomato, capsicum and cucumber when French bean was planted as intercrop as compared to sole cropping. It can observed from the table 1 that highest B:C ratio (3.14) was observed when tomato was planted with bean as intercrop. This increase in plant height, number of fruits, fruit weight and equivalent yield might be attributed to increase in soil fertility by planting French bean as leguminous inter crop (El-Gaid et al 2014).

It can be concluded that tomato along with French bean as intercrop is most beneficial intercropping system in natural farming module which will benefit the farming community in mid hills of Chamba district.

References

El-Gaid M A, Al-Dokeshy M and Nasse DM 2014. Effects of Intercropping System of Tomato and Common Bean on Growth, Yield Components and Land Equivalent Ratio in New Valley Governorate. *Asian Journal of Crop Science* 6(3): 254–261.

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Apical rooted cuttings: a promising technology to boost sustainable seed potato system in Himachal Pradesh

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***Keywords**:* Apical rooted cutting, micropropagation, mini-tuber

Introduction

Potato (*Solanum tuberosum* L) is the world's most important non grain food crop and is an important cash crop of Himachal Pradesh. Though, the crop has lower yield, fits in the cropping system of many small holder farmers and contributes to their income and food security.Healthy disease free seed is the most important requirement for sustainable potato production In Himachal Pradesh, non availability of disease-free quality seed potato is a major constraint. Seed is the most significant input in potato production and accounts for almost 40-50% of the total production cost. High seed cost forces farmers to use of previous year harvest as seed which has progressive viral degeneration resulting in low yield and higher disease incidence due to which farmers resort heavy application of chemical pesticides. Use of hi-tech systems like aeroponics, to produce quality seed tubers, require huge capital investment and primarily benefits larger landowners. There is need to develop alternate seed system for small holder farmers of Himachal which ensures good quality seeds at affordable prices.

Material and methods

Disease free mother culture of potato variety 'Kufri Himalini' were procured from CPRI Shimla and *in vitro* plants were multiplied on MS medium. One month old culture was hardened and planted in portrays.The apical cutting (2-3 cm) with two leaves was taken from the mother plants every 12-15 days either to replant in the mother bed for further cutting or plant in pro-trays filled with coco peat for rooting.

Results and conclusion

Each cutting rooted in 10-15 days in cocopeat without application of any growth regulators, In around 45 days, one micro plant produced upto eight rooted cuttings. These rooted cuttings of 15-20 days old were planted pots for first generation (G0) seed production. Each cutting produced 7-8 mini tubers. Thus each tissue culture raised plant could produce 40 minitubers which is at par with aeroponic technology. Batch-wise pedigree of the cuttings was maintained for virus testing so as even if any plant out of a cutting is found infected with a virus during testing, all the counterparts of the cutting/sister counterpart tubers can be rejected. Apical rooted cuttings (ARC) that integrates the use of tissue culture in potato seed system, is an easy to implement technology, with a small production cycle and can provide quality disease-free seed at par with aeroponics technology at a much lower cost.
This technology can easily be adopted by progressive farmers, FPOs to produce seed potato and supply it to small farmers in timely manner.

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Optimizing FPC Success: The Impact of Extension Institutes as Producer Organization Promoting Institutions Using Structured Four-Pillar Strategy

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Keywords: FPCs, POPIs, Reporting and Compliance

Introduction

Development of Farmer Producer Companies (FPCs) has emerged as a significant strategy to improve the socio-economic conditions of small and marginal farmers. However, the success of FPCs is contingent upon the support provided by Producer Organization Promoting Institutions (POPIs). Extension institutes, acting as POPIs, play a vital role in the development, sustainability, and effectiveness of FPCs. This study explores the effectiveness of extension institutes functioning as POPIs, focusing on a strategic framework built around four key pillars: Monitoring, Reporting and Compliance, Training, and Marketing. These pillars are essential in enhancing the operational efficiency and market competitiveness of FPCs.

Material and methods

To analyze the effective functioning of extension institutes as POPIs, a structured approach was developed based on four pillars:

Monitoring: This involved regular tracking of FPC activities to ensure alignment with goals and operational efficiency. Data collection tools, such as field visits and feedback forms, were used to gather information about FPC performance.
Reporting and Compliance: Standardized reporting formats were introduced to ensure transparency and accountability. Training sessions on regulatory compliance were conducted to ensure FPCs meet statutory requirements.
Training: Customized training programs were designed to enhance the skills of FPC members and management. These programs covered areas like leadership, financial management, business planning, and agricultural techniques.
Marketing: Extension institutes facilitated market linkages, identified potential buyers, and helped in branding and value addition. Workshops on market intelligence and strategy development were organized to enhance the market presence of FPCs. The impact of these interventions was evaluated using both qualitative and quantitative methods, including surveys, interviews, and financial analysis.

Results and conclusion

Structured approach of extension institutes acting as POPIs, based on the four pillars, has significantly enhanced the performance of FPCs. Monitoring ensures operational efficiency, while reporting and compliance maintain transparency. Training programs build capacity, and marketing support enhances market reach and profitability. This holistic approach has led to sustainable growth and improved socio-economic conditions for small and marginal farmers. The study underscores the importance of extension institutes as POPIs in promoting the success of FPCs and enhancing agricultural development.

Pillar	Key Outcomes
Monitoring	Improved operational efficiency; early issue detection
Reporting & Compliance	Enhanced transparency; increased access to schemes
Training	Better decision-making; skill development
Marketing	Increased market access; better price realization

References

Kumar S and Gupta P. 2019. Strategies for Enhancing the Sustainability of Farmer Producer Organizations. *International Journal of Rural Development 12*(3): 67-78.

Singh K and Sharma R. 2020. Role of Producer Organization Promoting Institutions in Strengthening Farmer Producer Companies. *Journal of Agricultural Extension Management* 45(2): 32-45.

Theme 4

Innovations in Sustainable Food Systems

ESFS-NF/ISFS2024/4001

An evaluation of Natural vs. Chemical Farming Modules for turmeric crop in Semi-Arid Gujarat Agroecosystems

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Keywords: *Bijamrut, Jivamrut, Ghanjivamrut*, Straw mulch

Introduction

Turmeric is one of the most important ancient spices of India.Turmeric is also called as "Indian Saffron''. India is the largest producer, consumer and exporter of turmeric in the world.On the other hand, inorganic fertilizerscontain concentrated forms of essential nutrients and provide readily available nutrients to plants, promoting rapid growth and high yields. However, excessive use of inorganic fertilizers can lead to soil degradation and environmental pollution. The organic manure gives better quality produce as compared to those grown with inorganic sources of fertilizer.

Material and methods

The experiment was conducted with two farming modules *viz*; natural farming (NF - natural input module) and conventional farming (CF - chemical input module). Among the different modules under testing, natural farming input module which consists three crop residue mulching practices like No Mulching (M_0), Crop residue mulch @ 5.0 t/ha (M_1) and Crop residue mulch @ 7.5 t/ha (M_2) as a main plot treatment along with three organic manures levels as a sub-plot treatment *viz*., *Ghanjivamrut* @ 2.5 t/ha(G_1), *Ghanjivamrut* @ 3.5 t/ha(G_2) and *Ghanjivamrut* @ 4.0 t/ha +(G_3). Common application of seed treatment with *bijamrut* (200 ml/kg) with *Jivamrut* @ 500 lit/ha at sowing, 30 and 60 DAS + *Jivamrut*foliar spray@ 7.5 % at 90 and 120 DAS in the case of conventional and chemical input applied.

Results and conclusion

In natural farming module, different residue management treatments along with *Ghanjivamrut* application did not exert significant effect on primary rhizomes/plant, secondary rhizomes/plant and yield (Table 1). The data revealed that the fresh rhizome yield increased with mulch (5.0 t/ha) and *Ghanjivamrut* (3.5 t/ha) combined application, which was 40.66 t/ha (natural farming–T_5) over conventional farming (19.29 t/ha). This may be owing to continuous availability of nutrients to turmeric plants because of their slow release of nutrients from *Ghanjivamrut* and incorporation of wheat straw along with microorganisms and supplemental nitrogen dose which helps in easy decomposition and slow releasing of nutrients in root zone area during entire crop growth period.In natural farming, if farmers have use own resources (Cow inputs) result obtained higher net return of Rs 1104360 with BCR 10.57 in T_5 (an application of 3.5 t/ha *Ghanjivamrut* along with wheat straw mulch @ 5.0 t/ha). In conventional farming, maximum net return of Rs 359677/ha with BCR 3.93.

The present study concluded that turmeric grown under natural condition in loamy sand soils of North Gujarat with application of 3.5 t/ha *Ghanjivamrut* + *Jivamrut* @ 500 lit/ha at sowing, 30 and 60 DAS + *Jivamrut* foliar spray@ 7.5 % at 90 and 120 DAS along with wheat straw mulch @ 5.0 t/ha recorded higher rhizome yield and economical realization.

Table 1: Effect of natural vs. chemical farming modules on yield attributes, yield andeconomics of turmeric

Treatment	No. of Primary rhizome	No. of Secondary rhizome	Fresh Rhizome Yield (t/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	BCR
T_1: No Mulch +*Ghanjivamrut* @ 2.5 t/ha	4.00	8.90	28.87	865980	750630	7.51
T_2: No Mulch + *Ghanjivamrut* @ 3.5 t/ha	4.20	8.40	34.21	1026390	911040	8.90
T_3: No Mulch +*Ghanjivamrut* @ 4.0 t/ha	4.15	9.05	36.22	1086600	971250	9.42
T_4: Wheat straw Mulch @ 5.0 t/ha + *Ghanjivamrut* @ 2.5 t/ha	4.25	9.15	34.22	1026690	911340	8.90
T_5: Wheat straw Mulch @ 5.0 t/ha + *Ghanjivamrut* @ 3.5 t/ha	4.15	9.60	40.66	1219710	1104360	10.57
T_6: Wheat straw Mulch @ 5.0 t/ha + *Ghanjivamrut* @ 4.0 t/ha	3.85	9.00	35.68	1070400	955050	9.28
T_7: Wheat straw Mulch @ 7.5 t/ha + *Ghanjivamrut* @ 2.5 t/ha	4.55	9.85	35.45	1063650	948300	9.22
T_8: Wheat straw Mulch @ 7.5 t/ha + *Ghanjivamrut* @ 3.5 t/ha	3.90	9.10	36.73	1101990	986640	9.55
T_9: Wheat straw Mulch @ 7.5 t/ha + *Ghanjivamrut* @ 4.0 t/ha	4.20	7.95	39.23	1176780	1061430	10.20
S.Em ±	0.34	0.89	3.10	-	-	-
C.D. (p=0.05)	NS	NS	NS	-	-	-
C.V. %	16.37	19.87	17.38	-	-	-
Conventional Farming	4.75	8.30	19.29	482325	359677	3.93

References

Manhas SS. 2009. Effect of different cultural practices on growth and yield of turmeric (*Curcuma longa* L.). Ph. D. dissertation, PAU, Ludhiana, India.

Verma A, Sarnaik DA 2006. Effect of different types of mulches on growth and yield of turmeric (*Curcuma longa* L.) *International Journal of Agriculture Science* 2: 425-426.

ESFS-NF/ISFS2024/4002

Postharvest application of microbial inoculants in litchi for increased shelf-life

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Keywords: Litchi, *Pseudomonus fluorescens*, Storage, *Trichoderma hrzianum*

Introduction

Litchi a subtropical short duration fruit preferred for its juicy sweet taste and flavour. Quick pericarp discoloration and microbial attack causes rapid deterioration of quality under storage. Due to enzyme inhibition and other protective effects, SO_2 is still the current practice to prevent the browning (Liang *et al*., 2012), but undesirable effects on fruit quality and health concerns have led to consumer rejection and legal restriction (Sivakumar *et al*., 2010).Thus the present experiment has been aimed to evaluate the performance of some microbial inoculants (*Pseudomonus fluorescens* and *Trichoderma harzianum*) as postharvest treatment to enhance the shelf life of litchi.

Material and methods

Cultures of *Pseudomonus fluorescens* and *Trichoderma harzianum* were diluted in double distilled water (@ 7.5, 10.0, 12.5 and 15.0 g per litre) and freshly harvested fruits were dipped into the solutions for 30 minute and kept on blotting paper for 10 minute. Treated fruits were then kept under cold chamber (modified atmospheric storage system at 10ºC, 90% RH). Different observations on physiological losses in weight, changes in pericarp colour, rotting index and other quality aspects like TSS, acidity, total sugar, reducing sugar etc. were observed at 2 days interval.

Results and conclusion

Under different doses of *P. fluorescens* resulted longer shelf life than the fruits treated with *T. harzianum* without much reduction in pericarp colour and fruit quality. Fruits under the treatment with *P. fluorescens* particularly @ 12.5g/l maintained most of all quality parameters as well as the pericarp colour. On the other hand *T. harzianum* and control treatment did not much effected the shelf life and quality of litchi.Lower physiological losses in weight, higher TSS, lower TSS acid ratio, higher sugar content has been maintained for long in case of *P. fluorescens* treatment (@12.5g/l). *P. fluorescens* treatment performed better with respect to most of all the quality aspect as well as higher shelf life. Maintenance of pericarp colour of litchi was also better in *P. fluorescens* treatment. With respect to maintenance of all quality parameters, pericarp colour and better shelf life, microbial inoculation of litchi fruits with *P. fluorescens* @ 12.5g/l performed best in the present experiment.

References

Liang YS, Chen NL, Ke LS. 2012. Influence of dipping in sodium metabisulfite on pericarp browning of litchi cv. Yu Her Pau (Feizixiao). *Postharvest Biology* and *Technology* 68: 72-77.

Sivakumar D, Terry LA, Korsten L. 2010. An overview on litchi fruit quality and alternative postharvest treatments to replace Sulphur dioxide fumigation. *Food Reviews International* 26: 162-188.

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Value Chain Dynamics of Green Pea: Pathways to Achieving SDGs 1, 2, and 8

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Keywords: Economic Growth, Value Chain, Sustainable Development

Introduction

Green pea production in Himachal Pradesh plays an important role in the agricultural economy, offering substantial income to small-scale farmers (Kumar et al. 2019). However, inefficiencies within the value chain can limit the potential benefits (Kaplinsky and Morris, 2001). This study analyzed the green pea value chain, identify bottlenecks, and suggest innovations that align with sustainable development goals.

Material and methods

Primary data were gathered through structured interviews with farmers, traders, and other stakeholders in the green pea value chain across Himachal Pradesh. Simple random sampling design was adopted to select the ultimate sample of the farmers. First of all, a list of vegetable growers was prepared. 30 farmers each from six blocks Theog, Rampur, Kullu, Pooh, Kaza and Keylong blocks were selected randomly. Thus, in all 180 respondents were selected randomly for the study. The value chain analysis framework was applied to assess different stages, including production, processing, and marketing. SWOT analysis was also conducted. Data were analyzed using descriptive statistics.

Results and conclusion

The value chain analysis revealed several critical bottlenecks, including inefficient market linkages, lack of proper storage facilities, and limited value addition at the farm level. The study found that farmers receive a relatively low share of the final consumer price due to the dominance of intermediaries. Introducing innovative practices, such as farmer cooperatives and direct marketing channels, can enhance the farmers' share of value addition. Additionally, integrating sustainable farming practices within the value chain can reduce environmental impact and improve crop resilience. The findings suggest that targeted interventions in the value chain can significantly boost the economic outcomes for green pea farmers, aligning with the objectives of sustainable development.

Table 1: Issues and innovations at different stages of the green pea value chain

S.N.	Stage	Issues identified	Suggested innovations
1	Production	Low productivity	Sustainable farming practices (Natural Farming)
2	Processing	Lack of facilities	Establishing small scale processing units
3	Marketing	Intermediary dominance	Farmer's co-operatives, FPOs.

References

Kaplinsky R and Morris M. 2001. *A handbook for value chain research*. International Development Research Centre.

Kumar R, Sharma P and Vyas V. 2019. Value chain analysis of vegetables in Himachal Pradesh: A case study of tomato and green pea. *Journal of Agricultural Development and Policy* 29(1): 45-54.

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Utilization of sand pear for development of dried products: a waste to worth approach

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***Keywords*:** Blanched, Candy, Polyphenols, Vinegar

Introduction

Sand pear is also called Asian pear or Korean pear as is popularly known as "Patharnakh" in Northern India and act as a rich source of vitamins, minerals, antioxidants and polyphenols (Chandel *et al.,* 2023; Samkaria *et al.,* 2024). Despite being rich in nutrients, this fruit is not used for table purposes especially because of its gritty texture and astringent nature. Because of this most of the produce still remains underutilized by the farmers. Hence, sand pear can be used for the development of value added products like chips ad cubes which can provide farmers and processors with an additional source of income.

Material and methods

The sand pear fruits were washed, peeled (1% NaCl), cut and blanched using different hot water (0-120 s) treatments and varied citric acid concentrations (0-1.00% for 0-60sec). The best treatment selected on the basis of sensory scores were osmotically dehydrated using different sugar syrup concentration 0-40ºB for 0-15 min and best treatment of chips were dried at 60ºC for 2h followed by 80ºC for 2h. The preparation of sand pear cubes, fruits were washed, peeled in 1% NaCl solution, then cut in cube shapes. The cube shapes sand pear blanched using different hot water treatment for 0-120sec and varied citric acid concentrations i.e. 0-1.5% for blanching time 0-120sec. Further the best treatment selected on the basis of sensory characteristics used for osmotic dehydration using syrup concentration 0-40ºB for 0-30 min and selected treatment of cubes used for drying at 60ºC for 2h followed by 80ºC for 1h.

Results and conclusion

Sand pear chips were treated with different treatmentsand best method i.e. citric acid blanching with 1.00% CA for 60 sec was selected on the basis of sensory characteristics with colour scores (8.45), appearance/ texture scores (8.50), flavour scores (8.40) and overall acceptability scores (8.50) for further osmotic dehydration. Best treatment (30ºB syrup concentration: 15 min) with highest colour scores (8.10), appearance/ texture scores (8.25), flavour scores (8.45) and overall acceptability scores (8.30) was reported (Fig 1a). However, the sand pear cubes treated with different blanching methods, citric acid blanching with 1.5 % CA for 90 sec was found best with colour scores (8.45), appearance/ texture scores (8.35), flavour scores (8.10) and overall acceptability scores (8.35). Further, best treatment of osmotic dehydration with 30ºB syrup concentration for 30 min of colour scores (8.00), appearance/ texture scores (8.10), flavour scores (8.00) and overall acceptability scores (8.00) was selected best (Fig 1b).

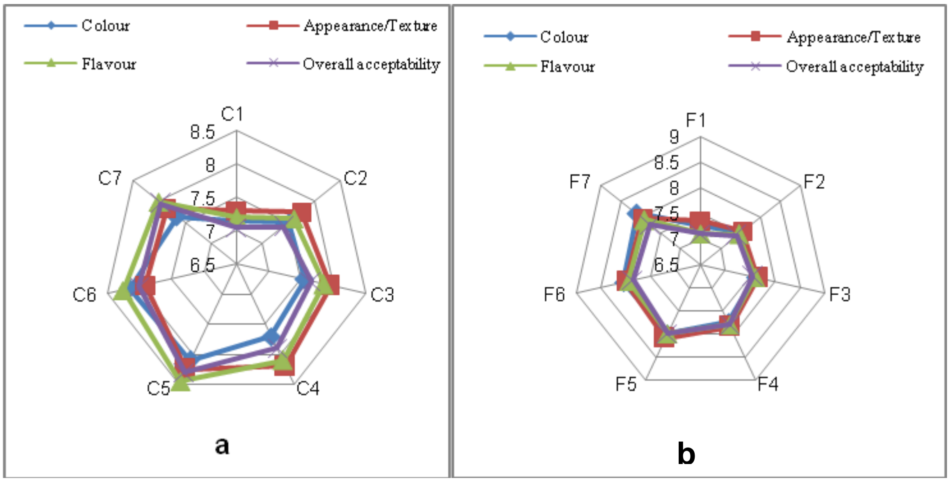

Fig 1 (a, b): Sensory quality of osmotic dehydrtaed sand pear chips and cubes

References

Chandel R, Kumar V, Kaur R, Kumar S, Kumar A, Kumar,D and Kapoor S. 2023. Bioactive compounds, health benefits and valorization of *Pyrus pyrifolia* (sand pear): a review. *Nutrition & Food Science 53*(7): 1061-1080.

Samkaria S, Sharma R, Soni P, Thakur A, Dileep KC, Thakur M and Attri SC. 2024. A review on phytochemical potential and enormous nutraceutical benefits of Sand pear (*Pyrus pyrifolia* L.). *Annals of Phytomedicine* 13(1): 388-396.

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Apple Pomace: A functional ingredient for boosting natural fiber in wheat pasta

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Keywords: Apple pomace, Bioactive compounds, Dietary fibre, Pasta, Polyphenols

Introduction

The shift from traditional to sustainable food systems has become a major focus worldwide, addressing environmental damage and the demand for more resilient farming methods. India, a major producer of fruits and vegetables, generates significant pomace from juice processing, which often goes to waste. Apple pomace is a heterogeneous mass consisting of skin and flesh (95%), seeds (2-4%) and stems (1%) is a valuable source of health-promoting compounds, mainly dietary fibre (DF) (35-65 g/100 g dry matter DM) and bioactive substances from the group of polyphenols (262-856 mg/100 g DM). The pomace is a valuable source of fiber, being cost-effective, with high water binding capacity and low enzyme digestibility. Utilizing this pomace can enhance the fiber content in various bakery products and reduce waste (Gumul *et al*., 2023).

Material and methods

To investigate the use of apple pomace in wheat pasta, the pomace was procured from a local industry. The pomace was grounded into a fine powder. The fiber content of the pomace was assessed using standard methods (AOAC, 2000) to determine its soluble and insoluble fiber levels. Wheat pasta was prepared with dried apple pomace at 10, 20, 30 and 50% levels, and a control, mixed in a rotary-roller mixer (Diosna, Germany) for 20 minutes. Extrusion was done using a Gina low-pressure extruder (Ostoni, Italy) at 50 °C and 3.4 × 10^5 Pa, followed by drying for 8 hours at 40 °C.

Results and conclusion

The results were analyzed to evaluate the impact of pomace on fiber enrichment and product quality. Findings were documented to guide market strategies for introducing these high-fiber, sustainable bakery products, highlighting their nutritional and environmental benefits. The control pasta had highest fat (2.25 g/100 g DM). Fat decreased with increasing apple pomace, with the highest pomace level showing 1.39 g/100 g DM. Reducing sugars and minerals varied, with apple pomace affecting these components differently. The analysis revealed a high fiber content (21.56 %) with soluble and insoluble fibers constituting a significant portion of the powder. Incorporating the pomace powder in pasta, with 10% pomace incorporation had fiber levels approximately 20-25% higher compared to control samples. Decrease in hardness and maximum cutting energy were also observed. Water absorption capacity was not influenced by the addition of apple pomace, with the exception of pasta made with 50% apple pomace. Sensory evaluation indicated that the pomace-enriched pasta was with acceptable taste, cooking time and texture.

References

AOAC. 2000. Official Methods of Analysis, 15th edn. Association of Official Analytical Chemists, Washington, DC.

Gumul D, Kruczek M, Ivanisova E, Słupski J and Kowalski S. 2023. Apple Pomace as an ingredient enriching wheat pasta with health-promoting compounds. *Foods* 12: 804-805

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Characterization of groundnut milk cream to expand its utilization for sustainable food systems

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Keywords: By-product utilization,Groundnut Milk cream, Vegan

Introduction

Groundnut cream is one of the by-products obtained during the processing of groundnut milk and tofu.The global peanut milk market is growing at the rate of 8.7%. The production and consumption of vegan milk products has increased tremendously and is accompanied by the accumulation of the by-products, which are not properly utilized and are discarded into the sewage or soil, posing environmental threat.The present study aims to understand the characteristics of groundnut milk cream, as affected by different treatments in the groundnut milk, for its utilization as a vegan alternative for dairy cream.

Material and methods

Groundnut milk was given microwave and ultrasonication treatment before separating the cream from the groundnut milk using centrifugal cream separator. The cream samples were stored at refrigerated temperature at 4±1°C for further studying the quality characteristics. The quality of cream samples was evaluated in terms of yield, pH, proximate composition, rheology and texture etc.

Results and conclusion

Some quality characteristics of the groundnut milk cream is shown in Table1. The cream samples were slightly acidic and had very high fat content, with the lowest fat content observed in microwaved sample. Moisture content in cream varies for differently treated samples. Water activity (a_w) is one of the few important parameters that dictate the shelf-life stability of food. The cream samples had high a_w(0.96) indicating a low stable food. The cream samples showed viscoelastic behaviour with lowering viscosity as shear stress increased. Firmness and consistency varied for all the cream samples. Most of the fat in groundnuts are monounsaturated and polyunsaturated fatty acids, which are a healthful type of fat, free from cholesterol.Understanding the quality characteristics and the healthful nature of groundnut fat, the cream obtained from groundnut milk can be utilized in vegan products replacing dairy cream which will be more sustainable for the planet and healthy for the people.

Table 1: Physicochemical characteristics of groundnut milk cream samples

Treatment	Yield (%)	pH	Moisture (%)	Fat (%)	a_w
Control	19.05	6.82	36.03	60.46	0.96
Microwave	19.04	6.96	38.69	53.65	0.96
Ultrasonic	17.39	6.92	36.21	57.23	0.96

References

Nimbkar S, Negi A, Thirukumaran R, Moses JA and Sinija VR. 2023. Effect of thermal and nonthermal techniques on the physicochemical quality of high-fat coconut cream. *Journal of Food Process Engineering* 46(12): e14462.

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Botanical and physico-chemical profiling of honey for food system resilience

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Keywords: Beekeeping, Honey, Pollen, Quality

Introduction

Honey, a natural sweetener produced by honeybees, is valued for its nutritional, medicinal, and economic benefits, containing over 180 beneficial compounds (Sharma et al., 2023). Honey is characterized by its physicochemical composition, sensory properties, and melissopalynological analysis, essential for detecting adulteration, botanical and geographical origins. The botanical as well as physiochemical profiling of honey provides insights into the nutritional and therapeutic potentials of the honey, making it valuable for health-oriented food products. This study, focused on the under-researched lower hills of Himachal Pradesh, aims to identify unique melliferous sources, supporting farmers in sustainable food production.

Material and methods

In this study, nine honey samples were collected from beekeepers from Hamirpur, Bilaspur and Una districts of Himachal Pradesh, located within the lower hills i.e. Sub-Montane and sub-Tropical zone of the state. Three regions were selected from each district*viz.,*Nadaun, Kharwar and Barsar from Hamirpur region, Lehri sarail, Bhatoli and Berthin from Bilaspur, while, Padiyola, Bangana and Haroli from Una region. Three samples were taken from each apiary for melissopalynological analysis. The identified samples were then subjected to physicochemical and mineral analyses by using standard procedure and protocols.

Results and conclusion

Pollen spectrum analysis showed the presence of two unifloral honeys with predominant pollen grains of *Adhatoda* sp. from Padiyola and *Dalbergia* sp.from Haroli region of Una. Statistically lower pH (3.97) while, total acidity (48.59 meq/kg), vit. C (30.85 mg/100g), phenol (97.21 mg/100g) and proline (73.41 mg/100g) was recorded in multifloral honey from Hamirpur (Barsar). Unifloral honey from Una (Padiyola) was having highest glucose content (33.42%), DPPH (71.09%) andiron content (6.08 mg/kg) but low ash (0.07%) and EC content (0.33 mS/cm). Highest TSS (79.9 ^{0}B), diastase content (21.40 DN) and manganese content (3.8 mg/kg) was in multifloral honey from Hamirpur (Nadaun). Unifloral honey from Una (Haroli) contained highest fructose content (39.99%) and significantly higher F:G ratio (1.35) but lowest sucrose (3.13%). Significantly higher Mg (89.20 mg/kg) and phosphorus (119 mg/kg) was in multifloral honey from Hamirpur (Kharwar), whereas, significantly higher calcium (148.26 mg/kg), potassium (794.96 mg/kg), highest zinc (8.5 mg/kg) and sodium (212 mg/kg) content was in multifloral honey from Bilaspur (Bhatoli). The results confirmed that all analyzed honeys met the quality standards of FSSAI (2020).

References

Sharma R, Thakur M, Rana K, Devi D and Bajiya MR. 2023. Honey, its quality and composition and their responsible factors. *International Journal of Bio-resource and Stress Management* 14(1): 178-189.

Table 1. Physico-chemical parameters of honeys from different locations

S. No.	Parameters	Hamirpur			Bilaspur			Una			$CD_{0.05}$
		Nadaun (M)	Kharwar (M)	Barsar (M)	Lehri sarail (M)	Bhatoli (M)	Berthin (M)	Padiyola (U)	Bangana (M)	Haroli (U)	
1	pH	4.92	5.96	3.97	4.51	5.34	4.52	4.15	4.72	4.88	0.12
2	EC (mS/cm)	0.69	0.74	0.66	0.43	0.68	0.45	0.33	0.38	0.35	0.07
3	Moisture (%)	15.46	20.13	20	19.09	18.61	14.77	18.35	19.15	16.79	0.81
4	Colour	0.46	0.35	1.91	0.43	0.18	0.33	0.16	0.99	1.39	0.06
5	TSS	79.9	77.3	74	76.2	78.17	79.97	78	77.47	78.1	0.39
6	Glucose (%)	31.84	30.27	31.68	32.34	31.05	28.85	33.42	33.12	29.71	1.63
7	Fructose (%)	34.06	37.17	35.08	36.12	36.3	34.54	36.91	34.46	39.99	1.83
8	G: F	1.07	1.23	1.11	1.12	1.17	1.2	1.1	1.04	1.35	0.09
9	Sucrose (%)	4.01	3.24	5.78	4.61	5.26	4.31	4.37	4.07	3.13	0.15
10	Total acidity (meq/kg)	32.55	17.4	48.59	37.57	20.48	36.67	41.33	34.43	33.56	0.49
11	Vit. C (mg/100g)	27.44	26.37	30.85	12.55	14.61	11.54	27.22	26.79	29.63	0.53
12	Ash content (%)	0.34	0.42	0.3	0.14	0.33	0.2	0.07	0.12	0.1	0.03
13	HMF (mg/kg)	13.92	18.91	86	36.5	25.2	23.25	29.17	34.75	31.74	1.31
14	Diastase content	21.4	20.67	4.53	15.44	19.31	19.47	20.42	17.47	18.39	0.68
15	Phenol content (mg/100g)	76.39	52.75	97.21	70.39	25.16	37.82	25.81	82.72	97.9	1.65
16	Amino acid (mg/100g)	57.81	46.52	73.41	25.88	31.69	69.36	19.96	21.12	37.96	2.15
17	DPPH (%)	65.51	50.07	70.36	61.75	32.76	45.59	33.28	66.24	71.09	3.02
18	Mg (mg/kg)	68.11	89.20	64.28	51.29	71.02	69.20	42.97	51.21	50.08	3.26
19	Ca (mg/kg)	129.3	112.4	79.48	99.68	148.26	133.05	104.63	98.26	103.11	5.17
20	P (mg/kg)	13	119	17	91	22.5	87	69.5	50	31	2.12
21	K (mg/kg)	348.7	546.94	194.99	210.94	794.96	476.14	348	286.94	277.9	22.03
22	Na (mg/kg)	119	135	204	186	212	121	193	129	119	6.47
23	Fe (mg/kg)	5.07	4.99	5.73	4.32	4.63	5.96	6.08	5.42	4.92	0.19
24	Mn (mg/kg)	3.8	2	1.5	0.5	1.5	1.9	3	2.7	2.8	0.12

M: Multifloral; U: Unifloral

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Preserving garlic's vitality: pre-treatment tactics for inhibiting enzymatic browning & optimizing drying protocol for powder's production

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Keywords*:* Allicin, Anti-microbial activity, Drying, Enzymatic browning

Introduction

Garlic is an annual herbaceous plant with a bulb consists of many cloves. About 65% of the weight of garlic bulb contained water, 28% carbohydrate, 2.3% organo-sulfur compounds, 2% protein, 1.2% free amino acid, and 1.5% fiber. Cutting chewing or crushing garlic bulb release the vacuolar enzyme alliinase, which react with allin to produce allicin, the main active component. It has been a subject of fascination and research for centuries, owing to its various culinary and medicinal significance. Processing is the best way to preserve the food stuff and provide consumers convenience for use garlic (Guo et al., 2023).

Material and methods

The study analyzed fresh garlic for physico-chemical and phytochemical characteristics and evaluated its peeling methods. The best peeling methods were chosen based on efficacy and color preservation. Pre-treated garlic slices were dried under tray dryers and then ground into a powder for enzymatic browning, color, and FTIR analysis. The best pre-treatment for preserving higher color parameters and maximum inhibition of PPO and POD was selected and further evaluated for physico-chemical, phytochemical, anti-microbial and techno-functional properties under various drying methods. Best drying methods was further evaluated for the particle size of powder and storage evaluation for 4 months. The cost of production for the developed garlic powder was calculated to determine its economic feasibility.

Results and conclusion

Microwave drying at 180W ensures the highest quality of garlic powder in terms of bioactives, allicin, and antimicrobial while tray dried powders were better in terms of colour parameters. Hybrid drying techniques also showed significant retention of valuable bioactive and also reduces the drying time and preserve colour in US+TD and MW+TD. MW+CNV and PH+CNV drying mode of microwave also allowed good retention of bioactive and antioxidant capacity but showed higher browning index indicating poor (darker) colour. MW drying showed good HR while, TD showed good CR. Microwave drying and hybrid drying techniques can be better alternative to traditional drying techniques in-terms of precise device control, drying efficacy, higher retention of bioactive compound for production of superior quality powder. Tray drying also retain sufficient amount of bioactive and had excellent colour values. The prepared dried garlic powder can be used as a food ingredient in products like sausages, sauces, as a flavouring agent in pickles, ketchups, pizza, soup, pasta, salted fish, kimchi and cured meat.

References

Guo X, Hao Q, Qiao X, Li M, Qiu Z, Zheng Z and Zhang B. 2023. An evaluation of different pretreatment methods of hot-air drying of garlic: Drying characteristics, energy consumption and quality properties. *Lwt*180: 114685.

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From Wild Herb to Pasta: Utilizing Stinging Nettle (*Urtica dioica* L.) for enhanced nutritional pasta products

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Keywords: Stinging nettle, Bioactive compounds, Stinging hairs, Underutilized, Fiber

Introduction

Stinging nettle (*Urtica dioica*) is a wild herbaceous perennial with stinging hairs, belonging to the Urticaceae family. Native to Europe, Asia, and Africa, it grows in rich soils in forest clearings and uncultivated areas, and is found in the Himalayan regions of India. Known for its high nutritional value, stinging nettle is rich in proteins, fats, dietary fibers, vitamins (A, B2, B5, C, E) and minerals. It also contains bioactive compounds with antioxidant, antiviral, and anti-inflammatory properties. Medicinally, it's used for conditions like Benign Prostate Hyperplasia, diabetes, and anemia. Despite its benefits, nettle is underutilized commercially, partly due to its stinging hairs. Increasing interest in functional foods offers potential for developing high-grade products like noodles and pasta from nettle, leveraging its health benefits while overcoming challenges related to its stinging properties (Viotti*et al.,* 2022). The present study was conducted with the prime objective to develop stinging nettle powder for preparation of nutritionally rich pasta.

Material and methods

The fresh stinging nettle leaves were washed and dried in mechanical dryer at 50±2 °C after blanching by standardized process (Arun, 2020) in water by adding 0.15 per cent Magnisium Oxide (MgO) and 2 per cent salt for 1 minute 45 seconds, and then the dried leaves were ground to 100 micron mesh size. The work is done in the Bakery laboratory of the Department of Food Science and Technology. Pasta was prepared with different concentration of dried stinging nettle powder compared to control (100 % semolina) in single screw extruder (model from La Monferrina, make P3), followed by drying for 48 hours at room temperature. Then the prepared pasta was evaluated for various quality characteristics.

Results and conclusion

The data presented in Table 1 represents the proximate quality of stinging nettle supplemented semolina pasta. The data reveals that with increase in the supplementation of stinging nettle powder in pasta, moisture and ash content of pasta increased from 12.65 to 12.83 per cent and 0.46 to 7.85 per cent, respectively. Crude protein, crude fat and total sugars were also increased with the increase in supplementation of stinging nettle powder. Crude fiber increased from 0.93% to 4.54%, reflecting the higher fiber content in nettle powder. Chlorophyll a, b, and total chlorophyll increase with nettle powder concentration (30% to 35%). Water activity slightly increases from 0.54 to 0.56, and energy value rises from 357.02 to 391.36 Kcal/100g. Antioxidant activity improves from 1.57% to 22.79%, while total phenols increase from 30.14 to 58.09 mg/100g.
Sensory analysis using the Cubadda scale showed that stickiness, bulkiness, and firmness increased with stinging nettle supplementation in semolina pasta. Overall acceptability improved up to 33% nettle supplementation but declined beyond that due to an unpleasant taste. Therefore, 33% supplementation was found to be the optimal level.Stinging nettle's low cost and high nutrition make it an excellent addition to functional foods, benefiting both consumers and entrepreneurs.

Table 1: Proximate quality of stinging nettle supplemented pasta

Treatments (Semolina: Stinging nettle powder)	T0 (100:0)	T1 (70:30)	T2 (69:31)	T3 (68:32)	T4 (67:33)	T5 (66:34)	T6 (65:35)
Moisture content (%)	12.65	12.68	12.71	12.73	12.74	12.78	12.83
Ash content (%)	0.46	6.38	6.95	7.39	7.55	7.70	7.85
Crude protein (%)	7.15	13.45	13.59	13.73	14.09	14.27	14.58
Crude fat (%)	1.51	1.56	1.65	1.72	1.78	1.85	2.13
Crude fiber (%)	0.93	2.13	2.44	2.91	3.43	4.02	4.54
Chlorophyll a (mg/g)	-	2.41	2.62	2.73	2.86	2.94	3.03
Chlorophyll b (mg/g)	-	1.61	1.76	1.82	1.91	1.99	2.14
Total chlorophyll (mg/g)	-	3.54	3.73	4.15	4.61	5.08	5.24
Water activity	0.54	0.54	0.54	0.55	0.55	0.56	0.56
Energy value (Kcal/100g)	357.02	361.29	365.55	372.81	379.31	386.51	391.36
Antioxidant activity (%)	1.57	18.51	19.07	19.86	21.45	22.10	22.79
Total phenols (mg/100g)	30.14	54.14	54.78	55.43	57.02	57.81	58.09

References

Arun 2020. Development of process protocol for drying of stinging nettle leaves (*Urtica dioica* L.). M.Sc. Thesis. Department of Food Science and Technology, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Solan (H.P.), India. 105p.

Viotti C, Albrecht K, Amaducci S, Bardos P, Bertheau C, Blaudez D and Chalot M. 2022. Nettle, a long-known fiber plant with new perspectives. *Materials* 15(12): 4288.

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Assessment of the availability and affordability of organic and natural foods in urban India

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Keywords: Affordability, Availability, Natural, Organic, Survey

Introduction
Organic and natural farming are rapidly expanding in India, demonstrating a multitude of socioeconomic and environmental benefits. India has the largest number of organic producers in the world and the second largest area of land dedicated to organic farming(Willer et al., 2024), yet domestic consumer demand for these products lags behind. Consumers report that their barriers to purchase include low availability and affordability, yet research measuring the availability and affordability of these products is limited. This study aims to describe the availability and affordability of organic and natural foods and beverages in three cities in India: Hyderabad, Latur, and Visakhapatnam.

Material and methods
A food environment assessment of Hyderabad, Latur, and Visakhapatnam was conducted using a market basket survey. Three 0.5km radius circles were selected within each city based on socioeconomic status, representing higher-, middle-, and lower-income neighbourhoods. Fourteen sentinel products were selected for data collection, including bananas, chickpeas, coffee, daal, fruit juice, green leafy vegetables, mangos, milk, millets, nuts, rice, tea, tomatoes, and wheat flour. All vendors selling any of these sentinel products for home consumption were surveyed within each circle.Variables captured included whether an organic or natural version of these products was sold, the price of conventional and organic rice, and marketing characteristics. Availability was calculated as the absolute and relative frequency of vendors who sold at least one organic or natural sentinel product. Affordability was calculated as the median price of conventional versus organic rice.

Results and conclusion
487 vendors were surveyed across Hyderabad (n=141), Latur (n=120), and Visakhapatnam (n=226). Overall, 155 vendors (32%) sold at least one organic or natural product, with Latur having the highest availability (n=71, 59%), followed by Visakhapatnam (n=53, 23%) and Hyderabad (n=31, 22%).The variation in availability between cities was statistically significant ($p<0.001$; two-tailed Kruskal-Wallis test). In all cities, the middle-income circle had the highest proportional availability, although the variation in availability between neighbourhoods was only significant in Latur ($p<0.05$; two-tailed Kruskal-Wallis test). The median number of sentinel products for which vendors sold an organic or natural option was one (per city and overall), suggesting that even vendors who sold organic or natural options sold only a limited selection.The products with highest overall availability included milk (the strong presence of a local milk brand named 'Natural' in Latur drove high availability in the city), wheat flour, and tea.Natural was the most frequently used terminology across all products, followed by organic. Only 16 vendors sold an organic or natural rice option, while 207 sold a conventional rice product. The median price of rice was Rs. 86 for organic or natural rice compared to Rs. 50 for conventional rice. Organic or natural rice was significantly more expensive than conventional rice ($p<0.001$; one-tailed Mann-Whitney test). Overall, availability of organic or natural products in urban areas was relatively low, and organic or natural rice was significantly less affordable than conventional rice.

Table 1. Availability and affordability of organic and natural foods and beverages in Hyderabad, Latur, and Visakhapatnam.

			AVAILABILITY				AFFORDABILITY				
City	Neighbourhood	Total vendors	Organic vendors, n(%)	p-values (Kruskal-Wallis)	Organic sentinel foods, median (IQR)	p-values (Chi-squared)	Organic rice vendors (n)	Conventional rice vendors (n)	Organic median (IQR), min-max (INR)	Conventional median (IQR), min-max (INR)	p-value (Mann-Whitney)
Hyderabad	Higher income	25	9 (36%)		3 (5)		2	59	83.5 (23.5), 60-107	57.5 (10), 30-85	
	Middle income	22	11 (50%)		1 (0)						
	Lower income	94	11 (12%)		1 (0.5)						
	Total	**141**	**31 (22%)**	**0.104**	**1 (1)**	**<0.001**					
Latur	Higher income	16	9 (56%)		1 (1)		0	74	–	50 (10), 20-60	
	Middle income	30	21 (70%)		1 (0)						
	Lower income	74	41 (55%)		1 (0)						
	Total	**120**	**71 (59%)**	**0.015**	**1(0)**	**0.378**					
Visakhapatnam	Higher income	103	19 (18%)		2 (1.5)		14	74	85.9 (25), 48-250	50 (13.5), 28-210	
	Middle income	54	22 (41%)		1 (1)						
	Lower income	69	12 (17%)		1.5 (2.25)						
	Total	**226**	**53 (23%)**	**0.987**	**1 (2)**	**0.003**					
TOTAL		**487**	**155 (32%)**	**<0.001**	**0 (1.00)**	**<0.001**	**16**	**207**	**85.9 (30.5), 48-250**	**50 (15), 20-210**	**<0.001**

References

Willer H, Trávnícek J and Schlatter B 2024. *The World of Organic Agriculture Statistics and Emerging Trends 2024* (p. 356). Research Institute of Organic Agriculture FiBL; IFOAM.

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Transforming Indian agriculture through natural farming for sustainability

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Keywords**:** Climate resilience, Sustainable Development Goals

Introduction

Natural farming (NF) offers a sustainable alternative to conventional agriculture, by focusing on enhancing soil health and crop yields through natural resources and biodiversity. NF promotes soil fertility and microbial activity without relying on synthetic chemicals and supports long-term environmental health and sustainability. As of now more than 10 lakh ha area is covered under NF in India. Many states have taken up initiatives especially, Andhra Pradesh, Himachal Pradesh, Gujarat, Odisha, Madhya Pradesh, Rajasthan, Uttar Pradesh and Tamil Nadu. The Hon'ble Prime Minister, Sh. Narender Modi Ji envisioned that NF shall be most beneficial to 80 per cent of the agrarian community having small land holdings of 2 hectare or less. In our country however, about 60 per cent of the arable land is irrigated with ground water which is a precious resource under environmental stress conditions. Union Finance Minister Smt. Nirmala Sitharaman announced the setting up of 10,000 Bhartiya Prakritik Kheti Bio-Input Resource Centres over the next three years, targeted to facilitate one crore farmers to adopt NF. This agro-ecological farming under Prakitik Kheti Khushal KisanYojana (PK3Y) Scheme, promoted by NITI Aayog largely based on on-farm biomass recycling, use of on farm cow dung-urine formulations and exclusion of all synthetic inputs. These initiatives align with a number of the Sustainable Development Goals (SDGs) laid out by the United Nations, which address global issues such as hunger, poverty, climate change and environmental degradation.

Material and methods

NF is based on four pillars: *Jeevamrit, Beejamrit, Acchadan* Mulching and *Whapasa*-moisture and additional practices (Palekar, 2019). Key principles included are intercropping, the furrow cropping, contour bunding and integration of horticultural crops in multi-layer crop sequencing. Palekar developed crop management formulations namely, Agniaster, Brahmaster, Neemaster and many more. The study for transforming Indian agriculture to achieve global environmental benefits and support a circular economy involves the widespread adoption of sustainable practices that reduce reliance on external inputs and enhance resource efficiency. In recent times, the data became evident that farmers could be categorized into agricultural households based on their adoption of NF practices and its contributions to global environmental benefits and the circular economy of the country.

Results and conclusion

India has recognized NF as an achievable way for economic and environmental sustainability. Research highlights its effectiveness in improving soil health, water conservation and economic viability. The studies revealed that NF practices enhance resilience to climate variability, with a 30-50 per cent reduction in crop failure rates during extreme weather events. These findings indicate that NF is a crucial strategy for sustainable agriculture in India, offering substantial ecological and economic benefits. NF aligns closely with several Sustainable Development Goals (SDGs) by promoting practices that are environmentally sustainable, economically viable, and socially inclusive. Most important goals for Agriculture are, SDG-1, End poverty in all its forms everywhere, SDG-2, End hunger, achieve food security and improved nutrition and promote sustainable agriculture, SDG-6) 'Ensure availability and sustainable management of water and sanitation for all, SDG-8, Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all, SDG-9, Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation, SDG-12, Ensure sustainable consumption and production patterns and SDG-15, Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. NF practices are only the step to meet these SDGs. Nair et al. (2017) in Andhra Pradesh reported 20-30 per cent increase in soil organic carbon levels under NF compared to conventional practices. Additionally, water use is reduced by 50-60 per cent due to enhanced soil moisture retention. Biodiversity benefits are also notable, with NF systems showing a 40-50 per cent increase in on-farm biodiversity, including beneficial insects and birds. Economically, NF reduces input costs significantly; farmers in Karnataka have reported a 60-70 per cent reduction in expenditure on chemicals, leading to increased profitability. Income improvements are substantial, with natural farmers in Maharashtra earning an average of Rs.10,000 more per acre annually.

A circular economy model in NF emphasizes sustainability by recycling resources and minimizing waste, mimicking natural ecosystems. In this approach, organic matter, such as crop residues and animal manure, is returned to the soil to enhance fertility, reducing the need for chemical inputs. Water is conserved and reused, and biodiversity is promoted to naturally control pests and diseases. This model shall create a closed-loop system where resources are continually reused, reduced environmental impact and improved soil productivity which will contribute to a more sustainable and resilient food system.

References

Nair PKR, Reddy MS and Rao AS. 2017. Soil health and carbon sequestration in natural farming systems. *Journal of Sustainable Agriculture*, 40(6): 731-749.

Palekar S. 2019. Zero budget spiritual farming. www.palekarzerobudgetspiritualfarming.org

ESFS-NF/ISFS2024/4012

Sustainability through utilizing Plant derived bioformulations

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Keywords: Plant Extracts, Bioactive Compounds, Biostimulant, Growth

Introduction

Sustainable horticultural practices have propelled the exploration of alternative solutions over chemical farming to enhance crop yield and quality while minimizing environmental impact. Among these, plant-based extracts have emerged as a promising sustainable solution. The global market for plant-based extracts has been driven by increasing consumer demand for natural and bio-organic products, and is expected to grow from USD 40.24 billion in 2023 to USD 70.19 billion by 2030 with a CAGR of 8.27 per cent. India also has shown potential growth where plant-based extracts are used as biostimulants and bio-pesticides for crop production and protection. Government, non-government organizations and international bodies are promoting the use of natural products for further propelling market growth. These extracts can have the potential to boost plant immune systems for better growth, nutrient uptake, and overall crop quality.

Material and methods

Earlier research has identified several key bioactive compounds in plant extracts, including polyphenols, alkaloids, flavonoids, and terpenoids, which contribute to their effectiveness as biostimulants and bio-pesticides. These compounds also exhibit antimicrobial and antioxidant activity which made plant extracts as a potent tool for crop resilience against biotic and abiotic stresses. The European Union's Fertilizing Products Regulation (FPR) 2019/1009 highlights the importance of biostimulants, including plant-based extracts, in sustainable horticulture. This regulation aims to harmonize the market for plant based extracts and encourages the use of natural products to improve crop production while safeguarding human health and the environment.

Results and conclusion

Plant-based extracts are increasingly being recognized for their potential to improve horticultural sustainability as biostimulants to enhance nutrient uptake, increase tolerance to environmental stresses due to climate change. Studies have shown that crops treated with plant extracts exhibit better growth, higher resistance to diseases, and improved fruit quality, including size, color, and nutritional content, as biopesticides and bioinsecticides, offering a natural alternative to chemical pesticides and insecticides and as biofertilizers, bioactive compounds present in the extracts can stimulate activities of specific microbial communities leading to greater decomposition of organic matter which contributes to accumulation of microbial biomass carbon (Table 1).
Plant-based extracts are known for their ability to improve soil health, root development, increase tree vigour and improve yield. Government of India also supports the use of bio-inputs through several schemes, such as National Mission on Sustainable Agriculture (NMSA) and the Mission Organic Value Chain Development for North-Eastern Region. Additionally, there is a need for more extensive field trials to validate the efficacy of plant extracts under diverse climatic conditions for crop production.

Table: 1 Climate resilient crops usage for plant bioformulations

SN.	Scientific Name	Common Name	Active ingredient	Remarks
		Temperate		
1.	*Artemisia annua*	Indian Wormwood	Artemisinin, flavonoids	Improve yield (Djeugap et al., 2023)
2.	*Allium sativum*	Garlic	Sulfur compounds, allicin, flavonoids	Nutrient uptake and growth and fruit quality enhancer (Ghanizadeh et al., 2024)
3.	*Glycine max*	Soybean	Saponin	Boost plant growth (Jang and Kuk, 2019)
4.	*Glycyrrhiza glabra*	Licorice, Mulethi	Glycrrhizin, flavonoids, saponin	Growth and productivity (Abd El–Hamied, 2015)
5.	*Urtica dioica*	Stinging Nettle	Formic acid, histamine,	Natural fertilizer (Maricic et al., 2021)
6.	*Trifolium repens*	White clover	Saponin, tannin, isoflavone	improved plant growth (Wu et al, 2014)
7.	*Eruca sativa*	Arugula, Rocket, Taramira	Glucosinolates, flavonoids	Organic fertilizer (Khan et al, 2020)
		Sub-tropical		
1.	*Euphorbia hirta*	Asthma Weed, Snakeweed	Tannins, flavonoids, terpenoids	Stimulate plant growth and yield (Djeugap et al, 2023)
2.	*Azadirachta indica*	Neem	Azadirachtin, nimbin, triterpenoids	Improve plant growth (Kavya and Rai, 2022)
3.	*Indigofera heterantha*	Himalayan Indigo	Indican, tannins, and flavonoids	Improve plant vigour, nitogen fixer (Teanglum, 2014)
4.	*Moringa oleifera*	Moringa	Myricetin, quercitin, Saponin, tannin	Organic fertilizer and nutritional quality (Kavya and Rai, 2022)
5.	*Morinda citrifolia*	Noni, Indian Mulberry	Rubiadin, alkaloids flavonoids	Stimulate plant vigour (Girijamba et al 2014)

References

Anonymous. 2024. www.giiresearch.com/report/ires1470943-plant-extracts-market.

Godlewska K, Ronga D and Michalak I. 2021. Plant extracts-importance in sustainable agriculture. *Italian Journal of Agronomy* 16(2).

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Quality and drying characteristics of pea (*Pisum sativum* L.) grown under natural farming system

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Keywords: Drying, Green peas, Natural farming, Quality

Introduction

Pea (*Pisum sativum* L.) is one of the most commonly grown food legumes and it has been widely used in the human diet as a source of proteins, minerals, vitamins and other phytochemicals. Further, recently, the choice for food raised by natural farming has attracted the interest of consumers with regard to nutritional quality, safety and freedom from pesticide residues (Sharma et al. 2021; Chandel et al. 2024). Therefore, the physico-chemical, nutritional and sensory quality of SPNF peas was analysed and compared with CF peas. Takinginto consideration the seasonal availability and perishability of greenpeas, drying of peas was attempted with some pre-treatments to extend their shelf-life and to maintain the qualityas a sustainable food system approach.

Material and methods

Freshly harvested, well filled tender green peas (cv. PB 89) grown under both SPNF and CF systems were selected for this study. The SPNF produce was analysed for various quality parameters and compared with CF produce. Further, in order to study the drying behavior, the healthy peas were subjected to pre-treatments viz., T1: Blanching in 2 % NaCl for 2 min (SPNF), T2: Blanching in 2% NaCl for 2 min (CF), T3: Blanching in 2% NaCl for 2 min + Dipping in 0.5% Sodium Carbonate (Na_2CO_3) solution for 15 min (SPNF), T4: Blanching in 2% NaCl for 2 min + Dipping in 0.5% Sodium Carbonate (Na_2CO_3) solution for 15 min (CF) followed by drying at 65±2 ˚C. All the quality parameters were estimated as per the standard methods. Whereas, the sensory evaluation was done by using the 9-point hedonic scale. Statistical evaluation was performed by using one-way analysis of variance (ANOVA) with a significance level $P < P_{0.05}$.

Results and conclusion

The results revealed that the SPNF pea under the study had about 20 pods/100 g compared to 30 pods/100g in CF peas. It was also found that SPNF pea contained higher total solids (27.37%), TSS (13.02ºB), ascorbic acid (36.11 mg/100g), chlorophyll (33.58 mg/100g) and total ash content (1.87%) compared to CF pea (26.76%, 11.40ºB, 24.45mg/100g, 22.44mg/100g and 1.79%), respectively.Further, the data pertaining to drying of peas (Table 1) reveals that moisture content of dried pea was found highest (5.45) in control (untreated) and lowest in treatment T4 (3.20). Total sugars content (17.50), total phenols content (1.20), ascorbic acid (11.25) and chlorophyll content (12.50) were found maximum in T4 and minimum in control, respectively. Whereas, the highest ash content was found in control sample (1.81) and the lowest in T4 (1.73). The maximum scores for colour (8.80), texture (8.60), taste (8.50) and overall acceptability (8.82) were obtained in the peas which were blanched in 2% NaCl for 2 min + Dipping in 0.5% Sodium Carbonate (Na_2CO_3) solution for 15 min followed by drying whereas, minimum scores of all the above characteristics were observed in the untreated peas (T1).

Table 1: Effect of pre-treatments on quality of dried peas

Treatment	Moisture Content (%)	TSS (˚B)	Total Sugars (%)	Total Phenols (mg GAE/100g)	Ascorbic acid (mg/100)	Chlorophyll Content (mg/ 100ml)	Ash Content (%)
T_1 (Untreated)	5.45	23.21	15.72	1.29	8.42	6.18	1.81
T_2	3.22	24.14	16.65	1.17	10.36	10.63	1.75
T_3	4.53	23.95	16.12	1.16	9.23	8.97	1.80
T_4	3.20	25.20	17.50	1.20	11.25	12.50	1.76
T_5	4.51	24.47	16.87	1.19	10.82	11.16	1.73
$CD_{0.05}$	0. 12	0.10	0.20	0.08	0.18	0.25	0.05

Conclusively, the quality of fresh green peas grown under natural farming had better quality and drying characteristics than that of CF peas. SPNF peas blanched in 2% NaCl for 2 min + Dipping in 0.5% Sodium Carbonate (Na_2CO_3) solution for 15 min (SPNF Pea) were found superior as compared to other treatments.The dried peas can further be utilized for the preparation of various value-added products round the year for sustainable food system.

References

Chandel RS, Verma SC, Sharma R and Verma S 2024. Natural Farming- An agroecological initiative towards sustainable and local food system. Dr YS Parmar University of Horticulture and Forestry, Nauni-Solan (HP), 16p.

Sharma Rakesh, Gautam S and Hamid 2021. Effect of MAP on shelf-life of broccoli and cabbage grown under natural farming. *Indian Journal of Agricultural Sciences* 91 (9): 1353-7.

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Phosphate-rich organic manure: A sustainable innovation for enhancing wheat yield, quality and soil health

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Keywords: Nutrient content, Phosphate, Organic carbon,Yield

Introduction

Innovations in sustainable food systems are essential for mitigating challenges such as phosphorus deficiency and soil degradation, which compromise crop yields and quality. The persistent application of inorganic fertilizers exacerbates these issues, necessitating the exploration of alternative organic phosphorus sources. In this context, a field experiment was conducted at CSK HPKV, Palampur, on wheat (variety HPW-368) during the *rabi* season of 2021-22. The study assessed the effects of phosphate-rich organic manure (PROM), produced throughthe co-composting of organic matter with high-grade rock phosphate in 1:2 ratio, on wheat productivity, grain quality, and nutrient uptake in an acid Alfisol.

Material and methods

The experimental design was RBD with three replications. The treatment combinations were T1: Farmer's practice (100 kg/ha 12:32:16 + 3 t/ha FYM); T2:100% NPK; T3: 100% NPK + lime; T4: 100% NPK + 10 t/ha FYM; T5: 0.5 t/ha Ghanjeevamrit + Jeevamrit Sprays at 21 days interval (Natural Farming); T6: 100% NK + 3 t/ha PROM; T7: 100% NK + 75% P + 0.75 t/ha PROM; T8: 100% NK + 50% P + 1.5 t/ha PROM and T9: 100% NK + 25% P + 2.25 t/ha PROM. The recommended dose of fertilizer for wheat was 120:60:30 kg/ha NPK, using urea, SSP, MOP, respectively. PROM contained 6.45% moisture and 0.4, 2.3 and 0.2% of total N, P and K, respectively on dry weight basis. The digested plant samples were analyzed for crude protein (Jones, 1941) and nutrient content. The uptake was calculated by multiplying concentration of a particular nutrient with yield.

Results and conclusion

The integrated application of chemical fertilizers with PROM (T8) significantly enhanced wheat grain (38.7 q/ha) and straw (62.7 q/ha) yield, outperforming other treatments. The T8 treatment boosted grain yield by 45.4% over T2, and 16.9% over T4. The highest crude protein (12.9%), P (0.54%), and K (0.39%) content, along with total NPK uptake, were also observed under T8, closely followed by T9. The highest soil organic carbon (SOC) was under T4 (8.54 g/kg),which was significantly at par with T6 (8.46 g/kg) and T9 (8.42 g/kg). The highest available P wasrecorded in T8 (31.9 kg/ha) and was at par with T9 treatment (31.1 kg/ha). However, the lowest yield and nutrient uptake were recorded in T1 and T5. Whereas, the lowest SOC was recorded under T1 (7.92 g/kg) and was at par with T2 and T3 treatments.

The incorporation of organic manure through PROM improves soil structure and aggregation, reduces bulk density and increases soil organic content, which in turn favours better crop root proliferation, uptake of nutrients and higher their concentrations in wheat grains. Besides this, PROM during decomposition, forms complexes with sesquioxides through humus coating and ultimately increases the available P in soil. The efficiency of PROM as an effective alternate fertilizer was also reported by Noor et al. (2021) for maize crop. Thus, this study highlights PROM fertilizer as a key innovation in sustainable agriculture, significantly improving wheat yield, quality, and soil health in an acid Alfisol

Table 1: Effect of phosphate rich organic manure on yield, quality and soil parameters in wheat

Treatment	Grain yield	Straw yield	Crude protein	P content	K content	N uptake	P uptake	K uptake	SOC	Avail. P
	q/ha		(%)			(kg/ha)			(g/kg)	(kg/ha)
T_1	18.2	33.1	10.1	0.29	0.31	49.8	8.0	22.9	7.92	19.1
T_2	26.6	45.4	12.0	0.38	0.33	83.6	14.5	38.4	7.94	22.7
T_3	29.7	49.8	12.3	0.45	0.34	97.3	18.3	45.9	7.97	25.3
T_4	33.1	54.4	12.7	0.48	0.39	111.6	21.9	52.8	8.54	29.7
T_5	19.7	35.2	10.2	0.30	0.31	55.7	9.6	26.3	8.12	19.8
T_6	29.9	49.6	12.5	0.44	0.34	100.2	18.3	46.6	8.46	24.4
T_7	32.8	54.0	12.7	0.49	0.35	110.3	21.8	49.7	8.01	26.3
T_8	38.7	62.7	12.9	0.54	0.39	132.2	28.5	61.0	8.35	31.9
T_9	35.9	58.5	12.8	0.52	0.38	122.0	25.4	56.3	8.42	31.1
$CD_{0.05}$	2.8	4.1	0.2	0.02	0.03	9.3	2.1	4.2	0.11	1.2

References

Jones DB. 1941. Factors for converting percentages of nitrogen in foods and feeds into percentages of proteins. USDA Washington, DC. 183 (22)

Noor K, Sarwar G, Shah SH, Muhammad S, Zafar A, Manzoor MZ and Murtaza G. 2020. Formulation of phosphorous rich organic manure from rock phosphate and its dose optimization for the improvement of maize (*Zea mays* L.). *Journal of Plant Nutrition* 44(1): 96-119.

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Monthly variation in nutritional content of *Azolla pinnata* grown under natural farming

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Keywords: *Azolla pinnata*, Lignification, Nutritive Value, Spring, Winter

Introduction

Unavailability of round the year green fodder posses a great challenge to livestock farming in India. There is a significant shortfalls in the availability of dry fodder, green fodder, and concentrates recording shortages at 32, 25, and 47 per cent, respectively, in 2009-10 with projections indicating a deficit to 21.3, 40.0, and 38.1 per cent, respectively by 2025 (ICAR-NIANP, 2013). Himachal Pradesh emerges as a state prone to acute shortages of green fodder during lean periods, necessitating urgent measures to bridge the gap between availability and demand through better feed resource utilization and the incorporation of tree leaves. *Azolla*, an aquatic fern, thrives in standing water bodies, offering rapid biomass growth and nitrogen fixation potential. *Azolla pinnata*, the predominant species in India and the world and *Anabaena*, occurs in symbiotic relationship with endophytic nitrogen-fixing blue-green algae, enriching its biomass with essential nutrients. With a biomass doubling rate of every three days under favourable conditions, *Azolla* serves various purposes, including biofertilization, water purification, and livestock feed supplementation. *Azolla* contains 25-35 per cent CP and a host of essential amino acids and vitamins (vitamin A, vitamin B12, Beta-carotene), making it a valuable dietary supplement for ruminants.

Material and methods

The experiment was conducted to study the monthly variation in the nutritive value of *Azolla* that was cultivated by using natural farming inputs *i.e*. Jeevamrit and Ghanjeevamrit. An artificial water body in the form of pit size of 2 × 1 × 0.3 m was made with Silpaulin sheets over it. 500 g of fresh pure culture of *Azolla* was inoculated into the pits with 5 liter Jeevamrit and 2 kg Ghanjeevamrit added at weekly interval to maintain rapid growth and water level was maintained in the pits. Harvesting was carried out from the pits with minimum doubling time to allow rapid multiplication growth and to prevent overcrowding with pH test carried out periodically. Six pits of better growth were selected randomly of the twenty pits for evaluation of monthly variations in the nutritive value during the months of November, December, January, February, March and April to determine the Proximate and Van Soest components *viz*., dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), neutral detergent fibre (NDF), acid detergent fibre (ADF), organic matter (OM), total ash (TA), acid insoluble ash (AIA), nitrogen free extract (NFE), Calcium (Ca) and Phosphorous (P).

Results and conclusion

Table 1 depicts the monthly variation of various nutritional composition that was carried out. The DM displayed a decreasing trend with the highest recorded in December (5.70%) and lowest in the month of April (4.44%). The same trend as the above mentioned could also be observed for EE, CF, NDF, ADF,TA and AIA. The results obtained showcased that they were significantly higher during the initial months of the trail than that of final months. Critical analysis of the table illustrated that DM, EE, CF, NDF, ADF, TA and AIA was higher in the winters (Nov-Jan) and lower in Spring (Feb-April) due to mean environmental temperature in winter. The leaves increased in lignification with maturity reducing the digestibility of the cell wall carbohydrate (primarily hemicellulose and cellulose) with which it is co-bonded. Since lignin is a component of the NDF and ADF fraction, an increase in lignification increased the CF, NDF and ADF content of the leaves leading to poor growth and drying of *Azolla* in winters.

Table 1: Monthly variation in the nutritive value of *Azollapinnata* (% DM basis)

	November	December	January	February	March	April	Mean
DM	5.31	5.70	5.66	4.86	4.68	4.44	5.11
CP	19.76	19.61	20.19	21.23	22.30	23.23	21.05
EE	4.42	4.43	4.37	3.90	3.81	3.70	4.11
CF	14.85	15.68	14.86	14.18	13.60	13.23	14.40
NDF	42.15	43.03	42.98	38.98	38.43	37.78	40.56
ADF	30.65	31.72	31.25	29.06	29.11	28.28	30.01
OM	78.59	78.78	79.85	80.55	80.74	80.75	79.88
NFE	39.57	39.06	40.42	41.23	41.03	40.59	40.32
TA	21.40	21.23	20.16	19.45	19.26	19.25	20.13
AIA	7.84	7.88	7.84	7.28	7.01	6.91	7.46
Ca	1.51	1.55	1.57	1.63	1.66	1.68	1.60
P	0.20	0.21	0.20	0.23	0.24	0.26	0.22

On the contrary, nutritional paramaters such as CP, OM, NFE, Ca and P increased during the trail period *i.e.*, November, 2021 to April, 2022. Highest CP, OM, Ca and P was recorded in the month of April with 23.23, 80.75, 1.68 and 0.26 per cent, respectively (table 1) which were significantly higher than those recorded in the initial months of the study. The CP, OM, Ca and P content was recorded higher in the spring and lower in the winter due to the increased growth of *Azolla* during spring. Crude protein (CP%) content of *Azollapinnata* was higher in Feb-April which was subsequently lower than those in Nov-Jan which might be in response to decrease in the foliage nutrient concentration due to the dilutiuon effect (Singh and Todaria, 2012).

References

ICAR-NIANP. 2013. Vision 2050. National Institute of Animal Nutrition and Physiology, Bangalore, 36p.

Singh B and Todaria N P. 2012. Nutrients composition changes in leaves of *Quercus semecarpifolia* at different seasons and altitudes. *Annals of Forest Research* 55: 189-96.

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From Emissions to Income: Leveraging Carbon Credits in Farming System

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Keywords: Carbon credit, Carbon offsetting, Carbon trading, Gas Emission

Introduction

Carbon credits and offsets are essential tools for reducing greenhouse gas (GHG) emissions, measured in carbon dioxide equivalent (CO_2). These credits, derived from activities like afforestation, renewable energy projects, and improved agricultural practices, help mitigate climate change by offsetting GHGs. The global warming potential (GWP) of different gases, such as methane and nitrous oxide, varies, making CO2e a standardized measure for comparing their impact. India, with its vast agricultural land, has significant potential for carbon sequestration, enhancing soil health, and reducing GHG emissions through sustainable practices. Projects focused on carbon reduction contribute to climate goals and economic benefits.

Material and methods

True Cost Accounting (TCA) offers a comprehensive method to evaluate the real costs of products and services by including not only direct expenses like raw materials and labor but also the broader environmental and social impacts. In the context of food and agriculture, TCA assesses both the true costs and benefits of various food production systems throughout the supply chain. Traditional economic market prices often overlook external costs such as environmental degradation, poor animal welfare, and negative public health effects, which are not compensated for by either producers or consumers. TCA aims to factor these externalities into the overall cost equation. By accounting for both economic and environmental costs, TCA provides a more accurate representation of the true costs associated with cultivation and food production, encouraging more sustainable practices that minimize negative impacts on the environment and society.

True cost of GHG emissions

$$TC_{GHG} = U_{GHG} * MF_{GHG}$$

Where: U_{GHG} = total GHG emissions (ton CO_2eq); MF_{GHG} = Monetization value

Results and conclusion

CO_2 Equivalent per hectare for Overall Crops: The reduction of CO_2 equivalent of Natural Farming tomato with comparison to conventional farming tomato is presented in Table 1. The given sources represent reduction in different activities in agriculture, each contributing to GHG emissions ton per hectare. Seed production reduce 47.20 tons per hectare, fertilizer production 783.75 tons of GHGs. Soil and fertilizer 820.99 tons, while crop protection activities contribute zero tons, and energy use in the field accounts for 8.26 increase because of high mechanical work. Also CO_2 equivalent of Natural Farming potato with comparison to conventional farming potato. The reduction in different activities in agriculture, each contributing to GHG emissions ton per hectare.

Seed production reduce 209.57 tons per hectare, fertilizer production 863.62 tons of GHGs. Soil and fertilizer 128.78 tons, while crop protection activities contribute 51 tons, and energy use in the field accounts for 28.10 increase because of high mechanical work.

Table 1. CO_2 equivalent per hectare for overall crops

Sources	Total CO_2 eq/ha		Reduction in CO_2 eq	Total CO_2 eq/ha		Reduction in CO_2 eq
	Potato	Potato (NF)		Tomato	Tomato (NF)	
Seed production	242.54	32.97	209.57	47.20	-	47.20
Fertilizer production*	863.82	-	863.82	783.75	-	783.75
Soil / fertilizer	143.0	14.22	128.78	963.20	142.21	820.99
Crop protection	51.27	-	51.27	-	-	-
Energy use (field)	65.57	93.67	-28.1	85.41	93.67	-8.26

References

Ritchie H, Roser M and Rosado P. 2022. Fertilizers. Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/fertilizers'.

Timsina J, Dutta S, Devkota K P, Chakraborty S, Neupane R K et al. 2022.Assessment of nutrient management in major cereals: Yield prediction, energy-use efficiency and greenhouse gas emission. *Current Research in Environmental Sustainability*. 4: 100147.

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In silico bioinformatics models for predictive validation of natural farming practices

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Keywords**:** Natural farming, silico models, predictive validation, sustainable agriculture

Introduction

Natural farming has gained prominence as a sustainable agricultural practice, emphasizing the production of healthy food for a healthy planet while fostering ecological balance with no external synthetic inputs. Despite its potential benefits for small and large-scale farmers, the scientific validation of these practices remains a complex challenge, necessitating the development of innovative methodologies to ensure societal and scientific acceptance (Patel et al. 2024). In this regard, in silico bioinformatics models present a novel approach for the predictive validation of natural farming practices. These computational models can simulate intricate biological systems and their interactions, thereby offering valuable insights into the ecological and agronomic impacts of natural farming methods (Saharan et al. 2023). Through the creation of these prediction models, this research aims to promote scientific knowledge and implementation of natural farming, ultimately advancing sustainable agricultural systems.

Material and methods

The current study employs an integrated bioinformatics approach to build a model for predicting the outcomes of natural farm inputs such as *beejamrit, jivamrit*, mulching, *whapasa*. These inputs are utilized with inter-cropping/multi-cropping, single as well as multilayered systems of different agri-horti-based crops such as vegetables and fruit crops with leguminous and fodder crops etc. A wide range ofpublicly available bioinformatic resourceinformation encompassing genomics, transcriptomics, proteomics and metabolomics data of plants and microbiomewith environmental parameters were used. These data were pre-processed and integrated into a machine learning framework to build predictive models by using bioinformatics tools for sequence analysis; annotation; phylogenetic analysis, and for statistical modelling. Pathway enrichment analysis provides an understandingof the impact of natural inputs at a molecular level (Fig 1).

Results and conclusion

Predictive models revealed the influence of natural farming inputs on crop development at the molecular level. The models also predicted potential genetic adaptations in under specific natural farming crop models. Predictive models for natural inputs possibly predict the soil quality and crop yield while models for inter-cropping can guide farmers in planning their planting strategies. Therefore, the *in-silico* approach will offer a technology-driven solution for scientific validation and acceptance of natural farming practices. Future applications could include the development of user-friendly software tools for farmers, enabling data-driven decisions in sustainable agriculture.

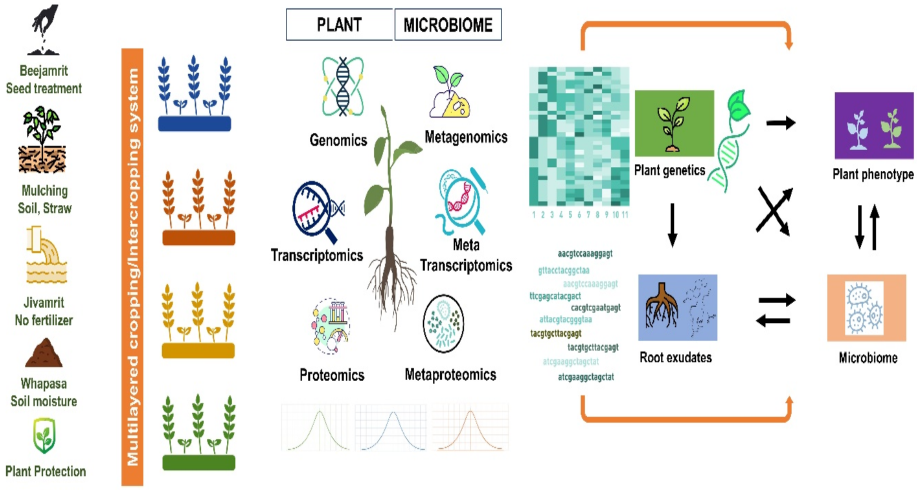

Fig. 1: Integrated approach depicts natural farming practices with multi-omics techniques

References

Patel M, Islam S, Glick BR, Choudhary N, Yadav VK, Bagatharia S, Sahoo DK and Patel A. 2024. Zero budget natural farming components *jeevamrit* and *beejamrit* augment *Spinacia oleracea* L.(spinach) growth by ameliorating the negative impacts of the salt and drought stress. *Frontiers in Microbiology* 15: 1326390.

Saharan BS, Tyagi S, Kumar R, Vijay Om, H, Mandal, BS and Duhan JS. 2023. Application of Jeevamrit improves soil properties in zero budget natural farming fields. *Agriculture* 13(1): 196.

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Biofortification with amino acid chelates improved nutrition and anti-oxidant activity in apple

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Keywords: Amino acid chelates, Biofortification, Phytic acid, Ursolic acid

Introduction

Apple cultivation is of prime importance in Himachal Pradesh, contributing approximately Rs. 4,000 crores annually to the state's economy. The fruits of apple are excellent source of organic acids, vitamin-C and antioxidants including phytic acid and ursolic acid. Currently, increasing pressure on natural resources due to urbanization and industrialization has led to environmental degradation, climate change and biodiversity loss. Moreover, indiscriminate use of chemical fertilizers in crop management has led to declining productivity with rising plant and human health issues. To ensure local natural resources conservation, the adoption of eco-friendly practices can fulfil our sustainable development goals (SDGs) including social, economic and environmental goals. Organic nutrient sources are the readily available latest novelties for transition to sustainable agriculture, enabling higher quality production with reduced fertilizer use (Ganesan, 2024).

Nowadays, amino acid complexes are becoming popular globally among the farming communities as an affective measure to correct the nutrient deficiencies (Marukhlenko et al., 2022). Amino acid complexes enhance the fruit nutrient content by improving soil health, leading to higher levels of essential vitamins, minerals, and antioxidants in the fruit. Besides, amino acids bind with the phytic acid and result in increased bioavailability of nutrients in the plants as well as humans. Thus, the biofortification of apple fruits through organic Zn complexes is a viable approach for the sustainable development through improved crop performance and soil health.

Materials and methods

The study was conducted at the Experimental Block of Department of Fruit Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. The efficacy of zinc amino acid complexes *vis-a-vis* Nano Zn amino chelates was evaluated in apple. Four different zinc amino acid complexes viz., Zn glycinate (Zn-Gly), Zn gluconate (Zn-Glu), Zn amino acid chelate (Zn-AAC), nano Zn amino acid chelate (NZn-AAC) were used at the concentration of 200 mg/L and 400 mg/L each and zinc sulphate ($ZnSO_4$) was applied at 0.05% (control). Foliar application of Zn nutrient sources was carried out at four stages i.e., 15 days before bud break, petal fall, fifteen days after petal fall and after harvest. Fruit nutrient content and antioxidants estimation was carried out as per the standard procedures.

Results and conclusion

The study revealed that nano zinc amino acid chelate at 400 mg/L ($NZn\text{-}AAC_{400}$) registered the most influential effect on apple flesh and peel nutrient content. $NZn\text{-}AAC_{400}$ depicted the maximum increase of 40.0 and 57.8 per cent in K and Ca content in apple flesh as compared to $ZnSO_4$. However, all the applied Zn organic complexes showed insignificant effect for the studied apple flesh nutrients. Similarly, maximum per cent increase of 50.0, 70.8, 37.2 and 30.7 in P, K, Ca and Mg content of apple peel was observed with $NZn\text{-}AAC_{400}$ compared to $ZnSO_4$, which registered the lowest values. Additionally, the application of treatmentsNZn-

AAC_{400}, NZn-AAC_{200} and Zn-AAC_{400} resulted in similar effect for Zn content in the apple peel. The data demonstrated that NZn-AAC_{400} had the most promising effect on antioxidant content of apple fruits (Table 2). Phytic acid is an antinutrient compound which results in reduction of nutrient availability. In our study, $NZnAAC_{400}$ treatment showed highest per cent decrease of 46.7 per cent in fruit phytic acid content compared to $ZnSO_4$. Similarly, a decrease of 2.1, 2.0 and 3.4 times in PA: Ca, PA: Mg and PA:Zn ratios was recorded with $NZnAAC_{400}$ treatment as compared to control. Ursolic acid is a major triterpenoid known for its antibacterial, anti-inflammatory and anti-tumorous properties. $NZnAAC_{400}$ significantly increased the ursolic acid content in apple peels by 37.5 per cent, compared to control.
It can be concluded that the foliar application of Zn amino acid complexes namely, NZn-AAC, Zn-AAC, Zn-Gly and Zn-Glu offers a significant impact on fruit nutrient and antioxidant content of apples.NZn-AAC was the best in improving the fruit flesh and peel nutrient content. The results also demonstrated reduction in phytic acid content and increase in ursolic acid content resulted from Zn biofortification through enrichment of fruit nutrients. Moreover, considering the high consumption of apple, the usage of organic Zn complexes can be a viable eco-friendly approach to improve bio-available Zn in humans.

Table 1: Phytic acid and Ursolic acid content of apple affected by foliar application of different bio-organic Zn sources

Zinc nutrition	Phytic acid (%)	PA: Ca	PA: Mg	PA: Zn	Ursolic acid (µg/mL)
Zn-Gly_{200}	1.58	2.27	8.04	50.37	211.74
Zn-Gly_{400}	1.39	1.82	6.54	37.92	239.15
Zn-Glu_{200}	1.59	2.36	8.38	56.28	204.01
Zn-Glu_{400}	1.55	2.15	7.52	44.20	235.05
Zn-AAC_{200}	1.32	1.63	5.89	33.42	240.88
Zn-AAC_{400}	1.27	1.54	5.40	28.96	248.73
NZn-AAC_{200}	1.12	1.30	4.63	22.95	258.01
NZn-AAC_{400}	1.09	1.21	4.36	19.96	273.95
$ZnSO_4$	1.60	2.59	8.95	68.98	199.24
$CD_{0.05}$	0.12	0.13	0.46	3.70	2.99

References

Ganesan S. 2024. Biotic farming using organic fertilizer for sustainable agriculture. *Physical Sciences Reviews* 9(1): 201-209.
Marukhlenko AV, Mariya A, Morozova MJ, Mbarga V, Antipova AV, Syroeshkin IV, Podoprigora T and Maksimova V. 2022. Chelation of zinc with biogenic amino acids: Description of properties using balaban index, assessment of biological activity on *Spirostomum ambiguum* cellular biosensor, influence on biofilms and direct antibacterial action. *Pharmaceuticals* 15(8): 979.

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TOPSIS for Decision-making in Food Studies

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Keywords: Beneficial, Data analysis, Euclidean distance, Rank, TOPSIS

Introduction

Food comprises multiple constituents exhibiting various functional roles. Making decisions based on multiple criteria or considerations is known as multi-criteria decision making, and it is a difficult procedure. In the last few decades, numerous researchers have devised various approaches to address this issue. TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution), a multi-criteria decision-making method was found appropriate for taking such decisions. This approach will give ranks to all considerations thereby helping researchers to select the best alternative.

Material and methods

Methodology of TOPSIS approach was adopted as per the steps described in literature (Hedayati et al., 2021). Firstly, criteria were classified as beneficial and non-beneficial. Weightage was given to each criterion and a decision matrix was established. Normalization of decision matrix was done followed by establishing weighted normalized decision making matrix. In next step, positive and negative ideal solutions were calculated. Euclidean distance from these ideal solutions were calculated. Closeness coefficient was then calculated and its maximum value was considered as the best.

Results and conclusion

This approach successfully given ranks to multiple considerations and helped researchers in selecting appropriate alternative. Weightage given to each criterion played a crucial role in taking right decisions. Panelists providing weightage to criteria of a food commodity should have sufficient knowledge and experience of working on that commodity.

References

Hajiaghaei-Keshteli M, Cenk Z, Erdebilli B, Ozdemir YS and Gholian-Jouybari F.2023. Pythagorean Fuzzy TOPSIS Method for Green Supplier Selection in the Food Industry. *Expert Sys. Appl*. 224, 120036.

Hedayatia S, Niakousarib M, Damyehc MS, Mazloomia SM, Babajafaria S and Ansarifard E.2021. Selection of appropriate hydrocolloid for eggless cakes containing chubak root extract using multiple criteria decision-making approach. *LWT-Food Science and Technology* 141: *110914*.

Gao L and Hailu A. 2013. Identifying preferred management options: An integrated agent-based recreational fishing simulation model with an AHP-TOPSIS evaluation method. *Ecological Modelling* 249: 75–83.

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Utilization of Hill lemon for the preparation of functionally enriched blended beverage

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Keywords: Blended beverages, Giloy, Harad, Hill lemon, RTS, Vitamin C

Introduction

The consumption of functional and blended beverages has been on the rise in recent years due to their antioxidant properties, which enhance the body's immune system. Their consumption has undergone significant changes and new products have emerged, driving growth in the health drink market (Theba et al., 2024). Numerous naturally occurring foods, such as citrus fruits, giloy and harad can provide a variety of nutrients, including zinc, selenium, iron, and vitamins C, D and E. Therefore, to exploit their nutritional and functional properties, Hill lemon-based functionally enriched blended beverages were developed.

Material and methods

Hill lemon (galgal) juice was obtained by using a screw-type juice extractor. The galgal juice was strained, packed in PET bottles and stored in a refrigerator. Harad juice was obtained by using two methods viz. cold extraction and hot extraction (heating time: 2 minutes) and best method was selected on the basis of minimum saponin content. Giloy stem juice was extracted as per the standard method. Different combinations of hill lemon, harad and giloy juices were tried for the preparation of juice blends. The optimized combination of juice blend was further used in the development of Hill lemon-based functionally enriched blended beverages by mixing different proportions of hill lemon-harad-giloy and sugar syrup to adjust the desired TSS of the product with different combinations of response surface methodology.

Results and conclusion

The hill lemon (galgal) fruits, harad fruits and giloy stems contained a substantial proportion of ascorbic acid (38.40, 9.48 and 3.77 mg/ 100 ml), total phenols (73.00 mg/ 100 ml, 201.24 mg/ ml and 63.98 mg/ 100 ml) besides 5.75, 6.24 and 2.81 per cent total sugars, respectively. Hot extraction method consisting of heating of grinded mass with water in 1: 2 ratios for 2 minutes followed by filtration was optimized to yield minimum saponins (1.47 %) with better physico-chemical attributes. A hill lemon-based functionally enriched blended beverage containing 14 per cent fruit (prepared by mixing 65 per cent hill lemon juice, 12.5 per cent harad juice and 22.5 per cent giloy juice) with a TSS of 12 °Brix was determined to be the best blend with the highest level of utilization of hill lemon as the functional ingredient.

References

Theba T, Nayi P and Ravani A. 2024. Beetroot-based blended juice: Process development, physico-chemical analysis and optimization of novel health drink. Food Chemistry Advances 4:1-9.

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Maize flour based bakery products: An approach towards Sustainable Food Systems

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Keywords: Maize, Local variety, nutrition, bakery products, muffins, muffin premix

Introduction

Maize (*Zea mays* L.) is one of the leading crops after rice and wheat which is widely cultivated as cereal grain around the world. It is a crop with a lower carbon footprint compared to wheat, due to its adaptability to diverse climatic conditions and its relatively lower water and fertilizer requirements. Maize kernel is the edible and nutritious part of the plant and is good source of carbohydrates, protein, fat, vitamin B complex such as B_1, B_2, B_3, B_5, and B_6, vitamin C, vitamin E, vitamin K, various minerals together with large amount of beta-carotene and fair amount of selenium[1]. Apart from this, absence of gluten in maize makes it healthy alternative for people suffering from celiac disease. Thus, maize being gluten free nutritious rich grain was utilized for the development of bakery products as a healthy approach towards sustainable food systems. The study was conducted with the prime objective to develop maize flour based muffins and muffin pre-mixes from the Local variety of maize which exhibited appreciable nutritional and organoleptic quality. Thus, by incorporating maize flour into bakery products, the food industry can reduce dependence on more resource-intensive grains which will way towards advancing sustainability within the food industry.

Material and methods

The investigation was carried in the department of Food Science and Technology, Dr Y S Parmar UHF, which aims at standardization of formulation of maize flour based muffin pre-mixes and muffins through RSM. Kernels of local variety of maize were milled into fine fractions (250 µm) with a milling yield of 47.66 ± 0.70 per cent which was utilized for product development. Muffin is a formulation that contains all ingredients like flour, sodium hydrogen carbonate, sodium bicarbonate, powder sugar, fat, curd and milk while the premix contains all the ingredients normally used for the preparation of muffin, except fat, curd and milk[2]. For uniform mixing, the ingredients of muffin premix were sieved 1-2 times through 40 mesh (355µm) size sieve and packed in Aluminium laminated pouches.

Results and conclusion

Flour of local variety of maize was found to possess higher total phenols (56.28±1.36 mg/100 g), total carotenoids (88.72±2.32 µg/g) and antioxidant activity (36.03 ± 4.32 DPPH%). Optimization of ingredients for development of muffin pre-mix and muffins from Local variety of maize through Response Surface Methodology includes maize flour (29.72%), curd (14.86 %), sugar (20.80%) sodium hydrogen carbonate (1.40%) sodium bicarbonate (0.89%) refined oil (8.92%) and milk (23.77%) where the batter was baked at 180°C for 15 minutes for the preparation of muffins. Muffin pre-mix is a convenient mix that contains all ingredients normally used for the preparation of muffin, except fat, curd and milk. Nutritional composition of muffins prepared from local variety of maize flour (Table 1.0) had appreciable amount of crude fiber (3.59%), total phenols (33.97 mg/100g), antioxidant activity (28.82%), carbohydrates (54.34%), crude protein (8.80%), crude fat (14.40%) and energy value (435.75 kcal/100g) with moisture content as 19.95%. Chemical composition of muffin pre-mix prepared from Local variety recorded the moisture content as 7.85 ± 1.00 per cent with water activity as 0.69 ± 0.03, ash content as 1.57 ± 0.04 per cent, protein as 8.60 ± 1.23 per cent, fiber content as 1.59 ± 0.27 per cent and antioxidant activity as 28.90 ± 1.95 per cent (Table 1).

Table 1: Chemical composition of maize flour based bakery products

Parameter	Muffin Premix	Muffins
Moisture (%)	7.85 ± 1.00	19.95 ± 1.02
Water activity	0.69 ± 0.03	0.76 ± 0.06
Ash content (%)	1.57 ± 0.04	2.87 ± 0.09
Crude protein (%)	8.60 ± 1.23	8.80 ± 1.10
Crude fat (%)	4.75 ± 0.88	14.40 ± 1.11
Crude fiber (%)	1.59 ± 0.27	2.91 ± 0.36
Total phenols (mg/100 g)	45.47 ± 3.13	41.00 ± 2.13
Antioxidant activity (%)	28.90 ± 1.95	32.01 ± 1.10
***Carbohydrates (%)**	75.78 ± 2.01	65.52 ± 3.01
Energy value (Kcal/100g)	389.31 ± 0.02	435.75 ± 0.02

The muffins packed in LDPE pouches showed non significant changes upto 10 days under refrigerated conditions while muffin premixes exhibited appreciable quality in aluminum laminated pouches upto 21 days. Thus, the utilization of maize for the development of different food products support the possibility of developing bakery product with an excellent nutritional profile and quality, which would raise the farmer's income, apart from providing health benefits to the general masses.

References

Murdia LK, Wadhwani R, Wadhawan N, Bajpai P and Shekhawat S. 2016. Maize utilization in India: an overview. *American Journal of Food and Nutrition* 4: 169-176

Kathuria P, Kaur G and Kanojia V. 2021. Physico-chemical and functional properties of whole maize flour blended with wheat and gram flour. *Asian Journal of Dairy and Food Research* 40: 301-308.

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Bibliometric analysis of SDGs relevance in Farmer Producer Organisations

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***Keywords*:** Farmer Producer Organisations, Sustainable Development Goals

Introduction

Farmer Producer Organisations (FPOs) have immense potential to contribute to achieving the SDGs. Agriculture plays a crucial role in achieving eight SDGs, including ending poverty, zero hunger, clean water, affordable energy, sustainable consumption and production, combating climate change, conserving oceans, and protecting life on land (Nhemachena et al., 2018). FPOs are contributing to better health and nutrition (SDG 2) by promoting organic farming practices. This study assesses the relevance of SDGs with FPOs, recognizing their significance in achieving a sustainable and equitable future (Mourya and Mehta, 2021). By supporting FPOs, we can accelerate progress towards the SDGs and promote sustainable agriculture practices.

Material and methods

The bibliographic data to analyse the relevance of SDGs with Farmer Producer Organisations were obtained from the dimensions and Scopus database which is referred to as the most important and influential database to retrieve academic records and conduct bibliometric analysis. The keyword combinations that were searched on 2 May, 2024 in the dimensions database was 'Farmer Producer Organisations (FPOs)' under the title and abstract and in the Scopus database was 'Farmer Producer Organisation' OR 'Farmer Producer Organization' OR 'FPO' AND (agriculture OR farming OR rural development OR cooperative) for a year 2015- 2024. Total 184 publications were obtained from dimensions database that were reduced to 180 because there were repeated publications and 31 publications were found from Scopus database that were reduce to 29 due to repetition of publications. A total of 209 publications were analysed to study the relevance of SDGs with Farmer Producer Organisations.

Results and conclusion

The number of publications related to Farmer Producer Organisations (FPOs) all over the world has been rising per year. The number of published documents was only 1 in 2015, which reached 73 in the year of 2023, seventy-three times more than the number in the starting year of this analysis. The total number reached 172 in 2023 and 183 in the year 2024 till April month; marking that the publications of academic papers in this research field increased by 172 times in the past decade. Hence, we can say that Farmer Producer Organisations (FPOs) is constantly drawing attention from the academic circle. From the dimensions and Scopus database it was founded that out of the 209 publications of FPOs 73 publications talked about the Sustainable Development Goals that were fulfilled by the FPOs. From the figure 1 it can be evaluated 9 SDGs are fulfilled by the FPOs with major focus on the SDGs-2 i.e. to eradicate poverty.Poverty issue is resolved by FPOs as less amount of equity capital is accumulated during the initial phase of business. The strategy emerged from studies in Asia and Africa for contravening such vicious cycles of poverty was to harmonize small agro-enterprise accompanying with complementary interventions such as positive spill-overs including technological innovation, rural credit systems, communications, human capital formation and physical infrastructure.

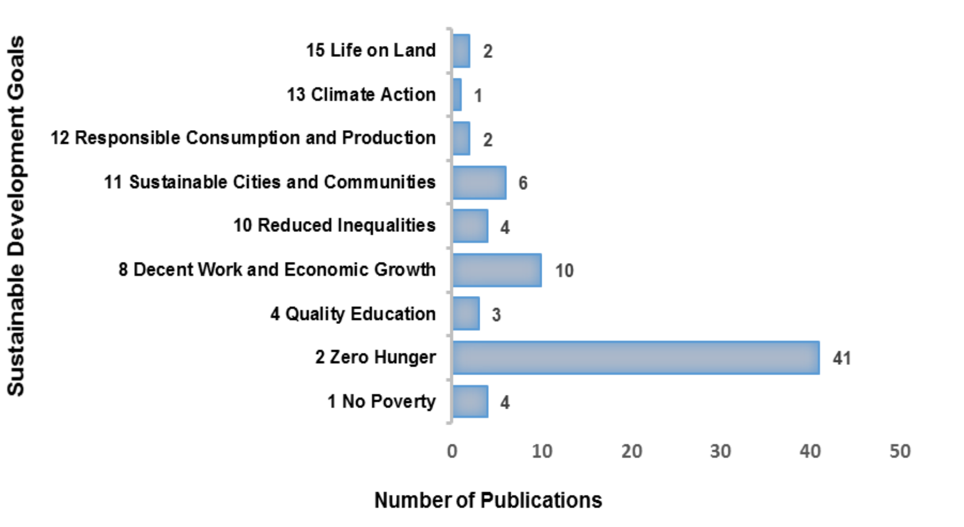

Fig 1: Sustainable Development Goals fulfilled by FPOs

References

Nhemachena C, Matchaya G, Nhemachena CR, Karuaihe S, Muchara B and Nhlengethwa S. 2018. Measuring baseline agriculture-related sustainable development goals index for Southern Africa. *Sustainability*, 10(3):849.

Mourya M and Mehta M. 2021. Farmer Producer Company: India's magic bullet to realise select SDGs? *International Journal of Rural Management*, 17(1): 115-147.

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Seed production in Garden pea under natural farming system

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Introduction

Pea (*Pisum sativum* L.) is a herbaceous annual plant belonging to family Fabaceae. It is the second most important legume of the world (Pawar *et al.,* 2017) Natural farming reduces input costs for farmers by eliminating the need for chemical fertilizers and pesticides, leading to higher profit margins. Additionally, it promotes sustainable agricultural practices, which can enhance long-term economic resilience.

Material and methods

The present study evaluated the effect of spacing and intercropping on quality seed production of pea cv. Pusa Pragati under natural farming during *Rabi* season. Intercrops included were coriander (cv. Solan selection), fenugreek (cv.IC-374),spinach (cv. Pusa Harit) at 3 different spacing *viz*., 50×7.5 cm, 60×7.5 cm and 70×7.5 cm in plot size of 3.5 m ×1.2 m and were sown in between the pea rows. Seed crop of coriander, fenugreek and spinach was harvested in the month of April, May and June. NF components (*beejamrit, ghanjeevamrit, jeevamrit* etc) were followed.

Results and conclusion

Effect of intercropping and spacing was found significant for all the parameters. Treatment combination (Spacing 70x7.5 cm + Pea + fenugreek) was found best for the pod length (cm), green yield per plot^{-1},seed yield g plant^{-1} and plant height at peak reproductive stage. In natural farming system, when pea is grown with spacing 70x7.5 cm along with intercrop fenugreek found as best combination with respect to yield parameters.

Table 1: Green pod yield and seed yield in pea under natural farming system

Green pod yield (kg plot^{-1})									
	B1	B2	B3	B4	B5	B6	B7	B8	Mean A
A_1	0.069	0.076	0.076	0.068	0.077	0.072	0.081	0.074	0.074
A_2	0.07	0.062	0.073	0.077	0.073	0.066	0.081	0.066	0.071
A_3	0.077	0.076	0.094	0.074	0.086	0.048	0.054	0.051	0.07
Mean B	0.072	0.071	0.081	0.073	0.079	0.062	0.072	0.064	
CD (0.05)									
Intercrop (A)	0.003	0.002	0.001						
Spacing (B)	0.005	0.003	0.002						
A×B	0.009	0.005	0.003						
Seed yield (g plant^{-1})									
	B1	B2	B3	B4	B5	B6	B7	B8	Mean A
A_1	7.8	7.7	8.1	6.86	7.5	8.4	6.6	6.86	7.47
A_2	7.13	7.5	6.53	8.23	8.03	7.8	6.46	6.83	7.31
A_3	9.56	7.33	10.73	7.56	7.8	6.3	6.53	8.46	8.03
Mean B	8.16	7.51	8.45	7.55	7.77	7.5	6.53	7.38	
CD (0.05)									
Intercrop (A)	0.597	0.296	0.209						
Spacing (B)	0.975	0.483	0.341						
A×B	1.688	0.836	0.591						

References

Pawar Y, Verma LR, Verma P, Joshi HN, More SG and Dabhi JS. 2017. Influences of integrated use of organic and inorganic sources of nutrients on growth, flowering and yield of garden pea (*Pisum sativum* L.) cv. Bonnevile. *Legume Research* 40: 117-124.

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Farmers' preference rating of fodder tree species for sustainable dairy development in north-western Himalayas

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***Keywords*:** Leaf biomass, fodder tree species, palatability, growth

Introduction

Livestock sector is essential for traditional agriculture in India, providing nutritional security and income from milk, eggs, meat, wool, and other products. India's livestock population is one of the largest, which globally includes 192.49 million cattle, 109.85 million buffaloes, 74.26 million sheep, and 148.88 million goats, growing by 4.6% from 2012 to 2019. Despite this growth, fodder production has remained static, creating feed shortages, especially during lean seasons. In Himachal Pradesh, there was a shortage of dry fodder and green fodder as much as 50 per cent and 21 per cent respectively, in 1972, whereas corresponding shortages for these feed stuffs during 2002 was estimated to be about 37 per cent and 59 per cent for dry as well as green fodder, respectively Dhungana et al. (2012). Fodder tree leaves are vital in regions with limited alternatives, as their nutritional value varies by species and season. Farmers' traditional choices reflect their knowledge of nutritional benefits, ease of cultivation, and growth patterns.

Material and methods

To determine farmers' preference ratings for fodder trees, a study was conducted using a semi-structured open questionnaire, gathering data from 100 respondents (25 per location) in specific regions of Kinnaur district (Reckongpeo, Karchham, Kilba, and Sangla) in Himachal Pradesh. The questionnaire was designed based on criteria suggested by Mekoya et al. (2008), which included palatability, growth rate, beneficial effects, ease of propagation and leaf biomass. Each respondent was asked to list and rank the fodder trees used for animal feeding in their area. Farmers rated each species for each parameter individually, assigning scores from 1 to 4, where 1 was poor, 2 fair, 3 good, and 4 excellent. These preference scores were treated as continuous variables and analyzed statistically using one-factor analysis with OPSTAT software.

Results and conclusion

Based on farmers' perceptions in Kinnaur district, , *Fraxinus xanthoxyloides* had the highest palatability (3.75), followed by *Morus alba* (3.40), *Salix spp*. (2.53), *Celtis australis* (2.11), *Quercus leucotrichophora* (1.92), *Ulmus laevigata* (1.86), *Quercus dilatata* (1.83), *Populus spp.* (1.78), *Robinia pseudoacacia* (1.61) and *Quercus ilex* (1.17). *Populus spp*. was rated as the fastest-growing species (3.10), followed by *Salix spp*. (3.07), *F. xanthoxyloides* (2.48), *M. alba* (2.30), *U. laevigata* (2.15), *R. pseudoacacia* (2.06), *Q. leucotrichophora* (1.86), C. *australis* (1.67), *Q. dilatata* (1.67) and *Q. ilex* (1.39). Regarding beneficial effects, M. alba ranked highest (3.37), followed by *F. xanthoxyloides* (2.64), *Salix spp*. (2.12), *Q. leucotrichophora* (2.08), *Q. ilex* (2.0), *C. australis* (1.89), *U. laevigata* (1.60), *R. pseudoacacia* (1.56), *Q. dilatata* (1.50) and *Populus spp*. (1.45).

For propagation, *Salix spp.* led with a score of 3.08, followed by *Populus spp*. (3.00), *F. xanthoxyloides* (2.77), *M. alba* (2.53), *U. laevigata* (2.32), *Q. leucotrichophora* (2.31), *R. pseudoacacia* (2.25), *Q. ilex* (1.61), *C. australis* (1.56) and *Q. dilatata* (1.44). In terms of leaf biomass yield, *Q. leucotrichophora* ranked highest (2.92), followed by Q. *dilatata*

(2.42), *M. alba* (2.40), *U. laevigata* (2.07), *Populus spp*. (2.06), *Salix spp*. (1.89), *C. australis* (1.78), *F. xanthoxyloides* (1.60), *R. pseudoacacia* (1.44) and *Q. ilex (*1.03). Overall, *M. alba* emerged as the best-performing fodder species in Kinnaur district, with an overall score of 2.80, followed by *F. xanthoxyloides* (2.65), *Salix spp*. (2.54), *Populus spp.* (2.28), *Q. leucotrichophora* (2.22), *U. laevigata* (2.00), *R. pseudoacacia* (1.78), *Q. dilatata* (1.77), *C. australis* (1.69) and *Q. ilex* (1.44) respectively. The study revealed that majority of the farmers agreed with *Morus alba* as the best performing fodder tree species based on palatability, faster growth rate, beneficial effects, ease of propagation and leaf biomass in Kinnaur district of Himachal Pradesh.

References

Dhungana S, Tripathee HP, Puri L, Timilsina YP and Devkota KP. 2012. Nutritional analysis of locally preferred fodder trees of middle hills of Nepal: A case study from Hemja VDC, Kaski district. *Nepal Journal of Science and Technology* 13: 39-44.

Mekoya A, Oosting SJ, Fernandez RS and Van der Zijpp AJ. 2008. Multipurpose fodder trees in Ethiopian highlands: Farmer's preference and relationship of indigenous knowledge of feed value with laboratory indicators. *Agricultural Systems* 96: 184- 194.

ESFS-NF/ISFS2024/4025

Hill Lemon RTS Beverages: Sustainable innovative approache for utilization of naturally grown hill lemon

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Keywords: Hill lemon, Hill lemon peel extract, natural, beverages, antioxidant activity

Introduction

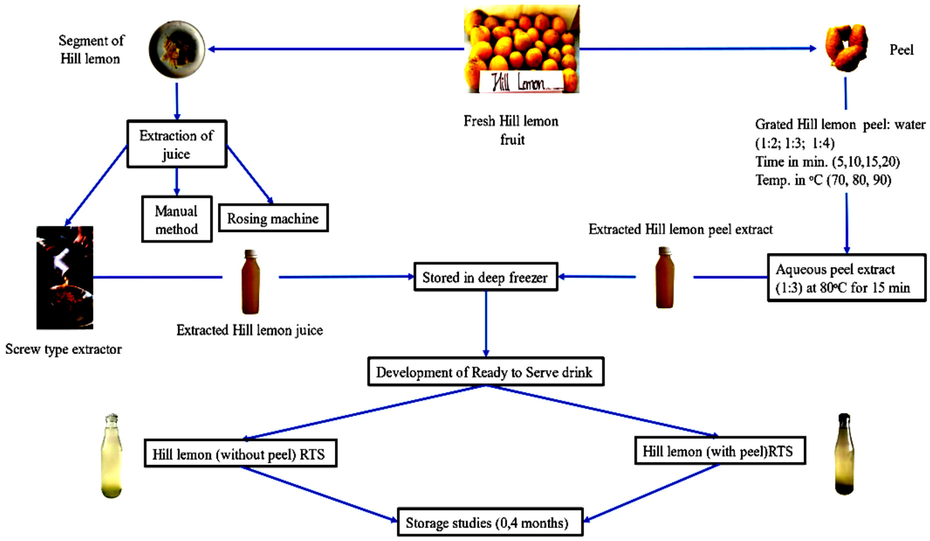
Food security is akey goal of the 21st century, it closely aligns with sustainable development goals 2 and 3, which aim to end hunger and encourage well-being for all. The Hill Lemon (*Citrus pseudolimon* Tanaka)is an underutilized naturally grown organicfruit of the Himalayas. This whole fruit of Hill lemon isquite rich in bioactive compounds and known for itspotential health benefits (Manchanda et al., 2023). Despite its great properties, Hill lemon (HL) fruit remains unexplored, and its peel (comprising 25 % of the fruit) which is a great source of minerals and bio-active componentsis often discardedduring processing. Utilizing acidic HL juice and functional peel extract for the preparation of chemical-freebeverages can provide significant health benefitsand new ways for the utilization of this naturally grown fruit.

Material and methods

The study aimed to prepare, compare, and evaluate the storage studies ofboth HL juice Ready to Serve (RTS) drinks, HL juice, and HL peel extract blended RTS. HL juice was extracted using three methodsscrew type extractor, manual method, and rosing machine. The best extraction method was selected based on the highest sensory scores, maximum yield, and shortest extracting time.Additionally, HL peel extract was prepared using 36 pretreatments involving different ratios of grated HL peel and water (1:2, 1:3, and 1:4), temperature (70, 80, and 90 ^{o}C), and time (5,10,15 and 20 min).The final pretreatment was selected based on optimum sensory as well asthe good antioxidant profile of the extract.
HL juice RTS and HL juice and peel extract blended RTS were prepared by trying different recipe formulations of HL juice as well as peel extract through the heat processing method. No artificial acidulant or chemical preservative was added to the end product. Sugar was added up to 10% to maintain a desirable sugar acid blend of the end product.The best productwas selected based on the best sensory scores and optimum antioxidant activity. Further, the drinks were stored for 0 and4 months to assess any sensory and chemical changes. The key highlights in the chemical analysisincluded mineral estimation, limonin, naringin, antioxidant activity, phenol content, and optimum organic acid content.

Results and conclusion

Preparation of Hill lemon peel extract: Different ratios of grated HL and water i.e. 1:2, 1:3 & 1:4 at different temperatures of 70, 80, 90 ^{o}C and boiling temperature for 5, 10, 15 and 20 min were used for the extraction of aqueous peel extract. Among 36 pre-treatments, the ratio 1:3 at 80 ^{0}C for 15 min was selected based on the sensory scores and good antioxidant activity of peel extract. Preparation and standardization of Hill lemon RTS beverages: The result of the conducted study showed that the screw-type extractor was best among the three extraction methods (manual, screw-type extractor, rosing machine) based on the sensory scores and minimum time required to extract HL juice.



Among the beverages, HL juice RTS was prepared using six treatment formulations, in which 6 % HL juice was selected based on the sensory and optimum titratable acidity. No artificial acidulant or chemical preservative was added to the end product. For, another beverage *i.e.* HL juice and peel extract blended RTS, the beverage was prepared by maintaining the same HL juice concentration of 6 % (the optimized concentration) while varying the concentration of the peel extract from 1 to 5 %. The final concentration of 6 and 4 % of the Hill lemon juice and Hill lemon peel, respectively was selected based on the best sensory and good antioxidant and mineral profile. It has been observed that Hill lemon juice can be used for the preparation of refreshing beverages. Additionally, the incorporation of peel extract significantly increased the sensory quality, and overall mineral and antioxidant profile. Further storage studies showed that the product could be kept for 4 to 6 months without any significant change in sensory and functional characteristics.

References

Manchanda P, Kaur H, Mankoo RK, Kaur J, Kaur M and Sidhu GS. 2023. Effect of solvent ratio, temperature and time on extraction of bioactive compounds and their antioxidant potential from callus, leaf and peel extracts of *Citrus pseudolimon* Tanaka. *Journal of Food Measurement and Characterization* 17(6): 6180-6190.

ESFS-NF/ISFS2024/4026

Effect of seed priming by salicylic acid and natural formulation of *beejamrit* in bean seed germination

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Keywords: Hydropriming , Salicylic acid, Seed Germination

Introduction

Phaseolus vulgaris L., Kidney Bean /French Bean and Rajmash, is one of the most important leguminous vegetable/ pulse crop. It is grown for its tender pods and dry bean. It is a nutritious vegetable contains 1.7 per cent protein which helps in nitrogen fixation. Contender variety is tolerant to powdery mildew and mosaic which make it first preference of farmers to fetch high returns. Seed priming is one of the seed treatments to improve germination and emergence even under stress condition.

In this research study seed priming was done for 6 hours respectively in distilled water (hydro-priming), different concentrations of Salicylic acid (75 ppm, 100ppm and 125ppm) and Beejamrit formulation (2, 5 and 10%). The treatment combinations (100 ppm for 6 h) of salicylic acid showed higher results and Beejamrit (5% for 6 h) found to be second best. The present study investigated seed priming technology using salicylic acid and beejamrit on its effects on plant growth and seed quality of *Phaseolus vulgaris* L. cv. Contender.

Material and methordss

The research experiment was carried out in the Laboratory of Department of seed science and technology, college of Horticulture, Nauni, Solan (H.P.) in the year 2024 consisted of 3 seed treatments and absolute control and 3 soaking durations. Treatments including seed soaking in salicylic acid @ 100ppm, Beejamrit @ 5% and hydropriming at three different durations i.e. 4,6 and 8 h for each seed treatments. For each treatment seed quality parameters were recorded. According to ISTA guidelines were followed to conduct the test, on germination percentage, days to germination and speed of germination.

Results and conclusion

Salicylic acid priming produced the best effects, increasing germination percentage and speed the fastest, taking the fewest days for germination. Salicylic acid priming ranked slightly higher than beejamrit priming, which came in second place with good germination results. Third place was to hydropriming, which improved germination metrics somewhat but was less successful than both salicylic acid and Beejamrit. With the lowest germination percentage, slowest germination speed, and longest germination period, the control (unprimed seeds) didn't show best results.In addition to being a successful seed priming agent, beejamrit is a sustainable option for the environment and society. It contributes to a comprehensive strategy for rural development by strengthening small-scale farmers, improving agricultural sustainability, and maintaining ecological health through the promotion of low-cost, traditional methods in improving the quality of seeds.

References

Madaik S. 2024. Studies on effect of intercropping and manurial practices on yield and quality of garlic (*Allium sativum* L.). Department of Vegetable Science. Dr. Yashwant Singh Parmar University of Horticulture and Forestry Solan. P. 136.

ESFS-NF/ISFS2024/4027

Enhancing shelf life and quality of peaches with pre-harvest GRAS chemicals

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Keywords: GRAS, Putrescine, Salicylic acid

Introduction

Peach (*Prunus persica* L. Batsch) is a popular fruit with a short shelf life, posing challenges for storage and transport (Nagwa et al., 2007). To extend its post-harvest life and maintain quality, pre-harvest foliar sprays of calcium chloride, putrescine and salicylic acid are explored. Calcium chloride maintains cell wall integrity, putrescine delays senescence by regulating ethylene, and salicylic acid enhances resistance to oxidative stress and pathogens. These chemicals are collectively called as Generally Regarded As Safe (GRAS) (Ali et al., 2014). Understanding the effects of these treatments could improve preservation, reduce post-harvest losses, and increase market value of peaches. This study evaluated the effectiveness of GRAS as foliar application to extend shelf life of peach fruits.

Material and methods

The experiment was conducted at in the Experimental Block of the Department of Fruit Science, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni - Solan (H.P) to study the "Effect of foliar sprays of Calcium Chloride, Putrescine and Salicylic acid on shelf life of 8 years old Glohaven and Redhaven peach cultivars. The experiment was laid out in a Randomized Block Design Factorial, consisting of ten treatments with three replications. Peach fruits were sprayed at three different stages during their growth and development. The fruit sample from each experimental plants were collected at optimum harvest maturity for further analyses.

Results and conclusion

The results showed that physiological loss in weight (PLW) increased for both 'Glohaven' and 'Redhaven' peach cultivars during storage, irrespective of the treatment. However, all treatments significantly reduced weight loss compared to the control. Calcium Chloride at 2.0% was the most effective, resulting in the lowest PLW across both cultivars. On the 9th day, PLW was reduced to 4.96 per cent for 'Glohaven' and 4.65% for 'Redhaven' with calcium Chloride treatment, compared to 6.63 and 6.49 per cent in control. Total sugars content increased while acidity decreased over the storage period, leading to a higher sugars/acid ratio. On the harvest day, the lowest sugars/acid ratio (13.34 and 13.74) was recorded, which increased significantly by the 9^{th} day to 23.98 for 'Glohaven' and 24.23 for 'Redhaven'. Putrescine 2 mM and calcium chloride 1.5 per cent resulted in the lowest sugars/acid ratios in freshly harvested fruits, while the highest ratios (45.86 and 46.09) were noted in the control by the 9th day of storage.

Overall, calcium chloride, putrescine, and salicylic acid effectively reduced % PLW and improved fruit quality during storage, with calcium chloride @ 1-2 per cent showing the most significant impact on enhancing shelf life and maintaining the quality of peach fruits.

Table 1: Effect of Calcium Chloride, Salicylic acid and Putrescine on the per cent physiological loss in weight of peach fruits stored at ambient storage

Cultivars / Treatments	Per cent Physiological Loss in Weight (% PLW)							
	Glohaven				Redhaven			
	3 days	6 days	9 days	Mean	3 days	6 days	9 days	Mean
T_1: $CaCl_2$ @ 1.0%	1.74	3.55	5.77	3.69	1.88	3.66	6.16	3.90
T_2: $CaCl_2$ @ 1.5%	1.79	3.54	6.19	3.84	2.06	3.26	6.11	3.81
T_3: $CaCl_2$ @ 2.0%	1.36	2.88	4.96	3.06	1.14	2.83	4.65	2.87
T_4: SA @ 2.0mM	1.92	3.24	6.49	3.88	1.76	3.56	6.15	3.83
T_5: SA @ 3.0mM	1.55	3.41	5.21	3.39	1.90	3.63	5.31	3.61
T_6: SA @ 4.0mM	1.93	3.22	5.87	3.67	2.22	3.40	6.07	3.90
T_7: PUT @ 2.0mM	1.80	3.87	5.20	3.62	1.60	3.18	4.77	3.18
T_8: PUT @ 3.0mM	1.72	3.05	5.94	3.57	1.71	3.35	6.10	3.72
T_9: PUT @ 4.0mM	1.92	3.92	6.48	4.11	1.84	2.96	6.01	3.60
T_{10}: Control	2.66	4.56	6.63	4.62	2.60	4.06	6.49	4.38
Mean	1.84	3.52	5.88		1.87	3.39	5.78	
CD (0.05)								
Treatment (T) :				0.17				0.26
Cultivar (C) :				0.09				0.14
T×C :				0.29				0.46

References

Ali I, Abbasi NA and Hafiz IA. 2014. Physiological response and quality attributes of peach fruit *cv*. Florida king as affected by different treatments of calcium chloride, putrescine and salicylic acid. *Pakistan Journal of Agriculture Sciences* 51(1): 33-39

Nagwa A, El-Megeed A, Abd El-Fattah S and Wally M. 2007. Effect of calcium and boron treatments on yield, fruit quality, leaf and fruit mineral contents of pear trees grown in calcareous soils. *Journal of Advance Agricultural Research* 12: 459-77.

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Evaluation of pre-sowing treatment using salicylic acid and beejamrit as seed priming on seed germination in bell pepper

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Keywords: Beejamrit, Bell pepper, Germination, Salicylic acid, Seed priming

Introduction

Irregular germination and poor seedling growth are some key challenges in *Capsicum annuum L*. (bell pepper) during plant establishment. Seed priming is a pre-sowing treatment to enhance seed germination efficiency, potentially improving crop yields. Seed priming with salicylic acid, a naturally occurring phytohormone enhances seed germination, vigor, and antioxidant activity, regulating plant physiology. Beejamrit priming, a natural farming technique, uses beneficial microbes and nutrients to enhance seed quality cost-effectively. Hence, present investigation examines how salicylic acid and beejamrit priming affect seed quality.

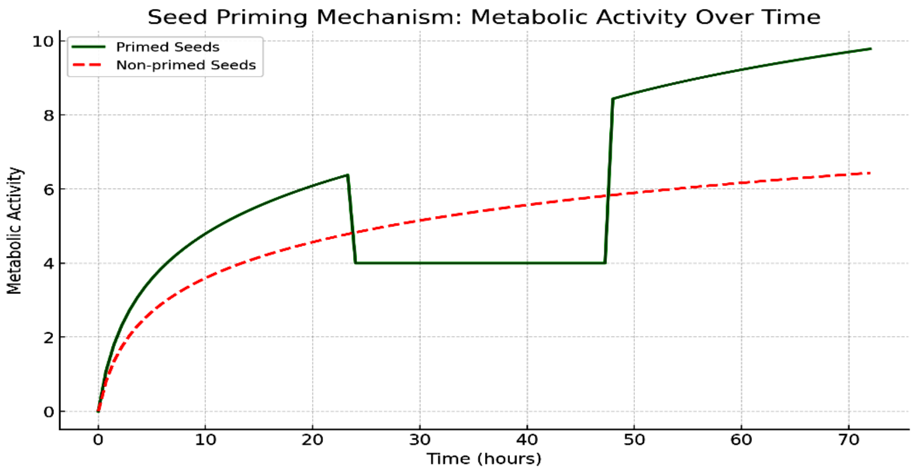
Material and methods

This experiment was carried out evaluate the effects of seed priming on germination and seedling vigor. It compared three treatments: Salicylic acid (75 ppm), *Beejamrit* (5%), and hydropriming, each applied for 6, 8 or 10 hours, whereas a control group with no soaking was also included. The priming process involved hydrating and dehydrating seeds to boost metabolic activity, potentially improving germination speed and seedling health. After treatment the seeds were dried and put for germination to assess quality parameters including germination percentage, germination speed, and time to germination.

Results and conclusion

Results portrayed were remarkable in salicylic priming, where the percentage of germination showed a significant increase, the rate of germination was best, and the number of days taken for germination was the least. Beejamrit priming followed in second place, showing good germination but slightly lower as compared to salicylic acid priming. Hydropriming came third, providing only moderate improvements in germination metrics and being less effective than both Salicylic acid and Beejamrit. Unprimed seed did not perform so well, with the lowest percentage of germination, the lowest rate of germination, and the longest time to germination. Though Beejamrit had less effectiveness than salicylic acid, the obtained results legitimized its use as an alternative in organic farming. Hydropriming improved to some extent but was less effective in this respect.

Seeds that were unprimed provided the least favourable results, thus proving the importance of seed priming for better crop establishment. *Beejamrit* represents a locally-sourced, cost-effective, and sustainable seed priming solution. This organic methodology enhances germination rates and promotes agroecological practices. By advancing incremental improvements and directly empowering smallholder farmers, it reduces reliance on synthetic agrochemicals. Consequently, this approach fosters the preservation of traditional agricultural techniques, contributing to socio-economic resilience within rural communities.



Mechanism of seed priming

References

Mukherjee S, Sain S, Ali MN, Goswami R, Chakraborty A, Ray K, Bhattacharjee R, Pradhan B, Ravisankar N and Chatterjee G. 2022. Microbiological properties of Beejamrit, an ancient Indian traditional knowledge, uncover a dynamic plant beneficial microbial network. *World Journal of Microbiology & Biotechnology* 38(111).

ESFS-NF/ISFS2024/4029

Utilisation of industrial potato waste: Extraction of bioactive compounds from potato peel and mash

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Keywords: Antioxidants activity, Waste utilization, Peel, Mash, Ethanol

Introduction

Potato peels and mash are the industrial wastes that contains abundant amount of antioxidants that are underutilized, however, they can be extracted and used effectively by different extraction techniques such as Magnetic stirrer (MS) and microwave-assisted extraction (MAE).

Material and methods

Microwave-Assisted Extraction (MAE) and magnetic stirrer (MS) were the two extraction methods used on potato peel and mash powder, utilizing ethanol as the solvent. MAE was conducted at different power levels (300, 600 and 900 W) and durations (30, 20 and 10 seconds), whereas MS was performed at various temperatures (25, 35, and 45°C) and time intervals (30, 40, and 50 minutes).

Results and conclusion

While comparing the range analysis among these the extraction efficiency trend in decreasing order was MAE> MS for total phenols and flavonoids and similar trend was also seen in antioxidant activities. Maximum TPC content 376.09 mg GAE/100g for potato mash and 495.65 mg GAE/100g for potato peel was found by MAE extraction technique instead of MS.The Total Flavonoid Content (TFC) of potato peel and mash was estimated to be 248.07 and 253.11, respectively. These results demonstrated that more flavonoids were extracted by the MAE method rather than MS.The most significant results for antioxidant activity were observed with MAE at 600 W for 20 seconds; antioxidant activity was evaluated as 2.11 (peel) and 2.01 (mash) DPPH Trolox µmol/TE/100g.

It is suggested to apply MAE rather than MS due to its better performance in extracting bioactive chemicals from potato peel and mash, including flavonoids and phenolics, and fostering their efficacy as antioxidants.

ESFS-NF/ISFS2024/4030

Moringa seed flour: A promising ingredient for enhancing the nutritional and sensory attributes of traditional food

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Keywords: Debittered Flour, Moringa, Seeds

Introduction

Moringa oleifera is a nutrient-rich plant often referred to as the "miracle tree," has gained prominence in the food industry. While the use of moringa leaf powder in value-added products has been extensively studied, the potential of moringa seed flour remains largely untapped. This study aimed to explore the incorporation of moringa seed flour into *cheela* instant mix, a popular Indian traditional snack, to optimize its nutritional profile and enhance its consumer appeal. By partially substituting chickpea flour with moringa seed flour, we sought to create a more nutritious and convenient food product.

Material and methods

In this study, moringa seeds were subjected to debittering treatment (boiling for 35 mins followed by tray drying at50 °C and grinding),thus two types of moringa seed flours were obtained: raw and debittered. Savory Indian pancake (also known as *cheela*) mix was supplemented with moringa seed flours by 0 to 50 per cent replacement of chickpea flour. On the basis of sensory evaluation, the *cheela* mix with most acceptable was selected for further analysis. The selected *cheela* mix was analysed for proximate composition, functional properties, color parameters, textural, phytochemical and mineral composition.

Results and conclusion

The *cheela* mix incorporated with 40 per cent DMSF was selected for further analysis on the basis of sensorial properties, which demonstrated superior nutritional values, with higher levels of protein (24.70%), fat (14.63%), and fiber (7.63%) compared to the control mix. values. The L*, a* and b* values of control *cheela* instant mix were 87.37, 3.17 and 25.08 respectively, while those for 40% DMSF *cheela* instant mix were 79.43, 3.67 and 30.17 respectively. Additionally, the incorporation of DMSF enhanced functional properties such as water and oil absorption capacities. Mineral analysis revealed an increase in potassium, phosphorus, and zinc in the *cheela* mix from 296.87 to 434.47, 212.98 to 303.60 and 213.32 to 272.76 mg/100g respectively on supplementation with DMSF.

DPPH radical scavenging ability and TPC also improved in *cheela* instant mix with addition of 40 per cent DMSF by 15 and 12.35 per cent respectively. Thus, *cheela* instant mix supplemented with debittered moringa seed flour offers a convenient and nutritious way to supplement diets.

References

Dhawi F, El-Beltagi HS, Aly E and Hamed AM. 2020. Antioxidant, antibacterial activities and mineral content of buffalo yoghurt fortified with fenugreek and Moringa oleifera seed flours. *Foods* 9(9): 1157.

Giuberti G, Rocchetti G, Montesano D and Lucini L. 2021. The potential of Moringa oleifera in food formulation: A promising source of functional compounds with health-promoting properties. *Current Opinion in Food Science* 42: 257-269.

ESFS-NF/ISFS2024/4031

Process development for the preparation of fig bar

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Keywords: Antioxidant activity, dried figs, dried fig bar, honey, jaggery

Introduction

Figs (*Ficus carica*) are a very short duration crop and farmers and traders suffer severe post-harvest loss. Therefore, processing of fresh figs into fig products is highly desirable. So the present study was conducted to standardize the process for the preparation of fig bar.

Material and methods

The fig bars developed in the present study was prepared from both dried figs as well as fresh fig pulp. In both type of bars the supplementation of sugar by honey and jaggery was done at the rate of 20, 40, 60, 80 and 100 per cent. Fig bars were made by grinding dried figs and in the case of fresh fig, pulp was heated upto 70°B. Sugar and roasted nuts in the form of powder was added in pulp. Bars were molded, refrigerated, and packed for physico and phyto-chemical analysis.

Results and conclusion

Compared to control (with refined sugar), addition of honey and jaggery considerably enhanced the minerals and phytochemical content of the formulated fig bars. Sensory analysis favoured dried fig bar with 80 per cent honey and 100 per cent jaggery while fresh fig bar with 60% honey and 100% jaggery and the selected fig bars were further evaluated for shelf-life studies. The storage period had a significant impact on the reduction of some phytochemical constituents, while the physicochemical constituents were slightly affected. The selected bars remained safe for consumption for three 3 months. FTIR analysis revealed functional groups corresponding to phenols and sugars. The study showed high scope for low grade figs for value addition. Phytonutrients rich fig based intermediate products (Fig bar) with honey and jaggery were developed.

Compared to control (with refined sugar), the developed products were found rich in natural sugars, minerals and bioactive compounds. Fig bars will therefore be healthier and more nutritionally rich than those that are purchased commercially.

References

Aslam H, Nadeem M, Shahid U, Ranjha MMAN, Khalid W, Qureshi TM, Nadeem MA, Asif A, Fatima M, Rahim MA and Awuchi CG. 2023. Physicochemical characteristics, antioxidant potential, and shelf stability of developed roselle-fig fruit bar. *Food Sci. Nutr.* 11: 4219-4232.

Kumari N and Sharma A. 2020. Scope of fig (*Ficus carica* L.) cultivation in north-west India. In: Rashtriya Krishi, p. 73-74.

ESFS-NF/ISFS2024/4032

Development, standardization, quality assessment and shelf life studies of apple juice based carbonated beverages

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***Keywords*:** Carbonated beverages, sustainable innovation

Introduction

Apples (*Malus x domestica* Borkh.), the fourth most significant fruit consumed globally, with an estimated rise in global production of 83.7 million tonnes (USDA, 2024) suffers high postharvest losses owing to underutilization of culled/unmarketable produce in the beverage industry. Further, shift in consumers' preference for synthetic drinks with no nutritive value lead to sustainable idea of developing apple-based carbonated beverages that offer nutritional components in addition to the distinct effervescent taste, fragrance, and shelf life. In that context,the present study focused on developing thirst-quenching and functionally rich apple based carbonated drinks with improved product's sensory and nutritional qualities.

Material and methods

Three carbonated drinks, namely carbonated apple juice, carbonated pure apple drink, and carbonated spiced apple drink, were prepared using standardized recipes. The required quantity of spice extract (2%) was prepared by blending cumin (116 g; freshly roasted) + black pepper (70 g) + ginger powder (50g) in 1 litre water followed by boiling, and subsequent cooling and storing in pre sterilized glass bottles. The carbonation was done by incorporating carbon dioxide at 30-40 bar pressure. The carbonated beverages were kept for storage study under low temperature (2±1°C) condition for 4 months' duration. Furthermore, the biochemical and organoleptic properties were assessed at various intervals during storage.

Results and conclusion

Standardized process protocol for the preparation of three apple based carbonated beverages i.e. carbonated apple juice, carbonated pure apple drink, and carbonated spiced apple drink is presented in Fig.1. Physico-chemical properties of the apple fruit i.e. TSS, pH, percent acidity, total sugars, reducing sugars, ascorbic acid content, total phenols and antioxidant activity were found to be 10-12 °B, 3.4, 0.6%, 10.17%, 9.26%, 10.8 mg/mL, 63.89 mg GAE/100 g, and 71 %, respectively. Irrespective of the developed beverages, the physico-chemical attributes i.e., pH, titratable acidity, ascorbic acid, total phenols and antioxidant activity exhibited a gradual decrease with slight increase in reducing sugars and TSS during storage under low temperature condition (2 ± 1°C). Furthermore,the sensory evaluations for color, odour, taste, body/texture, aftertaste and overall acceptability decreased throughout storage for carbonated drinks.The present study reveals the potential applications for avoiding glut of apples in the market, source of income generation for small and medium scale farmers and processors in addition to scope for its commercial exploitation.

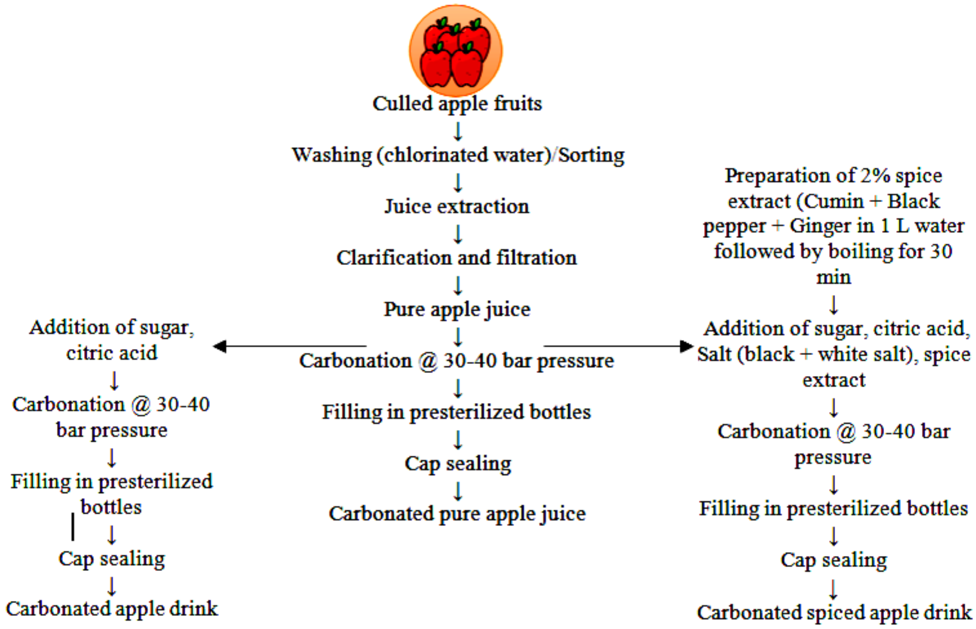

Fig 1: Standardized process protocol for the preparation of carbonated apple juice, carbonated pure apple drink and carbonated spiced apple drink

References

United States Department of Agriculture Foreign Agricultural Service. 2024. Fresh Apples, grapes, and pears: World Markets and Trade.

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Optimizing bioactive compound extraction from kachnar leaves (*Bauhinia variegata* L.): A comparison of microwave and conventional techniques

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Keywords: *Bauhinia variegata* leaves, Extraction, Phytochemicals, Antioxidant

Introduction

Medicinal plants have been integral to traditional medicine across cultures for centuries, providing natural remedies for medical treatments. *Bauhinia variegata* L. is a plant native to Asia and the Indian subcontinent and holds significant medicinal importance due to its rich phytochemical composition and diverse therapeutic properties. *B. variegata* leaves are known for their medicinal properties, including anti-inflammatory, antimicrobial, and antioxidant effects. Plants contain wide variety of antioxidants, most commonly the class of phenolic and flavonoid compounds. Kachnar has received limited attention regarding the innovative optimization of extraction processes for these beneficial components.

Material and methods

This study utilized a Box-Behnken design to optimize dynamic microwave-assisted extraction (MAE) for maximizing the yield of total polyphenol content (TPC) and total flavonoid content (TFC) from B. variegata leaves. Antioxidant capacity of the extracted fractions was evaluated using the DPPH and FRAP assays.

Results and conclusion

The DPPH radical scavenging activity was determined to be 4.257 mg TE/g, while the ferric reducing antioxidant power (FRAP) was measured at 40.375 mg TE/g. By optimizing three key factors microwave power, extraction time, and solid-to-liquid ratio a cost-effective method for obtaining phenolic acid-rich extracts was established. The optimal extraction parameters for polyphenols and flavonoids were determined to be: microwave power of 489.64 W, extraction time of 1 minute, and a solid-to-liquid ratio of 1:30 g/mL. FE-SEM imaging revealed that the application of MAE significantly altered the morphological structure of the extract residue.

Valuable phytochemicals extracted from Kachnar leaves can be incorporated into food products to create high-added-value products.

References

Bansod SP, Parikh JK and Sarangi PK. 2023. Pineapple peel waste valorization for extraction of bio-active compounds and protein: Microwave assisted method and Box Behnken design optimization. *Environmental Research* 221: 115237.

Elakremi M, Sillero L, Ayed L, ben Mosbah M, Labidi J, ben Salem R and Moussaoui Y. 2022. *Pistacia vera* L. leaves as a renewable source of bioactive compounds via microwave assisted extraction. *Sustainable Chemistry and Pharmacy* 29: 100815.

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Integrating natural farming and Agri-PV for sustainable agriculture

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Keywords: Agri-PV, Renewable Energy, Sustainable Agriculture

Introduction

Several studies indicate that natural farming boosts production, enhances sustainability, conserves water, and improves soil health and ecosystems. It is often known as a cost-effective practice with potential for increasing employment and promoting rural development (Bishnoi and Bhati, 2017). Similarly, agrivoltaics is an upcoming innovative concept combining agriculture with solar energy production on the same land, turning land into a dual-purpose powerhouse for both food and renewable energy. This concept optimizes sunlight exposure while facilitating traditional agricultural practices, providing several benefits such as crop protection and better yield, better water-use management, pesticide reduction. Integrating Agri-PV systems with Natural Farming could further optimize land use by generating renewable energy alongside sustainable agriculture (Dupraz et al., 2011). This synergy enhances crop yields and provides a dual income source for farmers, making the system economically viable and environmentally friendly.

Material and methods

A solar PV system integrated with apple and cherry orchards was modelled to assess energy output and agricultural productivity on a 1-hectare farm in Shimla, Himachal Pradesh, India. The farm, situated at 2206 m altitude, was designed with a steel and aluminium Agri-voltaic structure, allowing for 4.5 x 1.8m spacing between rows to ensure adequate sunlight for crops. Cherries and apples were planted beneath the installation, with rainwater management systems integrated into the design. The energy efficiency of the system was based on Fraunhofer ISE data, with regional solar irradiation adjustments for Shimla. The HT-SAAE PV modules, with a power output of 300W-320W and efficiency of 11.6-12.3%, were used as a reference, though modifications are possible for specific regional needs. Economic analysis considered local electricity pricing from Himachal Pradesh State Electricity Board and agricultural cost estimates from a local farmer. This study focuses on Shimla, which has higher-than-average solar irradiation, suggesting significant geographic variability in solar potential across India.

Results and conclusion

The findings provide an economic assessment for Agri-PV implementation on cherry and apple orchards in this region. The study found that the combined Agri-PV and Natural Farming system resulted in a quick ROI of 5.3 years for cherry and 5.9 years for apple production (fig.1). The integration not only boosted fruit quality and yield but also reduced input costs through natural farming practices. The dual-use system proved economically sustainable, enhancing farmer income and promoting renewable energy generation. Future studies should explore the broader applicability of this approach in diverse agricultural contexts.

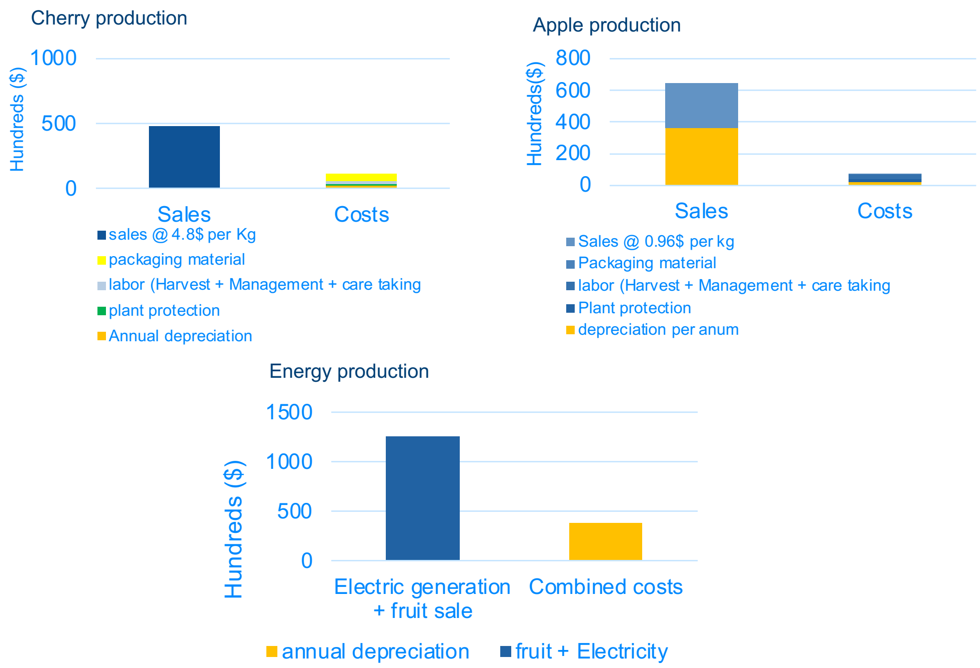

Fig 1: Costs and profits for fruit and electricity production

References

Bishnoi R and Bhati A. 2017. An overview: Zero budget natural farming. *Trends in Biosciences* 10(46): 9314-9316.

Dupraz C, Marrou H, Talbot G, Dufour L, Nogier A and Ferard Y. 2011. Combining solar photovoltaic panels and food crops for optimising land use: Towards new agrivoltaic schemes. *Renewable Energy 36*(10): 2725–2732.

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Utilization of Sand pear for the development of mixed fruit bar

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***Keywords*:** Fruit bar, Sand pear, Total soluble solids

Introduction

Sand pear (*Pyrus pyrifolia* L.) has rough texture and consists of diverse bioactive compounds that confer medicinal and health promoting benefits (Samkaria et al., 2024). The fruits have low acid content with bland flavor thereby having less appeal towards consumers and with heavy fruit bearing a huge quantity of fresh produce goes waste due to lack of processing and value addition practices. As the availability of raw material is at very low price during glut season, the processing can results in higher profit margin so it can be recognised as an ideal option to improve or uplift the economic status of small and marginal farmers along with employment generation. So, keeping the above points in view its fruits can be utilized for the preparation of sand pear fruit bar and sand pear based mixed fruit bar which is a convenient, sweet, and chewy snack which offers a balanced blend of sweetness along with essential nutrients. Further, the development of value added products like fruit bar can affirm that converting the fresh produce into value added products become very important to utilize the unmarketable raw material for income generation along with sustaining its value and cost.

Material and methods

Sand pear fruits were procured from the local market (Solan) and used for the preparation of fruit bars. Recipe for the sand pear fruit bar included seven treatments at varied TSS levels (20, 24, 28 and 32 ºB) and under each TSS level, the citric acid content was 0, 0.25, 0.50, 0.75, 1.00, 1.25 and 1.50 per cent. The best recipe on the basis of sensory evaluation was further used for the preparation of sand pear based plum and apricot fruit bar and the concentration of sand pear and plum/apricot was varied as 100:0, 90:10, 80:20: 70:30, 60:40 and 50:50 to select the best combination.

Results and conclusion

Sensory evaluation reveals that treatment having 0.75 per cent citric acid was selected as the best recipe for the development of sand pear fruit bar at 20 and 24 ºB TSS. Further at 28 ºB TSS level treatment having 1 per cent citric acid was selected as the best recipe and at 32 ºB TSS the treatment with 1.25 per cent citric acid was selected as the best recipe. All the four best recipes from each TSS level were further evaluated and the recipe with 24ºB with 0.75 per cent acid content was found to be best for the preparation of sand pear fruit bar.The optimized recipe was further utilized to prepare mixed fruit bar. The best recipes for sand pear based plum and apricot mixed fruit bars consisted of sand pear and plum/apricot used in the ratio of 50:50 fruit part. Whereas, for the preparation of mixed fruit bar from sand pear, plum and apricot the recipe with sand pear (45%), plum (25%) and apricot (30%) was standardized.

References

Samkaria S, Sharma R, Soni P, Thakur A, Dileep KC, Thakur M and Attri SC. 2024. A review on phytochemical potential and enormous nutraceutical benefits of Sand pear (*Pyrus pyrifolia* L.). *Ann. Phytomed*. 13(1): 388-396.

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Green approach towards crop nutritionthroughplant growth promoting rhizobacteria

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***Keywords*:** PGPR, Crop resilience, Soil productivity, Sustainability

Introduction

Excessive utilization of chemical fertilizers unfavorably affects soil microorganisms, soil fertility and the overall environment. This overreliance on agro-chemicals has raised public health concerns, triggers considerable research efforts to explore alternative approaches that complement chemical practices in agriculture. Among these, leveraging the potential of beneficial soil bacteria to enhance plant growth and productivity has gained exceptional devotes. Application of plant growth promoting bacteria (PGPR) is the viable option for crop resilience is an effective strategy to secure not only crop yield but also soil health, particularly for cultivating superior nutrient- efficient fruit plants. PGPR are naturally occurring soil microbes that colonize the rhizosphere and plant root surfaces, exerting beneficial effects on plant health and growth. These bacteria promote plant growth by mobilizing soil nutrients, producing various plant growth regulators, and protecting plants from phytopathogens through inhibitory actions.

Material and methods

Six-year-old peach trees cv. Shan-i-Punjab were selected for the study. Biological inoculants namely, *Bacillus subtilis* and *Pseudomonas fluorescens*in combination with chemical fertilizers (100, 75 and 50%) in seven different treatment combinations were applied. Standards procedures were followed for the determination of qualitative and quantitative characteristics during the study.

Results and conclusion

The results inferred that the vegetative growth, flowering, fruiting parameters, yield, quality and soil nutrient status were significantly enhanced with the conjoint application of plant PGPRs and inorganic fertilizers. Highest increment in plant spread, fruit retention, number of flower buds per shoot, fruit yield per tree, fruit length, fruit breadth, fruit volume, TSS: acidity, reducing sugars, non-reducing sugars content was recorded under treatment application of 75 per cent of reduced inorganic NPK along with FYM and *B. subtilis* consortia. Available macronutrient contents of soil (NPK) increased by 13.88, 7.59 and 15.11 per cent, respectively. Microbial biomass in terms of total bacterial population improved by 1.38 times compared to chemical fertilization. The study concluded that conjoint application of PGPR consortium + FYM at reduced NPK fertilizers significantly improved qualitative and quantitative traits.
This approach aligns with agro-ecological farming using biological formulations along with reduced synthetic chemical inputs.

References

Karlidag H, Esitken A, Turan M and Sahin F. 2007. Effects of root inoculation of plant growth promoting rhizobacteria on yield, growth and nutrient elements contents of leaves of apple. *Scientia Horticulturae* 114: 16-20.

ESFS-NF/ISFS2024/4037

Innovative Agridrone solutions for natural Farming

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Keywords: Dorne, natural farming, seeding, spray

Introduction

The agricultural drones play a significant role in revolutionizing monitoring of crops for various pest incidence, plant protection, nutrient management strategies and can contribute towards sustainable and optimized crop production. These unmanned aerial vehicles are so designed that they can be equipped with different sensors having potential to provide real-time pictures of crop conditions. High-resolution camera on a drone makes it capable of surveying, crop scouting and spraying. Amongst different type of drones,verstality of hexacopters and octocopters is evident in applications like precision agriculture tasks (Yallappa et al., 2017). The additional rotors enhance stability and payload capacity and make these drones well-suited for tasks requiring heavier payloads.

Their ability of being an efficient agricultural equipment can also be extended to the natural farming systems.

Uses of drones and methodology to be adopted:

Seeding: Drones are being successfully used to seed cover crops in different agricultural systems. Drone usage in addition to saving times also helps to maintain the soil quality as no intrusion in the field is required. As natural farming is multi crop system, hence in the presence of one crop the sowing of other crop in the field without disturbing the soil ecology is possible by using aeroseeder or broadcaster with the drones.

Crop health monitoring: Drone equipped with thermal and multispectral camera on the underside can help to monitor the crops being grown in the multi cropping systems. These cameras catch the images at one-second interval, can store them and transfer them to ground station via telemetry.

Pest monitoring: Drones equipped with different sensors like multispectral, hyperspectral, and thermal cameras provide a comprehensive view of crop health and have the ability to identify even the minor changes in plant. This quality of the drones enable them in early detection of any pest incidence. Multispectral imagery has enabled the early identification of diseasesby detecting spectral changes in infected plants (Panda et al., 2018).

Application of various inputs: Drones having an automated spraying capability have valuable application in the agriculture. Though drones are being effectively used in pesticide and fertilizer applications in different countries but in India drones are not being used in the application of pesticides due to non-availability of any recommendation by CIBRC. In case of natural farming various inputs like jeevamrit, and ghanjeevamrit are used for promoting the seed germination and growth of plants. Various astras viz. neem astra, brahmastra and agniastra are used effectively in managing different classes of insect pests. Khati lassi, is used to manage different diseases in the plants. These all inputs can be very efficiently sprayed using agridrones. But one hasto be careful in filtering the inputs before loading in the tank as the nozzles in the drone are very fine and quite expensive for replacement. The advantage with the application of these inputs using drone is that it will efficiently enter into the lowest level of multilayered cropping system due the force exerted by the propellers and the leaves being dislocated by the wind of propellers.

Transportation of inputs: In the areas with hilly terrains where natural farming is being practised, these drones can be helpful in carrying the inputs from one place to another. A drone having payload capacity of 10 Kg can carry up to 10 Kg of input at one time. The agridornes are drones of small category only with maximum payload capacity of 10 Kg.

Drones have empowered farmers with increased insights into their fields and thus addressing pest infestations at the early stages. The usage of drones in agriculture has unveiled possibilities for modern farming practices which are cost effective and need less labour. These unmanned aerial vehicles have revolutionized the methodology for monitoring, surveying and application of inputs in the agroecosystems. Advanced technologyand precision in operation has revolutionised the agricultureby delivering benefits which can be utilised throughout the crop cycle.

References

Panda SS, Mishra VK, Sena DR. 2018. Identification of citrus greening using multispectral remote sensing data from unmanned aerial vehicle. *Journal of Applied Remote Sensing* 12: 016003.

Yallappa MK, Wang Q, Qi H, Hu C. 2017. Performance evaluation of developed UAV for crop protection applications. *Journal of Intelligent & Robotic Systems* 85: 491-506.

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Effect of mango seed kernel flour substitution with wheat flour on Asian noodle quality

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Keywords: Dried noodles, Cooking quality, Functional ingredient, Flour, Textural properties

Introduction

Mango (*Mangifera indica* Linn.) is widely grown in India, which results in generating a significantquantity of seed waste being produced during processing. Thus, present project was designed to utilize mango seed kernel flour (MSKF) and evaluate its substitution effect with wheat flour on Asian steam dried noodle quality.

Material and methods

MSKF was incorporated in wheat based Asian steam dried noodles at the level of 0%, 2.5%, 5% and 7.5% (w/w). Prepared noodle samples were evaluated in terms of proximate (moisture, crude fat, crude protein, crude fibre and carbohydrate content), instrumental colour (L*, a* and b*), cooking quality (cooking time, cooking loss and cooked weight), textural quality (hardness, springiness, cohesiveness, chewiness and adhesiveness) and sensory analysis.

Results and conclusion

Significant variations were noticed in the crude fat and total ash content in the MSKF noodles. Cooking time of the noodles fortified with MSKF was around 6.8 min which higher in comparison with control noodle 5.8 min. Cooking loss significantly increased from 0.89% (control) to 1.72% (7.5% MSKF noodles) indicating the disruption of gluten network in the wheat noodles. A usual pattern of increase in hardness of cooked noodles from 13.83 N (control) to 28.51 N (2.5% MSKF noodles) manifested the strengthening of noodles due to the incorporation of MSKF. However, further decline in hardness recorded 25.87 N for 7.5% MSKF noodles indicated the weakening of network due to higher concentration of MSKF. Sensory attributes revealed the higher scores and overall acceptability (7.9) with 2.5% MSKF noodles. Thus, 2.5% MSKF can be employed as a functional ingredient to enhance the nutritional value of noodles while promoting the effective utilization of agro waste.

References

Awolu OO, Sudha LM and Manohar B. 2018. Influence of defatted mango kernel seed flour addition on the rheological characteristics and cookie making quality of wheat flour. *Food Science & Nutrition* 6(8): 2363-2373.

Mwaurah PW, Kumar S, Kumar N, Panghal A, Attkan AK, Singh VK and Garg MK. 2020. Physicochemical characteristics, bioactive compounds and industrial applications of mango kernel and its products: A review. *Comprehensive Reviews in Food Science and Food Safety* 19(5): 2421-2446.

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Automation in Natural Farming

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Keywords: Automation, Drip irrigation system, Filtration, Jeevamrit

Introduction

Use of chemicals and fertilizers in agriculture enhances the crop yield significantly, However, this has also led to various illeffects such as drastic reduction in the soil fertility and soil health which ultimately adversely affect the health issues inhumans. These factors have presently led to adapting the chemical and fertilizer free natural farming system.An ideal natural farming system improves the process of nutrient cycling and minimize drastically theusage of external costly inputs. The newly adopted and practiced natural farming also known as agroecology or ecological farming, is a sustainable approach to agriculture that focuses on working with natural ecosystems and minimizing the use of synthetic inputs.According to the natural farming components, the method needs no inputs (farmyard manure, organic or chemical). Mainlyair, water, and sun provide 98-98.5 percent of plant nutrients, and the remaining 1.5 percent from the soil are available free of cost. The application of jeevamrit is one of the most important wheels of the natural farming system.

Material and methods

Application of jeevamrit is enhance the soil microbesusing an inoculum of water (200 liters), fresh cow dung (10 kg), cow urine (10 liters), jaggery (1-2 kg), pulse/gram flour (1-2 kg) and handful farm soil. For manual or conventional preparation, these materials are mixed in a plastic drum and it is ready after one week. It is applied @500 litres/ hectare twice in a month through irrigation water.The objective of automation in natural farming is todesign, develop, and implement an automated system to preparation of jeevamrit with reducedoperator assistance. The automation system consists of the catch pit for collection of cow urine, mixing tank, mixing stirrer machine, sludge pump, jeevamrit processing tanks, blower for aeration, filtration unit, jeevamrit storage tank, distribution tank, booster pumps, distribution main and lateral lines, emitters etc.

Results and conclusion

The ingredients used for the preparation of 1000 L of jeevamrit have been scaledfrom the composition of jeevamrit and placed in the mixing tank. After complete mixing of the ingredients, liquid material is transferred from mixing tank to processing tank with the help of sludge pump. The air circulation in clockwise direction flows with the help of blower. About after one week, the prepared jeevamrit is filtered through three step vertical filtration unit and stored in storage tank after passing through filtration unit and disk filter. Afterwards, prepared filtered jeevamrit is conveyed to distribution tank. Jeevamrit is applied by using distribution lines, lateral lines and ultimately through drippers to the plants into the field. The automation plant for preparation of jeevamrit with a surface drip irrigation system for distribution of jeevamrit into fields have been successfully constructed and implemented at Dr Y S Parmar University of Horticulture & Forestry-Nauni, Solan (HP). The performance of automation system revealed the net saving of 60-80 per cent labour resources, 20-40 per cent higher conveyance efficiency and minimizing 10-20 per cent application losses with potential capacity of the plant fulfill the supply of jeevamrit to 6 ha land, The drip irrigation systems are usually powered by a gravity tank for the supply of jeevamrit to reach each node of the drip system. If the field to be covered is large, then thesystem may be operated by using booster pump instead of gravity. The precision w.r.t. quantity as well as depth of application of jeevamrit is achieved by using automation system and thus the automation system is way forward for transforming the conventional agriculture to smart agriculture, which enable young generation to attract into farming activities. The following are the specifications in terms of capacity and nos. of various components of the automation system for natural farming:

Component	Capacity	Number
Catch pit	200 L	1
Mixing tank	2000 L	1
Processing tanks	1000 L	3
Vertical filtration unit	3 stages	1
Storage tank	5000 L	1
Distribution tank	10000 L	1
Sludge pump	1 HP	1
Booster pump	2 HP	2
Disk filter	-	3
Gate Valve	2.5 inch	3
Distribution HDPE pipe	32 mm	-
Lateral pipes	16 mm	-
Emitters	2/4 LPH	-
Drip accessories	-	-

References

Das S, Khurana M, Gulati A. 2024. Zero Budget Natural Farming: Implications for sustainability, profitability and food security. NABARD Research study No. 43: 1-58.

Sumathi V, Abdullah M. 2022. Smart Automation for Production of Panchagavya Natural Fertilizer. Agronomy 12: 3044. https://doi.org/10.3390/agronomy12123044

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Antioxidant rich nutraceutical tablets from Black Carrot Pomace

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Keywords: Black carrot juice residue, bioactive compounds, drying methods

Introduction

Black carrot pomace, a byproduct of juice processing, is abundant in valuable bioactive compounds such as anthocyanins (including malvidin, petunidin, and cyanidin), polyphenols, vitamins, and minerals. These constituents exhibit various health benefits, including anti-allergic, anti-inflammatory, antidiabetic, anticancer, and strong antioxidant properties through effective free radical scavenging (ROS).The rich phytochemical profile of black carrot pomace highlights its potential utilization in the food and health industries, offering natural alternatives for enhancing nutritional value of the existing foods and for developing functional foods and nutraceutical products that promote health.

Material and methods

Preparation of anthocyanin-rich extract and pomace powder: Freeze-dried powder (100 g) with best color and phytochemicalprofile was extracted using 2 L acidified distilledwater (1% citric acid, w/v) as solvent in an ultrasonic bathoperating at 250 W, 25 °Cfor 3 min followed by concentration of extract to 100 ml using a vacuum concentrator at 40 ºC under constant rotation and freeze-dryingagain.

Preparation of tablets: Tablets were formulated following the method of Makinistianet al. (2020) with modifications. The freeze-dried powder was combined with extract, freeze dried again followed by pressing into tablets (800±20 mg) using a hydraulic press at 3 kN for 10 seconds.

Results and conclusion

The quality parameters of boththe drying methods are compared in Table 1. Each 800 mg tablet, containing 16.33 mg of anthocyanins, 38.69 mg of total phenols, 31.08 mg of total flavonoids, and 2.67 µmol TE DPPH free radical scavenging activity can contribute to substantial health benefits. Consuming two tablets daily would contribute approximately 15% of the recommended daily intake of phenols and 100% of the daily requirement for anthocyanins, based on recommended intake levels reported by Tresserra et al. (2013).

The disintegration time of the black carrot pomace tablet in the presentstudy was approximately 30 min which can be ascribed tohigh solubility of the tablet components in water.Approximately 38% of the anthocyanins were released during the initial 10 min;however, after 45 min, around 75% of the anthocyanins werefound released. The study impliesthat black carrot waste (pomace) drying can limit the impact of food waste on the environment and the tablet formulation can deliver a nutraceutical product to wellness-orientedconsumers.

Table 1: Quality parameters of jamun pomace powders

Parameters	Jamun pomace powder		p<0.05
	Cabinet dried	Freeze dried	
Moisture (g/100 g)	7.50±0.16	2.60±0.08	S
Water activity (a_w)	0.46±0.01	0.31±0.01	S
Angle of repose (º)	33.53±1.31	28.57±1.50	S
Carr's Index (%)	19.28±0.50	14.95±0.43	S
Hausner ratio	1.46±0.05	1.30±0.03	S
Hygroscopicity (g/100 g)	15.57±0.70	15.11±0.72	NS
D_{50}(μm)	447.06±12.43	284.87±5.29	S
Span	1.76±0.05	1.28±0.04	S
Glass transition temperature (T_g)	54.60±2.50	55.80±3.05	S
Phytochemical constituents			
TMAC (mg CGE/100 g)	610.62±25.6	681.72±31.8	S
Polymeric color (%)	15.70±0.55	12.09±0.49	S
Total phenols (mg GAE/100 g)	1267.58±50.25	1379.06±53.51	S
Total flavonoids (mg QE/100 g)	1278.02±55.12	1332.83±58.22	S
DPPH free radical scavenging activity	105.65±4.23	120.28±5.84	S

**Values are expressed as mean±standard deviation; S: significant (p<0.05) difference among columns*

References

Makinistian FG, Gallo L, Sette P, Salvatori D and Bucalá V 2020. Nutraceutical tablets from maqui berry (Aristotelia chilensis) spray-dried powders with high antioxidant levels. *Drying Technology*.

Tresserra-Rimbau A, Medina-Remón A, Pérez-Jiménez J, Martínez-González MA, Covas M I, Corella D ... and Lamuela-Raventós RM. 2013. Dietary intake and major food sources of polyphenols in a Spanish population at high cardiovascular risk: the PREDIMED study. *Nutrition, Metabolism and Cardiovascular Diseases* 23(10): 953-959.

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Nutritional profiling and development of anthocyanin-enriched osmodehydrated bamboo candy with black carrot extract

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Keywords: Anthocyanins, Bamboo shoots, Black carrot extract, Osmotic dehydration

Introduction

Bamboo shoots, a staple in many Asian cuisines, are rich in nutrients like vitamins, minerals, and bioactive compounds, which contribute to their health-promoting properties. However, the presence of cyanogenic glycosides requires proper processing to ensure safety. Osmotic dehydration offers a way to enhance the nutritional quality of bamboo shoots while preserving their sensory characteristics. This study focuses on developing a low-sugar, anthocyanin-enriched osmodehydrated candy using bamboo shoots and black carrot extract. The goal is to create a nutritious snack with improved shelf life, enhanced color, and a rich profile of bioactive compounds.

Material and methods

Fresh bamboo shoots from four varieties (*Bambusa vulgaris* RRS BallowalSaunkhri, *Bambusa vulgaris* Ludhiana, *Dendrocalamus strictus*, and *Bambusa nutans*) were selected and stored under refrigeration. The shoots were brought to room temperature, cleaned, and cut into 2 cm circular rings. Blanching was performed at 100°C for 30 minutes to remove cyanogens. The rings were then immersed in sucrose solutions of 20, 40 and 60 °B for osmotic dehydration, with a bamboo-to-solution ratio of 1:10. After 24 hours, the osmodehydrated bamboo was mixed with black carrot extract and citric acid, left undisturbed for 24 hours, and then dried at 65°C for 3 hours. Physicochemical analyses were conducted on both raw bamboo shoots and the final product**.**

Results and conclusion

The physicochemical analysis of bamboo shoots revealed significant variations across the four varieties. Dendrocalamusstrictus had the highest yield (32.52%) and lowest TSS (1.5° Brix), while Bambusa vulgaris (Ludhiana) showed a slightly lower yield (30.49%) but comparable TSS (1.60 °Brix). Bambusa vulgaris (RRS Ballowal Saunkhri) exhibited a moderate yield (28.76%) with TSS at 1.80°Brix. The lowest yield was observed in Bambusa nutans (26.87%), but it had the highest TSS (2.5°Brix), indicating a potentially sweeter final product.Upon osmotic dehydration and enrichment with black carrot extract, the bamboo candies exhibited enhanced anthocyanin content and vibrant color. The final product showed improved nutritional properties, including higher antioxidant activity, total phenolic content, and ascorbic acid levels compared to the raw bamboo shoots. Sensory evaluation indicated that the osmodehydrated candy had a pleasant taste, color, and texture, making it a viable snack option.The study successfully demonstrated that osmodehydrated bamboo shoots, when enriched with black carrot extract, can be transformed into a nutritious, anthocyanin-rich candy with extended shelf life.

The results suggest that this product could serve as a healthier alternative to traditional confections, leveraging the health benefits of both bamboo shoots and black carrot extract. Future research could explore scaling up production and assessing consumer acceptance on a larger scale.

ESFS-NF/ISFS2024/4042

Formulation of phytonutrients rich date jam with natural sweetener

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Keywords: Date palm, natural sweetener, bioactive, natural sugars

Introduction

Date palm (*Phoenix dactylifera* L.) is a crucial crop in Africa and Asia, known for its natural sweeteners rich in phytonutrients, making it a viable alternative to refined sugar in functional foods. Dates are high in dietary fiber, including cellulose, hemicellulose, pectin, and fructose, with a fiber content of 6.4-11.0 per cent. Jam, a semi-solid product, is made by heating fruit pulp with sugar and adding pectin and citric acid.

Material and methods

Refined sugar in date jam was substituted with honey at varying concentrations (25, 50, 75 and 100%) to create different formulations. These formulations underwent extraction processes to quantify bioactive compounds and assess antioxidant activity within the jam. Additionally, sensory analysis was conducted to evaluate the organoleptic properties of each jam formulation.

Result and conclusion

Results showed that as the concentration of honey increased, a notable enhancement was observed in the total soluble solids (TSS), reaching 71.50 °B, and moisture content, which was measured at 13.82 per cent. The formulation with 100% honey exhibited the highest levels of bioactive compounds, including total phenols (145.60 mg GAE/100g), flavonoids (128.26 mg QE/100g), and antioxidant activity (623.30 mg TE/100g). The formulationwas identified as the most suitable for shelf-life studies, demonstrating stability for up to 6 months while maintaining acceptable microbial safety and organoleptic properties.
The study concluded that replacing refined sugars with honey presents a unique opportunity to produce a jam that is not only delicious but also offers enhanced functional benefits.

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Sustainable utilization of artificially immature dates in functional confectionary: Effects on quality attributes and shelf stability

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Keywords: Artificial ripening; refined sugar replacement; natural sweetener

Introduction

Date palm is one of the agricultural crops which substantially contribute to food waste problem by generating large amount of waste in the form of second grade or prematurely fallen fruits. Despite their rich nutritional composition, these are being burned or regarded as waste leading to environmental threats. Therefore, this research addresses the utilization of immature dates using artificial ripening technique and specifically focusing on its potential as a substitute for refined sugars at 0-100% levels in functional toffee production.

Material and methods

Immature dates at *Khalal* (TSS 25 ºB, moisture 55.14%) stage were artificially ripened to obtain soft dates in *Tamar* (TSS 40 ºB, moisture 45.48%) stage. The prepared soft dates were further utilized in the production of date pasteDate paste was made from mature date fruit was incorporated in sugar toffee by substituting refined sugar at 0%, 25% , 50% , 75% and 100% levels. The prepared toffee formulations were evaluated for physicochemical properties, phytochemical content, textural characteristics and mineral profile. The formulation selected toffee based on sensory evaluation was further assessed for shelf-life studies.

Results and conclusion

Compared to control formulation, incorporation of date paste significantly ($p<0.05$) improved physicochemical, phytochemical, functional as well as textural and mineral profile as confirmed by ICP-AES and FT-IR analysis. Date-based formulations presented a significantly ($p<0.05$) lower hardness and darker color compared to control. Toffee formulated with 100% replacement of refined sugar with date paste achieved depicted highest fibre (4.15%), ash (3.83%), total phenolics (143.66 mg GAE/100g), antioxidant activity (71.35%) and reduced total sugars (32.68%) content, owing to nutritional richness of date fruit.Among the different toffee formulations, the toffee formulated using 50% substitution of date paste with granular sugar attained the higher overall acceptability on a 9-point hedonic scale, indicating that 50% substitution of date paste was desirable and hence was selected for shelf-life evaluation. The storage of selectedformulation at ambient temperature (25±1ºC) temperature significantly ($p<0.05$) influenced the quality attributes of prepared premix. Date toffee wrapped in butter paper and laminated foil under ambient temperature conditions showed satisfactory microbial and organoleptic quality for 3 months and hence was shelf stable.

The study demonstrated that date fruit can effectively substitute traditional sweeteners at maximum levels in sugar toffee while maintaining desirable texture, functional attributes and organoleptic quality. Date toffee contained higher amount of reducing sugars, crude protein, crude fiber and ash content compared to toffee prepared from refined sugar; making it an excellent reservoir of natural sugars, fibre and minerals. Valorization of immature dates can be a sustainable approach for developing nutritious products along with date waste management.

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Value addition of *Aloe vera* by removing aloin to enhance natural quality attributes

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Keywords: *Aloe vera* juice, Aloin, Quality, Storage, Vermicelli

Introduction

Aloe vera isknown from centuries for being used to care degenerative diseases. Therefore, different value added product viz. Aloe vera juice, nectars, vermicelli and dehydrated Aloe vera gel can be prepared from the Aloe vera by applying different approaches of processing and value addition. However, commonly occurring problem in consumption of these commodities in fresh from is due to its bitter taste (*Aloe vera*, bitter gourd) and highly acidic as well as astringent taste (aonla). Guava fruits besides having medicinal importance also possess good flavour and acceptability; thus having positive attribute for blending purpose.

Material and methods

The present investigation was aimed to standardize pre-treatment for removal of the bitter compound 'aloin' from *Aloe vera* gel, to standardize formulation for preparation of *Aloe vera* based vermicelli, to optimize suitable drying temperature for dehydration of *Aloe*. First experiment was conducted for removal of the bitter compound 'aloin' from *Aloe vera* gel. Second experiment was conducted for preparation of vermicelli using seventeen treatment formulations of *Aloe vera* juice. Third experiment was conducted for drying of *Aloe vera* gel using nine dehydration temperature. Further experiment wasconducted to study the effect of blending proportions on the quality of blended Aloe vera nectar using juice of*Aloe vera*, bitter gourd, aonla and guava.

Results and conclusion

The results indicated that aloin free *Aloe vera*gel obtained by giving pre-treatment with 7.5 % ethanol for 3 hours to *Aloe vera* piece having preparation size of 5 cm was found superior based on minimum aloin content. The vermicelli prepared using 24 % *Aloe vera* juice, 1 % isabgol husk, 75 % wheat flour found superior based on stability of nutritional as well as higher sensory quality during six months storage. Drying of *Aloe vera* gel at four stage dehydration temperatures was found superior based on stability of nutritional and higher sensory quality attributes during six months storage. The nectar prepared from 12% *Aloe vera* juice, 2% Bitter gourd juice, 2% Aonla juice and 4% Guava pulp having 16.00°Brix TSS and 0.30 per cent acidity was extremely liked on the basis of 9-point Hedonic scale and found best on the basis of nutritional composition.

The aloin free *Aloe vera* juice can be obtained by giving pre-treatment with 7.5 % ethanol for 3 hours to *Aloe vera*piece having preparation size of 5 cm. *Aloe vera* juice can be utilized for vermicelli preparation by using formulation of 24 % *Aloe vera* juice, 1% isabgol husk, 75 % wheat flour. *Aloe vera* gel can also be utilized for dehydration at four stage dehydration temperature of 75°C for 2 hours, 70°C for 3 hours, 65°C for 4 hours and 60°C for about 10 hours. Further blended nectar can be prepared by using 12% *Aloe vera* juice, 2% Bitter gourd juice, 2% Aonla juice and 4% Guava pulp having 16°B TSS and 0.30% acidity.

Table 1: Effect of blending formulation on total sugars, ascorbic acid and phenol contents of blended nectar during storage

AV: BG: AO and GV Blends (B)	Sodium (mg/100g)				Potassium (mg/100g)				Overall acceptability			
	Storage (Month)			Mean (B)	Storage (Month)			Mean (B)	Storage (Month)			Mean (B)
	0	3	6		0	3	6		0	3	6	
B_1- 2:2:12:4	48.32	48.30	48.25	48.29	26.81	26.80	26.78	26.79	7.45	6.81	6.48	6.92
B_2- 2:12:2:4	64.52	64.50	64.45	64.49	33.50	33.49	33.48	33.49	7.17	7.15	6.99	7.10
B_3- 4:4:8:4	48.23	48.22	48.18	48.21	28.88	28.87	28.85	28.86	7.37	7.20	6.85	7.14
B_4- 4:6:6:4	48.65	48.62	48.60	48.62	22.10	22.08	22.05	22.08	7.74	7.64	7.58	7.65
B_5- 4:8:4:4	52.12	52.10	52.00	52.07	30.48	30.45	30.43	30.45	7.57	7.60	7.35	7.51
B_6- 6:4:6:4	47.70	47.65	47.65	47.66	30.33	30.32	30.30	30.31	7.75	7.45	7.27	7.49
B_7- 6:6:4:4	48.28	48.25	48.23	48.25	25.16	25.15	25.13	25.14	7.85	8.01	7.80	7.88
B_8- 8:4:4:4	47.31	47.28	47.25	47.28	25.75	25.72	25.70	25.72	8.32	8.32	8.13	8.25
B_9- 12:2:2:4	45.34	45.33	45.28	45.32	17.58	17.56	17.53	17.56	8.80	8.60	8.34	8.58
Mean (T)	50.05	50.03	49.99	50.02	26.73	26.71	26.69	26.71	7.78	7.64	7.42	7.61
$CD_{0.05}$	B=0.02 S=NS B =NS				B=0.02 S=NS B =NS				B=0.06 S=0.03 B =0.09			

References

Elbandy MA, Abed SM, Gad SSA and Abdel-Fadeel MG. 2014. Aloe vera gel as a functional ingredient and natural preservative in mango nectar. *World J. Dairy Fd. Sci.* 9(2): 191-203.

Hamid GH, Ei-Kholany EA and Nahla EA. 2014. Evaluation of aloe vera gel as antioxidant and antimicrobial ingredients in orange-carrot blend nectars. *Middle East J. Agric. Res.* 3(4): 1122-1134.

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Technology for freeze dried naturally Jackfruit slice

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***Keywords**:* Jackfruit, frozen, Freeze dried, Packaging, Quality, Storage

Introduction

Jackfruit (*Artocarpus heterophyllus* L.) is an important Indian seasonal fruit grown across the country and is believed to be the native of Western Ghats and well known as health promoter and rich source of Vitamin A and C and E. Dehydrated jackfruit slice holds a promising and potential market for chips and snakes, etc.Freeze drying becomes the best dehydration process to apply to thermolabile products to reduce nutritional and sensory degradation and this method as one of the most important processes for the preservation of heat sensitive biological materials. Freeze drying is maintained the intrinsic colour, aroma, taste, and shape and biochemical characteristics of food materials (Mujumdar et al., 2007).

Material and methods

Fresh and firm and ripe jackfruits were washed thoroughly in tap water and the bulbs werecollected and the seeds are separated from the bulbs. The bulbs werecut into uniform size slices and loaded into tray and were kept under frozen at -20°C in 24 h. The frozen jackfruit slices were dried under freeze drier at 50, 55 and 60 °Ctemperature.The freeze dried jackfruit slices were packed in four different level of packaging material *of* high density polyethylene, low density polyethylene, aluminum laminated foil and polypropylene bags) of 95 micron each gauge thickness and stored at ambient temperature for six months. Physico-chemical parameters, nutritional parameters, organoleptic parameters (9-point Hedonic scale) and microbial parameters (CFU/g) were evaluated at initial, three and six months storage.

Results and conclusion

The result of the study revealed that freeze dried jackfruit slices prepared by using 50 °C temperature when pack in 95 micron aluminum laminated bag was shown the better total phenol, ascorbic acid, total sugar, crude fibre and β-carotene(Nair et al.,2023) and higher overall acceptability (Table 1). It can be concluded that jackfruit slice with frozen at -20^{0}C in 24 h can be dried under freeze dryer at 50^{0}C found better overall acceptability without altering quality..

References

Mujumdar AS, Zhang M and Duan X. 2007. Studies on the microwave freeze drying technique and sterilization characteristics of cabbage. *Dry. Technol*. 25 (10): 1725-1731.

Nair AM and Geetha LPR. 2023. Changes in sugar and acid content of freeze-dried pulp of Annona species stored at ambient temperature. *J. Pharm. Innov*., 12 (10): 151-153.

Table 1: Overall acceptability score (9-point Hedonic scale) of freeze dried jackfruit slices

Storage(C)	Packaging (B)	Overallacceptability (9-point Hedonic scale)			
		Temperature(A)			Mean(BC1)
		A1-50 °C	A2-55 °C	A3-60 °C	
C1-Initial	B1-HDPE	8.27	8.17	8.01	8.15
	B2-LDPE	8.26	8.15	8.01	8.14
	B3-AL	8.26	8.17	8.03	8.16
	B4-PP	8.27	8.14	8.01	8.14
	Mean(AC1)	8.26	8.16	8.02	8.15
C2-3 Months	B1-HDPE	8.04	7.90	7.67	7.87
	B2-LDPE	8.00	7.81	7.62	7.81
	B3-AL	8.16	8.03	7.82	8.00
	B4-PP	8.10	7.93	7.73	7.92
	B4-PP	8.10	7.93	7.73	7.92
	Mean(AC2)	8.08	7.92	7.71	7.90
C3-6 Months	B1-HDPE	7.88	7.74	7.51	7.71
	B2-LDPE	7.83	7.65	7.44	7.64
	B3-AL	8.02	7.88	7.62	7.84
	B4-PP	7.96	7.80	7.57	7.78
	Mean(AC3)	7.92	7.77	7.54	7.74

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