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Impact of Integrated Nutrient Management on Seed Quality of Field Pea During Ambient Storage

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Abstract: The experiment was conducted at CCS, Haryana Agriculture University, Hisar, Haryana from 2016-18 and encompassed of nineteen treatment amalgamations of biofertilizers viz., Rhizobium & PSB @50 ml/10 kg, FYM & Vermicompost @ 20 t/ha and 5 t/ha respectively and inorganic fertilizer viz., 20kg N, 40 kg P_2O_5 per ha. The newly harvested field pea seeds of complete nineteen treatment plot combinations were kept in plastic containers under normal room environments up to a period of fifteen months and seed quality was evaluated at a regular interval of five months. The treatment combination of Rhizobium and PSB along with 75% recommended dose of nitrogen showed significantly higher germination(88.33%), seedling length (26.60 cm), dry weight (0.41 g), vigour index-I (2350) and vigour index-II (36) followed by Rhizobium with 100% RDN after fifteen months of storage at room temperature as compared to control. The electrical conductivity 531 was minimal even after treatment with Rhizobium and PSB along with 75% RDN followed by Rhizobium with 100% RDN after a storage at room temperature, with maximum in the control group. This conjoint application of Rhizobium + PSB at 75% recommended dose of nitrogen performed best in terms of seed quality parameters viz., germination%, dry weight, seedling length, vigour index-I and II and electrical conductivity.

Keywords: Field pea, PSB, Nitrogen, Rhizobium, Storage

Integrated nutrient management helps maintaining soil fertility to an ideal level which is imperative to attain maximum advantage for crop productivity. Use of excessive nutrients leads to declination of nutrient-use effectiveness making fertilizer consumption inefficient and it create adversative impact on atmosphere (Aulakh and Adhya 2005) as well as groundwater excellence (Aulakh et al 2009). The inorganic fertilizer singly is detrimental to soil health and soil productivity, usage of organic and bio-fertilizers augments crop production and helps to maintain soil health (Akbari et al 2011). INM is a vital step to fulfill the twin concerns of nutrient surfeit and nutrient exhaustion (Sangeeta et al 2014). Keeping in view the increasing demand of pulses, there is a critical need to increase productivity. Quality seed has a major role in the agricultural production. The use of quality seeds may increase productivity of crop by 15-20% (Chauhan et al 2015). In field pea, seed quality decline due to many reasons which results in poor germination. One such reason of deterioration could be probably imbalanced mother plant nutrition (Maruthi and Paramesh 2016). In recent years, realized that seed yield and quality were better under organic as compared to inorganic fertilizers application. So, in order to improve the seed quality, better nutritional management practices are to be adopted. Integrated nutrient management holds great assurance in meeting the growing nutrient demands of intensive agriculture. The advantage of integrated nutrient management increases water holding capacity, amount of nutrients, resistance to diseases and make the soil able to withstand drought and also plays a great role in seed quality and storability. Considering these facts, the purpose of this study was to study the effect of integrated nutrient management on seed storage.

MATERIAL AND METHODS

The experiment was performed during 2015-17 at CCS Haryana Agriculture University, Hisar, Haryana. The freshly harvested seeds of the field pea variety "HFP 529" were kept in plastic containers under normal room environments up to a period of fifteen months. The seeds of each treatment plot were sampled at an interval of five months and evaluated for seed quality parameters in a completely randomized design. The biofertilizers, rhizobium and phosphorous solubilizing bacteria were used as seed treatment @50 ml/10 kg of seed while farm yard manure (FYM) and vermicompost were used @ 20 t/ha and 5 t/ha respectively. The recommended dose of fertilizers (RDF- 20kg N + 40 kg P2O5 + 0 kg K2O per ha) was applied to the plots as per the treatment details. The samples were analyzed for key characteristics viz. germination %, dry weight, seedling length, vigour index-I, vigour index-II and electrical conductivity. The OPAQUE tool is used for statistical analysis. Treatment details are given below in Table 1. The following parameters were tested on the seed obtained after adopting standard seed production and post-harvest practices.

Germination (%): One hundred seeds obtained from individual treatment plot in three replications were kept in between adequate moistened rolled towel papers (BP) and placed at 25^{0}C in seed germinator. On the 5th day first count was taken and final count was on 8th day. Only normal seedlings were measured for percent germination (ISTA2011).

Seedling length (cm): Seedling length of 10 arbitrarily selected normal seedlings was measured for germination test.

Dry weight (g): Seedling dry weight was evaluated for ten seedlings after the final count of the germination test (8 days). The seedlings of individual treatment were dried in a hot air oven for 24 h at 80±1^{0}C. The dried seedlings were weighed.

Vigour index I and II: Seedling vigour indices were calculated according to the method reported by (Abdul-Baki and Anderson1973).

a. Vigour index-I (on seedling length basis)= Standard Germination (%) X Average seedling length (cm)
b. Vigour Index–II (on seedling dry weight basis)= Standard Germination (%) X Average seedling dry weight (g)

Electrical conductivity (µS cm^{-1}g^{-1}): 50 healthy seeds in three replications were soaked in 75 ml distilled water. Seeds were immersed entirely in water and beakers were surrounded with foil. Subsequently, these samples were kept at 25°C for 24 h. The electrical conductivity of the seed leachates was recorded using a direct reading on conductivity meter and expressed in µS/cm/ gram.

RESULTS AND DISCUSSION

The germination percentage showed a significant decline subsequently five, ten and fifteen months of ambient storage. The maximum decline was after fifteen months of natural storage in all the treatment combinations. However, the maximum germination percentage (88.33) after fifteen months of ambient storage of field pea seed was observed in the treatment amalgamation of Rhizobium + PSB + 75% RDN and minimum (68) was recorded in control (Table 1).

Table 1. Effect of integrated nutrient management on standard germination (%) of field pea seeds stored at ambient condition

Treatments	Fresh seeds	5 months	10 months	15 months	Mean
T_0: Control	87.33	81.33	78.33	68.00	78.75
T_1: Rhizobium+FYM (100%)	93.00	91.33	87.00	81.33	88.17
T_2: Rhizobium+FYM (75%)	92.33	88.67	86.00	79.33	86.58
T_3: Rhizobium+Vermicompost (100%)	90.33	86.00	82.00	73.67	83.00
T_4: Rhizobium + Vermicompost (75%)	89.67	83.33	80.00	71.00	81.00
T_5: Rhizobium + Nitrogen (100%)	97.33	94.67	91.33	87.67	92.75
T_6: Rhizobium + Nitrogen (75%)	95.67	94.00	90.33	86.00	91.50
T_7: PSB+FYM (100%)	92.67	90.00	86.67	80.67	87.50
T_8: PSB+FYM (75%)	92.00	88.33	85.00	78.00	85.83
T_9: PSB+ Vermicompost (100%)	90.00	85.00	80.33	71.67	81.75
T_{10}: PSB+ Vermicompost (75%)	89.00	83.00	79.67	70.33	80.50
T_{11}: PSB+ Nitrogen (100%)	96.67	94.33	91.00	87.00	92.25
T_{12}: PSB+ Nitrogen (75%)	94.33	92.33	88.33	83.67	89.67
T_{13}: Rhizobium +PSB+100% FYM	95.00	93.33	89.33	85.33	90.75
T_{14}: Rhizobium +PSB+75% FYM	94.67	93.00	89.00	84.67	90.33
T_{15}: Rhizobium+PSB+100% Vermicompost	91.67	88.00	84.33	77.00	85.25
T_{16}: Rhizobium+PSB+75% Vermicompost	91.33	87.33	83.00	75.33	84.25
T_{17}: Rhizobium +PSB+75% Nitrogen	97.67	95.33	91.67	88.33	93.25
T_{18}: RDF	93.33	92.00	87.67	82.67	88.92
Mean	92.46	88.87	85.22	78.59	
CD (p=0.05)					
Treatments 0.536					
Storage 0.224					
Treatment X Storage 1.072					

RDF- 20kg N, 40 kg P_2O_5 per ha, Rhizobium- 50 ml/10 kg, PSB- 50 ml/10 kg, Nitrogen 100%- 20 kg/ha

The higher germination percentage in T_{17} during the period of natural storage might be because of the better accumulation of food reserves like protein and carbohydrates due to the inoculation of biofertilizers along with nitrogen at the time of seed development. There was decline in germination percent in all the nutrient combinations because of natural ageing irrespective of treatment leading to seed deterioration. These results are in accordance with that of Amjad and Arjun (2002), Khan et al (2013) and Singh et al (2015).

Seedling length and dry weight of all the treatment combinations showed a significant decrease with the advancement of ageing period and the highest decline in both the characters was observed after fifteen months of natural storage (Table 2). The highest seedling length (26.60) after fifteen months of ambient storage was with the application of Rhizobium + PSB + 75% RDN while the shortest was recorded in control (13.37cm). The highest dry weight after fifteen months of natural ageing in both the treatment combination of Rhizobium + PSB + 75% RDN and Rhizobium + 100% RDN (0.41) followed by PSB + 100% RDN (0.40) and the lowest was observed in control (0.22) (Table 3). Among all the treatments T_{17} and T_5 showed better seedling length and dry weight throughout storage. This might be due to the buildup of more quantities of seed elements like carbohydrates in the seed due to the nutrition of field pea plants by the co-inoculation of Rhizobium and PSB along with inorganic nitrogen and conversion of macromolecules into micromolecules due to release of certain enzymes (Yadav and Khurana 2005). Decline in seedling length and seedling dry weight during storage may be due to decline in utilization of reserve constituents during germination of the stored seeds (Dhakal and Pandey 2001). Ageing led to reduce in seedling length and seedling dry weight which is similar with findings of earlier researchers(Verma et al2003, Singh et al 2003 , Nagarajan et al 2004, Kumar and Verma 2008).

Vigour index -I and Vigour index -II declined significantly with the increase in period of ageing in all the nineteen treatment combinations of field pea seed (Fig. 1and 2). The vigour index-I and II after the fifteen months of natural ageing was maximum in Rhizobium + PSB + 75% RDN (2350 and minimum in control (909, 15). Similar results were reported

Table 2. Effect of integrated nutrient management on seedling length (cm) of field pea seeds stored at ambient condition

Treatments	Fresh seeds	5 months	10 months	15 months	Mean
T_0	23.37	22.07	17.10	13.37	18.98
T_1	28.93	26.90	23.90	21.17	25.23
T_2	27.87	25.70	22.20	19.80	23.89
T_3	26.17	24.07	19.07	16.97	21.57
T_4	25.80	23.90	18.90	16.20	21.20
T_5:	31.50	30.20	28.40	26.50	29.15
T_6	30.70	28.60	26.63	24.60	27.63
T_7	28.40	26.20	22.70	20.30	24.40
T_8	27.33	25.50	21.43	18.90	23.29
T_9	26.03	24.03	19.03	16.63	21.43
T_{10}	25.43	22.87	17.90	15.80	20.50
T_{11}	31.27	29.83	27.27	25.10	28.37
T_{12}	29.90	27.70	25.20	22.80	26.40
T_{13}	30.43	28.23	26.10	23.90	27.17
T_{14}	30.03	28.07	25.33	23.27	26.68
T_{15}	27.00	25.20	21.40	18.67	23.07
T_{16}	26.60	24.30	19.90	17.80	22.15
T_{17}	32.17	30.83	28.67	26.60	29.57
T_{18}	29.33	27.07	24.03	21.80	25.56
Mean	28.02	26.07	22.46	20.04	
CD (p=0.05)					
Treatments	0.148				
Storage	0.062				
Treatment X Storage	0.296				

See Table 1 for details

by Kumar and Verma (2008) and Singh et al (2015).

The alteration of electrical conductivity throughout seed soaking is usually used as an indicator for testing the integrity of plasma membrane. Electrical conductivity (µS/cm/g) of seed leachates enlarged significantly after ageing in every treatment combination of field pea (Table 4). The maximum electrical after fifteen months of ambient storage conductivity was in control (996 µS/ cm/g) while minimum (531 µS/cm/g) was in Rhizobium + PSB + 75% RDN. The better performance in T_{17} and T_5 may be due to the inoculation of biofertilizers along with the inorganic nitrogen which may have increased the cell membrane stability and decreased the leakage of solutes from the seeds because of availability of more nutrients for the growth of plant and seed development which ultimately led to intact seed coat (Namvar et al 2013). The increase in electrical conductivity

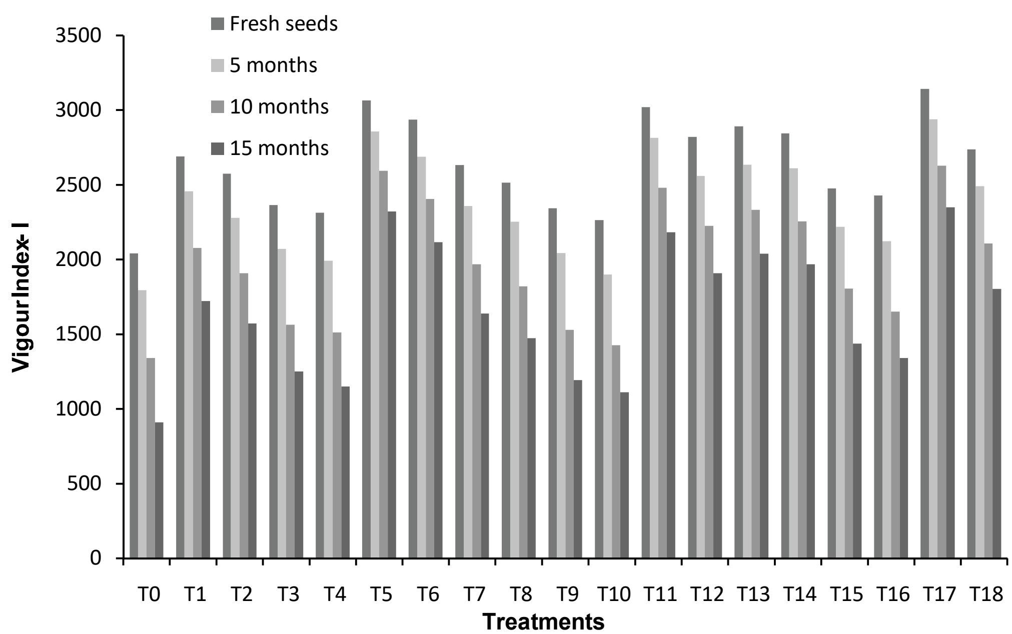

Fig. 1. Effect of integrated nutrient management on vigour index-I of field pea seeds stored at ambient condition

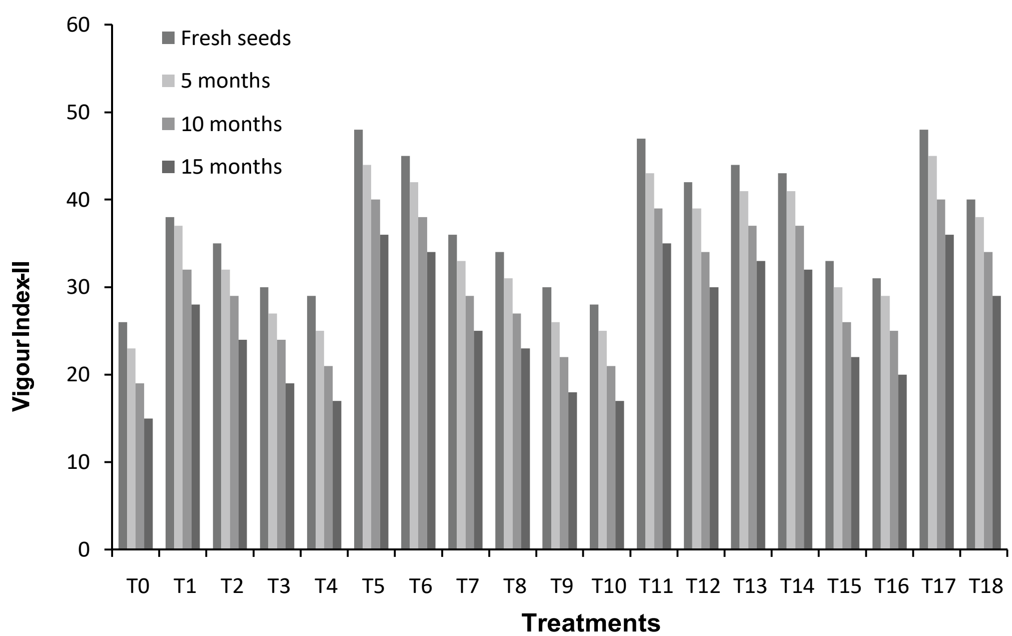

Fig. 2. Effect of integrated nutrient management on vigour index-II of field pea seeds stored at ambient condition

Table 3. Effect of integrated nutrient management on seedling dry weight (g) of field pea seeds stored at ambient condition

Treatments	Fresh seeds	5 months	10 months	15 months	Mean
T_0	0.30	0.28	0.25	0.22	0.26
T_1	0.41	0.40	0.37	0.34	0.38
T_2	0.38	0.36	0.33	0.30	0.34
T_3	0.34	0.32	0.29	0.26	0.30
T_4	0.32	0.30	0.27	0.24	0.28
T_5:	0.49	0.47	0.44	0.41	0.45
T_6	0.47	0.45	0.42	0.39	0.43
T_7	0.39	0.37	0.34	0.31	0.35
T_8	0.37	0.35	0.32	0.29	0.33
T_9	0.33	0.31	0.28	0.25	0.29
T_{10}	0.32	0.30	0.27	0.24	0.28
T_{11}	0.48	0.46	0.43	0.40	0.44
T_{12}	0.45	0.42	0.39	0.36	0.41
T_{13}	0.46	0.44	0.41	0.38	0.43
T_{14}	0.46	0.44	0.41	0.38	0.42
T_{15}	0.36	0.34	0.31	0.28	0.32
T_{16}	0.34	0.33	0.30	0.27	0.31
T_{17}	0.49	0.47	0.44	0.41	0.45
T_{18}	0.43	0.41	0.38	0.35	0.39
Mean	0.39	0.37	0.34	0.31	
CD (p=0.05)					
Treatments	0.020				
Storage	0.008				
Treatment X Storage	NS				

See Table 1 for details

Table 4. Effect of integrated nutrient management on electrical conductivity (µS $cm^{-1}g^{-1}$) of field pea seeds stored at ambient condition

Treatments	Fresh seeds	5 months	10 months	15 months	Mean
T_0	511	793	914	996	804
T_1	327	555	710	834	607
T_2	346	602	723	859	633
T_3	414	739	869	924	737
T_4	448	758	881	939	757
T_5:	233	378	455	558	406
T_6	289	412	523	641	466
T_7	334	589	718	846	622
T_8	373	656	770	886	671
T_9	433	742	878	932	746
T_{10}	458	762	887	946	763
T_{11}	257	391	465	571	421
T_{12}	312	538	688	798	584
T_{13}	304	427	538	652	480
T_{14}	311	470	584	698	516
T_{15}	401	724	846	896	717
T_{16}	412	738	855	913	730
T_{17}	206	347	434	531	380
T_{18}	326	552	700	813	598
Mean	362	602	720	812	
CD (p=0.05)					
Treatments	1.781				
Storage	0.743				
Treatment X Storage	3.562				

See Table 1 for details

during the period of ageing is because of the increase of leakage due to changes in the membranes of aged deteriorated seeds which directed to electrolyte leakage. The loss of membrane integrity due to destruction of phospholipids leads to increased membrane permeability and release of electrolytes, amino-acids and enzymes from cells (Zamani et al 2010). Similar results were also reported earlier by Goel et al2003 and Kumari et al2014.

CONCLUSION

The conjoint application of *Rhizobium* + PSB at 75% recommended dose of nitrogen (RDN) performed best in terms of seed quality parameters viz., germination%, dry weight, seedling length, vigour index-I and II and electrical conductivity. The experiment emphasized that to some extent reduced dose of inorganic nitrogen was best when applied in combination with bio-fertilizer (Rhizobium+PSB) for improving the storage potential of field pea seed as compared to the rest of treatments.

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