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Relative Contribution of Different SRI Practices Towards Growth and Yield of Rice under Temperate Conditions

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Abstract: Field experiment on the relative contribution of the system of rice intensification (SRI) practices towards the growth and yield of rice was conducted at the Mountain Research Centre for Field Crops, Khudwani, Anantnag during the *kharif* seasons of 2018 and 2019. The treatments comprised a set recommended practices in which 35 days seedlings, 4 seedlings/hill at 15x15 cm spacing with, application recommended dose of fertilizers + 5t FYM/ha, chemical weed control and flooded method of irrigation was followed, replacing sequentially each conventional practice with a practice recommended under SRI in the subsequent treatments. There were nine treatments with change in seedling stage, number of seedling/hill, plant to plant spacings, farm yard manure, weed management and irrigation method . The use of young seedlings planted singly and at a wider spacing of 25 x 25 cm resulted in a significant improvement in growth and yield attributes as compared to the recommended practice. The sole use of organic manures @7.5 or 10 t/ha resulted in a significant decrease in the growth yield attributes and yield. However, combined use of all the SRI practices along with a recommended dose of fertilizers and 10 t FYM/ha resulted in a 12.5% yield increase over the recommended practice.

Keywords: Rice**,** Rice intensification**,** Organic manures**,** Plant population

Rice is the most important cereal crop of India as it is the staple food for the majority of its population. The total production of rice during 2022-23 is estimated at 135.54 million tonnes from an area of 47 million ha. The demand for rice in India is projected at 150 million tonnes by 2030. Rice is also one of the important food crops of UT of Jammu and Kashmir with a production of 58.16 lakh tonnes and an area of 2.67 lakh ha during 2020-21. Rice is a water-guzzler crop and takes 3000 -5000 L of water to produce a kg of rice. The most popular practices for growing irrigated rice crop are the continuous flooding of rice, high plant population, transplanting older seedlings, and heavy reliance on inorganic fertilizers (Thakur et al 2023). Dwindling water resources on account of increasing demand and reduced rainfall has necessitated looking for alternative methods of rice cultivation such as aerobic rice, direct seeded rice and system of rice intensification (SRI). System of rice intensification is a paradigm shift from conventional rice cultivation practices. It advocates the planting of young seedlings, singly, at a wider spacing of 25 cm x 25 cm, nourished by organic manures. Weeding mechanically, an irrigation regime of just moist soil rather than flooding, by alternate wetting and drying (AWD) is recommended (Hussain et al 2012). All these practices help in saving seed, water, improving soil fertility and increasing productivity per unit of land and water (Stoop et al 2002). The practices are of varied nature and require diverse kinds of techniques and inputs. Young seedlings, single seedling and wide spacing are non-monetary inputs but require skilled hands. Mechanical/manual weeding is labor-intensive. Organic manures are meagerly available and alternate wetting and dry methods of irrigation also demands more labour. It is imperative to identify the practices that contribute more to the growth and yield of rice so that farmers can be given a package of the practices that are feasible under a given socio-economic situation. In this backdrop drop a set of treatments was formulated, replacing sequentially each conventional practice with a practice recommended under SRI. The first treatment was a typical set of conventional practices and the last treatment a set of SRI practices. The experiment was conducted to assess relative contribution of different SRI practices towards the growth and yield of rice.

MATERIAL AND METHODS

Field experiment on relative contribution of different SRI practices towards growth and yield of rice under temperate conditions at Mountain Research Centre for Field Crops (MRCFC), SKUAST-Kashmir, Khudwani, Anantnag during *kharif* seasons 2018 and 2019. Khudwani is located between 33°70´ N latitude and 75° 10´ E longitude with an altitude of

1590 m amsl. The soil of the experimental plot was silty clay loam in texture, low in soil available N (225 kg/ha), medium in P (14.8 kg/ha) and K (220.0 kg/ha). Rainfall received during 2018 and 2019 was 390 mm and 415 mm, respectively. There were nine treatments, comprising recommended practices along with various combinations of age of seedling, seedling per hill (Table 1). *Jhelum* a high yielding with better cooking quality, greater tolerance to cold, and moderately resistant to blast was used as the test variety. A recommended fertilizer dose of 120, 60, 30 kg/ha of N, P_2O_5 and K_2O was used as per treatment details.

RESULTS AND DISCUSSION

Growth attributes: Plant height was significantly affected by various treatments (Table 2). With each level of replacing the conventional treatments with SRI treatments, there was an increasing trend of plant height up to T_4. Wider spacing resulted in a significant increase in plant height. However, sole dependence on organic manures resulted in a significant decrease in plant height. Combined use of all the SRI practices along with 10 t FYM and the recommended dose of fertilizers resulted in the production of the tallest plants. The use of single seedlings at wider spacing reduces the inter-plant competition, resulting in taller plants with a greater number of tillers. The leaf area index followed a similar trend with a gradual increase with the introduction of young and single seedlings. The increase was significant with the use wide spacing of 25 x 25 cm. Replacement of inorganic fertilisers with sole use of organic manure significantly reduced leaf area index. However, a combined application of recommended dose fertilizers along with 10 t FYM/ha resulted in the highest leaf area index. SPAD readings, an index of chlorophyll concentration in leaf, recorded at flowering stages were also significantly influenced by various treatments. With the substitution of each conventional practice with SRI practice, there was an increase in SPAD

Table 1. Treatment details

Treatment	Age of seedling (Days)	Seedlings per hill	Spacing (cm)	Nutrient management	Weed management	Water management
T_1^*	35	4	15x15	RFD+ FYM 5 t ha^{-1}	Chemical control	Submerged conditions
T_2	15	-do-	-do-	-do-	-do-	-do-
T_3	15	1	-do-	-do-	-do-	-do-
T_4	15	1	25x25	-do-	-do-	-do-
T_5	15	1	25x25	FYM 7.5 t ha^{-1}	-do-	-do-
T_6	15	1	25x25	FYM 10 t ha^{-1}	-do-	-do-
T_7	15	1	25x25	-do-	Cono weeder 2 times	-do-
T_8	15	1	25x25	-do-	-do-	Alternate wetting and drying (AWD)
T_9	15	1	25x25	RFD+ FYM 10 t ha^{-1}	-do-	AWD

*Recommended practice

Table 2. Relative contribution of different SRI practices on growth parameters of rice under temperate conditions

Treatments	Plant height (cm)	Leaf area index	SPAD	PAR (%)	No. of tillers/m^2		
					Maximum tillering	Flowering	Harvesting
T_1	117.6	4.48	35.4	88.0	399	375	358
T_2	122.0	4.48	36.1	91.0	414	385	364
T_3	122.0	4.59	36.5	91.5	411	382	365
T_4	124.5	4.83	37.5	93.0	422	388	387
T_5	107.3	4.14	29.3	84.0	380	374	368
T_6	110.8	4.32	29.9	86.0	385	370	366
T_7	123.4	4.80	33.1	89.0	416	391	372
T_8	127.5	4.98	34.0	89.5	424	397	387
T_9	130.3	5.27	38.5	95.5	447	430	410
CD (p=0.05)	5.2	0.34	2.68	4.18	15.92	15.39	14.75

readings up to T_4. However, the trend was reversed with the omission of inorganic fertilizers and the application of organic manure only. The combined application of FYM + recommended dose of fertilizers resulted in significantly higher SPAD values. The sole application of organic manure alone did not suffice the nutrient requirement of the crop as it contains a smaller amount of nutrients (Gosh et al 2022). However, the application of synthetic fertilizers in combination with organic manures had a synergistic effect on the growth attributes of the crop (Khan et al 2004). The combined application of 10 t FYM+RDF in the backdrop of all SRI practices resulted in maximum interception PAR at flowering stages (Table 2). PAR is influenced by the plant height, leaf area index and orientation of the leaves as result of taller plants, higher leaf area index and higher chlorophyll content. Periodical tiller count/m^2 revealed a decreased trend from maximum tillering to flowering which further decreased as the crop advanced to harvesting . The increase in tillers acquired statistical significance when the young and single seedlings were planted at a spacing of 25 x 25 cm. As 5 t/ha FYM + RDF was replaced by 7.5 t/ha FYM alone. There was significant decrease in the number of tillers/ m^2. Manual weeding and alternate wetting and drying also displayed some beneficial effects on the tillering behaviour. However, integrated use of 10 t/ha FYM + RDF along with all recommended practices of SRI recorded highest no. of tillers at harvest which was on an average 14.5% higher over the conventional method of rice cultivation. Young seedlings and single seedlings, planted widely with mechanical weeding, AWD combined with INM provided the best possible conditions for profuse tillering and plant growth. Young seedlings planted at the second or third phyllochron have high tillering potential (Veeramani et al 2012). SRI practices lead to tillering for a prolonged time resulting in a higher number per unit area (Thavaprakash et al 2008). INM results in an increased supply of nutrients for a prolonged time resulting in higher leaf area index and more no. of tillers and higher dry matter accumulation (Singh et al 2005, Thakur et al 2009).

Yield attributes: There was a gradual increase in number of panicles/m^2 with the replacement of 35 days old seedlings with 15 days old seedlings and 4 seedlings with 1 seedling /hill (Table 3). When 15 days old seedlings were planted singly, the number of panicles/m^2 increased more sharply and reached 382 (average). This amounted to around a 10% increase over the recommended package of practices. Transplanting young seedlings at the 2nd or 3rd phyllochron with wider spacing has higher tillering potential. Closer plants with a greater number of seedlings per hill resulted in higher below and aboveground intra-plant competition for water, light and space resulting in weak plants with less no. of tillers/hill. The higher number of tillers later translated into a higher number of panicles/m^2. The use of young seedlings with wider spacing enables the single plants to form a strong source during the vegetative phase by producing higher number of tillers (Thakur et al 2009). However, the application of FYM alone @ 5 or 10 tones/ ha resulted in a significant decrease in panicles/m^2 over T_4. Combining 10 t/ha + RFD in the backdrop of all SRI practices (T_9) resulted in a significant increase in no. of panicles/m^2, no. of grains/ panicle and 1000 grain weight (Table 4). It appears that the application of FYM alone does not suffice the nutrient requirement of the crop and INM strategy in combination with all SRI practices provides a conducive environment for high growth and yield attributes (Mangaraj et al 2022).

Table 3. Relative contribution of different SRI practices on yield attributes, yield and nutrient uptake of rice under temperate conditions

Treatment	Panicles m^{-2}	Filled grains per panicle	1000 grain weight (g)	Grain yield (t ha^{-1})	Percent change over RP	Straw yield (t ha^{-1})	N (kg/ha)	P (kg/ha)	K (kg/ha)
T_1	348	76.0	24.7	6.09	0.0	7.88	107.9	22.4	132.7
T_2	355	76.6	24.7	6.20	1.81	8.24	113.2	22.3	133.2
T_3	359	77.6	25.0	6.30	3.45	8.28	114.4	23.8	142.1
T_4	382	81.8	25.6	6.56	7.72	8.47	122.8	22.4	145.2
T_5	342	65.9	24.8	5.02	-17.57	6.96	78.1	17.1	103.4
T_6	347	70.7	23.2	5.17	-15.11	7.22	84.2	16.1	109.6
T_7	350	84.4	25.5	6.09	0.00	7.21	111.0	20.7	126.3
T_8	356	87.2	26.0	6.17	1.31	7.26	113.2	23.6	128.1
T_9	396	93.8	26.5	6.83	12.15	8.65	136.1	27.8	154.1
CD (p=0.05)	15.33	4.20	1.25	0.31		0.40	5.60	1.87	5.59

Grain and straw yield: The grain and straw yield was significantly affected by various treatments (Table 3). There was a gradual increase in grain yield with the use of young seedlings planted singly. However, the increase was sharper and significant with the widening of the spacing from 15 x 15 cm to 25 x 25 cm. The increase in the grain yield in T_4 was 0.47 t/ha amounting to 7.7% over recommended practice. The benefit of young and single seedlings planted widely was

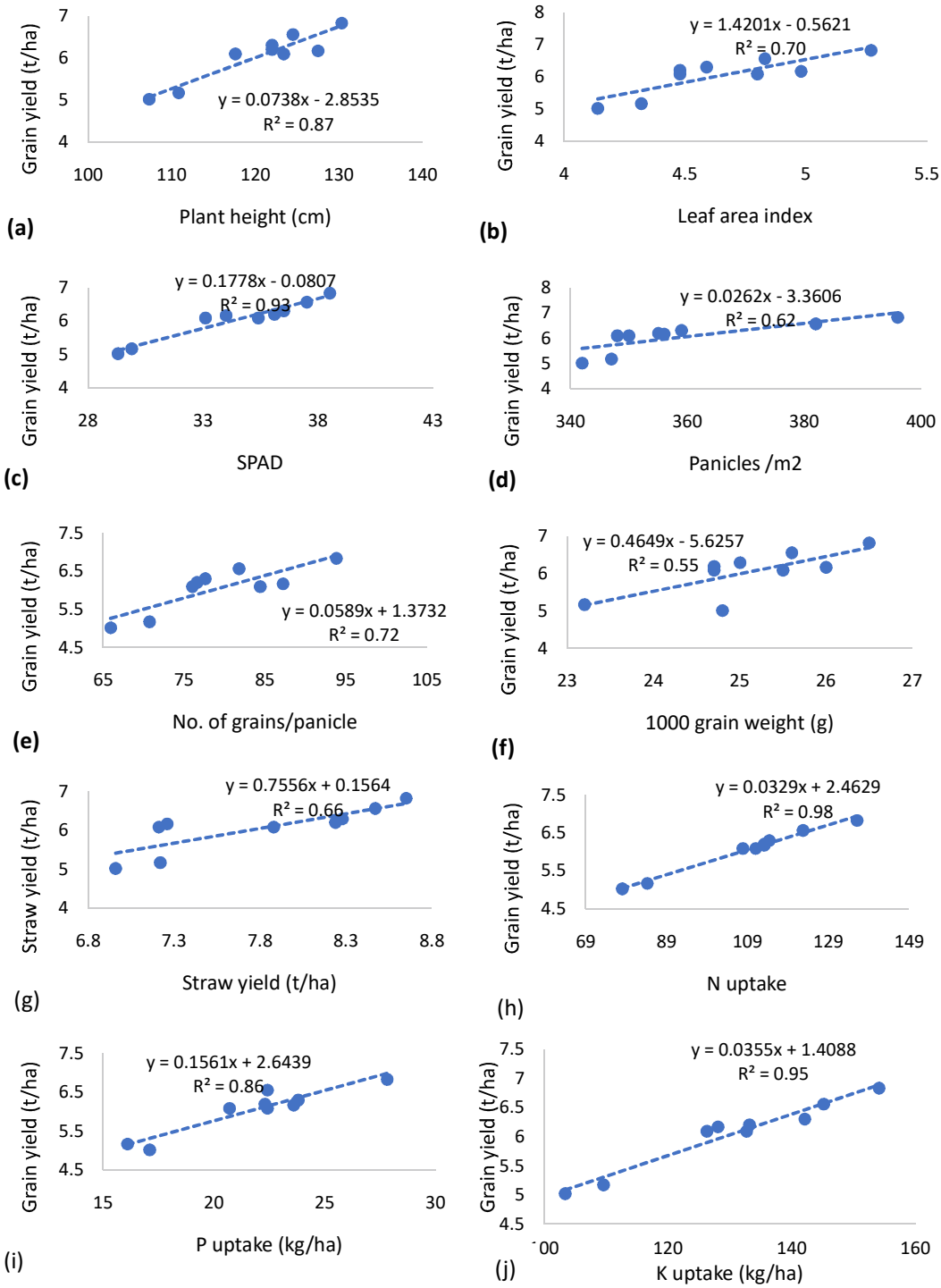

Fig. 1. Relationship of grain yield (t/ha) with plant height (cm) (a), leaf area index (b), SPAD (c), panicles/m^2(d), no of grains /panicle (e), 1000 grain weight (f), straw yield (g), Total N uptake (h), total P uptake (i) and K uptake (j)

reversed when the recommended fertilizer dose of was omitted and 7.5 or 10 t/ha of FYM was applied and there was a net drop of 15 to 17.5% decrease in yield over the recommended practice. Mechanical weeding and alternate wetting and drying resulted in an increasing trend of grain yield but a significant increase of 12.15 % was achieved only with the integrated use of 10 t/ha FYM + RFD. The use of organic manures and indigenous nutrient supply alone may not be enough to meet the large nutrient requirements of present-day high-yielding cultivars. Therefore, integrated nutrient management in which both organic manures and inorganic fertilizers are used simultaneously has been suggested as the most effective method to maintain a healthy and sustainable soil system while increasing crop productivity (Ram et al 2020, Paramesh et al 2020). Straw yield, an economically important commodity in Kashmir, was also significantly affected by various SRI practices. The use of young and single seedling/hill resulted in a 7.5% increase in straw yield over recommended practice. Using organic manures @ 7.5 to 10 t/ha alone resulted in a significant decrease in straw yield over the conventional method of rice cultivation with 5 t/ha FYM+ RDF. Use of all standard SRI practices well fertilized 10 t/ha FYM+RDF produced maximum straw yield. The increase was to the extent of 12.15% over the recommended practice. Implementation of SRI practices by using young, single seedlings planted at a spacing of 25 x25 cm, intermittently irrigated, cono-weeded and fertilized with10 t/ha FYM+RDF provided the most congenial conditions for profuse tillering (Dibakar et al 2022). Higher leaf and tiller growth resulted in more biomass accumulation a part of which was partitioned into the straw yield (Vijayakumar et al2004).

Nutrient uptake: Nutrient uptake was significantly affected by various treatments due to influence of various treatments on grain and straw yield and also due to differences in nutrient concentration of plants caused by various treatments (Table 3). The highest N, P and K uptake was observed in T_9. There was a steep decrease in nutrient uptake when only FYM was applied at 7.5 t/ha (T_5) and 10 t/ha (T_6) without RDF.

Relation between grain yield and growth and yield attributes: Grain yield had a significant and positive relation with plant height, leaf area index, SPAD, panicles /m^2, grains/panicle, 1000 grain weight, straw yield, N uptake, P uptake and K uptake. This indicates that all these parameters had a positive influence on the grain yield (Fig. 1).

CONCLUSION

The use of young, single seedlings planted at a spacing of 25 x 25 cm, rotary weeding and intermittent drainage had a synergistic role in enhancing yield by 14.5%. Thus application of organic materials such as farmyard manure considerably improves soil physical properties and nutrient uptake resulting in greater growth, yield and yield components.

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AUTHORS CONTRIBUTION

Ashaq Hussain: Conceived the idea, wrote the paper, Aabid Hussain Lone: Did the laboratory analysis of plant samples. S. Sheraz Mahdi: Did the statistical analysis, M. Anwar Bhat: Reviewed the paper and helped in statistical analysis. Intikhab Aaulam Jehangir: Helped in execution of field experiment and writing the paper

REFERENCES

Dibakar G, Koushik B, Milan S, Dibakar R, Anupam D, Sukamal S, Moulick MD , Brestič H, Pavla VV, Mohamed MH and Akbar H 2022. The combination of organic and inorganic fertilizers influence the weed growth, productivity and soil fertility of monsoon rice. *PLOS ONE* | https://doi.org/10.1371/journal.pone.0262586 January 27, 2022.

Hussain A, Bhat, MA and Ganie MA 2012. Effect of number and age of seedlings on growth, yield, nutrient uptake and economics of rice (*Oryza sativa*) under system of rice intensification in temperate conditions. *Indian Journal of Agronomy* **57**(2): 33-37.

Khan AR, Chandra D, Nanda P, Singh SS, Ghorai AK and Singh SR 2004. Integrated Nutrient Management for Sustainable Rice Production. *Archives of Agronomy and Soil Science* **50**: 161-165.

Mangaraj S, Paikaray, RK, Maitra SS, Pradhan R, Garnayak, LM, Satapathy M, Swain B, Jena S, Nayak B, Shankar T, Alorabi M, Gaber A and Hossain A 2022. Integrated nutrient management improves the growth and yield of rice and greengram in a rice-greengram cropping system under the coastal plain agro-climatic condition. *Plants* **11**: 142.

ParameshV, Dhar S, Dass A, Kumar B, Kumar A, El-Ansary DO and Elansary HO 2020. Role of integrated nutrient management and agronomic fortification of zinc on yield, nutrient uptake and quality of wheat. *Sustainability* **12**: 3513.

Sai Ram M, Shankar T, Maitra S, Adhikary R and Swamy GVVSN 2020. Productivity, nutrient uptake and nutrient use efficiency of summer rice (*Oryza sativa*) as influenced by integrated nutrient management practices. *Crop Research* **55**: 65-72.

Singh SP, Sreedevi B, Kumar RM, Krishnamurthy P and Subbaiah SV 2006. Comparative performance of different methods of rice establishment. *National Symposium on System of rice Intensification-Present and Future prospect* held at ANGARU Rajendranager from, 2006- 2005, 93.

Stoop WA, Uphoff N and Kassam A 2002. A review of agricultural research issue raised by the system of rice intensification (SRI) from Madagascar: Opportunities for improving system for resource poor farmers. *Agriculture Systems* **71**: 249-274.

Thakur AK, Mandal KG, Verma OP and Mohanty RK 2023. Do System of Rice Intensification practices produce rice plants phenotypically and physiologically superior to conventional practice? *Agronomy* **13** (4): 1098.

Thakur AK, Uphoff N and Antony E 2009. An assessment of physiological effects of System of Rice Intensification (SRI) practices compared with recommended rice cultivation practices in India. *Journal ofExperimental Agriculture* **46**(1): 77-98.