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Medha Shreya
M.Sc. Scholar, Department of Agronomy, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Dr. Victor Debbarma
Assistant Professor, Department of Agronomy, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Medha Shreya
M.Sc. Scholar, Department of Agronomy, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Effect of system of rice intensification and organic manure on yield attributes and economics of Rice (*Oryza sativa L.*)

Medha Shreya and Dr. Victor Debbarma

Abstract

The field experiment was conducted at Crop Research Farm during *Kharif* season 2022, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj, Uttar Pradesh. The objective was to study the effect of System of Rice Intensification and organic manure on yield attributes and economics of rice (*Oryza sativa* L.). The result showed that treatment six (T_6) [25 cm x 25 cm + FYM (18t/ha)] recorded significantly higher number of panicles /plant (13.33) higher number of grains /panicle (155.67) higher test weight (24.92g),higher grain yield (5.73t/ha), higher straw yield (6.13 t/ha) harvest index (48.24%) compared to other treatment combination. The maximum gross return (201350 INR/ha), maximum net return (143237 INR/ha), highest benefit cost ratio (2.46) was also recorded in treatment 6[25 cm x 25 cm + FYM (18t/ha)].

Keywords: System of rice intensification, FYM, yield attributes and economics

Introduction

Rice (*Oryza sativa* L.) is one of the most important stable food crops in the world. In Asia, more than two billion people are getting 60 -70 % of their energy requirements from rice and its derived products. (Ranjitha and Reddy, 2014) [12]. Production of rice rank second among the food grain and half of the world population receiving the highest (26.2%) calories intake from it in the developing countries of their dietary protein. Rice is an excellent source of carbohydrate and to a certain extent it provides protein to regular human diet. So it is used as staple food crop by about half of the world population and eaten as cooked rice and also used for various preparations inhabiting in the humid tropics and subtropics. (Tomar *et al*., 2018) [17]
In world rice growing in 165.12 million ha, the production is 509.42 million tonnes and the yield is about 4.61 metric tons/ha (USDA, 2022) [19]. Among the rice growing countries of the world, India has the largest rice acreage and ranked second in production after wheat in the world. In India rice is grown in 45.07 million ha, the production level is 122.27 million tones and the yield is about 2713 kg/ha (GOI, 2021) [7]. In Uttar Pradesh state ranks third in the country in production of rice. it grown over area about 5.68 mha which comprise of (13.5%) of total rice in India. Annual rice production is around 15.66 million metric ton, the average yield is 2759 kg/ha (GOI, 2021) [7].

Rice cultivation is in crisis the world over and India with a shrinking area, reducing water availability, fluctuating annual production, stagnating yields and escalating input (Thakur *et al.*, 2016) [16]. The production cost of paddy has consistently been increasing owing to the escalating costs of seeds, fertilizers, labour and water scarcity is becoming more a global concern and signal of serious water scarcity are already evident in several agricultural areas. In India, rice cultivation consumes 80% of the total water available for agriculture. About 50-80% of total water applied to rice fields is lost as deep percolation, while only 30-40% is utilized consumptively. Increasing scarcity due to increasing demand for water from other sectors threatens the sustainability of irrigated rice production and to overcome all these problem, development of novel technologies that require less water than conventional flooded rice without experiencing yield losses (Jat *et al*., 2020) [9].

The SRI, a knowledge based low external input technology, developed in the 1980s by Fr. Henri de Laulanie in Madagascar to benefit farmers with small landholdings, promises to enhance the rice productivity, where farmers were obtaining low rice yield, with no deleterious impact on natural resources at affordable costs for poor smallholder farmers. He suggested transplanting single seedling, planting single seedling per hill in a square pattern and using a rotary hoe perpendicular in two directions, with the uses of 10 -12 days old seedlings, helps in ensuring that the plant has enough space to spread and deepen its roots, as well as develop a large canopy for intercepting sunlight and instead of flooding the paddy field, soil should be kept moist during vegetative phase under SRI and only at later stages from panicle initiation till physiological maturity 5 cm water height should be maintained, which makes plants' rhizosphere well-aerated and their rooting condition are more oxidize and promotes soil microbial activity which improves the soil health. SRI even offers advantages for seed multiplication. Saving on seed cost as the seed requirement is less. Cost of external inputs gets reduced as chemical fertilizers and pesticides are not used Incidence of pests and diseases is low as the soil is allowed to dry intermittently (Ali and Izhar, 2017) [1]. The main objective of SRI is to enhance the productivity by better utilization of resources *viz*. land, labour, capital and water. SRI method of cultivation is said to promote greater root growth and higher soil biological activity in the rhizosphere, By adopting this system of cultivation we could save water (30-40% irrigation water), protect soil productivity ,save environment by checking methane gas from water submerged paddy cultivation practices bring down the input cost besides increasing the production.

An imbalance use of fertilizer is also a main cause of low production in rice because the continued use of inorganic fertilizers has resulted in a decline in soil fertility and also decreases soil organic matter which causes deterioration of the physical, chemical and biological health of soil. (Singh et al., 2018) [17] g. Organic manures are natural products used by farmers to provide food (plant nutrients) for the crop plants. There are a number of organic manures like farmyard manure, green manures, compost prepared from crop residues and other farm wastes, vermicompost, oil cakes, and biological wastes – animal bones, slaughter house refuse. Organic manures like -Farm yield manure i.e. FYM (0.5% N, 0.2% P2O5 & K_2O 0.5%), Poultry manure (2.1%N, 2.61% P2O5, K_2O 2.94%) & Goat manure (4.9% N, 4.1% % P2O5, K_2O 1.9%) GOI, (2020) [7] which helps to produce maximum crop yield with optimum input level. However, organic manures should not be seen only as carriers of plant food. These manures also enable a soil to hold more water and also help to improve the drainage in clay soils. They provide organic acids that help to dissolve soil nutrients and make them available for the plants.

Materials and Methods

The field experiment was carried out during *Kharif* season 2022 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P). The experiment field's soil had a sandy loam texture, pH of 7.8 that was virtually neutral, a low level of organic carbon (0.48%),medium levels of available N (225 kg /ha), available P (13.6 kg/ha) and K (215.4 kg/ha). The treatment consists of 3 different plant spacing (20cm x 20cm, 25cm x 25 cm and 30 cm x 30 cm) and organic manures [Goat manure (3 t/ha), Poultry manure (2.9 t/ha) and FYM (18 t/ha)]. The experiment was laid out in Randomized Block Design (RBD) with 9 treatments and replicated thrice. The treatment combination are T_1 [20cm x20cm + Goat manure (3t/ha)] T_2 [20cm x20cm + Poultry manure (2.9t/ha)], T_3 [20cm x20cm + FYM (18t/ha)], T_4 [25cm x25cm + Goat manure (3t/ha)], T_5 [25cm x 25 cm + Poultry manure (2.9t/ha)] T_6 [25cm x25cm + FYM (18t/ha)], T_7 [30cm x 30cm +Goat manure (3t/ha)] T_8 [30cm x 30cm +Poultry manure (2.9t/ha)],T_9[30cm x 30cm +FYM (18t/ha)].Data recorded on different aspect of crop, *viz*, growth, yield attributes and yield were subjected analysis by analysis of variance method Gomez and Gomez (1976) [8].

Result and Discussion

Yield attributes

Number of panicles/plant: The data revealed the significant and higher number of panicles/plant (13.33) was recorded in the treatment 6 [25cm x 25cm FYM (18t/ha)].However, treatment 5[25cm x 25cm+Poultry manure(2.9t/ha)] and treatment 9[30cm x 30cm + FYM(18t/ha)] were found statistically at par with the treatment 6[25cm x 25cm+ FYM(18t/ha)] (Table 2). Significant and higher number of panicles /plant was observed with the spacing 25cm x 25cm might be due to transplanting of young seedling, wider spacing and low inter - plant competitions helps in formation of more number of tillers resulted in increase in $C0_2$ assimilation rate, delay in senescence of flag leaf and effective translocation of photosynthates from source to sink increases the production of higher number of panicles. Similar result was reported by Ali and Izhar (2017) [1]. Further, significant and higher number of panicles/plant was observed with the application of FYM(18t/ha) might be due to slow and continuous supply of nutrients throughout the various growth stage of rice plants helps to assimilate sufficient photosynthetic products, which increase the dry matter and source capacity resulted in higher production of panicles /plant. Similar result was recorded by Singh *et al. (*2018) [17].

Number of grains/panicle: The data revealed that significant and higher number of grains/panicle (155.67) was recorded in the treatment 6 [25 cmx 25 cm + FYM (18t/ha)] (Table2). Significant and higher number of grains /panicle was observed with the spacing 25cm x25cm might be due to larger, deeper and longer-lived root system, which not only uptake macronutrients but also uptake micronutrients in large amount for their synthesis of essential enzymes which helps in plant metabolism. More micronutrients uptake by plants helps to convert macronutrients more efficiently into the cells and tissues that constitute grains. Similar result was reported by Debbarma *et al*. (2015) [3]. Further, significant and higher number of grains /panicle was observed with the application FYM(18t/ha) might be due to essential minerals supplied by FYM, it act as catalyst for efficient use of that applied nutrients, which helps in increasing the grains per panicle. Similar result was reported by Singh *et al*. (2018) [17].

Test weight (g): The data revealed that significant and higher test weight (24.92g) was recorded in the treatment 6 [25 cm x 25cm+ FYM (18t/ha)]. However, treatment 5[25 cm x 25cm+Poultry manure (2.9t/ha)] and treatment 9[30 cm x 30cm + FYM (18t/ha)] were found statistically at par with the treatment 6[25cm x 25cm+ FYM(18t/ha)] (Table 2). Significant and higher test weight was observed with the spacing 25cm x25cm might be due to SRI transplanting method, resulted in deeper and larger root volume, profuse and stronger tillers and well filled panicles resulted in higher weight of grains. Similar result was reported by Debbarma *et al*. (2015) [3]. Further, significant and higher test weight was observed with application FYM (18t/ha) might be due to supply of adequate nutrients it increases photosynthetic activities, as a result it translocates more photosynthates in the reproductive stage of crop results in more crop growth and increase in test weight. Similar result was recorded by Upadhyay *et al*. (2022) [18] in wheat**.**

Grain yield (t/ha): The data revealed that significant and higher grain yield (5.73t/ha) was recorded in the treatment 6 [25cm x 25cm+ FYM (18t/ha)]. However, treatment 5[25cm x 25cm + Poultry manure (2.9t/ha)] and treatment 9[30cm x 30cm + FYM (18t/ha)] were found statistically at par with the treatment 6[25 cm x 25cm+ FYM (18t/ha)] (Table 2). Significant and higher grain yield was observed with the spacing 25cm x 25cm might be due to reduction in inter-plant competition for nutrients resulted in better root and canopy development, it helps in utilizing photosynthates for higher grain yield. Similar result was reported by Debbarma *et al*. (2015) [3]. Further, significant and higher grain yield was observed with the application FYM (18t/ha) might be due to store house nature of FYM for macro and micronutrients which enhance the metabolism process, enlarge source and sink capacity resulted in higher gain yield production. Similar result was observed by Singh *et al*. (2018) [17].

Straw yield (t/ha): The data revealed that significant and higher straw yield (6.13t/ha) was recorded in the treatment 6 [25cm x 25cm+ FYM(18t/ha)].However, treatment 5[25cm x 25cm+Poultry manure(2.9t/ha)]and treatment 9[30cm x 30cm + FYM(18t/ha)] were found statistically at par with the treatment 6[25cm x 25cm+ FYM(18t/ha)] (Table 2). Significant and higher straw yield was observed with the spacing 25cm x 25cm might be due to using younger plants, resulted in higher production of dry matter and accumulation in stem, leds to higher production of straw. Similar result was reported by Debbarma and Abraham, (2017) [2]. Further, significant and higher straw yield was observed with the application FYM (18t/ha) might be due to proper decomposition and mineralization, FYM supplies available plant nutrients directly to the plant and also it has solubilizing effect which fixes nutrients in the soil. Similar result was recorded by Kavinder *et al.* (2019) [10] in wheat.

Harvest index (%): The data revealed that significant and higher harvest index (52.21%) was recorded in the treatment 6 [25cm x 25cm+ FYM(18t/ha)].However, treatment 5[25cm x 25cm+Poultry manure(2.9t/ha)]and treatment 9[30cm x 30cm + FYM (18t/ha)] were found statistically at par with the treatment 6[25cm x 25cm+ FYM (18t/ha)] (Table 2). Significant and higher harvest index was observed with the spacing 25cm x 25cm might be due to transplanting of younger plants with proper distance between them, plants utilizes more phyllochronic potential to produce higher grain and straw yield which ultimately increases the harvest index. Similar result was reported by Jat *et al*. (2020) [9]. Further, significant and higher harvest index was observed with the application FYM (18t/ha) might be due to slow and continuous release of nutrients for various growth stages, rice plant assimilates sufficient photosynthetic products, which increases dry matter and source capacity, resulted in increase in yield attributes, ultimately increases grain as well as straw yield and finally harvest index increases. Similar result was reported by Singh *et al*. (2018) [17].

Economics: The maximum gross return (201350 INR/ha), maximum net return (143237 INR/ha) highest benefit cost return (2.46) was also recorded in treatment 6 [25cm x 25cm+ FYM (18t/ha)] (Table 3). Higher benefit cost ratio was observed with spacing 25cm x 25cm might be due to less seed requirement for transplanting, low cost of conoweeding, low labour requirement and complete avoidance of chemical fertilizers, increases the gross returns as well as net returns, resulted in higher benefit cost ratio. Similar result was reported by Ali and Izhar, (2017) [1]. Further, higher benefit ratio was observed with the application of FYM (18t/ha) might be due to slow release, excellent and balanced nutrient supply by FYM throughout the growing life cycle of plant, relatively increases the grain and straw yield of the former treatment, which increases the gross return as well as net return ultimately increases the benefit cost ratio. Similar result was reported by Singh *et al*. (2022) [15] in wheat.

Table 1: Influence of System of Rice Intensification and organic manure on yield and yield attributes.

S. No.	Treatment	Number of panicles/plant	Number of grains/panicle	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha):	Harvest index (%):
1.	20cm x 20 cm + Goat manure (3t/ha)	11.27	154.17	24.63	3.30	3.63	47.59
2.	20 cmx 20cm + Poultry manure (2.9t/ha)	11.97	154.60	24.69	3.33	3.67	47.61
3.	20 cmx 20 cm + FYM (18t/ha)	12.20	154.83	24.71	5.33	5.70	48.19
4.	25cm x25cm + Goat manure (3t/ha)	12.83	155.07	24.79	3.47	3.60	48.14
5.	25cm x25cm + Poultry manure (2.9t/ha)	12.80	155.10	24.84	3.80	3.90	47.90
6.	25cm x25cm + FYM (18t/ha)	13.33	155.67	24.92	5.73	6.13	48.24
7.	30cm x 30cm + Goat manure (3t/ha)	12.70	154.87	24.75	3.60	3.80	47.98
8.	30cm x 30cm + Poultry manure (2.9t/ha)	12.77	154.90	24.77	3.77	3.87	47.49
9.	30cm x 30cm +FYM (18t/ha)	12.77	154.90	24.78	5.67	6.07	48.15
	F- Test	S	S	S	S	S	NS
	Sem ±	0.53	0.60	0.07	0.12	0.11	0.94
	CD (0.05)	1.12	1.27	0.15	0.22	0.18	-

Table 2: Influence of System of Rice Intensification and organic manure on economics.

S. No.	Treatment	Total cost of cultivation	Gross return (INR/ha)	Net returns (INR/ha)	B:C ratio
1.	20cm x20cm + Goat manure (3t/ha)	38613	116160	77547	2.00
2.	20cm x20cm + Poultry manure (2.9t/ha)	39813	117230	77417	1.94
3.	20cm x20cm + FYM (18t/ha)	58113	187290	129177	2.22
4.	25cm x25cm + Goat manure (3t/ha)	38613	121710	83097	2.15
5.	25cm x25cm + Poultry manure (2.9t/ha)	39813	133200	93387	2.34
6.	25cm x25cm + FYM (18t/ha	58113	201350	143237	2.46
7.	30cm x 30cm +Goat manure (3t/ha)	38613	126400	87787	2.27
8.	30cm x 30cm + Poultry manure (2.9t/ha)	39813	132150	92337	2.31
9.	30cm x 30cm +FYM (18t/ha)	58113	199250	141137	2.42

Conclusion

Based on the above findings, it is concluded that System of Rice Intensification (SRI) along with the application of organic manures improved the yield attributes of rice. Maximum gross return, net return and benefit cost – ratio was recorded with the spacing of 25cm x25cm along with application of FYM (18t /ha).

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