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Effect of System of Rice Intensification and organic manure on growth and yield of Rice (*Oryza sativa* L.)

Medha Shreya*[1] and Victor Debbarma[2]

Department of Agronomy, Naini Agriculture Institute, SHUATS, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj 211 007, U.P., India

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ABSTRACT

A 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 growth and yield of rice (*Oryza sativa* L.). The result showed that treatment six (T6) [25 cm x 25 cm + FYM (18t/ha)] recorded significantly higher plant height (86.73 cm), maximum number of tiller/plant (21.77), plant dry weight (29.98 g), crop growth rate at 80 -100 days after transplant (DAT) (4.98 g/m2/day), relative growth rate at 80 -100 DAT (0.0146 g/g/day), 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.

Key words: *System of Rice Intensification, Organic manure, Growth parameters and yield attributes.*

Introduction

Rice (*Oryza sativa L.*) is the most important cereal crop in the developing world and is a stable food of about two- third of the global population and its cultivation secures livelihood for more than two billion people. Rice provides (21%) and (15%) per capital of dietary and protein respectively also which provides instant energy as its most important component is carbohydrate (77.2%) and considerable amount of amylase (20-32%) and fat (2.0 -2.5%) and low amount of Ca. The hulled rice grain contains as much B group vitamins as wheat (Meena *et al.*, 2013). Rice has commercial and industrial importance also besides grains. Rice flour is rich in starch and is used for making various food materials. Rice straw mixed with other materials is used to produce porcelain, glass and pottery. Rice is also used in manufacturing of paper pulp, livestock bedding, mulching and packing material.

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). 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). 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).

Infact, rice cultivation is in crises with a shrinking area, fluctuating annual production, stagnating

(*1M.Sc. Scholar, 2Assistant Professor)

yield and escalating input costs. Further, decreased yield due to reduced plant population, severe compition due to closer spacing and poor tillering and increased cost of labour during peak farming operations such as transplanting, weeding and harvesting. The cost of cultivation of paddy has consistently been increasing owing to the escalating costs of seed, fertilizers, labour, and other inputs. Manual transplanting is quite expensive, laborious, time consuming and causes a lot of drudgery,it takes about 300 -350 man hours /ha which is roughly 25% of the total labour requirement of the crop (Goel *et al.,* 2008). With increasing labour scarcity due to urbanization, sustaining the interest of farmer in the rice cultivation has become challenge.

During the last decade or 2, a new approach, widely known as System of Rice Intensification method of transplanting (SRI), knowledge based low external input technology has attracted attention because of its apparent success in increasing rice yield. The SRI was introduced in India during the year 2000 as a viable alternative of rice cultivation that enhance the productivity and profitability while minimizing the inputs (Debbarma and Abraham, 2017). The SRI, helps in increasing the tillering potential and also 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 due to this their rooting condition become more oxidized, resulted in enhancing the synthesis of cytokinin and also maintain higher cytokinin fluxes from roots to shoot during the ripening stages, which helps to maintain higher levels of rubiso in leaves causes a greater photosynthesis rate (Sanoh *et al.,* 2006). 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). 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),promotes soil microbial activity which improves the soil health and enhance the soil productivity, save environment by checking methane gas from water submerged paddy cultivation practices bring down the input cost besides increasing the production.

Imbalance and high level use of chemical or inorganic fertilizers had led to soil degradation problems, changes the soil biota which provide declining trend in the productivity of rice even when grown under adequate N,P &K application (Jat *et al.,* 2020) The escalating prices of chemicals fertilizers and world energy crisis have diverted attention of agronomists and soil scientists to find out the other possible alternate source nutrients.

Awareness about crop quality and soil health increased the attention of people towards organic farming. Incorporation of organic manures has been given rise a hope to reduce the cost of cultivation and minimize adverse effects of inorganic fertilizers especially on deterioration of soil structure, soil health and environmental pollution (Debbarma *et al.,* 2020) in wheat. 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% P_2O_5 and KO 0.5%), Poultry manure (3.023 % N, 2.63% P_2O_5, 1.4% KO) & Goat manure (3% N, 1% P_2O_5, 2%KO) GOI,(2020) which helps to produce maximum crop yield with optimum input level. FYM improves physical properties of soil especially the structure, water holding capacity, bulk density, porosity, cation exchange capacity as well as enzymatic activities were enhanced that encourages root development and yield of crops (Shekara *et al.,* 2010). Organic Poultry manures are an excellent fertilizer containing nitrogen, phosphorus, potassium and micronutrients for healthy growth of plants. Organic manure such as poultry manure increases the organic matter (OM) content of soil and in turn releases the plant nutrients in available form for the use of the plants. It contained essential nutrient elements association with high photosynthetic activities and thus promotes root and vegetative growth. Goat manure is rich in nitrogen levels, which makes it an excellent soil conditioner. Goat manure improves soil texture which in turn provides a rich environment for roots to grow as well as allow for excellent water retention. 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 × 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 [20 cm x20cm + Poultry manure (2.9t/ha)], T_3[20cm x20cm + FYM (18t/ha)], T_4 [25 cm x 25 cm + Goat manure (3t/ha)], T_5 [25 cm x 25 cm + Poultry manure (2.9t/ ha)] T_6 [25 cm x25 cm + 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).

Results and Discussion

Plant height (cm): The data revealed that significantly and higher plant height (Significant and highest plant height (86.73cm) was recorded in the treatment 6 [25cm x 25cm+ FYM(18t/ha)] which was significantly superior over rest of the treatment (Table 1). Significant and higher plant height was observed with the spacing 25cm x 25cm might be due to lesser leaf area during the initial growth stages and it stimulates the effect of cell division which causes more cell elongation, resulted in higher plant height. Similar result was reported by Debbarma and Abraham (2017). Further, significant and higher plant height was observed with the application of FYM (18t/ha) might be due to gradual mineralization and availability of nutrients along with moisture holding capacity of soil by FYM. Similar result was reported by Singh and Singh (2018) in wheat.

Number of tillers/plant: The data revealed that significant and higher number of tillers (21.77) was recorded in the treatment 6 [25 cm x 25 cm+ FYM(18t/ ha)]. However, treatment 5[25 cm x 25 cm + Poultry manure (2.9t/ha)] and treatment 9[30 cm x 30 cm + FYM(18t/ha)] were found statistically at par with the treatment 6[25 cm x 25 cm+ FYM(18t/ha)](Table 1). Significant and higher number of tillers/hill was observed with the spacing 25 cm x 25 cm might be

Table 1. Influence of System of Rice Intensification and organic manure on growth parameters.

Sl. No.	Treatments	100 DAT			80-100 DAT	
		Plant height (cm)	Number of tillers/ plant	Plant dry weight (g)	CGR (g/m^2/day)	RGR (g/g/day)
1.	20cm x20cm + Goat manure (3t/ha)	83.93	19.13	18.22	4.80	0.0128
2.	20cm x20cm + Poultry manure (2.9t/ha)	84.07	19.80	18.26	4.80	0.0144
3.	20cm x20cm + FYM (18t/ha)	84.53	19.93	18.41	4.91	0.0141
4.	25cm x25cm + Goat manure (3t/ha)	84.73	21.03	29.01	4.92	0.0138
5.	25cm x25cm + Poultry manure (2.9t/ha)	85.76	21.63	29.03	4.84	0.0137
6.	25cm x25cm + FYM (18t/ha)	86.73	21.77	29.98	4.98	0.0146
7.	30cm x 30cm +Goat manure (3t/ha)	85.35	20.60	27.91	3.02	0.0129
8.	30cm x 30cm + Poultry manure (2.9t/ha)	85.48	20.50	27.92	2.90	0.0126
9.	30cm x 30cm +FYM (18t/ha)	86.13	20.73	27.94	3.06	0.0125
	F -Test	S	S	S	S	S
	Sem ±	0.60	0.55	0.06	0.15	0.0007
	CD (0.05)	1.27	1.16	0.13	0.32	0.0014

due to well-maintained of plant population and wider spacing, it minimizes the plant density and intra-plant competition for light, air, moisture and nutrients resulted in higher number of tillers/plant. Similar result was reported by Debbarma *et al.* (2020a). Further, significant and higher number of tillers/hill was observed with the application FYM(18t/ha) might be due to the proper mineralization of the organic manure supplied available plant nutrients directly to plants and also had a solubilizing effect on fixed form of nutrients in soil. Similar result was reported by Debbarma *et al.* (2020b).

Plant dry weight (g) : The data recorded that significantly and highest plant dry weight (29.98 g) was recorded with treatment 6 [25 cm x 25 cm + FYM (18t/ha)]. However, treatment 5[25 cm x 25 cm + Poultry manure (2.9t/ha)] and treatment 9 [30 cm x 30cm + FYM(18t/ha)] were found statistically at par with the treatment 6 [25 cm x 25cm+ FYM(18t/ha)] (Table 1). Significant and higher plant dry weight was observed with the spacing 25 cm x25 cm might be due to greater and deeper root growth, which helps in contributing to increase in nutrient uptake throughout the crop cycle. Similar result was reported by Debbarma *et al.* (2015). Further, significant and higher dry weight was observed with the application FYM (18t/ha) might be due to the stimulation effect of FYM which helps in improving the soil physical properties, increasing soil productivity and supplying higher amount of nutrients demand to plant uptake, which improve the vegetative growth and dry matter production. Similar result was reported by Debbarma *et al.*, (2020) in wheat.

Crop growth rate (g/m²/day): The data revealed that at 80 -100 DAT, significant and higher crop growth rate (4.98g/m²/day) 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 1). Significant and higher Crop growth rate was observed with the spacing 25cm x 25cm might be due to higher radiation use efficiency in the leaf photosynthesis which led to higher photoassimilate production, resulted in higher crop growth rate. Similar result was reported Debbarma *et al.*(2015). Further, significant and higher Crop growth rate was observed with the application of FYM(18t/ha) might be due to organic sources release slow and continuous availability of nutrients enhance cell division, elongation as well as various metabolic processes which increases plant growth attributes which ultimately attained the highest source capacity and dry matter accumulation. Similar result was reported by Singh *et al.* (2018).

Relative growth rate (g/g/day): The data revealed that at 80 -100 DAT, Significant and higher relative growth rate (0.0146g/g/day) was recorded in the treatment 6 [25 cm x 25 cm+ FYM(18t/ha)]. However, treatment 5 [25 cm x 25cm + Poultry manure (2.9t/ha)] and treatment 9[30 cm x 30 cm + FYM (18t/ha)] were found statistically at par with the treatment 6[25cm x 25 cm + FYM (18t/ha)](Table 1). Significant and higher relative growth rate was observed with the spacing 25 cm x 25 cm might be due to proportion of mature tissue increases, then de-

Table 2. 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.	20 cm x 20 cm + Goat manure (3t/ha)	11.27	154.17	24.63	3.30	3.63	47.59
2.	20 cm x 20 cm + Poultry manure (2.9t/ha)	11.97	154.60	24.69	3.33	3.67	47.61
3.	20 cm x 20 cm + FYM (18t/ha)	12.20	154.83	24.71	5.33	5.70	48.19
4.	25 cm x 25 cm + Goat manure (3t/ha)	12.83	155.07	24.79	3.47	3.60	48.14
5.	25 cm x 25 cm + Poultry manure (2.9t/ha)	12.80	155.10	24.84	3.80	3.90	47.90
6.	25 cm x 25 cm + FYM (18t/ha)	13.33	155.67	24.92	5.73	6.13	48.24
7.	30 cm x 30 cm + Goat manure (3t/ha)	12.70	154.87	24.75	3.60	3.80	47.98
8.	30 cm x 30 cm + Poultry manure (2.9t/ha	12.77	154.90	24.77	3.77	3.87	47.49
9.	30 cm x 30 cm +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	-

cline because of limiting or sub-optimal levels of resources like water and nutrients. Decrease in nitrogen availability resulted in reduction in the survival probability of the crop. Similar result was recorded by Debbarma and Abraham, (2015). Further, significant and higher relative growth rate was observed with the application FYM(18t/ha) might be due to apart from the nutrient with in the soil organic themselves ,soil organic matter contributing to nutrients release from soil minerals by weathering reaction, and thus helps in nutrient availability to the crop resulting in higher RGR.

Yield attributes and yield

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 (18 t/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 C02 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). 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).**

Number of grains/panicle : The data revealed that significant and higher number of grains/panicle (155.67) was recorded in the treatment 6 [25cmx25cm+FYM(18t/ha)]**(Table 2).** 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). 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).

Test weight (g): The data revealed that significant and higher test weight (24.92g) 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 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). 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) 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[25cm 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). 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).

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). 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) 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). 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).

Conclusion

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

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