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Effect of different organic sources of nutrients on growth and development of rice (*Oryza sativa* L.) under the SRI method

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ABSTRACT

The study was conducted during the *Kharif* season in 2022 at the research field of the School of Agriculture, Department of Agronomy, Lovely Professional University in Phagwara, Punjab. The objective of the study was to determine the "Effect of different organic sources of nutrients on growth and yield of rice (*Oryza sativa* L.) under the SRI method". The experiment was set up using a randomized block design with twelve treatments and each replicated three times. The treatments included various combinations of different organic sources of nutrients viz., T1 (100 % RDN from farmyard manure), T2 (100 % RDN from vermicompost), T3 (100 % RDN from poultry manure), T4 (100% RDN from groundnut oilcake), T5 (100% RDN from mustard oilcake), T6 (50 % RDN from farmyard manure + 50 % RDN from vermicompost), T7(50 %RDN from farmyard manure + 50 %RDN from poultry manure), T8 (50% RDN from farmyard manure + 50 % RDN from groundnut oilcake), T9 (50 % RDN from farmyard manure + 50 % RDN from mustard oilcake), T10 (50 % RDN from vermicompost+ 50 % RDN from poultry manure), T11 (50 % RDN from vermicompost + 50 % RDN from groundnut oilcake) and T12 (Control). Among the twelve treatments, T4 (100% RDN from groundnut oilcake) showed the most significant impact on the growth and yield. This treatment led to higher growth parameters, such as plant height (98.80 cm), number of tillers hill^{-1} (18.13), dry weight (66.40.g), root and shoot ratios (0.12), yield parameters like test weight (22.87g), effective tillers hill^{-1} (17.67), grain yield ha^{-1}(6.09 t), straw yield ha^{-1} (9.85 t) and harvest index (38.53%).

Key words: *Rice, System of rice intensification, Organic manures, Oil cakes, Sustainable agriculture.*

Introduction

Rice (*Oryza sativa* L.) is a vital crop that serves as a staple food for most of the world's population (Prusty *et al*., 2020). Rice is an important source of energy and essential nutrients including carbohydrates, protein, iron, and zinc, particularly for millions of people living in low-income countries. Additionally, rice is easily digestible and provides a significant amount of dietary fiber (Fukagawa and Ziska, 2019). Rice cultivation is a significant agricultural activity in the world, occupying approximately 160 million hectares (Mha) of land globally. The crop is grown in upland and lowland areas. India, China, and Indonesia are the top three countries in rice cultivation area. China has the highest rice production, while Australia has the highest rice productivity due to the use of advanced farming technologies.

In India, rice is grown on 43 Mha of land, and the country produces 112 million tons (Mt) of milled rice with an average productivity of 2.6 tons per

hectare. India's rice cultivation is diverse, with the crop being grown in various conditions ranging from hills to coasts. The top rice-producing states in India are West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab, and Telangana (Pathak *et al*., 2020).

Expansion of agricultural land and the use of agrochemicals has contributed to habitat loss, soil degradation and biodiversity loss. As the global population is expected to exceed nine billion by 2050, there is a need to increase food production while also conserving biodiversity. One approach to address this challenge is organic agriculture, which aims to reduce the negative impacts of agriculture on the environment. Organic agriculture is a farming system that avoids the use of synthetic fertilizers, pesticides, and other chemicals, and instead relies on natural methods to manage pests, diseases and maintain soil health. Organic farming practices include crop rotation, intercropping, and the use of compost another organic matter to enhance soil fertility. The focus is on promoting the health of the soil, crops, and animals, which in turn leads to healthier ecosystems. Organic agriculture is a promising approach to reduce the negative impacts of agriculture on the environment while maintaining food security. Organic farming practices promote soil health, biodiversity, and the conservation of natural resources, while producing high-quality and nutritious food (Katayama *et al.,* 2019; Santhosh Kumar *et al.,* 2017).

However, traditional rice farming methods, where fields are kept flooded for most of the growing season, consume enormous amounts of water, which is a scarce resource in many regions. Another promising approach is "system of rice intensification" (SRI), which involves reducing the amount of water used in rice cultivation by planting seedlings farther apart and using intermittent irrigation rather than continuous flooding. SRI has been found to increase rice yields by up to 30% while reducing water consumption by up to 50% (Santiago Arenas *et al.,* 2019; Prusty *et al*., 2020). This method of rice cultivation enhances rice yields and is currently used by over 20 million farmers in 60 countries. Generally, it involves various modifications to traditional rice-growing practices, such as growing seedlings in nurseries with minimal water, transplanting young seedlings, planting single seedlings in hills, mechanical weeding, using organic matter to improve soil fertility, and intermittent irrigation (Doni *et al*., 2019). In the SRI method of rice cultivation, organic fertilizers are recommended over chemical fertilizers. This is because organic fertilizers can enhance soil fertility and provide essential nutrients to the rice plant in a sustainable way, without harming the environment or human health. Organic fertilizers also improve soil structure and promote the growth of beneficial microorganisms, which further improve soil health. Overall, the use of organic fertilizers is consistent with the principles of the SRI method, which aim to promote sustainable and environmentally friendly rice cultivation (Hidayati and Anas, 2016).

Objective of the research

In order to gain further insight towards the effect of different organic sources on the growth and yield of rice in the SRI method, the proposed experiment is being conducted.

Materials and Methods

A research experiment was conducted in the field of Agronomy at the School of Agriculture, Lovely Professional University in Phagwara during early July in 2022. The experiment aimed to investigate the impact of different organic sources of nutrients on the growth and yield of rice (*Oryza sativa* L.) using the SRI method.

Experimental details

A research trial was setup in a randomized block design with three replications. Twelve treatments with different organic sources and their combinations along with the SRI method of cultivation were provided in rice variety PR-126. The spacing followed was 25x25cm. All organic manures (farmyard manure, vermicompost, and poultry manure) were applied at basal dose and oil cakes (ground nut oil cake, mustard oil cake) were applied in split doses at @ 0,30 and 60 DAT.

Measurement of growth parameter

Growth parameters viz., plant height(cm), number of tillers (hill^{-1}), were recorded by using measuring tape and scale respectively. The plant dry weight (g) was calculated by adding oven dried root and shoot weightat 70°C for 24 hours.van the root to shoot ratio in rice was calculated after drying, by dividing the weight of the root by the weight of the shoot, and rounding off the result to the nearest whole number or decimal point. This ratio can then be re-

corded for analysis (Abdala *et al.*, 1998).

$$\text{Root shoot ratio} = \frac{\text{dry weight of root}}{\text{dry weight of the shoot}}$$

Statistical analysis

The average values of all parameters were measured for each treatment, and statistical analysis was conducted using the OP stat software package.

Results and Discussion

Effect of organic manures and oil cakes on growth parameters in rice under SRI method

A critical review of the Table 1 represents that application of 2 t ha^{-1} of groundnut oil cake in three split doses resulted in a significant increase in plant height (98.80 cm) which was at par with the treatment T5 and the lowest was recorded in treatment T12. The application of oil cakes such as groundnut can significantly increase the plant height (Ashraf and Khan, 2010). This could be due to the high nitrogen content in these oil cakes, which enhances plant growth and development. Additionally, the application of organic manures including oil cakes can improve soil health and increase nutrient availability, resulting in better plant growth. According to Sultana *et al*., 2008, it was found that there were significant improvements in plant height when the high-yielding fine rice variety BRRI dhan 38 was treated with mustard oil cake applied in three split doses.

A perusal of the Table 1 clearly shows that the number of tillers $hill^{-1}$ (18.13) were recorded higher in treatment T4, which is statistically at par with the treatment T5, and the lowest number of tillers $hill^{-1}$ (12.70) was observed in treatment T12 (control). 2 t ha^{-1} of groundnut oil cake combined with SRI planting method resulted in a greater number of tillers $hill^{-1}$. Nitrogen is required for plant vegetative growth and a higher proportion of nitrogen is present in groundnut oil cake, resulting in good physiological benefits, notably a rise in the number of tillers. The number of tillers increased in direct proportion to the amount of groundnut oil cake applied. Organic sources may have increased nutrient availability and improved soil structure, resulting in a large number of tillers. The results are consistent with (Thakur *et al.*, 2010) employing the SRI approach with a spacing of 25 × 25 cm, resulting in more tillers $hill^{-1}$ (18.8).

A review of the Table 1 clearly shows that the combination of SRI method and groundnut oilcake as a source of fertilizer showed significantly higher dry weight (66.40g $hill^{-1}$) under treatment T4. On the other hand, the control treatment without any fertilizer (T12) had the lowest dry weight (54.57 g $hill^{-1}$). The increase in dry weight might be due to the sufficient availability of essential nutrients, including nitrogen, phosphorus, potassium, and micronutrients, which is crucial for optimal plant growth and high dry-weight production. Proper cultural practices, such as optimum planting density also a reason for higher dry weight. Furthermore, the SRI approach, which involves transplanting younger seedlings, minimizing water consumption, and using organic sources, can improve rice plant dry matter

Table 1. Effect of different organic sources of nutrients on growth parameters in rice under SRI method.

Treatments	Plant height $hill^{-1}$ (cm)	No of tillers $hill^{-1}$	Dry weight $hill^{-1}$(g)	Root shoot ratio
T1: 100 % RDN from farmyard manure	91.20	14.67	57.87	0.08
T2: 100 % RDN from vermicompost	95.27	15.30	2.03	0.10
T3: 100 % RDN from poultry manure	96.15	16.03	6.03	0.11
T4: 100% RDN from groundnut oilcake	98.80	18.13	66	0.12
T5: 100% RDN from mustard oilcake	97.93	17.53	65.23	0.11
T6: 50 % RDN from farmyard manure + 50 % RDN from vermicompost	92.27	13.47	58.69	0.09
T7: 50 %RDN from farmyard manure + 50 %RDN from poultry manure	92.40	13.60	58.57	0.07
T8: 50% RDN from farmyard manure + 50 % RDN from groundnut oilcake	94.93	14.67	61.09	0.09
T9: 50 % RDN from farmyard manure + 50 % RDN from mustard oilcake	94.07	14.40	61.19	0.10
T10: 50 % RDN from vermicompost+ 50 % RDN from poultry manure	93.53	13.60	59.93	0.09
T11: 50 % RDN from vermicompost + 50 % RDN from groundnut oilcake	96.90	16.47	64.83	0.11
T12: Control	89.23	12.70	54.57	0.04
S.Em(±)	0.41	0.44	0.46	0.08
CD(P=0.5)	0.86	0.91	0.96	0.10

output (Chapagain, and Yamaji, 2010). Overall, these findings have significant implications for sustainable agriculture practices, particularly in areas where chemical fertilizers are prohibitively expensive or unavailable. Oil cake fertilization can improve plant growth and production, especially in terms of increasing plant dry weight (Muthukumar and Karmelreetha, 2020).

A perusal of Table 1 clearly shows that a significantly higher root–shoot ratio of 0.12 was found in treatment T4, which is significantly at par with treatments T5, T11, and T3. Conversely, treatment T12 (control) had the lowest root-to-shoot ratio of 0.04. Higher root-shoot ratio is due to increased root growth and development i.e., plants with a higher root-to-shoot ratio often exhibit enhanced root growth and development. This can be attributed to increased root branching, elongation, and proliferation of root hairs, which collectively result in a larger root system.

Effect of organic manures and oil cakes on yield parameters in rice under the SRI method

Analysis of Table 2 shows that the significantly highest test weight (22.87 g) was recorded in treatment T4, which was statistically at par with treatment T5, and the lowest test weight (20.00 g) was observed in treatment T12. Application of oil cakes significantly increased 1000 grain weight which might be due to genetic variability of the plant, the weight of individual grains, length, breadth, and thickness of the grains. Grains with larger dimensions will generally weigh more than smaller grains, (Naik *et al.*, 2016; Alim, 2012).

After a critical review of Table 2, it is observed that the highest number of effective tillers hill^{-1} (17.67) was recorded in treatment T4, which was statistically at par with treatment T5, and treatment T11 and the lowest number of effective tillers hill^{-1} (12.0) was observed in the treatment T12. The observed increase in effective tillers could be attributed to the provision of a sufficient amount of nutrients during the crucial tillering stage, which promotes strong and vigorous tiller growth. The continuous presence of nutrients facilitates robust tillering, leading to the development of a higher number of productive tillers per hill. This favourable outcome can be achieved through the application of oil cakes in split doses.

A perusal of the Table 2 clearly shows that application of 2t of groundnut oil cake records significantly higher grain yield of 6.0 tha^{-1} which is at par with the treatment T5 and T11. The control treatment (T12) recorded the lowest grain yield of 3.59 tha^{-1}. The attainment of maximum grain yield in rice cultivation can be attributed to the continuous supply of nutrients throughout the entire crop duration promoting optimal growth and development which ultimately leads to higher grain yield. Additionally, the System of Rice Intensification (SRI) method of cultivation has shown promising results in boosting grain yield (Bisarya *et al.*, 2018).

Table 2. Effect of different organic sources of nutrients on yield parameters in rice under SRI method.

Treatments	No of effective tillers (hill^{-1})	Test weight	Grain yield (tha^{-1})	Stover yield (tha^{-1})	Harvest index (%)
T1: 100 % RDN from farmyard manure	13.67	20.60	4.49	7.74	36.71
T2: 100 % RDN from vermicompost	14.00	21.40	5.44	9.17	37.31
T3: 100 % RDN from poultry manure	16.33	21.48	5.59	9.20	37.37
T4: 100% RDN from groundnut oilcake	17.67	22.87	6.09	9.85	38.53
T5: 100% RDN from mustard oilcake	17.00	22.56	5.74	9.44	37.87
T6: 50 % RDN from farmyard manure + 50 % RDN from vermicompost	13.33	20.70	4.75	8.96	34.72
T7: 50 %RDN from farmyard manure + 50 %RDN from poultry manure	14.00	20.87	4.83	8.37	36.12
T8: 50% RDN from farmyard manure + 50 % RDN from groundnut oilcake	13.67	21.20	5.24	8.76	37.20
T9: 50 % RDN from farmyard manure + 50 % RDN from mustard oilcake	14.67	21.07	5.26	8.92	37.04
T10: 50 % RDN from vermicompost+ 50 % RDN from poultry manure	13.00	21.00	4.94	8.82	35.55
T11: 50 % RDN from vermicompost + 50 % RDN from groundnut oilcake	16.67	22.00	5.73	9.45	37.93
T12: Control	12.00	20.00	3.59	6.46	33.68
S.Em(±)	0.51	0.22	0.17	0.26	0.66
CD(P=0.5)	1.06	0.45	0.36	0.54	1.36

A critical review of the Table 2 clearly represents the maximum straw yield (9.8 tha^{-1}) obtained from treatment T4 which is statistically at par with the treatment T5 and T11, and the treatment T12 (control without any fertilizer) recorded the lowest grain yield (6.46 tha^{-1}). Higher straw yield might be due to more nitrogen presents in oil cakes and enhanced plant growth.

Table 2 also shows that the highest harvest index is observed in the treatment T4, with a value of 38.5%, followed by treatment T11, with a value of 37.9%. Treatment T5 also had a relatively high harvest index of 37.8%, and the lowest harvest index has recorded in treatment T12 (control without any fertilizer) with a value of 33.6%. higher harvest index might be due to timely crop management, and higher quantity of groundnut oil cake application (2 tha^{-1}).

Conclusion

The study evaluated the effect of organic sources of nutrients on growth parameters in rice under the System of Rice Intensification (SRI) method. The use of organic manures and oil cakes significantly improved the growth and yield parameters of rice. Specifically, applying 2t of groundnut oil cake per hectare in three splits resulted in a significant increase in plant height, number of tillers per hill, dry weight, root shoot ratio, effective tillers, test weight, grain yield, and straw yield. Mustard oil cake also had a similar effect on plant height as groundnut oil cake over control and other treatments. Further studies are required to investigate the long-term effects of organic sources.

Conflict of Interest: The authors have stated that they do not have any conflicts of interest.

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