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Influence of nutrient management on growth, yield attributes and yield of Basmati rice (*Oryza sativa* L.) under SRI method

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Abstract

A field experiment was conducted at Campus for Agriculture Research and Advanced Studies Dhablan, P.G. Department of Agriculture, G.S.S.D.G.S Khalsa college, Patiala during Kharif *season of 2022 with aim to find the "Influence of nutrient management on growth, yield attributes and yield of basmati rice (*Oryza sativa *L.) under SRI method". The experimental field was laid out in randomized block design with 12 treatments in 3 replications. Treatments consist of T_1: Control, T_2: 100% RDF (Recommended dose of fertilizers), T_3: 75% RDF (Recommended dose of fertilizers), T_4: 50% RDF (Recommended dose of fertilizers), T_5: 10t FYM ha^{-1}, T_6: 15t FYM ha^{-1}, T_7: 3t Poultry manure ha^{-1}, T_8: 2t Vermicompost ha^{-1}, T_9: 50% RDF ha^{-1} + 3t Poultry manure ha^{-1}, T_{10}: 50% RDF ha^{-1} + 2t Vermicompost ha^{-1}, T_{11}: 50% RDF ha^{-1} + 3t Poultry manure ha^{-1} + 0.5 t Neem cake ha^{-1} and T_{12}: 50% RDF ha^{-1} + 1.5 t Vermicompost ha^{-1} + 0.5 t Neem cake ha^{-1}. The results revealed that treatments T_{12} showed significantly higher plant height (cm), number of tillers hill^{-1}, dry matter accumulation (g) and leaf area index at 30, 60, 90 DAT and at harvest.*

Key words: Basmati rice, NPK, Farm yard manure, Vermicompost, Poultry manure, Neem Cake, SRI

Introduction

Rice (*Oryza sativa* L.) is the main staple food in many countries and most important crop in the developing world. Rice belongs to family Poaceae and order Poales, having chromosome no 2n= 24. Basmati is a sanskirt word which means "perfumed one" or "fragrant" whereas in hindi language basmati means "full of aroma". A hot and humid climate is required for basmati rice cultivation. It is best suited to areas with high humidity, prolonged sunlight, and a steady supply of water. The average temperature required throughout the crop's life ranges from 21 to 37^{0}C. It is photo periodically short-day plant. It is best suited to soils with a high water retention capacity and a high content of clay and organic matter.

Basmati rice is famous for its excellent cooking and eating quality that is why it known as King of all Rice's in the world. Basmati rice is long grain rice which has typical pandan like flavor caused by the compound 2-acetyl-1-pyrroline. Other aroma compounds are hydrocarbons, aldehydes, alcohols and esters. It contains 35g total carbs, 35g net carbs, 3g protein and 150 calories, eight important amino acids, folic acids, no cholesterol and low in sodium.

In India rice cultivation is practiced under transplanting methods in which nursery is raised than uprooting of the seedling occur after 25-29 days after that transplanting of seedlings. But this method requires water continuously, so in other to avoid these difficulties several methods have been developed that are SRI (System of Rice Intensification), drum seeder, direct seedling methods, which are being accepted by the growers day by day. The system of rice intensification entails cultivating rice with as much organic manure as possible, beginning with young seedlings planted singly at a wider spacing in a square pattern, and continuing with intermittent irrigation that keeps the soil moist but not inundated, as well as frequent inter cultivation with weedier that actively aerates the soil. The basic principles of

SRI are planting young seeding (<14 days) singly in a square pattern (Stoop *et al*. 2002). In SRI Methodology, it is noticed that the productivity will not only increase but cost of cultivation as well as input use efficiency will also be enhanced (Ghosh *et al.* 2007).

All the macronutrients such as nitrogen, phosphorus, potassium and micronutrients-iron and zinc are required in rice cultivation. (Ram *et al*. 2020) They revealed that yield improvements with INM were due to instantaneous and rapid supply of nutrients through chemical fertilizers and steady supply through mineralization of FYM for prolonged period. Nitrogen is an essential plant nutrient for the increase of plant height, leaf size, panicle number and high yield per hectare whereas phosphorous is important in the early growth stages of rice plant and potassium for achieving good yield. Using both organic and inorganic forms of fertilizers, such as FYM, vermicompost, poultry manure, together can help the soil become healthier and promote the growth and productivity in the crop.

Materials and Methods

G.S.S.D.G.S Khalsa College Patiala, Campus for Research and Advanced Studies Agriculture Research Farm Dhablan was the site of the experiment. The coordinates are 30.33^0N (North Latitude) and 76.28^0 E (East Longitude). It is located in the state of Punjab and in North West India. The Indo-Gangetic plain is location. Due to sub-tropical climate, average maximum temperature changes at wide range but arises up to 45^0C during summer, while the average minimum temperatures goes down to 6-10^0C during summer. The maximum temperature goes up to 36.33^0C in summer and minimum temperature goes up to 15.50^0C during the crop period. The highest rainfall of this region was 17.94 mm and average highest relative humidity recorded was 96.14 % during the crop period.

The soil of the experimental field was clayey in texture having basic pH (7.6) with medium organic carbon (0.52), medium available nitrogen (262 kg ha^{-1}), medium available phosphorous (22.6 kg ha^{-1}) and medium available potassium (130 kg ha^{-1}). Pusa Basmati 1109 variety was sown in nursery and transplanted in the field with the spacing of 25 × 25 cm. All the recommended doses of organic and inorganic nutrients were applied accordingly in the field. The field was laid out in Randomized Block Design with three replications. Growth and growth contributing characters were recorded at 30, 60, 90 DAT and at harvest.

Plant height was recorded in cm and was measured from the soil surface to the apical bud up to the foliate. The number of tillers $hill^{-1}$ counted from the five randomly tagged plants from the field and the mean was calculated than recorded. For dry matter accumulation, samples were sun dried and kept in oven 60 f C for 48-72 hours to get constant weight and observed. Leaf area index (LAI) in each plot was observed in between 12:00 pm to 2:00 pm.

All the data recorded during the investigation were subjected to Analysis of variance (ANOVA) as described by Gomez and Gomez (1984) for using Randomized Block Design at 5% level of significance.

Results and Discussion

Plant height (cm)

Plant height is an important attribute of plant during the growth and development of the basmati rice. The data on plant height as influenced by nutrient management under SRI method is tabulated in Table 1 and represented graphically in Graph 1.

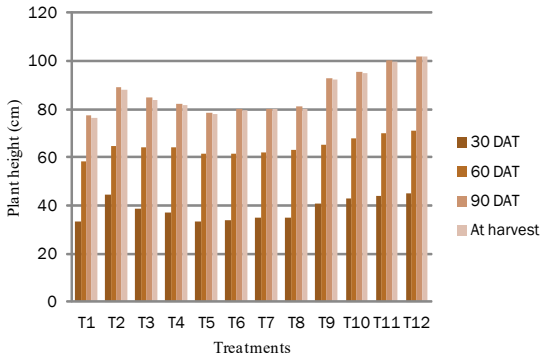
At 30 DAT, significantly higher plant height (45.23 cm) was observed in the treatment T_{12}, where 50% RDF + 1.5 t Vermicompost ha^{-1} + 0.5 t Neem Cake ha^{-1} was applied and was statistically at par with the treatment T_2 (44.54 cm), where 100% RDF (Recommended dose of fertilizers) was applied.

At 60, 90 DAT and at harvest maximum plant height (71.03, 101.92 and 101.63 cm) was recorded with the treatment T_{12}, where 50% RDF + 1.5 t Vermicompost ha^{-1} + 0.5 t Neem Cake ha^{-1} was applied and was statistically at par with the treatment T_{11} (69.72, 100.11 and 99.85 cm), where 50% RDF + 1.5 t Poultry manure ha^{-1} + 0.5 t Neem Cake ha^{-1} was applied.

Increase in plant height is due to availability of nutrients such as nitrogen, which might contributes to the plant growth and accelerate cell division and cell elongation that reflects the increase

Table 1: Influence of nutrient management on plant height (cm) of basmati rice under SRI method

Treatment	Plant height (cm)			
	30 DAT	60 DAT	90 DAT	At harvest
T_1: Control	33.17	58.47	77.16	76.40
T_2: 100% RDF (Recommended dose of fertilizers)	44.54	64.46	88.85	88.21
T_3: 75% RDF (Recommended dose of fertilizers)	38.56	64.34	84.94	83.76
T_4: 50 % RDF (Recommended dose of fertilizers)	36.79	63.95	82.16	81.65
T_5: 10t FYM ha^{-1}	33.37	61.49	78.27	77.76
T_6: 15t FYM ha^{-1}	33.98	61.52	80.30	79.29
T_7: 3t Poultry manure ha^{-1}	34.75	62.14	80.18	80.02
T_8: 2t Vermicompost ha^{-1}	35.08	63.03	81.07	79.81
T_9: 50% RDF + 3t Poultry Manure ha^{-1}	40.82	65.27	92.53	92.10
T_{10}: 50% RDF + 2t Vermicompost ha^{-1}	42.89	68.08	95.56	94.96
T_{11}: 50% RDF + 3t Poultry manure ha^{-1} + 0.5t Neem Cake ha^{-1}	43.72	69.72	100.11	99.85
T_{12}: 50% RDF + 1.5t Vermicompost ha^{-1} + 0.5t Neem Cake ha^{-1}	45.23	71.03	101.92	101.63
SEm±	0.39	0.70	0.85	0.91
CD (P=0.05)	1.14	2.02	2.44	2.62



Graph 1: Influence of nutrient management on plant height (cm) of basmati rice under SRI method

in plant height of basmati rice along with SRI method. Similar results were shown by Biswanath *et al*. (2019) and Shriame *et al*. (2000).

Number of tillers hill^{-1}

The number of tillers hill^{-1} is one of the growth characters which was recorded at 30, 60 and 90 DAT, which is depicted in Table 2 and illustrated graphically in Graph 2.

At 30 DAT, number of tillers hill^{-1} (12.93) increased significantly with the application of 50% RDF + 1.5 t Vermicompost ha^{-1} + 0.5 t Neem Cake ha^{-1} i.e. treatment T_{12} which was statistically at par with the treatments T_2 (100% RDF) and T_{11} (50% RDF + 1.5 t Poultry manure ha^{-1} + 0.5 t Neem Cake ha^{-1}) with number of tillers hill^{-1} 12.60 and 12.33 respectively.

At 60 and 90 DAT, higher number of tillers hill^{-1} (25.60 and 27.20) was recorded under the treatment T_{12} (50% RDF + 1.5 t Vermicompost ha^{-1} + 0.5 t Neem Cake ha^{-1}) which was at par with treatment T_{11} (50% RDF + 1.5 t Poultry manure ha^{-1} + 0.5 t Neem Cake ha^{-1}) at 60 and 90 DAT with number of tillers hill^{-1} 24.53 and 26.53 respectively.

As the initation and development of tillers is very much depended on the concentration of NPK in the mother stem at tillering stage of crop (Meena *et al*. 2003) and wider spacing, transplanting younger seedlings, alternative wetting and drying in SRI method maintains a thin film of water that might open the soil for both oxygen and nitrogen and promotes the root growth during the initial growth stages which ultimately increases tiller density (Uphoff, 2001).

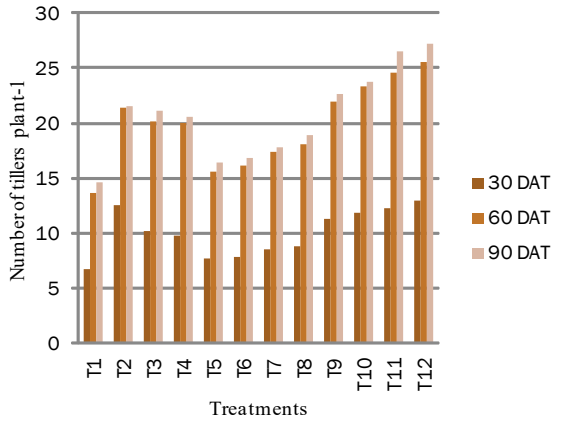
Dry matter accumulation (g)

Data of dry matter accumulation plant^{-1} (g) was observed at 30, 60, 90 DAT and harvest, which is represented in Table 3 and presented graphically in Graph 3.

At 30, 60, 90 DAT and harvest greater dry matter accumulation plant^{-1} (8.77, 19.83, 29.23 and

Table 2: Influence of nutrient management on number of tillers hill^{-1} of basmati rice under SRI method

Treatment	Number of tillers plant^{-1}		
	30 DAT	60 DAT	90 DAT
T_1: Control	6.73	13.67	14.67
T_2: 100% RDF (Recommended dose of fertilizers)	12.57	21.33	21.53
T_3: 75% RDF (Recommended dose of fertilizers)	10.20	20.13	21.13
T_4: 50 % RDF (Recommended dose of fertilizers)	9.80	20.07	20.53
T_5: 10t FYM ha^{-1}	7.76	15.53	16.40
T_6: 15t FYM ha^{-1}	7.87	16.20	16.87
T_7: 3t Poultry manure ha^{-1}	8.53	17.33	17.87
T_8: 2t Vermicompost ha^{-1}	8.87	18.13	18.93
T_9: 50% RDF + 3t Poultry Manure ha^{-1}	11.27	21.93	22.60
T_{10}: 50% RDF + 2t Vermicompost ha^{-1}	11.80	23.33	23.73
T_{11}: 50% RDF + 3t Poultry manure ha^{-1} + 0.5t Neem Cake ha^{-1}	12.33	24.53	26.53
T_{12}: 50% RDF + 1.5t Vermicompost ha^{-1} + 0.5t Neem Cake ha^{-1}	12.93	25.60	27.20
SEm±	0.19	0.40	0.35
CD (P=0.05)	0.54	1.14	1.01



Graph 2: Influence of nutrient management on number of tillers hill^{-1} of basmati rice under SRI method

30.93 g, respectively) was with the application of 50% RDF + 1.5 t Vermicompost ha^{-1} + 0.5 t Neem cake ha^{-1} i.e. treatment T_{12} and was statistically at par with treatment T_{11} i.e. 50% RDF + 1.5 t Poultry manure ha^{-1} + 0.5 t Neem cake ha^{-1} (8.51, 19.34, 29.01 and 30.43 respectively) whereas at 60 DAT, it was also at par with treatment T_{10} (18.51 g) which consist of 50% RDF + 2 t Vermicompost ha^{-1}.

Similar findings were noted by Biswanath *et al*. (2019) that different proportion of chemical fertilizers and organic manures influences plant height and dry matter accumulation of rice whereas the higher number of tillers hill^{-1} in SRI method increases the leaf area that increases the photosynthesis on account of vigorous root and shoot growth, which ultimately led to higher dry matter production at each stages of observation (Hussain *et al*. 2012)

Leaf area index (LAI)

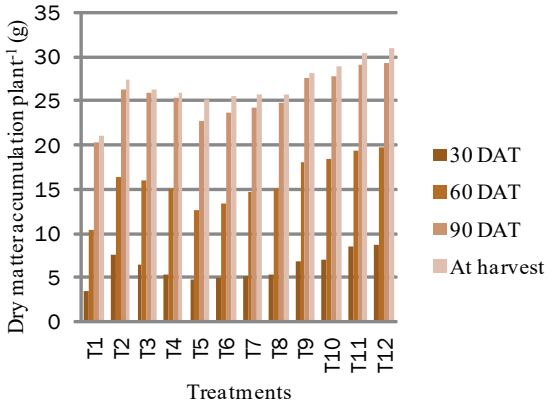
Data of Leaf area index (LAI) was observed at 30, 60 and 90 DAT, which is tabulated in Table 4 and illustrated graphically in Graph 4.

At 30 DAT, maximum leaf area index (2.17) in basmati rice was recorded with the treatment T_{12}, which consist of 50% RDF + 1.5 t Vermicompost ha^{-1} + 0.5 t Neem cake ha^{-1} and was statistically at par with the treatment T_2 (100% RDF) and T_{11} (50% RDF + 1.5 t Poultry manure ha^{-1} + 0.5 t Neem cake ha^{-1}) with 2.02 and 2 leaf area index (LAI), respectively. At 60 DAT, higher leaf area index (4.30) was recorded with treatment T_{12} (50% RDF + 1.5 t Vermicompost ha^{-1} + 0.5 t Neem Cake ha^{-1}) and was significantly at par with T_{11} (50% RDF + 1.5 t Poultry manure ha^{-1} + 0.5 t Neem Cake ha^{-1}) and leaf index was 4.13.

At 90 DAT, maximum leaf area (2.30) was recorded with T_{12} , which consist of 50% RDF + 1.5 t Vermicompost ha^{-1} + 0.5 t Neem Cake ha^{-1} and was significantly at par with treatments T_{11} (50% RDF + 1.5 t Poultry manure ha^{-1} + 0.5 t Neem Cake ha^{-1}), T_{10} (50% RDF + 2t Vermicompost ha^{-1}) and

Table 3: Influence of nutrient management on dry matter accumulation plant^{-1} (g) of basmati rice under SRI method

Treatment	Dry matter accumulation plant^{-1} (g)			
	30 DAT	60 DAT	90 DAT	At harvest
T_1: Control	3.41	10.47	20.38	21.04
T_2: 100% RDF (Recommended dose of fertilizers)	7.55	16.47	26.37	27.40
T_3: 75% RDF (Recommended dose of fertilizers)	6.49	16.03	25.90	26.27
T_4: 50 % RDF (Recommended dose of fertilizers)	5.34	15.14	25.40	25.90
T_5: 10t FYM ha^{-1}	4.80	12.73	22.67	25.17
T_6: 15t FYM ha^{-1}	4.92	13.44	23.71	25.50
T_7: 3t Poultry manure ha^{-1}	5.10	14.77	24.27	25.70
T_8: 2t Vermicompost ha^{-1}	5.31	15.05	24.83	25.80
T_9: 50% RDF + 3t Poultry Manure ha^{-1}	6.91	18.03	27.60	28.24
T_{10}: 50% RDF + 2t Vermicompost ha^{-1}	7.02	18.51	27.76	28.97
T_{11}: 50% RDF + 3t Poultry manure ha^{-1} + 0.5t Neem Cake ha^{-1}	8.51	19.34	29.01	30.43
T_{12}: 50% RDF + 1.5t Vermicompost ha^{-1} + 0.5t Neem Cake ha^{-1}	8.77	19.83	29.23	30.93
SEm±	0.10	0.52	0.44	0.58
CD (P=0.05)	0.28	1.51	1.26	1.68



Graph 3: Influence of nutrient management on dry matter accumulation plant^{-1} (g) of basmati rice under SRI method

T_9 (50% RDF + 3t Poultry Manure ha^{-1}) and leaf area index recorded was 2.27, 2.13 and 2.10 respectively.

The maximum leaf area index (LAI) was observed at 60 DAT, because of peak growth stage and after that crop enters into the reproductive phase with gradual senescence of leaves. Similar findings were reported by Yadav and Meena (2014).

Conclusion

On the basis of the results obtained from the present investigation, the following conclusions may be drawn that 50% RDF + 1.5 t Vermicompost ha^{-1} + 0.5 t Neem cake ha^{-1} improved the growth parameters, yield attributes and yield of basmati rice.

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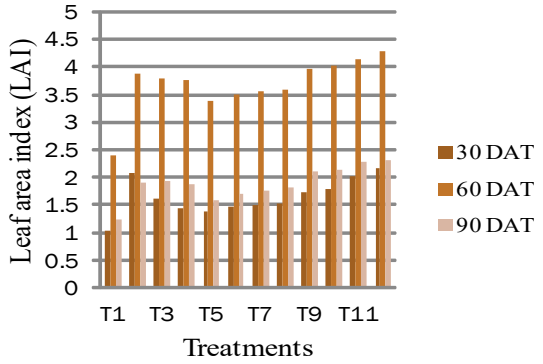
Table 4: Influence of nutrient management on Leaf area index (LAI) of basmati rice under SRI method

Treatment	Leaf area index (LAI)		
	30 DAT	60 DAT	90 DAT
T_1: Control	1.03	2.40	1.23
T_2: 100% RDF (Recommended dose of fertilizers)	2.07	3.87	1.90
T_3: 75% RDF (Recommended dose of fertilizers)	1.63	3.80	1.93
T_4: 50 % RDF (Recommended dose of fertilizers)	1.43	3.77	1.87
T_5: 10t FYM ha^{-1}	1.37	3.40	1.60
T_6: 15t FYM ha^{-1}	1.47	3.50	1.70
T_7: 3t Poultry manure ha^{-1}	1.50	3.57	1.77
T_8: 2t Vermicompost ha^{-1}	1.53	3.60	1.83
T_9: 50% RDF + 3t Poultry Manure ha^{-1}	1.73	3.97	2.10
T_{10}: 50% RDF + 2t Vermicompost ha^{-1}	1.80	4.03	2.13
T_{11}: 50% RDF + 3t Poultry manure ha^{-1} + 0.5t Neem Cake ha^{-1}	2.03	4.13	2.27
T_{12}: 50% RDF + 1.5t Vermicompost ha^{-1} + 0.5t Neem Cake ha^{-1}	2.17	4.30	2.30
SEm±	0.12	0.09	0.09
CD (P=0.05)	0.33	0.27	0.26



Graph 4: Influence of nutrient management on Leaf area index (LAI) of basmati rice under SRI method

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