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Effect of fertility levels and split application of nitrogen on growth, total nutrient uptake and economics of different rice cultivars

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Abstract
A field experiment was conducted during kharif season of 2017 to study the response of different fertility levels and split application of nitrogen on medium duration rice varieties at Agronomy Main Research Station, Odisha University of Agriculture and Technology, Bhubaneswar. Two fertility levels (100:50:50 kg $N:P_2O_5:K_2O$ ha^{-1} and 80:40:40 kg $N:P_2O_5:K_2O$ ha^{-1}) each having two different splitting schedules of nitrogen (¼ basal + ½ tillering + ¼ PI) and (¼ basal + ½ tillering + 1/8 PI+ 1/8flowering) were allotted to the main plots whereas four rice varieties (Hasanta, Mrunalini, Ashutosh and Swarna) were allotted to the sub plots in a split plot design along with three replications. Growth variables such as Plant height, Maximum dry matter, Number of effective tillers and Total Nutrient Uptake were higher under application of 100:50:50 kg $N:P_2O_5:K_2O$ ha^{-1} with four splits of nitrogen. Among the varieties, Mrunalini recorded the maximum number of effective tillers, maximum accumulated dry matter, the highest total nutrient (NPK) uptake (237.26 kg ha^{-1}), net return (Rs. 42,765ha^{-1}) and benefit: cost ratio (2.66).

Keywords: rice, fertility level, split application, growth

1. Introduction
Rice is a majour food source for a greater part of the world mass (Nguyen 2002) [2]. In India, rice is cultivated in an area of 43.9 million hectares with 104.32Mt of production. In Odisha, rice is a pioneer food crop and it covers an area of 4.4 million hectares, with production of 9.50 million tonnes ha^{-1} which is about 4.47 % rice produced in India. Among all the nutrients, Nitrogen is a major nutrient element for rice plants, as 75 per cent of leaf nitrogen is associated with chloroplast which physiologically helps in dry matter production through photosynthesis. The actual Nitrogen Use Efficiency is very less and remains between 20 to 25% in rice crop. During ripening stage, almost 70% of the nitrogen taken up by the straw is shifted to the grain. Nitrogen content of the grain tends to be maintained at a certain percentage. When more grains are produced as compared to the size of vegetative parts, a higher amount of nitrogen will be required for the grain growth to be continued and therefore the leaf nitrogen content will turn down abruptly. Under such situation some grains may suffer from nitrogen shortage (Yoshida, 1981) [5]. Hence the only way to attain a higher photosynthetic efficiency is to keep on providing nitrogen even upto heading. Application of nitrogen in splits is a well proven and accepted method of increasing the efficiency of applied nitrogen in most irrigated crops (Prasad, 2007) [4]. The response of the varieties towards the applied N- fertilisers varies as per their characteristics. An experiement was piloted to assess the effect of different fertiliser levels and nitrogen splits on growth,total nutrient uptake and ecocnomics of four different rice cultivars.

2. Materials and methods
The experiment was conducted during kharif season of 2017 at Agronomy Main Research Station, Odisha University of Agriculture and Technology, Bhubaneswar situated at $21^0$15' N and $85^0$52'E and 25.9 m above MSL. The soils of the region where experiment was carried out was sandy loam in texture with pH 5.6 with medium organic carbon status (0.71 %), low available nitrogen status (223 kg ha^{-1}), medium available phosphorus status (20 kg ha^{-1}) and medium potassium status (211 kg ha^{-1}). The total rainfall received during the period of cropping season was 1364.1 mm. The mean monthly temperature during the cropping season varied from 29.65^0C in September to 21.3^0C in December.
Two fertility levels (100:50:50 kg $N:P_2O_5:K_2O$ ha^{-1} and 80:40:40 kg $N:P_2O_5:K_2O$ ha^{-1}) each with two splitting schedules of nitrogen (¼ basal + ½ tillering + ¼ PI) and (¼ basal + ½ tillering+ 1/8 PI+ 1/8 flowering) were allotted to the main plots and four varieties (Hasanta, Mrunalini, Asutosh and Swarna) were allotted to the sub plots in a split plot design with three replications.
Recommended package of practices were followed in raising the rice crop.
Observations were taken down on various growth parameters such as height of the plant, maximum dry matter accumulation, number of effective tillers and also for total nutrient uptake. Comparative economics like net return, B:C ratio were worked out for different treatments considering the market price of inputs and outputs.

Table 1

Treatment	Growth parameters			Total nutrient uptake (kg ha^{-1})	Net Return (Rs. ha^{-1})	Benefit: Cost
	Plant Height (cm)	Effective tillers m^{-2}	Total dry matter accumulation (g m^{-2})			
F1- 80:40:40						
S1(3 splits)	114.18	320.51	1365.35	186.20	186.20	1.48
S2(4 splits)	115.45	324.86	1369.5	198.22	198.22	1.46
F2- 100:50:50						
S1(3 splits)	115.75	336.44	1399.62	209.00	209.00	1.58
S2(4 splits)	116.71	340.86	1409.00	236.72	236.72	1.68
SEm ±	0.07	0.09	0.22	0.39	0.39	0.003
CD (P= 0.05)	0.25	0.29	0.66	1.34	1.34	0.01
Variety						
V1-Hasanta	114.72	309.63	1362.04	201.70	201.70	1.51
V2-Mrunalini	116.74	392.60	1481.40	237.26	237.26	1.80
V3-Ashutosh	123.34	337.10	1415.39	205.56	205.56	1.58
V4-Swarna	107.3	283.34	1284.63	185.62	185.62	1.31
SEm ±	0.09	0.05	0.51	0.79	0.79	0.002
CD (P= 0.05)	0.26	0.15	1.50	2.31	2.31	0.008
F x V						
SEm ±	0.18	0.10	1.02	1.58	1.58	0.02
CD (P= 0.05)	0.52	0.30	3.00	4.63	4.63	0.06

3. Result and discussion-

a. Growth parameters

Height of the plants increased progressively and reached its maximum at harvest. The maximum plant height (116.71cm) was observed with application of 100:50:50 kg N: P_2O_5:K_2O ha^{-1} in four splits (¼ basal + ½ tillering + 1/8 PI + 1/8 flowering). This probably due to better balanced nutrition by the plants which preferably stimulated the cell division and multiplication and hence resulted in increased internode length. The higher N levels were responsible for increase in leaf number which gave higher photosynthesis, metabolic activity and cell division. This attributed to increased rice growth (Jaiswal and Singh, 2001).

Rice variety Ashutosh recorded the maximum plant height (123.34cm) among all the varities. Contrarily Swarna variety has attained only up to 107.3 cm height during harvest. This might be as a result of the genetic variability existing among the varieties.

b. Effective tillers m^{-2}

The number of tillers m^{-2} increased significantly with increase in fertiliser levels and number of splits. The maximum number of effective tillers (340.86) were observed with application of 100:50:50 kg N: P_2O_5:K_2O ha^{-1} in four splits. This might be due to the better utilisation of resources as an extra split of nitrogen is applied at flowering stage which helps in converting majority of tillers into effective tillers.

Among the varieties Mrunalini was observed with the maximum number of effective tillers (392.60). As the potential of any variety to produce tillers is genetically determined, the higher tillering capacity of Mrunalini is due to its superiority in genetic constitution over other varieties.

c. Total dry matter accumulation g m^{-2}

The amount of dry matter stored by the plant have raised significantly with increase in nitrogen doses and their split applications. The maximum accumulated dry matter 1409 g m-2 was noticed during harvest by application of 100:50:50 kg N: P_2O_5:K_2O ha^{-1} in four splits (¼ basal + ½ tillering + 1/8 PI + 1/8 flowering). This might be a result of better utilisation of resources as an extra split of nitrogen is applied at flowering stage which helps in converting majority of tillers into effective tillers. Out of the varieties, Mrunalini accumulated the maximum amount of total dry matter (1481.4 g m^{-2}). As the tillering ability of any variety is genetically determined, the higher tillering ability of Mrunalini was because of its superiority in genetic constitution over other varieties.

d. Total Nutrient Uptake

The nutrient uptake capacity of a plant is determined by the nutrient availability and absorption capacity which contributes towards the crop yield. The highest total nutrient (N+P+K) uptake (236.72 kg ha^{-1}) was recorded when 100:50:50 kg N: P_2O_5:K_2O ha^{-1} applied in four splits. This might be a result of greater biomass yield under the higher fertility level in comparison to the lesser one.

Among the varieties Mrunalini was recorded with the highest total nutrient uptake (237.26 kg ha^{-1}) and Swarna was recorded with the lowest total nutrient uptake (185.62 kg ha^{-1}). Pradhan *et al*. (2013) noticed that the lowest uptake of nitrogen by grain and straw was found in'Swarna' variety. The highest nutrient uptake of Mrunalini was because of the genetic potential of the variety to produce higher total biomass as compared to other varieties.

e. Comparative Economics

The highest net return (Rs.30735 ha^{-1}) and B: C ratio (1.68) was observed under application of 100:50:50 kg N: P_2O_5:K_2O ha^{-1} in four splits and among the varieties the maximum net return (Rs.35164 ha^{-1}) and B:C ratio(1.80) was observed in Mrunalini variety. This might be a result of the superior value of yield governing characters that eventually given rise to increase in yield which is the cause for higher net return. Minimum net return (Rs.20128 ha^{-1}) was observed under application of 80:40:40 kg N: P_2O_5:K_2O ha^{-1} in three splits and the minimum B: C ratio (1.46) was also observed under same fertility level when applied in four splits. This might be because of lower yield and more human labour requirement for application of an extra split of nitrogen at later stage.

4. Conclusion

From the above experiment it can be concluded that rice variety Mrunalini under application of 100:50:50 kg N:P_2O_5:K_2O ha^{-1} in four splits of nitrogen (¼ basal + ½ tillering + 1/8 PI + 1/8 flowering) produced the maximum plant height, effective tillers,

total dry matter with the maximum net return (Rs.42,765 ha^{-1}) and B-C ratio (1.95). So the treatment can be recommended to the farmers for getting higher productivity and profitability.

5. References

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