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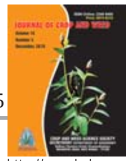

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Performance of medium duration rice varieties to varying levels of fertility and split application of nitrogen

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ABSTRACT

An experiment was conducted in kharif, 2017 to study the responses of medium duration rice varieties with different levels of fertility and split application of nitrogen at the Agronomy Main Research Station, Odisha University of Agriculture and Technology, Bhubaneswar. Two levels of fertility (100:50:50 kg application of N:P_2O_5:K_2O ha^{-1} and 80:40:40 application of N:P_2O_5:K_2O ha^{-1}) each with two different 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 the sub-plots were assigned with four rice varieties (Hasanta, Mrunalini, Asutosh and Swarna) in split-plot design having three replications. Yield attributing characters like panicle number m^{-2}, fertile grains $panicle^{-1}$,1000 grain weight etc. were more at 100:50:50 kg application of N:P_2O_5:K_2O ha^{-1} fertiliser dose with nitrogen application in four splits that resulted in maximum grain yield (4.87 ton ha^{-1}) and straw yield (7.2 ton ha^{-1}). Among varieties, Mrunalini observed with maximum grain yield (5.06 ton ha^{-1}), straw yield (7.41 ton ha^{-1}),nutrient uptake (NPK), net yield (Rs. 42.765 ha^{-1}) and benefit: cost ratio (2.66).

Keywords: Fertility level, nitrogen split, nutrient uptake, yield

Rice is a principal crop grown in many developing countries. In India, rice covers 43.9 million hectares contributing about 104.32 million tonnes of produce and average productivity is 2404 kg ha^{-1} (GOI 2016-17). Odisha occupies 8th position among the highest rice producing states, and produces about 4.47 per cent rice of the country. Among the agricultural inputs, nitrogen ranked first to give maximum output in agriculture. The Nitrogen Use Efficiency in rice crop varies from 20-25per cent.The nitrogen application in splits is an important strategy for efficient use of nitrogenous fertilisers in direct seeded rice as it reduces denitrification loss and increase nitrogen uptake and grain yield (Lampayan *et al*., 2010). Nitrogen application in four equal parts, *i.e*. seedlings, active tillering, PI and flowering, resulted in higher yield attributing characters and yield in rice than three equal parts, namely seedlings, active tillering and PI (Algeson and Rajababu ,2011). Approximately 70 per cent of the nitrogen taken by straw will be shifted to grains during ripening stage. Grain nitrogen content must be maintained at a specific percentage. When more grains are produced compared to the size of the vegetative parts, there will be need for more nitrogen to facilitate grain growth. So the leaf nitrogen content will be reduced and in some grains there may be little nitrogen left. Hence for higher yields, maintaining the level of leaf nitrogen level is necessary for higher photosynthetic activity. The only way to fulfil this requirement is the continuous absorption of nitrogen even after heading. (Yoshida, 1981)

Different crop varieties have varying responses to N-fertilizer as they have different on agronomic traits. A study was conducted to assess the impact of different levels of fertility and nitrogen application in different fractions on yield attributing characters, yield, total nutrient uptake and economy of four medium-term rice varieties.

MATERIALS AND METHODS

This experiment was undertaken in *kharif*, 2017 in Agronomy Main Research Station, Odisha University of Agriculture and Technology, Bhubaneswar located at 21º15¢ N and 85º52¢E and 25.9 m above MSL. The experimental site's soil texture was sandy loam with pH 5.6, medium in organic carbon (0.71 per cent), phosphorus (20 kg ha^{-1}) and potassium (211 kg ha^{-1}) but low in nitrogen availablility (223 kg ha^{-1}) .Total rainfall in crop season was 1364.1 mm. The average monthly temperature during the growing season ranged from 29.65^{0}C in September to 21.3^{0}C in December. Monthly evaporation data (by USDA pan evaporimeter) ranged from 3.3mm / day to 3.4mm / day. In the crop growth period the average bright sunshine hours (BSH) varied from 2 hrs / day in July to 7 hrs / day in December. Two dose of fertilisers (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 namely ; Hasanta (140-150 days), Mrunalini (146 days), Asutosh (145-155 days) and Swarna (135 days) were taken within

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the sub plots in split plot design done in three replications. Recommended dose was 80:40:40 kg $N:P_2O_5:K_2O$ ha^{-1} at (¼ basal + ½ tillering + ¼ PI). Sprouted seeds were sown on 17thJuly. After application of required amount of fertilisers during the main field preparation, the crop was transplanted with a spacing of 20 × 10 cm on 16th august. Manual weeding was done twice, first one at three weeks after tranansplanting and second was done at 2 weeks after the first weeding to keep the plot weed free. For protection from stem borer , leaf roller and mealy bug attack the crop was sprayed with Monocrotophos @ 1000 ml ha^{-1} at 30 DAT and 45 DAT. To protect the crop from sheath blight, Hexaconozole was applied two times (1ml $litre^{-1}$ of water) and thiomethoxam was sprayed (1 g per 4 litres of water) two times to prevent from attack of brown plant hopper. These two were sprayed in alternative weeks after transplanting. The crop was harvested on 21st and 25th December due to the variation in varietal duration, Observations were recorded on various yield attributes, grain yield, straw yield, harvest index and nutrient uptake. Comparative economics, such as net return, B: C ratio, has been calculated for different treatments. Data collected on various parameters were statistically analyzed following the standard analysis of the variance technique (ANOVA) as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Yield attributes

Yield of a crop is influenced by its yield attributing characters. Different fertiliser doses with different nitrogen splits were applied and their impact on yield attributing characters of different rice varieties were recorded and embodied in table 1. In the present investigation, 100:50:50 kg application of $N:P_2O_5:K_2O$ ha^{-1} with four splits of nitrogen resulted in higher panicle number m^{-2}(335.83), more fertile grains $panicle^{-1}$(154.73 and the highest 1000-grain weight (20.03 g).

The higher panicle number m^{-2} was probably because of increased early growth with the higher fertility level which resulted in higher tiller production and decreased tiller mortality. Increase in accumulation of photosynthates and translocation of these photosynthates to the reproductive part increased the filled grain numbers per panicle and hence the fertility percentage. The test weight of grain was the highest (20.03g) at higher fertility level because of balanced nutrition which resulted in better grain filling and due to sufficient nutrient availability. Higher photosynthetic efficiency as well as more effective translocation of photosynthates to the grain might also have increased the grain filling and weight of grain.

Among the varieties, Mrunalini was observed with highest panicle number m^{-2}(489.33), the highest number of fertile grains $panicle^{-1}$(189.20) and the highest value of 1000-grain weight(22.08g). This variation in the yield attributing characters among the varieties is probably the result of the variation in genetic potential between them. The test weight of a particular variety is more or less fixed.

Yield

Grain yield is basically a result of several growth factors such as genetic, environmental and management factors.

The maximum grain yield (4.87 ton ha^{-1}) was observed under 100:50:50 kg application of $N:P_2O_5:K_2O$ ha^{-1} in four splits (Table 1) which might be because of proper development and more effective transfer of photosynthates that resulted in production of more effective tillers, more fertile grains $panicle^{-1}$ and test weight. Under higher fertility level the production of crop was higher because of the higher vegetative and reproductive growth which might be due to the better development of chlorophyll. Due to the application of an extra split of nitrogen at flowering stage, balanced nutrient availability will be there in later flowering stage which might be responsible for higher dry matter partitioning which gives rise to better grain filling and higher test weight. Ramasamy *et al.* (1997) found that application of late nitrogen dose at flowering stage enhanced grain filling and increased rice yield. Yoseftbar (2013) also noticed higher grain yield with four splits of nitrogen as (¼ basal + ¼ tillering+ ¼ PI+ 1/4 flowering) than 2 or 3 split applicaton of nitrogen.

100:50:50 kg application of $N:P_2O_5:K_2O$ ha^{-1} in four splits resulted in a higher yield of straw (7.2 ton ha^{-1}) and the lowest grain: straw ratio (0.67) and harvest index (40.20%). This might be because of the imbalance in nutrient availability and nutrient uptake. Another probable reason for increasing straw yield is the more number of tiller production under higher doses of fertiliser. There might be lack of balanced availability of potassium at higher fertility level which might have resulted improper translocation of photosynthates from leaves to grain which is responsible for lower harvest index and grain: straw ratio.

Each variety is having its distinct genetic potential which exclusively affect its yield attributing characters and ultimately yield under varying environmental condition. In the present study, Mrunalini gave maximum grain yield (5.06 ton ha^{-1}) , straw yield (7.41 ton ha^{-1}) and lowest grain:straw ratio (0.68) and harvest index (40.67%). The yield advantage of this variety over others might be attributed to the higher value of yield governing characters such higher panicles m^{-2}, more grains per

Table 1: Yield attributing characters and yield of medium duration rice varities with different levels of fertility and nitrogen splits

Treatment	Yield Attributing characters			Yield		
Fertility level (kg N:P_2O_5:K_2O ha^{-1})	Numberof panicle m^{-2}	Fertile grains Panicle^{-1}	1000 grain wt (g)	Grain yield (ton ha^{-1})	Straw yield (ton ha^{-1})	Harvest index (%)
F1- 80:40:40						
S1(3 splits)	322.66	146.49	18.91	4.03	5.21	43.77
S2(4 splits)	327.25	149.25	19.1	4.20	5.62	42.81
F2- 100:50:50						
S1(3 splits)	331.75	151.99	19.65	4.40	6.16	41.72
S2(4 splits)	335.83	154.73	20.03	4.87	7.2	40.20
SEm (±)	0.45	0.14	0.08	0.02	0.01	0.001
LSD (0.05)	1.56	0.46	0.26	0.04	0.04	0.004
Variety						
V1-Hasanta	291.75	132.91	17.17	4.27	5.70	43.00
V2-Mrunalini	489.33	189.20	22.08	5.06	7.41	40.67
V3-Ashutosh	285.66	163.37	19.81	4.47	5.99	42.86
V4-Swarna	250.75	116.98	18.64	3.70	5.15	41.89
SEm (±)	0.53	0.12	0.06	0.03	0.01	0.002
LSD (0.05)	1.56	0.34	0.18	0.10	0.03	0.006
F x V						
SEm (±)	**1.06**	**0.24**	**0.13**	**0.07**	**0.15**	**0.004**
LSD (0.05)	**3.12**	**0.69**	**0.37**	**0.21**	**0.44**	**0.012**

Table 2:Interaction of fertility and nitrogen splitting effects on grain yields of rice varieties

Variety	Fertility Level (kg N:P2O5:K2O ha $^{-1}$)			
	F1- 80:40:40		F2- 100:50:50	
	S1(3 splits)	S2(4 splits)	S1(3 splits)	S2(4 splits)
V1- Hasanta	4.03	4.07	4.35	4.63
V2- Mrunalini	4.59	4.91	5.12	5.61
V3- Asutosh	4.11	4.28	4.47	5.03
V4- Swarna	3.40	3.54	3.67	4.19
SEm (±)	**0.07**			
LSD (0.05)	**0.21**			

panicle, more fertile grains per panicle, higher fertility percentage and maximum 1000-grain weight *etc*.

The interaction effect revealed that medium duration rice variety Mrunalini under 100:50:50 kg application of N:P_2O_5:K_2O ha^{-1} in four splits produced a significantly higher yield of grain (5.61 ton ha^{-1}) (Table 2).

Uptake of nutrients

The nutrient uptake capacity of a plant depends upon the availability of nutrients and absorption capacity of plant which results in crop yield. Higher nitrogen uptake (61.43 kg ha^{-1} in grain, 26.72 kg ha^{-1} in straw), phosphorous uptake (17.93 kg ha^{-1} in grain, 7.95 kg ha^{-1} in straw) and potassium uptake (10.75 kg ha^{-1} in grain, 111.9 kg ha^{-1} in straw) was observed with 100:50:50 kg application of N:P_2O_5:K_2O ha^{-1} with four splits of nitrogen. This might be the result of increased biomass production under the higher fertility level as compared to the lesser dose. Jaiswal and Singh (2001) reported that Higher nitrogen uptake was might be due to better establishment of roots, proper growth of plants and higher yield under higher N level. Devi *et al*. (2012) found that Nitrogen application in 4 equal parts (¼ basal + ¼ tillering+ ¼ PI+ 1/4 flowering) has recorded more N,P,K uptake than 2 or 3 split applications.Among the varieties Mrunalini was recorded with maximum N,P,K

Table 3: Nitrogen,phosphorus and potassium uptake (kg ha^{-1})of rice varieties under different fertiliser doses and nitrogen splits

Treatment	Nutrient uptake					
Fertility level (kg N:P_2O_5:K_2O ha^{-1})	N Uptake (kg ha^{-1})		P Uptake (kg ha^{-1})		K Uptake (kg ha^{-1})	
F1- 80:40:40	Grain	Straw	Grain	Straw	Grain	Straw
S1(3 splits)	52.61	19.99	15.50	6.58	9.50	81.99
S2(4 splits)	54.28	22.07	16.51	7.30	9.78	88.27
F2- 100:50:50						
S1(3 splits)	56.32	23.05	16.46	7.27	9.90	95.97
S2(4 splits)	61.43	26.72	17.93	7.95	10.75	111.9
SEm (±)	**0.213**	**0.097**	**0.073**	**0.070**	**0.097**	**0.239**
LSD (0.05)	**0.739**	**0.33**	**0.25**	**0.24**	**0.33**	**0.82**
Variety						
V1-Hasanta	55.65	21.96	16.50	7.17	10.03	90.36
V2-Mrunalini	63.00	26.40	18.05	7.61	10.69	111.4
V3-Ashutosh	56.77	22.18	16.58	7.24	10.19	92.58
V4-Swarna	49.22	21.28	15.28	7.07	9.02	83.73
SEm (±)	**0.496**	**0.115**	**0.164**	**0.107**	**0.105**	**0.205**
LSD (0.05)	**1.44**	**0.33**	**0.48**	**0.31**	**0.30**	**0.59**
F x V						
SEm (±)	**0.992**	**0.231**	**0.329**	**0.215**	**0.193**	**0.442**
LSD (0.05)	**2.89**	**0.67**	**0.96**	**0.63**	**0.56**	**1.29**

Table 4: Impact of fertility levels and nitrogen splits on comparative economics

Treatment	Cost of cultivation (Rs.ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Benefit: Cost
$V_1F_1S_1$	42000	61807	19807	1.47
$V_2F_1S_1$	42000	71132	29132	1.70
$V_3F_1S_1$	42000	63238	21238	1.51
$V_4F_1S_1$	42000	52334	10334	1.25
$V_1F_1S_2$	44135	62661	18526	1.42
$V_2F_1S_2$	44135	76175	32040	1.72
$V_3F_1S_2$	44135	65988	21853	1.49
$V_4F_1S_2$	44135	54751	10616	1.24
$V_1F_2S_1$	43055	67375	24320	1.56
$V_2F_2S_1$	43055	79775	36720	1.85
$V_3F_2S_1$	43055	68887	25832	1.59
$V_4F_2S_1$	43055	56974	13919	1.32
$V_1F_2S_2$	45190	72070	26880	1.60
$V_2F_2S_2$	45190	87955	42765	1.95
$V_3F_2S_2$	45190	78196	33006	1.73
$V_4F_2S_2$	45190	65480	20290	1.45

uptake in grain and straw and Swarna variety observed to have lowest nutrient uptake.

The cost of cultivation (Rs.45190 ha^{-1}) observed highest when applied with 100:50:50 kg N:P_2O_5:K_2O ha^{-1} in four splits. This is probably due to more use of fertiliser as compared to the lesser level. The human labour requirement for application of fertiliser of an extra split at flowering stage was also included. Mrunalini variety when applied with 100:50:50 kg N:P_2O_5:K_2O ha^{-1} with four splits of nitrogen resulted in maximum net return (Rs.42765 ha^{-1}) and B:C ratio (1.95).This is probably due to higher value of yield attributing characters that ultimately resulted in increase in yield which is the cause for higher gross and net return.

From the above experiment it can be inferred that the recently released OUAT rice variety Mrunalini when applied with 100:50:50 kg $N:P_2O_5:K_2O$ ha^{-1} in four nitrogen splits (¼ basal + ½ tillering + 1/8 PI +1/8 flowering) resulted in the maximum grain yield (5.61 ton ha^{-1}) and straw yield (7.27 ton ha^{-1}) and maximum net return (Rs.42765 ha^{-1}) and B:C ratio (1.95). So the treatment can be recommended to the farmers for getting higher productivity and profitability.

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