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Effect of nitrogen levels on growth, yield attributes and yield of red rice cultivars (*Oryza sativa* L.)

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Abstract
The experiment was carried out at Instructional cum Research Farm, IGKV, Raipur (C.G.) during *kharif* season, 2018 to study the Effect of Nitrogen levels on Growth, Yield attributes and Yield of red rice cultivars (*Oryza sativa* L.). The experiment consisted five red rice cultivars (Bantha luchai, Shrikamal, Kankadiya, Khuddi and Jyothi) in main plot and four nitrogen levels (0, 60 kg N ha^{-1}, 80 kg N ha^{-1} and 25 kg N ha^{-1} + LCC based nitrogen management) in sub plot under split plot design with three replications. The result revealed that among cultivar, maximum plant height was recorded by Shrikamal. Maximum number of tillers $hill^{-1}$, number of leaves and dry matter accumulation was observed in Jyothi variety. Maximum number of effective tillers $hill^{-1}$, panicle weight, test weight and grain yield were recorded under variety Jyothi. However, higher growth, yield attributes and grain yield were recorded by the application of 80 kg N ha^{-1}. Straw yield was not influenced by cultivars but affected by nitrogen levels. Significant interaction effect was noted on plant height, number of tillers, effective tillers and grain yield. Harvest index of red rice cultivars were not affected significantly due to different cultivars and nitrogen levels.

Keywords: Effective tillers, harvest index, Leaf colour chart (LCC), plant height, cultivars

Introduction
Rice (*Oryza sativa* L.) is a cereal crop belongs to the family poaceae and genus *Oryza* with chromosome no 24. The cultivation of rice ranks third in the production of agricultural commodity next to sugarcane and maize. It is the predominant dietary energy source of 17 countries in Asia and the Pacific, 9 countries in North and South America and 8 countries in Africa. India is one of the major centres for rice production (Rathna Priya *et al*., 2019) [11]. Red rice is characterized by a red bran layer in which most of the micronutrients are concentrated. Red rice contains high iron (5.5 mg/100 mg) and zinc (3.3 mg/100 mg). The zinc and iron content of red rice is two to three times higher than white rice (Ramaiah and Rao, 1953) [10]. Light to dark red color of the bran is due to anthocyanin. A great diversity in cultivars exists between the red rice. They are scented and non-scented, glutinous and non-glutinous, late and early maturity and have short and long grained. Almost all the rice growing Asian countries such as Sri Lanka, Philippines, Korea, China, Japan and India, red rice had created a significant place among white rice, earlier than the introduction of high yielding varieties. In earlier days, the colored rice was preferred due to its taste and medicinal value. However, colored rice remains unrecognized due to plant introduction and commercialization of agriculture. For Asian countries, rice is essential source of carbohydrates, energy and protein in human diet. By means of growing worldwide worries, about nation health and increasing markets of purposeful products, some special rice cultivars, including giant embryonic rice, black rice, and red rice are being developed in Korea (Li *et al*., 2008; Kong and Lee, 2010) [8, 5].
Nitrogen is major nutrient which limit the yield potential of rice cultivars. Rice crops especially prefer nitrogen fertilizer in ammonical form during the early stage and nitrate form during later stages of growth period, as nitrogen plays a key role in providing luxuriant vegetative growth, increase the herbage quality and growth of plants. Nitrogen fertilizers applied to soil undergo physical, chemical and biological transformation which ultimately becomes available to crops. Due to various losses and increase in cost, the efficient use of nitrogenous fertilizer is a

challenge. Application of over dose of nitrogen fertilizer results in lower yield due to lodging or insect pest attack. About 60 per cent of applied nitrogen is lost due to lack of proper management between the nitrogen demand and nitrogen supply. The higher nitrogen use efficiency can be accomplished by matching nitrogen supply with crop demand. By keeping the above facts about red rice cultivars and importance of different nitrogen doses, the present study had been conducted.

Materials and Methods

The experiment was carried out at Instructional cum Research farm, IGKV, Raipur (C.G.) during *Kharif* season, 2018 to study the effect of different nitrogen levels on growth and yield of red rice cultivars. The experiment was carried out in split plot design with three replications. A combination of five cultivar *viz*., Bantha luchai, Shrikamal, Kankadiya, Khuddi and Jyothi with four nitrogen levels 0, 60 kg N ha^{-1}, 80 kg N ha^{-1} and 25 kg N ha^{-1} + LCC (Leaf colour chart) based nitrogen management was taken in main plot and sub plot respectively.

Plant height was measured in centimetre from bottom to top most leaf with the help of measuring scale from five selective plants and by the same plants number of tillers and number of leaves was also counted. Data of dry matter was taken by uprooting the plants and oven dried at 65 °C then weighed through weighing machine.

CGR was calculated from the dry weight obtained at 25-50 DAT, 50-75 DAT and 75 DAT to at harvest using formula given by Leopold and Kridermann (1975) [7]:

$$\text{Crop growth rate (g day}^{-1}\text{ hill}^{-1}) = \frac{w_2 - w_1}{t_2 - t_1}$$

Where,

W_2-W_1 = Difference in oven dry biomass at the time interval

t_2 - t_1 = Time interval in days

Yield attributing characters *viz*., number of effective tillers and total grains $panicle^{-1}$ was counted at the field before harvest of crop, panicle length was measured with the help of a scale in centimetre; panicle weight and test weight were taken with the help of weighing machine. After harvesting of crop from net plots, bundles were sun dried and threshed were grain and straw were separated and weighed for the observation. Harvest index was calculated by using formula given by Donald.

$$\text{Harvest index (\%)} = \frac{\text{Grain yield (kg ha}^{-1})}{\text{Biological yield (kg ha}^{-1})}$$

Results and Discussion

Growth Parameters

Cultivars: Plant height, number of tillers, number of leaves, dry matter accumulation was significantly influenced due to different red rice cultivars. Maximum plant height was recorded by cultivar Shrikamal. Maximum number of tiller $hill^{-1}$ (15.09), number of leaves $hill^{-1}$ (50.70), dry matter accumulation (44.50 g $hill^{-1}$) were obtained under Jyothi variety. However, it was statistically at par with Khuddi in number of tillers and with Shrikamal and Khuddi in dry matter accumulation (Table 1). Crop growth rate (CGR) in g day^{-1} $hill^{-1}$ was calculated at 25-50 DAT, 50-75 DAT and 75 DAT to at harvest which are graphically depicted in figure 1. The CGR shows very slow growth and have nearly same pattern up to 25 to 50 DAT. The CGR increased up to 75 DAT to at harvest where it was recorded highest. This indicates that plants take more time to accumulate biomass at vegetative stage and it was quite faster at reproductive stage. These results might be due to their genetic makeup and different growth habits of red rice cultivars.

Nitrogen levels: Significant variation was observed due to application of different nitrogen doses in plant height and number of tiller of cultivars but number of leaves and dry matter accumulation were non-significant (Table 1). Among the different nitrogen levels, maximum plant height (166.85 cm) and number of tillers $hill^{-1}$ (15.18) was recorded with application of 80 kg N ha^{-1}. CGR was significantly affected at all the stages of crop growth. Application of 80 kg N ha-1 showed higher growth up to harvest. However, it was statistically at par with 60 kg N ha-1 and 25 kg N ha-1+LCC based nitrogen management. This shows that biomass increases with higher availability of nitrogen doses (Fig. 1). Higher uptake of applied nitrogen and greater availability of nutrient increase the plant height and number of tillers (Saha *et al*., 2017) [12] CGR.

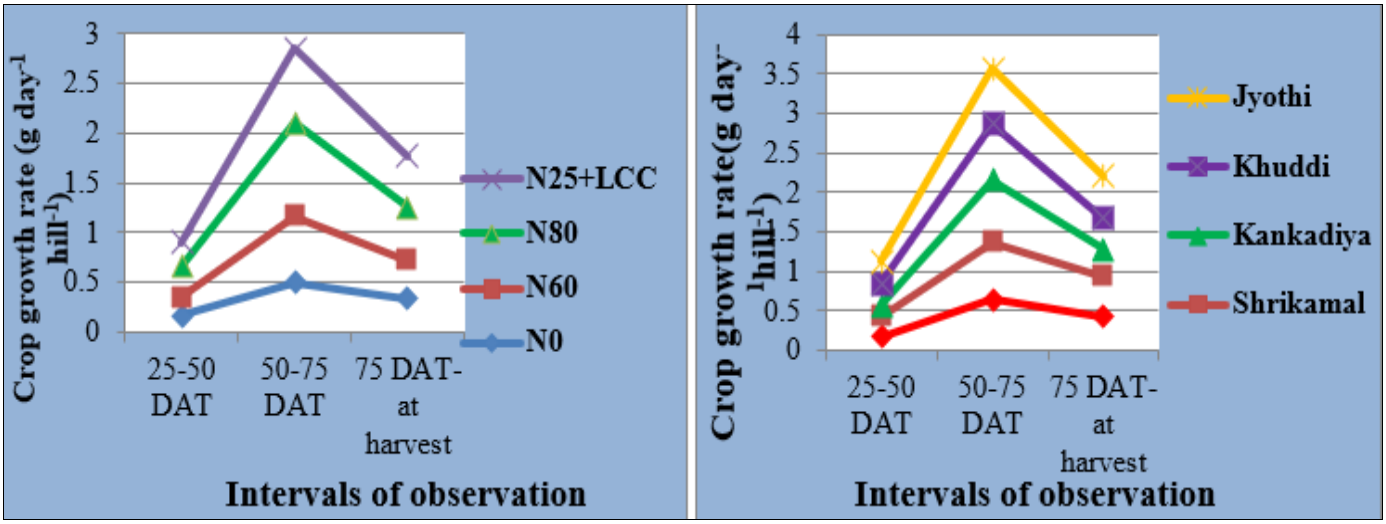

Fig 1: Crop growth rate as influenced by red rice cultivars and nitrogen levels

Table 1: Effect of nitrogen levels and cultivars on growth characters of red rice cultivars at harvest

Treatment	Plant height (cm)	No of tillers plant^{-1}	No of leaves hill^{-1}	Dry matter accumulation (g hill^{-1})
Cultivars				
Bantha luchai	145.85	10.88	39.16	35.99
Shrikamal	162.82	12.32	40.10	43.69
Kankadiya	146.99	11.65	40.02	37.23
Khuddi	150.78	14.47	43.42	39.83
Jyothi	91.63	15.09	50.70	44.50
SEm±	3.47	0.32	1.02	1.46
CD (p=0.05)	11.30	1.06	3.34	4.75
Nitrogen levels				
N_0	127.75	10.51	33.57	29.75
N_{60}	154.80	12.18	39.19	36.16
N_{80}	166.85	15.18	54.75	51.03
N_{25}+LCC	158.16	13.66	43.21	44.05
SEm±	1.65	0.15	0.89	1.69
CD (p=0.05)	4.78	0.44	2.57	4.89
Interaction	S	S	NS	NS

Table 2: Effect of nitrogen levels and cultivars on yield attributing characters and yield of red rice cultivars

Treatment	Effective tillers plant^{-1}	Panicle weight (g)	Panicle length (cm)	Test weight	Total grains panicle^{-1}	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest Index (%)
Cultivars								
Bantha luchai	10.53	2.69	19.62	16.43	140.81	2.76	3.27	46.02
Shrikamal	10.64	3.74	24.61	20.10	155.90	2.77	4.05	41.20
Kankadiya	11.18	2.88	22.55	21.43	162.48	2.80	3.62	44.48
Khuddi	12.14	4.00	26.53	24.73	166.33	3.29	3.82	46.19
Jyothi	13.08	4.33	26.05	28.92	171.89	3.92	4.55	46.25
SEm±	0.41	0.13	0.19	0.27	6.83	0.16	0.39	2.47
CD (p=0.05)	1.32	0.44	0.62	0.89	NS	0.52	NS	NS
Nitrogen levels								
N_0	9.34	3.26	23.47	21.77	139.32	2.63	3.30	44.41
N_{60}	10.51	3.39	23.87	22.16	150.73	3.14	3.96	44.44
N_{80}	14.47	3.81	24.20	22.89	176.75	3.38	4.26	45.08
N_{25}+LCC	11.75	3.65	23.94	22.47	171.11	3.28	3.92	45.39
SEm±	0.29	0.13	0.19	0.16	4.49	0.07	0.18	0.84
CD (p=0.05)	0.84	0.39	NS	0.47	12.98	0.22	0.52	NS
Interaction	S	NS	NS	NS	NS	S	NS	NS

Table 3: Interaction effect of red rice cultivars and different nitrogen levels on plant height and number of tillers of red rice cultivars at harvest

Cultivars	Plant height (cm)				Number of tillers plant^{-1}			
	Nitrogen levels				Nitrogen levels			
	N_0	N_{60}	N_{80}	N_{25}+LCC	N_0	N_{60}	N_{80}	N_{25}+LCC
Bantha luchai	123.7	152.3	152.4	155.0	9.67	10.40	11.80	11.67
Shrikamal	145.8	164.0	182.8	158.6	9.89	11.50	14.33	13.55
Kankadiya	113.7	148.1	165.3	160.9	10.13	11.67	12.97	11.83
Khuddi	131.7	147.4	163.0	161.1	11.53	12.34	19.00	15.00
Jyothi	85.3	89.6	93.8	97.8	11.33	14.98	17.78	16.27
			SEm±	CD (p=0.05)			SEm±	CD (p=0.05)
Comparison of two main plots			3.46	11.74			0.32	1.07
Comparison of two sub plots			1.65	4.80			0.15	0.44
Comparison of subplots at same level of main plots			6.93	11.55			0.64	1.06
Comparison of main plots at same level of sub plots			4.72	14.73			0.43	1.36

Table 4: Interaction effect of red rice cultivars and different nitrogen levels on number of effective tillers and grain yield of red rice cultivars

Cultivars	Number of effective tillers plant^{-1}				Grain yield (t ha^{-1})			
	Nitrogen levels				Nitrogen levels			
	N_0	N_{60}	N_{80}	N_{25}+LCC	N_0	N_{60}	N_{80}	N_{25}+LCC
Bantha luchai	9.00	9.80	12.20	11.13	2.34	2.93	3.13	2.62
Shrikamal	8.87	9.80	12.93	10.97	2.19	2.86	3.02	3.01
Kankadiya	9.27	10.60	14.00	10.87	2.54	3.01	2.62	3.01
Khuddi	9.83	12.13	15.33	12.27	2.86	3.04	3.64	3.61
Jyothi	9.71	11.20	17.87	13.53	3.21	3.84	4.50	4.13
			SEm±	CD (p=0.05)			SEm±	CD (p=0.05)
Comparison of two main plots			0.37	1.25			0.15	0.52
Comparison of two sub plots			0.25	0.73			0.07	0.21
Comparison of subplots at same level of main plots			0.75	1.73			0.31	0.52
Comparison of main plots at same level of sub plots			0.62	1.89			0.21	0.66

Yield attributes

Cultivars: Effective tillers plant^{-1}, panicle weight, panicle length, test weight were significantly influenced by red rice cultivars whereas, total grains panicle^{-1} was not influenced among all yield attributing characters. Significantly higher number of effective tillers plant^{-1}and test weight was recorded under variety Jyothi (13.08 and 28.92 g) respectively. Maximum Panicle weight (4.33 g) was recorded under Jyothi variety which was statistically at par with cultivar Khuddi. Higher panicle length (26.53 cm) was observed under cultivar Khuddi followed by variety Jyothi (Table 2).

Nitrogen levels: Among the different nitrogen levels, application of 80 kg N ha^{-1} produced significantly higher effective tillers hill^{-1} (14.47) and it was superior over all the different nitrogen levels (Table 2). Maximum panicle weight (3.81 g), test weight (22.89 g) and total grain weight panicle^{-1} (176.75) was obtained under 80 kg N ha^{-1} However, it was statistically on par with 25 kg N ha^{-1} + LCC based nitrogen management. Pradhan *et al*. (2014) also reported increased nitrogen levels increased the test weight. Panicle length of red rice cultivars showed non-significant result due to different nitrogen levels.

Yield

Cultivars: The maximum grain yield recorded with variety Jyothi (3.92 t ha^{-1}) but straw yield was not influenced by cultivars. Some factors such as panicle length, panicle weight and number of effective tillers are responsible for higher grain yield, Gewaily *et al*., (2018) [4].

Nitrogen levels: In case of nitrogen levels, application of 80 kg N ha^{-1} produced significantly higher grain yield (3.38 t ha^{-1}). However, it was statistically at par with 25 kg N ha^{-1} + LCC based nitrogen management. Maximum straw yield (4.26 t ha^{-1}) was recorded with 80 kg N ha^{-1} and it was statistically at par with 25 kg N ha^{-1} + LCC based nitrogen management and 60 kg N ha^{-1}. The harvest index of red rice cultivars was not affected significantly due to different nitrogen levels.

Interaction: The analysis of variance showed that highly significant interaction between nitrogen and cultivars was observed. The interaction effect of rice cultivars and nitrogen levels on plant height (182.2 cm) was found significant on cultivar Shrikamal with application of 80 kg N ha^{-1} over rest of the treatment combination, presented in table 3. Significantly higher number of tiller (19.00) was found in the treatment combination of Khuddi fertilized with 80 kg N ha^{-1} over rest of the treatment combinations. However, variety Jyothi fertilized with 80 kg N ha^{-1} recorded maximum effective tillers (17.87) also the combination produced higher grain yield (4.50 t ha^{-1}) which was statistically at par with treatment combination of variety Jyothi and 25 kg N ha^{-1} as basal + LCC based nitrogen management (4.13 t ha^{-1}), presented in table 4.

Conclusion

The present study on Effect of Nitrogen levels on Growth, Yield attributes and Yield of red rice cultivars (*Oryza sativa* L.) concluded that cultivar Shrikamal recorded heighted plant and variety Jyothi as short height plant. Variety Jyothi showed maximum growth and yield in most of the characters among all the red rice cultivars followed by cultivar Khuddi and application of 80 kg N ha^{-1} followed by 25 kg N ha^{-1} + LCC based nitrogen management showed highest values for growth, yield attributes and yield of red rice cultivars.

Conflict of interest: There was no conflict in this study.

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