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Response of local rice (*Oryza sativa* L.) cultivars to different nitrogen levels under rainfed upland conditions of Nagaland

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ABSTRACT

A field experiment was conducted during the *Kharif* season of 2014 to assess the response of local rice (*Oryza sativa* L.) cultivars to different levels of nitrogen under rainfed upland conditions of Nagaland. Treatments consisted of factorial combination of 5 nitrogen levels *viz*., 0, 20, 40, 60, 80 N kg/ha and 2 cultivars *viz*., 'Apaghi' and 'Inglongkiri'. The results of the study showed that increasing levels of nitrogen significantly enhanced growth characteristics and increased yield attributes of the upland rice cultivars. Application of 80 kg N/ha significantly enhanced plant height, number of green leaves per plant, number of tillers per running meter, crop growth rate (CGR), leaf area index (LAI) and root volume. The nitrogen dose at 80 kg/ha also recorded maximum number of grains per panicle, length of panicle, weight of panicle and the overall grain yield of 3197.00 kg/ha. Between the cultivars tested, the cultivar 'Apaghi' was found to be superior recording significantly higher panicle length and weight, number of grains per panicle and test weight ultimately recording the highest grain and straw yields of 3139.69 kg/ha and 4318.33 kg/ha respectively over the cultivar Inglongkiri.

Key words: Growth, Local rice cultivars, Nitrogen levels, Upland, Yield.

INTRODUCTION

Water is a looming crisis due to competition among agricultural, industrial and domestic users. In Asia more than 50% of irrigation water is used to irrigate rice however, due to decreased availability of labor and water there has been a gradual change in establishment method from manual transplanting of rice seedlings to dry-seeded rice (DSR). With the ever increasing growth in population, the world's rice demand is projected to increase by 25% from 2001 to 2025 (Maclean *et al.,* 2002) and in order to keep pace with the demand it is necessary to increase the yield per unit area with less water to fulfil the increasing rice demand with the shrinking resources. Under upland conditions where the crops are not flooded at all during the growth period is an effective way to save water and to reduce the methane emissions produced by flooded rice (Tuong *et al*., 2005). The area under upland rice has being shrinking due to lack of appropriate technologies like nutrient management and suitable varieties for rainfed ecosystems. Irrespective of management practices optimum yield of a crop cannot be realized until the crop itself is responsive to the various management practices. Superior performing cultivars with superior traits like early germination and establishment, taller plant height, higher number of tillers, LAI, high biomass accumulation, yield attributes and yield are necessary for yield performance under upland direct seeded conditions. Adequate and timely supply of nutrients is a prerequisite for realising good yields. Among the major nutrients required by rice, nitrogen is the most limiting nutrient because of submerged soil conditions, which favor rice production cause rapid turnover and loss of nitrogen from the soil (Khroteu Riste *et al.,* 2017). There is a need to quantify the requirement of nitrogen for the upland rice with particular condition to the cultivars, location and management conditions. The reliable information on the vital agro-techniques for successful upland rice cultivation under the agro-climatic condition of Nagaland is absolutely lacking. Hence, the present study was undertaken to identify the suitable cultivar and estimate the optimum nitrogen dose for maximum productivity of rice under upland conditions.

MATERIALS AND METHODS

The field experiment was conducted during the rainy (*kharif*) season 2014 at the experimental research farm of School of Agricultural Sciences and Rural Development (SASRD), Nagaland University campus, Medziphema ($25^0 45^/ 45^{//}$ N latitude and $95^0 53^/ 04^{//}$ E longitudes). Soil was well drained and sandy loam in texture, high in organic carbon (1.67%), medium in available nitrogen (268.72 kg/ha), available phosphorus (16.78 kg/ha) and available potassium (189.19 kg/ha). The experiment was laid out in Randomized Block Design (RBD) replicated thrice with 5 nitrogen levels, *viz*., 0, 20, 40, 60 and 80 kg/ha and 2 cultivars 'Apaghi' and 'Inglongkiri'. Nitrogen was applied in equal splits at seeding, active tillering and panicle initiation. A

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uniform dose of 30 kg P_2O_5/ha and 30 kg K_2O/ha was applied to all the plots as basal. The experimental area was ploughed twice with tractor drawn cultivator to obtain the desired tilth. The seed of rice was directly sown in lines on 2nd June 2014. The seed was treated with fungicide Carbendazim @ 1 g/kg seed. Thinning was done at 10 DAS to maintain the uniform plant stand in all the plots. Hand weeding was done twice at 20 and 40 DAS for control of weeds. The crop was harvested on different dates, 'Apaghi' on 126 DAS and 'Inglongkiri' on 131 DAS. Crop biometric observations viz., Plant height, plant population, leaf area index (LAI), crop growth rate (CGR), number of green leaves per plant, length and weight of panicle, number of grains per panicle, test weight, grain and straw yield, harvest index and phenological observations were recorded to study the response of the crop to the different treatments. The grain and straw samples were also analyzed for nitrogen uptake. The data recorded on various growth and yield parameters of rice crop were analysed following standard statistical procedure for analysis of variance.

RESULTS AND DISCUSSION

Growth attributes: Significant variations were recorded among the different treatments with respect to growth attributes of the crop (Table-1). Rice cultivar 'Inglongkiri' recorded significantly higher plant height, number of tillers per running meter, effective tillers per running meter and crop growth rate than 'Apaghi'. But Apaghi was found to record higher leaf area index. Production of the highest growth stature with 'Inglongkiri' might be due to difference in genetic makeup and its potential for profuse rooting and tillering ability under upland condition over 'Apaghi'. Plant growth parameters like plant height, number of tillers per running meter, leaf area index and crop growth rate significantly increased up to 80 kg N/ha. Response of rice cultivars to different levels of nitrogen was also reported by Sarkar *et al*. (1995 and Muthukrishnan *et al.* (1997). The highest stature of all the growth parameters, *viz*., plant height,number of tillers per running meter, leaf area index and crop growth rate was noticed with 80 kg N/ha, which may be due to higher application and availibility of N to the crop while, the lowest was noticed with the control plot (Kumar *et al*., 1996)

Yield attributes: The data on yield attributes viz., length of panicle, weight of panicle, number of grains per panicle, fertility percent and test weight are presented in Table-2. The cultivar 'Apaghi' recorded longest panicle length, highest number of grains per panicle, weight of panicle and test weight whereas, 'Inglongkiri' recorded the highest harvest index (41.18 %). This may be due to variation in their genetic components. (Rema Bai *et al*., 1992). Also, the cultivar 'Inglongkiri' was associated with slender seeds as compared to 'Apaghi' which had bold type of seeds which may have resulted in inferior yield attributes .This present findings are being supported by Satapathy and Nanda (1978) and Bindra *et al*. (2000). It was evident from the result of the data that the different doses of nitrogen performed differently on yield attributes. The application of 80 kg N/ ha recorded the longest panicle length, weight of panicle, number of grains per panicle and test weight which may be attributed to increased availibility of N to the crop due to application of higher doses of N which ultimately resulted in better crop growth and yield attributes.

Grain and straw yields: The results regarding grain yield, straw yield, and biological yield were significantly affected by different doses of nitrogen (Table-2). The cultivar 'Apaghi' was found to record significantly higher yield attributing characters than 'Inglongkiri' ultimately recording higher grain yield (3130.69 kg/ha) and straw yield (6199.90 kg/ha) over 'Inglongkiri' which recorded grain and straw yields of 2664.13 kg/ha and 3803.86 kg/ha respectively. The findings of present investigation were in close conformity with Pradhan *et al*. (2014). The grain yields varied from 2666.22 kg/ha in the control plot (N_1) to 2764.67 kg/ha in

Table 1: Growth attributes of local rice cultivars as influenced by different levels of nitrogen.

Treatment	Plant height at harvest (cm)	Plant population at 30 DAS (m^2)	No. of tillers per running meter at 60 DAS	No. of effective tillers per running meter	Leaf Area Index at 60 DAS	Crop Growth Rate at 45 DAS (g/m^2/day)	No. of green leaves per plant at 75 DAS
Nitrogen (kg/ha)							
N_1-0	146.17	118.67	5.28	7.08	1.51	3.63	6.13
N_2-20	153.67	122.83	5.63	7.77	1.77	4.17	6.32
N_3-40	158.67	127.67	6.12	8.60	1.83	4.35	6.58
N_4-60	160.82	130.33	6.28	9.75	2.16	4.63	7.03
N_5-80	165.00	136.33	6.72	9.92	2.48	4.90	7.33
SEm±	1.76	5.84	0.23	0.65	0.08	0.14	0.23
CD(P= 0.05)	5.23	NS	0.69	1.93	0.24	0.42	0.67
Cultivars							
V_1-Apaghi	152.80	122.20	5.58	7.99	2.03	4.11	6.45
V_2-Inglongkiri	160.93	132.13	6.43	9.26	1.87	4.56	6.91
SEm±	1.11	3.70	0.15	0.41	0.05	0.09	0.14
CD(P= 0.05)	3.31	NS	0.44	1.22	0.15	0.27	0.42

DAS-Days after sowing

Table 2: Yield and yield attributes of local rice cultivars as influenced by different levels of nitrogen

Treatment	Length of panicle (cm)	Weight of panicle (g)	No. of grains per panicle	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest Index(%)
Nitrogen(kg/ha)							
Control	28.00	4.89	141.67	30.17	2666.22	4710.77	36.94
N_1-20	28.30	5.21	143.63	30.67	2764.67	4825.44	37.05
N_2-40	28.50	5.76	157.18	31.83	2867.39	4901.59	37.66
N_3-60	28.92	6.10	167.63	33.17	2991.78	5249.22	37.16
N_4-80	29.25	6.30	175.60	34.00	3197.00	5322.38	38.02
SEm±	0.24	0.28	3.97	0.90	39.72	97.30	0.38
CD(P= 0.05)	0.72	0.82	11.78	2.67	118.01	289.09	NS
Cultivar							
V_1-Apaghi	29.70	7.59	189.65	35.53	3130.69	6199.90	33.55
V_2-Inglongkiri	27.49	3.72	124.64	28.40	2664.13	3803.86	41.18
SEm±	0.15	0.17	2.51	0.57	25.12	61.54	0.24
CD (P= 0.05)	0.46	0.52	7.45	1.69	74.63	182.84	0.71

N_2 (20 kg N/ha) to 2867.39 kg/ha in N_3 (40kg N/ha) to 2991.78 kg/ha in N_4 (60kg N/ha) to 3197 kg/ha in N_5 (80kg N/ha) with N_5 recording the highest grain yield among the different N levels. Significantly higher straw yields of 5322.38 kg/ha were also recorded under the treatment N_5. This is in consonance with Hari Om Katyal and Dhiman (2000) and Singh (1973). The interactions between nitrogen doses and cultivars were found non-significant on yield and yield attributing characters.

Phenological parameters: The influence on nitrogen doses and cultivars were found significant in the days to 50% flowering and maturity. Cultivar 'Apaghi' recorded early flowering (101 days) and maturity (122 days) as compared to 'Inglongkiri', which recorded days to flowering and maturity at 112 and 126 days respectively. Similar observations made by Nair (1984), who reported that the variation in cultivars is due to the genetic components.

Nitrogen uptake: The highest uptake of nitrogen by grain and straw was recorded with 'Apaghi', which was significantly higher than that recorded under 'Inglongkiri' indicating differential response of the cultivars to nutrient application which may be due to significant differences in root volume as recorded between the two cultivars. Increasing levels of nitrogen progressively enhanced the uptake of nitrogen up to 80 kg N/ha. The highest uptake of nitrogen by grain and straw was recorded with 80 kg N/ha, which was significantly higher than the rest of the nitrogen levels. Higher uptake of Nitroen under treatment N_5 may be due to higher availibility of Nitrogen under the treatment also superior growth attributes like higher LAI and root volumes associated with the treatment may have resulted in higher uptake of Nitrogen under the treatment. These results are supported by the findings of Srinivasan and Angayarkanni (2008).

Table 3: Grain and straw nitrogen uptake as influenced by different levels of nitrogen

Treatment	Nitrogen uptake (kg/ha)	
	Grain	Straw
Nitrogen (kg/ha)		
Control	37.41	35.62
N_1-20	39.87	37.66
N_2-40	44.01	40.49
N_3-60	46.47	42.66
N_4-80	53.00	45.55
SEm±	0.76	1.19
CD(P= 0.05)	2.25	3.54
Cultivar		
Apaghi	50.74	51.09
Inglongkiri	37.56	29.70
SEm±	0.48	0.75
CD (P= 0.05)	1.42	2.24

CONCLUSION

From the findings of the present experiment it may be concluded that the cultivar "Apaghi" was the superior upland rice cultivar exhibiting superior yield attributes and ultimately recording significantly higher grain and straw yields of 3139.69 kg/ha and 4318.33 kg/ha respectively over the cultivar Inglongkiri. Whereas, among the nitrogen levels tested, application of 80 kg N/ha was found to be the optimum level resulting in higher Nitrogen uptake and significantly enhanced growth and yield attributes of the upland rice cultivars ultimately resulting in higher grain yield of 3197.00 kg/ha.

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