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Response of rice (*Oryza sativa*) varieties to different levels of nitrogen under rainfed upland condition of Mizoram

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ABSTRACT : A field experiment was conducted during 2012 and 2013 at Kolasib District of Mizoram on the response of rice (*Oryza sativa* L) varieties to different levels of nitrogen. Plant height and dry matter production were the highest with 'Bhalum 3' at 90 kg N/ha. Panicles/m^2, filled grains/panicle, grain (4.50 tons/ha) and straw yield and nitogen uptake by grain and straw were also significantly higher with 'Bhalum 3'. Increasing levels of nitrogen enhanced panicles/m^2, filled grains/panicle, grain and straw yield and nitrogen uptake by grain and straw only up to 90 kg N/ha. Varieties and nitrogen levels interacted significantly and the highest grain yield and economics were recorded with 'Bhalum 3' at 90 kg N/ha and it was found to be optimum combination for upland rice.

Key **W**ords : Rainfed, Nutrient, Upland, Panicle, Yield

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Rice demand was projected to increase by 25 per cent from 2001 to 2025 to keep pace with population growth (FAO). Upland rice area is being shrinking due to lack of appropriate technologies on nitrogen levels and suitable varieties for rainfed condition. It is necessary to increase yield per unit area with less water to fulfill the increasing rice demand with shrinking resources. Water is a looming crisis due to competition among agricultural, industrial and domestic users. In Asia, more than 50 per cent of irrigation water is used to irrigate rice. 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 emission produced by flooded rice (Tuong *et al.*, 2005).

Nitrogen is the key nutrient that limits the rice production. In lowland rice ecosystems, the nitrogen–use efficiency is approximately 30 per cent, whereas in upland rice, whether irrigated or rainfed, nitrogen–use efficiency would be in the range of 40 to 60 per cent (Dubey *et al.*, 1983).

However, there is a need to quantify the requirement of nitrogen for the aerobic rice with particular condition to the cultivars, location and management conditions. The reliable information on the vital agro-techniques for successful aerobic rice in this region is absolutely lacking. The present study was undertaken to identify the suitable cultivars and estimate the optimum nitrogen dose for maximum productivity of rice under rainfed upland condition.

RESEARCH PROCEDURE

The field experiment was conducted during the rainy (*Kharif*) season 2012 and 2013 at upland of instructional farm, Krishi Vigyan Kendra, Kolasib ($24^0$31' 14.43''N latitudes and $92^0$31'46.92''E longitudes at 790 m above mean sea level) in the hills of Mizoram. Soil was heavy in texture, low in organic carbon (0.40%), available nitrogen, phosphorus and potassium. The experiment was laid out in split plot design with 4 varieties 'Bhalum 3', 'Aizawng', 'RCM-9' and 'RCM-10' in main plots and 4 nitrogen levels, *viz.*, 40, 60, 80 and 100 kg/ha, as sub plots. Nitrogen was applied in 4 equal splits at seeding, active tillering, panicle initiation, and grain filling. A uniform dose of 60 kg P_2O_5/ha and 50 kg K_2O/ha was applied to all the plots as basal. The

experiment area was ploughed twice with power tiller to obtain the desired tilth. The seed of rice was directly sown in rows on 6th June 2012 and 7th June 2013. The seed was treated with fungicide Carbendazim @ 1g/kg seed and then dibbled as 3-4 seeds with a spacing 20 cm. Thinning and gap filling were done at 15 DAS to maintain the uniform plant stand in all the plots. Hand weeding was done twice at 25 and 45 DAS for control of weeds. The crop was harvested on 29thOctober during both the year 2012 and 2013. The data recorded on various growth and yield parameters of rice crop were analyzed following standard statistical analysis of variance procedure.

RESEARCH ANALYSIS AND REASONING

The findings of the present study as well as relevant discussions have been summarized under the following heads:

Growth parameters :

Rice varieties 'Bhalum 3' and 'RCM-9' had significantly higher plant height and leaf-area index (LAI) than 'RCM-10' and 'Aizawng' (Table 1). The lowest LAI was associated with 'Aizawng'. Significantly higher dry matter was noticed with 'Bhalum 3' followed by 'RCM-9'. The lowest dry matter was produced by 'Aizawng'. Plant growth parameters like plant height, LAI and dry matter increased up to 90 kg N/ha only and at 100 kg N/ha there was significantly decreased in these parameters.

Production of the highest growth stature with 'Bhalum 3' might be due to its potential for profuse rooting and tillering ability under upland condition in the domain of investigation

Table 1 : Growth and yield attributes of rice varieties as influenced by different levels of nitrogen (pooled data of 2 years)

Treatments	Plant height at harvest (cm)	Leaf-area index at 60 DAS	Dry matter production at harvest (t/ha)	Panicles/m^2	Filled grains/panicle
Variety					
'Bhalum 3'	90.4	4.2	12.6	178.5	135.6
'Aizawng'	76.1	3.3	9.5	164.2	113.2
'RCM-9'	87.4	4.0	11.4	170.3	123.4
'RCM-10'	80.3	3.6	10.7	167.2	119.3
S.E. ±	1.1	0.1	0.2	1.4	2.0
C.D. (P=0.05)	3.6	0.4	0.8	5.1	7.1
Nitrogen (kg/ha)					
40	80.1	3.2	10.1	160.1	107.1
60	83.3	3.8	11.1	170.3	123.4
80	86.5	4.2	12.0	176.4	133.6
100	85.1	3.9	11.3	171.3	127.5
S.E. ±	0.9	0.1	0.1	1.4	1.7
C.D. (P=0.05)	2.8	0.2	0.5	4.0	5.0

Table 2 : Yield, nitrogen uptake and economics of rice varieties as influenced by different levels of nitrogen (pooled data of 2 years)

Treatments	Grain yield (t/ha)	Nitrogen uptake by grain (kg/ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	Benefit: cost ratio
Variety					
'Bhalum 3'	3.50	22.5	39060	16620	1.76
'Aizawng'	2.56	15.8	28760	6320	1.30
'RCM-9'	2.96	18.5	33250	10800	1.48
'RCM-10'	2.78	17.3	31210	8870	1.39
S.E. ±	0.10	0.7	0.86	0.82	0.06
C.D. (P=0.05)	0.37	2.4	2.96	2.86	0.21
Nitrogen (kg/ha)					
40	2.33	14.8	26210	4070	1.18
60	3.00	18.8	33660	11310	1.50
80	3.40	21.1	38040	15390	1.68
100	3.08	19.4	34570	11720	1.51
S.E. ±	0.09	0.5	0.92	0.92	0.07
C.D. (P=0.05)	0.27	1.5	2.65	2.65	0.19

over 'Aizawng', which might be due to reverse response, since the varieties susceptible to withstand moisture stress, would lead to poor growth especially under upland condition. The highest stature of all the growth parameters, *viz.*, plant height, LAI and dry matter production, was noticed with 80 kg N/ha, while the lowest was noticed with the 40 kg N/ha (Kumar *et al.*, 1996). The increased rate of nitrogen application at the highest level failed to produce higher dry matter.

Yield attributes and yield :

'Bhalum 3' produced significantly higher number of panicles/m^2 and filled grains/panicle than all the other varieties (Table 1). However, number of panicle with 'RCM-9' was at par with 'RCM-10' and 'Aizawng'. 'Aizawng' produced the lowest number of panicles/m^2 and filled grains/panicle.

Increasing level of nitrogen up to 80 kg N/ha significantly enhanced the number of panicles/m^2 and filled grains/panicle, over the nitrogen levels. The lowest was recorded with 40 kg N/ha. Effective translocation of assimilates to the sink might have resulted in sound filling of grains as revealed by the highest number of filled grains/panicle. The poorest condition of all the yield attributes resulted with 40 kg N/ha. Better performance under 80 kg N/ha in respect of yield attributes of rice under upland condition confirms the findings of Maheswari *et al.* (2007) and Dubey *et al.* (1983).

The significantly higher grain yield was produced by the variety 'Bhalum 3' than that of all the other varieties (Table 2). The grain yield of 'RCM-9' and 'RCM-10' were at par and the lowest grain yield was produced with 'Aizawng'. Increasing levels of nitrogen progressively enhanced the grain yield up to 80 kg N/ha and thereafter the yield declined. Significantly higher grain yield was recorded with 80 kg N/ha over other doses.

Nitrogen uptake :

The highest uptake of nitrogen by grain was recorded with 'Bhalum 3' which was significantly higher than all other varieties (Table 2). Among the varieties the highest uptake of nitrogen was recorded in 'Bhalum 3' followed by 'RCM-9'. The lowest uptake of nitrogen by grain was noticed on 'Aizawng'. Increasing levels of nitrogen progressively enhanced the uptake of nitrogen up to 80 kg N/ha and thereafter the uptake of nitrogen declined. The highest uptake of nitrogen by grain was recorded with 80 kg N/ha, which was significantly higher than rest of the nitrogen levels. The uptake of nitrogen was lower with 40 kg N/ha due to its poor LAI and dry-matter production leading to lesser uptake.

Economics :

Gross, net returns and benefit: cost ratio of rice under upland condition differed significantly with varieties and levels of nitrogen (Table 2). The significantly higher gross and net returns and benefit: cost ratio was realized with the variety 'Bhalum 3', higher than all other varieties. However, gross and net returns and benefit: cost ratio of 'RCM-9', were at par with 'RCM-10'. Remunerative economic returns play a key role for adoption of any refined version of agro-techniques. In the present study gross and net returns as well as benefit: cost ratio was found highest with 'Bhalum 3' and at nitrogen level of 80 kg/ha.

Hence for rice grown under upland condition, variety 'Bhalum 3' with application of 80 kg N/ha was found optimum as it has resulted in the growth of upland rice and higher productivity besides enhancing profitability.

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