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Response of Cyanobacteria at Different Levels of Mineral Nitrogen and Moisture on Performance of Paddy

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A field study was performed to evaluate the response of cyanobacterial inoculation with three doses of mineral nitrogen (30,60 and 90kg N/ ha) and two moisture levels (continuous submergence and alternate drying and wetting) on yield, yield-attributing character of *Kharif* rice and post harvest organic carbon status of soil. It appears from the statistical analysis that the algal inoculation significantly increased the number of tillers and biomass accumulation of paddy. It was further investigated that BGA shown its better response at lower level of nitrogen (30k N ha). The impact of continuous submergence has clearly shown its positive effect on soil organic status but it did not make any significant difference on yield and yield attributing characters over wetting and drying.

Keywords: Blue green algae, N levels and moisture levels.

The paddy crop is able to utilize only up to 35 per cent of the added chemical nitrogen. In such a situation it is essential to develop a system which not only supplements the nitrogen supply but also enable the crop to utilize more of the applied nitrogen. Nitrogen fixing blue green algae from the most potential biological system under rice field conditions which promises both. It is a established fact that BGA can contribute up to 30kg nitrogen per hectare per season under favorable conditions but the establishment of BGA is greatly influenced by certain environmental factor such as intensity of light, concentration of inorganic nitrogen source, moisture status of soil and temperature. Goyal (1985) reported that the blue green algal growth is greatly influenced by the type, quantity and mode of application of the nitrogenous fertilizers and pesticides in the field. The purpose of the study is to find out the optimum levels of different growth affecting factors of BGA which can give us better rice productivity.

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MATERIAL AND METHODS

The field experiment was conducted during *kharif* 2003 as instructional farm of India Gandhi Agricultural University, Raipur. The soil was Vertisol, medium in organic carbon (0.34%), low in available nitrogen (180.50 kg/ha) phosphorus (6.18 kg/ha) and rich in potassium (392.10 kg/ha) with pH 8.02. The experiment was conducted in split-split design with twelve treatments replicated thrice with a plot size of 6 m × 4.2 m. The treatments included with two levels of irrigation (continuous submergence & alternate drying and wetting) in the main plot and three levels of fertilizer N application (30,60 and 90 kg N ha^{-1}) in sub plots, each having two sub sub plots with and without cyanobacterial inoculation. The paddy variety Mahamaya with a spacing of 20 x 10 cm was maintained. Cyanobacterial inoculation was done a week after transplantation by adding soil based inoculum (mixed culture) @ 10 kg ha^{-1}. The crop was harvested at maturity. Grain yield, straw yield, N-uptake by plant and soil organic carbon content

were recorded after harvest of crop. Nitrogen content in the plant samples was determined by microkjheldal method as described by Jackson (1973) using Gerherdt auto distillation system (Vapodest-30).

RESULTS AND DISCUSSION

The response of BGA inoculation, fertilizer nitrogen application and higher moisture level on BGA performance were evaluated in respect of No. of tillers per square meter, grain and straw yield, soil organic carbon status and total N-uptake by crop. It appears from the statistical analysis that the fertilizers nitrogen application and algal inoculation influenced the performance of rice. It has come from the study that under adequate soil moisture level the order of response was fertilizer N>algal inoculation > moisture status.

Individual effect of fertilizer, algae and moisture levels

Highest response of fertilizer N levels was observed (Table 1). The nitrogen of N level on yield attributing parameters shown significant increase at higher N levels over lower levels. However, nitrogen application @90 kg ha^{-1} significantly increased the grain yield over 30kg N level only. The data also indicated that the effect of N levels on grains yield and its components was greater than moisture and algal levels (Table 2 & 3). Significant increase in grain and straw yield at higher N levels (90kg N/ha) may be due to greater availability of N at higher doses of N application compared with lower N doses. The total N uptake by the crop was increased significantly with increasing levels of N. However, the straw yield and No. of tillers were significantly influenced by BGA inoculation (Table 2).

The data presented in Table 3 indicated

Table 1. Effect of different fertilizer nitrogen and moisture levels on yield, yield attributing characters of paddy and organic carbon status of soil.

Moisture levels (C)	Fertilizer N-levels (kg/ha) (A)		
	30	60	90
	Grain yield (q ha^{-1})		
Cont. submergence	34.52AiCi	37.29 AiiCi	39.83 AiiiCi
Alt. Drying & wetting	34.20 AiCii	36.85 AiiCii	39.57 AiiiCii
Mean(A)	34.36	37.07	39.70
	CD (A) 0.05 = 3.54		
	Straw yield (q ha^{-1})		
Cont. submergence	39.08AiCi	42.98 AiiCi	44.53 AiiiCi
Alt. Drying & wetting	37.22 AiCii	42.71 AiiCii	44.31 AiiiCii
Mean(A)	38.15	42.84	44.42
	CD(A)0.05 = 1.64		
	No. of tillers (meter^{-2})		
Cont. submergence	315.00AiCi	376.83 AiiCi	392.67 AiiiCi
Alt. Drying & wetting	304.50AiCii	357.50 AiiCii	384.67 AiiiCii
Mean(A)	309.75 367.17	388.67	
	CD (A) 0.05 = 11.64		
	Soil organic carbon (percentage)		
Cont. submergence	0.38AiCi	0.39 AiiCi	0.40 AiiiCi
Alt. Drying & wetting	0.36 AiCii	0.38 AiiCii	0.39 AiiiCii
Mean(A)	0.37	0.38	0.39
	CD (A) = 0.05=0.016		
	Total N-uptake (kg ha^{-1})		
Cont. submergence	50.47AiCi	59.95 AiiCi	69.60 AiiiCi
Alt. Drying & wetting	47.67 AiCii	58.12 AiiCii	67.53 AiiiCii
Mean(A)	49.07	59.04	68.56
	CD (A) 0.05 = 6.22		

that there was no significant effect of continuous submergence on crop yield and N-uptake by crop. However, the soil organic carbon level and yield attributing character like No. of tillers per square meter were significantly influenced by continuous submergence over alternate wetting and drying. The statistical non-significance of yield and N-uptake data may be due to the reception of good and effective rainfall throughout the growth period of crop, which makes the condition of alternate wetting and drying at par with continuous submergence.

Table 2. Effect of different fertilizer nitrogen and BGA levels on yield, yield attributing characters of paddy and organic carbon status of soil.

Fertilizer N levels (kg/ha) (A)	BGA levels (B)	
	Control	BGA applied
	Grain yield (q ha^{-1})	
30	33.22 AiBi	35.50 AiBii
60	36.74 AiiBi	37.40 AiiBii
90	39.51 AiiiBi	38.89 AiiiBii
Mean (B)	36.49	37.60
	CD (B) 0.05 = 1.58	
	CD (ABi-ABii)0.05 = 2.12	
	CD (AiB - AiiiB) 0.05 = 4.03	
	Straw yield (q ha^{-1})	
30	35.73 AiBi	40.57 AiBii
60	42.09 AiiBi	43.60 AiiBii
90	44.19 AiiiBi	44.64 AiiiBii
Mean (B)	40.67	42.94
	CD (B) 0.05 = 1.39	
	CD (ABi-ABii) 0.05 = 2.41	
	CD (AiB - AiiiB) 0.05 = 2.37	
	Number of tiller (meter^{-2})	
30	288.00 AiBi	331.50 AiBii
60	352.83 AiiBi	381.50 AiiBii
90	378.33 AiiiBi	399.00 AiiiBii
Mean (B)	339.72	370.67
CD (B) 0.05 = 7.21		
	CD (ABi-ABii 0.05 = 12.49	
	CD (AiB - AiiiB) 0.05 = 14.59	
	Soil organic carbon (percentage)	
30	0.35 AiBi	0.39 AiBii
60	0.36 AiiBi	0.41 AiiBii
90	0.36 AiiiBi	0.43 AiiiBiii
Mean (B)	0.36	0.41
	CD (B) 0.05 = 0.02	
	CD (ABi-ABii)0.05 = 0.03	
	CD (AiB - AiiiB) 0.05 = 0.03	
	Total N-uptake (kg ha^{-1})	
30	45.60 AiBi	52.54 AiBii
60	56.74 AiiBi	61.34 AiiBii
90	66.76 AiiiBi	70.37 AiiiBii
Mean (B)	56.37	61.41
	CD (B) 0.05 = 3.41	
	CD (ABi-ABii)0.05 = 5.91	
	CD (AiB - AiiiB) 0.05 = 7.48	

Table 3. Effect of different BGA & Moisture levels on yield, yield attributing characters of paddy and organic carbon status of soil.

BGA levels (B)	Moisture levels (C)	
	Control submergence	Alt. Drying & Wetting
	Grain yield (q ha^{-1})	
Control	36.62 BiCi	36.35 BiCii
BGA applied	37.80 BiiCi	37.39 BiiCii
Mean (C)	37.21	36.87
	CD (C) 0.05 = 1.70	
	CD (BCi-BCii)0.05 = 2.30	
	CD (BiC - BiiiC) 0.05 = 2.31	
	Straw yield (q ha^{-1})	
Control	41.03 BiCi	40.31 BiCii
BGA applied	43.36 BiiCi	42.52 BiiCii
Mean (C)	42.20	41.41
	CD (C) 0.05 = 1.66	
	CD (BCi-BCii)0.05 = 2.36	
	CD (BiC - BiiiC) 0.05 = 2.17	
	Number of tiller (meter^{-2})	
Control	345.11 BiCi	334.33 BiCii
BGA applied	377.89 BiiCi	363.44 BiiCii
Mean (C)	361.50	348.89
	CD (C) 0.05 = 6.74	
	CD (BCi-BCii)0.05 = 9.53	
	CD (BiC - BiiiC) 0.05 = 9.86	
	Soil organic carbon (percentage)	
Control	0.36 BiCi	0.35 BiCii
BGA applied	0.41 BiiCi	0.40 BiiCii
Mean (C)	0.39	0.37
	CD (C) 0.05 = 0.007	
	CD (BCi - BCii)0.05 = 0.009	
	CD (BiC - BiiiC) 0.05 = 0.018	
	Total N-uptake (kg ha^{-1})	
Control	57.35 BiCi	55.39 BiCi
BGA applied	62.67 BiiCi	60.16 BiiCii
Mean (C)	60.01	57.77
	CD (C) 0.05 = 2.80	
	CD (BCi-BCii)0.05 = 3.96	
	CD (BiC - BiiiC) 0.05 = 4.41	

Combined effects

The combined effect of fertilizer nitrogen and algae on paddy yield and its attributes were found statistically significant at lower N level i.e. 30 kg N/ha[1] (Table 2). This shows that the Blue Green Algae can perform well at lower N levels. This observation was in close agreement with Adhikary and Sahu (2000) who clearly mentioned that higher level of nitrogenous fertilizer application showed a depressive effect on nitrogenous activity of cyanobacteria. However, at same algal level the fertilizer N effect was found numerically significant for the above parameters with N_{90} over N_{30} level only. This was due to the more release of nitrogen from the fertilizer and not due to the algalization.

Although there was no significant effect of moisture levels on crop yield and N-uptake except soil organic carbon yield attributing character like No. of tillers. However, the algal inoculation made of significant difference in straw yield, No. of tillers, soil organic carbon and total

N-uptake by the crop at both moisture levels. This may be due to the presence of high moisture level in all the treatments by regular precipitation throughout the cropping period so there was no significant difference existed between the continuous submergence and alternate wetting and drying treatments. Rogar & Watanabe (1982) reported that algalization when effective increase the size of rice plant, its nitrogen content, the number of tillers, panicles, spikelets and filled spikelets per panicle. They also mentioned that algalization produces both a cumulative and residual effect attributed to a buildup of the soil nitrogen, organic matter and the algal flora.

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