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Role of Cyanobacteria on Yield of Rice in Saline Soil

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Abstract: An experiment was carried out in the saline soil of Satkhira during the aman season of 2000 in order to test the effectiveness of the cyanobacterial inoculum on yield of rice. The modern rice variety BRRIdhan 31 was used as the test crop. There were six treatments for the experiment viz. T_1 (control), T_2 (Recommended Fertilizer Dose), T_3 (RFD-20%N), T_4 (RFD-20%N+Cyanobacteria), T_5 (RFD-40%N) and T_6 (RFD-40%N+Cyanobacteria). Eight cyanobacterial strains were isolated, identified and brought under pure unicyanobacterial cultures from the selected location. Cyanobacterial inoculum was applied @ 20 kg ha^{-1} in two equal splits-7 and 30 days after transplanting. Results of field trials indicated that cyanobacterial inoculum could supplement up to 20% nitrogen for rice cultivation in saline soils. Inoculation of the cyanobacterial inoculum in the saline soil resulted 80.48% increase in yield over control.

Key words: Cyanobacteria, rice yield, saline soil

INTRODUCTION

Soil salinity appears to be a major problem in Bangladesh agriculture. Agricultural land use in saline areas is very poor, which is much lower than the country's average cropping intensity[1]. Rice production in the country has been seriously hampered by the high soil salinity and this problem is becoming more serious every year[2]. Improving the fertility of the saline soil is an utmost necessary from the agriculture point of view. The saline soil of Bangladesh have been managing by the farmers themselves using the impact of monsoon rains during the salinity and allowing easy cultivation of transplanted aman rice. Soils which contain sufficient neutral soluble salts in the root zone to adversely affect crop growth and production are termed saline soils[3]. Soluble salts are predominantly the chlorides and sulphates of sodium, calcium and magnesium. Sodium chloride is the dominant salt. The saturated paste pH of saline soil is less than 8.5 and the electrical conductivity of the saturation extract is generally more than 4 dS m^{-1} at 25°C. Saline soils are not suitable for crop production although they have high agriculture potential[3]. The present study has been planned to identify the Cyanobacterial strains occurring in saline soils and to determine the role of cyanobacteria on yield of rice in saline soil.

MATERIALS AND METHODS

The experiment was conducted at Shymnagar, Satkhira during the T. Aman season of 2000. The experimental plot belongs to non-calcareous Grey Floodplain. The soil was loam with pH 7.9, organic matter 1.93%, total nitrogen 0.18%, available P 18.3 ppm, available S 14.5 ppm exchangeable K 0.5 me100^{-1}g, Na 4.5 me100^{-1}g, Ca 7.2 me100^{-1}g, Mg 3.7 me100^{-1}g, Electrical Conductivity 6.4 dS m^{-1} and Cation Exchange Capacity 19 me100^{-1}g. Soil texture, pH, Organic matter, total nitrogen, available P, S, exchangeable K, Na, Ca, Mg, EC and CEC were determined following standard methods[4-9]. The experiment consisted of six treatments comprising T_1=Control, T_2=Recommended Fertilizer Dose (RFD), T_3=RFD-20%N, T_4=RFD-20%N+Cyanobacteria, T_5=RFD-40% N and T_6=RFD-40% N+Cyanobacteria. The experiment was laid out in randomized complete block design (RCBD) with four replications having unit plot size of 5x4 m^2. The fertilizer rates used were 65 kg N ha^{-1} from urea, 8 Kg P ha^{-1} from triple superphosphate, 30 Kg K ha^{-1} from muriate of potash and 5 kg S ha^{-1} from gypsum. Urea was applied in three equal splits-first during final land preparation and the remaining in two equal splits at maximum tilllering and panicle initiation stages of crop growth. Cyanobacterial inoculum was applied @ 20 kg ha^{-1} in two split-7 and 30 days after transplanting. The rice variety used was BRRIdhan 31 as test crop. Thirty five days old seedling were transplanted on 4 Aug. 2000, maintaining a spacing 20x15 cm^2, three seedling being transplanted $hill^{-1}$. Necessary intercultural operations were done as and when required during growth period of crop. The crop was harvested plot wise on 17 Dec. 2000. The yield components and yield were recorded. All the parameters under study were statistically analyzed by F-test to examine the treatment effects and

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the mean difference were adjudged by Dancan's multiple range test (DMRT)[10].

RESULTS AND DISCUSSION

Plant height: The plant height of rice plant was significantly affected due to application of different treatments (Table 1). Plant height observed due to different treatments ranged from 111.51 to 121.25 cm. The tallest plants (121.25 cm) were observed in treatment T_4 (RFD-20%N+Cyanobacteria) which was statistically identical to those recorded in treatment T_2 (RFD), T_3 (RFD-20%N) and T_6 (RFD-40%N+Cyanobacteria). The second tallest plants of 116.31cm were recorded in the treatment T_2 (RFD) which was followed by those observed in treatments T_3(RFD-20% N), T_5 (RFD-40% N) and T_6 (RFD-40%N+Cyanobacteria). The plant height observed by the treatments T_2, T_3 and T_6 were 116.31, 114.18 and 115.12 cm, respectively. The shortest plant height was observed 111.51 cm in the control treatment. The highest plant height was found in the treatment T_4 (RFD-20%N+Cyanobacteria) due to presence of cyanobacteria. So it is clear that there is better effect of cyanobacteria on plant height.

Number of tillers hill^{-1}: The number of tillers hill^{-1} was not significantly affected by the treatments (Table 1). The maximum number of tillers hill^{-1} was observed 10.12 in treatment T_4 (RFD-20%N+Cyanobacteria) and the minimum of 8.12 was in control (T_1). The number of tillers hill^{-1} varied from 8.12 to 10.12. The number of tillers hill^{-1} recorded in the treatments T_2 (RFD), T_3 (RFD-20%N), T_5 (RFD-40%N) and T_6 (RFD-40%N+Cyanobacteria) were 9.60, 9.06, 8.55 and 9.12, respectively.

Although the effect of treatments was not significant but the treatments having cyanobacteria (T_4 and T_6) had higher number of tillers which indicate that cyanobacteria have effects on number of tillers hill^{-1}.

Panicle length: The application of different treatment significantly increased the panicle length of rice (Table 1). Panicle length ranged from 22.05 to 22.25 cm. Results show that the treatment having T_4 (RFD-20%N+Cyanobacteria) gave maximum panicle length but this number was statistically identical to those observed in treatments T_2(RFD), T_3(RFD-20%N), T_5 (RFD-40%N) and T_6(RFD-40%N+Cyanobacteria). The minimum panicle length (22.05 cm) was observed in control (T_1).

Grains panicle^{-1}: Results show that the number of grains panicle^{-1} was significantly influenced due to different treatments. The number of grains panicle^{-1} ranged from 114.12 to 126.24. All the treatments significantly increased the grains panicle^{-1} over control. Among the treatments, T_4 (RFD-20%N+Cyanobacteria) produced the highest number of grains panicle^{-1} (126.24) which were statistically identical with T_2 (RFD), T_3 (RFD-20%N), T_5 (RFD-40%N) and T_6 (RFD-40%N+Cyanobacteria). The lowest number of grains panicle^{-1} (114.12) was obtained in control treatment (T_1). It was noted that cyanobacteria gave better result in producing grains panicle^{-1}.

1000 grain weight: Results show that the weight of 1000 grain of the crop was not significantly affected by the treatments applied. The 1000 grain weight of rice ranged from 25.10 to 25.60 g due to different treatments. The maximum grain weight of 25.6 g was observed in treatment T_4 (RFD-20%N+Cyanobacteria). The lowest grain weight of 25.10 g was noted in control. The second maximum grain weight was observed 25.40 g in the treatment T_2 (RFD). The grain weight of the treatments T_3(RFD-20%N), T_6 (RFD-40%N +Cyanobacteria) and T_5(RFD-40%N) were observed 25.30, 25.25 and 25.20 g, respectively (Table 1).

Grain yield: Results show that the grain yield of BRRIdhan 31 was significantly influenced by different

Table 1: Effect of Cyanobacterial inoculum on yield components of BRRIdhan 31 at selected location

Treatments	Plant height (cm)	No. of tillers hill^{-1}	Panicle length (cm)	Grains Panicle^{-1}	1000 grain weight (g)
T_1: Control	111.51c	8.12	22.05c	114.12b	25.10
T_2: RFD	116.31ab	9.60	25.12a	122.34ab	25.40
T_3: RFD-20%N	114.18ab	9.06	25.02a	120.29ab	25.30
T_4: RFD-20%N Cyanobacteria	121.25a	10.12	25.25a	126.24a	25.60
T_5: RFD-40%N	113.19bc	8.55	24.75ab	119.50ab	25.20
T_6: RFD-40%N Cyanobacteria	115.12ab	9.12	24.85ab	121.57ab	25.25
SE±	3.89	NS	1.60	3.39	NS

Table 2: Effect of Cyanobacterial inoculum on grain and straw yields of BRRIdhan31 at selected location

Treatments	Grain Yield (t ha^{-1})	%increase in yield over control	Straw Yield (t ha^{-1})	%increase in yield over control
T_1: Control	2.51e	-	3.49e	-
T_2: RFD	4.07b	62.15	5.95b	70.49
T_3: RFD-20%N	3.62c	44.40	5.05c	44.70
T_4: RFD-20%N Cyanobacteria	4.53a	80.48	6.38a	95.70
T_5: RFD-40%N	3.12d	24.30	4.57d	30.95
T_6: RFD-40%N Cyanobacteria	4.01b	59.76	5.65b	61.89
SE±	0.13		0.17	

In a column, the figures having common letter(s) do not differ significantly at 5% level of significance

treatments. The grain yields observed due to different treatments ranged from 2.51 to 4.53 t ha^{-1}. All the treatments gave significantly higher yield over control. The highest grain yield of 4.53 t ha^{-1} was produced in treatment T_4 (RFD-20%N+Cyanobacteria) and the lowest grain yield of 2.51 t ha^{-1} was observed in control (Table 2).

The treatments under study resulted in 24.30 to 80.48% yield increase over control. The maximum % yield increase (80.48%) was observed in the treatment T_4 (RFD-20%N+Cyanobacteria).

The treatment T_4 contains cyanobacteria which indicate that the maximum yield might be due to application of cyanobacteria and cyanobacteria can supplement more than 20%N.

So, it is that application of cyanobacterial biofertilizer has effect on the yield of rice in saline soil (Table 2).

Bhuiya *et al.*[11] conducted an experiment at BAU farm soil and found that cyanobacteria can increase 44.67% yield of rice but the experiment was conducted not in saline soil.

Watanabe[12] observed that cyanobacteria increased the grain yield of rice, 2% in the first year, 8% in the second year, 15% in the third year and 19.5% in the fifth year.

Beresteskii *et al.*[13] stated that in a pot experiment inoculation *Nostoc linckia* and *Anabaena muscicola* increased the grain yield of rice by 18%.

Straw yield: Results show that the straw yield of BRRIdhan 31 was significantly influenced due to application of different treatments. Like grain yield, all the treatments gave significantly higher straw yield, over control. The straw yield ranged from 3.49 to 6.38 t ha^{-1}. The highest straw yield of 6.38 t ha^{-1} (95.70% increase over control) was obtained in treatment T_4 (RFD-20%N+Cyanobacteria). The lowest grain yield of 3.49 t ha^{-1} was found in control (T_1). The highest straw yield of 6.38 t ha^{-1} was recorded in treatment T_4 (RFD-20%N+Cyanobacteria). This treatment had cyanobacterial inoculum which may have effect on straw yield. It seems from this result that cyanobacteria can give significantly higher yield.

Mian[14] reported that the rice straw (IR8) dry matter was found to increase by 103,131 and 134%, respectively due to the application of previously ^{15}N labeled *Azolla caroliniana, Anabaena variabilis* and *Nostoc muscorum* in some water logged soils of Bangladesh.

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