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GROWTH OF CYANOBACTERIA IN SALINE SOIL AMENDED WITH NP FERTILIZERS

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Abstract

Assessment of cyanobacterial population in saline soil amended with three rates of each of N (0, 50, 100 kg ha^{-1}) and P (0, 25, 50 kg ha^{-1}) fertilizers in a factorial combination showed a significant variation during growth of rice. Quantitatively the population of cyanobacteria ranged from 26.90 to 70.83 × 10^4 g^{-1}, 32.07 to 82.03 × 10^4 g^{-1} and 31.03 to 74.47 × 10^4 g^{-1} soil at 30, 60 and 90 days of transplantation of rice seedlings respectively. The highest and lowest values were encountered in $N_{50}P_{50}$ and $N_{100}P_0$ treatments respectively irrespective of the sampling intervals. Addition of P accentuated the proliferation of cyanobacteria while that of N inhibited their abundance significantly with increasing level of the applied fertilizers. Joint contribution of P and N stimulated significantly better growth of cyanobacteria.

Key words: Cyanobacteria, Nitrogen, Phosphorus, Saline soil

Introduction

The significant contribution of cyanobacteria (blue-green algae) in the flooded rice soils to atmospheric nitrogen fixation has now been well recognized (Roger and Kulasooriya 1980, Kaushik 2002, Rinaudo *et al*. 1971 and Araragi *et al*. 1978). Among the nitrogen fixing agents in the rice field ecosystem, the immence significance of cyanobacteria as an alternative source of N_2-fixation deserves more attention, recently, due to continuous increase of the cost of synthetic N-fertilizer. The process of nitrogen fixation is virtually a complex biochemical process and mainly depends on environmental conditions. Abundance of cyanobacteria in soil and their potential capacity practically determine the extent of N to be fixed.

Intensive cultivation of rice causes the tremendous depletion of nutrients like NPK Zn in the soil. To over come this problem, the use of these chemical fertilizers become unavoidable for rice farming areas. The significant positive role of P-fertilization on growth of the indigenous cyanobacteria in rice field ecosystem has already been established by Roger and Kulasooria (1980), Khushik (2002) and Begum *et al*. (2008).

Reports are available on the performance of cyanobacteria in the normal rice field (Rinaudo *et al*. 1971 and Araragi *el al*. 1978), in contrast, very little information about their role in salt affected rice field is available (Kaushik 2002). A field experiment was, therefore, designed to evaluate of the role of N and P on the growth of cyanobacteria in a saline induced rice field situated in the belt of southern part of Bangladesh.

Materials and Methods

A field experiment was conducted in a moderately saline (Ec 7.3 dsm^{-1}) rice field of Khulna district during boro season. N (urea) (0, 50, 100 kg N ha^{-1}) and P (TSP) (0, 25, 50 kg P ha^{-1}) in a factorial combination together with a basal dose of K (MP) (50 kg K ha^{-1}) were applied. The field was ploughed mechanically, watered and leveled. The land was, finally, divided into three blocks. Each block was again subdivided into nine sub-plots. The unit plot size was 4m × 2m. Nine treatments, in triplicate, were allocated following a randomized block design. N and P were applied, accordingly, into two equal splits during final land preparation and at maximum tillering stage of rice.

Thirty days old seedlings of BR dhan-28 variety of rice collected from farmer seed bed were transplanted at the rate of three seedlings per hill. The hill-to-hill distance was 15 cm. The line to line spacing was 20 cm. Weeds were removed manually whenever required. Irrigation was given frequently to maintain the water level (1.25 cm above the soil surface). Soil samples were collected at 30, 60 and 90 days after transplanting for quantitative enumeration of cyanobacteria following standard method.

Results and Discussion

Impact of N and P on the abundance of cyanobacteria was found to be modified appreciably (Table 1). Incorporation of P-fertilizer caused a significant increase in the number of cyanobacteria with the increase in the rate of the fertilizer at 30, 60, and 90 days of transplantation.

Table 1. Abundance of indigenous cyanobacteria (× 10^4 g^{-1} soil) in rice field amended with NP fertilizers.

Treatments (kg ha^{-1})	Days of transplantation		
	30	60	90
N_0P_0	28.00 f	37.87 cd	35.00 cd
N_0P_{25}	42.00 d	46.70 c	37.77 c
N_0P_{50}	64.37 b	65.73 b	57.10 b
$N_{50}P_0$	25.64 f	38.00 cd	26.43 e
$N_{50}P_{25}$	54.00 c	62.28 b	62.11 b
$N_{50}P_{50}$	70.83 a	82.03 a	74.47 a
$N_{100}P_0$	26.90 f	30.07 d	31.03 de
$N_{100}P_{25}$	34.40 e	45.73 c	36.00 cd
$N_{100}P_{50}$	35.40 e	44.27 c	41.77 c

Level of significance, P = 0.05. In a column, figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly as per DMRT.

At 30 days of transplantation of rice seedlings, the maximum number of cyanobacterial population (70.83×10^4 g^{-1} soil) was recorded in the plot receiving 50 kg P and 50 kg N ha^{-1} together. Similarly, the second highest number (64.37×10^4 g^{-1} soil) was in the sub-plot with 50 kg P ha^{-1} only. In contrast, the minimal number of population (26.90×10^4 g^{-1} soil) was in the treatment where 100 kg N ha^{-1} was applied alone. Very identical number of the population i.e. 34.40×10^4 and 35.40×10^4 g^{-1} soil was recorded in the treatments with 100 kg N along with 25 kg P and 100 kg N together with 50 kg P ha^{-1}, respectively. Cyanobacterial population decreased with the increase of applied N though not significantly.

However, at 60 days of transplantation, the maximal number of cyanobateria (82.03×10^4 g^{-1} soil) was in the plot with N and P at the rate of 50 kg ha^{-1}. Incorporation of 25 kg P ha^{-1} showed 46.70×10^4 g^{-1} soil of the cyanobacteria. The number, however, increased significantly to 65.73×10^4 g^{-1} soil when the amount of P increased from 25 to 50 kg ha^{-1}. Number of cyanobacterial population decreased insignificantly from 37.87×10^4 to 30.07×10^4 g^{-1} soil due to increase of nitrogen from 0 to 100 kg ha^{-1}.

Similarly at 90 days of transplantation, the lowest number of cyanobacterial population (26.43×10^4 g^{-1} soil) was in the treatment provided with 50 kg N ha^{-1} alone. Supply of 25 kg P ha^{-1} showed 37.77×10^4 g^{-1} soil of cyanobacterial population and the number increased significantly to 57.10×10^4 g^{-1} soil due to increase of P from 25 to 50 kg ha^{-1}. The population was estimated to be 62.11×10^4 g^{-1} soil ranking the second highest in the treatments receiving 25 kg P and 50 kg N ha^{-1} applied in combination. However, the number increased significantly to 74.47×10^4 g^{-1} soil when 50 kg N with 50 kg P applied together ranking the highest position among the treatments imposed in the experiment. The number of cyanobacterial population decreased significantly to 41.77×10^4 g^{-1} soil when 100 kg N and 50 kg P ha^{-1} was applied together. Addition of P (0, 25, 50 kg P ha^{-1}) resulted a significant increase in the number of cyanobacteria with the increase in the level of P over the control irrespective of the duration of sampling.

Retardation in the number of cyanobacteria was assessed to be the highest in the plot supplied with N (50 and 100 kg N ha^{-1}). However, this depressive situation was significantly improved due to supplementation of P at intermediate level of N (50 kg N ha^{-1}). The stimulatory and positive interaction of P with N promoted the growth of cyanobacteria significantly at all stages of sampling. However, the stimulative effect of P was found to be reduced at the highest level of N when applied in combination. Moreover, the efficacy of P became leveled off in the presence of 100 kg N ha^{-1} resulting a nonsignificant variation in the number of cyanobacteria in the treated plot. The number of cyanobacteria was found to increase with the growth span up to 60 days and thereafter their abundance decreased at 90 days of transplantation of the rice crop.

Application of N in the rice field significantly retarded the cyanobacteria enumerated in the location under investigation at 30, 60 and 90 days of transplantation of rice seedlings.

This suggests that enrichment of the soil with fertilizer-N inhibited the growth of cyanobacteria. The reason might be attributed to the fact that N_2- fixing cyanobacteria are profoundly favoured by a lack or competitiveness of the other algae and can proliferate profusely in soil poor in nitrogen content particularly in rice field. This possibly explains the fact that nitrogen fixing cyanobacteria are retarded or at least affected to some extent in the presence of nitrogen in soil. Similarly the selective action and inhibitory effect of added N-fertilizers on N_2- fixing blue-green algae in rice fields of Ivory Coast was reported by other workers (Renaudo 1974).

Supply of P generally encouraged the growth of cyanobacteria resulting a significant flush in their number irrespective of the duration of sampling intervals. These findings are in agreement with the reports of other investigators (Than Thun 1969 and Srinivasan 1978). The positive relationship of growth of blue-green algae with the available P content of soil has also been demonstrated earlier (Araragi *et al*. 1978, Okuda and Yamaguchi 1952, Ishizawa *et al*. 1975 and Yamaguchi 1975).

Results revealed that the inhibitory impact of fertilizer N on the abundance of cyanobacteria can be overcome significantly due to incorporation of P in the with N-fertilized plot. However, this positive interaction of P with N was found to be only statistically significant at intermediate dose of N i.e. 50 kg N ha^{-1}. The role of P became leveled off resulting an insignificant impact on the growth of cyanobacteria at the highest dose of N (100 kg N ha^{-1}). Nevertheless, the interaction of P with intermediate dose of N ($N_{50}P_{25}$, $N_{50}P_{50}$) was significantly better to promote the growth of cyanobacteria than the individual impact of intermediate rate of N i.e. 50 kg N ha^{-1} irrespective of sampling intervals.

The outcome of the investigation suggests that modern methods of biotechnology may be improved through cyanobacterial biofertilization, provided the relationship of cyanobacteria with soil is well understood through coordinated research in the laboratory and field.

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