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INFLUENCE OF NITROGEN AND PHOSPHORUS ON THE ABUNDANCE OF CYANOBACTERIA. I. RICE FIELD OF NURJAHANPUR, BRAHMANBARIA, BANGLADESH

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A field experiment was conducted in a traditionally rice growing area at Nurjahanpur in the district of Brahmanbaria to evaluate the impact of N (0, 60,120 kg N ha^{-1}) and P (0, 30, 60 kg P ha^{-1}) fertilizers in all possible combinations on the abundance of cyanobacteria. Results showed that the number of cyanobacteria enumerated at 30, 60 and 90 days of transplantation of rice seedling (BR-28) varied significantly from 48.60×10^4 to 283.70×10^4, 54.93×10^4 to 331.00×10^4 and 48.70×10^4 to $312.30\times10^4 g^{-1}$ soil, respectively. The maximal and minimal values were recorded in $N_{60}P_{60}$ and $N_{120}P_0$ treatments, respectively, irrespective of the sampling intervals. Addition of P promoted the growth of cyanobacteria and that of N inhibited their abundance significantly with the increasing level of the fertilizers. Supplementation of P with N stimulated better growth of cyanobacteria reflecting the positive and beneficial interaction of P in the presence of lower dose of N significantly. However, at higher dose of N (120 kg ha^{-1}), P failed to do so.

Keywords: Abundance; Cyanobacteria; Nitrogen; Phosphorus; Rice field.

Introduction

A significant constraint in increasing the yield of rice is the supply of adequate nutrients, among which nitrogen, being an essential element, plays an important role. Nutrient nitrogen is considered as the most limiting factor in soil and use of inorganic fertilizers to meet the crop requirement is unavoidable for intensive farming practices. On global basis out of 180 million tones of nitrogen added annually on earth surface, the synthetic fertilizer nitrogen accounts for only 1/3, while 2/3 comes from microbiological processes known as biological nitrogen fixation[1]. Among the biological nitrogen fixing agents, the significant contribution of cyanobacteria is well accepted. De[2] as a pioneer, reported the presence of cyanobacteria in Indian rice fields. The paddy field ecosystem provides an environment favourable for the growth of cyanobacteria with respect to their requirement for light, water, temperature, humidity and nutrient availability. The higher abundance of cyanobacteria in paddy soils[3] varies widely depending on physicochemical properties of soil and biotic factors[4] and climate condition[4,5].

The growth of cyanobacteria has been reported to be profoundly better in soil deficient in N[6,7] and rich in P[8-10]. However, opinions are also available on the stimulative effect of algalization in the presence of fertilizer-N[11] and statistically nonsignificant interaction was observed between applied N and algalization[12]. Literature review showed that no such work has been done yet in Bangladesh on the influence of added fertilizers on the growth of cyanobacteria in the rice field where use of N and P fertilizers is a common practice. Thus, a field experiment was conducted to assess the effect of urea and TSP on the abundance of cyanobacteria in a traditionally rice growing area.

Material and Methods

A field experiment was conducted in a rice field at Nurjahanpur in the district of Brahmanbaria during boro season. Three rates of each of N as urea (0, 60,120 kg N ha^{-1}) and P as TSP (0, 30, 60 Kg P ha^{-1}) in a full factorial combination was applied using BR-28 as the test crop. The experimental plots were ploughed by a tractor. The weeds were completely removed and the land was watered and leveled. Finally, the land was divided into three blocks. Each block was again subdivided into nine sub plots. The size of each plot was 4m x 2m. The unit plot was separated from each other by levy. The design followed was a randomized block one. The fertilizers were broadcasted as per treatment combinations. Nitrogen and phosphorous were applied into two equal splits during land preparation and maximum tillering stage of growth of rice plant. Thirty

Table 1. Effect of nitrogen and phosphorus on growth of cyanobacteria (× 10^4 g^{-1} soil) in rice field at 30, 60 and 90 days of transplantation.

Treatments	Days of transplantation		
	30	60	90
N_0P_0	104.00d	141.30c	131.00d
N_0P_{30}	173.30c	249.30b	222.70c
N_0P_{60}	278.70a	319.00a	282.00b
$N_{60}P_0$	72.50e	101.80d	94.37e
$N_{60}P_{30}$	203.70b	250.00b	212.30c
$N_{60}P_{60}$	283.70a	331.00a	312.30a
$N_{120}P_0$	48.60f	54.93e	48.70g
$N_{120}P_{30}$	52.67f	73.67 de	62.20 fg
$N_{120}P_{60}$	58.43 ef	87.77 de	79.67 ef

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

days old HYV (BR-28) seedlings of rice were collected from farmer seed bed. The healthy and uniform seedlings were selected. Three seedlings were sown in each hill on 10 January, 2005. The hill-to-hill distance was 6 inches. Weeds were controlled manually as and when required. Irrigation was given time-to-time to maintain the water level (half inches above the soil surface). Soil samples were collected from each plot at 30, 60, and 90 days of transplantation for quantitative estimation of cyanobacteria.

Results and Discussion

The result presented in Table 1 showed that cyanobacterial population was influenced significantly by different doses of applied nitrogen and phosphorus at 30, 60 and 90 days of transplantation of rice seedlings recorded in the field experiment conducted at Nurjahanpur in the district of Brahmanbaria.

At 30 days of transplantation, the maximum number of cyanobacterial population was (283.70×10^4 g^{-1}soil) found in the treatment receiving 60 kg P and 60 kg N ha^{-1}. The second highest number of cyanobacterial population was recorded in the plot supplied with 60 kg P ha^{-1} only. However, the lowest number of cyanobacterial population (48.60×10^4 g^{-1} soil) was estimated in the treatment where the highest amount of nitrogen (120 kg ha^{-1}) was applied only. Very close number of cyanobacterial population i.e. 52.67×10^4 and 58.43×$10^4$$g^{-1}$soil was recorded in the treatments receiving 30 and 60 kg P ha^{-1} with 120 kg N ha^{-1}, respectively. However, the number of cyanobacterial population was found to increase significantly with the amount of phosphorous applied alone. In contrast, the number of cyanobacterial population decreased significantly with the increase in the amount of nitrogen applied i.e. from 0 to 120 kg ha^{-1}.

At 60 days interval of transplantation of rice seedling, the maximum number of cyanobacterial population was enumerated (331.00×10^4 g^{-1} soil) in the plot where 60 kg P ha^{-1} with 60 kg N ha^{-1} was used together. Similarly, the second highest number of cyanobacterial population (319.00×10^4 g^{-1} soil) was recorded in the plot provided with 60 kg P ha^{-1} only. It was found that 249.30×10^4 g^{-1} soil cyanobacterial population was observed in the sub plot when 30 kg P ha^{-1} was applied in the absence of N fertilizer. However, when the rate of nitrogen was increased from 0 to 60 kg ha^{-1}, the number of cyanobacterial population reduced recordedly from 141.30×10^4 to 101.80×10^4 g^{-1} soil and was statistically significant. The lowest number of cyanobacterial population was 54.93×10^4 g^{-1} soil enumerated in the treatment supplemented with only 120 kg N ha^{-1}.

At 90 days of transplantation, the maximum cyanobacterial population (312.30×10^4 g^{-1} soil) was recorded in the treatment supplied with both P and N at the rate of 60 kg ha^{-1}. The second highest number of cyanobacterial population was estimated to be 282.00×10^4 g^{-1} soil recorded in the sub plot of the experiment fertilized with 60 kg P ha^{-1} only. The lowest number of cyanobacterial population (48.70×10^4 g^{-1} soil) was found in the treatment receiving the highest level of N (120 kg ha^{-1}). It could be noted that these variations in number of the cyanobacterial population was highly significant due to various treatments applied.

The number of cyanobacterial population was found to vary significantly due to individual and combined effect of applied N and P. The number of cyanobacteria increased significantly with the increase in the level of applied fertilizer P at all stages of transplantation. In contrast, the addition of N- fertilizer behaved on the other way round resulting a significant depression in the number of the same. It may be noted that the extent of depression was more aggravated at the highest level of N (120 kg ha^{-1}) irrespective of the duration of collection of sample from the rice field. However, surprisingly and significantly the situation could be improved when nitrogen was coupled with phosphorus. This positive interaction of P with N was found to be highly effective and significant at lower dose of nitrogen (60 kg N ha^{-1}) only. It is interesting to note that the role of phosphorus was drastically reduced at the highest level of N i.e. 120 kg N ha^{-1} but became statistically non significant. This possibly suggests that 60 kg P ha^{-1} might not be sufficient enough to over come the inhibitory role of nitrogen to promote the growth of cyanobacteria in the rice field of Nurjahanpur. The findings of the present investigation agreed favourably well with the observation of other investigators. Generally, under N-deficient conditions, N_2-fixing BGA are favoured by a lack of competitiveness caused by other algae and can develop profusely[6,7]. However, Mahapatra *et al.*[13] indicated that the growth of diatoms, *Ulothrix* and *Spirogyra* was dominant in the absence of fertilizer while addition of 160 kg N ha^{-1} induced the dominance of *Nostoc muscorum, Anabaena cylindrica* and *Volvox* sp. Similarly in paddy soils, P-fertilizers enhanced the algal growth and ARA[14,15]. Okuda and Yamaguchi [16] also reported that BGA growth was poor at 0 to 5 ppm available P but vigorous above 6 ppm. The sequence of abundance of cyanobacteria followed the order: 60 days > 90 days > 30 days of transplantation of rice seedlings in the field.

In paddy fields in Senegal, maximal algal biomass was observed between tillering and panicle initiations [17]. However, in wetland fields of India, the density of the biomass was maximal a little later than in Senegal[18]. Nevertheless, during the dry season algal density was found to be highest just after heading of rice crop in the Philippines. This variation might be due to duration and intensity of light availability[19].

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