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EFFECT OF NPKSZn FERTILIZERS ON THE GROWTH OF CYANOBACTERIA IN RICE FIELD OF BANGLADESH

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Application of NPKSZn fertilizers in rice field showed a significant variation in both qualitative and quantitative distribution of cyanobacteria. Out of eighteen genera of cyanobacteria, ten genera were heterocystous and diazotrophic covering the most common species of *Nostoc* and *Anabaena, Calothrix, Aulosira* and *Scytonema* in abundance. However, the distribution of *Nodularia* sp. was relatively restricted. Eight genera of non-heterocystous cyanobacteria were accounted widely for *Oscillatoria* sp. and commonly for *Aphanocapsa* sp. and *Microcoleus* sp. Quantitatively, the number of cyanobacteria varied between 12.7×10^4 and 0.02×10^4 g^{-1} in NPSZn and NP treatments respectively. Supply of phosphorus generally promoted the growth of cyanobacteria significantly with other fertilizers. In contrast, incorporation of potassium showed much reduction in their population. Interestingly, interaction of the applied fertilizers on the growth of cyanobacteria was quite evident.

Keywords : Cyanobacteria; Growth; NPKSZn fertilizers; Rice field.

Introduction

About 91.3% of rice is produced and consumed in the tropical South and South East Asia. World production of rice is reported to be 3710 kg ha^{-1}, where 3799 and 2348 kg ha^{-1} are in Asia and Bangladesh respectively[1]. For the increased production of grain per hectare, the contribution of soil fertility has got no alternative. Contrary to this, continuous use of chemical fertilizers, especially urea, particularly in intensive rice cultivation results in the degradation of the biological properties of soil and, in turn, indirectly the environment. Thus, now-a-days, the concept of organic farming is gaining momentum in the advanced countries. Application of cyanobacterial inoculants could be the cheapest and easiest way to increase the yield of rice because of their capability to enrich the soil through fixation of nitrozen[2]. Roger and Kulasooriya[3] observed that the best results of inoculation with cyanobacteria could be obtained when indigenous species or strains are applied. Metting[4] reported that the main limiting factors for the enhancement of the presence of indigenous cyanobacteria in a rice field ecosystem are the lack of data about the ecology, systematic and environmental elements promoting or modulating the growth increase in biomass. The paddy field ecosystem is quite favourable for the groth of N_2-fixing cyanobacteria[5-7] and their population can be increased by applying TSP and gypsum[5] and essential nutrients[8].

Since the soils of Bangladesh are, in general, deficient in nitrozen and majority of the farmers are unable to meet the cost of fertilizer -N, so harvesting of indigenous N_2-fixing cyanobacteria under local condition could be a logical approach. It is expected that the output of the cyanobacteria is the function of total number of viable cyanobacteria input and/or naturally present and the efficiency of N_2-fixation of the individual strains. This possibly necessiates the prior assessment of the cyanobacterial strains in the rice field.

Thus, an attempt was made to evaluate the qualitative and quantitative status of cyanobacteria in the Bangladesh Rice Research Institute (BRRI) Farm, Gazipur as influenced by various combinations of N, P, K, S and Zn fertilizers.

Materials and Methods

A field experiment was set up with BR11 variety of rice in the BRRI Farm during Boro season. N, P, K, S and Zn were applied at the rate of 120, 26, 33, 30 and 5 kg ha^{-1} in the form of urea, TSP, MP, gypsum and zinc sulphate respectively. The treatment combinations of NPKSZn, NPSZn, NKSZn, PKSZn, NSZn, NPKS, NPKZn, NPK, NP, NK and N together with a control were arranged according to a randomized block design with four replications.

Samples of soil (0-5 cm) were collected from each plot after 45 days of transplantation. One composite sample comprised four sub-samples of each plot collected squarely. Enumeration of cyanobacteria was studied from their growth in enrichment cultures using Fogg's medium[9] following the most probable number (MPN) method[10] using a probability table[11]. The cyanobacterial forms in the enrichment cultures were identified following standard literatures[12-13].

Results and Discussion

Qualitative distribution of cyanobacteria : In addition to the presence of different species of 18 genera of cyanobacteria, the members of eukaryotic algae (members of Chlorophyceae, Bacillariophyceae and Euglenophyceae) were recorded in the treated experimental plots. The distribution of cyanobacteria was found to vary markedly with treatments (Table 1). This variation in cyanobacterial population might be due to the variation in applied fertilizers. Among 18 genera, 10 genera were heterocystous and diazotrophic and the rest were non-heterocystous. Different species of *Nostoc* were very common in most of the treated plots. Similarly species of *Anabaena, Calothrix, Aulosira* and *Scytonema* were also found to be common. More or less similar results have been reported earlier from different rice field ecosystem of Bangladesh[14]. Venkataraman[15] and Okuda and Yamaguchi[16] also reported the predominance of *Nostoc* spp. in most of the soils of rice fields. Wide distribution of the species of *Nostoc, Calothrix, Aulosira* and *Anabaena* in rice growing soils of India was reported by Goyal[17] as well. However, the restricted distribution of *Nodularia* sp. is close to the previous findings[18].

Among the non-heterocystous forms, spp of *Oscillatoria* were most widely distributed forms. Next to it, spp of *Aphanocapsa* and *Microcoleus* were common. Khan and Venkataraman[14] also recorded the presence of non-heterocystous cyanobacteria in different rice fields of Bangladesh. The cyanobacteria might contribute biologically fixed nitrogen under microaerophilic conditions of the sub-soil zone of the rice field. Stewart *et al.*[19] suggested that certain non-heterocystous cyanobacteria are able to fix atmospheric nitrogen because of the presence of nitrogenase enzyme in them.

Quantitative distribution of cyanobacteira : Quantitative variation in cyanobacteria in rice field due to application of nitrogen, phosphorus, potassium, sulpher and zinc in various combinations was found to be statistically significant (Table 2). Highest number of cyanobacteria (12.7×10^4 g^{-1}) was recorded in the rice growing plots receiving nitrogen, phosphorus, sulpher and zinc and that of the lowest number (0.020×10^4 g^{-1}) was enumerated only in nitrogen and phosphorus treated plot. The variation in cyanobacterial population among the treatments ranged from 0.020×10^4 to 12.7×10^4 g^{-1}. Marked variation was also observed in the indigenous cyanobacterial population among the locations and agro-ecological zones of Bangladesh. The highest number of cyanobacterial population of 21.4×10^4 to 25.6×10^4 g^{-1} soil was recorded in the soils of old Brahmaputra Flood plain while the lowest numberof 0.416×10^4 to 1.90×10^4 g^{-1} soil was recorded in soils of Madhupur tract[20].

In the present study the treatments effects were significant. However, the

Table 1. Effect of NPKSZn fertilizers on the growth of cyanobacteria in rice field.

Treatment Denotations	Cyanobacteria identified
T_9	*Gloeothece sp.*
$T_{1, 3, 8, 9, 12}$	*Aphanocapsa spp.*
T_{2-12}	*Oscillatoria spp.*
T_3	*Phormidium sp.*
T_8	*Lyngbya sp.*
$T_{1, 8, 10-11}$	*Microcoleus spp.*
T_8	*Cylindrospermum sp.*
$T_{1-3, 6-10}$	*Nostoc spp.*
$T_{4, 7-9}$	*Anabaena spp.*
T_2	*Microchaete sp.*
$T_{4, 6, 9}$	*Pseudoanabaena sp.*
T_8	*Nodularia sp.*
$T_{8, 11}$	*Aulosira spp.*
T_7	*Plectonema sp.*
T_{8-10}	*Scytonema spp.*
$T_{1, 9, 12}$	*Calothrix spp.*
T_7	*Gloeotrichia sp.*
T_1	*Hapalosiphon sp.*

Denotations : T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8, T_9, T_{10}, T_{11} and T_{12} represent combination of fertilizers viz NPKSZn, NPSZn, NKSZn, PKSZn, NSZn, NPKS, NPKSn, NPK, NP, NK, N and control, respectively.

Table 2. Quantitative distribution of cyanobacterial population in rice field.

Denotations	Treatments	Cyanobacteria x 10^4 g^{-1}
T_1	NPKSZn	0.275
T_2	NPSZn	12.700
T_3	NKSZn	0.132
T_4	PKSZn	0.099
T_5	NSZn	0.188
T_6	NPKS	0.275
T_7	NPKZn	0.133
T_8	NPK	0.056
T_9	NP	0.020
T_{10}	NK	0.056
T_{11}	N	0.056
T_{12}	Control	0.060
LSD at 1% level		0.040

combinations of NPK, NK and N showed no significant variation in quantity of cyanobacteria in soils. Results further revealed that quantitative variation in NKSZn and NPKZn, and NPKSZn and NPKS treatments was also not significant. The treatment effects showed the following sequence : NPSZn > NPKSZn = NPKS > NPKZn > NKSZn > NSZn > PKSZn > Control> NPK = NK = N > NP.

Results presented in Table 2 clearly demonstrated that the cyanobacterial population was same in NPK, NK and N treated plots accounting 0.056×10^4 g^{-1}. Moreover, the impact of these treatments was also not significantly different from the control. It has been noted that triple and tetra combinations of fertilizers promoted the growth of cyanobacteria better than the dual and single combination of applied fertilizers. Similar views were reported by other investigators [21,22] too.

It is very interesting to note that the impact of interactions of NPKSZn fertilizers on both qualitative and quantitative distribution of cyanobacteria is quaite consievable (Tables 1-2). The stimulative role of phosphorus on the growth of cyanobacteria has been observed. These findings are in good agreement with the views of Srinivasan[23] who proposed that in paddy soils, phosphorus supplying manure enhances cyanobacterial growth. Contrary to this, the glaringly negative effect of potassium on the growth of cyanobacteria has been recorded (Table 2) and it is in good accord with the previous views of Mahapatra *et al.*[22].

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