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IMPACT OF CYANOBACTERIA AND UREA–N ON GROWTH AND YIELD OF BR-26 VARIETY OF RICE

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A pot experiment in the greenhouse was conducted with cyanobacteria (*N.ellipsosporum*,25g pot^{-1}) and urea–N (120 kg N ha^{-1}) alone and in combination (½ N + cyanobacteria) with a HYV rice (BR-26) as the test crop. Results showed that the performance of cyanobacteria was found to be the best to improve the number of sterile and fertile panicles, content of nitrogen and protein in grain except the number of tillers of rice among the treatments applied though not significantly. However, the treatments caused a significant variation in case of yield of grain and uptake of nitrogen by grain yielding the maximal due to application of cyanobacteria. In contrast, impact of fertilizer-N alone and in association with cyanobacteria caused an identical effect in all the parameters of rice under study.

Keywords: Cyanobacteria; Content; Protein; Rice; Uptake; Urea-N; Yield.

Introduction

The application of organic or synthetic nitrogen fertilizers undoubtedly play a dominant role in increasing the yield of paddy. In modern farming, fertilizer N may be considered the kingpin due to introduction of improved and high N-responsive varieties of rice. However, the increasing cost of N-fertilizer and the widening gap between supply and demand N fertilizer have caused a serious constraints on the poor farmers particularly in developing countries. Considering such dynamic problem, IRRI[1] recommended biological nitrogen fixation by cyanobacteria (blue green algae) and heterotrophic microorganisms in the root zone as an alternative source of nitrogen. Roger *et al.*[2] stated that a unique set of conditions exists for biological nitrogen fixation in wetland rice field ecosystem. Firstly, the aquatic plant habitat provides suitable and favorable sites for the activity of autotrophic N-fixing cyanobacteria. Secondly, the anaerobic condition in a submerged soil is quite suitable for the activity of heterotrophic N-fixing cyanobacteria, the nitrogenase that is labile. Watanabae[3] conducted field experiments consecutively for 5 years inoculating soil with BGA and observed an increase in yield of rice about 1-20%. The auther recorded that fertilization of rice field with BGA is almost equivalent to 29 kg N ha^{-1} supplied as ammonium sulphate. It has also been reported that about 20-30 kg N ha^{-1} can be supplemented by algalization under various agroclimatic conditions[4-6]. Literature review reveals that only scanty reports are available regarding the significance of cyanobacteria in rice fields of Bangladesh[7]. With this view in mind, a greenhouse experiment was conducted to ascertain the impact of cyanobacteria (*N.ellipsosporum*) on growth and yield of a high yielding variety of rice (BR-26).

Material and Methods

Samples of soil collected from rice field of Nurjahanpur in the district of Brahmanbaria, Bangladesh was air-dried and ground to pass through 2mm sieve. Collected soil was a composite sample of five sub-samples selected randomly. Six kg of soil sample was placed into each clean dry earthen-ware pot (25cm × 18cm). The potted soil was treated with single and dual combinations of fertilizer-N and cyanobacteria (*N.ellipsosporum*) together with a control. The treatments applied in the experiment were control, cyanobacteria (25 g pot^{-1}), fertilizer- N (120 kg N ha^{-1}) and ½ N + cyanobacteria (60 kg N ha^{-1} + 25 g cyanobacteria pot^{-1}). Nitrogen was applied as urea. The treatments were coupled with basal doses of P (60 kg P ha^{-1} as TSP) and K (40 kg K ha^{-1} as MP). Four treatments, in triplicate, were arranged in a randomized block design in the greenhouse, Department of Soil, Water and Environment, University of Dhaka.

Fertilizers were added to the soil in the form of water solution and mixed thoroughly. The potted soil was kept submerged (1-2 cm water on the surface) for 3 days and then fresh algal inoculum was added. The soils in the pot were then allowed to dry up to a moist condition in order to facilitate the growth of algal inoculum. Then 21 days old healthy rice seedlings (BR-26) of uniform size were transplanted at the rate of 2 seedlings hill^{-1} and 3 hills pot^{-1}. Tap water was added to keep the soil moist. Weeds were removed as they appeared. The experiment was continued up to maturity. Number of tillers at maximum tillering stage, sterile and fertile panicles at maturity and yield of grain were recorded. Quality of grain was analyzed by determining nitrogen and protein content.

The soil sample was analyzed for some chemical properties. pH was measured electrochemically by using a combined glass/ calomel electrode with Corning pH meter from a soil suspension (soil: water ratio being 1:2.5). Organic carbon was estimated by following the method of Walkley and Black[8]. Sample of soil was digested with conc. H_2SO_4 and digestion mixture for total N determination[9]. Grain sample was digested with a mixture of conc. H_2SO_4 and $HClO_4$ for N estimation[10]. Available N and P were extracted with 2M KCl solution[11] and Trougs solution (N/500 H_2SO_4 soln.), respectively. Available S was extracted with 500 ppm P (calcium dihydrogen phosphate [Ca $(H_2PO_4)_2$]) as presented by Fox *et al* [12]. Sulpher in the extract was determined colorimetrically by using Shimadzu uv/vis lamps spectrophotometrically after developing turbidity with $BaCl_2$[13] at 420 nm wave length. N content in the KCl extract and total N in soil and grain digests were estimated by Kjeldahl method[9]. Available P was determined colorimetrically after developing phosphomolybdo-yellow phosphoric acid complex[9]. Chemically, the soil had p^H 5.5, organic C 0.83 %, total N 0.16 %, available N 4.30 mg 100 g^{-1} (NH_4-N 0.50 mg 100 g^{-1} and NO_3-N 3.80 mg 100 g^{-1}), available P 6.21 µg g^{-1} and available S 3.22 µg g^{-1}.

Results and Discussion

The agronomic characteristics, yield of grain, nitrogen content and uptake and protein content of rice grain as influenced by cyanobacterial inoculation alone and in combination with urea-N have been measured and the results thus obtained are presented in Table 1. Number of tillers estimated at maximum tillering stage of rice due to cyanobacterial inoculation alone and in association with urea-N did not vary appreciably and was found to be statistically not significant (Table 1). The number of tillers produced ranged from 25.00 to 26.50 pot^{-1}. It is found that only about 2.75% increase in number of tillers was recorded in the pot treated with cyanobacteria alone over the control. However, the number increased to 8.92% when urea-N was applied in combination with cyanobacteria. It may be noted that the combined application of cyanobacteria and fertilizer-N failed to improve the number of tillers significantly and became almost equally effective to cyanobacteria alone to modify the growth of the same. Similarly, the individual performance of cyanobacteria and urea-N has also been found to be statistically identical when the number of tillers was taken into consideration. Number of sterile panicle pot^{-1} varied markedly from 0.67 to 7.00 in the pot supplemented with cyanobacteria (25 g pot^{-1}) and N (60 kg ha^{-1}) plus cyanobacteria (25 g pot^{-1}), respectively (Table 1). However, the variation between the treatments was not significant at all. The number of sterile panicle pot^{-1} reduced drastically to almost nil (0.67 pot^{-1}) in the treatment receiving only cyanobacteria in comparison to other treatments accounting around 87.4% less than that of control. Contrary to this, fertilizer-N alone and in association with cyanobacteria were found to be statistically identical reflecting their equal efficiency to reduce the sterility of panicles. The best role was played by cyanobacteria alone when applied at the rate of 25 g pot^{-1} to control the sterility of panicles. However, an opposite trend was observed when the number of fertile panicles pot^{-1} was taken into account (Table1). The number of fertile panicles increased recordedly when cyanobacteria was applied alone in comparison to the control though not statistically significant. Pots treated with cyanobacteria alone caused about 28% increase in the number of fertile panicles. In contrast, the efficacy of cyanobacteria was found to be reduced by 20% when applied in conjunction with fertilizer-N. Nevertheless, fertilizer-N alone improved the situation only by 0.8% when compared with the value achieved by the interaction of cyanobacteria × fertilizer-N. The orders of the treatments were: control < N_{120} < N_{60}+ cyanobacteria(25g) < cyanobacteria (25g).

The positive and significant impact of cyanobacteria alone and in combination with fertilizer–N was observed on grain yield of rice pot^{-1} as well (Table 1). The pattern of grain yield was almost similar to that of number of sterile panicles pot^{-1}. The highest grain yield was recorded in the pot treated with 25g fresh cyanobacteria. Addition of 25g cyanobacteria pot^{-1} resulted more than 2-fold increase in grain yield of rice in comparison to the control. The increase in yield was found to be significant. However, the efficacy of cyanobacteria was reduced significantly when applied with chemical N-fertilizer. Moreover, the effect of interaction of cyanobacteria and fertilizer-N was found to be in no way superior to fertilizer alone and was not statistically significant. The reason might be due to the fact that added chemical N-fertilizer suppressed the activity of cyanobacteria. Further more, the superiority of cyanobacteria was recorded to be significantly better than fertilizer alone and in combination with cyanobacteria. Application of cyanobacteria alone and in combination with urea-N positively influenced the quality of rice grain

Table 1. Effect of cyanobacteria and urea-N on growth and yield of high yielding variety of rice (BR-26).

Treatments	No Tiller pot^{-1}	No Sterile panicle pot^{-1}	No Fertile panicle pot^{-1}	Grain Yield g pot^{-1}	Grain N Content percent	Grain N Uptake mg pot^{-1}	Grain N Protein percent
Control	24.33	5.33	19.00	13.70	0.313	0.043	1.96
$Cyanobacteria_{25}$	25.00	0.67	24.33	28.28	0.420	0.119	2.63
N_{120}	25.67	6.33	19.34	21.97	0.366	0.080	2.29
N_{60}+$Cyanobacteria_{25}$	26.50	7.00	19.50	21.64	0.354	0.076	2.21
LSD P=0.05	NS	NS	NS	6.33	NS	0.043	NS

with respect to nitrogen content and uptake (Table 1).Percent nitrogen content and uptake (mg pot^{-1}) by rice grain was found to be stimulated by the treatment combinations though not significantly. Accumulation of nitrogen in the grain showed similar reflection of grain yield of rice. Absorption of the nutrient was observed to be maximal in the grain where the soil was treated with cyanobacteria alone resulting an increase in the content and uptake of the same up to 34.2 and 176.0%, respectively over the control. However, the accumulation of nitrogen in the rice grain due to single application of urea-N and its coupling with cyanobacteria was found to be statistically identical. The pattern of protein content in the rice grain followed the same sequence as in the case of nitrogen content and uptake. Variation in protein content was observed among the treatments but not statistically significant at all. These findings corroborated well with the findings of other investigators elsewhere. Kaushik[14] reported that effective algalization could cause a relative increase in grain yield of paddy about 14% over the treatments and 16 % over the control. Similarly, an average relative increase in grain yield over the control was 28% due to algalization and 32% with N-fertilizers[15-18]. Sankaran[19-20] indicated that "any supply of nitrogen by way of nitrogenous fertilizers (except urea as foliar spray) seems to inactivate the algae in nitrogen fixation". However, the present results suggest that partial N-fertilization with cyanobacteria could be effective to increase the yield of rice significantly. Similar beneficial effects of algalization in the presence of fertilizer –N has been reported by Singh *et al.*[21] who found that supplementation of 60 kg urea-N ha^{-1} with algal inoculum resulted in a grain yield comparable to that obtained with 120 kg N as urea. Aiyer *et al*[22] also observed a uniform beneficial effect of inoculums at every level of nitrogen. Similar observations were also made in pot and field experiments by Venkataraman and Goyal[23].

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