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UTILIZATION OF BLUE-GREEN ALGAE AS BIOFERTILIZER FOR PADDY CULTIVATION

S. Iftikhar Ahmed and Ahmedunnisa

PCSIR Laboratories, Karachi-39.

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The paper examines the possibility of employing blue-green algae (Cyanophyceae) as a biofertilizer for the cultivation of rice, particularly as improved yield of the crop is not adversely affected from the salinity problem. BGA or blue-green algae are also self-perpetuating.

INTRODUCTION

Rice is supposed to be one of the major staple foods for the world population. It is also one of the most major crops of Pakistan, occupying an area of more than 2 million hectares of arable land with an average production of about 3.2 million tons per year [5].

The soaring cost of fertilizers and the shortage in supply as well as the purchasing potential of the rural farmers have placed them in an inconvenient situation. This is particularly true for marginal and small farmers. In such a situation it would be relevant to consider other alternative natural sources, so that at least a part of our fertilizer requirement, especially those of nitrogenous fertilizers which are used 4 times more as compared to all the other fertilizers collectively, could be met [5]. It is of interest to note that according to Sarles and others, approximately 80% of earth's atmosphere is nitrogen [6, 7]. Extensive scientific efforts are necessary so that the huge sources of atmospheric nitrogen could be made available to our crops. There are a few microorganisms, including some of the blue-green algae (BGA) which are capable of utilizing this nitrogen. As early as 1939 P.K. Singh [6] suggested that the fertility of the tropical rice fields was largely due to the activity of nitrogen fixing BGA. Besides nitrogen, these algae are known to provide the plants with many other useful organic substances like growth factors, vitamins etc. A steady increase in the yield of rice was observed at the International Rice Research Institute, Manila, Los Banos Philippines, for 23 successive crops during a span of 12 years without the addition of nitrogen fertilizers [2,3,8].

It is universally accepted that the major part of nitrogen that goes into the biosphere is due to the activity of these organisms. Nitrogen fixation by chemical means is a costly process but because the BGA obtain energy required for nitrogen fixation through photosynthesis, the system is rather self-supporting. In some countries including USSR, China, India, Burma, Egypt, Vietnam, nitrogen fixing BGA are used on a large scale in the cultivation of paddy [1, 2, 4] and it is said that the money and labour spent on nitrogenous fertilizers is greatly curtailed. These nitrogen fixing organisms grow in abundant water required during the cultivation of paddy and fix nitrogen from the atmosphere. On ageing and deterioration of the algal cells, the fixed nitrogen becomes available to the rice plant in sufficient quantities.

The use of BGA to meet the nitrogen requirement would not only save the land from adverse salinity effects but would also improve organic content, texture, and soil fertility. Once this technology is developed, it could be a constant asset for the paddy farmers in saving the money spent on nitrogenous fertilizers and also in improving the land.

MATERIALS AND METHODS

In order to study the effects of BGA on rice yield under our conditions, field experiments were conducted on a small scale with a mixture of BGA, *Anabenza, Aulosira, Nostoc, Plectonema* and *Tolypothrix* [2,3]. Multiplication of the starter culture was accomplished as follows.

2 kg. of ordinary soil was mixed with 20 g. of superphosphate in trays of the size of 17" x 9" x 9" with 10 litres of ordinary tap water. After the soil settled down and the water cleared up, 1 g. of the dried culture was sprinkled evenly on the surface of water and distributed equally by gentle stirring.

To prevent insects attack 0.5 g. of *Furadon* per tray was used. The pH of the water was determined as 7.0 within a week; a thick algal mat of the inoculated BGA mixture was formed. Fast growth of algae specially in hot summer months (33-40°) was observed. The algae was collected after 15-20 days and sun-dried. After complete drying it was stored in polythene bags for field experiments. Two experimental plots of the size 16 ft x 16 ft. were prepared for the control and two similar plots for the treated ones. For our experiments IRI-6 rice variety was used. Before transplantation the soil nitrogen was determined as 0.54% and pH was 7.0. All four experimental plots were flooded with water and left for two weeks so that undesirable seeds may germinate and the seedlings removed. Sowing of paddy seeds was carried out in the month of May. Transplantation was done after one and half month when the plants had gone to about 6" in height. After one week of transplantation, a homogenous mixture of BGA (40 g. of dried BGA in 500 ml. of water) was equally distributed in each of the plots, whereas the other two were left as control. No chemical fertilizers were used during the experiment in control plots as well as those with BGA. After transplantation, pH was recorded every week for a period of ten weeks. In the control experiments, pH remained at 7.0, whereas, in the plot with BGA it gradually changed to 8.0 in the sixth week and remained constant afterwards. Harvesting was done in the middle of October. Random samples of ten plants were taken from each of the control plots as well as plots with BGA. Their comparative mean values have been represented in a tabular form.

Photographs from plots with control plants and those treated with BGA as well as the respective spikes have also been provided.

OBSERVATIONS

Observations were made regarding length of the plants, total weight of the plant, number of spikes/plant, number of grains/plant and weight of grains/plant. Values regarding the control plants and those with BGA have been represented on dry weight basis by Table 1 and 2 respectively.

DISCUSSIONS

Based on the results shown in Table 1 and 2, the use of BGA (to meet the nitrogen requirement of paddy plants) seems to be quite encouraging in soils poor in nitrogen and organic content, as used in our experiments. In porous soils like sandy loam, the effect of BGA is further enhanced and reflected in the form of overall health of the plants and better yield. The use of BGA is very economical in view of the ever increasing cost of chemical fertilizers, and therefore, it has brightened prospects for

Table 1. Control plants showing the length of the plants, total weight of the plant, no. of spikes/plant No. of grains/plant and the total weight of grain/plant on dry weight basis.

S. No.	Length of the plant (inches	Total weight of the plant (g)	No. of spikes/ plant	No. of grains/ plant	Total weight grain/ plant (g)
1.	241	80	15	859	18.2
2.	21.5	70	13	720	17.4
3.	24.0	85	15	802	18.0
4.	22.3	72	14	700	16.5
5.	21.4	75	13	640	15.0
6.	19.0	68	11	600	14.2
7.	21.3	70	12	630	15.1
8.	18.9	71	12	635	15.0
9.	19.2	70	13	580	14.2
10.	21.0	75	13	650	15.3
Range =	18.9–24.1	70–85	12–15	580–859	14.2–18.2

Table 2. BGA treated plants showing the length of the plants, total weight of the plant, No. of spikes/plants, No. of grains/plant and the total weight of grain/ plant on dry weight basis.

S. No.	Length of the plant (inches)	Total weight of the plant (g)	No. of spikes/ plant	No. of grains/ plant	Total weight of grain/ plant (g)
1.	24.5	94	16	1630	33.2
2.	24.0	86	16	1255	33.0
3.	26.3	74	18	1086	32.5
4.	28.5	77	18	1100	33.4
5.	24.1	60	16	870	18.0
6.	24.0	59	17	859	18.3
7.	28.4	71	16	1060	25.5
8.	26.2	70	18	1035	25.0
9.	24.3	73	16	1100	25.1
10.	24.2	70	18	1095	25.5
Range =	24.0–28.5	86–94	16–18	859–1630	18.0–33.4

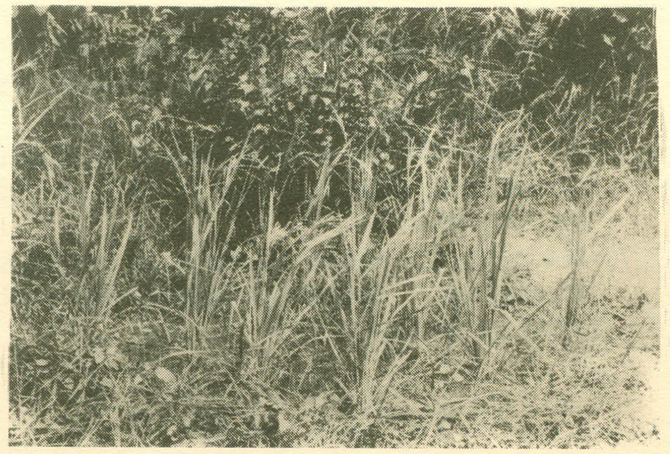

Fig. 1. Control plants showing poor growth with less fruiting.

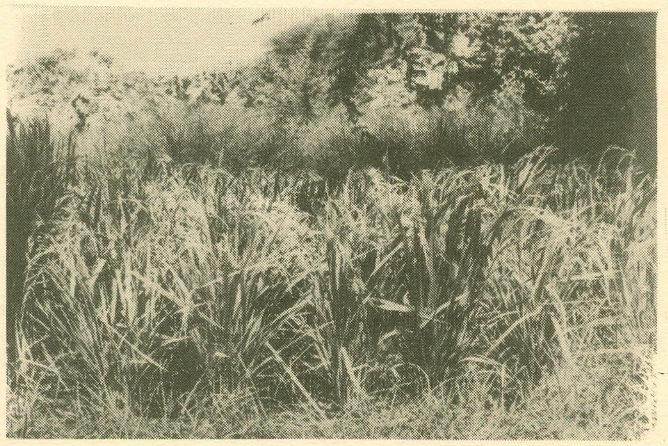

Fig. 2. Plants treated with B.G.A. showing vigorous growth and abundant fruiting.

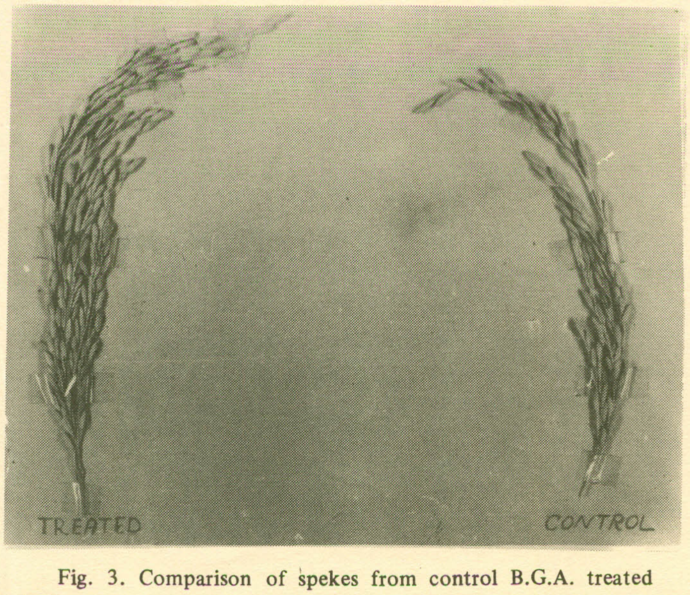

Fig. 3. Comparison of spekes from control B.G.A. treated plant.

marginal farmers. In addition, the presence of BGA improves the organic content and texture of the soil and does not aggravate the salinity problem. It also cuts down the labout of the farmer, because once the BGA is established in a paddy field, it persists for future paddy crops. It is, therefore, imperative that the farmers should be encouraged to use this technique.

If we look at the data incorporated in Tables 1 and 2, the difference between control plants and those treated with BGA is very striking and reflected in all the characters taken into consideration. The ranges provided at the bottom for every column show the extent of difference (minimums and maximums) in the control plants as compared to those treated with BGA. Since these differences fall on the higher side, one is bound to think about the possible explanation.

As already mentioned in the section on Materials and Methods, no chemical fertilizers were added throughout the experiments, and thus the only difference between control plants and plants with BGA is in the supply of nitrogen through nitrogen fixation. It seems rather certain that in the absence of the supply of any chemical fertilizers, especially in soils lacking in organic material, the very presence of living and dead BGA would have provided nitrogen and the required organic matter, and consequently, would have contributed to such a vast difference between control and treated plants as shown in Tables 1 and 2. Since the soil was of the sandy loam type which does not retain large quantities of water required for paddy plants, it is likely that this factor, when coupled with nitrogen supply through BGA would have substantially contributed in the striking difference found between control and treated plants.

As already emphasized earlier, the increasing cost of fertilizers and shortage in supply as well as the purchasing potential of the rural farmers plead for extensive use of BGA. In several countries the use of BGA as a fertilizer for paddy is increasing with time, and therefore, BGA is also considered of immense importance and utility for Pakistan, more so in view of the short supply and high cost of chemical fertilizers as well as the ever increasing salinity problem. It is further felt that considerable research under our climatic and soil conditions would be needed to make the use of BGA effective and popular for paddy farmers.

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