Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 02, Issue: 03 (MAY-JUNE, 2022)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Benefits of Blue Green Algae (BGA) in Rice Field

([*]Hansa Kumawat[1], Neha Khardia[1] and Archana Kumawat[2])
[1]Research Scholar, Rajasthan College of Agriculture, Udaipur
[2]Research Scholar, JNKVV, Jabalpur, Madhya Pradesh
[*] hanshikasingatiya@gmail.com

Cyanobacteria

BGA are oxygen evolving, nitrogen fixing prokaryotes using sunlight as the energy source for N2 fixation. Occurrence varies with climatic factors and soil conditions. Abundant in rice fields. As there are high levels of copper sulphate and combine nitrogen in the irrigation water, low occurrence of BGA is reported in Australian paddy fields. Predominant genera are Anabaena, Nostoc, Calothrix, Aulosira, Aphanothece and Gloeotrichia. The cyanobacterial nitrogen fixation has a swich on mechanismhich gets activated when the combined nitrogen level falls below 40 ppm which enables algal biomass to produce more of biologically fixed nitrogen as soon as the nitrogen fertilizer level is reduced in the ecosystem due to loss and utilization. It has been observed that the removal of algae from paddy field water greatly reduced the in situ nitrogen fixation. Application of BGA by farmers can save approximately 40-60 Kg urea as an average consumption of BGA has been found to be 20-30 kg N/ha/season.

Role of blue green algae in rice field

Availability of fixed nitrogen for rice

It is now well established that N 2 -fixation by BGA plays a vital role in the buildup and maintenance of soil fertility, but it is equally important to understand how much, when, and in what ways the fixed N is made available to the rice plants. Evidence on these aspects is still scanty and mostly hypothetical. Nutrients fixed by the algae are released either through exudation or through microbial decomposition after the cells die. Laboratory experiments have frequently shown that BGA liberate large portions of their assimilated nitrogenous substances; however, the large amounts recorded may be a methodological artifact due to osmotic shock in resuspending the cells or a physical damage of the algal material. No information is available on the exudation of fixed nitrogen by BGA under field conditions but it is clear that only part of it is available to rice, some being either reincorporated by the microflora or volatilized.

Release of nutrients through microbial decomposition after the death of the algae appears to be the principal means by which N is made available to the crop. The susceptibility to decomposition and the amount of nutrients released depend on:

- the physiological stage of the algae,
- the composition of the associated microflora,
- the suitability of the cell wall as a substrate for microorganisms, and
- the relative biodegradabilities of specific components of the algal walls.

Some algae are decomposed in 2-3 days, others withstand microbial digestion for more than 4 weeks. Laboratory experiments demonstrated that more than half of the nutrients contained in an algal biomass can be regenerated in less than 1 month with the aid of microbial degradation. A strain of Bacillus subtilis was found to decompose several N 2 -fixing BGA very rapidly, about 40% of algal nitrogen being converted to ammonia within 10 days. Grazers, through their digestive tracts, also make algal nitrogen available to rice, but there is no information on this aspect. In paddy fields the death of the algal biomass is most frequently associated with soil desiccation at the end of the cultivation cycle and algal growth has frequently resulted in a gradual buildup of soil fertility with a residual effect on, rather than an immediate benefit to, the standing rice crop. In the Philippines algal growth did not significantly increase the yield of rice but a buildup of N in the soil was observed. In a 5-year pot experiment it was found that during the first, second, or third year, crop yield in the presence and absence of algae did not differ. But thereafter, yield increased progressively in the presence of algae, and fell in their absence. In the fourth and fifth years, the yields in the presence of algae were much higher than yields in their absence, and also those at the start of the experiment. Soils where algae grew abundantly showed a considerable increase in N, while there was a loss in N soils where algal growth was absent. Field experiments conducted with Tolypothrix tenuis for 4 consecutive years indicated that only one-third of the field algae were decomposed in the first year; the rest remained as residual soil N. This was cited as the reason for continued yield increases in successive years. A study of C-N ratios and mineralization of nitrogen in inoculated and noninoculated pots for a 4-year period showed that more humus was formed under algae and that the humus was more easily decomposable. The pattern of distribution of total organic and mineral nitrogen studied in inoculated and noninoculated plots indicated a higher mineral nitrogen content and a low mineralizable index of N in the inoculated dots, a phenomenon very much desirable for slow release of soil reserve. The evidence cited shows that although BGA increase the available soil N, their influence on the rice plants is a delayed phenomenon. 15 N studies of availability of algal nitrogen to rice are very scarce. spread on the soil and 51% from the algae incor-prated into the soil. That shows that BGA nitrogen is readily available to rice; however, more direct information on quantification and dynamics of transfer of fixed N from BGA cells to rice plants is needed.

Growth-promoting effects of BGA

Besides increasing nitrogen fertility, BGA have been said to benefit rice plants by producing growth-promoting substances. Most of the documentation from field experiments is based on indirect evidence, the additive effects of BGA inoculation in the presence of nitrogenous fertilizers (40-120 kg N ha $^{-1}$) being interpreted as an index of a contribution through biologically potent substances produced by the algae. Such interpretations have to be treated with caution since there are other possibilities by which a crop would perform better in the presence of algae. For example, an initial algal growth could temporarily immobilize the added fertilizer N and thereby minimize losses. Subsequent algal decomposition during the growth of the crop may result in a slow release of nitrogen and a more efficient utilization by the crop. More direct evidence for hormonal effects has come primarily from treatments of rice seedlings with algal cultures or their extracts. Presoaking of rice seeds in BGA cultures or extracts has decreased losses from sulfate-reducing processes and this has been attributed to the enhancement of germination and a faster seedling growth due to algal exudates. N 2 -fixing BGA have supported early recovery of transplanted seedlings and prolonged the period of tillering, which has resulted in increased length and number of ears, and number of grains per ear. Water-soluble products from 8 Calothrix spp., Anabaena sp., and a Stratonostoc sp. had a rhizogenous effect and stimulated plants organs. Presoaking of rice seedlings in extracts of Phormidium (a non-N 2 -fixing BGA) has been shown to accelerate germination, promote the growth of roots and shoots, stimulate vegetative growth of the plants and increase the weight and protein content of the grains. The probable nature of these substances has been likened to that of a gibberellin. Also the growth pattern of rice seedlings treated with algal filtrate from Aulosira fertilissima resembled seedlings treated with gibberellic acid. On the other hand, extracts of Cylindrospermum muscicola that have given a positive effect on root growth of rice seedlings had an action similar to that produced by vitamin B12, which was found to be present in the algal cells (1.5µg ·g -1). Vitamin B12 has also been extracted from Tolypothrix tenuis. It has also been shown that amino acids (cysteine, tyrosine, phenylalanine) obtained from algal extract had a rhizogenous effect on rice. The production by BGA of substances that have a growth-promoting effect on rice plants is well established, but whether these substances are hormones, vitamins, amino acids or any others, as well as their mode of action, is still unclear. It has also been established that algal-growth-promoting substances are beneficial to crops other than rice, and that the production of such substances is not confined to BGA. Beneficial effects of algal inoculation in paddy fields may be partially due to growth-promoting substances, but the relative contribution by algae of N or other substances is still not clear.

Detrimental effects of algae

Blooms caused by filamentous algae can be detrimental to the rice plants, particularly to direct-seeded rice before the tillering stage. If the bloom forms before the rice seedlings have emerged, it may present a physical barrier that prevents the seedlings from penetrating the floodwater. The algal bloom is also harmful when the shoots and rice seedlings have not yet emerged from the water and, being in active growth, are passing through a particularly delicate stage. The occurrence of a thick mat of algae during planting of seedlings damages the plants by entangling with them and choking the seedlings. Wind may also move the algal bloom, pushing the young plants beneath the surface. Another harmful action develops when the water dries up and the algae form a layer at the bottom of the field. This layer envelops the seedlings, which are not yet deeply rooted, and drag them to the surface when the water is let in again. Heavy dressings of ammonium sulfate have been reported to induce the growth of an algal “scum” that interferes significantly with the early growth of rice seedlings. There is one report of a loss of a rice crop mainly due to interference of algae with tiller formation. The most harmful genera for rice are the filamentous or reticulated colonial types. Among these, the most frequently reported belong to the Chlorophyceae. Of the different algae identified in Louisiana rice fields, the two worst genera were Spirogyra and Hydrodictyon. BGA are occasionally cited but rarely as a dominant species. In a review of algal weeds and their chemical control, the only BGA cited was Oscillatoria. However, a report cites BGA as detrimental: the Cyanophyceae which succeeded Chlorophyceae that have been controlled by algicides may cause up to 25% losses. On the other hand, Nostoc and Gloeotrichia blooms that developed in California rice fields after incorporation of crop residues interfered with seedling development, but variations in yield did not indicate significant differences between plots where residues were incorporated or burnt. A better growth and yield of rice were also observed in the presence of algae (Cyanophyceae and Chlorophyceae) than in plots treated with $CuSO_4$ or Algaedyn. Among the algae that are detrimental to rice, BGA can be considered incidental, and even where they had produced a bloom at the beginning of the cultivation cycle, their effect on yield was very rarely negative.

Epiphytism

Epiphytic BGA have been observed on wetland rice, deepwater rice and on weeds growing in rice fields. In the wetland rice field ecosystem, BGA epiphytic on rice and weeds make a limited contribution to the nitrogen input but play an important role, providing inoculum for the regeneration of algal blooms that are periodically affected by adverse conditions. In deepwater rice, which offers a much greater biomass for colonization, the nitrogen contributed by the epiphytic BGA is agronomically significant. BGA were found to grow preferentially on submerged decaying tissues. An endophytic growth inside the leaf sheath was also observed in deepwater rice. All these cases support the observation that algal epiphytism and endophytism are probably related to abiotic effects rather than biotic relationships.

Other effects

The presence of BGA in the rice field has other effects on the crop. Excretion of organic acids by Anabaena sp. and Tolypothrix tenuis has been shown to increase the availability of phosphorus to the rice plant, but this action, also observed in Chlorella was not specific to BGA. Inoculation of the field and presoaking of the rice seeds decreased sulfide injury to rice crop. This was related to an oxygenation of the medium unfavorable for sulfate-reducing bacteria and to a growth-promoting effect that enhances seedling development which increases resistance to sulfide. A successful colonization of rice fields by BGA has been reported to prevent the growth of weeds; a negative correlation was observed between submerged weeds and floating BGA biomasses, but these interactions have not been fully explained.