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Nitrogen Fixing Blue Green Algae (BGA) in Rice Fields in India

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ABSTRACT

Blue Green Algae (BGA) have the capacity to self generate photosynthates from CO_2 and water. It is gratifying to note that Aulosira is the most important alga of the rice fields of India. Algalization has been found to benefit all the growth parameters. The propagation of BGA enriches the N_2 status of soil and also provides organic matter and biological quotient substances for plant growth. The relationship between photosynthesis and N_2 fixation is the subject of considerable current interest. The two metals directly involved in N_2 fixation are Mo and Fe. Depending upon the nature and concentration of the pesticides their effect may be stimulatory or inhibitory.

Key words : Blue green algae, Rice Fields, Nitrogen fixing

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INTRODUCTION

About 79% Nitrogen is present in our atmosphere but crop plant cannot utilize nitrogen in elemental form and crops starve amidst plenty. Cyanobacteria are present abundantly in rice fields and are important in helping to maintain rice field fertility through N_2 fixation. Many rice fields soil contain a high density of cyanobacteria and over 50% of cyanobacterial genera that are in existence in rice paddy fields are heterosystus philamentus cyanobacteria (Kim, Dong & Lee, 2006).

The N_2 fixing BGA have attracted considerable attention because of the well established fact that they contribute significantly to the N_2 status of aquatic habitats of the soil. In India, rice is cultivated on about 40 million hectares area, which constitute about 30% - 40% of total area under cereals. The ability of rice to grow year after year in the absence of manure is due to the fixation of atmospheric nitrogen by BGA (De, 1939; Singh, 1961).

DISTRIBUTION OF BGA IN RICE FIELDS

BGA are widely distributed throughout the tropical, sub-tropical and temperate region. In the rice fields of U. P. and Bihar there is dominant, widespread and universal growth of an algal community of BGA constituted mainly by Aulosira fertilissima. A survey of CRRI indicated the predominance of species of Aulosira, Cylindrospermum, Nostoc, Anabaena, Aphanothece and Gloeotrichia (Singh,1978).

Westiella is found very dominant in Maharashtra. Gujrat soils are rich in Mastigoclade. Cylindrospermum is dominant in Karnataka and Calothrix is found dominant in Punjab, Vidarbha and Konkan of Maharashtra. The ubiquitous occurrence of Aulosira fertilissima was marked in Kerala and Tamil Nadu (Venkatraman, 1972). Aulosira fertilissima is found dominantly in Madras and Kerala (Sunder Rao et al., 1963). In India, dark mats of Scytunema and Aulosira are often found in grass lawn and paddy fields. Aulosira fertilissima is the most active fixer in paddy fields of Central India (Singh, 1961).

ECOLOGICAL ASPECTS

A good growth of the BGA takes place generally over a pH range of 7.5 to 8.5. The availability of light, affects the growth and activity of BGA. After the first few showers of the rainy season (Last week of June-Middle of October) when moist and humid condition prevail, the surface of soil is covered with a thick growth of BGA. N_{2-} fixing BGA occurs in a variety of fresh water habitats ranging from Antarctic to the Thermal Springs. The Algae in the rice fields showed better growth at a high temperature range 30°C to 40°C (Singh, 1975).

PHYSIOLOGY

The main photosynthetic pigments in the BGA are chlorophyll a, Phycobili proteins including Phycocyanin, Allo Phycocyanin, Phycoerythrin, carotenes and Xanothophylls. The enzymes concerned with photosynthesis, respiration and N_2 fixation are all located on the Photosynthetic Lamellae and both Photo System I & II are operative and Oxygen (O_2) is evolved during the process. The BGA can assimilate N_2 from Nitrate, Nitrite – Ammonia, Hydroxyl amine, Urea, Casein, Amino Acids, Uric Acids and Nitrogen (Holm-Henson, 1968). A direct co-relates has been observed between the rates of growth and N_2 fixation because metabolites for nitrogenase activity are derived from photosynthesis and respiration. Di-Nitrogen supports good growth of BGA under optimum conditions.

The heterocyst possesses the ideal conditions for N_2 fixation because of the absence of the evolution of O_2 by them. Unicellular non-heterocystus algae such as Gloeocapsa (Wyatt and Silvey, 1969) and Aphanothece (Singh, 1973) are important because they fix N2 under aerobic conditions.

There is a close functional relationship between photosynthesis and nitrogen fixation in the cells as evidenced by a higher rate of N_2 fixation in light than in darkness. However, heterotrophic N_2 fixation has been demonstrated in many BGA in darkness in the presence of certain organic substances but the growth of the Organisms and the rate of N_2 fixation were very low.

The N_2 fixing capability must be induced in vegetative cells of heterocystus algae under aerobic conditions or nutritional studies must be carried out on the vegetative cells which are capable of fixing N2 under semi-anaerobic or aerobic conditions. The mutations with the loss of spores in heterocyctus algae have shown a greater ability to fix N_2 than the parent since growth is stopped at an early stage owing to sporulation in the wild type. The advantageous nature of the mutants is observed in nature because spores protect the organisms against various pathogens and adverse conditions.

MINERAL NUTRIENTS

In addition to the major mineral elements N, P, Mg, S, K, Ca, Fe, Mo, Mn, Na, Co, Zn and Cu are also considered to be essential for the BGA. Mo, Mn, Fe and Co are also required for N_2 fixation. The only metals directly involved in the N_2 fixation are Mo and Fe.

Reports on increase in soil fertility due to BGA are available (Venkatraman, 1972). The nutrient status of field growing BGA on dry weight basis indicated presence of 31% -71% ash, 1.6 to 3.2% N; 3.8% - 5.9% as free N; 12.8 to 29.7% C; 0.05% - 0.18% P; 0.1% - 0.6% K; 0.5% - 7.5% Mg; 1.0 to 8.3% Ca and the C:N ratio ranged from 6.6 to 11.6 (Roger et al 1986). This indicates that BGA have better N availability than other organic manures. The C:N ratio varied between 10.8 to 15 (Singh, 1961).

ALGAL INOCULATION, GROWTH, CROP YIELD AND ALGALIZATION

Attempts have been made in the past (Gonzalves and Gangala) to co-relate the algae and the physical, chemical nature of the soil such as texture, pH and calcium content and reported that besides pH (7.5-7.9) the cultivation practices of the soil, the pressure of fertilizers and the abundance of moisture might be responsible for the dominance of the BGA. Manuring with cow-dung also increased the proportion of myreophyceae (Mitra, 1951).

Venkatraman (1972) recommended production of soil based algal inoculums in open air ponds, shallow trays and cement tanks. Open air soil culture method is simple, less expensive and easily adoptable. This is very suitable for farmers.

Useful strains of the BGA can be inoculated under waterlogged conditions and lime to promote the growth of the inoculums and after incubation for certain periods the algae can be used as inoculums.

EFFECT OF PESTICIDES

The success of modern agriculture depends on the extensive use of pesticides in general and that of rice in particular which usually affect natural growth by being either an inhibitor of photosynthesis, or respiration or growth (Dodge, 1975). However, an undesirable side effect from the use of pesticides is that they enter into fresh water eco system by spray, drift, leaching, runoff or accidental spills (Vander, 1996). It is, therefore, important to assess the adverse effects of the pesticides in aquatic ecosystems.

Depending upon the nature of concentration of the chemicals their effect may be stimulating or inhibitory (Venkatraman and Rajyalaxmi, 1972). Algicides are usually applied in rice fields to control maorophytic (Chara, Nitella) or malforming algae (Spirogyra, Hydrodictyons).

A preferential inhibitory effect of insecticides on green algae which resulted in the promotion of cyanobacterial growth was observed in BHC (Ishiyawa & Matsuguchi, 1966) & PCP (Watanabe & Roger, 1984).

Some herbicides seem to affect specifically the N_2 fixing ability of cyanobacteria as directed by an inhibition observed in N_2-free medium but not in presence of inorganic N_2. This was observed by dichlone (fungicide/algicide) (Kashyap & Pandey, 1982) & machete (betachlor) (Vasampayan & Singh, 1978).

Pesticides interfere with photosynthetic machinery of the naturally occurring cyanobacteria. Heterocysts and their adjacent veg cells maintain a kind of symbiotic relationship in a cyanobacterial system in that the heterocysts supply fixed N_2 to veg cells and in return utilize their carbohydrate and energy for N_2 fixing (Fogg *et al.,* 1973). Pesticides which inhibit photosynthesis thus indirectly affect the N_2 –fixing machinery of Cyanobacteria.

CONCLUSION

In rice fields N_2 fixing by BGA has been the most efficient system in sustaining rice production in traditional cultivation. Moreover, inoculation is one of the efficient methods to increase BGA N_2 fixation. Inoculation, when successful, is a low cost technology with cost effective ratio for more favourable than that of many green manures (Venkatraman, 1981).

Attempts at extending symbiosis to the rice plants and the transferring of N_2 fixing genes to them will be a major contribution to the algal N_2 fixing research.

The effect of pesticides on BGA is reported to be stimulatory or inhibitory. Besides, increasing Nitrogen fertility, BGA benefit rice plants by producing growth promoting substances.

Direct evidence of hormonal effects has come primarily from treatments of rice seedlings with respect to BGA cultures as their extracts enhance the germination of rice seedlings, promote the growth of root and shoot and increase the weight of the plant and protein content of the grain. (Venkatraman, 1972).

The BGA N_2 fixation is a boon for the rice cultivation in India in traditional manner. More research to enhance the system of N_2 fixation by BGA will further give fillip to the rice production which will prove very beneficial in the long run.

REFERENCES

De, P. K. 1939. The role of BGA in N_2 fixation in rice fields in the yield of crops. *Indian Jour Agric Sci*. 20: 327-342.

Dodge A. D. 1975. Some mechanisms of herbicide action. *Sci Prog Oxf*. 62: 447-466.

Fogg, G. E., Stewart, W. D. P., Fay, P. & Walsby, A. E. 1973. The Blue-green algae, Academic press, London.

Gonzalves, E. A. & Gangala, K. S. 1949. J. Univ. Bombay 18 : 51-59.

Holm-Henson. 1968. Ecology, Physiology and Biochemistry of BGA. *Ann. Rev. Microbiol.* 22: 47-70.

Ishizawa, S. & Matsuguchi T. 1966. Effects of pesticides and herbicides upon microorganisms in soil and water under waterlogged condition. *Bulletin of the National Institute for Agricultural Science B*. 16: 1-90.

Kashyap, A. K. & Panday, K. D. 1982. Herbicide machete on anaboena sources. *zeitschrift for pfulnzenphysiologie* 107(4): 339-349.

Kim, J. D. and Choul G. L. 2006. Diversity of heterosystous filamentous cyanobacteria (BGA) from Rice Paddy field & their differential susceptibility to ten fungicides used in Korea. *Jour Microbiol. Biotechnol.* 16(2): 240-246.

Mitra, A. K. 1951. The algal flora of certain Indian soils. *Indian J. Agri. Sc.* 21: 357-373.

Singh, P. K. 1973. Effect of pesticides on blue-green algae. *Arch. Microbiol*. 89: 317-320.

Singh , P. K. 1975. Fertilizer tolerance of BGA. Annual Report, CRRI, Cuttack

Singh, P. K. 1978. N_2 economy of rice soils in relation to N2 fixation by BGA and Azolla: In National Symposium on Increasing Rice Yield in Kharif. CRRI Cuttak.

Singh, R. N. 1961. The role of blue-green in nitrogen economy of Indian agriculture ICAR Publ. New Delhi.

Sundarar Rao, W. V. B., Goyal, S. K. and Venkatraman, G. S. 1963. Effect of Inoculation of Aulosira fertilizer on Rice Plants. *Cur. Sci*. 32: 366-67.

Vaishampayan, A., Singh H. R. & Singh, H. N. 1978. Bioloical effects of rice field herlacide stam F-34 on various strains of the nitrogen–fixing blue-green alga *Nastoc musicorum*. *Biochem. Physiol. pflanz*. 173: 410-419.

Vander Werf, H. M. G. 1996. Assessing the impact of pesticides on the environment. agric ecosys. *Eviron*. 60: 81-96.

Venkataraman, G. S. 1972. Algal biofertilizers and rice cultivation. Today and tomorrow's publication, New Delhi,India.

Venkataraman, G. S. & Rajyalakshmi, B. 1972. Relative tolerance of nitrogen-fixing blue-green algae to pesticides. *Indian J. agric. sci*. 42(2): 119-121.

Venkataraman, G. S. 1981. Blue-green algae; a possible remedy to nitrogen scarcity. *Curr*. *Sci*. 50: 253-256.

Watanabe, I. & Roger, P. A. 1984. Nitrogen fixation in wetland rice fields in current development in biological n2-fixation Ed . N. S. Subba Rao. Oxford and IBH publ.CO.

Wyatt, J. T. & Silvey, J. K. S. 1969. N_2 fixation by *Gloeocapsa*. *Science*. 165: 908-909.