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BIODIVERSITY, OCCURRENCE AND SUCCESSION OF CYANOBACTERIA IN RICE FIELDS

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Occurrence and growth of cyanobacteria in rice fields are generally dependent on availability of water. The fields with less nitrogen and plenty of water harbour better growing heterocystous forms. The interesting coincidence is that most of the fields with better irrigation facilities have also better application of fertilizer and it results into a dense canopy of the crop and little growth of heterocystous cyanobacteria. However, such fields have rich growth of non- heterocystous cyanobacteria and green algae. However, those fields which are not submerged and have little or no application of fertilizers support enough growth of many terrestrial nitrogen fixing cyanobacteria. Observations throughout the rice cropping period indicated that during submerged conditions it starts with the growth of forms like *Microcoleus, Phormidium* and planktonic *Oscillatoria* and *Lyngbya*. Certain fields even in early stages show growth of *Wollea* or certain planktonic or mucilaginous species of *Anabaena spiroides*. After about forty five days of transplantation if the fields were found maintaining knee deep water an abundant growth of *Aulosira* and *Aphanothece* and rarely that of *Gloeotrichia* were observed. At the end of the crop when fields were having moist soil condition depending upon nutrient condition growth of either *Scytonema, Cylindrospermum* and *Nostoc* or growth of terrestrial *Oscillatoria, Lyngbya* and *Microcoleus* were observed. Observations on recurrence of certain cyanobacteria like *Aulosira, Aphanothece, Anabaena* and *Gloeotrichia* during consecutive three or four years/crops revealed that the first two forms *viz. Aulosira* and *Aphanothece* continued their appearance and abundance during subsequent years but the later two *viz. Anabaena* and *Gloeotrichia* were found to be quite erratic.

Key Words: Diurnal movement, Growth pattern, Perennation, Planktonic forms, Succession.

Cyanobacteria are prokaryotic organisms with oxygen evolving photosynthetic system. Many of them are capable of fixing atmospheric nitrogen (Stewart, 1980), and there role in the conservation of nitrogen level in the rice field ecosystem is considered to be of great economic significance. Primarily, attempts have been made to use them directly in the rice fields as biofertilizers (Venkataraman, 1972, 1981). Recently, there have been attempts to indirectly get the fixed nitrogen in the form of NH_3, released extracellularly (Stewart and Rowell, 1975; Ownby, 1977; Ladha *et al.*, 1978; Rai *et al.*, 1980; Stewart *et al.*, 1980; Guerrero, *et al.*, 1982; Musgrave, *et al.*, 1982; Ramos *et al*, 1982; Bergman 1984; Kerby *et al.*, 1986). Use of cyanobacteria as biofertilizers has been focussed in recent years, with the view to reduce total dependence on chemical fertilizers. The importance of cyanobacteria, in enriching tropical rice fields, and soil emphasized, since the original suggestion of De (1939). A thorough understanding of basic factors controlling nitrogen fixation will be essential to exploit them to the best advantage. Strains with ability to maintain the synthesis and activity of nitrogenase even in the presence of combined nitrogen may be of greater advantage since cultivated soils always contain some amount of combined nitrogen.

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MATERIALS AND METHODS

Present study was carried out in the paddy fields of five districts *viz a viz.* Allahabad, Bareilly, Jhansi, Gorakhpur and Mathura of Uttar Pradesh, India. Soil samples and algal patches (free floating, attached to soil and adhering to rice plants) were collected from different locations covering almost all the agro-climatic regions of Uttar Pradesh principally during the kharif cropping season (June to November) of 1991-1997. Surface soil (0-5 cm) was scrapped from a minimum of 10 spots from a specific area, sun dried and mixed together thoroughly. Enrichment cultures of the soil samples were raised to 10 cm petridishes containing 1 gm of soil sample and 10 ml of BG-11 medium at 28± 2°C under 4-5 K lux light intensity. Visible masses of cyanobacterial samples were collected in plastic vials and polythene bags, containing BG-11 medium (Rippka *et al.*, 1979). A portion of sample was fixed in Formalin for microscopic observations and the rest was used for isolation. All the specimens were critically examined for their morphological features and biometric characters and assigned to their respective binomial using the well known manuals (Geitler, 1932; Desikachary, 1959; Starmach, 1966; Baker and Bold, 1970; Anagnostidis and Komarek, 1988).

OBSERVATION AND RESULTS

(I) Occurrence and growth of cyanobacteria in rice fields:

Occurrence and growth of cyanobacteria in rice fields are generally dependent on availability of water (Tiwari and Singh, 2005). The fields with less nitrogen and plenty of water harbor better growth of heterocystous forms. The interesting coincidence is that most of the fields with better irrigation facilities have also better application of fertilizers and this result into a dense canopy of the crop and little growth of heterocystous cyanobacteria. However, such fields have rich growth of non-heterocystous cyanobacteria and green algae. It becomes obvious, even in those fields which are not submerged and have little or no application of fertilizers but support enough growth of terrestrial nitrogen fixing cyanobacteria. In the same way, the low lying fields which remain submerged throughout the cropping period have scattered growth of rice plants but show rich growth of floating colonies of *Aulosira, Glooetrichia* and *Tolypothrix*.

(II) Succession of cyanobacteria in Rice fields:

There are numerous variations in succession and growth of algal forms after transplantation in rice fields. In water logged condition, certain green algae (Chlorococcales or Volvocales) often form a green scum which may get accumulated on one side of the fields and they rarely continue for longer period and usually disappear within a week. Distinct growth of non- heterocystous forms like *Microcoleus, Oscillatoria* and *Lyngbya* appear on the surface of the fields. When water of field is absorbed and evaporated, many terrestrial forms like, *Scytonema, Camptylonemopsis, Tolypothrix, Lyngbya, Oscillatoria* along with mucilaginous patches of *Aphanothece, Anabaena, Cylindrospermum* and certain green algae start appearing in different colours. However, if fields remain submerged and undisturbed for 10 to 15 days, the bottom is colonized by mucilaginous and minute colonial growth of certain heterocystous forms including *Nostoc, Anabaena* and some planktonic growth appear. However, bloom formation in rice field is a rare phenomenon. Growth of cyanobacteria in the rice fields is never uniform throughout the cropping period and floristic composition may differ even between two adjacent fields. There are only certain floating forms like *Aulosira* which sustain unialgal growth for quite some time where sufficient water level is maintained. Normally the flora continuously change due to, fast decline of water level. Where soil conditions are such that fields get dried quickly every irrigation cycle impart a new type of floristic composition. However, other physico-chemical parameters also play important role in growth of cyanobacteria, but water being the dynamic medium plays a vital role in the change of growth patterns of these organisms. Although not realized but often there is demarcation in the distribution pattern of heterocystous and non- heterocystous forms in the rice field ecosystem. It has been observed that non-heterocystous forms are mostly restricted to soil surface or associated with terrestrial forms of *Nostoc* and *Calothrix* species. However, non-heterocystous forms like *Microcystis, Oscillatoria, Arthrospira* and *Trichodesmium* grow independently and gregariously only in specialized habitats. Heterocystous forms grow independently as planktonic forms, free floating on the water surface also attached to the soil surface as terrestrial forms. One of the obvious reasons for the universal distribution of heterocystous forms may be their efficient potential to fix nitrogen. It was also observed that the growth of planktonic forms is prolific but much sensitive and dependent on the interaction of many physical, chemical and biological parameters. The terrestrial communities, on the other hand, continue grow slowly so long as even little moisture is available in the soil. The terrestrial forms also have efficient mechanism of perennation.

(III) Diurnal rhythms:

In submerged rice-fields, cyanobacteria live on bottom or surface of water and also remain suspended in aquatic medium. Many forms of cyanobacteria take advantage of their gliding movement, presence of pseudo-vacuoles and trapping of air bubbles in the colonial mucilage or diurnal movement in aquatic ecosystem. Colonies, filaments and hormogonia are continuously exploring the most optimum location from the view point of bright or dim light, nitrogen fixation, nutrient and photosynthesis. Long mucilaginous strains of *Anabaena* or finger like tubular projections are often present in flooded rice-fields either hanging from the water surface or growing erect from the bottom of the fields. During the cropping period, when dried rice-fields get submerged during irrigation, many large terrestrial flakes trap the gas bubble in the morning (produced during photosynthesis) and rise up along with soils to the surface of water before noon and remain their for a few hours but settle down again on the bottom during the night. Such diurnal movement may continue for several days.

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