

Distribution pattern of *Aulosira* spp. in five Districts of Chhattisgarh on the basis of Physico-Chemical characterization

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Abstract:

Cyanobacterial species are commonly present in rice field's soil. *Aulosira* spp. is the nitrogen fixing cyanobacterial genera that present in rice fields. So the present paper attempted to physico- chemical characterization of *Aulosira* spp. from 192 rice fields soil samples collected from five district of Chhattisgarh [known as rice bowl]. Influence of soil type, pH and conductivity were correlated on their population for allelopathic application of local strains. At different locations and the pH of the soil varies from 5.0 to 8.1. Conductivity varies from 0.060 to 1.036. Altogether 06 species belonging to *Aulosira* genus were obtained and characterized. Present study proved that environmental factors and physico-chemical properties cumulatively decided the distribution of *Aulosira* Spp.

Keywords: *Aulosira*, rice field soil, nitrogen fixation.

Introduction:

The flooded Rice soil ecosystem is characterized by aerobic and anaerobic zones in three major ecological layers, the flood water and the surface of the soil, the anaerobic flow layer and the rhizosphere. The flood water and the surface of the soil provide the sites for aerobic phototrophic nitrogen fixation by free living Cyanobacteria (Roger and Kulasooriya, 1981). In return, cyanobacteria provide a large amount of nitrogen and phosphorus, which are the most required nutrients at the time of rice cultivation. Association and importance of cyanobacteria with rice fields have been known from ancient times. Appearance of cyanobacteria in rice fields is observed during the early stage of sowing due to continuous supply of water, rich nutrient availability, and high level of CO₂.

Chhattisgarh stretches across latitudinal expanse of the 17°46'N to 24°05'N on one hand to the longitudinal meridian of 82°15' E to 84° 20' E on the other hand, which is a hot torrid zone possessing a tropical type of climate that varies among districts. In Chhattisgarh rice field's four types of soil are present. These soils contain around 62% clay, 10% alumina, 9-10% iron oxide, and 6- 8% lime and magnesium carbonate (Singh et al. 2014). Soils of Chhattisgarh are fertile, which makes them suitable for production of various crops including rice. Despite their importance in rice fields, few reports are available about cyanobacteria in the rice fields of Chhattisgarh (Sharma and Naik 1996 and 1998, Shrivastava et al. 2009, Bajpai, 2013 and Sharma et al. 2017). However, these reports are confined to identification of cyanobacteria in the paddy fields. There is no comprehensive research or data are available to establish the role of pH and EC values on distribution pattern of *Aulosira* spp. in rice fields of Chhattisgarh because pH is essential parameters which influence the biochemical relations and possibly affecting cyanobacterial species distribution in rice fields (Sharma and Jain, 2016). The present investigation deal with the collection of *Aulosira* strains from 192 rice fields of Chhattisgarh and analysis of physico-chemical properties of soil, along with their impact on the diversity of the *Aulosira* spp. in different district of Chhattisgarh. The aim of present study was also to provide detailed microscopic observations of different species of *Aulosira* isolated from rice fields of Chhattisgarh.

Materials and Methods

A. Collection of the soil samples:

Soil samples were collected randomly from 192 rice fields belonging to 5 district of Chhattisgarh during kharif cropping season. The soils were contained fertilizers which were used by the farmer's

- Baloda Bazaar-Bhatapara district (site-1)
- Dhamtari district (Site-2)
- Gariaaban district (Site-3)
- Mahasamund district (Site-4)
- Raipur district (site-5)

Isolation of *Aulosira* Spp.: The collected soil samples were maintained by modified Chu-10 medium (Gerloff et al, 1950) amended with 1ml⁻¹ Fogg's micronutrients a solution (Fogg 1949) was taken as the enrichment culture.

Morphological observation of cyanobacteria:

Morphological observations of *Aulosira* spp. [shape and size of the vegetative cells, heterocyst's and akinetes] in the axenic cultures were studied by using an Olympus microscope as described by Prescott (1950), Desikachary (1959), Anand (1989) and Komarek (2010). Cyanobacterial images were study at 100X magnification.

B. Determination of physico-chemical properties of collected soil samples:

a. Soil type: The soils of Chhattisgarh state comprise mostly of iron rich Bhata soil, Kachhar Soil, Dorsa soil, Matasi soil, Kanhar soil.

b. pH and conductivity: The pH and conductivity of the soil samples were determined by using digital pH meter and conductivity meter, respectively. Conductivity was measured in mS/cm. Before measuring pH of the rice field's soil sample, the electrode contained KCl and was properly calibrated by using pH buffer of 4.0 and 9.2. The soil samples were prepared by dissolving 2.5 g of soil sample in 10 mL double distilled water. The readings were measured in triplicate.

Results and Discussion:

- a. Number of *Aulosira* spp. recorded: The present study showed that genus *Aulosira* spp. was recorded from 14 rice fields out of 192 rice fields' samples of Chhattisgarh state (Table-2). Total six species of *Aulosira* namely *A. aenigmatica*, *A. fertilissima*, *A. fertilissima v. tenuis*, *A. laxa*, *A. prolifica* and *A. pseudoramosa* were recorded. The detailed microscopic observations of different species of *Aulosira* isolated from rice fields of Chhattisgarh were shown in Table-1.
- b. Distribution pattern of *Aulosira* spp. in relation to soil type: Present study shows that ***A. fertilissima*** was most dominating spp. in the Chhattisgarh region (Fig-1) which was reported from 6 fields out of 192 fields and present in 4 types of (Dorsa, Kachhar, Kanhar and Matasi) soils except Bhata soil (Table-2). *A. aenigmatica*, *A. prolifica* and *A. pseudoramosa* were found in Matasi soil, *A. fertilissima v. tenuis* was found in Dorsa soil and *A. laxa* was found in Kachhar soil (Table-2). Present study shows that maximum 4 spp. *A. aenigmatica*, *A. fertilissima*, *A. prolifica* and *A. pseudoramosa* were recorded from Matasi soil which is the one of the most important rice field's soil of Chhattisgarh State. No spp. was recorded from Bhata soil (Fig -2).
- c. Soil pH: The analysis of rice field's soil from 192 samples of five district of Chhattisgarh state has shown that the pH range of the soils varies from 4.08 ± 0.20 to 8.05 ± 0.305 . Singh et al. (2014) showed that micronutrient availability is pH dependent. Cyanobacteria may also influence the pH due to their metabolic activities.
- d. Conductivity: In the present study site conductivity varies from 0.036 ± 0.10 to 1.718 ± 0.152 (Table-2). *Aulosira* spp. was recorded from 0.060-1.036 (Table-2). It has evident that the micronutrient availability is pH dependent. The electrical conductivity helped to improve cyanobacterial growth. (Bajpai, 2013).
- e. Physicochemical characterization of *Aulosira* spp.: The present study shows that in the study site *Aulosira* spp. prefer acidic to alkaline pH {pH 5.0-8.1 (Table-2)}. Similar finding were reported by Singh, 1961, Koushik, 1994, Nayak and Prasanna 2007. Higher value of pH can be attributed to higher growth rate of cyanobacterial population which utilized CO₂ through photosynthesis (Chaterjee and Raziuddin, 2006). Acidic soils are therefore one of the stressed environments for these organisms and they are normally absent at pH values below 5. Nayak and Prasanna (2007) investigated the cyanobacteria were more in number at high pH in rice fields. Cyanobacteria have been found not only to grow in highly saline-alkali soils, but also improve the physico-chemical properties of the soil by enriching them with carbon, nitrogen and available phosphorus (Kaushik, 1994). Subhashini and Kaushik (1981) reported that the pH of the alkaline soil decreased when treated with cyanobacteria. Normally eukaryotic algae flourish under these conditions. However Aiyer (1965) observed *Aulosira ferrilissima* and *Calothrix brevissima* have been reported to be ubiquitous in Kerala rice fields with pH from 3.5 to 6.5.

Table-1 General characteristics of *Aulosira* spp. isolated from five district of Chhattisgarh

| S. No | Name of <i>Aulosira</i> spp. | Vegetative cell | | | Heterocyst | | | Akinete | | | Special features (Sheath) |
|-------|---|----------------------|---------------------------------|---------|---------------------|---------------------|----------|-------------|---------------------------------|----------|-----------------------------------|
| | | Shape | Dimension Length Width um um | | Shape | Dimension Length um | Width um | Shape | Dimension Length Width um um | | |
| 1. | <i>A. aenigmatica</i> | Sub quadrate | 3-8 | 5.5-6.0 | Spherical & oblong | 6-8 | 6-7 | barrel | 3-5 | 7 | Sheath thin, membranous |
| 2. | <i>A. fertilissima</i> | Cylindrical / barrel | 5-7 | 6 | Oblong / elliptical | 10-14 | 8-9 | angular | 18-20 | 10-12 | Sheath thick, firm & brown |
| 3. | <i>A. fertilissima</i> v. <i>tenuis</i> | cylindrical | 3.5-10 | 3.5-5.5 | cylindrical | 8-10 | 4-7 | cylindrical | 11-15 | 5-8 | Sheath thin firm & brown |
| 4. | <i>A. laxa</i> | barrel | 3-4 | 5-8 | spherical | 5-8 | 5-8 | Not seen | Not seen | Not seen | Sheath thin delicate & hyaline |
| 5. | <i>A. prolifica</i> | Cylindrical | 5-14 | 5 | Cylindrical | 6-10 | 4.5-7 | Not seen | Not seen | Not seen | Sheath thin homogeneous |
| 6. | <i>A. pseudoramosa</i> | Cylindrical | 7-8 | 6 | Cylindrical | 8.5-8.0 | 6.5-7.5 | Not seen | Not seen | Not seen | Sheath thick, hyaline uneven firm |

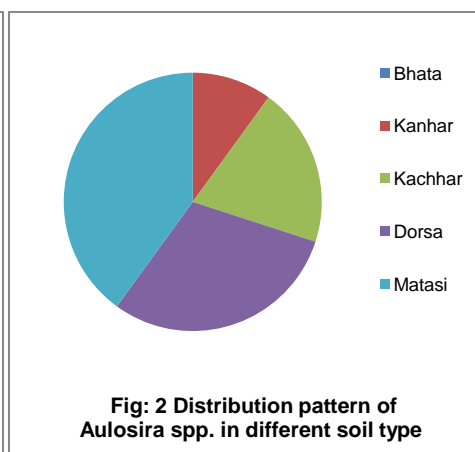
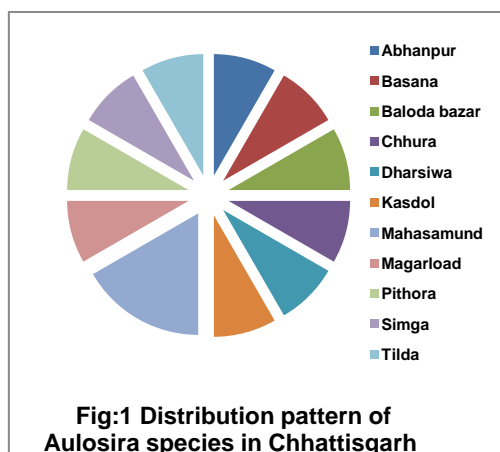
f.

g. Table-2 Distribution pattern of genus *Aulosira* observed in rice fields of Chhattisgarh in relation to physiochemical properties of soil

h.

| S.No | Name of species | pH range | Conductivity range | Soil type | No. of fields | Dominant soil type | Dominant site |
|------|---|----------------------|--------------------|-----------------------------|---------------|--------------------|---|
| 1. | <i>A. aenigmatica</i> | 6.5 (Acidic) | 0.284 | Matasi | 1 | Matasi | Mahasamund |
| 2. | <i>A. fertilissima</i> | 6.4-7.4 (wide range) | 0.270-0.694 | Dorsa Kachhar Kanhar Matasi | 6 | 4 types of soils | Abhanpur, Balodabazar, Chhura, Dharsiwa, Mahasamund |
| 3. | <i>A. fertilissima</i> v. <i>tenuis</i> | 7.1 (neutral) | 0.546 | Dorsa | 1 | Dorsa | Tilda |
| 4. | <i>A. laxa</i> | 5.0-6.8 (Acidic) | 0.060-0.444 | Dorsa Kachhar | 3 | Kachhar | Basana, Pithora |
| 5. | <i>A. prolifica</i> | 6.3-8.1 (wide range) | 0.254-1.036 | Matasi | 2 | Matasi | Magarload, Simga |
| 6. | <i>A. pseudoramosa</i> | 7.1 (neutral) | 0.530 | Matasi | 1 | Matasi | Kasdol |

i.



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