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Studies On Occurrence and Distribution of Cyanobacteria During Kharif and Rabi Season from Coastal Paddy Fields

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Abstract

The study area is well situated within the tropics and flanked by Arabian sea to the West and Western Ghats to the East. Having a monsoon type of climate, paddy is the one of the main crop which is cultivated during kharif and rabi season. In the present study coastal paddy field habitats were studied for a period of three consecutive years. The fields selected were analyzed for physico-chemical parameters. The studied parameters were correlated with the distribution of cyanobacteria in the two growing seasons. The results revealed that occurrence of cyanobacteria was comparatively more in kharif season than in rabi season.

Keywords: Cyanobacteria, physico-chemical parameters, paddy, kharif, Rabi, Coastal

INTRODUCTION:

The study area, which is situated well within the tropics and flanked by the Arabian Sea to the west and the Western Ghats (Sahayadris) rising to an average height of one kilometer to the east, has tropical-maritime and monsoon type of climate, with profound topographic influence. Accordingly, the climate is equable and moist throughout the year. Other features of the climate are the regular and sufficient rainfall during the southwest monsoon season, mainly from June to September and temperate weather during the rest of the year with little or no clear cut demarcation between what is generally termed as the winter period (January-February) and the hot weather period (March-May). The climate is generally pleasant. Discomfort may be felt in the absence of wind particularly during pre-monsoon and post-monsoon months.

The monsoon bursts over the state in the beginning of June and withdraws from it by early October. The annual rainfall is of the order of 350cm. As a result of the orographic influence, rainfall increases rapidly towards the Western Ghats from 250-300cm along the coast to over 400cm nearer the Ghats. Over 90% of the annual rainfall occurs during the monsoon months of June to September. July is the rainiest month when about 36% of the annual rainfall is recorded.

Soils can be classified as laterite, alluvial and sandy. The major portions of soils are lateritic.

In the present study coastal paddy field habitats influenced by different soil conditions were selected. The paddy field habitats were analyzed for their physico-chemical parameters **(Table 1)**. In the paddy fields growth of BGA and algal succession are governed by climatic and physico-chemical parameters (Roger, 1985).

MATERIALS AND METHODS:

Collection of water samples for analyses of physico-chemical parameters: Water and soil samples were collected for analyzing physico-chemical parameters from the two selected paddy field habitats every month in the two growing seasons of kharif and rabi.

A. Analyses of water samples

Analyses of water samples were carried out using the methods given in 'Standard Methods' (APHA, 1995) and 'Chemical and Biological Methods for Water Pollution Studies' (Trivedy and Goel, 1989).

1. **Temperature** of the water in degree Celsius was checked every month with the help of a thermometer.
2. **pH** of water was determined using a digital pH meter (pocket pH meter-Elico model).
3. **Dissolved Oxygen** in the water was determined by Winkler's Method, the details of which are described below:
4. The study constituted mainly the collection of water and soil samples containing blue green algae from the coastal paddy fields during the two growing seasons for three consecutive years. Collection of the soil samples containing blue greens was done, at regular

intervals from the growing, till the harvesting of the paddy in each growing season. Care was taken to collect algal samples from the surface of the soil, from the surface of submerged parts of the paddy plants and from the water surface. Identification of the blue green algae isolated from various sites was carried out by using standard keys (Desikachary, 1959; Anand, 1989; Prasad and Srivastava, 1992; Santra, 1993).

RESULTS:

The physico-chemical analyses of water and soil in the coastal paddy fields during the three consecutive years of study period showed the following results, Water temperature ranged between 25^0C to 28^0C The pH of water ranged from 5.1 to 6.5 and pH of soil ranged from 5.2 to 7.1. Electrical conductivity of water varied widely from 1.26-5.65mmhos/cm whereas EC of soil ranged from 4.7 to 6.5mmhos/cm. Dissolved oxygen (DO) varied from 2.1 to 8mg/l during the study period. Calcium content of water varied from 1.56 to 4.96mg/l and of soil varied from 1.8 to 4.1mg/l. Magnesium content of water varied from 1 to 3.7mg/l whereas Magnesium content of soil ranged from 0.17 to 1.5mg/l. Chloride content of water ranged from 5.3 to 8.2mg/l and of soil ranged from 6 to 10mg/l. Phosphorus content of water ranged from 0.01 to 0.32mg/l whereas Phosphorus content of soil fluctuated widely from 5.96 to 72.62kg/ha. Nitrogen content of soil ranged from 0.26 to 1.47kg/ha. Potassium content of paddy fields fluctuated from 85.3 to 224kg/ha.

The soil samples were analyzed for microelements Zn, Fe, Mn, Cu, and B. Zn varied from 1to 4ppm, Fe ranged from 51 to 85ppm, Mn ranged from 0 to 2ppm, Cu ranged from 1 to 2ppm and B ranged from 0 to 1ppm in the soil samples **(Table 1)**. Distribution of BGA: The study revealed 84 species belonging to 16 genera from two selected rice field habitats of Goa. The distribution of BGA during the three consecutive years of the study period is depicted in the **Table 2**. The study revealed that in the coastal paddy fields, variations in the distribution of genera and species for the two growing seasons of paddy *i.e.* kharif and rabi were observed. Thus the study that, higher pH shows better distribution of BGA in coastal fields. Among the other physico-chemical parameters analyzed higher parameters showed better distribution of BGA. The comparatively higher nutrient content of the paddy fields in both cultivation seasons showed better distribution of BGA *viz.,* the P content, dissolved Oxygen, Calcium, Magnesium, N, K and micronutrients were in higher amounts in coastal paddy feilds**. (Table 1).**

Table 1: Physico-chemical parameters of water and soil samples of paddy fields from coastal area for kharif and rabi seasons during the three consecutive years study period.

Water Sample								Soil Sample								
EC Mmhos / cm	**Temp ^{0}C**	**DO mg/l**	**Ca mg/l**	**Mg mg/l**	**P mg/l**	**Cl mg/l**	**pH**	**EC mmhos/ cm**	**N kg/ha**	**P kg/ha**	**K kg/ha**	**Ca mg/l**	**Mg mg/l**	**Cl mg/l**	**Zn ppm**	**Fe ppm**
5.58	27.00	8.00	4.96	2.20	0.32	5.80	7.10	6.50	0.45	17.88	179.20	2.20	0.23	6.20	3.32	85.03
5.18	26.00	7.40	1.72	2.00	0.12	5.70	6.50	5.80	0.42	23.84	156.80	2.50	0.20	6.10	2.77	79.52
5.65	25.50	6.20	1.63	2.00	0.01	5.30	6.60	5.50	0.40	8.94	134.40	2.00	0.32	6.00	3.82	69.80
5.39	27.20	6.50	1.56	2.00	0.02	6.20	6.20	5.40	0.33	5.96	156.80	2.00	1.50	7.80	1.62	74.43
5.02	28.00	6.80	4.52	1.00	0.02	7.10	5.80	5.30	0.26	5.96	224.00	1.80	0.20	9.00	2.92	59.58
5.34	26.00	6.20	3.70	1.20	0.01	8.20	5.60	5.10	0.52	17.88	112.00	2.80	0.19	10.2	3.38	43.14
4.53	25.00	6.80	3.60	3.10	0.25	7.10	5.70	4.80	0.56	8.94	145.60	3.80	0.17	10.0	3.14	51.08
1.26	25.00	5.80	3.50	3.70	0.3	6.50	5.40	4.70	1.47	26.82	89.60	3.40	0.26	9.20	1.72	80.84
4.91	26.50	6.60	3.20	2.80	0.28	8.10	5.30	5.20	0.35	8.94	89.60	3.50	0.23	6.50	3.16	62.02
4.65	27.50	2.10	4.20	2.00	0.3	5.40	5.20	5.10	0.57	72.62	85.30	4.10	0.25	6.20	3.06	59.24
4.75	26.37	6.58	3.25	2.20	0.16	6.54	5.91	5.31	0.53	19.67	137.76	2.82	0.33	7.72	2.89	66.28
1.27	1.04	0.66	1.21	0.82	0.13	1.06	0.58	0.45	0.31	19.68	44.19	0.80	0.31	1.73	0.70	13.24

Legend: EC = Electrical Conductivity; DO = Dissolved oxygen
All values are mean of three readings.

Table 2: Distribution of cyanobacteria in kharif and rabi season in coastal paddy fields			
Sr. No.	**Seasons & Year →**	**Kharif season (June to October)**	**Rabi season (December to April)**
	Study sites →	**Coastal fields**	**Coastal fields**
	Cyanobacterial species↓		
1	*Microcystis aeruginosa*	-	-
2	*M. elabens*	-	+
3	*Chroococcus turgidus*	+	+
4	*C. minutes*	-	-
5	*C. pallidus*	-	-
6	*C. cohaerens*	-	-
7	*Gleocapsa punctate*	+	+
9	*G. kuetzingiana*	-	+
10	*Aphanocapsa banaresensis*	+	+
11	*A. stagnina*	+	+
12	*A. saxicola*	+	+
13	*A. castagnei*	+	+
14	*Lyngbya spiralis*	-	+
15	*L. bergei*	+	+
16	*L. dendrobia*	+	+
17	*L. confervoides*	-	+
18	*L. martensiana*	+	+
19	*Oscillatoria ornate*	-	-
20	*O. limosa*	+	+
21	*O. subbrevis*	+	+
22	*O. curviceps*	+	+
23	*O. princeps*	+	+
24	*O. proboscidea*	+	+
25	*Oscillatoria anguina*	+	+
26	*O. Formosa*	+	+
27	*O. chlorine*	+	+
28	*O. martini*	+	-
29	*O. chalybea*	+	+
30	*O. tenuis*	+	+
31	*O. simplissima*	+	+
32	*O. limnetica*	+	-
33	*O. pseudogeminata*	+	-
34	*O. claricentrosa*	+	+
35	*O. salina*	+	+
36	*O. acuminate*	+	+
37	*O. brevis*	+	+
38	*Spirulina meneghiniana*	+	+
39	*S. princeps*	+	+
40	*Phormidium jadinianum*	-	-
41	*P. microtomum*	+	+
42	*P. purpurascens*	+	-
43	*P. mucosum*	+	-
44	*Cylindrospermum stagnale*	+	+
45	*C. muscicola*	+	+
46	*Nostoc punctiforme*	+	+
47	*N. entophytum*	+	+
48	*N. paludosum*	+	+
49	*Nostoc linckia*	+	+
50	*N. rivulare*	+	+
51	*N. carneum*	+	+

52	*N. ellipsosporum*	+	+
53	*N. calcicole*	+	-
54	*N. passerinianum*	+	+
55	*N. muscorum*	+	+
56	*N. commune*	+	+
57	*N. Microscopium*	+	+
58	*N. hatei*	+	+
59	*N. sphaericum*	+	+
60	*Anabaena sphaerica*	+	-
61	*A. oryzae*	+	+
62	*A .fertilissima*	+	-
63	*A. naviculoides*	+	+
64	*A. variabilis*	+	+
65	*A. torulosa*	-	+
66	*Scytonema simplex*	+	+
67	*S. coactile*	-	-
68	*S. bohneri*	+	+
69	*S. schmidtii*	-	-
70	*S. fremyii*	-	-
71	*Tolypothrix nodosa*	-	-
72	*T. tenuis*	-	+
73	*Tolypothrix fragilis*	-	-
74	*T. byssoidea*	-	+
75	*T. conglutinate*	+	-
76	*Calothrix castellii*	-	+
77	*C. membranacea*	-	-
78	*C. marchica*	+	+
79	*Rivularia aquatic*	-	+
80	*C. weberi*	-	-
81	*C. membranacea*	+	+
82	*C. marchica*	+	+
83	*Rivularia aquatic*	+	+
84	*R. globiceps*	-	+

Legends: + → (Present), - → (Absent)

DISCUSSION:

In the paddy fields growth of BGA and algal succession are governed by climatic and physico-chemical factors. Among the soil properties, pH is the most important factor determining the algal flora composition. Under natural conditions BGA grow preferentially in environments that are neutral to alkaline pH (Roger, 1985). This is the reason why positive correlation occurs in the paddy fields between: water pH and BGA number, soil pH and N_2 fixing algal biomass (Roger and Reynaud, 1982; Pereira *et al*., 2005; Ghadai *et al*., 2010).

In the present study, in coastal fields water pH ranged from 5.1-6.5. The study revealed that the alkaline pH in the habitats supported growth of BGA.

In the present study, temperature in all the study sites ranged from 25^0C to 31^0C during study period. Temperature is known to influence the composition of algal biomass and productivity. Low temperature decreases productivity while higher temperatures are known to favour BGA and increase algal productivity, with optimal temperature for luxuriant growth of BGA range from 30^0C-35^0C (Roger and Kulasooriya, 1980).

In the present study amount of P varies in different habitats., 5.96 to 72.62kg/ha in coastal fields, it can support luxuriant growth of BGA. Availability of P plays an important role in determining BGA growth which has been substantiated by various workers (Okuda and Yamaguchi, 1952;

Quesada and Valiente, 1996; Begum *et al*., 2008).

The study revealed a variation in Ca contents in different habitats. Ca content ranges from 1.56- 4.96mg/l in water and 1.8-4.1mg/l in soils of coastal fields. Since the it shows maximum Ca content, it can favour luxuriant growth of BGA. Previous studies suggested better growth of BGA in soils with optimum Ca levels (Healey, 1973; Roger and Reynaud, 1985).

The study suggests that coastal paddy fields are most suitable for the growth of BGA in kharif season and the rabi season shows comparatively lesser although there are reports that indicate BGA growth in pH range of 5 to 6 (Durell, 1964; Aiyer, 1965).

Various physico-chemical factors viz., light, temperature, pH, humidity, water and nutrient availability are known to favour the growth of cyanobacteria in paddy fields (Mitra, 1951). Therefore, the understanding of physico-chemical parameters and documentation of cyanobacteria can be applied for sustainable agricultural practices by reducing the application of chemical fertilizers to obtain indigenous inocula for algalization of fields.

CONCLUSION:

The forms showed variations in their occurrence during both kharif and rabi seasons. Maximum diversity of the BGA forms were observed in the kharif season as compared to rabi season in coastal fields. The study suggests that coastal fields are most suitable for the growth of BGA which in turn support the local crop of paddy as a natural biofertilizer. The study identifies heterocystous cyanobacteria which are potential biofertilizers and can be used to produce a local inoculum.

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