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Rhizosphere Algae of Paddy in Vidarbha region of Maharashtra State

K. J. Cherian

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Abstract

The microorganisms in the rhizosphere act as microbiological buffers and protect the plant from the infection of the pathogens. The actual mechanism of the buffering may be different for different types of plants. Plants influence the growth of microorganisms in its rhizosphere. The rhizosphere microorganisms showed different qualities and quantities in different types of plants and its stages and depths. Addition of organic manures to soil will increase the microbial activity in the soil. In all 84 taxa of 30 genera where identified through collection as well as cultures studies from the experimental fields. 56 belongs to Caynophyta, 19 belongs to Chlorophyta and 9 belongs Bacillariophyta. Rhizosphere of 4 varieties of rice (Nagpur-22, Ratna, Jaya and Sakoli-6) were studied. Blue-green algae were pre-dominant in the rhizosphere of all the 4 varieties. More species of algae were found in the rhizosphere (39 algal taxa) than in the non rhizosphere soil (26 algal taxa). The inter-specific differences in rhizosphere algae were present, as 13 algal taxa were attracted by all the 4 varieties of rice whereas others were not.

For Correspondence:

Department of Botany, Hislop College, Nagpur, India
Email: cherian_kj@yahoo.in

Introduction

Algae play an important role in the economy of soil. Hiltner (1904) introduced the term 'Rhizosphere'. Information has been accumulated on the subject of the abundance and activity of various microorganisms in the rhizospere of different species of plants. Although the algae are invariably represented in the micro flora of soils, our knowledge of their occurrence in the rhizospere is meager. The rhizosphere micro flora of root exerts certain effects known as 'Rhizosphere effect'. The microorganisms in the rhizosphere act as a microbiological buffers and protect the plant from the infection of the pathogens. The actual mechanism of the buffering may be different for different types of plants.

Rhizospere is an ecological niche which comprises the surface of plant roots (rhizoplane) and the region of the surrounding soil in which microbial population is affected by the presence of roots. The rhizosphere generally extends a few centimeters from the rhizoplane. The microorganism of the soil exert a variety of beneficial effects on the growth of the higher plants, on the other hand plants influence the growth of microorganisms in its rhizosphere. The microorganisms like Bacteria, Fungi and Algae play an important role in soil by solubilizing phosphorus and

making it available to plants, thus increasing the fertility of the soil (Wani, More & Patil 1979). Particular plants attract specific groups or species of microorganisms (Katznelson *et al.*, 1948). The living plants furnish algae in its rhizosphere with more suitable conditions (Gonzalves & Yalavigi, 1960).

The extent to which the plant benefits from the rhizospere micro flora is not clear. It may protect the plant from soil born pathogens or mineralizing activity of them. Gray & Williams (1971) proposed that terrestrial algae may function in the formation and stabilization of soils. Enhanced growth of algae in the rhizosphere has been observed by several workers (Katznelson 1946, Shtina 1959 b, Hadfield 1960, Gonzalves & Yalavigi, 1960, Cullimore & Woodbine 1963). The microbial population in the rhizosphere was more than the distant soils (Agnihothrudu, 1953). Gonzalves & Yalavigi (1960) concluded that more algae were found in the rhizospere than other areas at the same depths. The seedlings of Tea plants significantly increase the algal population in the root zone (Hadfield 1960). Cullimore & Woodbine (1963) reported stimulatory rhizosphere effect of Pea root on soil algae. The rhizosphere microorganisms showed different qualities and quantities in different types of plants and its stages and depths.

Addition of organic manures to soil will increase the microbial activity in the soil. Application of Sesamum oil cake to red sandy soil stimulate increase bacterial and fungal population, while Groundnut oil cake stimulate bacteria and inhibit fungal activity. Amendment of soil with gypsum, sulphur & groundnut oil cake increase the number of rhizosphere flora (Sunar & Chohan, 1971). Phorate granules, a systemic insecticide affects the rhizosphere micro flora of various plants (Tiwari, 1972, Kandaswamy *et al.* 1975, Visalakshi & Nair (1979). The light intensity and mineral nutrients affects the abundance of rhizosphere flora (Newman 1978). Algalization decreases the rhizosphere mycoflora of Rice plants (Gangawane & Saler, 1979).

Material and Methods

In Vidarbha, both transplanted variety as well as drilled variety was used for cultivation. In all 23 varities of rice were used, of which 19 of transplanted variety and 4 drilled variety. The transplanted variety yield more than the drilled variety. Total 4 varieties *i.e.* Nagpur-22, Ratna, Jaya, Sakoli-6 were grown in the fields for the study. The seed rate (40 – 50 kg/hector), distance between two rows of plants (20 cm.) and fertilizers (100:50:50: N.P.K.) were as done in normal course of cultivation. Plant population per hector was maintained as 3.50 lakhs.

Paddy field of Umrer in Nagpur district was chosen for experimental studies. Plants were sowed in July and transplanted in August. Plants showed healthy growth and were observed regularly. The rhizosphere and non rhizosphere soil samples were collected from September to October and also after the harvesting of the crop i.e. November.

Rhizosphere soil sample

Plants were carefully dug out from the field and superfluous soil adherent to the roots gently removed by shaking to release the root system. The entire root was then snipped off and transferred to a measured amount of sterile distilled water in a wide mouthed bottle. The contents of the bottle were then subjected to vigorous shaking and the root system further washed out in to the bottle before being removed and discarded. The resulting suspension was then filtered through a dried Whatman no. 1 filter paper

which after filtration was introduced into culture media. Multiple of cultures were made in different media.

Non- rhizosphere soil sample

Soil samples from similar depth away from the roots of the rice plants were taken for each variety of rice. These samples were inoculated into the culture media. Multiple cultures of the sample were made in different media to rule out the possibility of an algae missing from the observation.

Culture media: Two types of cultures, liquid and moist, were prepared for studying the soil algae and fresh collections. The bottles and conical flasks were used for the liquid cultures whereas petridishes were used for the moist cultures. The culturing vessels with culture media were sterilized in an autoclave at 2 lbs pressure for 20 minutes prior to inoculation.

Three different culture media were employed for culturing. They are as follows :

1. De's (1939) modified Beneck's medium
2. Allen and Arnon's (modified) medium (Allen&Arnon, 1955, b)
3. Chu. No. 10 (Modified Medium (Cerloff *et al.,* 1950)

Culture media were made in double distilled water with required constituents.

Results and Discussion

The occurrence of an alga at a particular region is confirmed by soil cultures. The spores can reach other regions of soil due to drainage or cultivation method. In dry powdered soils only spores of algae can present and not any vegetative stage of it. Such sample shows algal growth only after 15 days. The alga which make the presence within 10 days after inoculation were considered to be present in vegetative stage.

In all 84 taxa of 30 genera could be identified through collections as well as culture studies, out of which 56 belong to Cyanophyta, 19 belong to Chlorophyta and 9 Bacillariophyta. The genera collected with the number of species in parenthesis are Microcystis (1), Chroococcus (8), Gloeothece (3), Aphanocapsa (5), Aphanothece (2), Chlorogloea (1), Oscillatoria (11), Phormidium (8), Lyngbya (3), Anabaenopsis (1), Nostoc (4), Anabaena (3), Aulosira (1), Plectonema (1), Tolypothrix (1), Calothrix (2), Hapalosiphon (1), Chlamydomonas (2), Chlorococcum (2), Scenedesmus (3), Ulothrix (5), Geminella (2), Protococcus (1), Closterium (3), Cosmarium (1), Fragillaria (1), Synedra (1), Achnanthes (1), Navicula (2), Cymbella (2), Nitzschia (2). The Cyanophycean members were dominated over other classes of algae as it has 66.66% of the total whereas only 22.73% Chlorophyceae and 10.71% Bacillariophyceae were present in the experiment field.

The rhizosphere algae of 4 varieties of rice (Nagpur-22, Ratna, Jaya and Sakoli-6) were studied. Nagpur-22 variety of rice had 24 taxa of algae out of which 17 belonged to Cyanophyta, 5 belonged to Chlorophyta and 2 belonged to Bacillariophyta. The 24 taxa were distributed amongst 17 genera as Chroococcus (3), Aphanocapsa (1), Oscillatoria (3), Phormidium (2), Lyngbya (1), Nostoc (2), Anabaena (1), Plectonema (1), Tolypothrix (1), Calothrix (2), Chlamydomonas (1), Chlorococcum (1), Protococcus (1), Closterium (1), Cosmarium (1), Fragillaria (1), Cymbella (1).

In all 20 taxa were identified from the rhizosphere of Ratna variety out of which 14 belonged to Cyanophyta, 3 belonged to

Chlorophyta and 3 belonged to Bacillariophyta. These taxa were distributed amongst 16 genera as Chroococcus (3), Aphanocapsa (1), Aphanothece (1), Oscillatoria (1), Phormidium (2), Lyngbya (1), Nostoc (1), Anabaena (1), Plectonema (1), Tolypothrix (1), Hapalosiphon (1), Chlorococcum (1), Protococcus (1), Cosmarium (1), Fragillaria (1), Navicula (2). The Jaya variety showed 19 taxa in its rhizosphere which belonged 13 to Cyanophyta, 3 to Chlorophyta and 3 to Bacillariophyta. The species of 13 genera were included. They are Chroococcus (2), Aphanocapsa (1), Oscillatoria (2), Phormidium (3), Nostoc (2), Anabaena (1), Tolypothrix (1), Calothrix (1), Chlorococcum (1), Protococcus (1), Cosmarium (1), Fragillaria (1), Nitzschia (2). The rhizosphere of Sakoli-6 variety holded 26 algal taxa which belonged 18 to Cyanophyta, 6 to Chlorophyta and 2 to Bacillariophyta. They are Chroococcus (3), Aphanocapsa (2), Oscillatoria (1), Phormidium (3), Lyngbya (2), Nostoc (2), Anabaena (1), Aulosira (1), Tolypothrix (1), Calothrix (2), Hapalosiphon (1), Chlamydomonas (1), Chlorococcum (1), Ulothrix (1), Geminella (1), Protococcus (1), Cosmarium (1), Fragillaria (1), Cymbella (1).

The common rhizosphere algae of all the 4 varieties of rice were Chroococcus minor, C. schizoder-maticus, Aphanocapsa grevillei, Oscillatoria sancta, Phormidium luridium, P. tenue, Nostoc muscrum,Anabaena naviculoides, Tolypothrix byssoidea, Chlorococcum humicolo, Protococcus viridis, Cosmarium granatum, Fragillaria brevistriata F. elongata. The algae which were present in both rhizosphere and non-rhizosphere were Chroococcus minutes, Aphanocapsa fronticola, Lyngbya hieronymusii, Ulothrix variabilis Geminella minor.

The result shows that blue green algae were pre-dominant in rhizosphere soils of all the 4 varieties of rice studied. Since the rhizosphere provides rich food base and alkaline soils, it supports the blue green algae than other groups of algae (John 1942). More species of algae were found in the rhizosphere (39 algal taxa) than in the non-rhizosphere soil (26 algal taxa). As the plant develops, the soil around the roots naturally becomes more favorable medium for the growth of algae as it may be receiving certain exudates from the roots. Maximum number of algal species was found when the plant begins to flower. However it is likely that as the number of algal species increase in the region of the rhizosphere, some of the algal spores may be carried away from the rhizosphere by small animals or may be washed down by rain to places away from roots.

Conclusion

Culture and collection studies of soil algae of the experiment field proved the dominance of Cyanophyceae over other groups of algae present. Number of algal taxa was found to be more in the rhizosphere than in the non-rhizosphere. The inter-specific differences in rhizosphere algae were present, as 13 algal taxa were attracted by all the 4 varieties of rice whereas others were not.

S. No.	Name of Alga	Nagpur-22	Ratna	Jaya	Sakoli-6
	CYANOPHYTA				
1	Chroococcus limneticus		p		0
2	Chroococcus minutes				p
3	Chroococcus minor	P	p	p	p
4	Chroococcus schizodermaticus	P	p	p	p
5	Chroococcus tenax	P			
6	Aphanocapsa fonticola				p
7	Aphanocapsa grevillei	P	p	p	p
8	Aphanothece naegelii		p		
9	Oscillatoria princeps	P			
10	Oscillatoria proboscidea	P		p	
11	Oscillatoria sancta	P	p	p	p
12	Phormidium bohneri			p	p
13	Phormidium luridum	P	p	p	p
14	Phormidium tenue	P	p	p	p
15	Lyngbya hierogymusii	P			p
16	Lyngbya lachneri		p		
17	Nostoc muscorum	P	p	p	p
18	Nostoc spongiaeforme	P		p	p
19	Anabaena naviculoides	P	p	p	p
20	Aulosira aenigmatica				p
21	Plectonema tomasinianum	P	p		
22	Tolypothrix byssoidea	P	p	p	p
23	Calothrix epiphytica	P		p	p
24	Calothrix marchica	P			p
25	Hapalosiphon welwitschii		p		p
	CHLOROPHYTA				
26	Chlamydomonas globosa				p
27	Chlamydomonas mucicola	P			
28	Chlorococcum humicolo	P	p	p	p
29	Ulothrix variabilis				p
30	Geminella minor				p
31	Protococcus viridis	P	p	p	p
32	Closterium parvulum	P			
33	Cosmarium granatum	P	p	p	p
	BACILLARIOPHYTA				
34	Fragillaria brevistriata f. elongate	P	p	p	p
35	Navicula clavata		p		
36	Navicula grivillei		p		
37	Cymbella cymbiformis	P			
38	Nitzschia dissipata				
39	Nitzschia gracillis				

Table I: Rhizosphere Algae of four varieties of Rice

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CYANOPHYTA

1. Chroococcus macrococcus
2. Chroococcus minutes.
3. Chroococcus spelaeus.
4. Chroococcus turgidus v. fuscescens.
5. Aphanocapsa fonticola.
6. Aphanocapsa nivalis.
7. Aphanothece microscopica.
8. Chlorogloea microcystoides.
9. Oscillatoria curviceps v. angusta.
10. Oscillatoria jenensis.
11. Oscillatoria subbrevis.
12. Phormidium africanum.
13. Phormidium foveolarum.
14. Phormidium jenkelianum.
15. Phormidium uncinatum.
16. Lyngbya aerugineo-coerulea.
17. Lyngbya heironymusii.
18. Anabaenopsis circularis.
19. Nostoc microscopicum.
20. Anabaena laxa.

CHLOROPHYTA

21. Chlorococcum vitiosum.
22. Ulothrix variabilis.
23. Geminella minor.
24. Closterium acutum

BACILLARIOPHYTA

25. Synedra affinis
26. Cymbella austriaca

Table II: Non-rhizosphere algae of the experiment field

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