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IMPACT OF SIX ELEMENTS AND LIME ON THE GROWTH OF ALGAE IN POT CULTURE

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Abstract

Effect of N P K S Ca Mg and lime on the establishment and growth of algae in a rice-soil ecosystem has been examined in a pot culture experiment. A variation in the qualitative and quantitative estimation of algal flora was observed due to application of some of these fertilizers. However, the treatment rates showed some variation on both the parameters. Altogether 35 genera were identified. The fertilizers stimulated the propagation of 7 genera of Bacillariophyceae followed by 14 of Chlorophyceae. Only one genus, *Euglena*, from Euglenophyceae was recorded. Though 13 genera of Cyanophyceae were observed their abundance was very poor. The response of the genera of Cyanophyceae was either limited or nil to the application of N, K and lime. The results revealed that low does of fertilizers are essential for the establishment and proper growth of algae.

Introduction

Cultivation of blue-green algae (BGA) as an alternate source of nitrogen, particularly in low land rice soil, has now been gaining momentum due to increased crisis and production cost of N-fertilizer, specially in developing countries. The rice field ecosystem has been assigned to be very much conducive and favourable for the stimulative abundance and normal growth of BGA (Prikhod' kova 1971).

However, the growth of algae in the rice field is markedly inhibited by the presence of parasitic bacteria (Roger and Reynaud 1979), H_2S and low p^H (Kulasooriya and De Silva 1978). Limited information is available on the effects of nitrogen (Roger et al. 1980), phosphorus (Srinivasan 1978), potassium (Mahapatra et al. 1971), and magnesium (Stewart *et al.* 1979) on the growth of BGA in rice field. Many other essential elements such as S and Ca are required for optimal growth and development of BGA but their roles on algal community in rice fields have not been demonstrated.

Thus, a pot experiment was conducted to follow the implications of N P K S Ca Mg and lime on the growth of indigenous algae in wet land rice soil ecosystem.

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Materials and Methods

Soil sample (0-15 cm) collected from deep water rice field at Sonargaon was air-dried and ground to pass through 2 mm sieve. Five kilograms of soil sample was placed into each of the forty clean-dry earthen-ware pots (25 x18 cm). The potted soil was separately treated with three rates of each of S, Ca and Mg (20, 40 and 60 kg ha^{-1}) as $CaCl_2$, $MgCl_2$ and elemental S respectively and lime ($CaCo_3$) to raise the pH from 5.5 to 6.5 and 7.5. All these treatments were coupled with a basal level of NPK at the rate of 90, 60 and 80 kg ha^{-1} respectively. Moreover, three rates of N (60, 90, 120 kg ha^{-1}) as urea with a basal dose of P and two rates of P (60 and 100 kg ha^{-1}) as TSP with a basal dose of K and two rates of K (40, 80 kg ha^{-1}) as MP with a basal dose of N were included. Together with a control, 19 treatments in duplicate, were arranged in a randomized block design.

Polythylene sheet was used to avoid any contamination from the pot. Soil samples were kept submerged (1-2 cm water on the surface) for 7 days. The potted soils were then allowed to dry up to moist condition to facilitate the growth of algae present in the soil. Then 21 days old rice seedlings (BR-4) of uniform size were transplanted at the rate of 2 plants $hill^{-1}$ and 3 hills pot^{-1}.Tap water was added to keep the soil submerged. Weeds, other than algae, were removed as they appeared. The experiment was continued up to maturity of rice.

p^H(5.5) was measured electrochemically by using a combined glass/calomel electrode with a corning pH meter from a soil suspension (soil: water, 1:2:5), Total N (0.15%) was estimated by Kjeldhal digestion method and that of available P (18 $\mu g\ g^{-1}$) was measured colorimetrically after developing phosphomolybdo- yellow phosphoric acid complex. Algal samples were collected for three times from all the treatments at an interval of one month from the date of transplantation. Each sample was a mean of three sub-samples. The relative abundance of each form of algae were identified and recorded under microscope on a scale of 0-5.

Results and Discussion

The effect of N P K S Ca Mg and lime on the establishment and growth of algae has been observed(Table 1). The treatments showed variation in algal growth over the control. Most of the treatments produced almost double the amount of algae in comparison to control. The total abundance score of algae recorded in the control treatment was only 11.

The result shows that the variation in total abundance score of algae among the rate of each chemical was not statistically significant (Table 1). However, the chemical fertilizers resulted a significant change in algal amount indicating their positive effect on

Table 1. Effect of N P K S Ca Mg and lime on the growth and abundance of algae in rice soils.

Treatments (Kg/ha)	Nitrogen			Phosphorus		Patassium		Calcium			Magnesium			Sulphur			pH		Control	
Algal forms	60	90	120	60	100	40	80	20	40	60	20	40	60	20	40	60	6.0	7.5	5.5	Total
CHLOROPHYCEAE																				
Pandorina	3	5	2	1	1	1	2	2		2	3	2	1	1	3	2	1	2	1	35
Eudorina	2	4	1		2	3			2		1		2	1			1	3	1	23
Ulothrix																		1		01
Stichococcus									1											01
Leptosiropsis												1				1				02
Coleochaete (Young)																	1			01
Oedogonium				1		1			1			1			2		3			09
Pithophora															2					02
Chlorococcum	3	2	3	1		2		2	1	1	1			4		3	2	2	1	28
Chlorella	2	1	2	2	2	1	3	1	3	1	2	1	3	3	2	3	2	2	1	37
Crucigenia		1																		01
Mougeotia									1									1		02
Closterium				1							1									02
Cosmerium																	1			01
Sub-Total	10	13	8	6	5	8	5	5	9	4	8	5	6	9	9	9	11	11	4	= 145
EUGLENOPHYCEAE																				
Euglena	2		1		2		3	1			1			1					1	= 12
BACILLARIOPHYCEAE																				
Fragilaria	2	1	1	2	2	2	3	1	2	4	3	4	2	1	3	1		1		35
Synedra	1		3	1			1	1		1	1					3				12
Cocconeis				1	1			1		1		1	1						1	07
Navicula	2	1	2	3	2	4	2	4	3	3	5	5	2	3	4	4	4	3	3	59
Pinnularia	2	1	2	2	2	1	3	2	2	3	2	2	1	2	1	2	1	2	2	35
Gyrosigma													1							01
Gomphonema											1									01
Sub-Total	7	3	8	9	7	7	9	9	7	12	12	12	7	6	8	10	5	6	6	= 150

CYANOPHYCEAE																					
Microcystis				1							1								1		03
Chroococcus				1	1							1	2		1						06
Gloeocapsa												1	1		1				1		04
Aphanothece													1								01
Myxosarcina				1								1	1								03
Xenococcus	1																1		1		03
Oscillatoria				1					1				1				1		1		04
Phormidium		1			1										1		1				04
Nostoc					1																01
Anabaena					1				1			1									03
Scytonema		1														1					01
Homoeothrix																					01
Calothrix				1	2	1		1	1	1	2	1	1	3			1	3			15
Sub-Total	–	1	2	5	6	1	–	1	3	2	2	5	7	3	4	1	3	3	–		= 49
TOTAL	19	17	19	20	20	16	17	16	19	18	23	22	20	19	21	20	19	20	11		

LSD at 5% level = 1.82

the growth of algae. This suggests that the algae need these fertilizers in small amount for their normal growth.

A close comparison of the data suggests that addition of NPK fertilizers could stimulate the propagation of algal flora in rice soil significantly at 5% level. Yoshida *et al.* (1973) also observed that N fertilizers increased algal growth, but generally there were more BGA in pot without N fertilizer. Similarly Than Tun (1969) reported that nitrogenous fertilizers increased the total algal biomass and depressed the growth of *Anabaena*. In paddy soils, P supply enhances algal growth (De and Mandal 1958). The growth of BGA seemed closely related to the available P (Okuda and Yamaguchi 1952) and showed tendency to correspond to total and available P content of soil (Araragi *et al.* 1978). In contrast, K was reported to have either no effect (Marathe 1963) or a depressive effect (Mahapatra *et al.* 1971) on algal growth.

Moderation of pH from 5.5 to 6.5 and 7.5 had also a significant effect on algal growth. Abundance of available nutrients at pH 7.5 might have enhanced the vegetative propagation of algae. This is in accordance with the findings of Yamaguchi (1975).

The response of Mg to algal proliferation was the best among the chemicals used. The total abundance score of algae in the pot receiving 20 kg Mg ha^{-1} was 23 and the score decreased as the level of Mg increased though not significantly.

Data also revealed that no BGA appeared in the control pot. Moreover, even in the treated pots the abundance of score of BGA was not very appreciable. This suggests that the propagating units of BGA were naturally so minimum in quantity that those algae could not compete well with other algae for their proper establishment and growth.This is in accordance with the observation of Khan (1984)who worked with some rice growing soils of Bangladesh. Venkataraman (1975) also found that only 33 percent of the 2213 rice field soil samples of India analysed for algal components, harboured nitrogen fixing BGA.

During this investigation 35 different types of algal genera have been identified. However, only seven genera were common in all the treatments. Rest of the genera were found to vary in different treatments. The genera *Stichococcus*, *Mougeotia* and *Gomphonema* were scarcely detected in pots treated with calcium and magnesium. The most common genera identified were *Pandorina*, *Chlorella*, *Chlorococcum*, *Eudorina*, *Fragilaria*, *Navicula* and *Pinnularia*. Among the most common genera the highest frequency was recorded for *Navicula* (59) followed by *Chlorella* (37). The distribution for *Pandorina*, *Fragilaria* and *Pinnularia* was equal having the frequency 35. The frequency of *Chlorococcum* and *Eudorina* was 28 and 23 respectively. Two more genera *Calothrix* (15) and *Synedra* (12) were also recorded though their frequency distribution was comparatively less.

Furthermore, it has been seen that algal genera identified belonged to four classes and their order of abundance may be arranged as Bacillariophyceae (150), Chlorophyceae (145), Cyanophyceae (49) and Euglenophyceae (12). The results also revealed that the members of the family Cyanophyceae responded poorly to the applied fertilizers.

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