PRELIMINARY OBSERVATIONS ON THE INTERACTION OF DIFFERENT RICE SOIL TYPES TO INOCULATION OF BLUE-GREEN ALGAE IN RELATION TO RICE CULTURE

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Investigations carried out in the Central Rice Research Institute on the rôle of blue-green algae in the enrichment of rice soil yielded very encouraging results to improve rice production (Relwani, 1963, 1965; Relwani and Manna, 1964; Relwani and Subrahmanyan, 1963; Subrahmanyan *et al.*, 1964 *a*, 1964 *b*, 1964 *c*; 1965). The success in this line of work prompted us to test the soils of a few other rice-growing regions of India as to their suitability for application of the schedule evolved in our experiments. Some preliminary results of such tests carried out with soils from Karjat (Maharashtra), Palur (Madras), Pattambi and Kayamkulam (Kerala), Nellore (Andhra), Nagenahalli (Mysore) and Titabar (Assam) are reported in this account. Work is in progress to cover more regions.

Methods

For each of the soil types six treatments, *viz.*, *A*: Control; *B*: *A* + Algae; *C*: lime at 1,000 Kg./Ha., superphosphate at 20 Kg. P_2O_5/Ha. and sodium molybdate at 0·28 Kg./Ha.; *D*: C + Algae; *E*: ammonium sulphate at 20 Kg. N./Ha.; and *F*: ammonium sulphate at 40 Kg. N./Ha. were tried under pot culture in five replicates. Eight Kg. of soil were used in each of the pots. The fertilizers measured in terms of quantity soil per pot were applied as basal dressing after puddling. Only two plants were grown per pot. Variety *CR.T. 141* (145 days duration) was grown as the test crop. Blue-green algae inoculation consisting of a mixture of N-fixing species of *Nostoc*, *Anabena* and *Scytonema*, from the laboratory culture of one of us (R. S.), was used at the rate of about one mgm. per pot.

The respective soil types have been analysed for their physical and chemical properties before the crop was planted.

Results and Discussion

The grain yield data of control and the response of the above-mentioned treatments are presented for the different soil types in Table I.

TABLE I

Response of blue-green algae under different soil types. Grain yields of control and response of different treatments over control (Average of five replications)

Main crop season. Variety *T. 141*

Treatments	Karjat	Palur	Pattambi	Kayam-kulam	Nellore	Nagena-halli	Titabar
A—Control ..	1·71	2·66	3·74	4·64	7·40	12·00	14·48
B—Control + Algae ..	−0·33	+0·10	−0·60	+1·72	+2·12	−0·12	+1·82
C—Fertilizer mixture (Lime + Superphosphate + sodium molybdate)	−0·11	+0·84	+0·08	+0·10	+2·54	+0·56	+0·34
D—Fertilizer mixture + Algae ..	−0·96	+1·16	+0·52	+0·80	+3·10	+3·86	+2·44
E—Ammonium sulphate at 20 Kg. N/Ha. ..	−0·67	+0·96	+1·94	+1·38	+2·00	+4·74	+0·24
F—Ammonium sulphate at 40 Kg. N/Ha. ..	+0·55	+1·99	+1·92	+2·38	−0·78	+6·76	+0·86

It may be seen from Table I that there was a great variation in the control yields varying from only 1·71 gm. (Karjat soil) to as high as 14·48 gm. (Titabar soil) which indicates very well the contribution of soil factor for increasing yield of rice.

Application of blue-green algae alone gave a definite positive response for soils of Kayamkulam, Nellore and Titabar.

The addition of fertilizer mixture (treatment *C*) gave a good response with Nellore soil only whereas this did not seem to improve yields in the case of other types. This would indicate that the indigenous flora have thrived much better contributing to the nitrogen enrichment in Nellore soil. It may be pointed out that the pH of this soil was as high as 9·0 (Table II) which is a factor conducive to blue-green algae growth.

In the treatment *D* (fertilizer mixture + algae) positive response was found in all the instances except with Karjat soil. The response to blue-green algae in terms of percentage over the respective controls was in the following order: Palur, Nellore, Nagenahalli, Titabar, Kayamkulam and Pattambi.

TABLE II

Analytical data (physical and chemical properties) of different soils used in the experiment

	Karjat	Palur	Pattambi	Kayam-kulam	Nellore	Nagena-halli	Titabar
pH (suspension) 1:2·5	7·90	7·60	5·60	6·05	9·00	5·55	4·95
pH (saturated paste)	7·80	7·30	5·70	5·80	8·40	5·50	4·70
ECe of saturated extract	0·33	1·02	0·84	1·32	0·39	0·33	0·42
% Sand ..	50·08	60·70	53·35	93·5	63·17	56·52	61·53
% Silt ..	24·54	13·10	24·06	1·6	5·56	15·68	19·15
% Clay ..	25·38	26·20	22·59	4·9	30·27	27·80	19·32
Textural class ..	Clay loam	Clay loam	Clay loam	Sandy	Sandy clay	Clay loam	Loam
Carbon (Org.) Walkly Black	0·373	0·491	2·026	0·290	0·633	1·385	0·603
Total N% ..	0·0317	0·048	0·2183	0·0281	0·0684	0·1278	0·0664
Loss on ignition ..	4·92	2·91	10·4	1·28	3·64	6·67	2·58

With 20 Kg. N/Ha. the percentage response over control was in the following order: Pattambi, Nagenahalli, Palur, Kayamkulam and Nellore. In the case of the other two soils the response was negligible.

With 40 Kg. N/Ha. the percentage response over control was in order: Palur, Nagenahalli, Kayamkulam and Pattambi. In the other soils the response was negligible. The response with fertilizer mixture on Nellore soil was superior to ammonium sulphate at both 20 and 40 Kg. N/Ha. In the other instances, the responses were almost at par with 20 Kg. N/Ha.

Fertilizer mixture + algae gave definitely higher response compared with 20 Kg. N for Palur soil and 40 Kg. N for Nellore and Titabar soils. In the other instances the response to ammonium sulphate was better than fertilizer mixture and algae.

It may be mentioned in this connection that laboratory cultures of respective soil types with nutrient solutions gave a good growth of several species

of indigenous blue-green algae including nitrogen fixers such as *Nostoc* sp., *Tolypothrix* sp., *Anabaena* sp., etc., though there was a time lag in their appearance. In the pot cultures the poorest response with Karjat soil where algal growth was poor would appear to be due to lack of one or more nutrients in that soil other than fertilizer mixture applied. In the present state, this soil might require a different schedule of fertilizer mixture for manifestation of better blue-green algal growth.

The better response over even 40 Kg. N/Ha. with fertilizer mixture and algae in the instances of Nellore and Titabar soils would indicate that algae supply certain other substances for the growth of the rice crop. The lesser response in other soils with similar treatment is presumably due to lack of certain factors for the full manifestation of the blue-green algae. It was interesting to note that in the Nellore and Titabar soils the algal growth was more pronounced than in the other instances.

It was mentioned above that the response to the *soil factor alone* (control) was better in the Nellore, Titabar and Nagenahalli soils than in the others. Most of the major factors for growth of plants are the same whether they are rice plants or algae.

From the analysis of the soil before planting (Table II) it is not possible to single out any one factor or factors acting as a limiting factor. It may noted, however, that the initial carbon or nitrogen content of the soil has no correlation to the response of the rice crop nor any of the other properties apparently. Both algae (in the laboratory cultures and pots) and the rice crop thrived better in the above-mentioned three soils. This would indicate that there are other factors concerned limiting growth in the other soils for the rice plant as well as algae.

From the better response even over 40 Kg. N/Ha. in instances of algal inoculation in the three above-mentioned soils in particular where algal growth was also pronounced, it is apparent that certain factors limiting growth besides nitrogen are made good by the manifestation of blue-green algae. It is possible that the organic matter given out as extra-cellular product by the blue-green algae as well as the organic matter left behind after the growth season, contain the growth-promoting substances with trace elements linked to carbon in a particular manner beneficial for growth. The former acts during the current season and the latter adds to the fertility of the soil, a favourable residual effect (Subrahmanyan *et al.*, 1965). Work in progress on the chemistry of the soils is expected to throw light on this problem.

SUMMARY

The results of investigation with soils of seven different regions of India for testing their suitability for the nitrogen enrichment of them using the blue-green algae are dealt with. Of the soils studied (of Karjat, Palur, Pattambi, Kayamkulam, Nellore, Nagenahalli and Titabar) those of Nellore, Nagenahalli and Titabar were the best as regards their response to algal inoculation as well as yield potential. Results also indicated that apart from nitrogen supply, the algae contribute certain other growth promoters beneficial to the rice crop. Studies on the physical and chemical properties of the soil before planting do not apparently disclose any limiting factor for growth of the rice plant or algae, but the performance of both in the soils indicate that some essential organic substance/s or trace elements could be the limiting factor/s.

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