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BLUE-GREEN ALGAL TREATMENT AND INOCULATION HAD NO SIGNIFICANT EFFECT ON RICE YIELD IN AN ACIDIC WETLAND SOIL

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A field experiment on an acidic soil poor in available phosphorus showed that a pretreatment of rice seedlings with a blue-green algal culture and/or inoculation of the field with a composite inoculum of N_2-fixing blue-green algae had no significant effect on rice yield.

INTRODUCTION

Over the past three decades, there have been reports on the use of blue-green algae (BGA) inoculants (algalization) to enhance biological N_2 fixation (BNF) and grain yield in wetland rice fields. The reports conflict in both the success of inoculation and the inoculation's effect on rice yield (Roger and Kulasooriya, 1980).

When successful, algalization increased yield by an average 14% (field experiments). The increase was attributed to N_2 fixation and the production of growth-promoting substances by BGA. This so-called "auxinic effect" was studied mostly *in vitro* or in pot experiments, hardly representative of field conditions (Roger and Kulasooriya, 1980).

Possible reasons for algalization failure include soil properties, climatic factors, biotic factors, and the quality of the inoculum. Studies of the relationship between the physicochemical properties of the soil and response to algalization indicate that low pH limits BGA growth (Okuda and Yamaguchi, 1952; Subrahmanian et al., 1965). A negative correlation between pH and the abundance of soil BGA was also reported in several ecological studies of rice soils (see Roger *et al.*, this issue).

This note reports a field experiment conducted to study the effect of algal inoculation in an acidic soil and to test if the pretreatment of rice seedlings with BGA culture could increase rice yield in such a soil.

MATERIALS AND METHODS

Experimental Design

The experiment was conducted in an acidic soil poor in available phosphorus, located in Luisiana (Laguna Province, Philippines) (Table 1). The indigenous algal population in the upper one centimeter of the soil, evaluated by plating on BG11 agarized medium, was 1.3×10^5 colony forming units (CFU)/cm^2, among which 17% (1.5×10^4 CFU/cm^2) were

Table 1. Chemical and algological characteristics of Luisiana soil.

Chemical properties		Algal flora (0-1cm soil layer)	
pH (water)	5.7	Total (CFU/cm^2)	1.3 x 10^5
Organic C (%)	1.42	BGA (CFU/cm^2)	2.2 x 10^4
Total N (%)	0.156	N^2-fixing BGA (CFU/cm^2)	1.6 x 10^4
CEC (meq/100g)	27.70	*Nostoc* spp.	94%
Na "	2.47	*Calothrix* spp.	5%
K "	0.75	Others	1%
Mg "	6.36		
Ca "	11.60		
Avail. p (ppm)	5.8		

N_2-fixing BGA, mostly *Nostoc* spp. The methods of analysis are described elsewhere (Roger et al. 1986).

The field experiment layout was a randomized design with six replicated plots (4 x 5 m) per treatment. Treatments were 1) control, 2) presoaking rice seedlings in a BGA culture, and 3) presoaking rice seedlings in a BGA culture and field inoculation with BGA.

Pretreatment of the Seedlings

Seeds of IR58 were soaked in a dense culture of *Nostoc* sp. (about 1.5 g dw/litre) for 48 h and spread on a seedbed at IRRI for germination. *Nostoc* culture used for soaking was evenly spread on the surface of the seedbed. Seeds soaked in water and grown on a seedbed where no BGA culture was applied served as control. After 14 days, BGA-treated seedlings and control seedlings were dipped in 1% zinc oxide solution for half an hour to prevent zinc deficiency. Seedlings were then transplanted in the field at 20 x 20 cm spacing on August 14, 1984.

BGA Inoculum

Inoculation at one week after transplanting, used simultaneously composite fresh and dry inocula to increase the chances of establishment of inoculated strains.

The fresh inoculum was a mixture of *Nostoc* sp. (Strain SL of IRRI's collection), *Anabaena variabilis*, *Aulosira fertilissima*, and *Tolypothrix tenuis*. The inoculum, obtained by decantation of liquid cultures in BG 11 medium without mineral nitrogen, contained about 4 g dw algal material per liter. It was applied at 250 ml/plot, equivalent to 500 g dw/ha.

The dry inoculum, applied at 20 kg/ha, was a mixture of 24 monostrain soil-based inocula produced on Maahas soil according to the method described by Venkataraman (1981). *Nostoc* was the dominant genus in the mixture.

Density of colony-forming units (CFU) in the dry inoculum was 2 x 10^6/g. Assuming an average density of 1.7 x 10^8 CFU/g dw in dried, powdered cultures of BGA (unpublished data), the applied inocula (fresh + dry) were equivalent together to 1.25 x 10^3 CFU/cm^2. The number of CFU of

BGA applied per hectare was therefore about 10 times less than the number of CFU already present in the soil. However, the quantity of inoculum applied (fresh + dry) was equivalent, on a CFU basis, to 70 kg of soil-based inoculum /ha, or seven times the recommended dose (Venkataraman, 1981).

Agronomic Practices

Plots were kept flooded (2-7 cm water depth) throughout the experimental period. Phosphorus and potassium were applied at 30 kg/ha. No nitrogen fertilizer was applied. Plots were hand weeded at 28 and 45 days after transplanting (DT). Insecticide carbofuran (Furadan G) was applied at 1.0 kg ai/ha after transplanting and at 14 and 35 DT. Insecticide monocrotophos was sprayed at 0.4 kg ai/ha at flowering. No herbicide was applied. At maturity (November 16), yield was estimated by harvesting plants at ground level from two 6-m^2 areas in each plot.

RESULTS AND DISCUSSION

The seedbeds showed no earlier germination of treated seeds nor difference in size or color of the seedlings. BGA material applied on the treated seedbed persisted for a few days but did not develop into a bloom.

In the field, large freshwater snails (*Ampullaria* sp.), predators of algae, were present in all the plots before transplanting. Furadan application reduced their number. During the crop cycle, a few colonies of mucilaginous BGA, mostly of the unicellular type, were observed, but no algal bloom developed in the inoculated or control plots. The density of BGA colonies at the beginning of the cultivation cycle was not higher in the inoculated plots.

Yield measurements (Table 2) were in agreement with the visual observations, showing no statistically significant differences between treatments.

Table 2. Straw and grain yield[a].

	Straw (kg/ha)	Unfilled grains (kg/ha)	Filled grains (kg/ha)	Shoot biomass (kg/ha)	Panicle per hill (g)
Control	1916 ± 315	208 ± 68	4142 ± 587	6267 ± 830	17.2 ± 2.4
Seedling treated	2016 ± 213	197 ± 84	4304 ± 409	6517 ± 571	17.8 ± 1.6
Seedling treated and soil inoculated	1973 ± 277	197 ± 50	4336 ± 349	6506 ± 552	18.0 ± 1.48
F value	0.20 ns	0.05 ns	0.30 ns	0.27 ns	0.32 ns
cv %	14	34	11	10	11

[a]each value is the average of six replications. Values are followed by the 5% confidence interval of the mean.

Our results confirm the earlier observation by Okuda and Yamaguchi (1952) and Subrahmanian *et al.* (1965) that algal inoculation might be ineffective in acidic soils. Despite a very high level of inoculation (seven times the recommended dose) and the utilization of a composite inoculum containing fresh and dry material, no BGA bloom was established. The presence of a fairly high level of propagules of indigenous N_2-fixing BGA in the field confirms that the absence of blooms in the field is due to unfavorable environmental conditions rather than the absence of BGA.

Pretreatment of rice seedlings with a BGA culture was reported to enhance rice growth in *in vitro* and pot experiments (see Roger and Kulasooriya, 1980) but did not significantly increase yield in the field.

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