Soil and crop management

Effect of surface application of straw on phototrophic nitrogen fixation

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A field experiment during the dry season tested the effect of surface application of straw on phototrophic nitrogen fixation. Continuously flooded study plots had received no N fertilizers for 5 years. Subplots were 1-m × 1-m metal frames inside each experimental plot. IR36 was transplanted at 16 hills/subplot at 20-cm × 20-cm spacing. Weeds were removed as they emerged. Treatments (each with 3 replications) were:

Control: carbofuran added at 3 kg active ingredient/ha every 2 weeks.

Straw treatment: ground straw (0.85% N) applied at 300 g/m^2 (3 t/ha). Carbofuran applied as in control.

Nitrogen-fixing activity (acetylene reduction) was measured and N_2-fixing blue-green algae (BGA) were counted 26, 41, 61, 84, and 98 days after transplanting (DT).

Seven core soil samples were taken randomly from each 1-m^2 plot by inserting 2-cm diameter, 12-cm-long glass tubes to about 5 cm below the soil surface. Tubes were plugged at the bottom and placed inside an airtight transparent cylinder, 7.2 cm in diameter and 32 cm long.

Incubation was in an atmosphere of 10% acetylene in air under sunlight (45-50 klux). A water bath maintained cylinder temperatures at 30-35° C. Ethylene produced after 15 minutes, 1 hour, and 3 hours incubation was determined by gas chromatography. The atmosphere of the cylinders was mixed before each sampling with a 50-ml syringe.

Acetylene reduction activity (ARA) present in paddy soil sampled at given days after transplanting (DT) of a rice crop at IRRI.[a]

	ARA[b] (mmol C_2H_4/m^2 per hour)					
	26 DT	41 DT[c]	61 DT	84 DT	98 DT[d]	Av
Control	32 a (80, 8, 8)	0 a (0, 0, 0)	115 a (60, 157, 128)	27 a (1, 80, 3)	113 a (4, 320, 13)	57
Straw applied	795 b (1224, 795, 366)	0 a (0, 0, 0)	65 a (20, 113, 8)	2 a (6, 0, 0)	41 a (18, 3, 103)	180

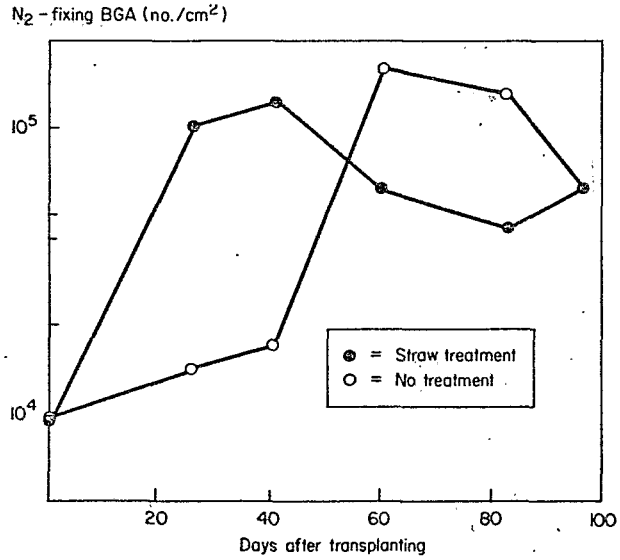
[a]Three hours incubation. [b]Figures in parentheses are replication values. Av values followed by common letter are not significantly different. [c]Measured 1 day after a heavy rain (80 mm). [d]Measured after harvest.

The same core samples were used to enumerate N_2-fixing BGA. Suspension dilutions of soil were plated on BG 11 medium without nitrogen.

Blooms of BGA appeared, but were not present in all replications of a given treatment at a given time. This agrees with results of acetylene reduction activity measurement, which varied widely between replications (see table). The small size of the plots, the irregular distribution of BGA in the fields, and the protection from inoculation by the water or the soil of the surrounding field by a continuous frame may not have permitted simultaneous growth of N_2-fixing BGA in the different replications of a treatment.

Plots in which straw was applied were characterized by an earlier growth of N_2-fixing BGA and a significantly higher ARA at the beginning of the growth cycle of rice (see figure). The presence of photosynthetic bacteria was not measured.

The beneficial effect of surface application of straw on photosynthetic N_2-fixation may be due to an increase of CO_2 availability in the photic zone, a decrease of mineral N and O_2 concentrations in the floodwater, and the provision of micro-aerobic microsites by the straw. Increased CO_2 availability and a low N concentration are known to favor the growth of N_2-fixing BGA. A low O_2 concentration and the micro-aerobic sites in the photic zone may have increased their specific nitrogen-fixing activity.



Evolution of the population of N_2-fixing BGA during a rice crop at IRRI.