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THE USE OF *SESBANIA* AS AN ALTERNATIVE SOURCE OF UREA-N FOR BR-11 RICE

S. Pervin, M.S. Hoque, M. Jahiruddin and M.H. Mian
Department of Soil Science, Bangladesh Agricultural University, Mymensingh, Bangladesh

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A field trial was conducted to evaluate the performance of *Sesbania* and *Azolla* manures as alternative sources of urea-N in producing higher yield of BR-11 rice. *Sesbania* (inoculated with *Bradyrhizobium* inoculant) treatment resulted in the highest rice yield of 4363 kg/ha with a yield benefit of 44% increase over control. The increase in rice yield was 32% due to urea and 31% for *Sesbania* (uninoc.). *Azolla* manuring could not give significantly higher yield because of insufficient biomass production due to elevated temperature prevailing during the growth period. *Sesbania* manuring enriched soil fertility by increasing organic matter level and P, K and S availability in soils.

Key words: *Azolla*, Rice, *Sesbania*, Urea.

Introduction

Nitrogen is the most deficient element in Bangladesh soils because of tropical climate favouring higher mineralization of organic matter and urea is the most commonly used fertilizer in these soils. This fertilizer is extensively used in rice crop which covers about 80% of the total cultivated area. Though the application of urea enhances crop yield, its continuous use deteriorates soil properties creating nutrient imbalance in soil [1]. One of the paradoxes in nature is the abundance of nitrogen in the atmosphere and its non-availability to most of the plants. The most valued asset of *Sesbania* plant is its ability to work with a bacterium, *Bradyrhizobium* sp. in root nodules and gather molecular nitrogen from the atmosphere. Goswami *et al.* [2] reported that *Sesbania aculeata* increased 0.5 t/ha rice yield and N recovery from 60 kg N/ha as *Sesbania aculeata* application was 35%. *Azolla* is also another green manuring plant. It is a small free floating aquatic fern and is capable of fixing atmospheric nitrogen through symbiosis with a blue-green alga, *Anabaena azollae*. The ^{15}N tracer studies indicate that N_2 fixed by *Azolla* is available to the rice plants [3-5] and this green manure can supply 20-30 kg N/ha in wetland rice soil [6]. Besides enriching the soil with nitrogen, *Sesbania* or *Azolla* green manure helps to improve the physical, chemical and microbiological properties of soil [7]. The present investigation was, therefore, undertaken to examine the effects of *Sesbania*, *Azolla* and urea application on the yield of rice, and on the soil properties.

Experimental

The experiment was conducted in old Brahmaputra Floodplain soil of Bangladesh Agricultural University Farm, Mymensingh, from April through December of 1989. The soil was silt loam having 6.4 pH, 1.85% organic matter, 0.125% total N, 12 ppm available P, 0.3 meq% exchangeable K and 20 ppm available S. The crop variety was BR-11 (Mukta) rice. There were five treatments as follows:

(i).Sesbania (inoc.) manuring. Seeds of *Sesbania aculeata* were coated with peat based *Bradyrhizobium* inoculant at the rate of 100 g/kg seed using gum acacia as the sticking agent. *Sesbania* seeds were sown in respective plots and were allowed to grow for 70 days. Thereafter, the plants were chopped and ploughed down in the soil and rice seedlings were tansplanted after four weeks of *Sesbania* incorporation. Before transplanting, growth of *Sesbania* in terms of nodulation and shoot dry matter weight were recorded from 1 m^2 area/plot after 45 and 70 days of sowing.

(ii).Sesbania (uninoc.) manuring. Sesbania seeds were sown without inoculating with *Bradyrhizobium*. The plants were chopped and ploughed down after 70 days of growth as in (i).

(iii). Azolla manuring. Fresh *Azolla (Azolla pinnata)* was applied at the rate of 0.33 kg/m^2 after seven days of transplanting of rice seedlings. May be because of high temperature (30 ± 2°C) *Azolla* did not grow well. *Azolla* was incorporated to soil after 20 days of its application.

(iv). Urea application. Urea was applied at the rate of 80 kg N/ha in three equal splits during land preparation, and after 30 and 60 days of transplanting.

(v). Control. No urea, *Sesbania* or *Azolla* was applied. The experiment was laid out in randomized complete block design with four replications. The treatment plots were of 5 x 4m. Basal fertilizer application was made with triple superphosphate, muriate of potash and gypsum at the rates of 60 kgP_2O_5/ha, 40 kg K_2O/ha and 20 kg S/ha, respectively.

The crop was harvested at maturity after four months of transplanting. Yield data were recorded plot-wise and yield components were scored from ten randomly selected hills from each plot. After harvest, soil samples from each plot were analyzed for pH, organic matter, total N, and available P, K and S contents [8].

Results and Discussion

Grain and straw yields. Grain yield of rice increased significantly due to the treatments. The yield potential of different treatments followed the order of : *Sesbania* (inoc.) > urea > *Sesbania* (uninoc.) > *Azolla* > control (Table 1). Application of *Sesbania* inoc. resulted in the highest grain yield of 4363 kg/ha although it was not significantly different from the yields due to urea (4018 kg/ha) and *Sesbania* uninoc. (3984 kg/ha) treatments. Incorporation of *Azolla* produced a yield of 3465 kg/ha, which, however, was not statistically different from that of the control. *Sesbania* (inoc.) treatment gave a yield benefit of 1323 kg/ha (44% increase) over control (Table 1).

Effect of various treatments on straw yield was similar to that observed in grain yeild. Thus, the highest straw yield (4497 kg/ha) was obtained from *Sesbania* (inoc.) treatment and the lowest yield (3119 kg/ha) from control (Table 1). Further, there was no significant difference in straw yields due to *Sesbania* (inoc.), *Sesbania* (uninoc.) and urea treatments. Similarly there was no significant difference between *Azolla* and control treatments. *Sesbania* (inoc.) resulted in 44% higher yield over control (Table 1).

Yield components. The number of tillers/hill increased significantly due to *Sesbania* and urea applications. The highest tillering was recorded in *Sesbania* (inoc.) treatment and the lowest in control. Next to *Sesbania* (inoc.), urea produced the highest number of tillers, followed by *Sesbania* (uninoc.) and *Azolla* treatments. Plant height was also found to be maximum (109.5 cm) in *Sesbania* (inoc.) manuring and minimum (94.7 cm) in control (Table 1). However, significant difference was not observed with the two *Sesbania* (inoc. and uninoc.) treatments and urea application. Similarly the plant height recorded in *Azolla* treatment was statistically similar with that observed in control.

The number of grains/panicle was recorded to be maximum in *Sesbania* (inoc.) manuring followed by a declining trend with *Sesbania* (uninoc.), urea, *Azolla* and control treatments. Of the five treatments, green manuring with *Sesbania* (inoc.) and *Sesbania* (uninoc.) gave statistically similar number of grains/panicle while the results due to other treatments were significantly different. Like yield and several other parameters, the highest 1000-grain weight was recorded in *Sesbania* (inoc.) treatment and the lowest in control. However, 1000-grain weight remained unaffected by urea, *Sesbania* (uninoc.) and *Azolla* applications.

Grain yield of the crop was positively correlated with tillers/hill (r= 0.960; P<0.01), grains/panicle (r= 0.949; P<0.05) and 1000-grain weight (r=0.921; P<0.05) (Table 3). As revealed from path coefficient analysis, the direct contribution of tillers/hill to grain yield was maximum. This indicates that grain yield was relatively more dependent on tillering and less on other components tested.

Soil properties. It appeared that when the soil was treated with green manures *(Sesbania* or *Azolla)* and urea, some soil

TABLE 1. EFFECT OF *SESBANIA*, *AZOLLA* AND UREA ON YIELD AND YIELD COMPONENTS OF RICE.

Treatment (N source)	Plant height (cm)	Grains/ panicle (no.)	1000-Grain weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
Control	94.7b	90d	23.4c	3040b (0)	3119b (0)
Urea-N	104.9a	118b	23.7b	4018a (32)	4484a (44)
Azolla	95.3b	105c	23.7b	3465b (14)	3390b (9)
Sesbania (unionc.)	109.5a	130a	23.8b	3984a (31)	4438a (42)
Sesbania (inoc.)	105.4a	129a	23.9a	4363a (44)	4497a (44)
LSD (P=0.05)	4.8	11	0.1	443	880

Figures in a column having common letter (s) do not differ significantly at 5% level of significance. uninoc. = uninoculated; inoc. = inoculated with *Bradyrhizobium* inoculant. Figures in parentheses indicate % increase over control.

TABLE 2. EFFECT OF *SESBANIA*, *AZOLLA* AND UREA ON SOIL PROPERTIES (AFTER HARVEST).

Treatment (N source)	pH	Organic matter (%)	Total N (%)	C:N ratio	Available P (ppm)	Exchangeable K (meq/100g)	Available S (ppm)
Control	6.3	1.85c	0.120	9:1	9.4e	0.293	19.5e
Urea-N	6.3	1.93bc	0.127	9:1	11.0d	0.315	20.4d
Azolla	6.3	2.18ab	0.122	10:1	12.0c	0.330	21.0c
Sesbania (uninoc.)	6.3	2.15ac	0.127	10:1	12.3b	0.338	22.0a
(Sesbania) (inoc.)	6.1	2.33a	0.130	10:1	13.0a	0.325	21.5b
LSD (P=0.05)	NS	0.31	NS	-	0.23	NS	0.17
Initial status	6.4	1.85	0.125	9:1	12.0	0.300	20.0

Figures in a column having common letter (s) do not differ significantly at 5% level of significance. uninoc. = uninoculated; inoc. = inoculated with *Bradyrhizobium* inoculant.

TABLE 3. PATH COEFFICIENT ANALYSIS SHOWING THE CONTRIBUTION OF COMPONENT CHARACTERS TO GRAIN YIELD.

Characters	Indirect effects through				Simple linear correlation of characters with grain yield
	Plant height	Tillers/ hill	Grains/ panicle	1000-grain weight	
Plant height	**-0.0607**	0.4549	0.2655	0.1919	0.8516 ns
Tillers/hill	-0.0490	**0.5628**	0.2417	0.2045	0.9600**
Grains/panicle	-0.0566	0.4778	**0.2847**	0.2433	0.9492*
1000-grain weight	-0.0444	0.4394	0.2644	**0.2620**	0.9214*

Residual effect (R^2) = -0.0001. * =P < 0.05. **= P < 0.01. ns = not significant. Bold denote direct effects.

properties *viz.* organic matter, available P and available S contents greatly varied while other soil characteristics *viz.* pH, total N and exchangeable K content remained nuaffected (Table 2). The level of soil organic matter increases to a considerable extent with *Sesbania* (inoc.) manuring and to a lesser extent with *Sesbania* (uninoc.) and *Azolla* treatments. Beneficial effects of *Sesbania* manuring were also noticed in case of available P and S contents of soil. The use of *Azolla* did not show beneficial effects in respect of P, K and S availability in soil. Urea application increased the P, K and S availability in soils.

Green manuring with *Sesbania* (inoc.) showed the best performance in this study. The higher yield of rice as obtained with *Sesbania* manuring agrees well to the findings of Maskana *et al.* [9] and Mann *et al.* [10]. Next to *Sesbania* (inoc.) manuring, urea performed better. Since, the experimental soil was highly deficient in nitrogen, its application in any form was certainly beneficial for the crop. Urea application ensured only N enrichment in soils but *Sesbania* manuring contributed N and many other nutrients, and further it improved organic matter content in soil. Such a beneficial effect of green manures on soil organic matter was also reported by other workers [11, 12]. Inoculated *Sesbania* manuring exhibited more pronounced effects compared to uninoculated *Sesbania* treatment primarily because of producing higher nodulation, dry matter weight and nutrient content (Table 4). *Azolla* did not give satisfactory results presumably due to their unsatisfactory growth under higher temperatures (28 ± 2°C) during August-September. Solaiman *et al.* [13] and Mian [14] stated that *Azolla* should be incorporated to soil after formation of a thick layer of biomass within 3-4 weeks of its application. They obtained good effect of *Azolla* in Boro rice where *Azolla* was grown and incorporated to soil during January-February when temperature was low (20 ± 5°C). After extensive reviewing, Subba Rao [6] stated that the use of *Azolla* in rice cultivation provided 20-30 kg N/ha, which was less than one-third of the N requirement of wet land rice. Beri and Meelu [15] observed that when temperature went above 30°C in May-June, *Azolla* could not be multiplied for incorporation to soil.

TABLE 4. NODULE NUMBER, DRY MATTER WEIGHT AND NUTRIENT CONTENT OF *SESBANIA* AT 45 AND 70 DAYS AFTER SOWING.

Parameter	45 DAS		70 DAS	
	uninoc.	inoc.	uninoc.	inoc.
Nodule no. /plant	39.9	49.0	8.7	11.2
DM weight (kg/ha)	2350	2500	3875	4562
N (%)	1.98	2.37	1.55	1.84
P (%)	0.214	0.218	0.137	
1.1611				
K (%)	2.25	1.95	1.26	1.03
S (%)	0.248	0.333	0.207	0.262

uninoc. = uninoculated. inoc. = inoculated with *Bradyrhizobium* inoculant.
DAS = days after sowing.

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