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INTEGRATED MANAGEMENT OF SESBANIA ROSTRATA AND UREA NITROGEN IN RICE UNDER A RICE-RICE CROPPING SYSTEM

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Abstract
An investigation was undertaken at the farming systems research site, Bagherpara, Jessore, to study the effects of green manuring (Sesbania rostrata) followed by five rates of N application on the grain yield of T. aman rice and physical and chemical properties of soil. Grain yield of rice increased significantly after green manuring. Application of a varied rates of N further improved the yield. Addition of 30 kg N/ha after green manuring produced almost similar grain yield to that of 90 kg N/ha without green manuring. Availability of N, P and K in the soil and the water holding capacity of the soil increased after green manuring.

Key words: Sesbania rostrata, Urea, Rice-rice cropping system.

Introduction
Rice is the staple food of a large proportion of the world population and it is the major wet season crop of Bangladesh. With the increase in irrigation facilities rice-rice sequence is becoming a major cropping system in the high and medium high land areas of Bangladesh. In the present energy crisis, an alternative to fertilizer nitrogen for maintaining the productivity of rice soils is a major concern of researchers. Green manures are good sources of nitrogen for rice (Eaqub and Miah, 1981; BRRI, 1988; Sethi et al., 1952; Singh, 1971 and Staker, 1958). Sesbania aculeata is used as green manure from time immemorial and it can save 30-60 kg N per hectare (Hossain et al., 1987; Aktar and Haque, 1989; Aktar et al., 1990; Tiwari et al., 1980 and Bhardwaj et al., 1981). Sesbania rostrata is a new green manuring species in Bangladesh which can fix nitrogen not only in root nodules but also in numerous stem nodules. Although many studies have been done on different aspects of Sesbania aculeata, very little information about

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Sesbania rostrata is available. In the present study attempts were made to fulfil the following objectives: (i) to test the feasibility of using Sesbania rostrata as a catch crop after harvest of Boro rice for manuring the following transplanted aman rice, (ii) to evaluate the amount of fertilizer N that can be substituted by Sesbania rostrata, and (iii) to study the availability of nutrients in soil after manuring.

Materials and Methods

The experiment was conducted at the Farming Systems Research (FSR) site, Bagherpara, Jessore, in 1991 under irrigated conditions in medium high land having a soil pH range of 7.0-8.5. It was laid out in a split-plot design with four dispersed replications. The following treatments were used:

Main plot: (1) Fallow (without green manure) and (ii) Sesbania rostrata as green manure. Sub-plot: Nitrogen at 0, 30, 60, 90, and 120 kg/ha.

Unit plot size was 100 m². Sesbania rostrata was sown during the last week of May. The crop was fertilized with 60 kg P2O5/ha. Fifty five days old Sesbania rostrata was harvested in the third week of July, weighed (@ 20 l/ha) and incorporated in the soil, and the land was prepared for subsequent transplanted aman rice. P and K fertilizers were applied at the rate of 60 kg P2O5 and 40 kg KgO/ha, respectively, in the fallow plot and only 40 kg K2O/ha in the green manured plot during final land preparation. Thirty day old rice seedlings were transplanted at 25 cm x 15 cm spacing during the third week of July. Three to four seedlings were used per hill. Five levels of nitrogen viz. 0, 30, 60, 90 and 120 kg/ha were applied as top-dressing in three equal splits viz. 15 days after transplanting, at maximum tillering and a week before panicle initiation. All cultural practices were done as and when necessary. The crop was harvested during the first fortnight of November. All data were statistically analyzed using "Analysis of Variance" technique and differences among treatment means were compared by means of Duncan’s Multiple Range Test (Steel and Tome, 1960). Economic analysis was done as per Perrin et al. (1979).

Results and Discussion

Effects of green manuring

The effects of green manuring of the yield of rice is summarized in Table 1. There was a significant increase in the grain yield of rice due to green manuring. The increase in grain yield with green manuring as compared to without green manuring was 10%. The increased grain yields obtained after green manuring were due to higher number of panicles/m² and number of filled grains/panicle. The results are in agreement with those of Pandey and Morris (1983).

Effects of nitrogen

The effect of nitrogen on the yield and yield components of rice is presented in Table 1. Plant height, effective tillers/m², number of grains/panicle, 1000-grain weight, grain yield and straw yield were significantly influenced by nitrogen rates. The plant height, grains/panicle and straw yield increased with the increase in nitrogen rate. The number of tillers/m² increased with the increase in nitrogen rates up to 30 kg N/ha. The grain yield of rice increased with the increasing levels of nitrogen up to 90 kg/ha. However, at higher level of N (120 kg/ha) a slight decrease in the grain yield was observed. These results are in conformity with those reported by Aktar and Haque (1989) and Aktar et al. (1990).

Interaction effect

The interaction effect of the green manuring and nitrogen rate was significant. Response to nitrogen application was significant both with or without green manure. Response to each kilogramme of applied nitrogen after fallow increased up to 90 kg/ha but after green
Table 1. Effect of green manuring and nitrogenous fertilizer on the grain yield of BR 11 rice at FSR site, Bagherpara, Jessore during 1988-1991.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant height (cm)</th>
<th>Effective tillers/m²</th>
<th>No. of grains/panicle</th>
<th>1000-grain Wt (g)</th>
<th>Grain yield (t/ha)</th>
<th>Straw yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green manuring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With GM</td>
<td>123.16 a</td>
<td>328.40 a</td>
<td>81.55 a</td>
<td>24.31</td>
<td>4.81 a</td>
<td>6.18 a</td>
</tr>
<tr>
<td>Without GM</td>
<td>119.54 b</td>
<td>326.70 b</td>
<td>80.10 b</td>
<td>24.43</td>
<td>4.40 b</td>
<td>5.58 b</td>
</tr>
<tr>
<td>Nitrogen rate (kg/ha)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>112.81 d</td>
<td>297.25 b</td>
<td>74.63 c</td>
<td>24.59 ab</td>
<td>3.94 c</td>
<td>4.74 c</td>
</tr>
<tr>
<td>30</td>
<td>119.21 c</td>
<td>341.50 a</td>
<td>77.88 c</td>
<td>24.76 a</td>
<td>4.59 b</td>
<td>5.18 c</td>
</tr>
<tr>
<td>60</td>
<td>121.74 b</td>
<td>341.75 a</td>
<td>76.25 d</td>
<td>24.16 c</td>
<td>4.70 b</td>
<td>6.27 b</td>
</tr>
<tr>
<td>90</td>
<td>125.73 a</td>
<td>334.25 a</td>
<td>82.00 b</td>
<td>24.33 be</td>
<td>5.09 a</td>
<td>6.93 a</td>
</tr>
<tr>
<td>120</td>
<td>127.28 a</td>
<td>323.00 a</td>
<td>93.38 a</td>
<td>24.01 c</td>
<td>4.70 b</td>
<td>6.27 b</td>
</tr>
</tbody>
</table>

Values in a column followed by common letter(s) do not differ significantly at 5% level.

manuring the highest response was observed only at 30 kg/ha and further addition of N decreased the yield (Fig. 1). Application of 30 kg N/ha after green manuring produced higher yield over that with 90 kg N/ha without green

manuring. This indicates that green manuring not only supplied nitrogen, but also improved soil conditions that enhanced yield even at lower rates of added nitrogen. Similar results were also reported by Tiwari et al. (1980); Akiar and Haque (1988); Aktar et al. (1989) and Meelu and Morris (1987).

**Economic analysis**

Total variable cost (TVC) was higher with green manuring than without green manuring. The net benefit with or without green manure increased up to 60 kg N/ha (Fig. 2). The budget analysis revealed that 0 and 30 kg N per hectare with green manuring and 0, 30 and 60 kg N per hectare without green manuring dominated all other treatments. At 60 kg N/ha the net benefit was similar with or without green manuring but at higher levels of N it decreased with green manure. Addition of N at above 60 kg/ha also decreased the net benefit compared to the lower levels of N. The study revealed that the benefit of green manuring was obtained only at lower levels of N particularly at 30 kg N/ha.
Nutrient availability in soil

The content of available N, P and K in soil increased with green manuring (Table 2). There has been 33, 80 and 64 per cent increase in available N, P and K contents of the soil after green manuring. The data indicated that the 33%

Table 2. Soil chemical properties before and after green manuring at FSR site Bagherpara, Jessore, 1991.

<table>
<thead>
<tr>
<th>Soil property</th>
<th>Before incorporation of GM</th>
<th>After incorporation of GM</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.6</td>
<td>7.5</td>
</tr>
<tr>
<td>% organic matter</td>
<td>0.99</td>
<td>1.15</td>
</tr>
<tr>
<td>Available N (kg/ha)</td>
<td>180</td>
<td>240</td>
</tr>
<tr>
<td>Available P (kg/ha)</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>Available K (kg/ha)</td>
<td>220</td>
<td>360</td>
</tr>
</tbody>
</table>

increase in available nitrogen content following green manuring was equivalent to 60 kg N/ha from urea. This increase in N availability due to green manuring was helpful in minimizing N application in rice to the extent of 60 kg N/ha, and obtaining similar yields at 30 kg N/ha with green manuring and 90 kg N/ha without green manuring (Fig. 1). Increased availability of N,

Table 3. Effect of green manuring on physical properties of soil.

<table>
<thead>
<tr>
<th>Depth of soil (cm)</th>
<th>With GM</th>
<th>Without GM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk density</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-15</td>
<td>135</td>
<td>1.41</td>
</tr>
<tr>
<td>15-30</td>
<td>1.49</td>
<td>1.50</td>
</tr>
<tr>
<td>30-45</td>
<td>1.43</td>
<td>1.43</td>
</tr>
<tr>
<td>Moisture content (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-15</td>
<td>21.48</td>
<td>19.45</td>
</tr>
<tr>
<td>15-30</td>
<td>20.76</td>
<td>20.85</td>
</tr>
<tr>
<td>30-45</td>
<td>2430</td>
<td>22.68</td>
</tr>
</tbody>
</table>

P and K in soil after manuring has been reported by several workers (Boawn et al., 1963; Shende and Sen, 1958; Prabhakar et al., 1972; Kute an Mann, 1969; and Debnath and Hajra, 1972). Like the chemical properties, physical properties of soil e.g. bulk density and moisture content at different soil depth improved due to green manuring (Table 3). Similar results were also reported by Larson and Clapp (1984).

Fig. 2. Total variable cost (TVC) and net benefit (NB) of green manuring (GM) and nitrogen fertilization in T. aman rice.

Limitations of green manuring

During the study it was found that establishment of Sesbania for green manuring and availability of Sesbania seeds were the major problems on the part of the farmers. Farmers were interested to plant green manure, but seeds were hardly found in the locality. Also, sometimes the land could not be prepared in desired time to sow the seeds of green manure due to uncertain and erratic monsoon rainfall (Anon., 1990).
Conclusion

Complementary use of green manuring with mineral fertilizers is considered important under Bangladesh conditions, particularly to increase the utilization efficiency of applied fertilizers and to maintain the currently deteriorating soil fertility at desired level. Based on the results, it can be concluded that *Sesbania rostrata* can be grown as green manure in between the two rice crops in Boro-T. aman cropping pattern. Green manuring with *Sesbania rostrata* efficiently economized N dose, it contributed slightly more than 60 kg N equivalent per hectare. These results suggest that farmers can apply only 30 kg N/ha after green manuring in transplanted aman rice to get a high rate of return on their investment and for amelioration of soil fertility problems.

References


