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CONTRIBUTION OF GREEN MANURE INCORPORATION IN COMBINATION WITH NITROGEN FERTILIZER IN RICE PRODUCTION

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ABSTRACT

An experiment was conducted at the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh during April to November, 2012 to study the combined effects of *Sesbania* green manure incorporation with different levels of nitrogen fertilizer on the growth and yield of BINA dhan7. There were five treatments for using *Sesbania* as pre-rice green manure (GM): Fallow (No GM), GM for incorporation at 40, 50, 60, and 70 days after sowing (DAS). T. Aman was planted after chopping the GM. For T. aman there were 9 treatments: Fallow plot received full dose (180 kg urea ha^{-1}) of N fertilizer while plots with GM received 50 and 75% of recommended N fertilizer. The experiment was laid out in a Randomized Complete Block Design with three replications. The highest grain yield of 5752 kg ha^{-1} and straw yield of 6654 kg ha^{-1} were observed in the plot treated with 75%recommended dose of nitrogen (RDN) and green manure incorporated at 50 DAS. The lowest grain yield (4783 kg ha^{-1}) and straw yield (5154 kg ha^{-1}) were recorded with GM incorporated at 40 DAS + 50% RDN. The N content and uptake by the grain and straw were differed significantly due to different treatments and maximum uptake was recorded with the application of 75% recommended dose of nitrogen (RDN) and green manure incorporated at 50 DAS. The overall results indicate that application of Sesbania green manure incorporated at 50 DAS in combination with 75% recommended dose of nitrogen could be considered more effective for BINA dhan7 production.

Key words: Rice, Green manure, *Sesbania*, Nitrogen, BINA dhan7

INTRODUCTION

Low soil fertility due to organic matter depletion is a major constraint severely affecting higher crop production in Bangladesh (BARC, 2012). Organic matter contributes to soil fertility and productivity through its positive effect on the physical,

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chemical and biological properties of the soil. But the organic matter content in many parts of Bangladesh soils has been seriously depleted due to intensive cropping with modern varieties, very little use of crop residues, little or no use of organic manures, absence of green manure etc. As a result, soil productivity, in general, has been degraded and stagnation in yield has occurred even with high dose of chemical fertilizers under rice based cropping patterns.

Adding inorganic fertilizers is a good way of correcting the deficiency of nutritional elements, but they not only add to the cost of production but often are not available to meet the demands of farmers. Although the fertilizers are very effective in increasing yield, they may deteriorate the soil structure and pollute the groundwater. In addition, chemical fertilizers are expensive due to the energy crisis and are unavailable to many farmers, particularly in developing countries like Bangladesh. In this situation, green manure can serve as a cheaper source of plant nutrition and has become popular with farmers. Green manuring is the process of growing leguminous crops and ploughing the same in soil. On decomposition, it results in increased soil fertility. At the same time, improving the organic matter content of soil also improves its water holding capacity, aeration, colloidal complex, and hence its ability to retain nutrients.

Although many green manure crops are available (Kerala Agricultural University, 2002), the N_2-fixing leguminous crop Dhaincha (*Sesbania aculeata*) is particularly important because it can fix 56.2-150 kg ha^{-1} of nitrogen (Bin, 1983). Studies with *Sesbania* green manuring at Bangladesh Agricultural University have shown very promising contribution of *S. aculeata* in supplementing N requirement of the following T. Aman rice and also recycling of S and P for the next crops. Many workers suggested green manuring along with N fertilizer application for slow release of nutrient elements during the entire period of crop growth (Singh et al., 1990). It has also been reported that green manuring provides a substantial amount of nutrients for the next crop (BRRI, 1998; Elahi, 1991). It is evident that the application of *Sesbania aculeata* along with the recommended chemical fertilizers may ensure adequate supply of nutrients especially nitrogen to the transplanted rice over the entire growing season for better plant growth with higher grain production (Pervin et al., 1995)

Although *S. aculeata* is known for long as a GM crop but there is a lack of adequate knowledge regarding the time and method of chopping and mixing the GM crop with the soil. Therefore, the present study was undertaken to find out the appropriate time for chopping and mixing *Sesbania* as a pre-rice green manure and to determine the optimum doses of N to be applied in combination with *Sesbania* green manure incorporated at different times for the production of BINA dhan7.

MATERIALS AND METHODS

The experiment was carried out at Soil Science Field Laboratory, Bangladesh Agricultural University, Mymensingh during April to November, 2012. The soil belongs to Sonatala series under the AEZ of the Old Brahmaputra Floodplain. The experimental soil was silt loam in texture. BINA Dhan7, a high yielding variety of rice was used in this experiment as test crop. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The experiment comprised of 9 treatments: T_0 (No GM + 100%RDN), T_1 (GM incorporated at 40 DAS + 50%RDN), T_2 (GM incorporated at 40 DAS + 75%RDN), T_3 (GM incorporated at 50 DAS + 50%RDN), T_4 (GM incorporated at 50 DAS + 75%RDN), T_5 (GM incorporated at 60 DAS + 50%RDN), T_6 (GM incorporated at 60 DAS + 75%RDN), T_7 (GM incorporated at 70 DAS + 50%RDN) and T_8 (GM incorporated at 70 DAS + 75%RDN). Here, RDN = Recommended dose of nitrogen (180 kg urea ha^{-1}) as per BARC Guide (BARC, 2005); GM = Green manure.

Green manuring crop, *Sesbania aculeata* was sown at a time on the same day but incorporated into the soil at different time interval i.e.40, 50, 60 and 70 DAS. Nitrogen, phosphorus, potassium and sulphur were supplied through urea, TSP, MoP and gypsum, respectively. The recommended fertilizer doses applied for the experiment were 180 kg urea ha^{-1}, 120 kg TSP ha^{-1}, 70 kg MoP ha^{-1}, 50 kg gypsum ha^{-1}. TSP, MoP and gypsum were applied as basal dose during final land preparation. Urea was applied in three instalments (the first instalment at 15 DAT, the second at 30 DAT and the third at 45 DAT). The seedlings of 25 day old were transplanted at a time in all the experimental plots maintaining a spacing of 20 cm x 20 cm although the green manure was incorporated into the soil at different time interval as per treatments. Intercultural operations such as irrigation and weeding were done as and when necessary. The crop was harvested at full maturity. Ten hills were randomly selected from each plot to record the yield contributing characters. Grain and straw yields were recorded plot wise and converted to kg ha^{-1}. Grain and straw samples were collected, dried, grounded, sieved and used for chemical analysis. Grain and straw samples were analysed for total nitrogen concentration following semi-micro Kjeldahl method (Bremner and Mulvaney, 1982). The N uptake by grain and straw was determined from the N content and yield data. All the data were statistically analyzed following F-test and mean comparison was made by Duncan's New Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Yield contributing characters

Yield contributing characters such as plant height, effective tillers $hill^{-1}$, panicle length, grains $panicle^{-1}$ and 1000-grain weight were influenced significantly due to application of green manure in combination with different levels of N fertilizer (Table 1). The tallest plant (94.21 cm), maximum number of effective tillers $hill^{-}$

^{1}(14.73), longest panicle (24.42 cm), maximum grains panicle^{-1} (84.80) and maximum 1000-grain weight (23.08 g) were recorded in the treatment GM incorporated at 50 DAS + 75% RDN which was statistically similar to all other treatments except where no green manure was incorporated, GM incorporated at 40 DAS + 50%RDN and GM incorporated at 70 DAS + 75% RDN.. Many research workers reported that combined application of *Sesbania* green manure and nitrogen fertilizer increased the plant height (Deshpande et al., 2011), effective tillers hill^{-1} (Paramanik et al., 2004), grains panicle^{-1} (Shrivastava et al., 2005; Deshpande et al., 2011 and Vaiyapuri et al., 2002) and1000-grain weight (Vaiyapuri et al., 2002).

Grain yield

The highest grain yield of BINA dhan7 (5752 kg ha^{-1}) was obtained in the treatment GM incorporated at 50 DAS + 75% RDN which was statistically similar to those observed in GM incorporated at 40 DAS + 75% RDN, GM incorporated at 60 DAS + 75%RDN and GM incorporated at 70 DAS + 75%RDN with the values of 5519, 5512 and 5448 kg ha^{-1}, respectively (Table 2). The increase of grain yield might be due to more availability of nitrogen to rice crop released by incorporation of green manure and due to other beneficial effects of GM. The lowest grain yield (4783 kg ha^{-1}) was obtained in the treatment GM incorporated at 40 DAS + 50% RDN which was at par with No GM + 100% RDN, GM incorporated at 50 DAS + 50% RDN, GM incorporated at 60 DAS + 50% RDN and GM incorporated at 70 DAS + 50% RDN were identical with T_1 with grain yield of 5115, 5222, 5127 and 4875 kg ha^{-1}, respectively. Dekamedhi and Medhi (2000) reported that grain yield of rice was significantly increased due to application of green manure in combination with N fertilizer. These results are also in agreement with Miah et al. (2001), Paramanik et al. (2004), Sarkar et al. (2004) and Chaudhary et al. (2011).

Straw yield

The highest straw yield (6654 kg ha^{-1}) was recorded in the treatment GM incorporated at 50 DAS + 75% RDN which was statistically similar to that recorded in GM incorporated at 60 DAS + 75% RDN) (6461 kg ha^{-1}). The lowest straw yield (5154 kg ha^{-1}) was recorded in the treatment GM incorporated at 40 DAS + 50% RDN (Table 2). Dekamedhi and Medhi (2000) found that straw yield of rice increased with the addition of green manure and urea-N.

Biological yield

The highest biological yield (12410 kg h^{-1}) was recorded in the treatment GM incorporated at 50 DAS + 75% RDN which was statistically similar to those recorded in GM incorporated at 40 DAS + 75% RDN, GM incorporated at 50 DAS + 50% RDN, GM incorporated at 60 DAS + 75%RDN and GM incorporated at 70 DAS + 75% RDN (Table 2). The lowest biological yield (9937 kg ha^{-1}) was noted in the treatment GM incorporated at 40 DAS + 50% RDN Which was on par with the treatments No GM + 100% RDN, GM incorporated at 60 DAS + 50% RDN and GM incorporated at 70 DAS + 50% RDN

Nitrogen content and uptake by rice grain and straw

N content and uptake both by grain and straw of BINA Dhan7 varied significantly due to application of green manure and N fertilizer. The N content in rice grain ranged from 1.037 to 1.430% and in rice straw from 0.532 to 0.644%. (Table 3).The highest N content both in rice grain (1.430%) and straw (0.644%) was observed in the treatment GM incorporated at 50 DAS + 75% RDN and the lowest value was noted in the treatment GM incorporated at 40 DAS + 50% RDN.

Nitrogen uptake by rice grain ranged from 49.54 to 81.54 kg ha^{-1}. The maximum N uptake 82.24 kg ha^{-1} by rice grain was observed in GM incorporated at 50 DAS + 75% RDN. The minimum N uptake of 49.54 kg ha^{-1} was observed in T_1 GM incorporated at 40 DAS + 50% RDN. The results are in agreement with Medhi et al. (1996) and Dekamedhi and Medhi (2000) who found that with the combined application of green manure and N fertilizer, N uptake by rice grain was increased. In case of rice straw, N uptake ranged from 27.39 to 42.86 kg ha^{-1}. The maximum N uptake 42.86 kg ha^{-1} by straw was observed in GM incorporated at 50 DAS + 75% RDN. The minimum N uptake by rice straw 27.39 kg ha^{-1} was recorded in GM incorporated at 40 DAS + 50% RDN. The results reveal that N uptake in rice grain was higher than that of straw. The total N uptake was the highest in GM incorporated at 50 DAS + 75% RDN and the lowest in GM incorporated at 40 DAS + 50% RDN which was statistically similar to that of GM incorporated at 70 DAS + 50% RDN. The results support the findings of Duhan et al. (2002) who found increased N uptake of rice with application of green manure along with N fertilizer.

CONCLUSION

On the basis of one year experimentation it can be concluded that incorporation of *Sesbania* green manure at 50 DAS along with the application of 75% of recommended N fertilizer is best for cultivation of BINA dhan7.

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Table 1: Effects of green manure and different levels of nitrogen on yield components of BINA dhan7

Treatments	Plant height (cm)	Effective tillers hill^{-1} (No.)	Panicle length (cm)	Grains panicle^{-1} (No.)	1000-grain weight (g)
T_0 (No GM + 100% RDN)	89.05c	13.33abc	23.19cd	78.33d	22.06bc
T_1 (GM incorporated at 40 DAS + 50% RDN)	88.55c	12.07bc	22.97d	71.67e	21.80c
T_2 (GM incorporated at 40 DAS + 75% RDN)	93.82ab	13.80ab	24.20ab	83.47ab	22.79ab
T_3 (GM incorporated at 50 DAS + 50% RDN)	92.13abc	13.03abc	23.88abc	82.67abc	22.17bc
T_4 (GM incorporated at 50 DAS + 75% RDN)	94.21a	14.73a	24.42a	84.80a	23.08a
T_5 (GM incorporated at 60 DAS + 50%RDN)	93.58ab	12.27bc	23.73abc	79.00cd	21.83c
T_6 (GM incorporated at 60 DAS + 75% RDN)	93.80ab	13.79ab	24.01ab	83.07abc	22.47abc
T_7 (GM incorporated at 70 DAS + 50% RDN)	90.23bc	11.93c	23.54bcd	77.00d	22.34bc
T_8 (GM incorporated at 70 DAS + 75% RDN)	91.13abc	12.67bc	23.77abc	80.47bcd	22.44abc
SE m (±)	0.727	0.312	0.154	1.36	0.141
CV%	2.04	6.99	1.57	2.84	2.00

Figure (s) in a column having common letters does not differ significantly.

GM = Green manure; RDN = Recommended dose of nitrogen; DAS = Day after sowing; SEm = Standard error of means; CV=Coefficient of variation

Table 2: Grain, straw and biological yields of BINA dhan7 as influenced by green manure and different levels of nitrogen

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})
T_0 (NO GM + 100% RDN)	5115cde	5666c	10780bcd
T_1 (GM incorporated at 40 DAS + 50% RDN)	4783e	5154d	9937d
T_2 (GM incorporated at 40 DAS + 75% RDN)	5519ab	6003bc	11520abc
T_3 (GM incorporated at 50 DAS + 50% RDN)	5222bcd	5938c	11160abcd
T_4 (GM incorporated at 50 DAS + 75% RDN)	5752a	6654a	12410a
T_5 (GM incorporated at 60 DAS + 50% RDN)	5127cde	5779c	10910bcd
T_6 (GM incorporated at 60 DAS + 75%RDN)	5512ab	6461ab	11970ab
T_7 (GM incorporated at 70 DAS + 50% RDN)	4875de	5641c	10520cd
T_8 (GM incorporated at 70 DAS + 75% RDN)	5448abc	6084bc	11530abc
SEm (±)	106.94	149.72	252.53
CV%	3.78	4.52	6.10

Figure (s) in a column having common letters does not differ significantly.

GM = Green manure; RDN = Recommended dose of nitrogen; DAS = Day after sowing; SEm = Standard error of means; CV = Coefficient of variation

Table 3: Effects of green manure and different levels of nitrogen on N contents and uptake of BINA dhan7

Treatments	Nitrogen content (%)		Nitrogen uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Total
T_0 (NO GM + 100% RDN)	1.317b	0.560bc	67.30c	31.72cd	99.02cd
T_1 (GM incorporated at 40 DAS + 50% RDN)	1.317b	0.532c	49.54f	27.39d	76.93f
T_2 (GM incorporated at 40 DAS + 75% RDN)	1.340b	0.560bc	74.06b	33.71c	107.8bc
T_3 (GM incorporated at 50 DAS + 50% RDN)	1.150c	0.588abc	59.90d	34.85bc	94.75de
T_4 (GM incorporated at 50 DAS + 75% RDN)	1.430a	0.644a	81.54a	42.86a	124.4a
T_5 (GM incorporated at 60 DAS + 50% RDN)	1.123c	0.588abc	57.40de	34.04bc	91.43de
T_6 (GM incorporated at 60 DAS + 75% RDN)	1.287b	0.616ab	70.98bc	39.80ab	110.8b
T_7 (GM incorporated at 70 DAS + 50% RDN)	1.090cd	0.560bc	53.21ef	31.59cd	84.80ef
T_8 (GM incorporated at 70 DAS + 75% RDN)	1.287b	0.616ab	70.16bc	37.42abc	107.6bc
SEm (±)	0.044	0.012	3.51	1.55	4.85
CV (%)	3.81	4.00	3.89	9.09	5.77

Figure (s) in a column having common letters does not differ significantly.

GM = Green manure; RDN = Recommended dose of nitrogen; DAS = Day after sowing; SEm= Standard error of means; CV = Coefficient of variation