J. Environ. Sci. & Natural Resources, **9(1): 35-40, 2016** ISSN 1999-7361

Residual Effect of Green Manure on the Growth and Yield of BRRI dhan28

M. R. Islam[1]*, Z. Ryhana[1], M. A. Hoque[1], A. Huda[2] and M. L. N. Begum[3]

[1]Department of Soil Science,
Bangaldesh Agricultural University, Mymensingh-2202
[2]Department of Soil Science,
Sylhet Agricultural University, Sylhet-3100
[3]Practical Skill Development Training Department,
Proshika, Mirpur-2, Dhaka-1216
* Corresponding author: rafiqss69@bau.edu.bd

Abstract

Green manuring is a promising technology to enrich soils with organic matter especially with nitrogen to boost up rice production. An experiment was, therefore, conducted at the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh during *boro* season of 2013 to evaluate the residual effect of *Sesbania* green manure on the growth and yield of BRRI dhan28. There were nine treatments laid out in a Randomized Complete Block Design (RCBD) with three replications. The results demonstrate that the treatment T_8 containing 75% recommended dose of nitrogen (RDN) and green manure incorporated at 70 DAS produced the highest grain yield of 4967 kg ha^{-1} and straw yield of 5359 kg ha^{-1}. The lowest grain yield (4208 kg ha^{-1}) and straw yield (4352 kg ha^{-1}) were recorded for the treatment T_1 (GM incorporated at 40 DAS + 50% RD of NF). Green manure exerted significant residual effect on grain N uptake, straw N uptake and total N uptake of BRRI dhan28. The residual effect of green manure was the higher in producing rice yields in treatments with the application of 75% of recommended N fertilizer with green manure incorporated at 50 or 70 DAS.

Key words: BRRI dhan28, Green manure, Residual effect, Yield

Introduction

Rice is the most important agricultural produce and the main staple food in Bangladesh. Total rice production in Bangladesh was 31.9 Mt (DAE, 2010). But it is insufficient to meet the demand of food requirement for our increasing population. Besides this, soil fertility depletion is a major constraint for higher crop yield in Bangladesh. To overcome soil fertility constraint, efficient soil fertility and fertilizer management are important. Organic matter contributes to soil fertility and productivity through its positive effect on the physical, chemical and biological properties of the soil. But the organic matter content in many of our 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, green manure etc. As a result, soil fertility, in general, has been degraded. According to Fertilizer Recommendation Guide BARC (2012), a good soil should have at least 2.5% organic matter but in Bangladesh, most soils have less than 1% organic matter. Losses of soil organic matter can be replenished by the application of organic manures (Glaser *et al.,* 2001). This undesirable consequence can be addressed properly by using organic sources like compost, FYM, cowdung, oilcake, crop residues, other organic wastes, leaf manuring and green manure. Green manuring is the most important one amongst all the organic manures. It is a good management practice in agricultural production, because it can improve soil fertility and quality (Lee *et al.,* 2010) and also supply N, a primary limiting nutrient for crops (Pypersa *et al*., 2005; Elfstrand *et al*., 2007). Although many green manure crops are available, 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). It has also been reported that green manuring provides a substantial amount of nutrients for the next crop (Nur-E-Elahi, 1991; BRRI, 1998). Incorporation of green manure crops into the soil has been shown to increase organic carbon, total nitrogen and crop yields (Gu and Wen, 1980). It has also been reported that green manuring, besides its role of supplying plant nutrition, renders the crop more tolerant to disease and insects and prevents soil erosion (Dreyfus *et al.,* 1985; Evans and Rotar, 1986; Singhabutra *et al*., 1987).

Due to residual effect the current increase in yield caused by fertilizer applied in earlier season and the residual effect can vary from year to year (Warren, 1992). Moreover, residual effect of green manure helps in improving physical, chemical and biological properties of the soil. The residual effect of green manure provide the most effective way to improve the nitrogen supply for succeeding crops (Thorup-Kristensen *et al*., 2003). From the economic and environmental point of view, green manuring with locally available resources is going to offer a great opportunity since the chemical fertilizers are getting costly day by day. It has been shown that organic matter cycling is related to the agricultural potential of soils (Tiessen *et al*., 1994). It is evident that the residual effect of green manure along with the application of 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. Therefore, the present study was undertaken to evaluate the residual effect of *Sesbania* green manure on the growth and yield of BRRI dhan28 and to investigate the residual effect of green manure on N uptake by BRRI dhan28.

Materials and Methods

Experimental site and soil

The experiment was carried out at the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh during *boro* season of 2013. The experimental soil belongs to the Sonatala series under the AEZ of Old Brahmaputra Floodplain. The soil was silt loam in texture having pH 6.39, organic matter content 2.5%, total N 0.168%, available P 4.76 ppm, exchangeable K 0.13 meq^{-1} 100 g soil, available S 12.47 ppm, exchangeable Na 0.297 meq^{-1}100 g soil, exchangeable Ca 6.09 meq^{-1}100 g soil and CEC 14.92 meq^{-1}100 g soil.

Treatments

The experiment was laid out in a Randomized Complete Block Design (RCBD) with nine treatments each replicated thrice. The treatments were 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). Where, GM = Green manure and RDN = Recommended dose of nitrogen.

Seedling transplanting

BRRI dhan28, a high yielding variety of rice was used as a test crop. Thirty five day-old seedlings were carefully uprooted from a seedling nursery bed and transplanted in the plots maintaining a spacing of 20 cm x 20 cm. Three seedlings were transplanted in each hill.

Green manuring crop

In the previous rice crop *Sesbania aculeata* was used as pre-rice green manuring crop. This green manuring crop was incorporated into the soil at 40, 50, 60 and 70 DAS as per treatments.

Application of fertilizers

The full amount of Triple Super Phosphate (TSP), Muriate of Potash (MoP) and gypsum @ 120, 70 and 50 kg ha^{-1}, respectively was applied at the time of final land preparation. The recommended rate of urea used was 180 kg ha^{-1}. Two levels of N fertilizer (urea) including 50% and 75% of the recommended dose were applied. The N fertilizer (urea) was applied in three equal splits; the first installment at 15 days after transplanting (DAT), the second installment at 30 DAT i.e. at maximum tillering stage and the third installment at 45 DAT i.e. at panicle initiation stage or booting stage of rice.

Intercultural operations

Irrigation was provided to the plots from deep tube well to maintain 5-6 cm water during the growing period of the crop. Some obnoxious weeds were controlled by uprooting and removing two times from the field.

Harvesting

The crop was harvested at maturity. The grain yield was obtained on 14% moisture basis while the straw yield was recorded on sun dry basis. Five hills were selected randomly from each plot and data on yield components including plant height, effective tillers per hill, panicle length, grains panicle^{-1} and 1000-grain weight were recorded.

Determination of N in plant samples

The N content in rice grain and straw was determined by Semi-micro Kjeldahl method. Nitrogen uptake was the calculated from N content and yield data.

Statistical analysis

The analysis of variance for various crop characters and also for various nitrogen concentrations and nitrogen uptake was done following the F-test. Mean comparisons of the treatments were made by the Duncan's New Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

Results and Discussion

Growth and yield attributes of BRRI dhan28

Growth and yield contributing characters such as plant height, effective tillers hill^{-1}, panicle length and filled grains panicle^{-1} of BRRI dhan28 showed insignificant response to residual effect of green manuring with *Sesbania* along with different doses of N-fertilizer (Table 1). The tallest plant (87.80cm) was recorded in the treatment T_8 (GM incorporated at 70 DAS + 75% RDN) and the shortest plant (69.47cm) was obtained in the treatment T_2 (GM incorporated at 40 DAS + 75% RDN). The highest number of effective tillers hill^{-1} (15.67) was found in T_2 (GM incorporated at 40 DAS + 75% RDN) and the lowest number of effective tillers hill^{-1} (11.67) was found in T_5 (GM incorporated at 60 DAS + 50% RDN). The highest panicle length (23.15 cm) was found in T_5 (GM incorporated at 60 DAS + 50% RDN) while the lowest panicle length (21cm) was observed in T_0 (No GM + 100% RDN).

The highest number of filled grains panicle^{-1} was found both in T_1 (GM incorporated at 40 DAS + 50% RDN) and T_8 (GM incorporated at 70 DAS + 75% RDN) treatments and the lowest was found in T_7 (GM incorporated at 70 DAS + 50% RDN).

Grain yield

Grain yield of BRRI dhan28 responded insignificantly to the residual effect of green manure in combination with N fertilizer (Table 2). The highest grain yield (4967kg ha^{-1}) was obtained in the treatment T_8 (GM incorporated at 70 DAS + 75% RDN) and the lowest grain yield (4208kg ha^{-1}) was obtained in the treatment T_0 (No GM + 100% RDN). The T_8 and T_4 showed 18.01 and 18.03% grain yield increase over control, respectively (Table 2 and Fig. 1). Moreover, it was shown that application of 75% recommended N with *Sesbania* green manure produced higher grain yield than that with 100% recommended N when the green manure was incorporated into the soil at 50 or 70 DAS. These results are in consistent with the findings of Hossain (2013) and Jahan (2014) who concluded that application of green manure can reduce 25% of recommended N in rice cultivation.

These results are also in agreement with Paturde and Patankar (1998); Dekamedhi and Medhi (2000); Singh *et al.* (2006); Ghosh (2007); Choudhury (2009). The grain yields obtained from different treatments may be ranked in the order of decreasing trend T_8> T_4> T_2> T_5> T_6> T_3> T_7> T_1> T_0.

Straw yield

Straw yield of BRRI dhan28 did not respond significantly under the study. The numerical variation shows the highest straw yield (5359 kg ha^{-1}) with 23.13% yield increase over control (Table 2 and Fig. 1) as recorded in the treatment T_8 (GM incorporated at 70 DAS + 75% RDN) and the lowest straw yield (4359 kg ha^{-1}) as recorded in the treatment T_0 (No GM + 100% RDN). The treatments may be ranked in the order of decreasing straw yield as T_8> T_4> T_2> T_6> T_7> T_3> T_5> T_1> T_0.

Nitrogen uptake by grain

A significant variation in N uptake by grain of BRRI dhan28 was observed due to residual effect of green manure in combination with N fertilizer (Table 3). The highest N uptake (64.19kg ha^{-1}) by grain was recorded in the treatment T_4 (GM incorporated at 50 DAS + 75% RDN). The lowest N uptake (44.62kg ha^{-1}) by grain was obtained in the treatment T_1 (GM incorporated at 40 DAS + 50% RDN). The results are in agreement with Medhi *et al.* (1996); Dekamedhi and Medhi (2000); Kumar *et al.* (2012); Hossain (2013) who reported that application of green manure produced increased N uptake by rice. The N uptake in grain may be ranked in the order of T_4> T_8> T_2> T_0> T_6> T_3>T_7> T_5> T_1.

Nitrogen uptake by straw

The N uptake by straw of BRRI dhan28 was influenced significantly due to residual effect of green manure along with urea-N (Table 3). The highest N uptake (42.42 kg ha^{-1}) by straw was obtained in the treatment T_8 (GM incorporated at 70 DAS + 75% RDN). The treatment T_5 (GM incorporated at 60 DAS + 50% RDN) produced the lowest N uptake (25.94kg ha^{-1}) in rice straw. The treatments may be ranked in the order of T_8> T_6> T_4> T_2> T_3 > T_0> T_7> T_1> T_5 in terms of N content in straw.

Total N uptake

There was a significant effect of green manure residues and urea-N on total N uptake by BRRI dhan28 (Table 3). The highest total N uptake (102.81 kg ha^{-1}) was recorded in the treatment T_4 (GM incorporated at 50 DAS + 75% RDN). The lowest total N uptake (72.32 kg ha^{-1}) was obtained in the treatment T_1 (GM incorporated at 40 DAS + 50% RDN). The total N uptake obtained from different treatments may be ranked in the order of T_4> T_8> T_6> T_2>T_0 > T_3> T_7> T_5> T_1.

Table 1. Residual effects of green manure and different levels of nitrogen on the growth and yield components of BRRI dhan28

Treatments	Plant height (cm)	Effective tillers $hill^{-1}$ (No.)	Panicle length (cm)	Filled grains $panicle^{-1}$ (No.)
T_0 (No GM + 100% RDN)	83.50	14.00	21.00	107
T_1 (GM incorporated at 40 DAS + 50% RDN)	82.33	12.33	23.08	111
T_2 (GM incorporated at 40 DAS + 75% RDN)	69.47	15.67	22.53	103
T_3 (GM incorporated at 50 DAS + 50% RDN)	83.26	13.67	23.06	97
T_4 (GM incorporated at 50 DAS + 75% RDN)	87.27	12	22.19	97
T_5 (GM incorporated at 60 DAS + 50% RDN)	69.60	11.67	23.15	110
T_6 (GM incorporated at 60 DAS + 75% RDN)	84.53	13	23.09	108
T_7 (GM incorporated at 70 DAS + 50% RDN)	82.56	13.67	22.00	92
T_8 (GM incorporated at 70 DAS + 75% RDN)	87.80	15	23.01	111
SE (±)	7.8166	1.0062	0.5069	6.5497
CV%	16.79	13.25	3.89	11.17
P value	0.113	0.085	0.104	0.112

GM = Green manure; RDN = Recommended dose of nitrogen; SE = Standard error of means; CV = Coefficient of variation

Table 2. Residual effects of green manure and different levels of nitrogen on grain and straw yields of BRRI dhan28

Treatments	Grain		Straw	
	Yield (kg ha^{-1})	% increase over control	Yield (kg ha^{-1})	% increase over control
T_0 (No GM + 100% RDN)	4208	-	4352	-
T_1 (GM incorporated at 40 DAS + 50% RDN)	4233	0.59	4493	3.23
T_2 (GM incorporated at 40 DAS + 75% RDN)	4814	14.4	4935	13.39
T_3 (GM incorporated at 50 DAS + 50% RDN)	4395	4.44	4785	9.94
T_4 (GM incorporated at 50 DAS + 75% RDN)	4966	18.01	5332	22.51
T_5 (GM incorporated at 60 DAS + 50% RDN)	4534	7.74	4761	9.39
T_6 (GM incorporated at 60 DAS + 75% RDN)	4418	4.99	4918	13.00
T_7 (GM incorporated at 70 DAS + 50% RDN)	4313	2.49	4918	13.00
T_8 (GM incorporated at 70 DAS + 75% RDN)	4967	18.03	5359	23.13
SE (±)	253.37	-	336.65	-
CV%	9.76	-	12.04	-
P Value	0.098	-	0.284	-

GM = Green manure; RDN = Recommended dose of nitrogen; SE = Standard error of means; CV = Coefficient of variation

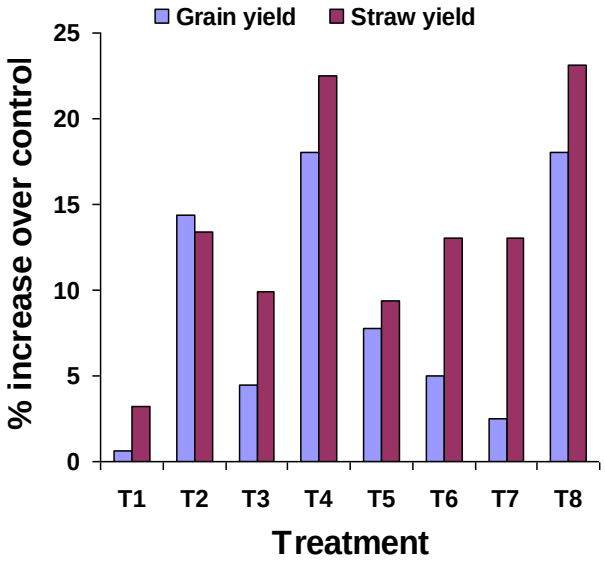

Fig. 1. Residual effects of green manure with different doses of recommended N on % yield increase over control

Table 3. Residual effects of green manure and different levels of N uptake by BRRI dhan28

Treatments	N uptake (kgha^{-1})		
	Grain	Straw	Total
T_0 (No GM + 100% RDN)	54.03bc	33.45bcd	87.49abcd
T_1 (GM incorporated at 40 DAS + 50% RDN)	44.62c	27.70cd	72.32d
T_2 (GM incorporated at 40 DAS + 75% RDN)	55.78ab	35.61ab	91.40abc
T_3 (GM incorporated at 50 DAS + 50% RDN)	53.10bc	33.92bc	87.01bcd
T_4 (GM incorporated at 50 DAS + 75% RDN)	64.19a	38.61ab	102.81a
T_5 (GM incorporated at 60 DAS + 50% RDN)	48.29bc	25.94d	74.22d
T_6 (GM incorporated at 60 DAS + 75% RDN)	53.17bc	39.27ab	92.44abc
T_7 (GM incorporated at 70 DAS + 50% RDN)	48.52b	31.79bcd	80.31cd
T_8 (GM incorporated at 70 DAS + 75% RDN)	56.80ab	42.42a	99.22ab
SE (±)	3.01	2.33	4.64
CV%	9.82	11.77	9.20
P Value	0.014	0.002	0.003

Figure (s) in a column having common letters do not differ significantly.
GM = Green manure; RDN = Recommended dose of nitrogen; SE = Standard error of means; CV = Coefficient of variation

Conclusions

Green manure exerted significant residual effect on grain N uptake, straw N uptake and total N uptake of BRRI dhan28. The residual effect of green manure was higher in producing rice yields in treatments with the application of 75% of recommended N fertilizer with green manure incorporated at 50 or 70 DAS. So it can be concluded that application of *Sesbania* green manure can reduce 25% of recommended N for BRRI dhan28 cultivation. The experiment was practiced in the Old Brahmaputra Floodplain for profitable rice cultivation. However, more study is needed to confirm the results in other AEZs of Bangladesh.

References

BARC (Bangladesh Agricultural Research Council). 2012. Fertilizer Recommendation GUIDE-2012. Soils Pub. No. 45 Bangladesh Agricultural Research Council, Farmgate, Dhaka.

Bin, J. 1983. Utilization of green manure for raising soil fertility in China. *Soil Science*, 115:65-66.

BRRI (Bangladesh Rice Research Institute). 1998. Proceedings of the Annual Internal Review for 1997. Rice Farming Systems, BRRI Joydebpur, Gazipur. Pub. No. 1701. 60p.

Choudhury, A. T. M. A. and Khanif, Y. M. 2009. Effect of nitrogen, copper and magnesium fertilization on yield and nutrition of rice. *Pakistan Journal of Science and Industrial Research*, 45(2):102-107.

DAE (Department of Agriculture Extension). 2010. Agriculture in Bangladesh at a glance, Panya Nirdeshika , Khamarbari, Farmgate, Dhaka.

Dekamedhi, D. and Medhi, D. N. 2000. Effect of green manures and urea on nitrogen mineralization in relation to growth of rice under upper Brahmaputra valley zone of Assam. *Indian Journal of Agricultural Science*, 70(5):829-830.

Dreyfus, B.; Rinauda, G. and Dommergues, Y. 1985. Observation on the use of Sesbania rostrata as green manure in paddy fields. *Journal of Applied Microbiology and Biotechnology*, 1:111-121.

Evans, D. O. and Rotan, P. P. 1986. Role of *Sesbania* in Agriculture. West View Press, Boulder, Colorado. 192 p.

Elfstrand, S.; Båth, B. and Mårtensson, A. 2007. Influence of various forms of green manure

amendment on soil microbial community composition, enzyme activity and nutrient levels in leek. *Applied Soil Ecology*, 36:70-82.

Ghosh, A. 2007. Comparative study on combined and individual effects of farmyard manure and green manuring with fertilizer N on growth and yield of rice (*Oryza sativa*) under submergence-prone situation. *Indian Journal of Agronomy*, 52(1):43-45.

Gu, R. S. and Wen, Q. X. 1980. Cultivation and application of green manure in paddy field of Chains. *Proceedings of Symptom on Paddy Soil*, pp. 207-219.

Glaser, B.; Lehman, J.; Fuhrboter, M.; Soloman, D. and Zech, W. 2001. Carbon and nitrogen mineralization in cultivated and natural savanna soils of Northern Tanzania. *Biology of Fertilizers and Soils*, 33:301-309.

Gomez, K. A. and Gomez, A. K. 1984. *Statistical Procedures of Agricultural Research*. 2nd ed. John Wiley & Sons. New York. pp. 207-215.

Hossain, M. B. 2013. Contribution of green manure incorporated in combination with nitrogen fertilizer in rice production. MS thesis, Department of Soil Science, BAU. pp 51-54.

Jahan, M. B. 2014. Effect of pre-rice green manuring on the growth and yield of BINA dhan7. MS thesis, Department of Soil Science, BAU. 46-53.

Kumar, M.; Yaduvanshi, N. P. S. and Singh, Y. V. 2012. Effects of Integrated Nutrient Management on Rice Yield, Nutrient Uptake and Soil Fertility Status in Reclaimed Sodic Soils. *Journal of Indian Society of Soil Science*, 60(2):132-137.

Lee, C. H.; Park, K. D.; Jung, K. Y.; Ali, M. A.; Lee, D.; Gutierrez, J. and Kimd, P. J. 2010. Effect of Chinese milk vetch (*Astragalus sinicus* L.) as a green manure on rice productivity and methane emission in paddy soil. *Agriculture, Ecosystems and Environment*, 138:343-347.

Medhi, B. D.; Barthakur, H. P. and Barthakur, S. N. 1996. Effect of organic and inorganic source of nitrogen in the nutrients in soil and soil solution and growth of rice. *Journal of Indian Society of Soil Science*, 44(2):263- 266.

Nur E-Elahi, M. 1991. Intercropping forage green manure with a grain legume in the pre rice dry wet period for food, feed and organic nitrogen across irrigated and rain fed rice ecosystems. *Rice Abstract*, 15(2):92.

Paturde, J. T. and Patankar, M. N. 1998. Effect of green manuring with *Sesbania rostrata* and *Sesbania aculeata* as well as levels nitrogen on yield of transplanted paddy variety SKL-7. *Agricultural Science Digest*, 18(3):213-216.

Pypersa, P.; Verstraete, S.; Thi, C. P. and Merckx, R. 2005. Changes in mineral nitrogen, phosphorus availability and salt-extractable aluminium following the application of green manure residues in two weathered soils of South Vietnam. *Soil Biology and Biochemistry*, 37:163-172.

Singh, R. P.; Yadav, P. K.; Singh, R. K.; Singh, S. N.; Bisen, M. K. and Singh, J. 2006. Effect of chemical fertilizer, FYM & biofertilizer on performance of rice & soil properties. *Journal of crop Research*, 32(2):283-285.

Singh, S. P.; Devil, B. S. and Subbiah, S. V. 1998. Effect of nitrogen levels and lime application on grain of hybrid rice. *International Journal on Rice*, 23(1):25-26.

Singhabutra, N.; Arunin, S. and Anuluxtipan, Y. 1987. Experiment on two *Rhizobium* strains for inoculation into *Sesbania* spp. used as green manure on the reclamation of saline soil. Paper presented at the 25th Annual Technical Meeting held from 2-6 Feb 1986. Kaset Start University, Bangkok.

Tiessen, H. D.; Cuevas, E. and Chacon, P. 1994. The role of organic matter in sustaining soil fertility. *Nature* (London), 371:783-785.

Thorup-Kristensen, K.; Magik, J. and Jensen, L. S. 2004. Catch crops and green manure as biological tools in nitrogen management in temperate zones. Advances in Agronomy, 79:227–302.

Warren, G. P. 1992. Fertilizer phosphorus sorption and residual value in tropical African soils. *NRI Bulletin 37, Chatam, U. K. Natural resources Institute*, pp: 89.