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Integrated effects of manures and fertilizers on the yield and nutrient uptake by BRRI dhan49

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Abstract

A field experiment was conducted at the Soil Science Field Laboratory of Bangladesh Agricultural University (BAU), Mymensingh during Aman season of 2011 to evaluate the effects of manures and fertilizers for maximizing the yield of BRRI dhan49. The experiment had six treatments, laid out in a randomized complete block design (RCBD) with four replications. The treatments were T_0 = Control, T_1 = STB-CF (HYG), T_2 = CD + STB-CF (HYG), T_3 = PM + STB-CF (HYG), T_4= CoM + STB-CF (HYG) and T_5 = Farmers' practice (FP). Organic manures including cowdung, poultry manure and compost were applied to the experimental plots @ 5, 3 and 5 t ha^{-1}, respectively. The recommended dozes of N, P, K and S supplied from urea, TSP, MoP and gypsum were 90, 15, 60 and 15 kg ha^{-1}, respectively. Yield contributing characters like plant height, effective tillers hill^{-1}, panicle length and grains panicle^{-1} of BRRI dhan49 were significantly influenced by the application of manures and fertilizers. The highest grain yield of 4.87 t ha^{-1} was observed in the treatment T_3 [PM + STB-CF (HYG)] and the lowest value of 3.61 t ha^{-1} was found in T_0 (control). The straw yield ranged from 4.10 to 5.51 t ha^{-1} in different treatments. The NPKS uptake by BRRI dhan49 was markedly influenced by manures and fertilizers. Based on overall results, the treatment T_3 [PM + STB-CF (HYG)] was found to be the best combination of manures and fertilizers for obtaining the maximum yield and quality of rice.

Keywords: Cowdung, Poultry manure, Compost, BRRI dhan49, Yield, Nutrient uptake

Introduction

Rice (*Oryza sativa*) is the staple food crop in Bangladesh and the cropping pattern of the country is predominately rice-based. In Bangladesh, rice dominates over all other crops and covers 77 % of the total cropped area and 93% farmers grow rice (BBS, 2011). The total area and production of rice in Bangladesh are about 11.7 million hectares and 31.98 million metric tons, respectively (BBS, 2011).

The soil fertility status in Bangladesh is gradually declining. The stagnating trend in the yield of major crops of the country has become an alarming issue for the scientist and policy makers (Bhuiyan, 1994). Low organic matter content of the soil, imbalanced use of chemical fertilizers, less use of organic manures and inadequate attention given for its improvement and maintenances are the major causes behind declining soil fertility in Bangladesh (Karim *et al.* 1994).

Soil organic matter (SOM) plays an important role in maintaining soil fertility and productivity. Organic matter acts as a reservoir of plant nutrients especially N, P and S and micro-nutrients and check leaching of the nutrients. The problem of nutrient deficiencies as well as nutrient mining caused by intensive cropping with HYV of rice and nutrient imbalance can be minimized by judicious application chemical fertilizers in combination with organic manures. Losses of SOM can only be replenished in the short term by application of organic matter such as manures.

Cowdung and poultry manure are the most popular and promising bulky organic manures produced from solid and liquid excreta of farm animals. They contain considerable amounts of essential nutrient elements required for plant growth. Hence, addition of a good amount of cowdung and poultry manure to the crop field is essential for soil fertility and productivity and maintenances of the SOM.

Many farmer's use more amount of N fertilizer than needed while they use less amount of other fertilizers such as P, K and S. They seldom use micronutrient fertilizers e.g. Zn and B. This practice in turn produces a negative impact on crop production (Rijpma and Jahiruddin, 2004). Continuous use of inorganic fertilizer deteriorates soil properties and causes a nutrient imbalance of soil including micronutrient deficiency. Furthermore, chemical fertilizers pollute soil and water making environment even more harmful for both terrestrial as well as aquatic life. Application of inorganic fertilizer has always been expensive inputs for crop production, especially for developing country like Bangladesh. In near future, chemical fertilizer is likely to be even more costly. This situation in turn will pose a serious threat to food security of vast millions of people of Bangladesh.

The problem of nutrient deficiencies as well as nutrient mining caused by intensive cropping with high yielding varieties of rice and nutrient imbalance can be minimized by judicious application of nutrients through organic manures or chemical fertilizers. The present research work was, therefore, undertaken to find out effect of manures and fertilizers on the yield and nutrient uptake by BRRI dhan49.

Materials and Methods

The experiment was carried out in the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh during the Aman season of 2011. The soil belongs to Sonatala series under the Agro-ecological Zone (AEZ) of Old Brahmaputra Floodplain. The experimental soil was silt loam in texture having pH 6.18, organic matter content 2.15%, total N 0.124%, available P 6.51 ppm, exchangeable K 0.074 me/100 g soil, available S 14.85 ppm and CEC 12.5 me/100 g soil. BRRI dhan49, 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 contained six treatments: T_0= Control, T_1 = STB-CF (HYG), T_2= CD + STB-CF (HYG), T_3= PM + STB-CF (HYG), T_4= COM + STB-CF (HYG) and T_5= Farmers' practice (FP). Here, STB=Soil Test Basis, CF=Chemical fertilizer, CD = Cowdung, PM = Poultry manure, COM=Compost, FP=Farmers' practice, HYG=High yield goal.

Organic manures including cowdung, poultry manure and compost were applied to the experimental plots @ 5, 3 and 5 t ha^{-1}, respectively. The nutrient content of manures has been depicted in Table 1. The recommended dozes of N, P, K and S supplied from urea, TSP, MoP and gypsum were 90, 15, 60 and 15 kg ha^{-1}, respectively. Triple superphosphate (TSP), muriate of potash (MoP), and gypsum were applied as basal dose to all the experimental plots. The amounts of N, P, K, and S coming from cowdung, poultry manure and compost were deducted from recommended N, P, K and S fertilizer doses on IPNS basis. Cowdung, poultry manure and compost were incorporated in the plots as per treatments 10 days before transplanting of the rice seedlings. The manure was mixed thoroughly with the soil. Urea was applied in three equal splits. The first dose of urea was applied 15 days after transplanting of rice seedlings. The rest doses of urea were top dressed 30 (active tillering stage) and 45 days after transplanting (panicle initiation stage).

Table 1 Nutrient contents in cowdung, compost and poultry manure

Manure	Nutrient contents			
	% N	%P	%K	%S
Cowdung	0.57	0.47	0.69	0.23
Compost	0.89	0.30	0.45	0.46
Poultry manure	1.18	1.13	0.81	0.35

Thirty-day old seedlings of BRRI dhan49 was transplanted in the plots maintaining a plant spacing of 20cm x 20cm. Three healthy seedlings were transplanted in each hill. Intercultural operations such as irrigation and weeding were done as and when necessary. The crop was harvested at full maturity. Grain yield was recorded on 14% moisture basis and straw yield on sun dry basis. Five hills were randomly selected from each plot at maturity to record the yield contributing characters. Grain and straw samples were analysed for N, P, K and S concentration following standard methods (Page *et al*., 1982). The NPKS uptake by grain and straw was calculated from the nutrient contents and yield data. All the data were statistically analyzed by F-test and the mean differences were adjudged by DMRT at 5% level (Gomez and Gomez, 1984).

Results

Yield contributing characters

Yield contributing characters such as plant height, effective tillers $hill^{-1}$, panicle length and grains $panicle^{-1}$ were influenced significantly due to application of organic manures and chemical fertilizers (Table 2). All the treatments significantly increased the plant height over control and the highest value (94.25 cm) was

recorded due to the application of poultry manure @ 3 t ha^{-1} in combination with chemical fertilizers (T_3) which was statistically similar with T_2 [CD + STB-CF (HYG)]. The lowest plant height (78.88 cm) was obtained in control (T_0). The maximum number of effective tillers $hill^{-1}$ (13.50) was obtained in the treatment T_3 [PM + STB-CF (HYG)] and the minimum value of 9.00 was found in control. The longest panicle length of 25.55 cm was recorded in T_3 which was statistically similar with T_2 and T_4. The shortest panicle length of 19.33cm was recorded in the control (T_0). The treatments T_1 [STB-CF (HYG)] and T_5 (FP) also increased the panicle length over the control. The number of grains $panicle^{-1}$ ranged from 112.2 to 133.7. The treatment T_3 produced the highest number of grains $panicle^{-1}$ which was statistically similar with T_2. The lowest value was obtained in the treatment T_0 (112.2). The 1000-grain weight was not influenced significantly due to application of organic manures and chemical fertilizers. The 1000-grain weight ranged from 19.27 to 23.35 g.

Table 2. Effect of manures and fertilizers on the yield components of BRRI dhan49

Treatment	Plant height (cm)	Effective tillers $hill^{-1}$(No.)	Panicle length (cm)	Grain $panicle^{-1}$ (No.)	1000-grain weight (g)
T_0 [Control]	78.88e	9.00d	19.33c	112.25d	19.27
T_1 [STB-CF (HYG)]	91.55c	11.50c	24.13b	128.75c	21.45
T_2 [CD + STB-CF (HYG)]	93.85ab	12.50b	25.45a	133.50ab	23.24
T_3 [PM + STB-CF (HYG)]	94.25a	13.50a	25.55a	133.75a	23.35
T_4 [COM + STB-CF (HYG)]	92.78bc	13.25a	25.38a	131.00bc	22.51
T_5 [Farmers' practice (FP)]	90.23d	12.00bc	23.85b	130.25c	21.00
SE±	1.10	0.35	0.45	1.58	0.30
CV (%)	3.34	2.12	2.45	3.58	6.12

Figure(s) in a column having common letter (s) do not differ significantly at 5% level of significance.
Here, STB = Soil Test Basis, CF = Chemical fertilizer, CD = Cowdung, PM = Poultry manure, CoM = Compost, FP = Farmers' practice, HYG = High yield goal, SE = Standard error of means; CV = Coefficient of variation

Grain yield

Results in Table 3 show that the grain yield of BRRI dhan49 was significantly influenced due to different treatments. The grain yield ranged from 3.61 to 4.87 t ha^{-1}. The lowest grain yield was obtained in the control (T_0). The highest grain yield was found in T_3 [PM + STB-CF (HYG)] which was statistically similar with T_1 [STB-CF (HYG)] and T_4 [COM + STB-CF (HYG)]. The grain yield due to different treatments may be ranked in the order of T_3> T_1> T_2> T_4 > T_5> T_0. The percent increase in grain yield of BRRI Dhan49 over control due to different treatments ranged from 18.28 to 34.90. The treatment T_3 and T_5 gave the highest (34.90%) and the lowest (18.28%) yield increase over control, respectively. It reveals that BRRI dhan49 responded better to the nutrients supplied from organic manures rather than to chemical fertilizers. This might be due to the quick release of nutrients from poultry manure.

Straw yield

Straw yield of BRRI dhan49 was also influenced significantly by different treatments under study (Table 3). The straw yield ranged from 4.10 to 5.51 t ha^{-1}. It was observed that the treatment T_3 [PM + STB-CF (HYG)] produced the highest straw yield. The lowest straw yield was obtained in T_0 (control). The straw yields due to different treatments may be ranked in the order of T_3> T_2> T_4> T_1> T_5>T_0. The treatments under study resulted in 22.43% to 34.39% increase in straw yield over control. It appears that the treatment T_3 gave the highest straw yield increase of 34.39% over control. Table 2 also indicates that organic manures served as the better source of nutrients in producing straw yields of rice.

Table 3. Grain and straw yields of BRRI dhan49 as influenced by manures and fertilizers

Treatment	Grain yield (t ha^{-1})	Increase over control (%)	Straw yield (t ha^{-1})	Increase over control (%)
T_0 [Control]	3.61c	-	4.10c	-
T_1 [STB-CF (HYG)]	4.68a	29.64	5.11ab	24.63
T_2 [CD + STB-CF (HYG)]	4.59ab	27.15	5.30ab	29.26
T_3 [PM + STB-CF (HYG)]	4.87a	34.90	5.51a	34.39
T_4 [COM + STB-CF (HYG)]	4.50ab	24.65	5.24ab	27.80
T_5 [Farmers' practice (FP)]	4.27b	18.28	5.02b	22.43
SE ±	0.10	-	0.10	-
CV (%)	2.55	-	1.99	-

Figure(s) in a column having common letter (s) do not differ significantly at 5% level of significance.
Here, STB=Soil Test Basis, CF=Chemical fertilizer, CD = Cowdung, PM = Poultry manure, COM=Compost, FP=Farmers' practice, HYG=High yield goal, SE = Standard error of means; CV = Coefficient of variation

Nutrient uptake by grain and straw of BRRI dhan49

Nitrogen uptake: The N uptake by grain and straw as well as total N uptake by BRRI dhan49 was significantly influenced by different treatments (Table 4). The N uptake by grain and straw ranged from 41.83 to 63.01 kg ha^{-1} and 23.5 to 37.20 kg ha^{-1}, respectively. The maximum N uptake by grain was recorded in T_3 [PM + STB-CF (HYG)]. The treatment T_3 was statistically similar with T_1 [STB-CF (HYG)], T_2 [CD + STB-CF (HYG)], and T_4 [COM+ STB-CF (HYG)] but significantly different from other treatments. The lowest grain N uptake of 41.83kg ha^{-1} was recorded in the control. The highest N uptake by straw was recorded in T_3 which was statistically similar with the treatments T_2 and T_4 but significantly different from all other treatments. The minimum N uptake by straw of 23.53 kg ha^{-1} was recorded in the control.

Table 4. The uptake of NPKS by BRRI dhan49 as influenced by integrated use of manures and fertilizers

Treatment	N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})		S uptake (kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_0 [Control]	41.83c	23.53c	7.25d	2.98d	7.20d	44.98d	4.28d	3.80d
T_1 [STB-CF (HYG)]	56.66ab	32.53b	9.84ab	4.14c	10.15bc	59.59c	5.73bc	5.19c
T_2 [CD + STB-CF (HYG)]	57.80ab	35.26ab	10.00ab	4.90ab	10.73ab	68.83ab	6.27ab	5.98ab
T_3 [PM + STB-CF (HYG)]	63.01a	37.20a	10.46a	5.05a	11.80a	70.36a	6.71a	6.52a
T_4 [COM + STB-CF (HYG)]	56.02ab	34.44ab	9.55bc	4.59b	10.36bc	64.15bc	5.76bc	5.56bc
T_5 [Farmers' practice (FP)]	52.42b	30.98b	8.87c	4.02c	9.27c	60.09c	5.21c	5.01c
SE ±	1.59	1.02	0.24	0.15	0.33	1.87	0.18	0.19
CV (%)	4.58	5.47	6.45	7.55	12.14	4.58	6.33	6.58

Figure(s) in a column having common letter (s) do not differ significantly at 5% level of significance
Here, STB=Soil Test Basis, CF=Chemical fertilizer, CD = Cowdung, PM = Poultry manure, COM=Compost, FP=Farmers' practice, HYG=High yield goal, SE = Standard error of means; CV = Coefficient of variation

Phosphorus uptake: The ranges of P uptake observed in grain and straw of BRRI dhan49 were 7.25 to 10.46 kg ha^{-1} and 2.98 to 5.05 kg ha^{-1}, respectively (Table 4). The highest P uptake by grain was recorded in T_3 and the lowest P uptake by grain was found in the control. In case of straw, the highest P uptake was recorded in T_3 which was statistically similar T_2. The lowest value was recorded the control (T_0). The treatments T_1 and T_5 were statistically similar in their effects on P uptake by straw.

Potassium uptake: Application of manures and chemical fertilizers significantly affect K uptake as well as total P uptake by BRRI dhan49 (Table 4). The K uptake by grain varied from 7.20 to 11.80 kg ha^{-1} while the values for straw ranged from 44.98 to 70.36 kg ha^{-1}. The highest K uptake of 11.80 kg ha^{-1} by grain was recorded in T_3 treatment which was statistically similar with the treatments T_2 treatments. In case of straw, the highest K uptake of 70.36 kg ha^{-1} was also recorded in T_3 treatment which was statistically similar with the treatments T_2 but significantly superior to all other treatments.

Sulphur uptake: Sulphur uptake by grain and straw as well as total S uptake by BRRI dhan49 was significantly increased due to the application of organic manures and chemical fertilizers (Table 4). Sulphur uptake by grain and straw ranged from 4.28 to 6.71 kg ha^{-1} and 3.80 to 6.52 kg ha^{-1}, respectively**.** In case of grain, the highest S uptake was recorded in T_3. The lowest uptake was recorded in the control. The treatment T_3 was statistically identical with T_2 but significantly different from all other treatments**.** In case of straw, the highest S uptake by BRRI dhan49 was recorded in T_3. The lowest uptake was recorded in control.

Discussion

In the present study the effects of manures and fertilizers on the growth parameters and yield as well as nutrient uptake by BRRI dhan49 have been elaborated. From the results it is observed that the yield contributing characters such as plant height, number of effective tillers $hill^{-1}$, panicle length, grains $panicle^{-1}$, filled grains $panicle^{-1}$, and 1000-grain weight are higher in T_3 treatment where poultry manure was applied in combination with fertilizers on IPNS basis as compared to those observed in other treatments. Organic manures were found better source of nutrients in respect of their effects on yield attributes of rice. Among the manures, poultry manure showed superior performance on plant height. This might be due to slow release of nutrients from poultry manures and efficient utilization of nutrients by plants. These results are in agreement with Parvez *et al.* (2008) who observed that the plant height of rice was significantly influenced by the application of organic manures and fertilizers. The effect of poultry manure and cowdung was more pronounced in producing the number of effective tillers $hill^{-1}$ as compared to chemical fertilizers. These results are well corroborated with the findings of Rajni Rani *et al.* (2001) who found increased number of effective tillers $hill^{-1}$ with the integrated use of vermicompost, PM and nitrogenous fertilizers in rice. The results reveal that cowdung, compost and poultry manure and compost influenced markedly the panicle length. These results are in agreement with Singh *et al.* (2005) who found increased panicle length with the application of urea, cowdung, and Azospirillum, individually or in combinations. A significant increase in panicle length due to of organic manures and fertilizers N, S, Zn and B was also noted by Hoque (1999). Mondal *et al.* (1990) observed that the number of spikelet's $panicle^{-1}$ of rice was increased with the increasing NPK rates and FYM application. Similar results were also reported by Chander and Pandey (1996). Razzaque (1996) noted a significant increase in grains $panicle^{-1}$ due to application of organic manures and fertilizer nitrogen. The effect of poultry manure was more pronounced in producing filled grains $panicle^{-1}$. Umanah *et al.* (2003) reported that poultry manure increased the grains per panicle. Hoque (1999) noted significant increase in filled grains $panicle^{-1}$ with the application of organic manures and fertilizers. These results are well corroborated with the findings of Rahman *et al.* (2009) who found an insignificant response of urea-N and manures on 1000-grain weight of BRRI dhan29.

Poultry manure was found more effective in producing grain yields of BRRI dhan49 as compared to cowdung and chemical fertilizers. These results are in agreement with the findings of Rajni Rani *et al.* (2001), Rahman *et al*. (2009) and Parvez *et al.* (2008). Poultry manure also demonstrated superior effect in producing straw yield of rice as compared to cowdung and chemical fertilizers. Ahmed and Rahman (1991) reported that the application of organic manure and chemical fertilizers increased straw yield of rice.

It is clear that the application of organic manures had positive influences on the N uptake by BRRI dhan49. Significant increase in N uptake by rice grain and straw with the application of organic manures and fertilizers was reported by Hoque (1999). Dongarwar *et al.* (2003) observed that the P uptake by rice grain was increased with the combined application of manures and fertilizers. Rahman *et al.* (2009) also found similar results with a trial on BRRI dhan29 using urea and manures. All the treatments receiving poultry manure and cowdung significantly increased the total K uptake by rice. It was observed that the K uptake by grain was much less than that by straw. These results are well corroborated with Meena *et al.* (2003) who reported that application of organic manure and chemical fertilizers significantly increased the K uptake by rice. The S uptake by rice was also influenced significantly due to application of manures and fertilizers. These results are in agreement with Akter *et al.* (2012) and Malika (2011) who found positive effects on S uptake by rice with application of manures and fertilizers.

Conclusion

From the present study it is observed that the application of manures and fertilizers showed better performance in respect of grain yield and yield contributing characters, nutrient uptake as compared to the application of fertilizers only. The performance of poultry manure was better than that of cowdung and compost for the growth and yield of rice. Application of poultry manure @ 3 t ha^{-1} in association with chemical fertilizers will be rewarding for the maximization of rice yield.

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