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INTEGRATED USE OF MANURES AND FERTILIZERS FOR MAXIMIZING THE GROWTH AND YIELD OF BORO RICE (*cv.* BRRI dhan28)

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ABSTRACT

Hoque A, Islam MR, Siddique AB, Afroz H, Yeasmen N (2014) Integrated use of manures and fertilizers for maximizing the growth and yield of boro rice (*cv.* BRRI dhan28). *J. Soil Nature* 7(2), 7-11.

A study was conducted at the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh during Boro season of 2012 to evaluate the effect of combined use of manures and fertilizers for maximizing the growth and yield of BRRI dhan28. The experimental soil was silt loam in texture. The experiment was laid out in a randomized complete block design with three replications. The treatments include T_0 [Control], T_1 [Soil Test Basis-Chemical Fertilizer], T_2 [(Cowdung) + STB-CF], T_3 [(Poultry Manure) + STB-CF], T_4 [(Compost) + STB-CF], and T_5 [Farmer's practice]. The recommended doses of N, P, K, S and Zn were 120, 15, 50, 15 and 2 kg ha^{-1}, respectively. The cowdung, poultry manure and compost were used @ 5, 3 and 5 t ha^{-1}, respectively. Application of manures and fertilizers significantly increased the yield attributes like plant height, panicle length, effective tillers $hill^{-1}$, grains $panicle^{-1}$ and grain and straw yields of BRRI dhan28. The maximum grain yield of 5651 kg ha^{-1} and straw yield of 6572 kg ha^{-1} were recorded in T_3 [(PM) + STB-CF]. The lowest grain and straw yields were found for T_0 (Control) treatment. The NPKS content and uptake in BRRI dhan28 were also influenced significantly due to integrated use of manures and fertilizers. The performance of the treatment T_3 was better than T_1, T_2 and T_4 in producing the yield of grain and straw of BRRI dhan28 although they received the same amount of nutrients. So, the treatment T_3 [(Poultry Manure) + STB-CF] can be used for the successful cultivation of BRRI dhan28.

Key words: *manure, fertilizer, growth, yield, BRRI dhan28*

INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food of Bangladesh. Rice contributes 91.1% of the total grain production and covers 74% of the total calorie intake of this country's people (MOA 2001).The food deficiency in Bangladesh could be minimized either by bringing more area under cultivation or by increasing the rice yield per unit area. Among the three types of rice, boro rice covers about 56.66% of total rice area, which contributes 43.24% of the total rice production in the country (BBS 2010). Rice is intensively cultivated in Bangladesh covering about 80% of arable land. Unfortunately, the yield of rice is low considering the other rice growing countries like Japan and China where the average yield is 6.7 and 6.3 t ha^{-1}, respectively (FAO 2004). A judicious combination of organic and inorganic sources of nutrients is necessary for sustainable agriculture that can ensure food production with high quality (Nambiar 1998).

The increasing land use intensity has resulted in a great exhaustion of nutrient in soils. In Bangladesh, most of the cultivated soils have less than 1.5% organic matter while a good agricultural soil should contain at least 2% organic matter. Moreover, this important component of soil is declining with time due to intensive cropping and use of higher dose of chemical fertilizers with little or no addition of organic manure in the farmer's field. Soil organic matter improves the physicochemical properties of the soil and ultimately promotes crop production. Evidences from different AEZ of the country have shown a decrease in the content of organic matter by the range of 15 to 30% over the last 20 years (Miah *et al.* 1997).

Integrated use of organic manure and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining better soil fertility. The long-term research at BARI revealed that the application of cowdung @ 5 t ha^{-1} $year^{-1}$ improved rice productivity as well as prevented the soil resources from degradation. Poultry manure is another good source of nutrients in soil. Organic manure can supply a good amount of plant nutrients and therefore can contribute to crop yields. Therefore, it is necessary to use fertilizer and manure in an integrated way in order to obtain sustainable crop yield without declining soil fertility.

Therefore, it would not be wise to depend only on inherent potentials of soils for higher crop production. More recently, attention is given on the utilization of organic wastes, farm yard manure, compost and poultry manures as the most effective measures for the improving soil fertility and thereby crop productivity. The application of different fertilizers and manures influences the physical and chemical properties of soil and enhances the biological activities. It is also positively correlated with soil porosity and enzymatic activity. Applications of both chemical and organic fertilizers need to be applied for the improvement of soil physical properties and supply of essential plant nutrients for higher yield. The present investigation was, therefore, undertaken to develop a suitable integrated dose of inorganic fertilizers and organic manures for boro rice and to observe the effects of different levels of inorganic fertilizers and organic manures on the yield components as well as yield of boro rice.

The study was, therefore, undertaken to evaluate the effects of combined use of manures and fertilizers on the yield and nutrient uptake of BRRI dhan28 and to determine the suitability of different sources of organic materials for using as manures for rice cultivation.

MATERIALS AND METHODS

The experiment was carried out at Soil Science Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from January to June, 2012. The soil belongs to Sonatala series under the AEZ-9 (Old Brahmaputra Floodplain). The 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 0.07 me%, available S 14.85 ppm and CEC 12.5 me%. BRRI dhan28, a high yielding variety of wheat 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 containing six treatments: T_0 [Control], T_1 [Soil Test Basis-Chemical Fertilizer], T_2 [(Cowdung) + STB-CF], T_3 [(Poultry Manure) + STB-CF], T_4 [(Compost) + STB-CF], and T_5 [Farmer's practice]. 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 recommended dozes of N, P, K and S supplied from urea, TSP, MoP and gypsum were 120, 15, 50, 15 and 2 kg ha^{-1}, respectively. Triple super phosphate (TSP), muriate of potash (MoP), and gypsum were applied as basal dose to all the experimental plots. The amounts of nitrogen, phosphorus, potash and sulphur fertilizers required per plot were calculated as per the treatments. Cowdung, poultry manure and compost were applied before one week of transplanting (21 January, 2012). The full dose of TSP, MoP and gypsum was applied one day before transplanting (28 January, 2012). Urea was applied in 3 equal splits. The first split of urea was applied 14 days after transplanting (12 February, 2012). Second split was applied as top dressing 30 days after transplanting (29 February, 2012) and the third split of urea 45 days after transplanting i.e. at panicle initiation stage.

Twenty-five days old seedlings were carefully uprooted from a seedling nursery and transplanted on 29 January 2012 on the experimental plots maintaining plant spacing of 20 cm x 20 cm. Three seedlings were transplanted in each hill. The number of rows and hills per plot was equal in all the plots. Intercultural operations such as irrigation and weeding were applied 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 analyzed for NPKS consents following standard methods. The NPKS uptake by grain and straw was calculated from their contents and yield data. All the data were statistically analyzed by F-test and the mean differences were ranked by DMRT at 5% level (Gomez and Gomez, 1984).

RESULTS

Yield contributing characters

Crop characters and yield contributing characters such as plant height, effective tillers $hill^{-1}$, panicle length and grains $panicle^{-1}$ and 1000-grain weight were influenced significantly due to application of cowdung, compost and poultry manure and NPKS fertilizers (Table 1). Plant height ranged from 75.19 cm to 99.72 cm. The tallest plant of 99.72 cm was found in T_3 [(PM) + STB-CF] which was identical to T_2 [(CD) + STB-CF] and T_4 [(COM) + STB-CF] with the value of 95.59 cm and 99.72 cm, respectively. The shortest plant of 75.19 cm was observed in control treatment. The highest number of effective tillers $hill^{-1}$ of 12.53 was found in T_3 [(PM) + STB-CF] and the lowest value of 6.93 was observed in T_0 (control). The treatment T_2 produced the highest panicle length (24.77 cm) which was statistically similar with the treatment T_1, T_3 and T_5. The minimum panicle length (21.89 cm) was observed in the control (T_0). The number of grains $panicle^{-1}$ varied from 95.17 to 154.4 with the highest value in T_4 [(COM) + STB-CF]. The treatments T_1, T_2 and T_4 were statistically similar with respect to grains $panicle^{-1}$. The lowest number of grains $panicle^{-1}$ (95.17) was found in control. These results are in agreement with Rajni *et al.* (2001), Sarfraz *et al.* (2002) and Singh *et al.* (2006) who found significant influence of organic manure and chemical fertilizers on yield parameters. The 1000-grain weight ranged from 22.70 g in T_0 (control) to 22.80 g in T_5 [Farmer's practice]. The treatments may be ranked in the order of $T_5 > T_4 > T_2 > T_1 > T_3 > T_0$ with respect of 1000-grain weight.

Table 1. Effect of combined use of manures and fertilizers on the crop characters and yield and yield contributing characters of BRRI dhan28

Treatments	Plant height (cm)	Effective tillers hill^{-1} (cm)	Panicle length (cm)	Grains panicle^{-1} (No.)	1000-grain weight (g)
T_0 [Control]	75.19c	6.93d	21.89b	95.17d	22.70
T_1 [STB-CF]	89.28b	10.60bc	24.69a	153.03ab	23.07
T_2 [(CD) + STB-CF]	95.59ab	11.07ab	24.77a	145.57abc	23.13
T_3 [(PM) + STB-CF]	99.72a	12.53a	24.34a	136.23bc	23.03
T_4 [(COM)+STB-CF]	94.77ab	11.73ab	24.37a	154.41a	22.40
T_5: [FP]	87.94b	9.40c	23.82a	131.77c	22.80
CV (%)	4.44	7.48	3.55	6.74	2.03
SE (±)	2.32	0.448	0.492	5.29	0.27

The figure(s) having common letter(s) in a column do not differ significantly at 5% level of significance

STB = Soil Test Basis, CF = Chemical Fertilizer, OM = Organic Manure, CD = Cowdung, PM = poultry manure, COM = Compost, FP = Farmer's practice, CV = Coefficient of variation, SE = Standard error of means

Grain yield

The grain yield of BRRI dhan28 varied significantly due to application of cowdung, poultry manure, compost and NPKS fertilizers (Table 2). The grain yield ranged from 3.34 to 5.65 t ha^{-1}. The highest grain yield (5.65 t ha^{-1}) was observed in T_3 [(PM) + STB-CF] and the lowest value (3.34 t ha^{-1}) was recorded in T_0 (control). The grain yield produced by T_3 was statistically similar with T_1 [STB-CF] although there was a numerical variation in grain yield between the treatments. Again the treatments T_1, T_2 and T_4 of 5.49, 5.22 and 5.19 t ha^{-1} respectively, produced identical grain yields. Based on grain yield, the treatments may be ranked in order of T_3> T_1> T_2> T_4> T_5> T_0. In association with same recommended fertilizer doses poultry manure treated plots gave better grain yield than cowdung and compost treated plots indicating the superior position of poultry manure. The increase in grain yield over control ranged from 37.18 to 69.19% where the highest increase was obtained in T_3 [(PM) + STB-CF] and the lowest one was obtained in T_5 [Farmer's practice]. Khan *et al.* (2007) reported that grain yield was significantly increased due to application of organic manure and chemical fertilizers.

Straw yield

Straw yields of BRRI dhan28 also varied significantly by different treatments under study (Table 2). The yields of straw ranged from 4.06 to 6.57 t ha^{-1}. The highest straw yield of 6.57 kg ha^{-1} was obtained in T_3 [(PM) + STB-CF] and the lowest value of 4.06 kg ha^{-1} was noted in T_0 (control). The treatment may be ranked in the order of T_3 >T_1>T_4 >T_2 >T_5 >T_0 in terms of straw yield. Poultry manure exerted comparatively better effect in producing higher straw yields as compared to cowdung and compost. Regarding the percent increase of straw yield, maximum increase (62.03%) was noted in T_3 [(PM) + STB-CF] and the minimum value (19.69%) was found in T_5 [Farmer's practice].

Table 2. Effects of combined use of manures and fertilizers on yields of grain and straw of BRRI dhan28

Treatments	Grain yield (t ha^{-1})	% Increase over control	Straw yield (t ha^{-1})	% Increase over control
T_0 [Control]	3.34d	0	4.06d	0
T_1 [STB-CF]	5.49ab	64.37	5.95ab	46.64
T_2 [(CD) + STB-CF]	5.22b	56.25	5.61d	38.41
T_3 [(PM) + STB-CF]	5.65a	69.19	6.57a	62.03
T_4 [(COM) + STB-CF]	5.19b	55.47	5.69b	40.50
T_5: FP	4.58c	37.18	4.86c	19.69
CV (%)	4.24	-	6.56	-
SE (±)	0.12	-	0.206	-

The figure(s) having common letter(s) in a column do not differ significantly at 5% level of significance

STB = Soil Test Basis, CF = Chemical Fertilizer, OM = Organic Manure, CD = Cowdung, PM = poultry manure, COM = Compost, FP = Farmer's practice, CV = Coefficient of variation, SE = Standard error of means

NPKS uptake by BRRI dhan28

The total N uptake both by grain and straw was influenced significantly by different treatments (Table 3). The highest total N uptake (104.5 kg ha^{-1}) was observed in T_1 and the lowest value (61.58 kg ha^{-1}) was found in T_0. The results presented in Table 3 show that the application of cowdung, compost and poultry manure exerted significant influence on the total P uptake by BRRI dhan28. The highest total P uptake (19.81 kg ha^{-1}) was obtained from T_1 which was statistically similar with the treatment T_3, and T_4. The lowest total P uptake (8.99 kg ha^{-1}) was observed in T_0 (control). Poultry manure exerted pronounced effect in increasing the P uptake by

rice compared to cowdung and compost. The total K uptake by grain and straw was also affected significantly by different treatments (Table 3). The highest total K uptake (182.39 kg ha^{-1} was obtained in T_3 and the lowest value (90.75 kg ha^{-1}) was observed in T_0. Nitrogen as urea and poultry manure exerted better performance in increasing the K uptake of BRRI dhan28 as compared to cowdung and compost. The total S uptake by grain and straw was also influenced significantly by different treatments (Table 3). The highest total S uptake (12.36 kg ha^{-1}) was found in T_2 which was statistically identical with the treatment T_3 and the lowest value (5.79 kg ha^{-1}) was observed in T_0. Chemical fertilizers in combination with poultry manure showed better effect in increasing the S uptake by BRRI dhan28 compared to the combination with cowdung and compost.

Table 3. Effect of manures and fertilizers on total N, P, K and S uptake by BRRI dhan28

Treatments	N uptake (kg $ha^{-1)}$	P uptake (kg ha^{-1})	K uptake (kg ha^{-1})	S uptake (kg ha^{-1})
T_0 [Control]	61.58d	8.99c	90.75d	5.79a
T_1 [STB-CF]	104.5a	19.81a	147.23b	9.92b
T_2 [(CD) + STB-CF]	88.45b	14.83b	146.76b	12.36a
T_3 [(PM) + STB-CF]	88.05b	19.45a	182.39a	12.28a
T_4 [(COM) + STB-CF]	88.66b	19.47a	147.82b	8.81c
T_5: FP	82.71c	16.14b	110.74c	7.86d
CV (%)	0.911	0.964	2.981	0.236
SE (±)	1.84	10.15	3.75	4.32

The figure(s) having common letter(s) in a column do not differ significantly at 5% level of significance

STB = Soil Test Basis, CF = Chemical Fertilizer, OM = Organic Manure, CD = Cowdung, PM = poultry manure, COM = Compost, FP = Farmer's practice, CV = Coefficient of variation, SE = Standard error of means

DISCUSSION

The organic matter content of Bangladesh soils is declining day by day due to intensive cropping with modern varieties with little or no use of manures. Combined use of manures and chemical fertilizers in soil is effective for soil health. It improves soil fertility and assures sustainable agriculture for future. The present study was conducted to evaluate the effects of combined use of manures and fertilizers on the growth and yield of BRRI dhan28. The results of the experiment show that the yield components of BRRI dhan28 were influenced significantly due to combined use of manures and fertilizers. Plants height responded significantly due to application of cowdung, poultry manure, compost and NPKS fertilizers. Parvez *et al.* (2008) also observed that the plant height of rice was significantly influenced by the incorporation of manures and fertilizers. Combined use of cowdung, poultry manure, compost and NPKS fertilizers significantly influenced the number of effective tillers $hill^{-1}$ of BRRI dhan28. These results are well corroborated with the findings of Parvez *et al*. (2008) who found increased number of effective tillers $hill^{-1}$ with the integrated use of manures and fertilizer in rice. The length of panicle of BRRI dhan28 was significantly influenced by the application of manures and fertilizers. The number of grains per panicle of BRRI dhan28 was increased due to application of manures and fertilizers Malika (2011), Parvez *et al.* (2008) and Rahman *et al*. (2009) also found increased number of grains per panicle of rice with the use of manures and fertilizers. The 1000-grain weight of BRRI dhan28 varied insignificantly due to application of manures and fertilizers. Similar results were reported by Rahman *et al*. (2007) and Parvez *et al.* (2008).

The highest grain and straw yield of BRRI dhan28 was observed in the treatment T_3 where poultry manure was applied in combination with chemical fertilizers on IPNS basis. Poultry manure performs better than other manures in producing grain yield of BRRI dhan28 as it contains more uric acid which enhances the decomposition process. So plants can uptake more nutrient from soil.

The N uptake by grain and straw was influenced significantly due to application of manures and fertilizers. The highest total N uptake was observed in treatment T_1 and the lowest value was found in T_0 (Control), Chemical fertilizer is used in T_1. Parvez *et al.* (2008) and Akter *et al*. (2012) reported that application of nitrogen from manures and fertilizers increased the N uptake both in grain and straw of rice. The maximum P uptake by grain was found in T_1 and that by straw was observed in T_3. Akter *et al*. (2012) observed that the P uptake by rice grain was increased with the combined application of manures and fertilizers. The highest total K uptake was obtained in T_3. The results are in agreement with Meena *et al*. (2003) who reported that application of organic manure and chemical fertilizers significantly increased the K uptake by rice. Combination of cowdung, poultry manure and compost with the chemical fertilizers showed better effects than other treatments in increasing S uptake by BRRI dhan28 (Malika 2011).

CONCLUSION

From the overall results it is observed that the treatment T_3 comprising IPNS system including poultry manure (3 t/ha) produced the maximum grain and straw yields of BRRI dhan28. It also demonstrated superior effect on yield attributes of rice. The treatments T_1 [STB-CF], T_2 [(CD) + STB-CF], T_3 [(PM) + STB-CF] and T_4 [(COM) + STB-CF] comprised the same amount of nutrients but the sources are different. However, the treatment T_3 showed better performance than T_1, T_2 and T_4 in respect of yield attributes and grain and straw yields of BRRI dhan28. Therefore, the treatment T_3 [(PM) + STB-CF] can be recommended for the cultivation of BRRI dhan28.

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