Research in
ISSN : P-2409-0603, E-2409-9325
AGRICULTURE, LIVESTOCK and FISHERIES
An Open Access Peer Reviewed Journal

Open Access
Research Article

Res. Agric. Livest. Fish.
Vol. 3, No. 1, April 2016: 99-104

EFFECTS OF ORGANIC AND INORGANIC FERTILIZERS ON THE GROWTH, YIELD AND NITROGEN UPTAKE BY BRRI dhan28

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ARTICLE INFO

Received
14.03.2016

Accepted
20.04.2016

Online
30 April 2016

Key words
Organic,
Inorganic fertilizers,
BRRI dhan28,
Yield,
Nitrogen uptake

ABSTRACT

A study was conducted at the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh during Boro season of 2014 to evaluate the effect of integrated use of manures and fertilizers for maximizing the growth and yield of BRRI dhan28. The experiment was laid out in a randomized complete block design with six treatments and four replications. The treatments include T_0 [Control], T_1 [Soil Test Basis-Chemical Fertilizer], T_2 [(Cowdung) + STB-CF] on IPNS basis, T_3 [(Poultry Manure) + STB-CF] on IPNS basis, T_4 [(Compost) + STB-CF] on IPNS basis, and T_5 [Farmer's practice]. The maximum grain yield of 4340 kg ha^{-1} (95.59% increase over control) and straw yield of 4024 kg ha^{-1} (56.42% increase over control) were recorded in T_3 [(PM) + STB-CF]. The lowest grain and straw yields were found for T_0 (Control) treatment. The N, P, K and S contents and uptake by BRRI dhan28 were profoundly influenced due to combined application 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. The results indicate that application of fertilizers in combination with poultry manure could be considered more effective in rice production. So, the treatment T_3 can be used for the successful cultivation of BRRI dhan28.

To cite this article: Islam MR, AKS Shawon, MLN Begum and A Huda, 2016. Effects of organic and inorganic fertilizers on the growth, yield and nitrogen uptake by BRRI dhan28. Res. Agric. Livest. Fish. 3 (1): 99-104.

INTRODUCTION

Rice is considered as staple crop in Bangladesh. It is not only the main source of carbohydrate but it also provides 69.61% of calories and 56.15% of the proteins in the average daily diet of the people (FAO, 2009). In the last three to four decades, great efforts in rice research and farming innovations were made to boost up rice production. Furthermore, rice alone contributes about 9.5% of the total agricultural GDP in the country. Among all crops, rice is the driving force of Bangladesh agriculture. In fact, food production in Bangladesh is dominated by a single crop (rice) and a single season boro, which accounts for over 60% of total rice production. The average yield of rice is 4.22 t/ha in Bangladesh whereas the yield in some other rice producing countries of the world such as Australia, Korea Republic, Japan and China are 9.54, 7.38, 5.33 and 6.69 ton per hectare, respectively (FAO, 2011).

High yield goal with higher cropping intensity demands more inputs, particularly fertilizer nutrients but raising productivity through chemical fertilizer nutrients is likely to have harmful effect on the environment – soil, water and climate. The cropping intensity of Bangladesh is 179% (BBS, 2011). The increasing cropping intensity without adequate and balanced use of chemical fertilizers and with little or no use of organic manures have caused severe fertility deterioration of our soils resulting in stagnating or even declining of crop productivity. The organic matter content of most of our soils is below 1.5% and in many cases it is less than 1% and decreasing day by day (BARC, 2012). Depletion of soil organic matter in many of Bangladesh soils has reached such an alarming stage that it is caused serious concern among the crop production specialists. It is now feared that unless drastic measures are taken to improve and maintain organic matter reserves, many soils would soon become unproductive. Moreover, tropical monsoon climate with high temperature and abundant rainfall provide favorable condition for enhanced microbial decomposition of soil organic matter. So, it is very difficult rather impossible to conserve and maintain high level of organic matter in the soils. Hence, management of soil organic matter has now become major issue in dealing with the problem of soil fertility and productivity in Bangladesh.

A suitable combination of organic and inorganic sources of nutrients is necessary for sustainable agriculture that will provide food with good quality. Nambier (1991) stated that combined use of organic manures and inorganic NPK fertilizers would be quite promising not only in providing greater stability in production, but also in higher soil fertility status. Cowdung, poultry manure and compost supply the macro and micronutrients especially N, P and S for crop production. The long term research of BRRI reveals that the addition of cowdung @ 5 t ha^{-1} yr^{-1} improves the rice productivity as well as prevents the soil resources from degradation (Bhuiyan, 1994). An improvement and maintenance of a good supply of organic matter is essential for sustenance of soil fertility and crop productivity. The present research work was, therefore, undertaken to evaluate the effects of integrated use of manures and fertilizers on the yield and nitrogen uptake by 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 conducted at the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh during the Boro season of 2013-2014. The study was performed to evaluate the effect of combined use of manures and fertilizers for maximizing the growth and yield of BRRI dhan28. The soil belongs to Sonatala series under the AEZ of the Old Brahmaputra Floodplain. The experimental soil was silt loam in texture having pH 6.3, organic matter 2.05%, total nitrogen 0.14%, available phosphorus 6.2 mg/kg, exchangeable K 0.068 me/100g soil and available sulphur 12.4 mg/kg. BRRI dhan28, a high yielding boro rice variety of rice was used in this experiment as the test crop. The experiment was laid out in a randomized complete block design (RCBD), where the experimental area was divided into 4 blocks. There were 6 different treatment combinations: T_0 - Control, T_1 - STB-CF (HYG), T_2 - STB-CF (HYG) + CD (5 t/ha) on IPNS basis, T_3 - STB-CF (HYG) + PM (3 t/ha) on IPNS basis, T_4- STB-CF (HYG) + COM (5 t/ha) on IPNS basis, T_5 - FP. Here, STB = Soil Test Basis; CF = Chemical Fertilizer; HYG = High Yield Goal; OM = Organic matter; PM = Poultry Manure; COM = Compost; FP = Farmers' practice. Well decomposed cowdung, compost and poultry manure were applied to the plots as per the treatments by mixing with the soil well before 7 days of sowing.

The nutrient contents of the manures are depicted in Table 1. 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. The full dose of TSP, MoP and Gypsum was applied one day before transplanting. Urea was applied in three equal splits. The first split of urea was applied after 15 days of transplanting. The second split was applied as top dressing after 30 days of transplanting i.e at maximum tillering stage. The third split was applied at panicle initiation stage. Thirty day old seedlings were carefully uprooted from a seedling nursery and transplanted on the experimental plots maintaining plant spacing of 20 cm x 20 cm. Three 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 sundry basis. Five hills were randomly selected from each plot at maturity to record the growth and yield contributing characters. Grain and straw samples were analyzed for N content following the method outlined by Bremner and Mulvaney (1982). The N uptake by grain and straw was calculated from its content and yield data using the equation, Nitrogen uptake = [Nitrogen content (%) x Yield (kg ha^{-1})]/100. All the data were statistically analyzed by F-test and the mean differences were ranked by DMRT at 5% level (Gomez and Gomez, 1984).

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

RESULTS

Growth and yield contributing characters

Growth and 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 the application of poultry manure, compost and NPKS fertilizers. The tallest plant of 89.70 cm was found in T_3 [(PM) + STB-CF] while the shortest plant of 77.30 cm was observed in control treatment. Cowdung when applied @ 5 t ha^{-1} with [STB-CF] (T_2) produced taller plants compared to the application of compost @ 5 t ha^{-1} with same doses of chemical fertilizers (T_2). The highest number of effective tillers $hill^{-1}$ of 13.85 was found in T_3 [(PM) + STB-CF] and the lowest value of 10.55 was observed in T_0 (control). The treatments T_1 [STB-CF], T_2 [(CD) + STB-CF], T_2 [(CD) + STB-CF], T_4 [(COM) + STB-CF] and T_5 [Farmer's practice] demonstrated statistically similar effective tillers $hill^{-1}$. The highest panicle length (23.30 cm) was found in T_3 [(PM) + STB-CF] while the lowest panicle length (19.25 cm) was observed in T_0. The number of grains $panicle^{-1}$ varied from 115 to 83.25 with the highest value in T_3 [(PM) + 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 $panicle^{-1}$ (83.25) was found in control. The 1000-grain weight ranged from 19.95 g in T_0 (control) to 20.90 g in T_1 [STB-CF].

Grain yield

The grain yield of BRRI dhan28 varied significantly due to application of cowdung, poultry manure, compost and NPKS fertilizers (Table 3). The grain yield ranged from 2220 to 4340 kg ha^{-1}. The highest grain yield (4340 kg ha^{-1}) was observed in T_3 [(PM) + STB-CF] and the lowest value (2220 kg ha^{-1}) was recorded in T_0 (control). Again the treatments T_1, T_2, T_4 and T_5 produced identical grain yields. Based on grain yield, the treatments may be ranked in order of $T_3 > T_2 > T_4 > T_5 > T_1 > T_0$. In association with same recommended fertilizer doses poultry manure treated plots gave better grain yield than cowdung and compost treated plots indicating the superior effect of poultry manure. The increase in grain yield over control ranged from 18.92% to 95.59% where the highest increase was obtained in T_3 [(PM) + STB-CF] and the lowest one was obtained in control as shown in Table 3.

Table 2. Effects of manures and fertilizers on the yield attributes of BRRI dhan28

Treatment combinations	Plant height (cm)	Effective tillers/hill (No.)	Panicle Length (cm)	Grains panicle^{-1} (No.)	1000-grain weight (g)
T_0 [Control]	77.30 c	10.55 b	19.25 c	83.25 b	19.95
T_1 [STB-CF]	79.70 bc	11.50 b	21.33 b	98.00 ab	20.90
T_2 [(CD) + STB-CF]	81.20 b	11.55 b	21.56 b	97.50 ab	19.90
T_3[(PM) + STB-CF]	89.70 a	13.85 a	23.30 a	115.00 a	20.55
T_4[(COM)+STB-CF]	79.60 bc	10.95 b	22.40 ab	102.25 ab	20.15
T_5:[FP]	80.25 bc	11.20 b	21.84 ab	91.00 b	20.85
CV (%)	2.35	11.64	4.42	12.22	5.03
SE (±)	0.957	0.675	0.477	5.976	0.513
P value	0.000	0.047	0.001	0.036	0.000

The figure(s) having common letter(s) in a column do not differ significantly at 5% level of significance.
CV = Coefficient of variation, SE = Standard error of means; STB = Soil Test Basis, CF = Chemical Fertilizer, OM = Organic Manure, CD = Cowdung, PM = poultry manure, COM = Compost, FP = Farmers' practice

Straw yield

Straw yields of BRRI dhan28 also varied significantly by different treatments under study. The yields of straw ranged from 2572 to 4024 kg ha^{-1} (Table 3). The highest straw yield of 4024 kg ha^{-1} was obtained in T_3 [(PM) + STB-CF] and the lowest value of 2572 kg ha^{-1} was noted in T_0 (control). The treatment may be ranked in the order of $T_3 > T_2 > T_5 > T_4 > T_1 > T_0$ in terms of straw yield. Poultry manure exerted comparatively better performance in producing straw yields as compared to cowdung and compost. Regarding the percent increase of straw yield, maximum increase (56.42%) was noted in T_3 [(PM) + STB-CF] and the minimum value (1.95%) was found in T_1 [STB-CF] as shown in Table 3.

Table 3. Effects of fertilizers and manures on the yield of BRRI dhan28

Treatment	Grain		Straw	
	Yield (kg ha^{-1})	% increase over control	Yield (kg ha^{-1})	% increase over control
T_0: (Control)	2220 c	-	2572 c	-
T_1: STB-CF (HYG)	2643 bc	18.92	2622 c	1.95
T_2: STB-CF (HYG) + CD (5t/ha)	3218 b	44.59	3225 b	25.29
T_3: STB-CF (HYG) + PM (3t/ha)	4340 a	95.59	4024 a	56.42
T_4:STB-CF (HYG) + Compost (5 t/ha)	3099 b	39.19	3150 b	22.57
T_5: (Farmers' Practice)	2958 b	33.33	3224 b	25.29
CV (%)	13.85		10.91	-
SE (±)	213.32		171.05	-
P value	0.0001		0.0003	-

The figure(s) having common letter(s) in a column do not differ significantly at 5% level of significance.
CV = Coefficient of variation, SE = Standard error of means; STB = Soil Test Basis, CF = Chemical Fertilizer, OM = Organic Manure, CD = Cowdung, PM = poultry manure, COM = Compost, FP = Farmers' practice

Nitrogen uptake by grain and straw of BRRI dhan28

Results in Table 4 indicate that the N uptake by grain of BRRI dhan28 varied significantly due to application of manures and fertilizers. The N uptake by grain ranged from 42.69 to 74.18 kg ha^{-1}. The highest N uptake (74.18 kg ha^{-1}) was recorded in T_4 [(COM) + STB-CF] which was identical with T_3 [PM + STB-CF] and T_5: FP and the lowest N uptake (42.69 kg ha^{-1}) was found in T_1 [STB-CF]. The straw N uptake of BRRI dhan28 was not significant due to application of manures and fertilizers (Table 4). The straw N uptake ranged from 28.81 to 40.72 kg ha^{-1}. The highest N uptake (40.72 kg ha^{-1}) was recorded in T_0 [Control] and the lowest N uptake (28.81 kg ha^{-1}) was found in T_5 [FP]. The Table 4 reports that the total N uptake by grain of BRRI dhan28 varied significantly due to application of manures and fertilizers. The total N uptake ranged from 73.14 to 109.59 kg ha^{-1}. The highest total N uptake (109.59 kg ha^{-1}) was recorded in T_3 [PM + STB-CF] which was statistically similar with T_4 [COM + STB-CF] and the lowest N uptake (73.14 kg ha^{-1}) was found in T_1 [STB-CF].

Table 4. Effects of fertilizer and manure on nitrogen uptake by BRRI dhan28

Treatment	N uptake (kg ha^{-1})		
	Grain	**Straw**	**Total**
T_0 [Control]	42.92 c	40.72	76.18 c
T_1 [STB-CF]	42.69 c	30.45	73.14 c
T_2 [(CD) + STB-CF]	54.45 bc	31.14	85.58 bc
T_3[(PM) + STB-CF]	71.22 ab	38.34	109.59 a
T_4[(COM) + STB-CF]	74.18 a	26.15	100.33 ab
T_5:FP	58.42 abc	28.81	87.23 bc
CV (%)	18.86	27.35	15.01%
SE (±)	5.40	4.46	6.6557
Level of significance	**	NS	**
P value	0.003	0.213	0.011

The figure(s) having common letter(s) in a column do not differ significantly at 5% level of significance.
CV = Coefficient of variation, SE = Standard error of means; STB = Soil Test Basis, CF = Chemical Fertilizer, OM = Organic Manure, CD = Cowdung, PM = poultry manure, COM = Compost, FP = Farmers' practice

DISCUSSION

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 performed 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 nutrients from soil. These results are well corroborated with Rahman *et al.* (2009) and Islam *et al.* (2014). The N uptake by grain and straw was also influenced significantly due to application of manures and fertilizers. The total N uptake was enhanced with the application of poultry manure in combination with chemical fertilizers. Chandel *et al.* (2003), Parvez *et al.* (2008) and Hoque *et al.* (2014) reported that application of nitrogen from manures and fertilizers increased the N uptake both by grain and straw of rice. Islam *et al.* (2014) also recommended poultry manure 3 t ha^{-1} + STB-CF for the yield maximization of BRRI dhan49 in Aman season.

CONCLUSIONS

It can be concluded that integrated use of manures and fertilizers improves rice yield to a significant extent than the single application of chemical fertilizers. Based on the overall results of the study, the application of poultry manure @ 3 ton/ha with chemical fertilizers on IPNS basis can be recommended for obtaining the maximum yield of BRRI dhan28 in Boro rice production with some further trials.

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