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Effect of Nitrogen Supplied from Manure and Fertilizer on the Growth, Yield and Nutrient Uptake of Rice

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Abstract: An investigation was undertaken to see the effect of added nitrogen supplied from poultry manure and urea-N on the growth, yield and nutrient uptake of BRRI Dhan 29 rice. There were eight treatments consisting of T_0 (control), T_1 (N_{100}), T_2 ($PM_{5.0}$), T_3 (N_{75} + $PM_{1.25}$), T_4 (N_{50} + $PM_{2.5}$), T_5 (N_{25} + $PM_{3.75}$), T_6 ($PM_{7.5}$) and T_7 (N_{120}). Application of poultry manure alone or in combination with urea-N significantly increased the plant height, number of effective tillers hill^{-1}, panicle length, number of grains panicle^{-1} and filled grains panicle^{-1} whereas 1000-grain weight varied insignificantly. The grain and straw yields increased significantly with different treatments and the highest yield was obtained with T_6 treatment which was statistically at par with T_5. The NPKS uptake was positively influenced by different treatments. Poultry manure was found the best source of N for rice. Application of poultry manure considerably increased the organic matter content, total N, available P, exchangeable K, available S and CEC of the post harvest soil and thus improved soil health.

Key words : Nitrogen, poultry manure, urea, growth, yield, nutrient uptake, rice

Introduction

Nitrogen is the most deficient nutrient in Bangladesh soil limiting crop production and a key element in the production of rice. Application of urea-N gives a good yield and urea has been found to be very effective nitrogenous fertilizer for rice (BRRI, 1984). However, the efficiency of applied nitrogen in rice is very low, generally ranging from 15 to 25% in wetland condition with the highest absorption rate of 30 to 50% (Prasad and De Datta, 1979). The low N use efficiency has always been a problem due to a substantial loss of the applied fertilizer through denitrification, volatilization and leaching.

Intensive cropping with improved varieties, low use of organic matter, improper soil and crop management practices in turn gradually resulted a marked depletion of inherent nutrient reserves which is responsible for stagnating even declining crop yields (BRRI, 1996). Continuous use of chemical fertilizers for long time may accelerate the depletion of soil organic matter in addition to micronutrient deficiencies. Organic matter acts as a reservoir of plant nutrients (mainly for N, P & S) and prevent leaching of the elements which are vital to plant growth. The most important role of organic matter for rice production is to supply N and to regulate the immobilization and mineralization of N in the soil. The use of organic manures and their proper management may reduce the need for chemical fertilizers thus allowing the small farmers to serve in part the cost of the production. Besides a good source of plant nutrients, organic matter also improves the physical, chemical and biological properties of soil and thus helps to increase and conserve the soil productivity. Poultry manure is a good source of organic matter as well as nutrients and provides an opportunity to uptake nutrients by plants for a long time. Poultry manure may play a vital role in solving the problem of nutrient deficiency in soil and in improving soil health. In addition, global environmental pollution can be controlled considerably by reducing the fertilizer use and by increasing the use of manures. The study was, therefore, undertaken to see the effect of poultry manure and urea-N on the growth, yield and nutrient uptake of rice and on post harvest soil properties.

Materials and Methods

An experiment was conducted at Bangladesh Agricultural University Farm, Mymensingh during the rabi season of 1999 to study the effects of nitrogen supplied from poultry manure and urea on the growth, yield and nutrient uptake of BRRI Dhan 29 rice. The soil belongs to the Sonatala series under the AEZ of Old Brahmaputra Floodplain. The soil was silt loam in texture having pH 6.6, organic matter 3.07%, total N 0.16%, available P 11.7 ppm, exchangeable K 0.09 me/100 g soil, available S 18.2 ppm and CEC 13.7 me/100 g soil. The experiment was designed with eight treatments, laid out in a randomized complete block design. The size of unit plot was 4x2.5 m^2. The treatment combinations were T_0 - control, T_1 -N_{100} (nitrogen @ 100 kg^{-1}), T_2 -$PM_{5.0}$ (poultry manure @ 5.0 t ha^{-1}), T_3 -N_{75} + $PM_{1.25}$ (nitrogen @ 75 kg ha^{-1} + poultry manure @ 1.25 t ha^{-1}),T_4 -N_{50} + $PM_{2.5}$ (nitrogen @ 50 kg ha^{-1} + poultry manure @ 2.5 t ha^{-1}) , T_5 -N_{25} + $PM_{3.75}$ (nitrogen @ 25 kg ha^{-1} + poultry manure @ 3.75 t ha^{-1}), T_6 - $PM_{7.5}$ (poultry manure @ 7.5 t ha^{-1}) and T_7 -N_{120} (nitrogen @ 120 kg ha^{-1}). The experimental field was adequately prepared by ploughing and laddering. Phosphorus @ 25 kg ha^{-1} from TSP, K @ 20 kg ha^{-1} from MP and S @ 10 kg ha^{-1} fromgypsum were applied as basal dose to all the plots. The full dose of poultry manure was applied to the plots one week before transplanting. Nitrogen from urea was applied in three equal splits as per the treatments. The 45 days old seedlings were transplanted in the experimental plots. The intercultural operations were done as and when necessary. The crop was harvested at maturity and the relevant data were recorded from randomly selected plants and also from plots. Grain and straw samples were analyzed for N, P, K and S uptake by the rice crop. Post harvest sol samples were also analyzed for soil pH (Jackson, 1962), organic matter content (Walkley and Black, 1934), total N (Jackson, 1962), available P (Olsen *et al.*, 1954), exchangeable K, available S and CEC (Black, 1965). The data were analyzed statistically and the mean difference was adjudged by Duncan's New Multiple Range Test (DMRT).

Results and Discussion

Yield components: All the treatments significantly increased the plant height, number of effective tillers hill^{-1}, panicle length, number of grains panicle^{-1} and filled grains panicle^{-1} although 1000-grain weight varied insignificantly with different treatments (Table 1). Poultry manure when applied alone or in combination with urea–N exerted more beneficial effects on the growth parameters as compared to single

Table 1: Effect of poultry manure and urea-N on the yield contributing characters of BRRI Dhan 29

Treatment	plant height (cm)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	Filled grains panicle^{-1}	1000-grain weight (g)
T_0 (Control)	71.56d	8.36e	20.89c	111.20e	80.76g	21.33
T_1 (N_{100})	75.15c	9.83d	23.26b	131.10b	86.65f	21.67
T_2 ($PM_{5.00}$)	80.15b	10.50bc	23.96ab	131.30b	102.70c	22.33
T_3 ($N_{75}+PM_{1.25}$)	79.56b	10.13cd	23.65b	127.10c	99.54d	22.33
T_4 ($N_{50}+PM_{2.50}$)	83.27a	10.43bc	24.05ab	132.00b	105.60c	22.55
T_5 ($N_{25}+PM_{3.75}$)	83.62a	10.80b	24.19ab	133.00b	108.80b	21.67
T_6 ($PM_{7.50}$)	83.81a	11.80a	24.89a	137.20a	113.20a	22.69
T_7 (N_{120})	80.06b	10.16cd	23.66b	120.10d	93.65e	22.33
LSD	2.453	0.545	1.201	3.218	3.148	NS
CV (%)	1.76	3.04	2.91	1.44	1.82	3.17

Figure(s) in a column having common letter(s) do not differ significantly at 5% level of significance
NS = Not significant

Table 2: Effect of poultry manure and urea-N on the grain and straw yields of BRRI Dhan 29

Treatment	Grain yield (t ha^{-1})	% increase over control	Straw yield (t ha^{-1})	% increase over control
T_0 (Control)	3.39d	-	3.01c	-
T_1 (N_{100})	4.37c	28.91	4.03b	33.88
T_2 ($PM_{5.00}$)	5.08b	49.85	4.45b	47.84
T_3 ($N_{75}+PM_{1.25}$)	4.78bc	41.00	4.23b	40.53
T_4 ($N_{50}+PM_{2.50}$)	5.11b	50.74	4.53b	50.50
T_5 ($N_{25}+PM_{3.75}$)	5.30ab	56.34	5.34a	77.41
T_6 ($PM_{7.50}$)	5.66a	66.96	5.66a	88.04
T_7 (N_{120})	4.80bc	41.59	4.18b	38.87
LSD	0.543	-	0.502	-
CV (%)	6.43	-	6.47	-

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

Table 3: Effect of poultry manure and urea-N on N,P,K,S uptake by BRRI Dhan 29

Treatment	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})			S uptake (kg ha^{-1})		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
T_0 (Control)	36.27f	15.35d	51.62e	8.41f	2.26e	10.39f	8.48g	48.46d	56.94d	3.66e	2.23d	5.89f
T_1 (N_{100})	47.19e	23.35c	70.54d	10.93e	3.76d	14.39e	11.36f	66.44c	77.80c	5.50d	3.26c	8.76e
T_2 ($PM_{5.00}$)	60.41bcd	27.61b	88.02bc	14.72bc	4.19b	8.91b	14.21cd	78.82b	93.03b	6.45abc	3.96b	10.41bc
T_3 ($N_{75}+PM_{1.25}$)	54.50d	25.40bc	79.45cd	12.44de	3.89bcd	16.33cd	13.39de	73.24bc	86.63bc	5.79cd	3.64bc	9.43cde
T_4 ($N_{50}+PM_{2.50}$)	61.28bc	30.78a	92.06ab	13.43cd	4.12bc	17.55bc	15.32bc	79.67b	94.99b	6.18bcd	3.94b	10.12cd
T_5 ($N_{25}+PM_{3.75}$)	64.62ab	27.25b	91.87ab	15.89ab	4.97a	20.86a	15.89b	94.04a	109.93a	6.52ab	4.81a	11.33b
T_6 ($PM_{7.50}$)	69.58a	33.38a	102.96a	16.97a	5.37a	22.34a	17.54a	101.82a	109.36a	7.13a	5.20a	12.33a
T_7 (N_{120})	55.20cd	22.57c	77.17cd	11.52e	3.68cd	15.20de	12.48ef	69.39c	81.87c	5.52d	3.55bc	9.07de
LSD	6.135	2.999	11.460	1.461	0.467	1.767	1.497	8.301	9.177	0.651	0.447	0.946
CV (%)	6.25	6.66	8.07	6.42	6.68	5.94	6.22	6.60	6.20	6.36	6.69	5.60

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

Table 4: Effect of poultry manure and urea-N on the properties of the post harvest soils

Treatment	pH	Organic matter (%)	Total N (%)	Available P (ppm)	Exchangeable K (me/100 g soil)	Available S (ppm)	CEC (me/100 g soil)
T_0 (Control)	6.52b	2.96bc	0.15	10.22	0.088	17.80	12.45d
T_1 (N_{100})	6.55ab	2.96bc	0.16	11.98	0.085	17.73	13.29c
T_2 ($PM_{5.00}$)	6.46c	3.12a	0.18	15.29	0.096	20.23	14.62b
T_3 ($N_{75}+PM_{1.25}$)	6.54ab	2.94c	0.15	14.05	0.095	18.50	14.44b
T_4 ($N_{50}+PM_{2.50}$)	6.654ab	3.10a	0.16	14.20	0.095	18.43	14.50b
T_5 ($N_{25}+PM_{3.75}$)	6.44c	3.08ab	0.16	15.03	0.098	20.32	14.59b
T_6 ($PM_{7.50}$)	6.59a	3.16a	0.17	15.35	0.100	20.33	16.05a
T_7 (N_{120})	6.38d	2.94c	0.15	12.08	0.086	17.10	13.24c
LSD	0.055	0.124	NS	NS	NS	NS	0.328
CV (%)	0.39	2.31	10.23	14.98	2.94	9.83	1.33
Initial soil status	6.63	3.07	0.16	11.70	0.095	18.20	13.66

Figure(s) in a column having common letter(s) do not differ significantly at 5% level of significance
NS = Not significant

application of urea-N. This might be due to the quick release of a number of nutrients like P, S etc. in addition to N from poultry manure. The higher rate of poultry manure showed more pronounced effects. These findings are in agreement with Khan (1998) who found increased plant height, effective tillers hill^{-1}, panicle length and grains panicle^{-1} of BRRI Dhan

29 due to cowdung, poultry manure and urea-N application.

Grain and straw yields: A significant positive effect on the grain and straw yields of BRRI Dhan 29 was observed from the application of poultry manure and urea-N (Table 2). All the treatments increased the grain and straw yields considerably over control. The maximum grain and straw yields of 5.66 t ha^{-1} and 5.66 t ha^{-1} were obtained in T_6 ($PM_{7.5}$) treatment which was statistically at par with T_5 (N_{25} + $PM_{3.75}$) and the minimum value of 3.39 t ha^{-1} and 3.01 t ha^{-1} were noted in the control. Application of poultry manure and urea-N increased grain and straw yields of rice 28.91 to 66.96 and 33.88 to 88.04 %, respectively over control. Gupta (1995) also observed that the increase in rice yield with organic manure (poultry manure, pig manure and FYM) was 34 to 55 % higher over the control and 5 to 22 % higher over NPK fertilizers. It can be mentioned here that BRRI Dhan 29 responded better to N supplied from poultry manure rather than to fertilizer-N.

Grain yield is a complex character that results from the interaction of many growth and yield contributing characters. It was observed that all the yield contributing characters such as plant height ($r=0.889^{***}$), panicle length ($r = 0.814^{***}$), number of effective tillers $hill^{-1}$ ($r = 0.931^{***}$), grains $panicle^{-1}$ ($r = 0.811^{***}$), filled grains $panicle^{-1}$ ($r = 0.891^{***}$) and 1000-grain weight ($r = 0.438^{**}$) were positively correlated with grain yield. This indicated that poultry manure and urea-N increased different yield components which in turn increased the grain yield of BRRI Dhan 29 rice. The results of the present study are in agreement with (BRRI, 1995).

Nutrient uptake by grain and straw: The N, P, K and S uptake by grain and straw of BRRI Dhan 29 rice was significantly influenced by different treatments (Table 3). The highest nutrient uptake by the crop was recorded in T_6 while the lowest in the control. The nutrient uptake was more pronounced by the poultry manure treated plants. A close relationship between nutrient uptake and yield of the crop was observed.

Post harvest soil properties: Table 4 reports the properties of post harvest soils as influenced by poultry manure and urea-N. All the treatments resulted a beneficial effect on the properties of post harvest soils. Poultry manure application considerably increased the CEC, organic matter content, total N, available P, exchangeable K and available S content of the post harvest soils while the effect of urea-N was inconsistent.

It may be concluded that BRRI Dhan 29 responded better to N supplied from poultry manure rather than from urea-N. Use of poultry manure alone or in combination with urea-N was found effective and beneficial for rice cultivation. Application of poultry manure improved soil properties and thus improved soil health. In all respects the treatment T_6 ($PM_{7.5}$) was found to be the best.

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