Effect of organic and inorganic nutrient management on soil fertility, yield and quality of rice cv. NERICA 10

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Abstract: An experiment was carried out in the farmer's field at Chaighati, Godaghari, Rajshahi from February to May 2012 to investigate the effect of organic and inorganic nutrient management on yield attributes, yield, quality and soil fertility status of rice cv. NERICA 10. Six treatments were used in this experiment which were T_1 = control, T_2 = RFD for MYG + cowdung 5 t ha^{-1}, T_3 = RFD for HYG, T_4 = RFD for HYG + cowdung 5 t ha^{-1}, T_5 = RFD for HYG + cowdung 5 t ha^{-1} based on IPNS, T_6 = RFD for HYG + 10% excess fertilizer of HYG. The experiment was laid out in a randomized complete block design with three replications. Most of the yield contributing characters and yield were significantly influenced by different treatments except 1000 grain weight. The highest grain (5.29 t ha^{-1}) and straw (5.69 t ha^{-1}) yield were obtained from the recommended doses of chemical fertilizers along with cowdung @ 5 t ha-^{1}. The protein and starch contents were also significantly influenced by the application of different treatments. Soil pH, organic matter and N, P, S contents were significantly increased in the cowdung added soil. The overall findings of this study indicated that organic and inorganic nutrient management for rice cv. NERICA 10 rice cultivation can be used as an alternate option of chemical fertilization to achieve maximum yield, quality as well as improving fertility status of soil.
Key words: Rice, organic and inorganic nutrient management, yield, quality, soil fertility status.

Introduction

New Rice for Africa (NERICA) is a popular rice variety of Africa and it has short life span (90 days in *Aus* and *Aman* season and 110 days in *Boro* season) and can be grown in any season of the year. It is a moderately stress tolerant and high yielding variety. The NERICA variety is the result of crosses between two different rice species (*Oryza sativa* and *Oryza glaberrima*). Fertilizers are indispensable for the crop production systems of modern agriculture. Among the factors that affect crop production, fertilizer is the single most important factor that plays a crucial role in the yield increase and other factors are not too limiting. Inorganic fertilizers today hold the key to the success of the crop production systems of Bangladesh agriculture, being responsible for about 50% of the total production (BARC, 1997). Proper identification and management of soil fertility problems are prequisites for boosting up crop production and sustaining higher crop yield over a long period of time. Bhuvaneswari *et al*. (2006) viewed that combined use of organic and inorganic fertilizers would be quite promising not only in providing greater stability in production, but also in higher soil fertility status. Soil fertility deterioration has become a major constraint to higher crop production in Bangladesh. The increasing cropping intensity without adequate and balanced use of chemical fertilizers 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 Bangladesh soils is below 1.5% and in many cases it is less than 1% (BARC, 2005). This may be due to favourable climatic condition for microbial activities throughout the year, frequent tillage operation and use of chemical fertilizers with no or very little use of manure. NERICA is photoinsensitive and drought resistant variety. Our government is trying to introduce it in Bangladesh. Therefore, this study was undertaken to evaluate the effects of organic and inorganic nutrient management on yield and quality of rice cv. NERICA 10.

Materials and Methods

The study was carried out during *Boro* season of 2012 in the farmer's field at Chaighati, Godaghari, Rajshahi. The experimental area is located at the north-western part of Bangladesh. The soil was silt loam in texture having pH 5.2, organic matter 1.25%, total N 0.09%, available P 8 µg g^{-1} soil, exchangeable K 0.11 cmol kg^{-1}, available S 9 µg g^{-1} soil determined by the method described by (Jackson, 1973; Page *et al*., 1982; Black, 1965). Nutrient contents in decomposed cowdung were N 1.1%, P 0.47%, K 0.69% and S 0.23. There were six treatments viz. T_1 = Control, T_2 = RFD for MYG + cowdung 5 t ha^{-1}, T_3 = RFD for HYG, T_4 = RFD for HYG + cowdung 5 t ha^{-1}, T_5 = RFD for HYG + cowdung 5 t ha^{-1} based on IPNS, T_6 = RFD for HYG + 10% excess fertilizer of HYG. The experiment was laid out in a randomized complete block design with three replications. One third of N and full doses of P, K and S were applied at the time of final land preparation and remaining N was applied in early tillering and late tillering stage. Decomposed cowdung was incorporated into soil 7 days before transplanting. Thirty day old seedlings were transplanted on 12 February 2012. Weeding and irrigation were done as and when necessary throughout the growing period. The plants were harvested when attained full maturity and data on yield and yield contributing parameters were collected from harvested samples. The grain and straw N content was determined by micro Kjeldahl method as described by Jackson (1973). Protein contents were calculated by multiplying the N content with 5.85. Analysis of variance was done with the help of computer package program MSTAT according to Gomez and Gomez (1984) and the mean differences among different treatments were adjudged by DMRT.

Results and Discussion

Yield contributing characters of rice cv. NERICA 10

Plant height of rice cv. Nerica 10 responded significantly due to the application of cowdung and fertilizers (Table 1). The tallest plant of 92.00 cm was found in T_5 (RFD for HYG + cowdung 5 t ha^{1} based on IPNS) which was statitically identical to T_6 (RFD for HYG + 10% excess fertilizer of HYG), T_3 (RFD for HYG) and T_4 = (RFD for HYG + cowdung 5 t ha^{-1}) with the value of 91.57 cm, 91.30 & 89.97 cm respectively. The shortest plant of 78.00 cm was observed in control treatment. The result indicated that the cowdung performed better in increasing

plant height in combination with inorganic fertilizers compared to inorganic fertilizers alone. Babu *et al.* (2001) also observed that the plant height was significantly influenced by the incorporation of organic and inorganic fertilizer. A similar findings also reported by Parvez *et al.* (2008).

Significant effect was found in total number of tillers hill^{-1} due to the application of cowdung and fertilizers (Table 1). The highest number of tillers hill^{-1} (10.46) was achieved at T_5 (RFD for HYG + cowdung 5 t ha^{-1} based on IPNS) and lowest number of tillers hill^{-1} (6.73) was recorded from the control treatment. A similar finding was reported by Mondol *et al*. (1987) who found that number of total tillers hill^{-1} increased with the application of chemical fertilizers.

There was a significant effect of different treatments on the production of effective tillers hill^{-1} of rice plants (Table 1). The highest number of effective tillers hill^{-1} (7.27) was found in the treatment T_5 (RFD for HYG + cowdung 5 t ha^{-1} based on IPNS) and the lowest value of 4.03 was observed in T_1. These results were corroborated with the findings of Uddin *et al.* (2009) who found increased number of effective tiller hill^{-1} with the integrated use of manures and fertilizers.

Table 1. Effect of organic and inorganic nutrient management on yield contributing characters of rice cv. NERICA 10

Treatment	Plant height (cm)	Total tillers hill^{-1}	Effective tiller/hill	Panicle length (cm)	Total grain per panicle	Filled grains Panicle^{-1}	1000 grain weight (g)
T_1	78.00c	6.73c	4.03c	17.33b	58.77b	51.15c	24.98
T_2	85.87b	7.76b	5.57b	22.77a	120.93a	102.90b	26.91
T_3	91.30ab	8.90b	6.67a	22.60a	123.07a	104.03b	26.84
T_4	89.97ab	10.13a	6.87a	23.10a	132.40a	106.10b	26.04
T_5	92.00a	10.46a	7.27a	23.20a	135.20a	117.86a	25.77
T_6	91.57a	9.06a	6.77a	22.83a	132.67a	105.06b	26.02
CV. (%)	3.53	9.54	6.93	3.63	9.21	6.92	4.95

Table 2. Effect of organic and inorganic nutrient management on yield of rice cv. NERICA 10

Treatments	Grain yield t ha^{-1})	% increased over control	Straw yield (t ha^{-1})	% increased over control
T_1	1.68d	_	2.04e	_
T_2	3.29c	95.83	4.27d	109.31
T_3	4.42b	163.09	4.91c	140.68
T_4	4.53b	169.64	5.07c	148.53
T_5	5.29a	214.88	5.69a	178.92
T_6	4.75b	182.73	5.37b	163.23
CV. (%)	6.93	-	3.19	-

T_1 =control , T_2 = RFD for MYG + cowdung 5 t ha^{-1} , T_3 = RFD for HYG, T_4 = RFD for HYG + cowdung 5 t ha^{-1}, T_5 = RFD for HYG + cowdung 5 t ha^{-1} based on IPNS, T_6 = RFD for HYG + 10% excess fertilizer of HYG .Fertilizer dose (MYG): $N_{98}P_{20}K_{50}S_{15}Zn_2B_1$ and (HYG): $N_{120}P_{25}K_{65}S_{20}Zn_3B_1$, Letter (s) in a column having common letters do not differ significantly at 1% level of significance. CV. = Coefficient of variance

The combination of cowdung and fertilizers significantly influenced the panicle length of rice cv. NERICA 10. The highest panicle length of 23.20 cm was found in the treatment T_5 (RFD for HYG + cowdung 5 t ha^{-1} based on IPNS) which were statistically identical with almost all treatments except control. These results are in agreement with Rahman *et al*. (2007) who found increased panicle lenth with the application of manures and fertilizers.

The number of total grains panicle^{-1} of rice cv. NERICA 10 rice varied significantly due to the application of fertilizers and manures application. The highest number of total grains panicle^{-1} (135.20) was found in treatment T_5 which were statistically identical with almost all treatments except control. A similar finding was reported by Kamara *et al.* (2011) who found that N fertilization significantly influenced the number of spikelets panicle^{-1} of rice cv. NERICA 10.

The number of filled grains panicle^{-1} of rice cv. NERICA 10 varied significantly due to different rates of fertilizer and cowdung application. The highest filled grains panicle^{-1} (117.86) was obtained with the treatment T_5 (RFD for HYG + cowdung 5 t ha^{-1} based on IPNS) and the lowest value (51.15) was obtained from control. Thus, the findings of this experiment is in agreement with Wang *et al*. (2011) who showed that the application of N, P and K fertilizer significantly increased the number of effective grains panicle^{-1} .

Results presented in (Table 1) revealed that 1000-grain weight of rice cv. NERICA 10 differed non significantly due to the application of different treatments. The heaviest grain weight of 26.91g was found in T_2 (RFD for MYG + cowdung 5 t ha^{-1}) and the lightest grain of 24.98 g was found in T_1 (control) treatment. A similar findings was reported by Debiprasad *et al*. (2010) who found that the application of 120 kg N ha^{-1} through chemical fertilizer with the combination of press mud and cowdung increased 1000 grain weight.

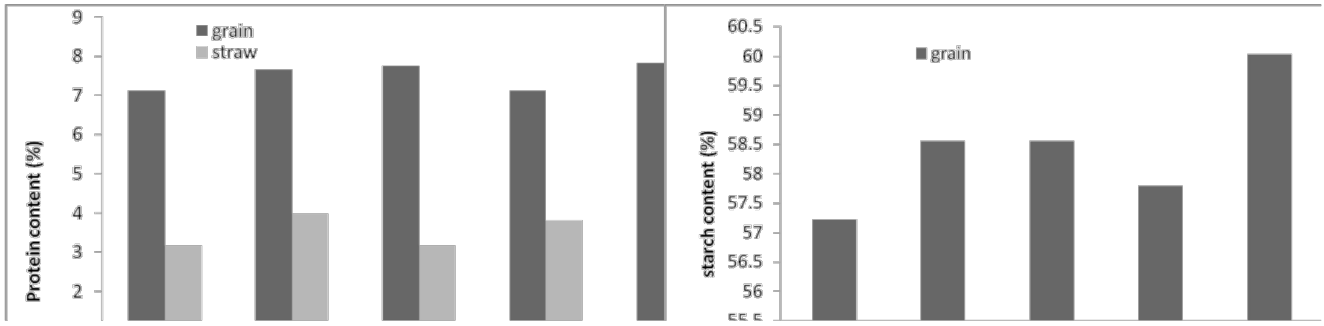
The highest grain yield 5.29 t ha^{-1} was observed in T_5 = (RFD for HYG + cowdung 5 t ha^{-1} based on IPNS) and the lowest value 1.68 t ha^{-1} was recorded in T_1 = control. Grain yield obtained in T_6 (RFD for HYG + 10% excess fertilizer of HYG) is statistically similar with T_3 (RFD for HYG), T_4 (RFD for HYG + cowdung 5 t ha^{-1}) although there was a numerical variation in grain yield among the treatments. The percentages of increased grain yield over control due to different treatments were also presented in the (Table 2). The highest percentage (214.88%) of increased grain yield over control was

recorded in the treatment T_5 and the lowest percentage (95.83%) of increased grain yield over control was recorded in the treatment T_2. Thus the finding of this experiment is in agreement with Yadav *et al.* (2010) who reported that grain yield was significantly increased due to application of chemical fertilizers and residual effects of organic manures.

The straw yield obtained from different treatments ranged from 2.04 to 5.69 t ha^{-1}. All the treatments gave higher straw yield over control. It was observed that the treatments T_5 (RFD for HYG + cowdung 5 t ha^{-1} based on IPNS) gave the highest straw yield (5.69 t ha^{-1}). The lowest straw yield (2.04 t ha^{-1}) was recorded in the treatment T_1 (control). The percentages of increased straw yield over control due to different treatments were also presented in the (Table 2). The highest percentage (178.92%) of increased straw yield over control was recorded in the treatment T_5 and the lowest percentage (109.31%) of increased straw yield over control was recorded in the treatment T_2. Awan *et al.* (1984) also reported that application of nitrogen with different levels on rice increased straw and grain yield.

The highest protein content in grain (7.84%) was obtained from treatment T_5 (RFD for HYG + cowdung 5 tha^{-1} based on IPNS) and lowest (7.13%) from control. Protein content in straw also exhibited significant variations at 1 % level of significance. The highest protein content (4.01%) in straw obtained from T_5 (RFD for HYG + cowdung 5 t ha^{-1} based on IPNS) which was statistically similar to the treatment T_2 (RFD for MYG + cowdung 5 t ha^{-1}). The lowest value (3.17%) was obtained from T_3 (RFD for HYG) (Fig. 1A). The findings of this experiment is in agreement with those of Prakash *et al.* (2002) who showed that higher nutrient uptake particularly N, due to the application of FYM which was probably responsible for the higher protein content and lower amylose content in rice than the commercial manure and chemical fertilizer.

In the evaluation of the rice cooking quality the starch content is considered the most important characteristics. The strach content of rice influence tenderness and stickniss of cooked rice. Results revealed that significant variations were found in grain strach due to different treatments. Starch content in grain (60.03%) was highest from treatment T_5 (RFD for HYG + cowdung 5 t ha^{-1} based on IPNS) which was identical to treatment T_2 (RFD for MYG + cowdung 5 t ha^{-1}), T_3 (RFD for HYG). Starch content in grain (57.21 %) was lowest from control treatment (Fig. 1B).



A **B**

Fig. 1. Efffect Effect of organic and inorganic nutrient management (A) on protein contents of rice (B) starch contents of rice cv. NERICA 10.

Changes in soil fertility status: The organic matter content of the post harvest soil was significantly influenced by different treatments (Table 3).The highest organic matter content (1.33%) was found in T_5 treatment which was statistically similar to the treatments T_2, T_3, T_4, T_6. The lowest organic matter content (1.25%) was recorded in T_1 treatment. The pH ranged from 5.2 to 5.3 Table 3. The highest pH value (5.3) was found in treatments T_2, T_4, T_5 & lowest pH value (5.2) was recorded in treatments T_1, T_3 & T_6.

Table 3 . Changes in soil fertility status due to nutrient management

Treatments	pH	OM (%)	Total N (%)	Available P µg g^{-1} soil	Available S µg g^{-1} soil	Exch. K cmol kg^{-1}
Initial soil	5.4	1.25	0.09	08	09	0.11
Post harvest soil						
T_1	5.42	1.25b	0.08b	7.00b	8.00bc	0.10
T_2	5.51	1.33a	0.08b	8.00ab	10.00a	0.11
T_3	5.42	1.32a	0.10a	9.00ab	10.00a	0.11
T_4	5.51	1.33a	0.10a	10.00a	9.00ab	0.10
T_5	5.51	1.33a	0.11a	9.00ab	8.00bc	0.11
T_6	5.42	1.32a	0.10a	8.00ab	7.00c	0.10

Combined effect of cowdung and chemical fertilizers on N content ranged from 0.08 % to 0.11%. The highest N content in soils (0.11%) was obtained by the treatment T_5 and the lowest total of N content in soils (0.08%) was

obtained by the treatment T_1.Combined effect of cowdung and chemical fertilizers on Phosphorus content in soils ranged from 7.00 ppm to 10.00 ppm. The highest P content in soils (10 ppm) was obtained by the treatment T_4 and the lowest total of P content in soils (7 ppm) was obtained by the treatment T_1. Combined effect of cowdung and chemical fertilizers showed better performance on K content in soils although the treatment effect was not found statistically significant. Potassium content in soils ranged from 0.10 meq% to 0.11 meq%. The S content of post harvest soils was significantly influenced by application of different treatments (Table 3). The highest S concentration was recorded in the treatments T_2 & T_3. The minimum was recorded in control treatment.

From the overall results, it may be concluded that organic and inorganic nutrient management can be used as an alternate option of chemical fertilizers for getting higher yield and quality as well as improving soil fertility of rice cv. NERICA 10 under the drought prone areas of Rajshahi.

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