INFLUENCE OF INTEGRATED USE OF ORGANIC MANURE AND CHEMICAL FERTILIZERS ON YIELD AND YIELD COMPONENTS OF RAINFED LOWLAND RICE cv. Binadhan 4

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Abstract

An investigation was carried out at BINA (Bangladesh Institute of Nuclear Agriculture) farm, Mymensingh during kharif-2 (T. aman) season of 2010 to evaluate the effect of organic manures (tobacco dust and press mud) and fertilizers on the yield as well as nutrient status both at grain and straw of T. aman variety (Binadhan-4). The experiment comprises of nine treatments laid out in a Randomized Complete Block Design. The treatments included, T_1 : Control (without application of any plant nutrients), T_2 : Recommended Fertilizer Dose (RFD) based on AEZ , T_3 : RFD based on HYG, T_4 : 75% RFD based on AEZ + 1 ton press mud/ha, T_5 : 75% RFD based on AEZ + 1 ton tobacco dust/ha, T_6 : 75% RFD based on AEZ + 2 ton press mud/ha, T_7 : 75% RFD based on AEZ + 2 ton tobacco dust/ha, T_8 : RFD based on HYG + 2 ton press mud/ha based on IPNS and T_9: RFD based on HYG + 2 ton tobacco dust/ha based on IPNS. Integrated application of manures and fertilizers significantly increased the yield and yield components of Binadhan-4. The treatment T_9 produced the highest grain (5.00 t ha^{-1}) and straw (7.58 t ha^{-1}) yield however, lowest grain (2.15 t ha^{-1}) along with lowest straw (3.33 t ha^{-1}) yield were recorded in control treatment. The N, P, K and S contents both at grain and straw of Binadhan-4 were also influenced due to application of manures and fertilizers. Highest %N and %P were obtained at T_7 while highest %K and %S were detected at T_9 in case of grain. In case of straw, highest %N, %P and %K were detected at T_9, T_6 and T_9, respectively, while %S showed insignificant irrespective of treatment. From this study, it was concluded that application of tobacco dust is better than that of press mud as organic manure for rice production. An integration of organic manure and chemical fertilizers is also necessary for maximizing rice yield under rainfed lowland conditions.

Key words: Fertilizer, organic manure, yield components

Introduction

Bangladesh with a population of about 160 million and having an area of 147,570 square kilometers is one of the most densely populated country in the world. Rice (*Oryza sativa* L) is the leading cereal crop in the world and staple food crop in Bangladesh. Among the crops grown in Bangladesh rice is covering an area of 11.06 million hectares and producing 38.13 million tons annually (FAO, 2007). Annual rice grain production in Bangladesh is about 32.3 million tons (AIS, 2011). Aman is an important crop in Bangladesh for covering large area of production. Total area under aman crop has been estimated at 5.66 million hectares as compared to 5.50 million hectares in Boro season (BBS, 2010). Soil fertility deterioration has become a major constraint to higher crop production in Bangladesh. The increasing cropping intensity without adequate and balanced use of fertilizers with little or no use of organic matters have caused severe fertility deterioration of soils resulting in stagnating or even declining of crop productivity. Among the chemical fertilizers used, the farmers generally apply nearly 75% of N fertilizer, 12% P fertilizer, 6% K fertilizer with little or no use of S and Zn fertilizers. Thus, a serious imbalance of nutrients in soil has occurred as the farmers are adding about 172 kg of nutrients annually where as crop removal is frequently more than 250 kg annually (Islam 2002). The organic matter content of most of our soils is below 1.5% and in many cases it is less than 1% (BARC, 2005). The farmers are using lesser quantities of cow dung and crop residues because most of these materials are being used as fuel for cooking, for building houses and as feed for cattle. In addition, humid tropic climate is prevailing in Bangladesh; mineralization of soil organic matter is rapid. Low organic matter content of our soil is now believed to be a vital reason for low productivity of soils because soil organic matter plays an important role on physical, chemical and biological properties of soil. Management of soil organic matter has now become a major issue in dealing with the problem of soil fertility and productivity in Bangladesh. Bhuvaneswari *et al.* (2006) viewed that combined use of organic manures and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in higher soil fertility status. Cow dung and poultry manure, the common manures of Bangladesh, can play a vital role in soil fertility improvement as well as in supplying most of the macro and micro nutrients especially N, P, K and S for

crop production. Judicious application of manures and fertilizers can increase the crop yield per unit area and minimize the nutrient imbalance in soil. Thus, the present research work was undertaken with a view to evaluating the effects of organic manures and chemical fertilizers on the yield and yield components, and nutrient uptake both in rice straw and grain of a popular rainfed lowland rice cultivar Binadhan-4.

Materials and Methods

An investigation was carried out during kharif-2 (T. Aman) (mid July to mid October) season of 2010 at BINA (Bangladesh Institute of Nuclear Agriculture) farm, Mymensingh with a view to evaluating the effects of manures and fertilizers on the yield and yield components, and nutrient status both in rice straw and grain of Binadhan-4. The soil belongs to sonatola series under the AEZ of Old Brahmaputra Floodplain. The soil was silty loam in texture having pH 6.2, organic matter content 1.57%, total N 0.09%, available P 13.0 ppm exchangeable K 0.034 meq.%, and available S 6.29 ppm. The experimental area belongs to sub-tropical climate and is characterized by high temperature accomplished by moderately high rainfall during kharif season. There were altogether nine treatment consisting of N, P, K and S fertilizers applied as urea, TSP, MOP and gypsum, respectively in association with two sources of organic manures such as tobacco dust and press mud. The treatment include, T_1: Control (without application of any plant nutrients), T_2: RFD based on AEZ, T_3: RFD based on HYG, T_4: 75% RFD based on AEZ + 1 ton press mud/ha, T_5 : 75% RFD based on AEZ + 1 ton tobacco dust/ha, T_6 : 75% RFD based on AEZ + 2 ton press mud/ha, T_7: 75% RFD based on AEZ + 2 ton tobacco dust/ha and T_8 : RFD based on HYG + 2 ton press mud/ha based on IPNS, T_9: RFD based on HYG + 2 ton tobacco dust/ha based on IPNS. The experiment was laid out in a Randomized Complete Block deign with three replications. The total number of unit plots was 27 and the size of unit plot was 5m x 4m. Total amount of P, K and S fertilizers were applied as basal during final land preparation but urea was applied in 3 equal splits. Tobacco dust and press mud were applied 7 days before transplanting. Forty day old seedlings were transplanted in the experimental plots maintaining three seedlings per hill. Intercultural operations were done as and whenever required. At maturity, the crop was harvested. The grain and straw samples were analyzed for N. P, K and S content following Micro kjeldahl method (Jackson, 1996), Olsen method (Olsen *et al.* 1954), 1 N NH_4OAC solution (Black, 1965) and $CaCl_2$ solution (0.15%) (Page *et al*. 1982), respectively. Initial and post harvest soil samples were also analyzed for physical and chemical properties of soil. All the data were statistically analyzed by F-test and the mean differences were adjudged by Duncan's Multiple Range Test (DMRT).

Table 1. Fertilizer doses (kg ha^{-1}) at different treatment

Treatment	N	P	K	S
T_1	0	0	0	0
T_2	65	8	25	8
T_3	90	12	36	10
T_4	63.75	8	26.75	8.8
T_5	58.75	7.3	27.25	8
T_6	78.75	10	34.75	11.6
T_7	68.75	8.6	35.75	10
T_8	52.5	7	19	4.7
T_9	57.5	7.7	18.5	5.5

Table 2. Nutrient content of different manure used in the experiment

Manure	N (%)	P (%)	K (%)	S (%)
Tobacco dust	1.0	0.13	0.85	0.20
Press mud	1.50	0.20	0.80	0.28

Results and Discussion

Yield and yield components of Binadhan-4

Plant height

Plant height of test variety Binadhan-4 was responded significantly due to application of different manures and fertilizers (Table 3). All the treatments gave significantly higher plant height over the control (T_1). The tallest plant of 121.00 cm was found in T_8 which was statistically identical with T_3, T_6, T_7 and T_9. Statistically identical plant height was found in T_2, T_4 and T_5. Press mud performed better in producing taller plant height in combination with chemical fertilizers as compared to tobacco dust. Sing *et al*. (2006) also observed that the plant height was significantly influenced by the incorporation of organic manures and fertilizers.

Panicle length

The length of panicle was significantly influenced by the application of manures and fertilizers (Table 3). The highest panicle length (27.33cm) was found in T_8 which were statistically identical with almost all treatment except T_1 and T_2. The lowest panicle length (24.47cm) was observed in T_1. The treatments were ranked in the order of T_8> T_9> T_5> T_3> T_6> T_4> T_7>T_2>T_1 in terms of panicle length. Morteza *et al.* (2011) also observed that the panicle length was increased with the application of manures and inorganic fertilizers.

Table 3. Effects of chemical fertilizers and organic manures on the yield components of Binadhan-4

Treatment	Plant height (cm)	Panicle length (cm)	Effective tiller/hill (No.)	1000-seed weight (g)	Grain yield (t/ha)	Straw yield (t/ha)
T_1	102.2 d	24.47c	6.93c	25.20b	2.15c	3.33d
T_2	112.00c	25.40bc	8.47b	25.93a	3.53b	4.63cd
T_3	119.60ab	26.93a	8.87ab	25.64ab	4.10ab	5.25bc
T_4	115.67bc	26.40ab	8.53ab	26.25a	3.93b	6.67ab
T_5	115.40bc	27.13a	8.97ab	26.05a	4.75a	6.92ab
T_6	116.73abc	26.80a	9.20ab	25.90a	4.53ab	7.08a
T_7	118.43ab	26.07ab	9.60a	25.67ab	4.92a	6.83ab
T_8	121.00a	27.33a	9.13ab	26.09a	4.83a	7.00a
T_9	118.47ab	27.20a	9.21ab	25.76ab	5.00a	7.58a
SE (±)	1.13	0.21	0.17	0.08	0.19	0.30
CV (%)	2.98	3.65	1.58	1.38	4.33	4.60

In a column having common letters do not differ significantly at 5% level of significance. SE (±) = Standard error of means

Effective tiller hill^{-1}

Application of manures and fertilizers significantly influenced the number of effective tiller hill^{-1} of Binadhan-4 (Table 3). The highest number of effective tiller hill^{-1} (9.60) was found in T_7 which was statistically identical with T_3, T_4, T_5, T_6, T_8 , T_9 and the lowest was found 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.

1000-seed weight

The 1000 seed weight of Binadhan-4 varied significantly due to application of manures and fertilizers (Table 3). The 1000 seed weight ranged from 25.20 g (in control plot) to 26.25 g (T_4). The treatments may be ranked in the order of T_4>T_8> T_5>T_2> T_6>T_9>T_7>T_3>T_1 with respect of 1000- seed weight. Similar results were also noted by Awan et al. (1984), and Rafey et al. (1989). Increase in grain weight at higher nitrogen rates might be primarily due to increase in chlorophyll content of leaves which led to higher photosynthetic rate and ultimately plenty of photosynthates available during grain development. Though the treatment T_3 and T_9 had highest percentage of nitrogen but it had no reflection on 1000-seed weight, it might be varietal response to a particular nutrient.

Grain yield

The grain yield of Binadhan-4 varied significantly due to different treatments (Table 3). Highest grain yield (5.00 t ha^{-1}) was observed in T_9 while lowest was recorded in T_1. The treatment T_9 produced identical grain yield with T_3, T_5, T_6, T_7 and T_8. In association with same recommended fertilizer doses tobacco dust treated plots gave better grain yield than press mud treated plots. This might be due to the quick release of nutrients from tobacco dust than press mud.

The increase in grain yield over control ranged from 39.09 to 57.0% where the highest increase was obtained in T_9 and the lowest was obtained in T_2 (Fig. 1). Yadav *et al.* (2010) reported that grain yield was significantly increased due to application of organic manure and chemical fertilizers.

Straw yield

Straw yield of Binadhan-4 also varied significantly by different treatments under study (Table 3). The highest straw yield of 7.58 t ha^{-1} was obtained in T_9 and the lowest of 3.33 t ha^{-1} was noted in T_1. Tobacco dust exerted comparatively better effect in producing higher straw yields as compared to press mud. Regarding the percent increase of straw yield, maximum straw yield increase over control (56.07%) was noted in T_9 and the minimum (28.08%) was found in T_2 (Fig. 1). Saha *et al.* (2007) reported that application of organic manure and chemical fertilizers increased the straw yields of rice. Though the treatment T_3 had higher percentage of nitrogen but it seems that straw yield of Binadhan-4 was not significantly influenced by only chemical fertilizer rather than combined application of both organic and inorganic fertilizers.

Nutrient content in rice grain and straw of Binadhan4

The grain and straw samples of Binadhan-4 were analyzed for estimating N, P, K and S content. The results of N, P, K and S contents of grain and straw have been discussed under the following sub-sections.

Nitrogen content

The N content in rice grain varied significantly in different treatments (Table 4). The highest N content of 1.52% was observed in T_7 and the lowest in T_1. Application of chemical fertilizers increased the N content in rice grain markedly in T_2 which was identical with T_3, T_5, T_6 and T_9 treatments.

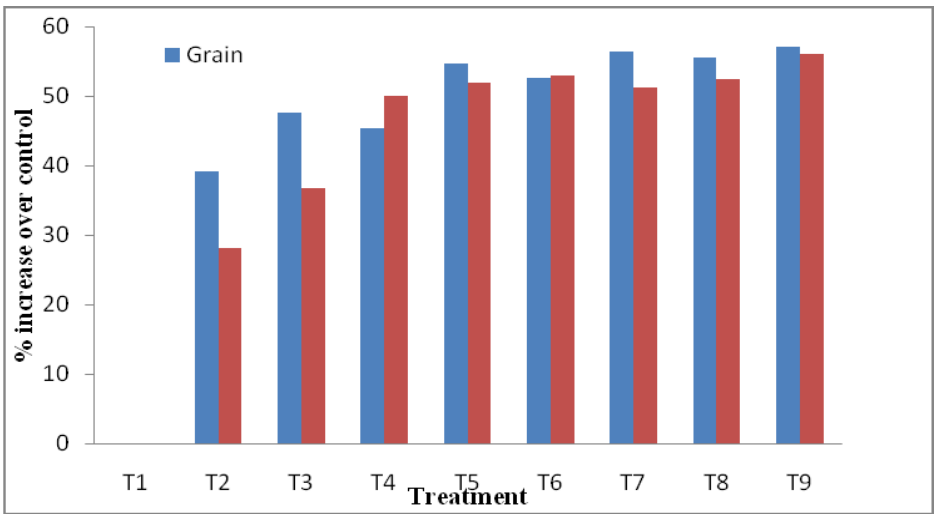

Fig.1. Percent increase of grain and straw yields over control as influenced by manures and fertilizers

Table 4. Effects of organic manures and chemical fertilizers application on N, P, K and S uptake of Binadhan 4

Treatment	Nutrient uptake (%)							
	Grain				Straw			
	N	P	K	S	N	P	K	S
T_1	1.24b	0.23d	0.19c	0.080b	0.40e	0.071d	1.33d	0.065
T_2	1.36ab	0.25c	0.20bc	0.103ab	0.55b	0.105ab	1.59ab	0.075
T_3	1.36ab	0.27abc	0.23b	0.115a	0.56bc	0.090bc	1.48c	0.085
T_4	1.51a	0.24cd	0.21bc	0.118a	0.63a	0.080cd	1.58ab	0.088
T_5	1.40ab	0.25c	0.20bc	0.120a	0.52d	0.090bc	1.61a	0.078
T_6	1.44ab	0.26bc	0.22bc	0.108a	0.56bc	0.100a	1.51b	0.075
T_7	1.52a	0.30a	0.22bc	0.108a	0.64bc	0.110ab	1.63a	0.075
T_8	1.46a	0.28ab	0.28a	0.118a	0.57b	0.080cd	1.62a	0.078
T_9	1.42ab	0.28ab	0.29a	0.123a	0.56a	0.080cd	1.65a	0.070
SE (±)	0.02	0.005	0.01	0.003	0.013	0.003	0.021	0.003
CV (%)	1.44	4.69	2.54	6.08	3.62	3.31	3.05	5.72

In a column having common letters do not differ significantly at 5% level of significance, SE (±) = Standard error of means

In the straw, N content varied significantly due to treatments variation. The N content in the straw ranged from 0.40% in T_1 to 0.64% in T_7. The effects of tobacco dust application @ 2 t ha^{-1} in combination with 75% recommended fertilizer dose based on IPNS was more pronounced in increasing the N content both in grain and straw of Binadhan-4 compared to press mud (2 t ha^{-1}). The results revealed that N content in rice grain was higher than that of straw. A significant increase in N content in rice grain and straw due to the application of manures and fertilizers has been reported by Mann *et al.* (2006).

Phosphorus content

Phosphorus content in the grain of Binadhan-4 varied significantly due to different treatments (Table 4). Phosphorus content in grain ranged from 0.23 to 0.30%. The highest P content (0.30%) in grain was found in T_7 (75% RFD based on AEZ + 2 ton tobacco dust/ha) and the lowest value (0.23%) was noted in T_1 (control). Phosphorus content in rice straw was influenced significantly due to use of manures and fertilizers. The highest P content in straw (0.11%) was observed in T_7 (75% RFD based on AEZ + 2 ton tobacco dust /ha) and the lowest value (0.071%) was recorded in T_1 (control). Application of tobacco dust in combination with fertilizers showed more pronounced effect in increasing the P content in rice grain and straw compared to press mud. Further, press mud exerted better performance than tobacco dust. An increase in P content both in rice grain and straw due to the application of manure and chemical fertilizers was reported by Indrani *et.al.* (2008).

Potassium content

The potassium content both in grain and straw of Binadhan-4 varied significantly due to application of organic manures and chemical fertilizers. The K content ranged from 0.19 to 0.29% in rice grain and 1.33 to 1.65% in straw (Table 4). The highest K content in rice grain (0.29%) and straw (1.65%) was

recorded in T_9 (RFD based on HYG + 2 ton tobacco dust/ha based on IPNS) and the lowest K content in grain (0.19%) and in straw (1.33%) was found in T_1 (control). Tobacco dust showed the best performance in increasing the K content both in grain and straw of Binadhan-4 compared to press mud. These results are in agreement with Krishnappa *et al.* (2006) who revealed that K content in grain and straw were increased due to application of organic manures and chemical fertilizers.

Sulphur content

The sulphur content in grain of Binadhan-4 varied significantly by different treatments (Table 4). The highest S content (0.123%) in grain was obtained in T_9(RFD based on HYG + 2 ton tobacco dust/ha based on IPNS) and the lowest value (0.080%) was noted in T_1. All the treatments caused an increasing effect on the S content of rice grain and the effect of tobacco dust was better compared to press mud in combination with same recommended fertilizer doses. In case of straw, S content varied insignificantly due to application of manures and fertilizers. Mann *et al.* (2006) reported that application of manures and fertilizers increased the S content both in grain and straw of rice.

Conclusion

It could be concluded from the present study that the application of tobacco dust based on IPNS with the recommended dose of chemical fertilizers showed better performance in respect of grain yield, yield contributing characters, nutrient content and uptake. So the application of tobacco dust based on IPNS with chemical fertilizers will be beneficial for T. aman rice cultivation.

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