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Effects of municipal solid waste compost and fertilizers on the growth and yield of Bina Dhan 7

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ABSTRACT

A field experiment was conducted at the Soil Science Field Laboratory of Bangladesh Agricultural Universit, Mymensingh during the aman season of 2010 to study the effect of Municipal Solid Waste (MSW) compost and chemical fertilizers on the growth and yield of BINA dhan7. The experiment was laid out in a randomized complete block design with four replications of each treatment. The treatments were T_0: control, T_1: Recommended fertilizer dose (RFD), T_2: compost 2.5 t ha+75% RDF, T_3: compost 5 t ha-^{1} + 50% RDF, T_4: compost 7.5 t ha^{-1} +50% RDF, T_5: compost 10t ha^{-1}, T_6: compost 10t ha^{-1} + 25% N, T7: compost 10 t ha^{-1} + 50% N, T8: compost 15 t ha^{-1}. Compost was prepared from the solid waste of the Mymensingh municipal area and applied before 7 days of transplanting as per treatments. The recommended doses of N, P, K and S were applied from urea, TSP, MoP and gypsum @ 120, 15, 60 and 10 kg ha^{-1}, respectively as per the treatments. Yield contributing characters of BINA dhan7 like plant height, panicle length, number of tillers hill-1 and filled grains panicle^{-1} were significantly influenced due to different treatments. Application of compost either alone or in combination with fertilizers exerted positive and significant effects on the parameters studied. The grain yield of BINA dhan7 due to different treatments ranged from 2.09 to 2.23 t ha^{-1} and the highest grain yield of 4.42 t ha-1 was observed in the treatment T2 and the lowest value of 2.09 t ha-1 was recorded in the treatment T8. Application of compost @ 2.5 t ha-1 with 75% of the recommended dose of NPKS fertilizers produced higher grain yield over 100% NPKS fertilization. The NPKS content and uptake of BINA dhan7 were also varied significantly due to the application of MSW compost and fertilizers alone or in combination.

Key words: Municipal solid waste compost, Chemical fertilizer, yield, Bina Dhan 7.

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INTRODUCTION

In Bangladesh, food security is synonymous with achievement self-sufficiency in rice production. Out of the total rice production in the country, about 44% comes from Boro and the rest 35% and 21% come from Aman and Aus crops, respectively (BBS, 2004). Unfortunately, the average rice yield in Bangladesh is 2.24 t ha-1 (BBS, 2005) which is very low as compared to other agriculturally advanced countries like Japan, China, Korean Republic and USA where per hectare yield is 9.74, 6.64, 6.06 and 9.03 ton ha-1 respectively (FAO, 2003).

Soil fertility deterioration has become a major constraint to higher crop production in Bangladesh. The increasing cropping intensity with imbalance use of chemical fertilizers and little or no use of organic manures have caused severe fertility deterioration of our soils and stagnating or even declining crop productivity.

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Soil organic matter plays an important role in sustainable soil fertility and crop productivity. Organic matter acts as a reservoir of plant nutrients especially N, P, K, S and also prevents leaching loss of the nutrients. A good soil should have at least 2.5% organic matter, but in Bangladesh, most of soils have less than 1% organic matter (BARC, 2005). Losses of soil organic matter can be replenished by application of organic manures (Glaser et al., 2001). Moreover, organic manures are cheap, friendly to our environment and are effective sources of nitrogen for most crops. It plays a vital role in improving physical, chemical and biological properties of the soil and ultimately enhances the crop production.

The composting of organic materials can help remedy this situation by transforming organic "waste" products into a nutrient-rich soil amendment capable of improving depleted or disturb soils and supplies other plant essential elements such as phosphorus, potassium, calcium, sulfur and micronutrients to varying degrees. Although compost is not high in nitrogen, phosphorous or potassium, but these nutrients are released slowly over a long period of time. Nutrients become available to plant roots at a slower rate with higher use efficiency from compost compared to inorganic fertilizers, therefore the nutrients are less likely to leach out of the soil. Only a fraction of the nitrogen, phosphorus, and potassium applied as compost is usable by the crop in the first year with more becoming available in the years that follow.

Compost is beneficial for more than its "fertilizing" capacity. It is highly regarded as a soil amendment because it plays an important role in sustaining soil fertility, and hence in sustainable agricultural production. In addition to being a source of plant nutrient, it improves the physico-chemical and biological properties of the soil. As a result the soil becomes more resistant to stresses such as drought, diseases and toxicity, helps the crop in improved uptake of plant nutrients and possesses an active nutrient cycling capacity because of vigorous microbial activity. These advantages manifest themselves in reducing cropping risks, higher yields and lower outlays on inorganic fertilizers for farmers. Composting decreases the amount of waste being deposited, and by the application of the mature compost to agricultural soils, reduces the use of artificial fertilizers (Huttl and Fussy, 2001). The effects of compost application to agricultural soils range from increasing in nutrient availability (mainly N and P) and soil organic matter content (Garcia-Gil et. al., 2002) to the suppression of pathogens (De Brito et. al., 1995; Fuchs, 2010) and changes in the composition and activity of soil microorganisms (Ros et al., 2003). In the twentieth century, the concept of sustainable agriculture has contributed to the popularity of composting, thereby making use of this technique's potential for closing nutrient cycles (Tittarelli et al, 2007), restoring organic matter to the soil (Marino, 2008), and at the same time reducing the application of artificial fertilizers and pesticides (Hargreaves et al., 2008). The present investigation was conducted with the aims to study the effect of municipal solid waste compost (MST) and fertilizers on the yield and yield contributing characters of BINA dhan7 and to study on the nutrient content and uptake of BINA dhan7.

MATERIALS AND METHODS

The experiment was carried out during the Aman season from July to November of 2010 in the field laboratory of the Department of Soil Science, Bangladesh Agricultural University, Mymensingh.

Experimental site and soil

The experiment was set up at the Field Laboratory of the Department of Soil Science of Bangladesh Agricultural University, Mymensingh during the aman season of 2010. The land of experimental field was medium high, belonging to the Sonatala soil series of Non-calcareous Dark Grey Floodplain soil under the Agro-ecological Zone (AEZ) of Old Brahmaputra Floodplain.

Soil

The soils were collected from Soil Science Field Laboratory, BAU, Mymensingh. The physical properties of the initial soil were sand (10.64 %), silt (78.0%), clay (11.36%) and textural class silt loam. The chemical characteristics of the initial soils were P^H 6.48, Cation exchange capacity 13.6, Organic carbon (1.16%), Total N (0.15%), Available P (12.80 ppm), Exchangeable K (0.11me/100g soil), Available S (11.50 ppm).

Climate

The experimental area has a sub-tropical climate which is characterized by high temperature, high humidity and high rainfall with occasional gusty winds in the Kharif season (March-September) and low rainfall associated with moderately low temperature during Rabi season (October-February). Monthly weather record of during the period from July-December, 2010 have been presented in Table 1.

Table 1
Monthly weather records during the whole experimental period (July-December2010).

Months	Temperature (°C) **	Rainfall (mm)*	Relative humidity (%)**	Sunshine (hours)*
July	28.46	757.0	89.52	87.69
August	29.33	321.3	87.42	136.89
September	28.96	175.1	86.77	90.28
October	27.35	218.3	85.10	189.68
November	24.10	67.0	85.07	226.30
December	19.63	00.0	83.55	202.32

* means monthly total and ** Means monthly average
Source: Weather Yard, Department of Irrigation and Water Management, Records of Climatologically Observations (Monthly), Bangladesh Agricultural University, Mymensingh.

Land preparation

The land was first opened on 19 July 2010 by repeated ploughing with a power tiller followed by country plough. Laddering was done properly which helped breaking clods and leveling the land followed by every plough. Weeds, stubbles and crop residues were removed from the land.

Rice crop

BINA dhan 7, a high yielding variety of rice was used as the test crop in this experiment. Life cycle of this variety ranges from 110 to 115 days. The average grain yield of the variety generally lies between 4.52 to 75.5 t ha^{-1}. The seedlings were collected from Soil Science Field Laboratory, Bangladesh Agricultural University, Mymensingh. The seedlings grow to a height of 95-100 cm within 20-25 days and can be transplanted on land.

Experiment

The experiment was laid out in a Randomized Completely Block Design (RCBD), where the experimental area was divided into 3 blocks representing the replications to reduce soil heterogenetic effects. Each block was divided into 9 unit plot with raised dyke treatments. Thus, the total number of unit plots was 27. The unit plot size was 4m×2.5m and plots were separated from each other by dyke. Unit blocks were separated from each other by 0.5m drains. Treatments were randomly distributed within the blocks.

Treatments

There were eight treatments out of which one was control where no fertilizer was used The treatment combinations used for the experiment were as follows:

T_o = Control (No fertilizer)
T_1 = 100% recommended fertilizer doses NPKS (RDF)
T_2 = 75% RDF + compost (2.5 t ha^{-1})
T_3 = 50% RDF + compost (5 t ha^{-1})
T_4 = 25% RDF + compost (7.5 t ha^{-1})
T_5 = Compost (10 t ha^{-1})
T_6 = 25% N + compost (10 t ha^{-1})
$T_{7=}$ 50% N + Compost (10 t ha^{-1})
T_8 = Compost 15 t ha^{-1}

Compost and fertilizer application

Well decomposed compost @ 2.5 t ha^{-1}, 5 t ha^{-1}, 7.5 t ha^{-1}, 10 t ha^{-1}, 10 t ha^{-1} (with 50% N) and 15t ha^{-1} were incorporated into the soil as per treatments at 7 days before transplanting of the rice seedlings. Composts were mixed thoroughly with the soil. Recommended nitrogen @ 120 kg/ha from urea was applied in three equal split as per treatment. The first dose of urea was applied at 7 days after transplanting. The remaining doses of urea were top dressed at 30 (active tillering stage) and 65 (panicle initiation stage) days after transplanting. Phosphorus, K, and S were applied @ 75, 120 and 56 kg/ha from triple super phosphate, muriate of potash and gypsum respectively in all the plots except control during final land preparation. The amount of N, P and K content in compost also reduced from the recommended N, P and K fertilizer dose applied to the soil. Chemical composition of compost used is presented in Table 2.

Table 2
Characteristics of municipal solid waste compost.

Characteristics	Value
Colour	Dark brown
pH	7.33
Organic matter (%)	22.5
Total N (%)	0.89
Total P (%)	0.30
Total K (%)	0.45
Total S (%)	0.46
C : N ratio	14

Transplanting of rice seedlings

The seedlings of BINA dhan7 was transplanted on 8th August, 2010 maintaining plant spacing of 20cm × 20cm. Three healthy seedlings were transplanted in each hill.

Intercultural operations

Different cultural operations were done during the field study as stated in Table 3. Necessary irrigations were provided to the pots from the deep tube well as and when necessary during the growing period of the crop. The crop was infested with some weeds that were uprooted by hand at 10, 20 and 40 days after transplanting. There was no serious infestation of insect pest and disease in the rice plants during the experimental period and no control measure was adapted.

The crop was harvested at full maturity on May 16, 2010. The harvested crop of each pot was bundled separately and brought to the threshing floor. Grain and straw yields were recorded treatment wise and expressed as ton ha^{-1} on 14% moisture basis.

Table 3
List of different cultural operations done during the field study.

Operations	Dates
First ploughing in the field	19.07.2010
Second ploughing and laddering	24.07.2010
Third ploughing and application of compost	07.08.2010
Fourth ploughing and laddering	09.08.2010
Final ploughing, plot preparation of fertilizer such as TSP, MOP, and gypsum	10.08.2010
Transplanting of rice seedling (BINA dhan-7)	11.08.2010
First weeding	21.08.2010
First split application of urea 7 days of transplanting	22.08.2010
Second weeding	14.09.2010
Second split application of urea after 30 days of transplanting	14.09.2010
Third split application of urea after 60 days of transplanting	09.10.2010
Harvesting and threshing	08.11.2010

Collection and preparation of plant samples

Three hills were randomly selected from each plot at maturity to record the yield contributing characters like plant height (cm), panicle length (cm), no. of tillers/hill no. of grains/plant, no of filled grains/plant and 1000-grain weight (g). The selected hills were collected before crop harvest on November 04, 2010 and necessary information were recorded accordingly. Grain and straw yields were recorded plot wise and expressed on sundry basis. Grain and straw samples were kept for chemical analysis.

Data recording

The plant height was measured from the ground level to the top of the panicle. Measurement for panicle length was done from basal node of the rachis to apex of each panicle. Total number of effective tillers hill^{-1} was recorded. The grains panicle^{-1} were counted and recorded. All panicle were taken and the filled and unfilled grains panicle^{-1} were counted and averaged. 1000-grains were taken from each plot and weighed in an electrical balance. Grain and straw yields of the rice plant recorded pot wise were obtained from each pot and weighed carefully. The yields were expressed as g pot^{-1} on 14% moisture basis.

Analysis of the initial soil

The initial soil samples were analyzed for both physical and chemical properties in the laboratory of the Department of Soil Science, Bangladesh Agricultural University, Mymensingh. The properties studied include particle-size analysis (Piper 1950), soil pH (Jackson 1962), organic carbon (OC) (Walkley and Black 1934), cation exchange capacity (CEC) (Jackson 1962). Total nitrogen was estimated by micro-Kjeldahl method (Page et. al., 1989), available phosphorus (Olsen et al. 1954), exchangeable potassium (Black, 1965), available sulphur (Page et. al., 1989) were also analyzed according the reference procedure.

Chemical analysis of grain and straw samples

Digestion of plant samples for total nitrogen determination

For the determination of nitrogen 0.1g oven dry ground plant sample (both grain and straw separately) were taken in a digestion vessel. Into the vessel, 1.1g catalyst mixture (K_2SO_4: $CuSO_4$.$5H_20$: Se=100:10.1), 3 ml 30% H_20_2 and 5 ml H_2SO_4 were added. The flasks were swirled and allowed to stand for about 10 minutes. Then heating was continued until the digest was clear and colorless. After cooling, the content was taken into 100 ml volumetric flasks and the volumes were made up to the mark with distilled water. A reagent blank was prepared in a similar manner. These digests were used for nitrogen determination.

Digestion of plant samples for P, K and S determination

Plant samples of 0.5g (grain and straw separately) were transferred into 100 ml digestion vessel. 10 ml of diacid mixture (HNO_3: $HClO_4$=2:1) were added into the vessel. After leaving for a while the flasks were heated at a temperature slowly raised to 200°C. Heating was stopped when the dense white fume of $HC10_4$ occurred. After cooling, the contents were taken into a 50 ml volumetric flask and the volume was made with distilled water. The digests were used for the determination of P, K and S.

Statistical analysis

The collected data were analyzed statistically by F-test to examine the treatment effects and the mean differences were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) and ranking was indicated by letters.

RESULTS AND DISCUSSION

Yield contributing characters of BINA dhan7

Plant height

Plant height of BINA dhan7 was influenced significantly due to the application of MSW compost and chemical fertilizers either as single or in combinations (Table 4). The plant height recorded in different treatments ranged from 73.33 cm to 82.20 cm. The maximum plant height of 82.20 cm was recorded in treatment T_2 (75% RDF+ compost 2.5 t ha^{-1}). The treatments T_1 (100% RDF), T_3 (50% RDF + compost 5 t ha^{-1}), T_4 (25% RDF+ compost 7.5 t ha^{-1}), T_5 (Compost 10 t ha^{-1}) and T_6 (25% N + compost 10 t ha^{-1}) recorded statistically identical plant height although the values were lower as compared to the treatment T_2. The minimum plant height of 73.33 cm was obtained in the control treatment (T_0). Application of compost alone @ 10 t ha^{-1} (T_5) and 15 t ha^{-1} (T_8) produced comparatively lower plant height with the value of 76.41cm and 73.40cm respectively but the values were higher than the control treatment. The results indicated that plant height of BINA dhan7 increased considerably due to the combined application of compost @ 2.5 t ha^{-1} with 75% NPKS fertilizers over the application of 100% NPKS recommended dose as chemical fertilizers. Sharma and Mitra (1990) reported that application of organic manure increased plant height significantly. Budhar et al. (1991) found that the plant height was significantly influenced by the basal incorporation of farm waste. Babu et al. (2001) also observed that the plant height was significantly influenced by the incorporation of organic manure and fertilizer.

Panicle length

The results in Table 4 showed that panicle length of the BINA dhan 7 increased significantly due to different treatments. All the treatments produced longer panicle over control (T_0). The panicle length due to different treatments varied from 17.88 to 21.83 cm. The maximum panicle length of 21.83 cm was obtained in the treatment T_2 (75% RDF + compost 2.5 t ha^{-1}) which was statistically similar to the all other treatments except for T_0,T_7 and T_8.The minimum value of 17.88 cm was noted in the control (T_0). The treatments T_1, T_3, T_4, T_5 and T_6 produced statistically identical panicle length. Statistically identical panicle length of 19.64 cm and 19.85 cm were also recorded in the treatments T_7 and T_8, respectively.

The results in Table 4 also indicated that application of fertilizers in combination with MSW compost was more effective in producing longer panicle length over single application of fertilizers at the recommended dose. Again, single application of compost even at higher rates was not comparable with the combined application of compost and fertilizers in producing panicle length. Ahmed and Rahman (1991) reported that the combined application of organic manure and chemical fertilizers increased the panicle length of rice. Hemalatha et al. (2000) observed that application of organic manure significantly increased panicle length of rice.

Number of tillers hill^{-1}

Application of MSW compost and inorganic fertilizers significantly increased the number of tillers hill^{-1}. The number of tillers hill^{-1} due to different treatments ranged from 6.20 to 10.57. The highest number of tillers hill^{-1} 10.57 was recorded in T_2 treatment while the lowest value of 6.20 was noted in the T_8 treatment. The second highest number of tillers hill^{-1} was found in T_3 treatment with the value of 9.50. The number of tillers hill^{-1} in the treatments T_7, T_4, T_5, T_6, T_0 and T_1 were 8.63, 8.30, 8.00, 7.43, 7.09 and 6.83 respectively. In control treatment (T_0), the number of tillers hill^{-1} was 7.09 which was statistically similar to the treatment T_6 (25% N + compost @10 t ha^{-1}). Table 4.1 indicated that all the treatments except for control and T_8 increased the number of tillers of BINA dhan7 due to the combined application of compost and fertilizers further more combined application of MSW compost and fertilizers increased the tillers hill^{-1} over single application of chemical fertilizers. Ahmed and Rahman (1991) reported that the application of organic and inorganic fertilizer increased the number of tillers of rice.

Filled grains panicle^{-1}

Results in the Table 4 showed that the number of filled grains panicle^{-1} varied significantly due to different treatments under study except for the treatment T_2. The number of filled grains panicle^{-1} ranged from 64.67 to 78.01 and the treatment T_2 produced the highest number of filled grains panicle^{-1} of 78.01 while the second highest number of filled grains 76.37 was recorded in the treatment T_6. The lowest value for grains panicle^{-1} 64.67 was recorded in the treatment T_8. The results indicated that application of compost and fertilizers either singly or in combination influenced the number of filled grains panicle^{-1}. Channabasavanna and Birandar (2001) also reported that organic manuring increased the number of filled grain panicle^{-1}.

1000- grain weight

The results presented in the Table 4 revealed that 1000-grain weight of BINA dhan7 was influenced insignificantly due to the different treatments. The 1000-grain weight due to different treatment ranged from 17.48g to 19.89g. The treatment T_2 recorded the highest value and control (T_0) recorded the lowest 1000-grain weight of BINA dhan7. The 1000-grain weight of BINA dhan7 due to the treatments T_o, T_1, T_2, T_3, T_4, T_5, T_6 T_7, and T_8 were 17.48, 19.53, 19.89, 18.05 19.45, 17.83, 18.60, 18.48 and 19.68g respectively. The results indicated that combined or single application of MSW compost and inorganic fertilizers resulted significant effect on the 1000-grain weight of BINA dhan7.

Table 4
Effect of MSW compost and fertilizers on the yield contributing components of BINA dhan7.

Treatments	Yield contributing components				
	Plant height (cm)	Panicle length (cm)	Tiller/hill (No.)	Filled grain/Panicle (No.)	1000-grain wt.(g)
T_0	73.33c	17.88c	7.09de	70.90b	17.48c
T_1	76.65b	20.48ab	6.83e	70.50b	19.53ab
T_2	82.20a	21.83a	10.57a	78.01a	19.89a
T_3	76.23b	21.24ab	9.50ab	68.13cd	18.05bc
T_4	77.40b	20.43ab	8.30bc	66.68d	19.45ab
T_5	76.41b	19.96ab	8.00c	69.63bc	17.83c
T_6	76.73b	20.51ab	7.43d	76.37a	18.60b
T_7	75.50bc	19.64b	8.63bc	70.38b	18.48b
T_8	73.40c	19.85b	6.20f	64.67e	19.68a
CV (%)	4.85	6.22	4.57	8.60	8.16
LSD at 5%	2.58	1.71	1.55	2.00	1.36
Level of significance	**	**	**	**	**

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

Grain and straw yields of BINA dhan7

Grain yield

The grain yield of BINA dhan7 was significantly influenced due to the single and combined application of MSW compost and fertilizers (Table 5). The grain yield varied from 2.09 to 4.42 t ha^{-1} due to different treatments. All the treatments produced significantly higher grain yield over control except for T_8. The highest grain yield of 4.42 t ha^{-1} (98.2% increase over control) was obtained in the treatment T_2 (75% RDF+ compost 2.5 t ha^{-1}) and the second highest value (3.72 t ha^{-1}) was recorded in the treatment T_5 (compost 10 t ha^{-1}). The lowest grain yield of 2.09 t ha^{-1} was observed in the treatment $T_{8.}$ The treatments can be ranked in order of T_2 > T_5 > T_3 > T_7 > T_6 >T_4 > T_3 >T_0 >T_8 in term of grain yields. Single application of compost @10 t/ha (T_5) and 15 t/ha (T_8) produced the yield of 3.72 t ha^{-1} and 2.09 t ha^{-1} which were 66.8% and 34.0% higher, respectively, over control. From the study it was observed that application of compost @ 2.5 t ha^{-1} with 75 % recommended doses of NPKS fertilizers performed the best in producing the grain yield of BINA dhan7. All the treatments where fertilizers and compost were applied alone or in combination produced significantly higher grain yield over control except for T_8.

The results also indicated that the application of compost @ 10 t ha^{-1} in combination with 50% N only exerted pronounced effect and produced second highest grain yield of rice. The percent increase in grain yield due to different treatments over control ranged from 30.9 to 66.8%. The results revealed that compost application @ 5 t ha^{-1} can reduce more than 50% recommended doses of fertilizers for rice cultivation. Integrated application of organic manures and chemical fertilizer significantly increased the grain yield of rice (Ahmed and Rahman, 1991; Calendacion *et al.*, 1990; Laxminarayana,. 2000).

Straw yield

All the treatments comprising compost and fertilizer application produced significantly higher straw yield of BINA dhan7 over the control. The straw yield due to different treatments ranged from 5.28 to 6.45 t ha^{-1}. The highest straw yield of 6.45 t ha^{-1} was obtained in the treatment T_1 (100% RDF) which was statistically similar to the treatment T_2 (75% fertilizer + compost 2.5t ha^{-1}). Straw yields due to the treatments T_3 (6.07 t ha^{-1}), T_4 (6.10 t ha^{-1}), T_5 (5.85 t ha^{-1}), T_6 (6.17 t ha^{-1}),T_7 (6.20 t ha^{-1}) and T_8 (5.49 t ha^{-1}) were statistically identical. The lowest straw yield of 5.28 t ha^{-1} was recorded in the treatment T_0. The straw yields of BINA dhan7 in all the treatments were always higher to their corresponding grain yields. Straw yield of rice due to different treatments may be ranked in the order of T_1 (6.45 t ha^{-1}) > T_2 (6.38 t ha^{-1}) > T_7 (6.20 t ha^{-1}> T_6 (6.17 t ha^{-1}) > T_4 (6.10 t ha^{-1}) > T_3 (6.07 t ha^{-1}) > T_5 (5.85 t ha^{-1}) >T_8 (5.49 t ha^{-1}) > T_0 (5.28 t ha^{-1}). The percent increase of straw yields of rice due to different treatment ranged from 10.7% to 22.1% over control.

Table 5
Effects of MSW compost and fertilizers on the grain and straw yields of BINA dhan7.

Treatment	Grain Yield (t ha^{-1})	% increase over control	Straw Yield (t ha^{-1})	% increase over control
T_0	2.23f		5.28b	
T_1	3.39cd	52.0	6.45a	22.1
T_2	4.42a	98.2	6.38a	20.8
T_3	2.92e	30.9	6.07ab	14.9
T_4	3.24d	45.2	6.10ab	15.5
T_5	3.72b	66.8	5.85ab	10.7
T_6	3.35c	50.2	6.17ab	16.8
T_7	3.63bc	62.7	6.20ab	17.4
T_8	2.09g	34.0	5.49ab	13.9
CV (%)	4.12		3.99	
LSD at 5%	0.34		0.95	
Level of significance	**		**	

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

It was observed from the study that N fertilization greatly influenced the yield of rice straw. Straw yield of rice decreased consistently with the application of compost at higher rates. Rice plants treated with fertilizers encouraged rapid vegetative growth leading to the production of higher straw yield. Khan *et al* (2007) also observed that combined application of NPK and organic manure significantly increased the straw yield of rice.

Nutrient content in grain and straw of BINA dhan7

The grain and straw samples of rice were analyzed for determining N, P, K and S content. The results of N, P, K, and S content of grain and straw have been presented and discussed under the following sub sections.

Nitrogen

Nitrogen content in the grain and straw (Table 6) of BINA dhan7 was increased due to the application of MSW compost and fertilizers in different combination. The N content in rice grain ranged from 0.09 to 1.32 %. The highest N content of 1.32% was observed in the treatment T_1 (100% recommended fertilizer dose) and it was statistically identical to the treatments except for T_8.The lowest N content of rice grain (0.09%) was recorded in the treatment T_8 (compost @ 15 t ha^{-1}). The N content in rice grain was comparatively higher than that of rice straw. The results indicated that MSW compost when applied singly or in combination with fertilizers exerted similar effect on N content of rice grain. Application of compost in combination with fertilizers tended to increase the N content in grain.

The N content in rice straw varied from 0.28 to 0.42 % (Table 6). The maximum N content in rice straw (0.42%) was recorded in the treatment T_1 (100% RDF) which was statistically similar to that observed in the treatment T_2 (75% RDF +compost @ 2.5 t ha^{-1}). The minimum N content in rice straw (0.28 %) was noted in the T_6 treatment. The treatments T_3, T_0, T_5 and T_8 indicated statistically similar results. It was also observed that application of compost at higher rates alone or at the lower rates in combination with chemical fertilizers resulted lower N content in rice straw compared to chemical fertilization application alone as noted in the treatment T_1. A significant increase in N content of rice grain and straw due to the application of manures and fertilizers was reported by many investigators (Verma, 1991; Azim, 1999).

Phosphorus

Phosphorus content in rice grain and straw of BINA dhan7 increased significantly due to the application compost and fertilizers (Table 6). The P content in rice grain ranged from 0.22% to 0.40% and the highest P content (0.40%) was observed in the treatment T_2 (compost 2.5 t ha^{-1} + 75% RDF). The second highest P content (0.38%) was recorded in the treatments T_3 (compost 5 t ha^{-1} + 50 % RDF).The treatments T_0 (control), T_5 (compost 10 t ha^{-1}), T_6 (compost 10 t ha^{-1} + 25% RDF)) and T_7 (compost 10 t ha^{-1} with 50% N) were statistically similar in P content by rice grains having values of 0.30%, 0.32%, 0.34% and 0.31%, respectively. The lowest value of P content in rice grain of 0.22% was recorded in the treatment T_4. The P content in rice grain was comparatively higher than that of rice straw. Kadu et al. (1991) conducted a pot experiment with rice cv. Sakoli-6 and found that the highest P content was obtained with the application of higher rates of NPK fertilizer in combination with FYM.

In case of rice straw, P content varied significantly due to different combinations of compost and fertilizers. Phosphorus content in rice straw varied from 0.036% to 0.066%. The maximum P content (0.066%) was observed in the treatments T_7 (compost 10 t ha^{-1} + 50% N). The lowest P content (0.036%) was noted in the control treatment (T_o). Statistically similar P values of 0.046%, 0.048%, 0.063%, 0.060%, 0.047%, 0.049% and 0.046% were observed in the treatments T_1, T_2, T_3, T_4, T_5, T_6 and T_8. Results also revealed that the use of compost in combination with fertilizer showed higher P content by BINA dhan 7 over fertilizer application alone. Gupta et al. (1995) stated that the concentration of P in rice tissue at different stages increased with the application of P and/or poultry manure. Increase of P contents both in grain and straw of rice due to application of manure and fertilizers was reported by many investigators (Azim, 1999 and Razzaque, 1996).

Potassium

Potassium content in rice grain due to different treatment varied from 0.12% to 0.28% (Table 6). All the treatments significantly increased K content in grain over control. The maximum K content of rice grain (0.28%) was found in the treatment T_2 (75% RDF+ compost 2.5 t ha^{-1}). Statistically similar K contents in rice grains were recorded in the treatments T_1 (0.20%), T_7 (0.20%), T_3 (0.25%), T_4 (0.20) and T_8 (0.21%). The lowest value of K content in rice grain of 0.12% was observed in the control treatment.

In case of rice straw, application of compost and fertilizers in different combinations influenced the potassium content insignificantly and the values of K content varied from 0.41% to 0.50%. The highest K content in rice straw (0.50%) was recorded in the treatment T_2 (75% RDF+ compost 2.5 t ha^{-1}). The control treatment recorded the lowest K content in rice straw (0.41%). It was observed that the K content in rice straw was higher than that in rice grain. Verma (1991) reported that incorporation of FYM significantly increased K content in paddy grain and straw.

Sulphur

Sulphur content in rice grain was significantly influenced due to different treatments. The S contents in rice grain ranged from 0.62% to 0.94%. The highest S content (0.94%) was observed in that plot which was treated with recommended doses of fertilizers (T_1). The treatments T_0 (0.62%) and T8 (0.63%) recorded statistically identical results. The lowest S content in grain was recorded in the treatment T_0 (0.62%). The treatments T_2, T_3, T_4 and T_7 also exerted statistically similar effect on the S content in rice grain. All the treatments increased the S content in rice grain considerably over control. All the compost treated plots, either single application of compost or in combination with chemical fertilizers tended to increase the S content in rice grain. Hossain (1996) reported that the S content in rice grain was improved from the combined use of organic manure with NPKS.

In case of straw, the S content in rice straw varied from 0.45% to 1.54%. The highest value of S content was 1.54% and found in the treatment T_8. The lowest value of S content in rice straw of 0.45% was recorded in the treatment T_5. The treatments T_1, T_2, T_3 and T_4 exerted statistically similar effect on S content of rice straw and the values were 0.67%, 0.79%, 0.74% and 0.67% respectively.

Table 6
Effect of MSW compost and fertilizers on the N, P, K and S content in grain and straw of BINA dhan7.

Treatment	N (%) Grain	Straw	P (%) Grain	Straw	K (%) Grain	Straw	S (%) Grain	Straw
T_0	1.16a	0.32cd	0.30cd	0.036d	0.12d	0.41	0.62d	0.81bc
T_1	1.32a	0.42a	0.35b	0.046bc	0.20bc	0.45	0.94a	0.67cd
T_2	1.18a	0.40ab	0.40a	0.048b	0.28a	0.50	0.77b	0.79c
T_3	1.28a	0.33c	0.38ab	0.063ab	0.25ab	0.42	0.74bc	0.74cd
T_4	1.13a	0.37b	0.22e	0.060ab	0.20bc	0.43	0.72bc	0.67cd
T_5	1.15a	0.36bc	0.32c	0.047bc	0.13d	0.42	0.66c	0.45e
T_6	1.25a	0.28d	0.34bc	0.049b	0.16cd	0.44	0.62d	0.61d
T_7	1.30a	0.39b	0.31c	0.066a	0.20bc	0.49	0.82ab	0.95b
T_8	0.09b	0.31cd	0.25d	0.046bc	0.21bc	0.42	0.63d	1.54a
CV (%)	6.26	3.17	3.33	0.67	1.71	1.87	3.13	3.75
LSD at 5%	0.173	0.095	0.055	0.017	0.055	-	0.122	0.145
Level of significance	**	**	**	**	**	NS	**	**

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

Nutrient uptake by grain and straw of BINA dhan7

Nitrogen

The results presented in the Table 7 indicated that the N uptake by rice grain and straw of BINA dhan7 was significantly influenced due to the application of compost and fertilizers alone or in combinations. The N uptake of rice grains due to different treatments ranged from 31.66 to 40.44kg ha^{-1}. The maximum N uptake by rice grain (40.44 kg ha^{-1}) was noted in the treatment T_2, followed by the treatment T_7 (38.36 kg ha^{-1}). The minimum N uptake (31.66 kg ha^{-1}) was recorded in the treatment T_8. The treatments T_3, T_4, T_5, T_6 and T_1 were statistically similar in terms of N uptake by rice grains. Results revealed that application of MSW compost in combination with fertilizers significantly increased the uptake of N by rice grain over control or only compost treated plots.

The N uptake by rice straw ranged from 16.69 to 32.93kg ha^{-1} .The maximum N uptake by rice straw (32.93kg ha^{-1}) was recorded in the treatment T_1 (100% RDF). The second highest N uptake by rice straw of 26.07 kg ha^{-1} was noted in the treatment T_2 (75% fertilizer + compost 2.5 t ha^{-1}) which was also statistically similar to the treatment T_7 (25.02 kg ha^{-1}). The minimum N uptake by rice straw (16.69 kg ha^{-1}) was recorded in the control treatment (T_o) which was statistically identical to the treatments T_6 (compost @ 10 t ha^{-1} + 25% N) and T_8 (0.31 kg ha^{-1}). Table 4.4 also shows that application of recommended dose of N P K S fertilizers recorded more N uptake by rice straw and the values was more as compared to the combined application of compost with fertilizers or single application of compost. Nitrogen uptake by rice grain was always higher than that by straw in all the treatments. Sharma and Mitra (1991) recorded the highest N uptake in organic manures and fertilizer treatment plots.

Phosphorus

There was a significant variation in P uptake by BINA dhan7 due to the various treatments (Table 7). Phosphorus uptake by rice grain varied from 3.23 to 13.52 kg ha^{-1}. The highest P uptake by rice grain (13.52 kg ha^{-1}) was found in the treatment T_2 with the application of compost @ 2.5 t ha^{-1} + 75% recommended dose of fertilizers. The treatments T_0 (control), T_4 (25% RDF + compost 7.5 t ha^{-1}) and T_6 (25% N + compost 10 t ha^{-1}) were statistically identical with the values of 0.30 kg ha^{-1} , 0.22 kg ha^{-1} and 0.34 kg ha^{-1} respectively. The lowest P uptake of 4.32 kg ha^{-1} was noted in the control treatment (T_o). It was further observed that application of compost @ 2.5 t ha^{-1} in combination with 25% recommended dose of fertilizers increased the P uptake of rice grain considerably over the application of NPKS fertilizers at recommended dose.

Table 7
Effect of MSW compost and fertilizers on N and P uptake by grain and straw of BINA dhan7 .

	N uptake		P uptake	
Treatments	Grain	Straw	Grain	Straw
T_0	35.02cd	16.69f	4.32f	2.20f
T_1	37.04bc	32.93a	7.13e	2.97e
T_2	40.44a	26.07b	13.52a	7.62a
T_3	36.98bc	23.75c	3.23g	3.90c
T_4	34.51d	20.21e	4.60f	3.69cd
T_5	34.17d	21.59d	8.40d	2.77ef
T_6	35.51cd	17.86f	4.71f	3.13de
T_7	38.36b	25.02bc	11.24b	4.73b
T_8	31.66e	16.90f	9.16c	2.99e
CV (%)	5.23	3.65	4.52	7.12
LSD at 5%	1.82	1.33	0.73	0.63
Level of significance	**	**	**	**

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

The P uptake by rice straw ranged from 2.20 kg ha^{-1} to 7.62 kg ha^{-1} .The maximum P uptake (7.62 kg ha^{-1}) by rice straw was obtained in the treatment T_2 with the application of compost @ 10 t ha^{-1} in combination with 75% recommended dose of fertilizers. The minimum P uptake of rice straw (2.20 kg ha^{-1}) was recorded in the control treatment (T_o) .The treatments T_5 (compost 10 t ha^{-1}), T_6 (25% N + compost 10 t ha^{-1}), T_1 (100% RDF) and T_8 (compost 15 t ha^{-1}) resulted statistically similar effect on the P content in the straws of BINA dhan7. The effect of compost application at different levels singly or in combination with fertilizers exerted increasing effect on the P uptake by rice straw. P uptake by straw with the values of 3.69 kg ha^{-1} and 4.73 kg ha^{-1} were noted in the treatment T_4 (compost 7.5 t ha^{-1} + 25% RDF) and T_7 (compost 10t ha^{-1} + 50% N). The results indicated that application of MSW compost and fertilizers alone or in combination increased the P uptake by rice straw.

Potassium

The potassium uptake by BINA dhan7 was influenced significantly due to different treatments. The K uptake by rice grain ranged from 2.42 kg ha^{-1} to 11.00 kg ha^{-1}. The maximum uptake of K by rice grain was observed in the treatment T_2 due to application of compost @ 2.5 t

ha^{-1} in combination with 75% recommended doses of NPKS fertilizer which was statistically superior to all other treatments. The second highest value was recorded in the treatment T_7 (compost @ 10 t ha^{-1} with 50% N) which was followed by treatments T_3 (compost @ 5 t ha^{-1}+50% RDF) and T_5 (compost @ 10 t ha^{-1}) with the values of 6.90, 6.80 and 4.2 kg ha^{-1} respectively. The treatments T_0 (control), T_4 (Compost @ 7.5 t ha^{-1}+25% RDF) and T_8 (compost @ 15 t ha^{-1}) were statistically identical but significantly superior to the control treatment T_0. The lowest K uptake (2.4 kg ha^{-1}) was recorded in the control treatment. Combined application of compost and fertilizers at different doses increased significantly the K uptake by rice grain over application of fertilizers at recommended dose or compost alone. Dixit and Gupta (2000) reported that uptake of K in grain showed increasing trends as a result of NPK fertilizers, farmyard manure and BGA inoculation either alone or in combination.

The K uptake by rice straw ranged from 23.02 to 40.01 kg ha^{-1}. The maximum K uptake (40.01 kg ha^{-1}) was observed in the treatment T_2. The second highest K uptake of 37.35 kg ha^{-1} was observed in the treatment T_7. The treatments T_3 (compost @ 5 t ha^{-1} + 50% RDF fertilizer), T_5 (composed 10 t ha^{-1}) and T_1 (100% RDF+NPKS) recorded K uptake of 24.50 kg ha^{-1}, 24.56 kg ha^{-1}, and 25.36 kg ha^{-1} which were statistically similar in terms of K uptake by BINA dhan7.The lowest K uptake by straw of 23.02 kg ha^{-1} was noted in control.

Table 8
Effects of MSW compost and fertilizers on K and S uptake by rice grain and straw of BINA dhan 7.

Treatments	K uptake		S uptake	
	Grain	Straw	Grain	Straw
T_0	2.40e	23.02g	11.08e	26.47g
T_1	3.90d	25.36ef	14.83d	40.37e
T_2	11.0a	40.01a	27.72a	49.02a
T_3	6.80b	24.50f	14.60d	44.93c
T_4	2.60e	26.43de	24.56b	39.15e
T_5	4.20d	24.56f	24.39b	42.92d
T_6	6.00c	31.19c	22.61c	36.96f
T_7	6.90b	37.35b	25.56b	47.06b
T_8	2.83e	27.18d	16.09d	42.63d
CV (%)	5.23	6.22	4.58	6.59
LSD at 5%	0.71	1.28	1.63	1.83
Level of significance	**	**	**	**

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

Sulphur

The results in Table 8 showed that there was a significant variation in S uptake by BINA dhan7 due to the application of MSW compost and fertilizers in different combinations. The uptake of S by rice grain and straw was significantly affected by different treatments. The uptake of S both in rice grain and straw ranged from 11.08 kg to 27.72 kg ha^{-1} and 26.47 kg to 49.02 kg ha^{-1} respectively. The maximum uptake of S (27.72 kg ha^{-1}) by rice grain was observed in the treatment T_2 (compost 2.5 t ha^{-1} + 75% RDF) which was significantly superior to all other treatments. The treatments T_3 (compost 5 t ha^{-1} + 50% RDF) and T_8 (compost @ 10 t ha^{-1}) were statistically identical in S uptake by rice grain with the values of 14.60 kg and 16.09 kg ha^{-1} respectively. Again, the treatments T_4 (compost 7.5 t ha^{-1} + 25% RDF), T_5 (compost 10 t ha^{-1}) and T_7 (compost @ 10 t ha^{-1} with 50% N) were statistically identical in S uptake by rice grain with the values of 24.56 kg , 24.39 kg and 25.56 kg ha^{-1} respectively. Overall results suggest that combined application of compost and fertilizers exerted increasing effect on the S uptake by rice grain. The lowest S uptake by grain (11.08 kg ha^{-1}) was recorded in the control treatment.

In case of straw, the highest S uptake of 49.02 kg ha^{-1} was observed in the treatment T_2 (compost 2.5 t ha^{-1} + 75% RDF). The second highest value for S uptake in rice straw (47.06 kg ha^{-1}) was recorded in the treatment T_7 (compost @ 10 t ha^{-1} with 50% N). The S uptake with the values of 36.96 kg, 39.15 kg, 44.93 kg and 40.37 kg ha^{-1} were observed in the treatments T_6 (compost 10 t ha^{-1}+25% N), T_4 (compost @ 7.5 t ha^{-1}+25% RDF), T_3 (compost @ 5 t ha^{-1}+50% RDF) and T_1 (100% RDF) respectively. Results reveals that the combined application of MSW compost and fertilizers exerted better performance on the uptake of S in straw of BINA dhan 7.

CONCLUSION

The application of MSW compost in combination with fertilizers has a positive impact on the yield and yield contributing characters as well as on the nutrient content and uptake of BINA dhan7. Application of compost @ 2.5 tons ha^{-1} in combination with 75% of the recommended dose of NPKS fertilizers produced the maximum yield of BINA dhan7 and the yield was considerably more as compared to that obtained from the application of NPKS fertilizers at the recommended dose. Combined application of compost and fertilizers increases rice yield and reduces the use of chemical fertilizers. Compost application @ 2.5 t ha^{-1} with 75% of the recommended dose of NPKS fertilizers may be practiced in the Old Brahmaputra Floodplain soils for the production on BINA dhan7 profitably.

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