

Application of Municipal Solid Waste Compost and Green Manure Exerted Residual Effects in Soil Nutrient Content and Plant Nutrient Uptake in Rice

ABSTRACT

Purpose: Rice is the main food in Bangladesh. With the global upsurge in population, rapid urbanization, and industrialization increasing waste production in urban areas. So, Waste management becoming a major concern to protect the landfill and control environmental pollution. Municipal solid waste (MSW) is considered an important recycling tool for compost production which can be a substitute for chemical fertilizers. We conducted a study to know the residual effects of MSW compost and Green manure (GM) on rice (BINA Dhan-7).

Methods: The experiment was with an RCBD design, eight treatments, and three replications. The present rice crop received no fertilizers during the cultivation period. MSW compost was applied to the preceding rice crops and GM inoculated with *Rhizobium* strains were incorporated as per treatments in 2 cycles of the Mungbean- Dhaincha- T. aman rice cropping pattern.

Results: The highest nutrient content and uptake were recorded with higher rates of MSW compost and GM application in the preceding crops. Compost is a slow-release source of nitrogen. Most nitrogen remaining after completion of the composting process is bound into organic forms and thus not available immediately for plant uptake. Residue contributes to improving soil quality for several years after application ceases. Repeated application of MSW compost and GM increases soil organic matter content, C: N ratio, and soil physical, chemical, and biological properties.

Conclusion: The study indicated that both MSW application and GM incorporation in the soil to the preceding crop exerted a significant residual effect on the nutrient content in soil and uptake in Rice.

Keywords: Municipal solid waste compost, Green manure, *Rhizobium*, Binadhan-7, nutrient content, nutrient uptake.

INTRODUCTION

Rice, a staple food for the majority of the world's population consumes about 50% of fresh water in Asia. Agricultural transformation, as a cornerstone of the new sustainable development agenda, must therefore be an eco-efficient revolution in the next few decades (Sandhu *et al.* 2021). The excessive use of synthetic chemicals, which vastly contaminate the environment, as well as the mechanical soil disturbance and irrigation, have led to a generation of resistant insects, fungi, weeds, etc., accumulation of chemicals in crops and soil, pollution of water and air and consequently contribute to some extent to the greenhouse effect and global warming (Tsvetkov *et al.* 2018). The decline in organic matter content of many soils is becoming a major process of soil degradation. Degraded soils are not fertile and thus cannot maintain sustainable production. An ideal soil contains about 5% organic matter of its volume. But organic matter content in most soils of Bangladesh is low to very low (Glaser *et al.* 2011). For optimal growth, development, and production, plants need all the necessary nutrients in balance. Integrated nutrient management in rice has many benefits to increase soil fertility and sustainable crop productivity (Shrestha *et al.* 2020).

At the same time, the high generation rates of organic waste and their open dumpsite in landfills are resulting in some adverse effects related to the environment, economy, and social life. Composting represents one of the cleaner technologies for diverting organic pollutants from landfill (Kanat G. and Erguven G. 2020). The primary goals of sustainable waste management are to protect human health and the environment and to conserve resources. In addition, goals include the prevention of the export of waste-related problems into the future (Brunner *et al.* 2013). Municipal solid waste can be composted and recycled as a source of plant nutrients and improves soil properties (Almendro-Candel *et al.* 2019). Recently, municipal solid waste has gained importance as an organic amendment for restoring soil fertility and improving soil biological, physical, and chemical properties because of high soil organic matter and lower concentrations of pollutants. Municipal solid wastes significantly increase the productivity of salt-affected soil and improve crop yields (Meena *et al.* 2019). MSW compost addition at the highest dose increase soil porosity and soil stability against water erosion. Soil pH, total organic C and N, cation exchange capacity, and available P, Ca, Mg, and K are also high in compost-amended soils. Compost significantly increases soil microbial biomass and dehydrogenase activity (Domínguez *et al.* 2019). Compost also reduces the bulk density of soil. Compost releases nutrients slowly over

time, and buffers the soil, neutralizing both acid and alkaline soils and bringing pH levels to the optimum range for nutrient availability to plants. It increases the CEC, AEC, and buffering capacity of soils for a longer time. It builds up nutrients in the soil and supplies nutrients slowly and steadily for a long time. Proper management of MSW compost and application in the soil can reduce the use of chemical fertilizers and save soil and the environment. Farmers use huge chemical fertilizers for cereal production, which causes health and environmental hazards. Adoption of legumes in cereal-based cropping systems and improvement of organic fertilizers are needed to reduce chemical fertilizer use (Achu *et al.* 2013). Green manures can play a cardinal role as it has able impacts on physical, actinic, and biological superiority of the soil and appropriately apology of soil fertility. Green manure not alone improves soil quality, but as well fixes atmospheric nitrogen in the soil if legumes are considered. Green manure can play an important role in this regard as it showed versatile impacts like improvement of soil physicochemical and biological properties and fertility, nutrient supply to succeeding crops, checking erosion, and plant protection (Maitra *et al.* 2018). Green manures enhance organic matter content and also supplements the nutrient pool of the soil which ultimately improves the soil quality and also suppresses the weeds (Das *et al.* 2020). Green manures improve the grain yield of rice and show residual effects in terms of improving soil properties and biological health (Surekha *et al.* 2014). BINA Dhan-7, a high-yielding variety of rice was used as the test crop in this experiment. The present study was undertaken to evaluate the enriched municipal solid waste compost on rice nutrient content and uptake as well as the growth and yield of rice.

2. MATERIALS AND METHODS

2.1 Experimental site and soil characteristics

A field experiment was carried out at the Soil Science Field Laboratory of Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh (24°56.11' N, 89°55.54' E) during the Kharif-2 season from 05 August to 16 November 2013. Soils belonging to the Sonatola soil series of Non-calcareous Dark Gray Floodplain under the AEZ-9: Old Brahmaputra Floodplain. The soil is AericHeplaquet under the order Inceptisols (US Soil Taxonomy) and Chromic-EutricGleysols (FAO Soil Unit). The experimental unit was under a subtropical humid climate and is

characterized by a hot and humid climate and cold winter. The soil (0-15cm) texture was silt loam including fairly level topography in medium-high land. Sand, silt, and clay % of this soil is 10.25, 74.50, and 15.25 respectively. This soil was belonging to a pH of 6.34 and organic carbon of 1.04%.

2.2 Treatment details experimental setup

Nine treatments were randomly distributed within the blocks including control, fertilizers, *Rhizobium* inoculated green manure, and municipal solid waste compost in different combinations. The treatments-T₀: Control (No fertilizer or MSW compost or manure), T₁: RDF (Recommended Dose of Fertilizers, NPKS for green manures and rice), T₂: GMR₁ (Green manures inoculated with *Rhizobium*-1 followed by rice + PKS), T₃: GMR₂ (Green manures inoculated with *Rhizobium*-2 followed by rice + PKS), T₄: GM R_{mix} (Green manures inoculated with mixed strains of *Rhizobium* followed by rice + 100% PKS), T₅: GM R_{mix}Com_{2.5} (Green manures inoculated with mixed strains of *Rhizobium* followed by rice + 75% PKS + compost 2.5 t ha⁻¹), T₆: GM R_{mix}Com₅ (Green manures inoculated with mixed strains of *Rhizobium* followed by rice +50% PKS + compost 5 t ha⁻¹), T₇: GM R_{mix}Com_{7.5} (Green manures inoculated with mixed strains of *Rhizobium* followed by rice + 25% PKS + compost 7.5 t ha⁻¹), T₈: GM R_{mix}Com₁₀ (Green manures inoculated with mixed strains of *Rhizobium* followed by rice + compost 10 t ha⁻¹). In the case of the present rice crop, all the plots received no fertilizers. Urea, triple superphosphate (TSP), muriate of potash (MoP), and gypsum were used in the previous crops as the source of N, P, K, and S, respectively. The recommended dose of fertilizers was N 90 kg ha⁻¹, P 24 kg ha⁻¹, K 65 kg ha⁻¹ and S 10 kg ha⁻¹. The experimental plots received MSW compost as per treatments in the preceding 2 crops. Well-decomposed MSW compost was incorporated into the soil as per treatments 7 days before transplanting and compost was mixed thoroughly with the soil. The first dose of urea was applied at 7 days after transplanting and rest at 30 and 60 days after transplanting BINA Dhan-7. P, K, and S were applied @ 20, 50, and 10 kg ha⁻¹ from triple super phosphate (TSP), muriate of potash (MoP), and gypsum, respectively, in all the plots except control as basal dose during final land preparation. Randomized Complete Block Design (RCBD) was followed where 3 blocks representing the replications to reduce the effects of soil heterogeneity. Each block was divided into 9 unit plots with raised dykes. The total number of unit plots was 27 and each size was 4.0m × 2.5m and plots were separated from each other by a 0.25m dyke. The blocks were separated from each other by 0.5m drains.

2.3 Crop management

BINA Dhan-7, a short-duration high-yielding variety of rice released by the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, Bangladesh in 2007. It takes about 110 to 120 days from cultivation to harvest. The plant height is 90-95 cm and the cultivar is of a non-lodging type. It is somewhat resistant to pests and diseases, especially resistant to blast diseases. All kinds of intercultural operations were done properly such as plowing, leveling, weeding, irrigation, fertilization, Insect-pest control, and harvesting. The seedlings of rice were transplanted on 31 January 2013 maintaining a spacing of 25 cm x 15 cm. Three healthy seedlings were transplanted in each hill. Intercultural operations were done as per requirement for normal growth of the crop. The rice was harvested at full maturity. The harvested rice of each plot was bundled separately and brought to the threshing floor. Grain and straw yields were recorded plot-wise and expressed as t/ha on a 14% moisture basis.

2.4 Data collection

2.4 Data collection and Nutrient analysis

Data on the various growth and yield contributing characters of the crop for each plot were recorded. The grain, straw, and soil samples from every plot were chemically analyzed for N, P, K, and S concentrations. Soil pH was determined by a pH meter with soil water suspension 2:1 ratio (Jackson *et al.* 1973). Soil organic carbon was determined using $K_2Cr_2O_7-H_2SO_4$ wet oxidation method (Walkley and Black, 1934). Available N, P, and K were measured using standard procedures of Bremner and Keenley (1965), Olsen *et al.* (1954), and Hanway and Heidel (1952), respectively. Available S was determined by $CaCl_2$ extractant (Chesnin and Yien, 1951).

2.5 Statistical analysis

Data on the yield contributing characters, nutrient content, and uptake were recorded. The collected data were analyzed statistically by F-test to examine whether treatment effects and the mean values were compared by Duncan's Multiple Range Test (DMRT) and ranking was indicated by letters (Gomez and Gomez, 1984). Collection and preparation of plant samples, data collection, soil analysis, chemical analysis of grain and straw samples, and nutrient uptake ($kg\ ha^{-1}$) = $(G_y \times N_{G_r})/100 + (S_y \times N_{s_t})/100$ were done. The software package, MSTATC was followed for statistical analysis.

3. RESULTS

3.1 Residual effect MSW compost and green manures on the nutrient content of BINA Dhan-7

N Content

The nitrogen content in rice grain ranged from 1.09% to 1.32%. The highest N content of 1.32% was observed in treatment T₈ (GM R_{mix}+ com₁₀) and it was statistically similar to those of the treatments T₅, T₆, and T₇. Again, the treatments T₁, T₂, T₃, and T₄ were statistically similar to treatment T₈. The lowest N content of rice grain (1.09%) was recorded in the control treatment T₀. The N content of rice straw also varied significantly due to different treatments and ranged from 0.40 to 0.53%. The treatments T₅ and T₇ exerted a statistically identical effect on the N content of rice straw with the same value of 0.51%. The treatment T₈ noted the highest N content in rice straw with values of 0.53%. Again, the treatments T₁ and T₃ were statistically similar in terms of the N content of rice straw with values of 0.48% and 0.50%, respectively. The N content in the straw of Binadhan-7 was comparatively lower than that in rice grain. All the MSW compost and green manure amended treatments recorded higher N content both in grain and straw of Binadhan-7 compared to the fertilizer treatment T₁. (Table 1)

P Content

Phosphorus content in the grain and straw of BINA Dhan-7 increased significantly due to the residual effect of MSW compost and green manures. The phosphorus content in rice grain due to different treatments ranged from 0.109% to 0.132%. The highest P content of 0.132% in rice grain was observed in treatment T₇ and the minimum value of 0.109% was noted in the T₀ (control) treatment. The treatments T₆, T₇, and T₈ were statistically identical in terms of P content in rice grain with the values of 0.130, 0.132, and 0.131. Again, the treatments T₃ and T₅ exerted an identical effect on the P content of rice grain. All the treatments recorded higher P content in rice grains over the treatments T₁ except the treatments T₂ and T₀. The P content in rice grain was comparatively higher than that in rice straw. The P content in rice straw also varied significantly and ranged from 0.029 to 0.048% (Table 4). The maximum P content (0.048%) in rice straw was recorded in the treatment T₈ (GM R_{mix}+ com₁₀) while the lowest value (0.029%) was observed in the control treatment. The treatments T₅ and T₆ were identical in terms of P content in rice straw with the same value of 0.044. (Table 1)

K Content

Potassium content in the rice grain of Binadhan7 varied significantly due to the residual effect of MSW compost and green manures and ranged from 0.120% to 0.161%. All the treatments significantly increased the K content of rice grain over control. The maximum K content in rice grain (0.161%) was found in treatment T₅ which was statistically identical to treatment T₈. The lowest value of K content in rice grain of 0.120% was observed in the control treatment. In straw, a residual effect of MSW compost and green manure influenced the K content significantly and the values of K due to different treatments varied from 1.29 to 1.66%. The maximum K content in rice straw (1.66%) was found in the treatment T₈ (GM R_{mix}+ com₁₀). The second highest value of K in straw (1.62%) was found in treatment T₇. The control treatment recorded the lowest K content in rice straw (1.32%). It was observed that the K content in rice straw was higher than that in rice grains. All the treatments recorded higher K content in rice grains over the treatments T₁ except the treatments T₂ and T₀. The residual effect was more pronounced in treatments receiving higher rates of MSW compost. (Table 2)

S content

The S content in rice grain ranged from 0.242% to 0.352%. The maximum S content in rice grain (0.352%) was found in the treatment T₈ (GM R_{mix}+ com₁₀) which was statistically identical to that of the treatment T₆ and T₇ with the values of (0.345%) and (0.350). The S content of rice grain recorded in the treatment T₄ and T₅ was statistically similar with values of 0.310% and 0.322%. The lowest value of S content in rice grain of 0.242% was observed in the control treatment. In straw, the S content ranged from 0.237 to 0.322%. The maximum S content in rice straw (0.322%) observed in the treatment was T₈ (GM R_{mix}+ com₁₀) which was statistically identical to that of the treatment T₇ with a value of (0.320%). The lowest S content in rice grain of 0.242% was observed in the control treatment. Again the treatments T₀, T₂, and T₃ exerted a statistically identical effect on the S content of rice straw. The residual effect was more pronounced in treatments receiving higher rates of MSW compost. (Table 2)

Residual effect MSW compost and green manures on the nutrient uptake by grain and straw of BINA Dhan-7

N uptake

The N uptake of rice grain ranged from 28.47 to 45.13 kg ha⁻¹ and that of rice straw from 14.60 to 27.47 kg ha⁻¹. The highest N uptake of grain (45.13 kg ha⁻¹) and straw (27.47 kg ha⁻¹) was obtained in the treatment T₈ (GM R_{mix}+ com₁₀) and the corresponding lowest values of 28.47 kg ha⁻¹ and 14.60 kg ha⁻¹, respectively were found in the control treatment (T₀). The total N uptake of rice grain and straw was also influenced significantly due to different treatments and ranged from 43.07 to 72.6 kg ha⁻¹. The highest total N uptake (72.6 kg ha⁻¹) was observed in the treatment T₈ (GM R_{mix}+ com₁₀) and the lowest value (43.07 kg ha⁻¹) was found in the control treatment (T₀). (Table 3)

P uptake

A significant variation in P uptake by BINA Dhan-7 was observed due to the various treatments (Table 5). The P uptake of rice grain ranged from 3.260 to 4.473 kg ha⁻¹ and that of rice straw from 1.060 to 2.490 kg ha⁻¹. The highest P uptake of rice grain (4.473 kg ha⁻¹) was obtained in treatment T₇ and that in straw (2.490 kg ha⁻¹) was obtained in treatment T₈. The corresponding lowest values of 3.260 kg ha⁻¹ and 1.060 kg ha⁻¹, respectively were found in the control treatment (T₀). The total P uptake by rice grain and straw was also influenced significantly by different treatments. The highest total P uptake (6.753 kg ha⁻¹) was observed in treatment T₈ (GM R_{mix}+ com₁₀) and the lowest value (4.32 kg ha⁻¹) was found in the control treatment (T₀). (Table 3)

K uptake

The K uptake of rice grain ranged from 3.13 to 5.57 kg ha⁻¹ and that of rice straw from 4.71 to 8.61 kg ha⁻¹. The highest K uptake by rice grain (5.57 kg ha⁻¹) and straw (8.61 kg ha⁻¹) was obtained in the treatment T₈ (GM R_{mix}+ com₁₀) and the lowest value in grain (3.13 kg ha⁻¹) and straw (4.71 kg ha⁻¹) was noted in the control treatment (T₀). The total K uptake of rice grain and straw was also influenced significantly by different treatments. The highest total K uptake (14.08 kg ha⁻¹) was observed in the treatment T₈ (GM R_{mix}+ com₁₀) and the lowest value (7.84 kg ha⁻¹) was found in the control treatment (T₀). (Table 4)

S uptake

The S uptake of rice grain ranged from 0.6320 to 1.204 kg ha⁻¹ and that of rice straw from 0.8650 to 1.670 kg ha⁻¹. The highest S uptake by rice grain (1.204 kg ha⁻¹) and straw (1.670 kg ha⁻¹) was obtained in the treatment T₈ (GM

$R_{\text{mix}+ \text{com}_{10}}$) and the lowest S uptake by grain ($0.6320 \text{ kg ha}^{-1}$) and straw ($0.8650 \text{ kg ha}^{-1}$) was found in the control treatment (T_0). The total S uptake by rice grain and straw was also influenced significantly by different treatments (Table 6). The highest total S uptake (2.874 kg ha^{-1}) was observed in the treatment T_8 ($\text{GM } R_{\text{mix}+ \text{com}_{10}}$) and the lowest value (1.497 kg ha^{-1}) was found in the control treatment (T_0). (Table 4)

DISCUSSION

The general recommendations that emerged from the present study were i) Application of both MSW compost and GM in the previous crop has considerable effects on the nutrient content of the soil, ii) Both MSW compost and GM increase the nutrient uptake of the present crop (BINA Dhan-7), iii) For both residual effects were more in treatments receiving compost at higher rates in the preceding crops. Composts release nutrients slowly, especially nitrogen. Organic matter from MSW compost was intensively mineralized, releasing a considerable amount of nitrogen. Most nitrogen remaining after completion of the composting process is bound into organic forms and not available for plant uptake immediately. Residual effects of compost application can maintain crop yield levels for several years after compost application ceases since only a fraction of the N and other nutrients in compost become plant available in the first year after application (Eghball *et al.*, 2004). The residual effects of organic materials can contribute to improvement in soil quality for several years after application ceases (Ginting *et al.* 2004). Organic wastes can have a long-term impact on crop productivity (Shehzadi *et al.* 2014). Repeated application of exogenous organic matter improves soil biological functions, increases soil organic carbon and nutrient content, improves soil aggregate stability, decreases the bulk density, and increases crop yield (Diacono and Montemurro, 2010). Repeated application of MSW compost consistently increases soil organic matter content and soil C: N ratio to levels greater than those of unamended soil (Crecchio *et al.* 2004; Montemurro *et al.* 2006; Walter *et al.* 2006). The C: N ratio of the soil depends on the nature of the composting material, compost maturity, rate of application of compost, and mineralization rate. Jackson *et al.* (2013) found no significant difference between 10 and 20 or 40 tons acre^{-1} of compost application in plant height in the 1st year indicating no advantage but observed a significant difference between 10 and 20 tons acre^{-1} in the 2nd year with plant height. Yield in both years was greater with increased compost applications but not significantly suggesting that compost has a residual effect on the soil and crop productivity. Additions of compost to soil have been shown to improve its physical and biological qualities. Becker

et al. (2010) showed that the bulk density and electro-conductivity of soil improved after compost amendments. Ros *et al.* (2006) found that long-term compost treatments have positive effects on the soil biota. They also found that microbial biomass carbon (C) and basal respiration were significantly increased for compost treatments. MSW compost could be useful to stabilize potentially toxic elements in sub-acidic contaminated soils and to increase the microbial activity and functionality in these latter soils (Garau *et al.* 2019). The residual crop yield benefits were only apparent when 10-20 tons of compost was applied in the previous year. Yield tended to increase as compost application rates increased. The benefits to the soil of adding organic matter as well as N with compost can increase longer-term soil productivity. Composts with high levels of available N tend to show more immediate plant response in terms of growth and yield, while compost with more N tied up in the organic fraction shows more carry-over growth response in subsequent seasons (Nweke *et al.* 2018). Recycling composted organic residues in agriculture can reduce the number of mineral fertilizers and improve the physicochemical and biological properties of cultivated soils (Cambier *et al.* 2014). The green manures inoculated with bacterial strain positively affect nutrient content in soil and the uptake of crops. The green manure crops with Zn fertilizers significant increase in mean Zn content in Basmati rice grain and straw in a two years study during both years (Singh *et al.*, 2019). The incorporation of pre-rice green manuring improves the soil's chemical properties and increases the grain yield of the succeeding wheat crops in a rice-wheat cropping system (Gautam *et al.* 2021). The application of MSW compost and green manure does not replace chemical fertilization but is used in association with fertilizers it in order to satisfy the necessity of crop nutrients.

CONCLUSIONS

Application of Municipal Solid Waste compost and incorporation of green manure exerted considerable residual effect on the nutrient content in soil and uptake in grain and straw of rice. The residual crop yield benefits through nutrient content and uptake from soil were only apparent when 10-20 tons of compost was applied in the previous year. Nutrient content in soil and uptake in rice increase as compost application rates increased. The benefits to the soil of adding organic matter as well as N with compost can increase longer-term soil productivity. Composts with high levels of available N tend to show more immediate plant response in terms of growth and yield, while compost with more N tied up in the organic fraction shows a mcarry-overover growth response in subsequent seasons. However the composition of MSW composts is important, it may contain some heavy metals also along with

nutrients. Further study on the effect of compost amendments on heavy metal concentration in soil should be needed.

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Table 1: Residual effect of MSW compost and green manures on the N and P content of grain and straw of BINA Dhan-7

Treatment	Nitrogen (%)		Phosphorus (%)	
	Grain	Straw	Grain	Straw

T ₀	1.09 ^e	0.40 ^e	0.109 ^f	0.029 ^g
T ₁	1.15 ^{de}	0.48 ^c	0.115 ^d	0.035 ^f
T ₂	1.18 ^{cd}	0.42 ^{de}	0.112 ^e	0.037 ^{ef}
T ₃	1.22 ^{bcd}	0.50 ^{bc}	0.121 ^b	0.041 ^{cd}
T ₄	1.19 ^{cd}	0.43 ^d	0.118 ^c	0.039 ^{de}
T ₅	1.25 ^{abc}	0.51 ^{ab}	0.121 ^b	0.044 ^{bc}
T ₆	1.30 ^{ab}	0.50 ^{bc}	0.130 ^a	0.044 ^{bc}
T ₇	1.24 ^{abc}	0.51 ^{ab}	0.132 ^a	0.045 ^b
T ₈	1.32 ^a	0.53 ^a	0.131 ^a	0.048 ^a
LSD _{0.05}	0.077	0.023	0.002	0.003
Level of significance	**	**	**	**
CV (%)	3.64	2.83	1.12	4.31

Figures in a column having common letters do not differ significantly at 5% level of significance. CV% = Coefficient of variation. LSD = Least Significant Difference

Table 2: Residual effect of MSW compost and green manures on the K and S content in grain and straw of BINA Dhan-7

Treatments	Potassium (%)		Sulphur (%)	
	Grain	Straw	Grain	Straw
T ₀	0.120 ^e	1.29 ^e	0.242 ^e	0.237 ^e
T ₁	0.130 ^d	1.40 ^d	0.255 ^e	0.243 ^e
T ₂	0.120 ^e	1.33 ^{de}	0.287 ^d	0.248 ^e
T ₃	0.150 ^b	1.55 ^{bc}	0.301 ^c	0.266 ^d
T ₄	0.140 ^c	1.50 ^c	0.310 ^{bc}	0.288 ^c
T ₅	0.161 ^a	1.58 ^{abc}	0.322 ^b	0.303 ^b
T ₆	0.150 ^b	1.60 ^{ab}	0.345 ^a	0.311 ^{ab}
T ₇	0.150 ^b	1.62 ^{ab}	0.350 ^a	0.320 ^a
T ₈	0.160 ^a	1.66 ^a	0.352 ^a	0.322 ^a
LSD	0.009	0.086	0.016	0.014
Level of significance	**	**	**	**
CV (%)	3.61	3.30	2.99	2.82

Figures in a column having common letters do not differ significantly at 5% level of significance. CV% = Coefficient of variation. LSD = Least Significant Difference

Table 3: Residual effect of MSW compost and green manures on the N and P uptake by grain and straw of BINA Dhan-7

Treatments	N uptake (kg ha ⁻¹)	P uptake (kg ha ⁻¹)
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	Grain	Straw	Grain	Straw
T ₀	28.47 ^e	14.60 ^f	3.260 ^c	1.060 ^e
T ₁	34.40 ^d	19.00 ^d	3.503 ^{bc}	1.383 ^{de}
T ₂	36.60 ^{cd}	17.07 ^e	3.477 ^{bc}	1.503 ^{cde}
T ₃	37.37 ^{cd}	20.97 ^c	3.703 ^{bc}	1.717 ^{bcd}
T ₄	37.70 ^c	17.20 ^e	3.740 ^{bc}	1.560 ^{cde}
T ₅	41.43 ^b	24.50 ^b	4.013 ^{ab}	2.017 ^{abc}
T ₆	44.27 ^{ab}	24.87 ^b	4.423 ^a	2.190 ^{ab}
T ₇	42.00 ^b	25.87 ^b	4.473 ^a	2.280 ^{ab}
T ₈	45.13 ^a	27.47 ^a	3.980 ^{ab}	2.490 ^a
LSD _{0.05}	0.289	0.134	0.054	0.054
Level of significance	**	**	**	**
CV (%)	4.32	3.73	8.85	19.11

Figures in a column having common letters do not differ significantly at 5% level of significance. CV% = Coefficient of variation. LSD = Least Significant Difference

Table 4: Residual effect of MSW compost and green manures on the K and S uptake by grain and straw of Binadhan7

Treatments	K uptake (kg ha ⁻¹)		S uptake (kg ha ⁻¹)	
	Grain	Straw	Grain	Straw
T ₀	3.13 ^f	4.71 ^e	0.6320 ^e	0.8650 ^f
T ₁	3.88 ^{def}	5.54 ^d	0.7623 ^{de}	0.9617 ^{ef}
T ₂	3.72 ^{ef}	5.40 ^d	0.8893 ^{cd}	1.007 ^{de}
T ₃	4.59 ^{bcd}	6.49 ^c	0.9313 ^{bc}	1.114 ^{cd}
T ₄	4.43 ^{cde}	5.98 ^{cd}	0.9827 ^{bc}	1.149 ^c
T ₅	5.30 ^{ab}	7.58 ^b	1.068 ^{ab}	1.454 ^b
T ₆	5.10 ^{abc}	7.95 ^{ab}	1.174 ^a	1.546 ^{ab}

T ₇	5.08 ^{abc}	8.21 ^{ab}	1.186 ^a	1.622 ^a
T ₈	5.47 ^a	8.61 ^a	1.204 ^a	1.670 ^a
LSD _{0.05}	0.077	0.683	0.134	0.122
Level of significance	**	**	**	**
CV (%)	9.03	5.87	7.82	5.39

Figures in a column having common letters do not differ significantly at 5% level of significance. CV% = Coefficient of variation, SE (\pm) = Standard error of means, LSD = Least Significant Difference

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