Postharvest soil fertility status of rice (Hybrid Dhan Hira 2) as influenced by vermicompost, pressmud and urea

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Abstract- A field experiment was conducted in Sher-e-Bangla Agricultural University Farm, Dhaka, Bangladesh during December, 2011 to April, 2012 to study the effect of integrated use of vermicompost, pressmud and urea on soil fertility status after harvest of rice (Hybrid Dhan Hira 2). Ten treatments coded from T_1 to T_{10} were used in this experiment. The highest amount of organic matter (1.67 %) were observed in T_9 treatment receiving 120 kg N/ha from vermicompost. The highest amount of total nitrogen (0.070 %), were observed in T_3 treatment receiving 90 kg N/ha from urea along with 30 kg N/ha from vermicompost. The highest amount of available phosphorus (11.71 ppm) and available sulfur (11.46 ppm) in postharvest soil were recorded in treatment T_2 receiving 120 kg N/ha from urea. The highest amount of available potassium (21.85 ppm) were observed in T_5 treatment receiving 60 kg N/ha from urea along with 60 kg N/ha from vermicompost. On the other hand the lowest values of these parameters were obtained from control treatment T_1.

Index Terms- Oryz*a sativa*, postharvest soil, pressmud and vermicompost.

I. INTRODUCTION

Considering the rapid growth of world population, improving crop productivity and resource use efficiency is highly required to ensure food security and environmental quality. The most appropriate way to reach this goal is to increase yield per unit area rather than by expansion of the cultivated area into natural resources. In this respect, evaluating soil fertility and productivity in order to increase production of any agricultural product can be a fundamental process. Determining the degree of soil productivity is highly important to evaluate soil fertility. Some of the elements such as nitrogen (N), phosphorus (P) and potassium (K) are more focused in Bangladesh in order to evaluate soil fertility because of plant urgent need and common deficiency of these elements in most Bangladeshi soils. Rice (*Oryza sativa* L.) occupies a pride place among the food crops cultivated in Bangladesh which has the largest area among rice growing countries and stands fourth in the production. The increase in rice production to feed a growing world population will require a threefold increase in applied N at present levels of N fertilizer use efficiency (Cassman and Harwood, 1995). It is therefore important to increase fertilizer N recovery and internal N utilization efficiency (NUE) in rice production systems through cultivar improvement and better crop and soil management (Ying et al., 1998). The nitrogen effect is manifested quickly on plant growth and ultimately on yields. Hence the fertility status of a soil depends largely on the nitrogen status of the soil (Sinha and Prasad, 1980). Intensive agriculture, involving exhaustive high yielding varieties of rice and other crops, has led to heavy withdrawal of nutrients from the soil; imbalanced and discriminate use of chemical fertilizers has resulted in deterioration of soil health (John et al., 2001). Nitrogen is commonly the most limiting nutrient for crop production in the major world's agricultural areas and therefore, adoption of good N management strategies often results in large economic benefits to farmers. Use of organic manures in present agriculture is increasing day by day, because of its utility not only improving the physical, chemical and biological properties of soil but also maintaining the good soil health. So, it is time to look for measures to stimulate sustainability in production of rice on long- term basis. A suitable combination of organic and inorganic sources of nutrients is necessary for sustainable agriculture that can ensure food production with high quality. Nambiar (1991) stated that integrated use of organic manure and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining better soil fertility. The use of vermicompost increases crop yield and lesses dependence on chemical fertilizers (Adorado *et al*., 2003). Pressmud from sugar mill is another enriched source of organic matter and contains substantial quantities of nutrients for improving physical conditions and improvement of soil fertility (Nisar, 2000). It also contains sulfur, which helps to acidify the soil. This acidification makes soluble calcium available and thus improves soil structure and decreases the leaching of salts. Under the scenario, balanced fertilization and complementary use of inorganic fertilizers with vermicompost and pressmud will go a long way in both improving the yield as well as improving the soil fertility. Hence, the experiment was conducted to study the soil fertility status after harvest of rice (Hybrid Dhan Hira 2) as influenced by vermicompost, pressmud and urea.

II. MATERIALS AND METHODS

Experimental soil: The soil of the experiment field was silty clay loam. The morphological, physical and chemical characteristics of the soil are shown in the Table 1 and 2.

Table 1. Morphological characteristics of the experimental field

Morphology	Characteristics
Agro-ecological zone	Madhupur Tract (AEZ- 28)
General Soil Type	Deep Red Brown Terrace Soil
Parent material	Madhupur Clay
Topography	Fairly level
Drainage	Well drained
Flood level	Above flood level

(FAO and UNDP, 1988)

Table 2. Initial physical and chemical characteristics of the soil

Characteristics	Value
Mechanical fractions: % Sand (2.0-0.05 mm) % Silt (0.05-0.002 mm) % Clay (<0.002 mm)	 29.04 41.80 29.16
Textural class	Silty Clay Loam
pH (1: 2.5 soil- water)	5.8
Organic Matter (%)	1.09
Total N (%)	0.04
Available K (ppm)	15.62
Available P (ppm)	9.88
Available S (ppm)	8.06

Experimental design and treatment: The experiment was laid out in a Randomized Completely Block Design (RCBD) with three replications. The total number of plots was 30, measuring 3 m × 3 m and ailes separated plots from each other. The distance maintained between two main plots is 1.0 m. The experiment consists of 10 treatments each with three replications were:**T_1**: No chemical fertilizer and no manures (Control), **T_2:**120 kg N/ha from urea, **T_3:** 90 kg N/ha from urea+ 30 kg N/ha from vermicompost (VC), **T_4**: 90 kg N/ha from urea+ 30 kg N/ha from pressmud, **T_5:** 60 kg N/ha from urea+ 60 kg N/ha from vermicompost (VC), **T_6:** 60 kg N/ha from urea+ 60 kg N/ha from pressmud, **T_7**: 30 kg N/ha from urea +90 kg N/ha from vermicompost (VC), **T_8:** 30 kg N/ha from urea+ 90 kg N/ha from pressmud,**T_9:** 120 kg N/ha from vermicompost (VC), and **T_{10}**: 120 kg N/ha from pressmud.

Planting material: Hybrid Dhan Hira 2 was used as the test rice variety in this experiment. This variety was imported from China. It is recommended for Boro season. Average plant height of the variety is 90-95 cm at the ripening stage. The grains are medium fine and white. It requires about 140-145 days completing its life cycle with an average grain yield of 8.0-9.0 t/ha (BRRI, 2006).

Fertilizer application and Organic manure incorporation: The amounts of N, P, K, S and Zn fertilizers required per plot were calculated as per the treatments. Two different types of organic manure viz. pressmud and vermicompost were applied according to treatments. Chemical compositions of the manures used have been presented in Table 3.

Table 3. Chemical compositions of the vermicompost and pressmud (oven dry basis)

Sources of organic manure	Nutrient content			
	N (%)	P (%)	K (%)	S (%)
Vermicompost	2.1	0.29	0.74	0.24
Pressmud	1.24	0.77	2.8	0.29

Crop harvest and data collection: The crop was harvested at full maturity when 80-90% of the grains were turned into straw colored.

Soil analysis: After harvest of crop soil samples were collected from each plot at a depth of 0 to 15 cm for analysis of both physical and chemical characteristics viz. organic matter, pH, total N and available P, K, and S contents.

Determination of nitrogen (N): Total N content of soil was determined followed by the Micro Kjeldahl method.

Available phosphorus: Available P was extracted from the soil with 0.5 M $NaHCO_3$ solutions, pH 8.5 (Olsen *et al.*, 1954).

Phosphorus in the extract was then determined by developing blue color with reduction of phosphomolybdate complex and the color intensity were measured colorimetrically at 660 nm wavelength and readings were calibrated the standard P curve (Page *et al*., 1982).

Exchangeable potassium: Exchangeable K was determined by 1N NH_4OAc (pH 7) extraction methods and by using flame photometer and calibrated with a standard curve Page *et al*.,(1982).

Available sulphur: Available S content was determined by extracting the soil with $CaCl_2$ (0.15%) solution as described by Page *et al*. (1982). The extractable S was determined by developing turbidity by adding acid seed solution (20 ppm S as K_2SO_4 in 6N HCl) and $BaCl_2$ crystals. The intensity of turbidity was measured by spectrophotometer at 420 nm wavelengths.

Statistical analysis: The data of different parameters were statistically analyzed to find out the significant difference of different treatments on soil fertility status of Hybrid Dhan Hira 2. The mean values of all the characters were statistically analyzed by following the analysis of variance (ANOVA) technique and using the MSTAT-C computer package program. The mean differences among the treatments were compared by least significant difference (LSD) test at 5% level of significance.

RESULTS AND DISCUSSION

Effect on pH of post- harvest soil: There was an insignificant effect of the different levels of treatments on soil pH of post-harvest soil of research field (Table 4). Whether, treatment T_2 showed the highest pH (6.0) and T_1 showed the lowest pH (5.3) in post-harvest soil.

Effect on organic matter (%): The level of organic matter in post-harvest soil increased due to combined application of vermicompost and pressmud with the combination of chemical nitrogenous fertilizer (Table 4). The maximum organic matter of post-harvest soil (1.67 %) was recorded from T_9 treatment receiving 120 kg N/ha from vermicompost. The lowest organic matter (1.01%) of post-harvest soil was recorded in control (T_1) treatment. Xu *et al.* (2008) reported that application of chemical fertilizer with organic manure increase soil organic matter.

Effect on total nitrogen of post harvest soil: The combined effect of different levels of vermicompost and pressmud with the association of chemical nitrogen fertilizer on total nitrogen of post harvest soil was significant (Table 4).The highest total nitrogen of post harvest soil (0.07%) was recorded in T_3 treatment receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost. The lowest total nitrogen of post harvest soil (0.035%) was recorded in control (T_1) treatment. Treatment T_3 gave 100 % higher total nitrogen (%) of post harvest soil over control treatment of hybrid dhan Hira 2 (Figure. 1).

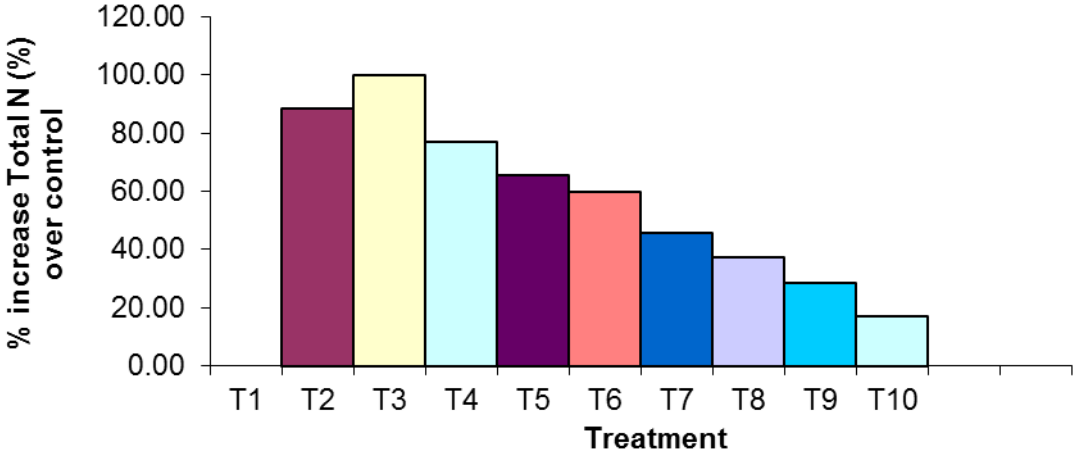

Figure 1. Effect of integrated use of vermicompost, pressmud and urea on percent increase of total N (%)

Effect on available phosphorus of post harvest soil: A significant difference in available phosphorus content of post harvest soil was observed at different levels of vermicompost and pressmud along with chemical nitrogenous fertilizer as the source of urea (Table 4). The highest available P (11.71ppm) in post harvest soil was recorded in T_2 treatment receiving 120 kg N/ha from urea which was statistically similar with T_3 and the lowest available P (9.97 ppm) in post harvest soil was noted in control (T_1) treatment. Treatment T_2 gave17.45 % higher available phosphorus of post harvest soil over control treatment of hybrid dhan Hira 2 (Figure. 2).

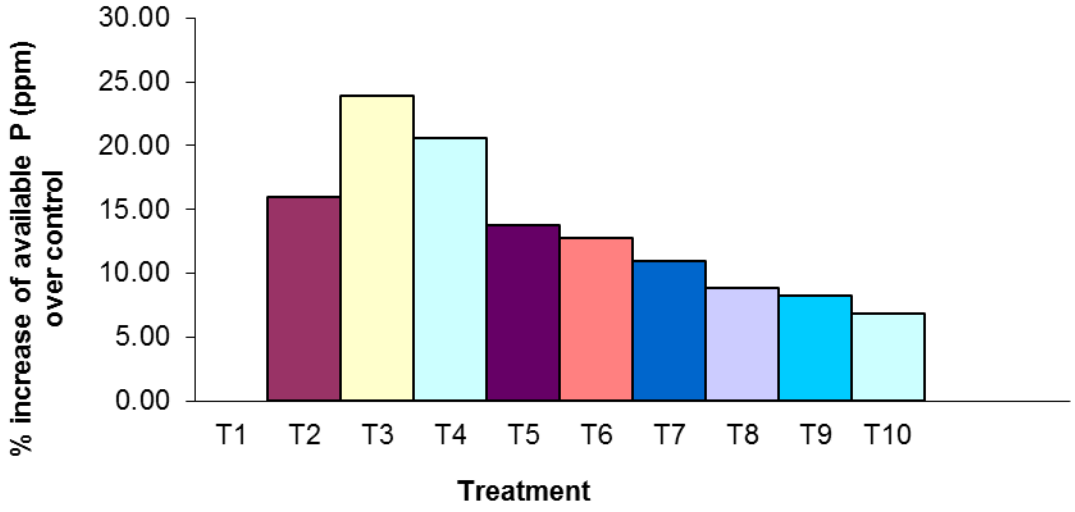

Figure 2. Effect of integrated use of vermicompost, pressmud and urea on percent increase of available P (ppm)

Effect on available potassium of post harvest soil: The maximum exchangeable potassium of post harvest soil (21.85 ppm) was found in treatment T_5 receiving 60 kg N/ha as the source of urea along with 60 kg N/ha from vermicompost (Table 4.9). The lowest exchangeable potassium content (10.45 ppm) in post harvest was found in control (T_1) treatment. Treatment T_5 gave 109.09 % higher available phosphorus of post harvest soil over control treatment of hybrid dhan Hira 2 (Figure. 3).

Effect on available sulfur content in post harvest soil: Available sulfur in post harvest soil showed statistically significant differences due to the application of different levels of vermicompost and pressmud along with chemical fertilizer urea as the source of nitrogen (Table 4). The highest available sulfur in post harvest soil (11.46 ppm) was recorded from T_1 receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost. On the other hand, the lowest available sulfur in post harvest soil (9.25 ppm) was obtained from T_1 (control) treatment. Treatment T_3 treatment gave 23.89 % increased available sulfur in post harvest soil over control treatment of hybrid dhan Hira 2 (Figure 3).

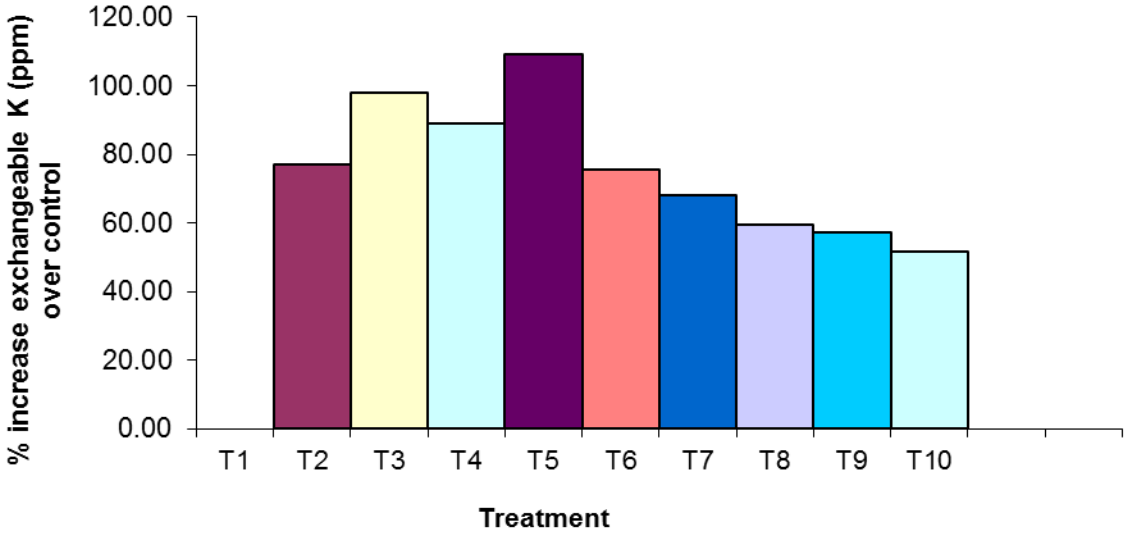

Figure 3. Effect of integrated use of vermicompost, pressmud and urea on percent increase of exchangeable K (ppm)

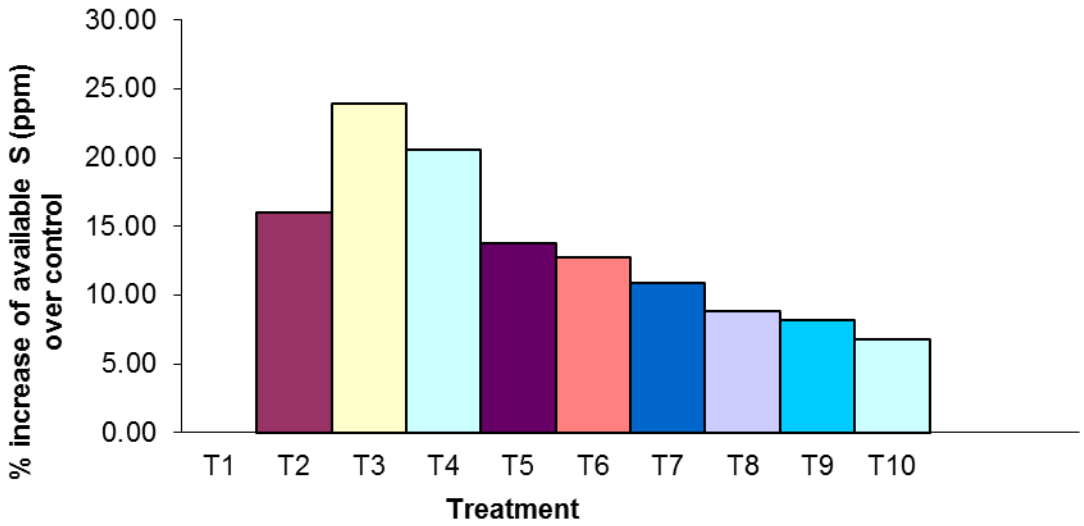

Figure 4. Effect of integrated use of vermicompost, pressmud and urea on percent increase of available S (ppm) of postharvest soil

Table 4. Effect of integrated use of vermicompost, pressmud and urea on the pH, organic carbon and NPK content in post harvest soil of rice (Hybrid Dhan Hira 2)

Treatment	pH	Organic matter (%)	Total N (%)	Available P (ppm)	Available K (ppm)	Available S (ppm)
T_1	5.3	1.01 j	0.035 e	9.97i	10.45 j	9.25 i
T_2	6.0	1.07 i	0.066 ab	11.71 a	18.51 d	11.46 a
T_3	5.8	1.12 g	0.070 a	11.67 a	20.67 b	10.73 c
T_4	5.7	1.09 h	0.062 abc	11.58 b	19.74 c	11.15 b
T_5	5.8	1.25 e	0.058 abcd	11.52 c	21.85 a	10.52 d
T_6	5.7	1.18 f	0.056 abcd	11.42 d	18.34 e	10.43 e
T_7	5.5	1.47 c	0.051 bcde	11.33 e	17.56 f	10.26 f
T_8	5.6	1.40 d	0.048 cde	11.26 f	16.65 g	10.07 g
T_9	5.4	1.67 a	0.045 de	10.90 g	16.45 h	10.01 g
T_{10}	5.5	1.61 b	0.041 de	10.78 h	15.85 i	9.88 h
LSD	0.153	0.017	0.017	0.054	0.076	0.054
CV (%)	1.43	1.63	3.00	0.27	0.23	0.30

Means in a column followed by same letter (s) are not significantly different at 5% level of significance by LSD

III. CONCLUSION

Soil fertility statuses of rice (Hybrid Dhan Hira 2) were statistically significant by different treatments. The highest amount of available phosphorus & sulfur in postharvest soil were recorded from T_2 treatment. The highest amount of total nitrogen was recorded in treatment T_3. The highest amount of organic matter was observed in T_9 treatment. On the other hand the lowest values of these parameters were obtained from T_1.

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