Effect of integrated use of vermicompost, pressmud and urea on the nutrient content of grain and straw of rice (Hybrid Dhan Hira 2)

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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 assess the effect of integrated use of vermicompost, pressmud and urea on the nutrient status of grain and straw of rice (Hybrid Dhan Hira 2). Ten treatments coded from T_1 to T_{10} were used in this experiment. The highest amount of nitrogen (1.092%), phosphorus (0.297 %), potassium (0.374 %) in grain and the highest amount of potassium (1.213%), sulfur (0.091%) in straw were observed in T_3 treatment receiving 90 kg N/ha from urea along with 30 kg N/ha from vermicompost. The highest sulfur (0.124 %) content in grain and the highest nitrogen (0.742%), the highest phosphorus (0.182 %) in straw was recorded in treatment T_2 receiving 120 kg N/ha from urea. The highest amount of nitrogen (93.81 kg/ha), phosphorus (26.07 kg/ha), potassium (32.82 kg/ha) and sulfur (10.79 kg/ha) uptake by grains and the highest amount of nitrogen (55.70 kg/ha), phosphorus (13.79 kg/ha), potassium (92.43 kg/ha) and sulfur (6.91 kg/ha) uptake by straw of rice were observed in T_3 treatment. On the other hand the lowest values of these parameters were obtained from control treatment T_1.

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

I. INTRODUCTION

Rice (Oryz*a sativa*) is the staple food of Bangladesh. More than 50% of the world population depends on rice as their staple food. Rice is intensively cultivated in Bangladesh covering about 80% of arable land. Unfortunately, the yield of rice is low considering the other rice growing countries like South Korea and Japan where the average yield is 7.00 and 6.22 t/ha, respectively (FAO, 1999). On the other hand, the demand for increasing rice production is mounting up to feed the ever-increasing population of the world. The rice-rice system is the most important cropping system in Bangladesh. Continuous cultivation of this highly exhaustive cropping sequence in most of the irrigated fertile lands has resulted in the decline of soil fertility in general and soil organic carbon (SOC) content in particular. This has led to a reduction in the total factor productivity and raised questions on the sustainability of this cropping system. Spiraling polices of chemical fertilizers, coupled with perceived deterioration of environment have led to a renewed interest in reliance on renewable organic materials including vermicompost and pressmud as sources of nutrients. 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. Depleted soil fertility is a major constrain to higher crop production in Bangladesh. The increasing land use intensity has resulted in a great exhaustion of nutrient in soils. The farmers of this country use on an average 102 kg nutrients/ha annually (70 kg N + 24 kg P + 6 kg K + 2 kg S and Zn) while the crop removal is about 200 kg/ha (Islam *et al*., 1994). In Bangladesh, most of the cultivated soils have less than 1.5% organic matter while a good soil should contain at least 2% organic matter. Grain yield and nutrient uptake of rice increased significantly with the application of vermicompost and inorganic fertilizer in a rate of 15 kg N/ha from vermicompost supplemented with 45-13-25 kg NPK/ha with a yield of 4.06 and 5.31 ton/ha (Banik and Bejbaruah, 1996). 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 quality. Considering the present situation the present study was undertaken to study the effect of integrated use of vermicompost, pressmud and urea on the nutrient content of Hybrid Dhan Hira 2.

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 (meq/100g soil)	0.14
Available P (mg/kg)	16.5
Available S (mg/kg)	14.4

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

Transplanting: Thirty two days old seedlings of Hybrid Dhan Hira 2 were carefully uprooted from the seedling nursery and transplanted in well puddled plot. Two seedlings per hill were used following a spacing of 15 cm × 20 cm.

Crop harvest and data collection: The crop was harvested at full maturity when 80-90% of the grains were turned into straw colored. Ten hills of rice plant were selected randomly for measuring the yield and nutrient content.

Collection and preparation of plant samples for chemical analysis: Grain and straw samples were collected after threshing for N, P, K and S analysis. The plant samples were dried in an oven at 70^0C for 72 hours and then ground by a grinding machine (wiley-mill) to pass through a 20-mesh sieve.

Determination of nitrogen (N): Nitrogen content of grain and straw were determined followed by the Micro Kjeldahl method.

Digestion of plant samples with nitric-perchloric acid for P, K and S: A sub sample weighing 0.5 g was transferred into a dry, clean 100 ml digestion vessel. Ten ml of di-acid (HNO_3: $HClO_4$ in the ratio 2:1) mixture was added to the flask. After leaving for a while, the flasks were heated at a temperature slowly raised to 200^0C. Heating were stopped when the dense white fumes of $HClO_4$ occurred. The content of the flask were boiled until they were became clean and colorless. After cooling, the content was taken into a 50 ml volumetric flask and the volume was made up to the mark with de-ionized water. P, K and S were determined from this digest by using different standard methods.

Determination of P, K and S from plant samples: Plant samples (grain and straw) were digested by di-acid (Nitric acid and Perchloric acid) mixture and Phosphorus content in the digest was measured by blue color development (Olsen *et al.*, 1954) method. The content of Potassium was estimated by Perchloric acid digestion method as proposed by Yamakawa (1992). Sulfur content was determined from the digest of the plant samples (grain and straw) with $CaCl_2$ (0.15%) solution as described by Page *et al*. (1982).

Nutrient uptake: After chemical analysis of straw and grain samples the nutrient contents were calculated and from the value of nutrient contents, nutrient uptakes were also calculated by following formula: Nutrient uptake (Kg/ha) = Nutrient content (%) × Yield (kg/ha)/100

Statistical analysis: The data of different parameters were statistically analyzed to find out the significant difference of different treatments on nutrient 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.

III. RESULTS AND DISCUSSION

Effect on nitrogen, phosphorus, potassium and sulfur content in grain: There was significant difference among the treatments in recording nitrogen, phosphorus, potassium and sulfur content in grain (Table 4). The maximum nitrogen content in grain (1.092%) was noted in the treatment T_3 receiving 90 kg N/ha from the source of urea along with 30 kg N/ha from vermicompost. The lowest nitrogen content in grain (0.542%) was found in control treatment (T_1). Jeong *et al*. (1996) found that 5 t/ha application of fermented chicken manure increased nitrogen concentration in rice plant. The phosphorus content in grain varied from 0.209 to 0.297 %. The highest phosphorus content (0.297 %) in grain was found in treatment T_3 which was statistically similar to T_2. The lowest phosphorus content in grain 0.209 % was found in control (T_1) treatment. The maximum potassium content in grain (0.374 %) was recorded in treatment T_3 receiving 90 kg N/ha from the source of urea along with 30 kg N/ha from vermicompost which was statistically identical to T_2 and T_4. The lowest potassium content in grain (0.247 %) was noted in control (T_1) treatment. Kadu *et al*. (1991) obtained highest potassium content in rice grain due to the application of highest doses of NPK with the association of farmyard manure. The maximum sulfur content in grain (0.124 %) was recorded in treatment T_2 receiving 120 kg N/ha from urea which was statistically similar to T_3, T_4 and T_5. The lowest sulfur content in grain (0.069 %) was noted in control (T_1) treatment.

Table 4. Effect of integrated use of vermicompost, pressmud and urea on nitrogen, phosphorus, potassium and sulfur content of grain of Hybrid Dhan Hira 2.

Treatment	Nitrogen content (%)	Phosphorus content (%)	Potassium content (%)	Sulfur content (%)
T_1	0.542 i	0.209 f	0.247 g	0.069 d
T_2	1.054 b	0.285 ab	0.368 ab	0.124 a
T_3	1.092 a	0.297 a	0.374 a	0.123 a
T_4	0.976 c	0.279 b	0.361 abc	0.118 a
T_5	0.902 d	0.261 c	0.352 bcd	0.112 a
T_6	0.821 e	0.258 cd	0.347 cd	0.108 ab
T_7	0.785 f	0.250 cde	0.341 de	0.093 bc
T_8	0.713 g	0.243 de	0.336 def	0.087 c
T_9	0.682 h	0.241 de	0.325 ef	0.084 cd
T_{10}	0.675 h	0.238 e	0.321 f	0.079 cd
LSD	0.017	0.017	0.017	0.017
CV (%)	1.02	0.47	0.80	3.18

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

Effect on nitrogen, phosphorus, potassium and sulfur content in straw: Nitrogen, phosphorus, potassium and sulfur content in straw were statistically significant due to the application of different levels of vermicompost and pressmud along with urea (Table 5). Nitrogen content in straw varied from 0.405 % to 0.742 %.The maximum nitrogen content in straw (0.742%) was found in the

treatment T_2 receiving120 kg N/ha from urea, which was statistically similar to T_3. The lowest nitrogen content in straw (0.405 %) was found in the control (T_1) treatment. Jeong *et al*. (1996) found that 5 t/ha fermented chicken manure increased nitrogen concentration in rice plant. The highest phosphorus content (0.182 %) in straw was found in treatment T_2 receiving 120 kg N/ha from urea, which was statistically similar to T_3, T_4 and T_5. The lowest phosphorus content (0.095%) in straw was found in the control (T_1) treatment. The highest potassium content in straw (1.213%) was found in treatment T_3 receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost. The lowest potassium content in straw (0.957 %) was noted in control (T_1) treatment. The maximum sulfur content in straw (0.091%) was recorded in treatment T_3 receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost. The lowest sulfur content in straw (0.048%) was noted in control (T_1) treatment.

Table 5. Effect of integrated use of vermicompost, pressmud and urea on nitrogen, phosphorus, potassium and sulfur content of straw of Hybrid Dhan Hira 2.

Treatment	Nitrogen content (%)	Phosphorus content (%)	Potassium content (%)	Sulfur content (%)
T_1	0.405g	0.095f	0.957i	0.048 d
T_2	0.742a	0.182a	1.202ab	0.084 ab
T_3	0.731a	0.181ab	1.213 a	0.091 a
T_4	0.704b	0.174abc	1.192 bc	0.081 ab
T_5	0.683c	0.171abcd	1.183cd	0.072bc
T_6	0.675c	0.164bcde	1.173de	0.068bc
T_7	0.637d	0.161cde	1.160 e	0.063cd
T_8	0.615e	0.159cde	1.127f	0.060cd
T_9	0.592f	0.156de	1.081 g	0.058cd
T_{10}	0.582f	0.153e	1.012 h	0.057cd
LSD	0.017	0.017	0.017	0.017
CV (%)	0.37	1.93	0.38	2.43

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

Effect on nitrogen, phosphorus, potassium and sulfur uptake by grain: Nitrogen, phosphorus, potassium and sulfur uptake by grains were significantly influenced by the application of different levels of vermicompost and pressmud along with chemical nitrogenous fertilizer (Table 6).The uptake of nitrogen by grain were ranged from 25 to 93.81 kg/ha. The highest nitrogen uptake by grains (93.81 kg/ha) of rice was observed in T_3 treatment receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost which was statistically superior to the rest of the treatments. The lowest nitrogen uptake by grain (25 kg/ha) was found in control (T_1). Azim (1999) carried out experiments with organic manures and fertilizers and found significantly higher N uptake in grain over control. The maximum phosphorus uptake (26.07 kg/ha) was noted in the treatment T_3 receiving 90 kg N/ha from the source urea along with 30 kg N/ha from Vermicompost, which was statistically superior to the rest of the treatments. The lowest phosphorus uptake (9.64 kg/ha) by grain was found in control treatment (T_1). Gupta *et al*. (1995) reported the highest phosphorus uptake by rice with combined application of poultry manure (PM) and fertilizer phosphorus. The maximum potassium uptake by grain (32.82 kg/ha) was found by T_3 treatment. The lowest potassium uptake by grain (11.40 kg/ha) was found in control (T_1) treatment. Cassman (1995) found that potassium uptake increased with the increasing organic matter. These results are in good agreement with Jeegadeeswari *et al*. (2001) who reported increased potassium uptake in rice grain due to the application of cowdung along with NPK fertilizers. The maximum sulfur uptake (10.79 kg/ha) was noted in the treatment T_3 receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost which was statistically superior to the rest of the treatments. The lowest sulfur uptake (3.17 kg/ha) by grain was found in control treatment (T_1).

Table 6. Effect of integrated use of vermicompost, pressmud and urea on nitrogen, phosphorus, potassium and sulfur uptake by grain of Hybrid Dhan Hira 2.

Treatment	Nitrogen uptake by grain (kg/ha)	Phosphorus uptake by grain (kg/ha)	Potassium uptake by grain (kg/ha)	Sulfur uptake by grain (kg/ha)
T_1	25.00i	9.64 j	11.40 j	3.17 j
T_2	84.56 b	22.87 b	29.52 b	9.95 b
T_3	93.81 a	26.07 a	32.82 a	10.79 a
T_4	78.38 c	22.40 c	28.96 c	9.47 c
T_5	69.18 d	20.02 d	27.00 d	8.59 d
T_6	59.03 e	18.55 e	24.92e	7.77 e
T_7	55.34 f	17.62 f	24.04 f	6.56 f
T_8	49.70 g	16.96 g	23.42 g	6.06 g

T_9	45.92 h	16.23 h	21.88 h	5.66 h
T_{10}	44.14 h	15.57 i	20.99 i	5.17 i
LSD	2.350	0.237	0.359	0.406
CV (%)	2.26	0.74	0.85	3.24

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

Effect on nitrogen, phosphorus, potassium and sulfur uptake by straw: Effects of vermicompost, pressmud along with urea on nitrogen, phosphorus, potassium and sulfur uptake by straw were statistically significant (Table 7). The maximum nitrogen uptake (55.70 kg/ha) was noted in treatment T_3 receiving 90 kg N/ha from the source urea along with 30 kg N/ha from Vermicompost which was statistically superior to the rest of the treatments. The lowest nitrogen uptake by straw (18.29 kg/ha) was noted in control treatment (T_1). Treatment T_3 recorded the maximum phosphorus uptake (13.79 kg/ha). The minimum phosphorus uptake by straw (4.29 kg/ha) was found in control (T_1) treatment. The maximum potassium uptake (92.43 kg/ha) by straw was found in T_3 treatment receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost which was statistically superior to the rest of the treatments. Control (T_1) treatment produced the minimum potassium uptake (43.22 kg/ha). Jeegadeeswari *et al*. (2001) also observed that the potassium uptake by rice was increased by the application of organic manure with nitrogen, phosphorus and potassium. The maximum sulfur uptake by straw (6.91 kg/ha) was noted in the treatment T_3 receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost which was statistically superior to the rest of the treatments. The lowest sulphur uptake (2.17 kg/ha) by straw was found in control treatment (T_1).

Table 7. Effect of integrated use of vermicompost, pressmud and urea on nitrogen, phosphorus, potassium and sulfur uptake by straw of Hybrid Dhan Hira 2.

	Nitrogen uptake by straw (kg/ha)	Phosphorus uptake by straw (kg/ha)	Potassium uptake by straw (kg/ha)	Sulfur uptake by straw (kg/ha)
T_1	18.29 j	4.29 i	43.22 j	2.17 i
T_2	53.27 b	13.06 b	86.30 b	6.03 b
T_3	55.70 a	13.79 a	92.43 a	6.91 a
T_4	50.40 c	12.46 c	85.35 c	5.80 c
T_5	45.97 d	11.51 d	79.62 d	4.84 d
T_6	42.19 e	10.25e	73.29 e	4.25 e
T_7	39.11 f	9.86 f	71.22 f	3.87 f
T_8	37.02 g	9.57 fg	67.86 g	3.61 g
T_9	35.38 h	9.32 g	64.61 h	3.47 gh
T_{10}	34.16 i	8.98 h	59.40 i	3.34 h
LSD	0.431	0.297	0.736	0.188
CV (%)	0.61	1.68	0.59	2.52

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

IV. CONCLUSION

Nutrient statuses of rice (Hybrid Dhan Hira 2) were statistically significant by different treatments. The highest amount of nitrogen, phosphorus, potassium in grain and the highest potassium & sulfur in straw were recorded from T_3 treatment. The highest sulfur content in grain and the highest nitrogen, the highest phosphorus in straw were recorded in treatment T_2. The highest amount of nitrogen, phosphorus, potassium, sulfur uptake by grains and straw of rice were observed in T_3 treatment receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost. On the other hand the lowest values of these parameters were obtained from T_1.

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