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Effect of different residues based vermicompost with chemical fertilizer on the growth and yield of *T. aman* rice

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ABSTRACT

A field experiment was conducted to reduce the chemical fertilizers with the integrated use of vermicompost and chemical fertilizers in *T. aman* rice cultivation. The research was conducted at the Soil Science Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during the *T. aman* season of 2019-20 at BINA farm Mymensingh. Six treatments were used in the experiment. These were T_1: Native soil fertility, T_2: 100% N from Chemical Fertilizer (CF), T_3:70%N from CF, T_4: 30% N from vermicompost-3 + 70% N from CF and T_5:30% N from vermicompost-4 + 70% N from CF and T_6: 100% PKS only. The experiments were conducted in a Randomized Complete Block Design with three replications. The test crop was *T. aman* rice (Binadhan-17). The treatment T_5 gave maximum grain yield (5.5 t ha^{-1}) of *T. aman* rice followed by 5.4 t ha^{-1} that did by the treatment T_4. But the treatments T_5, T_4 and T_2 gave identical grain yields of *T. aman* rice. Similar results were observed in case of straw yields of *T. aman* rice. The maximum total N, P, K and S uptake were also noted with the treatment T_5 (30% N from vermicompost-4 + 70% N from CF) followed by the treatment T_4 (30% N from vermicompost-3 + 70% N from CF) which were comparable with the treatment T_2 (100% chemical fertilizer). The result indicated that 30% N from either vermicompost-3 or vermicompost-4 with 70% N from CF gave comparable yields to the sole application of 100% N from CF alone. Therefore, overall 30% chemical fertilizers (N, P, K and S) could be saved with the integrated use of vermicompost-3 or vermicompost-4 following IPNS in the cultivation of *T. aman* rice.

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Introduction

Bangladesh is an agricultural country. Most of the people of her directly or indirectly are involved in agriculture. Rice is the most important and cultivated crop in Bangladesh. Total cultivable land of Bangladesh is 14,387,044 hectares and near about 70 percent of this land is occupied by Rice cultivation. In the year of 2018-19, total production of rice was 36391000 metric tons (BBS, 2019).

The demand of rice is higher than any other crop because rice is the staple food in our country. Intensive cultivation of rice has caused considerable damage to the environment and natural resources including

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buildup of salinity or alkalinity, water logging, water pollution, depletion of groundwater and health hazards due to excessive use of agro chemicals and pesticides and release of higher methane gas to the environment. For these reasons farmers, scientists and policy makers are now looking at the integrated approach to nutrient management for crops including rice to some extent.

Organic manure is two-way practices of saving the environment by transforming waste materials into a valuable resource that can be used to supplement soil nutrients. Its content of the soil is very important for the cultivation of rice. Besides nitrogen, phosphorous, potassium and sulphur, a considerable number of micronutrients are also present in organic matter which can nourish the soil. Dutta *et al*. (2003) reported that the use of organic fertilizers together with chemical fertilizers, compared to the addition of organic fertilizers alone, had a higher positive effect on microbial biomass and soil health.

Another tension now increased for waste materials. But we can use these waste materials to produce different organic manure such as vermicompost. Vermicompost is an important organic manure which can use as organic fertilizer. It is an excellent, nutrient-rich organic fertilizer. It is a peat like material which prepared with the action of earthworms containing most nutrients in plant available forms such as nitrates, phosphates, calcium, potassium, magnesium etc. It has high porosity, water holding capacity and high surface area that provides abundant sites for microbial activity and for the retention of nutrients (Olle, 2019). It is a product of interactions between earthworms and microorganisms by degradation of organic waste and the process is called vermicomposting (Arancon *et al.*, 2005). Bevacqua and Mellano (2013) reported that vermicompost treated soils had lower pH and increased levels of organic matter, primary nutrients, and soluble salts. Edwards and Burrows (2010) reported that vermicompost, especially those from animal waste sources, usually contained more mineral elements than commercial plant growth media. Vermicompost contains readily available nutrients such as nitrates, phosphates and exchangeable calcium and soluble potassium. The accumulating evidence shows that vermicompost has capability of influencing growth and productivity of plants (Rasool *et al.*, 2008).

Considering the environmental pollution related to excess use of chemical fertilizer, needs of an alternative approach based on biological origin, safe for use and less expensive generated for the management of nitrogen. Replacement of nitrogen fertilizer in the soil through application of vermicompost can cause reduction in the environmental pollution developed by washing nitrate from the soil. According to Amo-Aghaee *et al*., (2003), this type of organic fertilizers are not only safe for environment but if it applied in higher doses, unused nitrogen remained in soil in the form of organic nitrogen and it will eventually return to the plant at the times of its need by process of mineralization. In terms of intangible returns vermicompost not only supplies essential elements to plant but also improves physiochemical and biological properties of soil, thus having promise to marginal and resource poor farmers and this may be a good asset for sustainable agriculture. By using vermicompost, we can reduce the use of chemical fertilizer. For this, our environment and soil will be saved from bad effecst of fertilizer.

Considering the above fact, the present study was undertaken to investigate the effects of different residues based vermicompost on the growth and yield of T. aman rice and to reduce the usage of chemical fertilizer in rice cultivation.

Materials and Methods

The experiment was conducted at the Soil Science Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during the T.aman season of 2019-20 at BINA farm Mymensingh. Six treatments were used in the experiment. These were T_1: Native soil fertility, T_2: 100% N from Chemical Fertilizer (CF), T_3:70%N from CF, T_4: 30% N from vermicompost-3 + 70% N from CF and T_5:30% N from vermicompost-4 + 70% N from CF and T_6: 100% PKS only. The experiments were conducted in a Randomized Complete Block Design with three replications. The experimental period was August to November, 2019. The test crop was T. aman rice (Binadhan-17). The soil of experimental field belongs to the Sonatala soil series under the general soil type of Non-calcareous Dark Grey Floodplain. The chemical properties of the experimental soil have been given in the Table 1. The rice plants were harvested on 01 November 2019. Yield contributing characters and yields were recorded which were included plant height(cm), total tillers hill^{-1}, effective tillers hill^{-1}, Panicle length (cm),, No. of grains panicle^{-1}, No. of filled grains panicle^{-1}, 1000 grain weight (g), Grain yield (tha^{-1}), Straw yield (tha^{-1}) and Harvest index (%).

Table 1. Physico-chemical properties of initial soils.

Characteristics	Results
Textural class	Silt loam
pH (Soil: Water = 1:2.5)	6.80
Organic matter (%)	1.9
CEC (meq/100 g soil)	15.10
Total N (%)	0.12
Available P (µgg^{-1})	14.0
Exchangeable K (me/100 g soil)	0.145
Available S (µgg^{-1})	15

***Collection of vermicompost*:** Vermicomposts used in the experiment were collected from the Soil Science Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. Vermicompost-3 was prepared with the mixture of mustard straw and cowdung (1:1) with the action of earthworms where vermicompost-4 was prepared with the mixture of water hyacinth and cowdung (1:1) with the action of earthworms.

***Application of vermicompost and fertilizer*:** Fertilizer rates were applied on the basis of soil test according to FRG (2018). In case of manure treatments, IPNS (Integrated Plant Nutrient System) was followed i.e. chemical fertilizer N, P, K and S were balanced according to nutrients supplied from organic manures in respective cases. Therefore, N, P, K and S were also reduced from chemical fertilizer treatments in T. aman rice. Nutrient contents of different vermicompost i.e. vermicompost-3 and vermicompost-4 have been given in the Table 2. Vermicomposts and all chemical fertilizers (TSP, MoP and gypsum) were applied during final land preparation except urea. Urea was applied in three equal splits. First split was applied at 14 days after transplanting where 2nd and 3rd splits were applied at 30 and 45 days after transplanting. Fertilizer and manures rates have been given in the Table 3 for T. aman rice (Binadhan-17).

Table 2. Nutrient contents in different vermicomposts applied in *T. aman* rice.

Name of manures	%N	%P	%K	%S
Vermicompost-3	1.2	0.5	1.8	0.45
Vermicompost-4	1.1	0.45	1.4	0.5

Table 3. Full rates (100%) of fertilizers and 30% N equivalent vermicomposts for T. aman rice.

Crops	100% Nutrients (kg ha^{-1})				Manures (t ha^{-1})	
	N	P	K	S	30% N equivalent Vermicompost-3	30% N equivalent Vermicompost-4
T. aman rice	77.1	8.4	61.7	9.3	1.9	2.1

***Collection and preparation of soil samples*:** The soil was collected at a depth of 0-15 cm from the experimental field during initial i.e. before the setting of the experiment. The soil was drawn by means of augar and was mixed thoroughly. The collected soil was air-dried, mixed well and the gravels, pieces of plant roots, leaves etc. were picked up and discarded. About one-kilogram soil was stored in plastic container for different chemical and physical analysis.

***Physical and chemical analysis of soils*:** The initial soil samples were analyzed for both of physical and chemical properties such as texture, soil pH, organic matter content, total nitrogen, available phosphorus, exchangeable potassium and available S (Table 1).

***Textural class*:** Particle size analysis was carried out by hydrometer method (Black, 1965) and the textural class was determined by fitting the %sand, %silt and %clay to the Marshall's Triangular Coordinates following USDA system.

***Soil pH*:** Soil pH was measured by a glass electrode pH meter using soil: water suspension of 1:2.5 (10 g soil and 25 ml distilled water) as described by Jackson (1967).

***Organic carbon*:** Organic carbon was determined by wet oxidation method as described by Black (1965). The underlying principle was used to oxidize the organic matter with an excess of 1N $K_2Cr_2O_7$ in presence of conc. H_2SO_4 and conc. $H_3PO_4$and to titrate the excess $K_2Cr_2O_7$ solution with 1N $FeSO_4$.To obtain the organic matter content the amounts of organic carbon were multiplied by Van Bemmelen factor 1.73. The results were expressed in percentage (Page *et al.*, 1982).

***Determination of total nitrogen from soil samples*:** Total N content was determined following micro-kjeldahl method as described by Jackson (1967). Soil sample was digested with H_2O_2, conc. H_2SO_4 and catalyst mixture (K_2SO4:$CuSO_4.5H_20$: Sein the ratio 100:10:1). After completion of digestion, made the volume to 100ml.Distillation was performed with adding of 40% NaOH into the digest.The distillate was received in 2% boric acid (H_3BO_3)solution and 4 drops of mixed indicator of bromocresol green and methyl red solution. Finally, the distillate was titrated with standard H_2SO_4 (0.01N) until the color changed from green to pink. The amount of N was calculated using the following formula:

%N = (T-B) xNxl.4S

Where,

T = Sample titration value (ml) of standard H_2SO_4

B = Blank titration value (ml) of standard H_2SO_4

N = Strength of H_2SO_4

S = Sample weight in gram

***Determination of available phosphorus from soil samples*:** Available phosphorus was extracted from the soil samples by shaking with 0.5 M $NaHCO_3$ solutions at pH 8.5 following the method of Olsen *et al.* (1954). The extracted phosphorus was determined by developing blue color by $SnCl_2$ reduction of phosphomolydate complex and measuring the intensity of color colorimetrically at 660 nm wave length and the readings were calibrated to the standard P curve.

***Determination of exchangeable potassium from soil samples*:** Exchangeable potassium was extracted from the soil samples with 1N NH_4OAC (pH 7) and K was determined from the extract by flame photometer (Black, 1965) and calibrated with a standard curve.

***Determination of available sulphur from soil samples*:** Available S content was determined by extracting with 0.15% $CaCl_2$ solution (1:5 soil extractant ratio) and estimated by turbidimetric method using spectrophotometer at 535 ηm wavelength (Williams and Steinbergs, 1959).

***Chemical analysis of plant samples*:**

Preparation of plant samples: The representative grain and straw samples were dried in an oven at 65°C for about 72 hours before they were ground by a grinding machine. The prepared samples were then stored in paper bags and finally they were kept into a desiccator until chemical analysis.

Determination of total N from plant samples: Total N content was determined following micro-Kjeldahl method as described by Jackson (1967) from grain and straw samples. Each sample was digested with H_2O_2, conc. H_2SO_4 and catalyst mixture

(K_2SO_4:$CuSO_4$.5H_20:Se in the ratio of 100:10:1). After completion of digestion, made the volume to 100ml. Distillation was performed with adding of 40% NaOH into the digest. The distillate was received in 2% boric acid (H_3BO_3) solution and 4 drops of mixed indicator of bromocresol green and methyl red solution. Finally, the distillate was titrated with standard H_2SO_4 (0.01N) until the colour changed from green to pink. Then amount of N was calculated as soil analysis.

Determination of P, K and S from plant samples: Total P, K and S were determined following micro-Kjeldahl method as described by Jackson (1967). About 0.5 g of samples was transferred into dry clean 100 ml Kjeldahl flasks. 10 ml of di-acid mixture (HNO_3:$HClO_4$ = 2:1) were added into the flask. After leaving for a while the flasks were heated at temperature slowly raised to 200°C. The contents of the flaks were boiled until they became sufficiently clear and colorless. After cooling the digests were transferred into 100ml volumetric flaks and the volumes were made up to the mark with distilled water. Phosphorus was determined by developing blue color by $SnCl_2$ reduction of phosphomolybdate complex and measuring the intensity of color by calorimetrically at 660 µm wave length and the readings were calibrated to the standard P curve. Potassium was determined from the aliquot by flame photometer (Black, 1965) and calibrated with a standard curve. Sulphur was determined from aliquot by calorimetrically at 440 µm wave length (Williams and Steinbergs, 1959) and the readings were calibrated to the standard curve

***Calculation of nutrients uptake*:** After chemical analysis of straw and grain samples, the N, P, K and S contents were calculated and from the value of N, P, K and S contents, N, P, K and S uptakes were also calculated by the following formula of Jackson (1967).

Nutrient uptake = Nutrient content (%) x yield (t ha^{-1})/100

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

Results and Discussion

***Effects of vermicomposts on yield contributing characters of T. aman rice*:** Yield contributing characters such as plant height, panicle length, number of total tiller $hill^{-1}$, number of effective tiller $hill^{-1}$, number of filled grain $panicle^{-1}$, number of unfilled grain $panicle^{-1}$ of Binadhan-17 was significantly influenced by the different treatments (Table 4) ecxcept1000-grain weight of Binadhan-17. At harvest, plant height ranged from 101.9 cm to 89.6 cm. The tallest plant of 101.9 cm was found in the treatment T_2 which was identical to the treatment T_4, T_5 and T_3. The shortest plant of 89.6 cm was found in the treatment T_1. These are in agreement with those of Yadav and Malik (2005), Reddy *et al.* (1998) and Das *et al.* (2002) who have reported that different levels of vermicompost significantly increased plant height. The highest panicle length of 23.7 cm was found in the treatment T_5 and the lowest panicle length of 20.8 cm was observed in the control treatment T_1. All the vermicompost might have increased the soil fertility and other plant growth enhancing characters and for that reason increasing dose of vermicompost increased the panicle length as well. Hasan *et al.* (2002) reported the similar findings of this resulst. The maximum number of total tiller $hill^{-1}$ was observed in the treatment T_5 and the lowest number of total tiller $hill^{-1}$ was observed in the control treatment T_1. The results obtained from the present study regarding total tiller $hill^{-1}$ was similar with the findings of Singh and Singh (2005) and Patil and Bhilare (2006). The maximum number of effective tiller $hill^{-1}$ (9.9) was found in the treatment T_5 which was identical to that in the treatment T_4 with the value of 9.8. The minimum number of effective tiller $hill^{-1}$ (7.60) was found in the control treatment T_1. These results are supported with the findings of Rajni *et al.* (2001) who found that the number of effective tillers $hill^{-1}$is increased with the integrated use of vermicompost. The number of filled grains panicle-

^{1}ranged from 198 to 132.2. The highest filled grains panicle^{-1} (198) was found in the treatment T_5 (30% N from vermicompost-4 + 70% N from CF) followed by the treatment T_4 (30% N from vermicompost-3 + 70% N from CF) with the value of 191.7. The lowest number of filled grains panicle^{-1} (132.2) was found in the treatment T_1. Biswas (2016) also found significantly higher filled grains panicle^{-1} with application of vermicompost which is collaborated with these findings.

Table 4. Effects of different treatments on yield contributing characters of *T. aman* rice.

Treatments	Plant height (cm)	Panicle length (cm)	Effective tiller hill^{-1} (no.)	Filled grain panicle^{-1} (no.)	Unfilled grain panicle^{-1} (no.)	1000-grain weight (g)
T_1	89.6b	20.8b	5.9c	132.2c	44.7a	22.5
T_2	101.9a	23.4a	9.3ab	185.0ab	35.7ab	23.8
T_3	100.3a	23.3a	8.2b	171.7b	44.3a	23.9
T_4	101.3a	23.6a	9.8a	191.7ab	36.7ab	24.1
T_5	100.8a	23.7a	9.9a	198.0a	31.7b	24.3
T_6	97.7b	22.5ab	6.7c	144.0c	43.3a	23.3
SE(±)	**0.722**	**0.722**	**0.390**	**7.648**	**3.203**	**0.932**
CV(%)	**5.28**	**5.47**	**8.19**	**7.77**	**14.09**	**12.5**

In a column, figures having common letter(s) do not differ significantly at 5%level of probability; SE= Standard Error; CV= Coefficient of Variation; **Note:** T_1=Native soil fertility, T_2= 100% N from Chemical Fertilizer (CF), T_3=70%N from CF, T_4=30% N from vermicompost-3 + 70% N from CF, T_5=30% N from vermicompost-4 + 70% N from CF and T_6=100% PKS only.

The number of unfilled grains panicle^{-1} varied from 31.7 to 44.7. The highest number of unfilled grains panicle^{-1} (44.7) was obtained from the control treatmentT_1 and the lowest number of unfilled grains panicle^{-1} (31.7) was observed in the treatment T_5. The results indicated that application of vermicompost with chemical fertilizers reduced the unfertile grains. Similar results were also observed by Kumar *et al.* (2005). The 1000-grain weight ranged from 24.3 g to 22.5 g. The highest 1000-grain weight of 24.3 g was found in the treatment T_5 and the lowest value of 22.5 g was noted in the treatment T_1. The 1000-grain weights were not significantly varied with the different treatments. But the 1000-grain weight of T. aman rice was increased with the application of vermicomposts. However, the increased grain weight might be due to favorable effects of vermicompost and accumulation of materials that helped proper growth and development of the rice grain. Similar result was reported by Agrawal *et al.* (2003). They found that the treatment with 75% vermicompost+25% farmyard manure resulted in the greatest 1000 seed weight.

***Effects of vermicomposts on yields and harvest index of T. aman rice*:** The grain and straw yield of Binadhan-17 was significantly influenced by the different treatments (Table 5). The highest grain yield of 5.5 t ha^{-1} was recorded in the treatment T_5 and the lowest value of 2.7 t ha^{-1} was recorded in the treatmentT_1. The increase in grain yield over control ranged from 103.7 to 14.81% where the highest value (103.7%) was noted in the treatment T_5 and the lowest value (14.81%) was noted in the treatment T_6. The results of the present study were also in agreement with the findings of Ranwa and Singh (1999) where they reported that the application of vermicompost improved grain yield of crops. The highest straw yield of 5.3 t ha^{-1} was obtained in the treatment T_5 and the lowest value of 3.0 t ha^{-1} was noted in the control treatment T_1. The increase in straw yield over control ranged from 76.67 to 26.67% where the maximum value (76.67%) was noted in the treatment T_5 and the minimum value was found in the treatment T_6. Similar results were obtained by Banger *et al.* (1990) where they reported that compost increased straw yield significantly.

Table 5. Effect of different vermicompost with chemical fertilizers on rice grain and straw yields and yields increased over control of *T. aman* rice.

Treatments	Grain yield (tha^{-1})	Straw yield (tha^{-1})	Yield increased over control(%)	
			Grain	Straw
T_1	2.7c	3.0b	-	-
T_2	5.1a	5.2a	88.89	73.33
T_3	4.0b	4.8a	48.15	60
T_4	5.4a	5.2a	100	73.33
T_5	5.5a	5.3a	103.7	76.67
T_6	3.1c	3.8b	14.81	26.67
SE(±)	**0.234**	**0.279**	-	-
CV(%)	**9.47**	**10.69**	-	-

In a column, figures having common letter(s) do not differ significantly at 5% level of probability; SE= Standard Error; CV= Coefficient of Variation; **Note**: T_1=Native soil fertility, T_2= 100% N from Chemical Fertilizer (CF), T_3=70%N from CF, T_4=30% N from vermicompost-3 + 70% N from CF, T_5=30% N from vermicompost-4 + 70% N from CF, T_6=100% PKS.

The highest harvest index (HI) was obtained (Figure 1) from the treatment T_5 followed by the treatment T_4 and the lowest harvest index was recorded in the treatment T_6. Ali (1992) reported that N management strategy did not influence HI. On the other hand, Miah *et al.* (2004) also reported that levels of nitrogen fertilizer had exerted very little variation on harvest index. The present findings were well supported with those of earlier findings.

Effects of vermicomposts on N, P, K and S contents in rice grain and straw of T. aman rice: Nutrient (N, P, K and S) contents in rice grain and straw have been given in the Table 6. The maximum N, P, K and S concentration in rice grain (Table 6) was observed in the treatment T_5 (30% N from vermicompost-4 + 70% N from CF) followed by the treatment T_4 (30% N from vermicompost-3 + 70% N from CF).

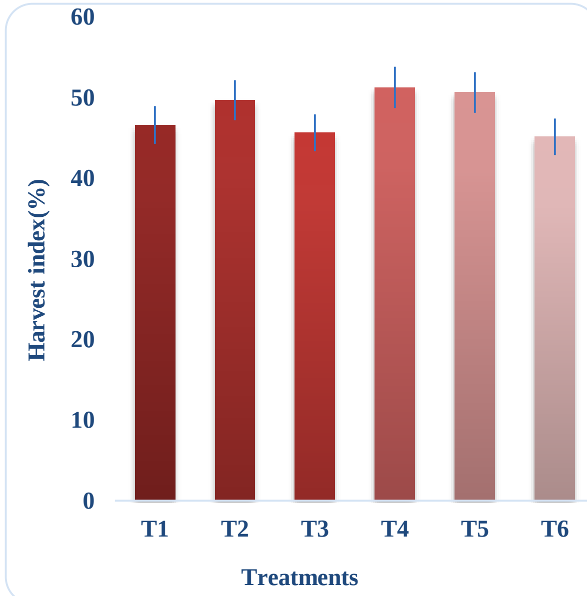

Figure 1. Effects of different treatments on harvest index (%) of T. aman rice. (Vertical bars indicates standard errors). **Note:** T_1=Native soil fertility, T_2= 100% N from Chemical Fertilizer (CF), T_3=70%N from CF, T_4=30% N from vermicompost-3 + 70% N from CF, T_5=30% N from vermicompost-4 + 70% N from CF and T_6=100% PKS only.

The lowest N, P, K and S content were observed in the control treatment T_1. Similar trends were also observed in case of rice straw regarding N, P, K and S contents. The result indicated that plants were more efficient in absorption of nutrients in the vermicompost with chemical fertilizers treatments than that of sole application of chemical fertilizers. This result is similar with Ravimycin (2016) where he reported vermicompost increased the nutrient contents in plant. Singh *et al.* (2001) also reported that Potassium content in grain was increased due to combined application of organic manure and chemical fertilizers which are supported these results. Azim (1999) reported that application of sulphure from manure and fertilizers increased S content both in grain and straw which also supports these results.

Table 6. Effects of different treatments on N, P, K and S contents in rice grain and straw of *T. aman* rice.

Treatments	Grain				Straw			
	N (%)	**P (%)**	**K (%)**	**S (%)**	**N (%)**	**P (%)**	**K (%)**	**S (%)**
T_1	1.02	0.18	0.26	0.09	0.552	0.09	1.29	0.05
T_2	1.13	0.27	0.34	0.11	0.634	0.12	1.38	0.07
T_3	1.11	0.24	0.31	0.1	0.557	0.1	1.34	0.06
T_4	1.14	0.28	0.35	0.12	0.645	0.13	1.38	0.08
T_5	1.14	0.28	0.35	0.13	0.653	0.13	1.38	0.08
T_6	1.03	0.22	0.33	0.1	0.562	0.11	1.35	0.07

Note: T_1 = Native soil fertility, T_2= 100% N from Chemical Fertilizer (CF), T_3=70%N from CF, T_4=30% N from vermicompost-3 + 70% N from CF, T_5=30% N from vermicompost-4 + 70% N from CF and T_6=100% PKS.

Effects of different vermicomposs on N, P, K and S uptake by T. aman rice: Effects of different residues based vermicompost with fertilizer showed significant variation on N, P, K and S uptakes in rice grain and straw (Table 7). The maximum NPKS uptake in ricegrain was obtained from the treatment T_5 which was statistically similar with the treatment T_4 (61.8 kgha^{-1}) and T_2 (57.5 kgha^{-1}) whereas, the minimum nutrient uptake in rice grain (27.0 kgha^{-1}) was observed from the control treatment T_1. Similar trends were also observed in nutrients uptake by rice straw.

Table 7. N, P, K and S uptakes in grain and straw of T. aman rice (Binadhan-17) as affected by different treatment.

Treatments	Nutrients uptake in grain (kgha^{-1})				Nutrients uptake in straw (kgha^{-1})			
	N	**P**	**K**	**S**	**N**	**P**	**K**	**S**
T_1	27.0c	4.8c	6.9c	2.4d	16.7d	2.7d	39.1c	1.5d
T_2	57.5a	13.7a	17.3a	5.6b	32.7ab	6.2ab	71.1a	3.6b
T_3	44.4b	9.6b	12.4b	4.0c	26.5bc	4.8bc	63.9ab	2.9c
T_4	61.8a	15.2a	19.0a	6.5ab	33.2ab	6.7a	71.1a	4.1ab
T_5	62.1a	15.3a	19.1a	7.1a	34.7a	6.9a	73.3a	4.2a
T_6	31.9bc	6.8bc	10.2b	3.1cd	21.2cd	4.1cd	50.8bc	2.6cd
SE (±)	3.565	1.025	1.202	0.432	1.719	0.382	3.316	0.432
CV(%)	9.59	9.72	8.28	9.65	10.18	9.90	10.52	9.65

In a column, figures having common letter(s) do not differ significantly at 5%level of probability; SE= Standard Error; CV= Coefficient of Variation; **Note:** T_1= Native soil fertility, T_2= 100% N from Chemical Fertilizer (CF), T_3=70%N from CF, T_4=30% N from vermicompost-3 + 70% N from CF, T_5=30% N from vermicompost-4 + 70% N from CF and T_6=100% PKS only.

Significant differences were observed in total NPKS uptakes due to combined effect of different residues based vermicompost with chemical fertilizers (Figure 2). The maximum total NPKS uptakes were noted in the treatment T_5 which was statistically similar to the treatments T_4 and T_2. The minimum total NPKS uptakes were found in the control treatment T_1. This was due to the fact that vermicompost added all kind of nutrients in soil and also reduced the loss of nutrients from the soil than the application only chemical fertilizers. Baron *et al.* (1995) found that the addition of organic manure has a positive influence on the N uptake by wheat plants. Similar result was found by Haque and Ali (2020) where totals nitrogen uptakes of mustard were significantly affected with the integrated application of vermicompost with chemical fertilizers. Khan *et al.* (2017) also reported that vermicompost increased the phosphorus uptake in straw. It is also with corroborated with Khan *et al.* (2017) and Haque and Ali (2020) where they also reported that combined application of vermicompost increased the phosphorous uptake in plant. The present findings were well agreement with those findings.

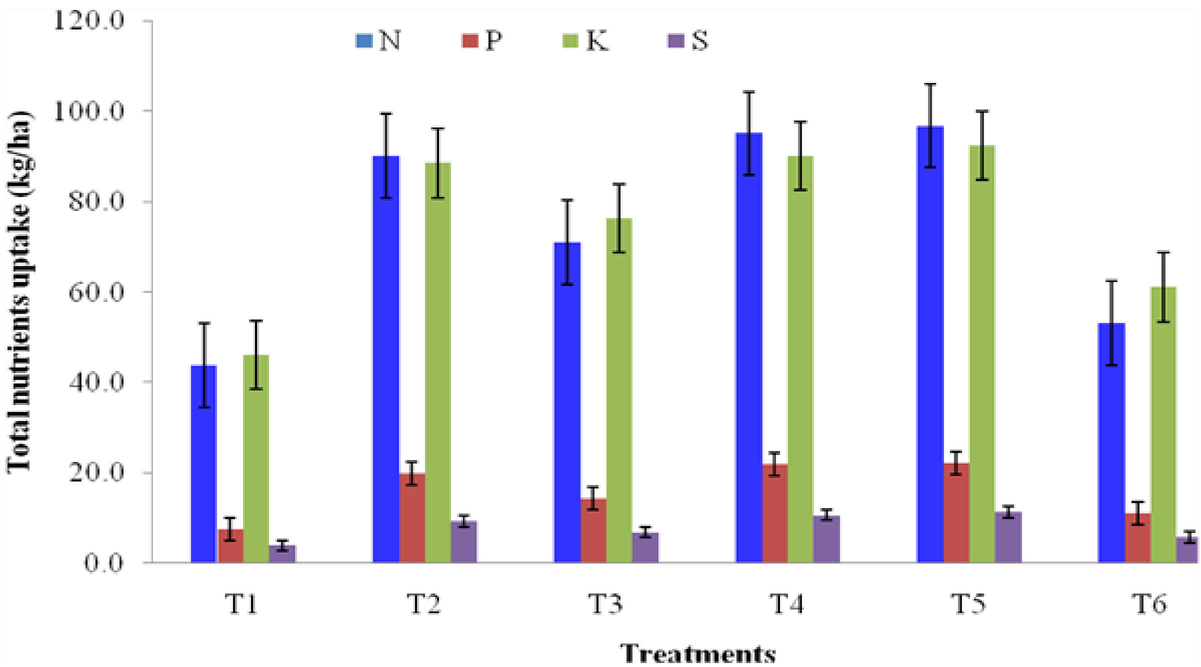

Figure 2. Total N, P, K and S uptake of T. aman rice as affected by different nutrients. (Vertical bars indicate Standard errors). **Note:** T_1=Native soil fertility, T_2= 100% N from Chemical Fertilizer (CF), T_3=70%N from CF, T_4=30% N from vermicompost-3 + 70% N from CF, T_5=30% N from vermicompost-4 + 70% N from CF and T_6=100% PKS only.

Conclusion

The results indicated that 30% N from either vermicompost-3 or vermicompost-4 with 70% N from CF gave comparable yield to the sole application of 100% N from CF alone. Therefore, overall 30% chemical fertilizers (N, P, K and S) could be saved with the integrated (IPNS) use of vermicompost-3 or vermicompost-4 in the cultivation of T. aman rice.

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