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EFFECT OF COMBINED USE OF DIFFERENT ORGANIC MANURES AND CHEMICAL FERTILIZERS ON THE YIELD AND NUTRIENT UPTAKE OF T. AMAN RICE Var. BRRI DHAN 31

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ABSTRACT

Nutrient uptake by T. Aman var. BRRIDhan31 were greatly influenced by the applications of different organic manures in combination with chemical fertilizers. Application of 70% NPKS + PM produced the highest grain yield of T. Aman rice, which was identical to that obtained with 100% NPKS with no manure. The grain yield ranged from 2.84 t ha^{-1} in T_1 (control) to 5.52 t ha^{-1} in the 70% NPKS + PM. The application of 3 t ha^{-1} PM with 70% NPKS (T_8) produced the highest grain yield of 5.52 t ha^{-1}, as well as the highest straw yield of 6.73 t ha^{-1}. It appears that the application of 3 t ha^{-1} PM with 70% NPKS can reduce the use of 30% NPKS as fertilizers. The economic analyses revealed that most of the treatments produce BCR (benefit-cost ratio) more than 3.0 showing that all of them were economically viable. The overall findings of the study indicated that the integrated use of chemical fertilizer and manure was important for producing better yield of T. aman rice.

Key words: *Organic manure, nutrient uptake, rice*

INTRODUCTION

Soil organic matter is a key factor for sustainable soil fertility and crop productivity. The increasing land use intensity without adequate and balanced use of chemical fertilizers and with little or no use of organic manure have caused severe fertility deterioration of our soils resulting in stagnating or even declining of crop productivity. The farmers of this country use on an average 172 kg nutrients ha^{-1} annually (132 kg N + 27 kg P + 17 kg K + 4 kg S and 2 kg Zn), while the crop removal is about 250 kg ha^{-1} (Islam, 2002). Since fertile soil is the fundamental resource for higher crop production, its maintenance is a prerequisite for long-term sustainable crop productivity. Organic matter undergoes mineralization with the release of substantial quantities of N, P and S, and smaller amount of micronutrients. In Bangladesh, most of the cultivated soils have less than 1.5% organic matter, while a good agricultural soil should contain at least 2% organic matter. Moreover, this important component of soils is declining with time due to intensive cropping and use of higher doses of nitrogenous fertilizers with little or no addition of organic manure. Consequently Z and B deficiencies are frequently reported on some soils and crops (Jahiruddin *et al.*, 1995 and Mondal *et al.*, 1992). Rice (*Oryza sativa* L.) is intensively cultivated in Bangladesh covering about 80% of arable land. Unfortunately, the

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yield of rice in this country is low (3.4 t ha^{-1}) compared to other rice growing countries like South Korea and Japan where the average yield is 6.00 and 5.6 t ha^{-1}, respectively (FAO, 2003). On the other hand, the demand for increasing rice production is mounting up to feed the ever-increasing population.

A suitable combination of organic and inorganic source of nutrients is necessary for sustainable agriculture that can ensure food production with high quality (Reganold *et al.*, 1990). Nambiar (1991) viewed 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 long-term research of BRRI revealed that the application of cowdung @ 5 t ha^{-1} yr^{-1} improved rice productivity as well as prevented the soil resources from degradation (Bhuiyan, 1994). Thus, it is necessary to use fertilizer and manure in an integrated way in order to obtain sustainable crop yield without affecting soil fertility. Based on the soil fertility problem as discussed above, the present study was undertaken to investigate the effect of combined use of chemical fertilizers and organic manures in producing T. Aman rice var. BRRI dhan31.

MATERIALS AND METHODS

A field experiment was conducted at Bangladesh Agricultural University farm, Mymensingh to evaluate the suitability of different sources of organic materials for integrated use with chemical fertilizers for the yield and nutrient uptake of T. Aman rice var. BRRI dhan31. The soil was Non-Calcareous Dark Grey Floodplain. The cultivar was used BRRI dhan31.

The experiment was designed with eight treatments for both the crops. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 5m x 4m. The treatment combinations were: T_1 (control), T_2 (70% NPKS), T_3 (100% NPKS), T_4 (70% NPKS + RS), T_5 (70% NPKS + DH), T_6 (70% NPKS + MBR), T_7 (70% NPKS + CD) and T_8 (70% NPKS + PM). The initial soil status and the composition of different organic manures are given in Tables 1 and 2.

The rates of N, P, K and S for the T. Aman rice was 100, 15, 45 and 10 kg ha^{-1}. Five different sources of organic matters, viz., rice straw (RS), dhaincha (DH), mungbean residues (MBR), cowdung (CD) and poultry manure (PM) were applied @ 5, 15, 10, 5 and 3 t ha^{-1}, respectively. Urea was applied in three equal splits. The first split was applied during final land preparation, the second split at active tillering stage and the remaining split at panicle initiation stage of the crop. Organic manure was applied to soil before final land preparation. All the cultural practices were done in time. Grain and straw were analyzed for determination of N, P, K and S contents. All the data were analyzed statistically following the F-test and the mean comparisons were made by DMRT at 5% level.

Table 1. General characteristics of initial soil

Characteristics	Value
% Sand	17.4
% Silt	67.0
% Clay	15.6
Textural class	Silt loam
pH (Soil: Water = 1:2.5)	6.8
Organic carbon (%)	1.15
Organic matter (%)	1.99
CEC (me/100 g soil)	10.10
Total N (%)	0.077
C:N ratio	9.30
Available P (ppm)	12.0
Available S (ppm)	13.9
Available Zn (ppm)	1.62
Exchangeable K (me/100 g soil)	0.13

Table 2 Chemical composition of different organic manures

Organic Materials	Nutrient composition (%)				
	H_2O	N	P	K	S
Rice straw	22	0.55	0.18	1.47	0.13
Dhaincha	80	1.55	0.37	1.47	0.12
Mungbean residues	70	1.12	0.27	1.05	0.12
Cowdung	40	1.13	0.27	0.68	0.15
Poultry manure	20	2.70	0.52	1.58	0.15

RESULTS AND DISCUSSION

Yield and yield components

Plant height of BRRI dhan31 did not increase significantly due to integrated use of organic manures and chemical fertilizers over sole use of chemical fertilizers (Table 3). However, either integrated use of chemical fertilizers and organic manure or sole use of chemical fertilizers produced significantly higher plant height over absolute control (T_1). The plant height varied from 60.8 to 105.2 cm where the highest value was obtained from T_8 (70% NPKS + PM) and the lowest from T_1 (control) and this variation was statistically significant. The panicle length

of rice (var. BRRI dhan31) was significantly influenced by the treatments applied (Table 3). The panicle length of rice varied from 17.04 to 25.86 cm due to different treatments. The maximum panicle length (25.86 cm) was observed in T_8 (70% NPKS + PM) treatment, which was statistically identical with T_2 (70% NPKS), T_3 (100% NPKS), & T_5 (70% NPKS +DH) treatments. The shortest panicle of 17.04 cm was obtained in T_1 (control) treatment. Hossain *et al.* (1997) reported that application of NPKS and green manure increased panicle length of rice. Ranjni *et al.* (2001) reported that panicle length significantly increased with the application of the various commercial fertilizers and FYM compared with the control.

Table 3. Effects of different treatment on the yield and yield component of T. aman rice var. BRRI dhan31.

Treatments	Plant height (cm)	Panicle length (cm)	Effective tillers hill^{-1}	Filled grains panicle^{-1}	1000-grain weight (g)	Straw yield (t ha^{-1})	Grain yield (t ha^{-1})	Increase over control (%)
T_1: Control	60.8c	17.04d	4.33d	51.3d	25.20	4.05g	2.84c	-
T_2: 70% NPKS	103.6a	24.65ab	9.33ab	108.7ab	25.40	5.56f	4.65b	64
T_3: 100% NPKS	105.4a	25.77ab	10.00a	121.0ab	25.28	6.28d	5.42a	91
T_4: 70% NPKS	89.8b	22.20c	7.67c	78.0c	25.47	6.12cd	4.78b	68
+RS	102.3a	24.60ab	9.33ab	112.3ab	25.20	6.50b	5.10ab	81
T_5: 70% NPKS	101.3a	24.21b	8.00bc	103.6b	25.33	6.39c	5.27ab	86
+DH	100.5a	23.40c	8.00bc	101.3b	25.20	6.15e	4.91ab	73
T_6: 70%	105.2a	25.86a	8.67abc	125.7a	25.87	6.73a	5.52a	94
NPKS+MBR								
T_7: 70% NPKS								
+CD								
T_8: 70% NPKS								
+PM								
CV (%)	2.3	2.20	7.50	7.87	-	0.66	3.78	-
S x	1.3	0.30	0.35	4.63	0.13	0.02	0.11	-

In a column, the figure(s) having common letter(s) do not differ significantly at 5% level of probability

The number of effective tillers hill^{-1} of BRRI dhan31 was significantly influenced due to the application of organic materials in combination with fertilizers (Table 3).The number of effective tillers hill^{-1} by different treatments varied from 4.33 to 10.00.The highest number of effective tillers hill^{-1} (10.00) was obtained in T_3 (100% NPKS) treatment which was statistically identical with the treatments T_2 (70% NPKS), T_5 (70% NPKS +DH), & T_8 (70% NPKS + PM). The lowest number of effective tillers hill^{-1} of 7.67 was obtained in T_1 (control) treatment, which was significantly inferior to all other treatments. The use of N, P, K, S and Zn fertilizers in Bangladesh soils have been reported to increase the number of fertile tillers of rice cultivars (Islam *et al.*, 1990; Islam and Hossain, 1993). The significant effect of different treatments was found on the production of filled grains panicle^{-1} (Table 3). The number of filled grains panicle^{-1} ranged from 51.33 to 125.67. The highest number of filled grains panicle^{-1} of 125.67 was obtained in T_8 (70% NPKS + PM) treatment, which was statistically similar to those found in T_2 (70% NPKS), T_3 (100% NPKS) & T_5 (70% NPKS + DH) treatments. The lowest number of filled grains panicle^{-1} of 55.33 was found in T_1 (control) treatment. All the treatments significantly increased grain panicle^{-1} over T_1 (control) treatment. Haque *et al.* (2001) found that higher number of filled grains panicle^{-1} in treatment where 80 kg N ha^{-1} supplied from organic source (FYM). There were no significant differences among the 1000-grain weight

obtained in different treatments applied (Table 2). The 1000-grain weight of rice varied from 25.20 to 25.87g due to different treatments. The maximum grain weight (25.87 g) was observed in treatment T_8 (70% NPKS + PM) and that of the lowest (25.20 g) was in T_1 (control). The result showed that the application of organic manures (PM) was better performing in producing 1000-grain weights. Similar results were also obtained by Kant and Kumar (1994).

Grain and straw yields of T. Aman rice (var. BRRI dhan31) responded significantly to the different treatment combinations (Table 3). The highest grain yield (5.52 t ha^{-1}) was obtained in T_8 (70% NPKS + PM) treatment, which was significantly higher than T_1 (control), T_2 (70%NPKS) and T_4 (70%NPKS + RS) treatments but statistically identical with T_3 (100% NPKS), T_5 (70% NPKS + DH), T_6 (70% NPKS + MBR) and T_7 (70% NPKS + CD) treatments. Treatment T_8 (70% NPKS + PM) resulted in 94% grain yield increase over the control. The lowest grain yield (2.84 t ha^{-1}) was observed in T_1 (control) treatment. The second highest grain yield (5.42 t ha^{-1}) was recorded in T_3 (100% NPKS) treatment. The straw yield of T. Aman rice varied from 4.05 to 6.73 t ha^{-1}. The highest straw yield (6.73 t ha^{-1}) was observed in T_8 (70% NPKS + PM) treatment which was statistically higher than all other treatments. The lowest straw yield (4.05 t ha^{-1}) was obtained in T_1 (control) treatment. These results agree to the earlier workers (Saleque *et al*., 2004; Haque, 1998 and Ishaque, 1998). Thus, the results indicate that nutrients for high yield goal based on soil analysis without organic manures increased the grain yield and decreased the straw yield. But the nutrients with organic manures increased both straw and grain yields.

Nutrient Uptake

Different combinations of inorganic fertilizer and organic manure significantly influenced the N uptake of grain and straw (Table 4). The N uptake by grain varied from 25.1 to 63.9 kg ha^{-1}. The highest N uptake by grain (63.9 kg ha^{-1}) was observed in treatment T_3 (100% NPKS), which was identical to that observed in T_8 (70% NPKS + PM) treatment. The N uptake by rice grain in the treatments T_6 (70% NPKS + MBR) and T_7 (70% NPKS + CD) were statistically identical with T_8 (70% NPKS + PM). The application of RS with 70% NPKS (T_4) did not show higher N uptake by rice grain compared to that obtained with T_2 (70% NPKS). On the other hand the highest N uptake by straw 46.9 kg ha^{-1} was observed in T_8 (70% NPKS + PM) treatment and the lowest N uptake by straw 14.1 kg ha^{-1} was observed in treatment T_1 (control). Phosphorus uptake by grain and straw were significantly influenced by the different treatments (Table 4). P uptake by grain ranged from 5.6 to 16.0 kg ha^{-1} by the treatments. The highest P uptake of grain (16.0 kg ha^{-1}) was recorded in treatment T_3 (100% NPKS) which was statistically identical to T_6 (70% NPKS + MBR) and T_8 (70% NPKS + PM) treatments. The lowest P uptake 5.6 kg ha^{-1} by grain was observed in treatment T_1 (control).Again the highest P uptake 5.1 kg ha^{-1} of straw was found in treatment T_8 (70% NPKS + PM) which was statistically significant over all other treatments. The lowest P uptake by straw 1.3 kg ha^{-1} was observed in treatment T_1 (control). The application of DH, MBR and CD with 70% NPKS show significant P uptake by rice straw compared to that obtained with 70% NPKS (T_2).

Table 4. Effects of different chemical fertilizers and organic manures on nutrients uptake by T. Aman rice var. BRRI dhan31

Treatments	Nitrogen (kg ha^{-1})		Phosphorus (kg ha^{-1})		Potassium (kg ha^{-1})		Sulphur (kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1: Control	25.1 e	14.2 d	5.6e	1.3 e	11.5 d	39.9 c	1.3d	1.7c
T_2: 70% NPKS	41.6 d	34.9 c	10.5d	3.1d	22.9 bc	95.9 ab	3.0c	3.6b
T_3: 100% NPKS	63.9 a	45.5 a	16.0a	3.7cd	30.8 a	88.7 ab	4.6ab	4.5ab
T_4: 70% NPKS +RS	40.4 d	39.3bc	10.5d	3.5cd	20.1c	79.2 b	3.0c	4.3ab
T_5: 70% NPKS +DH	53.4 c	44.0ab	12.8bcd	3.9bc	22.7 bc	98.7 a	4.4ab	4.5ab
T_6: 70% NPKS+MBR	54.2 bc	43.5ab	13.9abc	4.4b	26.6 abc	90.1 ab	4.6ab	4.6a
T_7: 70% NPKS +CD	53.8 bc	40. b	12.5cd	3.8bc	22.2 bc	88.8 ab	4.1b	4.8a
T_8: 70% NPKS +PM	59.0 ab	46.9a	15.2ab	5.1a	28.7ab	93.8 ab	5.2a	5.1a
CV (%)	4.20	4.98	8.01	7.44	11.82	8.30	8.92	9.20
S_X	1.19	1.11	0.56	0.15	1.58	4.04	0.19	0.22

In a column, the figure(s) having common letter(s) do not differ significantly at 5% level of probability

The results indicated that the K uptake of grain and straw was also significantly influenced by the different treatments (Table 4). The range of K uptake by grain varied from 11.5 kg ha^{-1} in control (T_1) treatment to 30.8 kg ha^{-1} in T_3 (100% NPKS) treatment. The highest K uptake in treatment T_3 (100% NPKS) was statistically identical to T_8 (70% NPKS + PM) and T_6 (70% NPKS + MBR). The treatments having RH, DH, MBR or CD with 70% NPKS recorded identical K uptake by rice grain with 70% NPKS application. The K uptake of straw also ranged from 39.9 to 98.6 kg ha^{-1}. The highest K uptake 98.6 kg ha^{-1} by straw observed in T_5 (70% NPKS + DH) was statistically identical to all other treatments with manures and chemical fertilizers except T_4 (70% NPKS + RS) treatment. The K uptake of straw was much higher than that of grain.

Sulphur uptake of grain and straw was significantly influenced by the different treatments (Table 4). The range of S uptake by grain was varied from 5.2 kg ha^{-1} in control (T_1) treatment to 1.3 kg ha^{-1} in T_8 (70% NPKS + PM) treatment. The highest S uptake by grain observed in treatment T_8 (70% NPKS + PM) was statistically identical to T_3 (100 % NPKS), T_5 (70% NPKS + DH) and T_6 (70% NPKS + MBR). The application of RS with 70% NPKS (T_4) showed identical S uptake by rice grain compared to that obtained with 70% NPKS application. The highest S uptake by straw 5.1 kg ha^{-1} was recorded in treatment T_8 (70% NPKS + PM) which was statistically similar with all other treatments except T_1 (control) and T_2 (70% NPKS). The lowest S uptake 1.7 kg ha^{-1} was obtained in T_1 (control). This was also statistically different from the rest of the treatments. Islam *et al.*, (1997) and Poongothai *et a*l., (1999) reported that application of S significantly increased S uptake by rice.

Economic Analysis

Economic yields and added benefits as influenced by integrated use of chemical fertilizers and organic materials on rice have been calculated and presented in Table 5. The highest grain and straw yields of 5.52 and 6.73 t ha^{-1}, recorded in T_8(70% NPKS + PM) giving the highest gross return of Tk. 50890 (Table 5). The second highest gross return of Tk. 49640 was found in T_3 (1000% NPKS). The results showed that all the treatments have B: C ratios higher than 3.0 (Table 5). The highest B: C ratio of 4.33 was found in T_8 (70% NPKS + PM) followed by 3.93 in T_3 (100% NPKS).

Table 5. Economic analysis as influenced by integrated use of chemical fertilizers and organic materials on T. Aman rice

Treatment	Economic yields (t ha^{-1})		Gross return (Tk ha^{-1})	Net return (Tk ha^{-1})	TVC (Tk ha^{-1})	BCR
	Grain	Straw				
T_1:Control	2.84	4.05	26770	-	-	-
T_2:70% NPKS	4.65	5.56	42760	15990	4070	3.92
T_3 :100% NPKS	5.42	6.28	49640	22870	5813	3.93
T_4:70% NPKS +RS	4.78	6.12	44360	17590	5820	3.02
T_5:70% NPKS +DH	5.10	6.50	47300	20530	5870	3.50
T_6:70% NPKS+MBR	5.27	6.39	48550	21780	6270	3.47
T_7:70% NPKS +CD	4.91	6.15	45430	18660	5820	3.21
T_8:70% NPKS +PM	5.52	6.73	50890	24120	5570	4.33

Based on the findings of the experiment, it may be concluded that for efficient production of T. aman rice, it is judicial to use organic manure or crop residues with chemical fertilizers.

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