Integrated use of cowdung and inorganic fertilizer on the performance of modern varieties of transplanted *aman* rice

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Abstract: An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh from June to December 2013 to study the effect of integrated use of cowdung and inorganic fertilizer on the performance of modern varieties of transplanted *Aman* rice viz. BR11, BRRI dhan56 and BRRI dhan57 and six levels of cowdung viz. 0, 5, 7.5, 10, 12.5, and 15 t ha^{-1} with BRRI recommended doses of inorganic fertilizers. The experiment was laid out in a randomized complete block design with four replications. Variety showed significant effect on yield contributing characters and grain yield. Significantly highest grain yield (6.11 t ha^{-1}) was obtained from BR11. The lowest grain yield (4.70 t ha^{-1}) was obtained from BRRI dhan57. Cowdung at 7.5 t ha^{-1} with BRRI recommended doses of inorganic fertilizers significantly produced highest grain yield (5.62 t ha^{-1}) and the plots receiving only inorganic fertilizers produced significantly lowest grain yield (5.07 t ha^{-1}). The effect of interaction between variety and fertilizer management showed significant variation on grain yield, although their effects on some crop characters and yield contributing characters were insignificant. The highest grain yield (6.25 t ha^{-1}) was produced by BR11 fertilized with cowdung at 7.5 t ha^{-1} and recommended doses of inorganic fertilizers.
Key words: Variety, Fertilizer management, Cowdung, Grain yield.

Introduction

Depletion of soil fertility is a major constraint for higher crop production in Bangladesh. Most of the cultivated soils contain less than 1.5% organic matter and on the other hand addition of organic matter is very low. A suitable combination of organic and inorganic sources of nutrients is very essential for sustainable crop yield. Khan *et al.* (2007) concluded that integrated nutrient management not only provides good scope for increasing yield but also maintain better soil fertility status. Among the management practices, application of organic fertilizers such as cowdung is more profitable and economic than other inorganic fertilizers to avoid attack of insects, pests and diseases. Cowdung plays a key role in rice production and it required in larger amount compared to other inorganic fertilizers. Effects of cowdung in the vegetative growth, development and yield have been widely recognized, particularly after the release of modern varieties (BRRI, 1990). The long term research of Bangladesh Rice Research Institute (BRRI) reveals that the application of dung manure at 5 t ha^{-1} y^{-1} improved soil resource from degradation (Bhuiyan, 1994). The efficient organic fertilizer management can increase crop yield and reduce production cost. It is essential to determine the optimum organic fertilizer dose to maximize rice yield under those circumstances. Along with variety and climatic factors, improved cultural practices can play an important role in augmenting the yield of rice. Cultivation of modern HYV rice can open a considerable opportunity in increasing rice production in Bangladesh. Therefore, yield performance of HYV rice must be studied in relation to various levels of cowdung with inorganic fertilizers. In intensive cropping system information regarding HYV rice and level of cowdung, integrated with inorganic fertilizers for transplanted *Aman* rice are meagre. So a suitable combination of variety and the rate of cowdung with inorganic fertilizers are necessary in order to obtain optimum yields. Therefore, the present study was undertaken to see the effects of cowdung with inorganic fertilizer on the performance of modern high yielding transplanted *Aman* rice.

Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, from June to December 2013 with a view to finding out the effect of integrated use of cowdung and inorganic fertilizers on the performance of modern varieties of transplanted *Aman* rice. The experimental site was medium high land belonging to Old Brahmaputra Floodplain (AEZ-9) (UNDP and FAO, 1988). The soil of the experimental field was more or less neutral in reaction having pH 6.5 and low in organic matter and fertility level. The experiment comprised three varieties viz. BR11 (V_1), BRRI dhan56 (V_2) and BRRI dhan57 (V_3) and six levels of cowdung viz. 0 tha^{-1} (F_1), 5 tha^{-1} (F_2), 7.5 tha^{-1} (F_3), 10 t ha^{-1} (F_4), 12.5 tha^{-1} (F_5), and 15 tha^{-1} (F_6) with BRRI recommended doses of inorganic fertilizers (Table1). The experiment was laid out in a randomized complete block design with four replications.

Table 1. BRRI recommended doses of inorganic fertilizers

Varieties	Urea (Kg ha^{-1})	TSP (Kg ha^{-1})	MoP (Kg ha^{-1})	Gypsum (Kg ha^{-1})	Zinc (Kg ha^{-1})
BR11	179.28	97.11	70.96	59.76	11.20
BRRI dhan56	164.34	89.64	56.02	52.29	7.47
BRRI dhan57	164.34	89.64	56.02	52.29	7.47

Source: BRRI rice production training module, 2013

Except urea all fertilizers were applied during final land preparation. Urea was top dressed in three equal splits at 15, 30 and 45 days after transplanting (DAT). Intercultural operations such as gap filling, weeding and pest management were done as and when necessary. Two modern varieties (BRRI dhan56 and BRRI dhan57) matured earlier than BR11 varieties. So the crop was harvested at maturity (when 90% grains become mature) on different dates from 15 November to 12 December 2013. The data on different agronomic characters were

recorded from the randomly selected five hills (excluding border hills and central 1 m X 1m) in each plot and those on grain and straw yields were recorded from the central 1 m^2 plot. All the data were analyzed using the "analysis of variance" technique and the mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Varietal performance: Crop characters, yield and yield components were significantly influenced by variety (Table 2). The tallest plant (107.50 cm) found in BR11 followed by BRRI dhan57 (106.32 cm) and the shortest one was found (100.93 cm) in BRRI dhan56. Variation in plant height might be due to different genetic make-up. These results were in consistent to those of Khisha (2002) and Rahman (2003) who recorded variable plant height among varieties. BR11 produced the highest number of total tillers $hill^{-1}$ (10.69) and effective tillers $hill^{-1}$ (9.41) which were statistically identical with BRRI dhan56 whereas the lowest values were recorded in BRRI dhan57. This result agreed with the findings of Kabir *et al*. (2004). BR11 and BRRI dhan57 produced longer panicle (23.27 cm) compared to BRRI dhan56 (22.68 cm). Islam *et al*. (2010) reported that panicle length influenced with variety. The highest number of total spikelets $panicle^{-1}$ (137.12), grains $panicle^{-1}$ (116.85) and sterile spikelets $panicle^{-1}$ (20.28) were found in BRRI dhan57 compared to BRRI dhan56 and BR 11. BRRI (1991) reported that the number of spikelets $panicle^{-1}$ was influenced significantly due to varietal differences. Yesmin (2007) found significantly different number of grains $panicle^{-1}$ among the varieties. The highest 1000-grain weight (26.82g) was found in BR11 and the lowest one (17.97g) in BRRI dhan57. The variation in weight of 1000 grains might be due to different sizes of grains that were partly controlled by genetic make–up of the studied varieties. Islam *et al.* (2010) also expressed similar view. BR11 produced the highest grain (6.11 tha^{-1}) followed by BRRI dhan56 (5.03 tha^{-1}) and the lowest one (4.70 tha^{-1}) was produced in BRRI dhan57. Grain yields differed due to varietal differences. Similar results were reported elsewhere (Sohel *et al.*, 2009 ; Tyeb *et al*., 2013 ; Kirttania *et al*., 2013 and Mondal *et al.*, 2013). The highest straw yield (6.38 tha^{-1}) and biological yield (12.49 tha^{-1}) were found in BR11 compared to other vatieties. The highest harvest index (49.64 %) was found in BRRI dhan56 followed by BR11 and the lowest one was recorded in BRRI dhan57. Kabir *et al*. (2004) and Tyeb *et al.* (2013) reported that variety had significant influence on harvest index.

Table 2. Effect of variety on yield contributing characters and yield of transplanted *Aman* rice

Varieties	Plant height (cm)	Total tillers $hill^{-1}$	Effective tillers hill-1	Length of panicle (cm)	No. of total spikelets $panicle^{-1}$	No. of grains $panicle^{-1}$	No. of sterile spikelets $panicle^{-1}$	1000- grain weight (g)	Grain Yield ($t\ ha^{-1}$)	Straw yield ($t\ ha^{-1}$)	Biological yield ($t\ ha^{-1}$)	Harvest Index (%)
BR11	107.50a	10.69a	9.41a	23.27a	130.01b	113.59b	16.42c	26.82a	6.11a	6.38a	12.49a	48.92ab
BRRI dhan56	100.93c	10.35a b	9.14ab	22.68b	119.74c	100.83c	18.91b	22.63b	5.03b	5.10c	10.13b	49.64a
BRRI dhan57	106.32b	9.02b	7.18b	23.27a	137.12a	116.85a	20.28a	17.97c	4.70c	5.40b	10.10b	46.56b
CV (%)	7.55	8.05	9.44	8.23	7.25	15.32	13.31	4.77	5.95	5.28	4.49	4.23
Level of sign.	**	**	**	**	**	**	**	**	**	**	**	**

In a column, figures having same letter (s) or without letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per DMRT. **= Significant at 1% level of probability.

Table 3. Effect of fertilization on yield contributing characters and yield of transplanted *Aman* rice

Fertilizer Management	Plant height (cm)	Total tillers $hill^{-1}$	Effective tillers $hill^{-1}$	Length of panicle (cm)	No. of total spikelets $panicle^{-1}$	No. of grains $panicle^{-1}$	No. of sterile spikelets $panicle^{-1}$	1000 -grain weight (g)	Grain Yield ($t\ ha^{-1}$)	Straw yield ($t\ ha^{-1}$)	Biological yield ($t\ ha^{-1}$)	Harvest Index (%)
F_1	102.49b	9.64b	8.19b	22.81	124.65c	104.52d	20.13a	22.41	5.07c	5.50c	10.57b	47.95
F_2	105.04ab	9.81b	8.30b	23.27	131.18ab	112.02abc	19.16a	22.50	5.44b	5.64b	11.10ab	49.18
F_3	107.39a	10.93a	9.58a	22.77	131.58ab	117.86a	13.72b	22.43	5.62a	6.01a	11.63a	48.34
F_4	105.77ab	10.17ab	8.85ab	23.19	132.21a	114.08ab	18.13ab	22.56	5.22c	5.51c	10.73a	48.62
F_5	105.50ab	9.80b	8.25b	23.46	128.21bab	106.09cd	22.12a	22.49	5.20c	5.51c	10.71a	48.57
F_6	103.30b	9.78b	8.26b	22.95	125.92bc	107.97bcd	17.96ab	22.46	5.12c	5.35c	10.47b	48.85
CV (%)	7.55	8.05	9.44	8.23	7.25	15.32	13.31	4.77	5.95	5.28	4.49	4.23
Level of sign.	**	*	**	NS	**	**	*	NS	**	**	**	NS

In a column, figures having same letter (s) or without letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per DMRT. NS= Non significant, **= Significant at 1% level of probability, *= Significant at 5% level of probability. F_1= BRRI Recommended doses of inorganic fertilizers (N, P, K, S and Zn), F_2= 5 t ha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers, F_3= 7.5 t ha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers, F_4= 10 t ha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers, F_5= 12.5 t ha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers, F_6= 15 t ha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers.

Effect of fertilizer management: Crop characters, yield and yield components were affected by fertilizer management. The tallest plant (107.39 cm) was found with 7.5 $^{tha-1}$ cowdung and BRRI recommended doses of inorganic fertilizers which was statistically identical with cowdung 5 tha^{-1}, 10 tha^{-1} and 12.5 tha^{-1} with inorganic fertilizers. The lowest plant height (102.49 cm) was obtained from only BRRI recommended doses of inorganic fertilizers. It was found that cowdung can supply a good amount of plant nutrients and thus can contribute to plant growth (Saha *et al*., 2007). The highest number of total tillers $hill^{-1}$ (10.93) and effective tillers $hill^{-1}$ (9.58) was obtained from the application of 7.5 tha^{-1} cowdung with inorganic fertilizers which was statistically identical with 10 tha^{-1} cowdung and inorganic fertilizers and the lowest value was recorded in only BRRI recommended doses of inorganic fertilizers. The highest number of total spikelets

panicle^{-1} (132.21) found in 10 tha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers while the highest number of grains panicle^{-1} (117.86) was found in 7.5 tha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers. The lowest number of total spikelets (124.65) and grains (104.52) panicle^{-1} were found in only BRRI recommended doses of inorganic fertilizers. The highest number of sterile spikelets panicle^{-1} (22.12) was obtained from application of cowdung 12.5 ha^{-1} with inorganic fertilizers and lowest (13.72) from the application of cowdung 7.5 tha^{-1} with inorganic fertilizers. The highest grain yield (5.62 tha^{-1}) was produced by cowdung 7.5 t ha^{-1} with inorganic fertilizers and the lowest grain yield (5.07 tha^{-1}) was recorded from control treatment (no use of cowdung). Application of cowdung encouraged the vegetative growth in terms of plant height and number of tillers hill^{-1} which ultimately resulted in the increase of grain yield (Mishra *et al.*, 2003). The highest straw yield (6.01 t ha^{-1}) was obtained from cowdung 7.5 t ha^{-1} with inorganic fertilizers and the lowest (5.35 t ha^{-1}) from control treatment. The highest biological yield (11.63 tha^{-1}) was recorded when the cowdung rate was 7.5 tha^{-1} with inorganic fertilizers which was statistically identical with 10 tha^{-1} and 12.5 tha^{-1} cowdung with inorganic fertilizers. The lowest biological yield (10.47 tha^{-1}) was found in 15 ton cowdung ha^{-1} with inorganic fertilizers which was statistically identical with control treatment (no use of cowdung) (Table 3).

Table 4. Effect of interaction between variety and fertilization on yield contributing characters and yield of transplanted *Aman* rice

Interaction on (Variety× Fertilizer Management)	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	Length of panicle (cm)	Total spikelets panicle^{-1}	No. of grains panicle^{-1}	No. of sterile spikelets panicle^{-1}	1000 -grain weight (g)	Grain Yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
$V_1 \times F_1$	105.68	9.55	8.68	23.00	117.81cd	99.73fg	18.08	26.40	5.88b	6.27ab	12.15c	48.39
$V_1 \times F_2$	107.60	10.95	9.65	23.20	136.42ab	121.37abc	15.04	27.01	6.24a	6.48ab	12.72ab	49.08
$V_1 \times F_3$	110.50	11.55	10.41	23.31	139.21a	127.09a	12.12	26.92	6.25a	6.57a	12.82a	48.74
$V_1 \times F_4$	109.30	11.10	9.45	23.43	139.82a	122.38ab	17.44	27.10	6.02ab	6.22ab	12.24bc	49.24
$V_1 \times F_5$	107.70	10.69	9.35	23.35	127.78bc	110.15c-f	17.63	26.78	6.18a	6.62a	12.80a	48.30
$V_1 \times F_6$	105.85	10.55	8.90	23.36	119.06cd	100.82efg	18.24	26.71	6.08ab	6.14b	12.22bc	49.78
$V_2 \times F_1$	96.35	9.18	7.98	22.26	115.98d	104.31efg	18.22	22.64	4.92def	4.95efg	9.87f	49.84
$V_2 \times F_2$	101.53	10.88	9.63	22.62	117.59cd	96.10g	21.49	22.27	5.12de	4.84g	9.96f	51.39
$V_2 \times F_3$	102.83	11.30	10.35	22.01	121.48cd	107.44d-g	14.04	22.59	5.47c	5.36cde	10.83de	50.51
$V_2 \times F_4$	99.25	10.86	9.70	22.95	122.53cd	101.95efg	14.03	22.81	5.07def	4.92fg	9.99d	50.79
$V_2 \times F_5$	104.00	10.00	8.75	23.77	123.07cd	96.02g	27.05	22.80	4.82efg	4.99efg	9.81d	49.18
$V_2 \times F_6$	101.65	9.63	8.41	22.48	117.80cd	99.19fg	18.62	22.68	4.80fgh	4.82g	9.62d	49.92
$V_3 \times F_1$	105.45	8.48	6.50	23.16	133.62ab	109.53c-f	24.09	18.03	4.42i	5.28c-f	9.70d	45.63
$V_3 \times F_2$	106.00	9.20	7.45	24.01	139.53a	118.58a-d	20.95	18.24	4.97def	5.61c	10.58e	47.06
$V_3 \times F_3$	108.85	9.95	8.00	23.00	134.05ab	119.07a-d	14.99	17.77	5.16d	6.11b	11.27d	45.77
$V_3 \times F_4$	108.75	9.10	7.40	23.19	140.84a	117.91a-d	22.93	17.77	4.58ghi	5.41cd	9.99f	45.84
$V_3 \times F_5$	104.80	8.70	6.60	23.26	133.79ab	112.10b-e	21.69	18.05	4.59ghi	4.92fg	9.51f	48.22
$V_3 \times F_6$	102.40	8.67	6.50	23.01	140.90a	123.89ab	17.01	17.99	4.49hi	5.09d-g	9.56f	46.85
CV (%)	7.55	8.05	9.44	8.23	7.25	15.32	13.31	4.77	5.95	5.28	4.49	4.23
Level of sign.	NS	NS	NS	NS	**	**			*	**	**	**

In a column, figures having same letter (s) or without letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per DMRT. NS= Not significant, **= Significant at 1% level of probability, *= Significant at 5% level of probability. V_1= BR11, V_2= BRRI dhan56, V_3= BRRI dhan57, F_1= BRRI Recommended doses of inorganic fertilizers (N, P, K, S and Zn), F_2= 5 t ha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers, F_3= 7.5 t ha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers, F_4= 10 t ha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers, F_5= 12.5 t ha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers, F_6= 15 t ha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers.

Interaction effect: Number of total spikelets panicle^{-1}, grains panicle^{-1}, grain yield and straw yields were significantly influenced by various interactions. The highest number of total spikelets panicle^{-1} (140.90) was obtained from BRRI dhan57 fertilized with 15 tha^{-1} cowdung with inorganic fertilizers which was statistically similar with others combinations BR11 and 7.5 tha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers , BR11 and 10 tha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers, BRRI dhan57 and 5 tha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers and also BRRI dhan57 and 10 t ha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers (Table 4). The lowest number of total spikelets panicle^{-1} (115.98) was obtained from BRRI dhan56 and only use of inorganic fertilizers. BR11 produced the highest number of grains panicle^{-1} (127.09) when fertilized with cowdung 7.5 tha^{-1} and recommended doses of inorganic fertilizers on the other hand BRRI dhan56 produced the lowest number of grains panicle^{-1} (96.02) when fertilized with 12.5 tha^{-1} cowdung and recommended doses of inorganic fertilizers. The highest grain yield (6.25 tha^{-1}) was obtained from BR11 when fertilized with cowdung 7.5 tha^{-1} and recommended doses of inorganic fertilizers which was as good as BR11 with 5 tha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers, BR11 with 10 tha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers, BR11 with 12.5 tha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers and BR11 with 15 tha^{-1} cowdung + BRRI recommended doses of inorganic fertilizers. The lowest grain yield (4.42 tha^{-1}) was obtained from the combination of variety BRRI dhan57 and application of no cowdung with inorganic fertilizers. The highest straw yield (6.62 tha^{-1}) was obtained from the interaction of BR11 and application of 12.5 tha^{-1} cowdung with inorganic fertilizers and the lowest one (4.82 tha^{-1}) was found in BRRI dhan56 with control. The highest biological yield (12.82 t ha^{-1}) was found in BR11 fertilized with cowdung 7.5 tha^{-1} + BRRI recommended doses of inorganic fertilizers which was statistically alike with BR11 fertilized with cowdung 12.5 t ha^{-1}with inorganic fertilizers. The lowest biological yield (9.51 tha^{-1}) was recorded in the combination of variety

BRRI dhan57 and application of cowdung 12.5 tha^{-1} with inorganic fertilizers.

Integrated use of cowdung with inorganic fertilizers can be an efficient practice for higher crop yield without degradation of soil fertility. BR11 performed the best for grain yield among the tested varieties. Cowdung 7.5 t ha^{-1} supplemented with inorganic fertilizers appeared as promising fertilizer management technique in terms of grain yield.

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