OnLine Journal of Biological Sciences 1 (9): 831-834, 2001

Effect of Rice Straw and Chemical Fertilizers on the Productivity and Economics of Boro Rice-Transplanted Aman Rice System

Naser H. M., N. C. Basak and M. F. Islam
On Farm Research Division, Bangladesh Agricultural Research Institute,
Joydebpur, Gazipur, Bangladesh

Abstract: In two years trial at multi location testing site, Netrakona, Bangladesh with 8 different fertilizer and straw incorporation treatments positive yield and economic response. Treatment with $^{2}/_{3}$straw + recommended fertilizer for moderate yield goal gave the highest grain (4.90 t ha^{-1}) and straw (5.46 t ha^{-1}) yields followed by T_6 i.e., the recommended fertilizer for high yield (4.74 t ha^{-1} grain and 5.32 t ha^{-1} straw). Like grain and straw yields highest gross return (TK.37030 ha^{-1}), return above variable cost (TK.26127 ha^{-1}) and benefit cost ratio (3.40) were obtained from T_3.

Key words: Rice straw incorporation, fertilization, rice yields and economics

Introduction

Boro rice-Transplanted Aman rice system is a predominant cropping pattern in Bangladesh under irrigated high to medium high land condition (BARC, 1997). Due to continuous practice of this rice based cropping system the yield level has decreased in the recent years. The situation has aggravated with no or little use of cowdung and non-practice of green manure. Now a days mostly cowdung is used as fuel and due to intensive cropping green manuring is practically not possible. On the other hand, fertilizers are out of reach to most of the farmers in Bangladesh due to higher cost, which is causing imbalance use of fertilizers. Katyal (1977) reported that yield decline due to imbalance NPK inputs may be prevented by supplying adequate doses of NPK or supplementing sub-optimal doses with green manuring.

To increase the fertility level of soil, rice straw incorporation can play a vital role in the Boro rice-T. Aman rice cropping system. Positive benefits of straw incorporation on grain and straw yields have been reported by many worker in India (Gaur and Sadasivan, 1981; Pandey *et al.*, 1985; Sharma and Mittra, 1990; Swarup, 1992; More, 1994).The Boro rice is harvested in the month of May to June and after threshing the rice grain, the straw is left here and most of which is damaged by rainwater. Because in this time sufficient rain occurs and the farmers can not dry and store the straw. However, the T. Aman rice is harvested in the dry month of November, which favours to dry and store the straw for cattle feeding. Thus the Boro rice straw can be utilized as organic residue to the succeeding T. Aman rice crop. After incorporation of this straw, it is possible to allow about one month before transplanting T. Aman rice seedlings. Straw incorporation in paddy fields produce gas like CO_2 CH_4, C_2H_4 and H_2S in huge amounts but their toxicity to rice has not been demonstrated (Neue and Scharpenseel, 1983 and Tsutsuki, 1983). To overcome the adverse effects of straw incorporation on growth due to organic acid production and N immobilization, delaying transplanting at least 1 month after straw incorporation was recommended for warmer regions (Tanaka, 1974; Beye, 1977 a).

Thus, the complementary use of rice straw with mineral fertilizer, particularly to increase efficiency of applied fertilizers and for maintaining soil fertility has got significance at present time. With this view in mind the experiment was under taken at multi location testing site, Netrakona belonging to Old Brahmaputra Floodplain under AEZ-9 during 1999-2000 to compare rice straw and fertilizer effects with the conventional practice of chemical fertilizer application on Boro rice- Fallow-T. Aman rice systems so that effective techniques and nutrient use efficiency may be developed.

Materials and Methods

The experiment was conduded at multi location testing (MLT) site, Netrakona under Bangladesh Agricultural Research Institute during February to November of 1999 and 2000. The soil of the experiment was silty loam in texture with pH 6.30, organic matter content 1.63 %, total N 0.084%, available P 15.67 ppm, available K 0.074 meq/100g soil, available S 15.17 ppm and available Zn content 1.50 ppm under AEZ-9 (Old Brahmaputra Floodplain soil). The design of the experiment was randomized complete block. The experiment was initiated with the first Boro crop. The land was divided in to 8 equal plot size of 10 x 10 m^2 for growing transplanted Aman rice with eight different treatments of straw incorporation and fertilizers. The treatment combination in T. Aman rice were given in Table 1.

About 45 days old seedlings of Boro rice (Var. BR3) were transplanted during 10-15 February, 1999 and 12-16 February, 2000. The seedlings were transplanted at a spacing of 25 x 15 cm^2. Fertilizers were applied @ 140-14-84-16-1 kg ha^{-1} of NPKSZn. One third urea and all other fertilizers were applied as basal. The remaining N was applied as topdress on 30-35 DAT and 70-75 DAT. Irrigation and other intercultural operations were done as and when necessary. The Boro rice crop was harvested during 26-28 May, 1999 and 25-30 May, 2000 at different heights as per straw incorporation treatment to be used in the next T. Aman rice. After harvest, the remaining rice straw was incorporated into the soil within a week by tilling the land with power tiller. High temperature and rainfall during the months of May and June favoured the decomposition of rice straw. The temperature and rainfall during the months of May and June, 1999 and 2000 were given in Table 2.

For transplanting the T. Aman rice the land was prepared by power tiller to incorporate and mix the rice straw well into the soil at least one week before transplanting the rice seedlings. During final land preparation one third urea and all other fertilizers were applied as basal. Nitrogen was topdressed at 30-35 DAT and 60-65 DAT. Thirty days old seedlings of T. Aman rice (Var. BR11 in 1999 and BRRI Dhan 33 in 2000) were transplanted at a spacing of 20 x 15 cm^2. Transplanting was done on 25-28 July in both the years. T. Aman rice was harvested on 20-25 November in both the years.

Table 1: Treatment combinations in T. Aman rice

Treatment	Combination
T_1	RF_2–30 kg Nha^{-1}
T_2	RF_2 + $^1/_3$ Boro rice straw
T_3	RF_2 + $^2/_3$ Boro rice straw
T_4	$^1/_3$ Boro rice straw + 65-22-25-20-5 kg NPKSZn ha^{-1}
T_5	$^2/_3$ Boro rice straw + 50-18-16-20-5 kg NPKSZn ha^{-1}
T_6	RF_1 (76-16-46-11-1.5 NPKSZn Kg ha^{-1})
T_7	RF_2 (60-8-30-4-0 NPKSZn Kg ha^{-1})
T_8	Farmers practice (65-10-10-0-0 NPKSZn Kg ha^{-1})

RF_1 = Recommended fertilizer for high yield goal
RF_2 = Recommended fertilizer for moderate yield goal

Table 2: Temperature and rainfall during the months of May and June 1999 and 2000

Month	May		June	
Year	1999	2000	1999	2000
Rainfall (mm)	378.6	466.4	216.8	479.9
Maximum temperature (^{0}C)	30.98	31.47	31.82	31.91

Source: IWMD, 2000

Table 3: Performance of Boro rice under Boro-T. Aman rice cropping system at Netrakona MLT site during 1999 and 2000

Year	Plant height (cm)	No. effective tillers hill^{-1}	No. grain panicle^{-1}	1000 grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
1999	73.38	10.93	92.82	23.30	4.06	4.49
2000	75.87	11.18	93.61	25.26	4.19	5.03

Table 4: Rice straw dry matter incorporated into the soil before T. Aman transplanting, 1999 and 2000

Treatments	Rice straw dry matter incorporated (t ha^{-1})		
	1999	2000	Mean
T_1 = RF_2 – 30 Kg N ha^{-1}		1.54	1.62
1.58			
T_2 = $^1/_3$ Straw + RF_2	2.65	2.76	2.71
T_3 = $^2/_3$ Straw + RF_2	3.74	3.95	3.85
T_4 = $^1/_3$ Straw + 65-22-5-20-5 Kg NPKSZn ha^{-1}	2.62	2.70	2.66
T_5 = $^2/_3$ Straw + 50-18-16-20-5Kg NPKSZn ha^{-1}	3.68	3.92	3.80
T_6 = RF_1(76-16-46-11-1.5 Kg NPKSZn ha^{-1})	1.51	1.65	1.58
T_7 = RF_2(60-8-30-4-0 Kg NPKSZn ha^{-1})	1.55	1.62	1.59
T_8 = Farmers practice (65-10-10-0-0 NPKSZn Kg ha^{-1})		1.57	1.69
1.63			

RF_1 = Recommended fertilizer for high yield goal.
RF_2 = Recommended fertilizer for moderate yield goal.

Data on yield and yield contributing characters were recorded and the data were analyzed statistically using ANOVA technique. The differences among the treatment means were evaluated by Duncan's New Multiple Range Test (DMRT) (Steel and Torrie, 1960). Economic analysis was done on the basis of prevailing market price of input and output (Reddy and Reddi, 1992).

Results and Discussion

Performance of Boro rice and straw incorporation : The performance of Boro rice has been presented in Table 3. Yield contributing characters like plant height, number of effective tillers hill^{-1}, number of grains panicle^{-1} and 1000 grain weight as well as grain and straw yields were better in 2000 than 1999. Grain yields in 1999 and 2000 were 4.06 t ha-^{1} and 4.19 t ha-^{1}, respectively. Straw yields in 1999 was 4.49 t ha-^{1} and that of in 2000 was 5.03 t ha-^{1}. The amount of Boro straw incorporated into in the soil before T. Aman transplanting has been presented in Table 4 showed that in all the treatments straw were incorporated though T_1, T_6, T_7 and T_8 were not straw incorporation plots. It was due to farmers general practice of harvesting Boro rice about 25-30 cm height from the ground level . However, the straw incorporated plots T_2, T_3, T_4 and T_5 received on average 2.71, 3.85, 2.66 and 3.80 t ha-^{1} of straw dry matter, respectively.

Agronomic performance of T. Aman: Yield and yield contributing characters of T. Aman (Table 5) showed that plant height in 1999 was statistically significant but in 2000 it was not significant. In both the years the straw incorporation treatments like T_2, T_3, T_4 and T_5 gave higher plant height compared to no incorporation of straw and use of low dose of fertilizer treatments (T_1 and T_8). An increase in plant height due to straw incorporation was reported by Bhuiya and Akhand (1983). Highest plant height was obtained from T_2 with 110.7 cm in 1999 and 94.22 cm in 2000 from T_4. Number of tillers hill^{-1} were also higher in some straw incorporation treatments. A number of earlier workers also reported an increase in productive tillers due to incorporation of straw/organic materials (Aganon, 1987; Rajput and Warsi, 1992; Jakhro, 1986; Bangaiah, 1995). In 1999 highest number of tiller hill^{-1} was obtained from T_2 (7.39) and in 2000 it was from T_3 (8.65). Filled grains panicle^{-1} in 1999 and 2000 was significant at 5% and 1% level, respectively. Highest number of filled grains panicle^{-1} (126.5) was obtained from T_2 in 1999 and it was 130.8 in 2000 from T_3. The 1000-grain weight was not statistically significant in any year due to straw incorporation and fertilization. This is in conformity with the findings of Maskina *et al*. (1987) and Sharma *et al*. (1987).

Grain and straw yields were not statistically significant in any year. However, increased yield in some straw incorporation treatments were observed. Ahmed *et al*. (2000) also reported higher yield of T. Aman through incorporation of Boro rice straw along with reduced level of inorganic fertilizers. In 1990 treatment T_6 i.e., recommended fertilizer for high yield goal (76-16-46-11-1.5 kg NPKSZn ha-^{1}) gave the highest grain (4.26 t ha-^{1}) and straw (4.96 t ha-^{1}) yield followed by T_3 i.e., $^2/_3$ straw + RF_2 (60-8-30-4-0 kg NPKSZn ha-^{1}) with grain yield 4.19 t ha-^{1} and 4.85 t ha-^{1} straw yield. In the second year (2000) the treatment T_3 gave the highest grain (4.90 t ha-^{1}) and straw (5.46 t ha-^{1}) yield followed by T_6 with grain yield 4.74 t ha-^{1} and straw yield 5.32 t ha^{-1}. The higher yield in the second year might be due to two years cumulative effect of straw incorporation. A number of earlier workers obtained increased grain yields due to straw incorporation over its removal (Gaur and Sadasivan, 1981; Pandey *et al*., 1985; Swarup, 1992; More, 1994 and Bangaiah, 1995). The treatments T_1 and T_8 i.e., the lower fertilizer doses with no addition of straw gave the lowest grain and straw yield.

Economic performance of T. Aman: Cost and return analysis of T. Aman in 1999 and 2000 had been presented in Table 6. Except gross return (TK. 32300 from T_6) in 1990, highest

Table 5: Effect of Boro straw and fertilizers on yield and yield contributing characters of T. Aman rice under Boro T. Aman rice cropping system at Netrakona MLT site during 1999 and 2000

Treatments	Plant height (cm)		No. tillers hill^{-1}		No. field grain panicle^{-1}		1000 grain wt. (g)		Grain yield (t ha^{-1})		Straw yield (t ha^{-1})	
	1999**	2000	1999*	2000	1999*	2000**	1999	2000	1999	2000	1999	2000
T_1	106.7b	90.65	7.26c	8.05	107.3cd	112.0e	24.80	25.68	3.80	4.00	4.30	4.89
T_2	110.7a	92.01	7.39a	8.35	126.5a	118.4d	25.25	25.70	3.93	4.34	4.68	4.95
T_3	109.2a	93.63	7.36ab	8.65	122.1abc	130.8a	24.48	26.54	4.19	4.90	4.85	4.56
T_4	110.5a	94.22	7.34abc	8.38	114.5abcd	125.5bc	24.23	26.15	4.06	4.66	4.73	5.28
T_5	109.5a	92.85	7.35ab	8.30	102.9d	123.3bc	25.25	26.18	3.96	4.68	4.76	5.16
T_6	109.7a	93.43	7.36ab	8.43	125.2ab	126.2ab	24.55	26.14	4.26	4.74	4.96	5.32
T_7	109.4a	93.20	7.31abc	8.39	115.3abcd	121.1cd	24.68	25.80	4.00	4.56	4.65	5.27
T_8	109.9a	94.20	7.30bc	8.55	109.1bcd	112.7e	25.10	25.70	3.89	4.28	4.56	5.03
Sx	0.492	NS	0.026	NS	5.106	1.205	NS	NS	NS	NS	NS	NS
CV%	1.10	3.25	0.91	6.07	10.84	2.43	5.96	3.78	9.26	12.78	11.68	13.75

Figures in column having letter(s) in common do not differ significantly but figure bearing dissimilar letter(s) differ significantly at * 5% level of probability .** 1% level of probability. NS = Not significant.

Table 6: Cost and return analysis of T. Aman rice as affected by Boro rice straw and fertilizer under Boro T. Aman rice cropping system at Netrakona MLT site during 1999 and 2000

Treatment	Gross Return (t ha^{-1})		Total variable cost (Tk ha^{-1})		Return above variable cost (Tk ha^{-1})		Benefit cost ratio	
	1999	2000	1999	2000	1999	2000	1999	2000
T_1	28750	30445	10512	10512	18238	19933	2.73	2.90
T_2	29850	32855	10903	10903	18947	21952	2.74	3.01
T_3	31755	37030	10903	10903	20852	26127	2.91	3.40
T_4	30785	35260	12195	12195	18590	23065	2.52	2.89
T_5	30100	35340	11588	11588	18512	23752	2.60	3.05
T_6	32300	35840	12329	12329	19971	23511	2.62	2.91
T_7	30325	34555	10935	10935	19390	23620	2.77	3.16
T_8	29510	32475	9689	9689	19821	22786	3.05	3.35

*Total Variable cost includes cost of seed, fertilizer, insecticide, man and animal labour.

Price: Rice seed: Tk. 13 kg^{-1}, Rice nonseed: Tk. 7 kg^{-1}, Rice straw: Tk. 0.50 kg^{-1}

gross return (TK. 37030 ha-^{1} in 2000), return above variable cost (TK.20852-26127 ha-^{1}) and benefit cost ratio (2.91-3.40) were obtained from T_3 i.e., $^{2}/_{3}$ straw + RF_2 (60-8-30-4-0 kg NPKSZn ha-^{1}).In farmers practice the total variable cost was the lowest (TK.9689 ha-^{1}) which contributed better benefit cost ratio (3.05-3.35) though its gross return (TK.29510-32475 ha-^{1}) was less compared to other treatments except T_1 (i.e, recommended fertilizer for moderate yield goal minus 30 kg N ha-^{1}).

From the above discussion it is clear that the incorporation of Boro rice straw has positive influence on the yield of succeeding T. Aman rice. Here, incorporation of $^{2}/_{3}$ rd Boro rice straw along with reduced level of inorganic fertilizers gave higher yield as compared to that obtained from full fertilizer supplied from inorganic source alone. As rice straw is a cheaper and easily available source at farm level, it can be recommended that the farmers should use the rice straw along with reduced rate of inorganic fertilizers to obtained higher yield and economic return from Boro rice-T.Aman rice system.

References

Aganon, C.P., 1987. Rice hulls as organic fertilizer on transplanted rice. IRRN., 12: 40.

Ahmed, M.M., M.F. Haq and M. F. Haque, 2000. Uses of Organic Manure and Crop Residues in Crop Production and Soil Fertility Management: On-Farm Research Experience. In: The Status of Integrated Plant Nutrition Systems (IPNS) in Bangladesh, SFFP, Dept. Agric. Extension, Bangladesh, pp: 37-41

Bhuiya, M.R. and M.S. Akhand, 1983. Effect of different sources of organic materials alone and in combination with two fertilizer levels on growth parameters and composition of rice. Bangladesh J. Agric., 7:32-39.

Bangaiah, B., 1995. Residue and fertilizer management in Rice-Wheat system. Ph.D. Thesis submitted to IARI, New Delhi, India.

BARC, 1997. Fertilizer Recommendation Guide-1997. Bangladesh Agricultural Research Council, New Airport Road, Farmgate, Dhaka.

Beye, G., 1977a. Effects of ploughing under of straw and duration of flooding before transplanting on the physio-chemical properties of two rice fields on rice development and yield (In French). Agron. Trop., 32: 31-40.

Gaur, A. C. and K. V. Sadasivan, 1981. Organic manures in aid of fertilizers. Indian Fmg., 31: 31-37.

Irrigation and Water Management Department (IWMD), 2000. Weather yard, Irrigation and water management department, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Jakhro A.A., 1986. Yield response of rice to unburned and burned rice husk. IRRN., 11: 25.

Katyal, J.C., 1977. Influence of organic matter on the chemical and electro-chemical properties of some flooded soils. Soil Biol. Biochem., 9: 259-266.

Maskina, M .S., Y. Singh and B. Singh, 1987. Wheat straw management for rice on a coarse textured soil. IRRN., 12: 40.

More, S. D., 1994. Effect of farm wastes and organic manures on soil properties, nutrient availability and yield of rice- wheat grown on sodic vertisol. J. Indian Soc. Soil. Sci., 42: 253-256.

Neue, U. and H. W. Scharpenseel, 1983. Gaseous products in submerged soils. In: Organic matter and rice. IRRI, Los Banos, Philippines, pp: 315-332.

Pandey, S.P., H. Shankar and V. K. Sharma, 1985. Efficiency of some organic and inorganic residues in relation to crop yield and soil characteristics. J. Indian Soc. Soil Sci., 33: 179-181.

Reddy, T. Y. and G. H. S. Reddi, 1992. Principles of Agronomy. Kalyani Publishers. New Delhi-110 002, India. pp: 23.

Rajput A.L. and A.S. Warsi, 1992. Effect of nitrogen and organic manure on rice (*Oryza sativa*) yield and residual effect on wheat (*Triticum aestivum*) Crop. Indian J Agron., 37: 716-720.

Sharma, H.L., C.M. Singh and S.C. Modgal, 1987. Use of organics in rice- wheat crop sequence. Indian J. Agric. Sci., 57: 163-168.

Sharma, A. R. and B. N. Mittra, 1990. Response of rice to rate and time of application of organic materials. J. Agric. Sci. Camb., 114: 249-252.

Swarup, Anand, 1992. Effect of organic amendments on the nutrition and yield of wet land rice and sodic soil reclamation. J. Indian Soc. Soil Sci., 40: 816-822.

Steel, R.G.D. and J.H. Torrie, 1960. Principles and Procedures of Statistics with Special Reference to the Biological Sciences. McGrow Hill Book Co. Inc. New York, Toronto, London. 107-109.

Tanaka, A., 1974. Methods of handling cereal crop residues in Asian countries and related problems. ASPAC Ext. Bull., pp: 43: 29.

Tsutsuki, K., 1983. Volatile products and low molecular weight phenolic products of the anaerobic decomposition of organic matter. In: Organic matter and rice. IRRI, Los Banos, Philippines. pp: 333-347.