

## RESPONSE OF T. AMAN AND BORO RICE TO RESIDUE RETENTION UNDER STRIP TILLAGE

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### Abstract

An on-farm research was conducted at Gouripur upazila under Mymensingh district of Bangladesh during *aman* and *boro* season in 2013-14 to evaluate the performance of unpuddled rice cultivation. The rice var. Hybrid Krishan2 in *aman* and BRRI dhan28 in *boro* season were transplanted by two tillage practices *viz.*, conventional tillage (CT) and strip tillage (ST) and two levels of crop residue i.e, no residue (R<sub>0</sub>) and 50% residue (R<sub>50</sub>). The experiment was designed in a randomized complete block design with four replications. ST yielded higher grains in *aman* season (5.67 t ha<sup>-1</sup>) and also in *boro* season (4.70 t ha<sup>-1</sup>) which were 9 and 13% higher compared to CT. Higher grain yield in ST leading to 26% higher BCR in *aman* and 23% higher in *boro* compared to CT. Retention of 50% residue increased by 5% yield in *aman* and by 4% yield in *boro* compared to no residue which contributed to 9% higher BCR in both *aman* and *boro*. ST combine with 50% residue retention yielded the highest grain yield in both of *aman* (5.97 t ha<sup>-1</sup>) and *boro* season (4.81 t ha<sup>-1</sup>) which attributed to obtain the highest BCR in *aman* (3.08) and *boro* (2.78).

### Introduction

Most of the farmers in the Asian continent cultivate rice (*Oryza sativa* L.) seedlings by transplanting in puddled soil for easy crop establishment (Singh *et al.*, 2014). Lands are prepared by single or two passes in dry condition followed by exposure to sun for a couple of days. Then after inundation, final land is prepared by ploughing, cross ploughing and laddering in standing water. However, this traditional puddling method is labour, fuel, time and capital consuming (Islam *et al.*, 2014). Nowadays most of tillage operations for puddling soil in Bangladesh are done by power tiller (Haque *et al.* 2008; Miah *et al.*, 2002). Puddling is detrimental to soil physical conditions (Hobbs and Morris, 1996) through destroying soil aggregates, breaking capillary pores, and dispersing the soils (Gupta *et al.*, 2003). Cloddy soil structure with less soil moisture and inadequate seed-soil contact resulted from the puddling (Sharma *et al.*, 1995) makes land preparation difficult for the following winter crops (Islam *et al.* 2014). Puddled rice transplanting consumes about 20-40 % of total water required for raising crop (Singh *et al.*, 2014) and it also promotes the formation of hard pan (Bhuiyan *et al.*, 1995), reduces soil organic carbon at double rate, and decreases soil fertility (Grace, 2003), has losses of irrigation water (Sayre and Hobbs, 2003), and damages the ecological environment (Grace, 2003). Adoption of minimum tillage may be a very good alternative to puddled transplanting as it is using widely for many crops around the world (Singh *et al.*, 2014). This technology has potentials to allow saving in labour, energy, water and time during rice establishment (Piggin *et al.*, 2002). Compared to conventional tillage, 25-26% water could be saved by strip tillage under unpuddled system (Islam *et al.*, 2012). Crop residues of cultivated crops are a significant factor for crop production through their effects on soil physical, chemical and biological functions as well as water and soil quality and increase crop yield (Kumar and Goh, 2000). Residue practice maintains soil micro-organisms and microbial activity which can also lead to weed suppression by the biological agents leading to increase crop yield (Kennedy, 1999). Considerable research work has been done on puddle transplanting, but there is alimited information on unpuddled rice transplanting under Bangladesh

condition. Therefore, the present study was conducted to examine the performance of rice to unpuddled transplanting system with the retention of crop residues.

## Materials and Methods

The experiment was conducted at farmer's field of Durbacakra, Guipure, Mymensingh, Bangladesh (the latitude of 24.75° N and the longitude of 90.50° E) during *aman* (July-Mid November) and *boro* (Mid November-June) season in 2013-14. This experimental area belongs to the Old Brahmaputra Floodplain which is characterized by dark grey non calcareous alluvium soils and these soils are mostly sandy loam under Sonatala series (Brammer, 1996). Climatic (rainfall and thermal condition) data were collected from the nearest weather station and are presented in Figure 1.

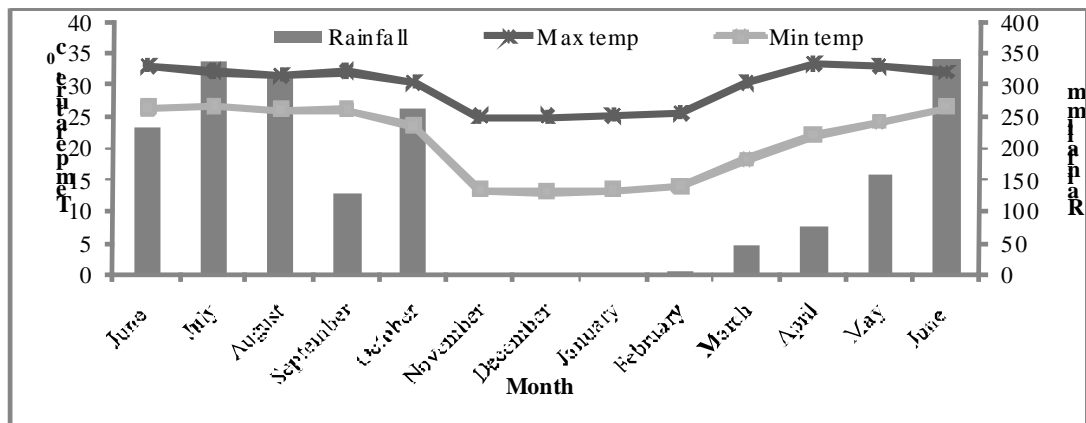


Fig.1. Monthly temperature and rainfall distribution pattern in Gouripur during the cropping season of 2013-14

[Source: Department of Irrigation and Water Management, Faculty of Agricultural Engineering and Technology, Bangladesh Agricultural University, Mymensingh]

The treatments were: (i) puddled condition conventional tillage (CT) and (ii) unpuddled condition strip tillage (ST) and two levels of crop residue *viz.*, no residue ( $R_0$ ) and 50% residue ( $R_{50}$ ). The treatments were laid out in randomized complete block design with four replications using unit plots of 9 m × 5 m. In tillage practice, CT consisted of two passes primary tillage by two wheeler tractor (2 WT) and exposed to sun for two days followed by inundating whole plot and puddling by 2WT with two passes to complete land preparation. ST was done by Versatile Strip Tillage Planter (VSTP) in single pass operation before inundating the field. Three days before ST, pre-plant Glyphosate (Roundup) was applied @ 75 ml / 10 L water. After ST, the land was inundated with 3-5 cm standing water one day before transplanting operation for making the land soft enough to transplant seedlings (Islam *et al.*, 2014). Twenty-five days old seedlings of rice var. Hybrid Krishan2 for *aman* season, and 40 days old seedlings of BRRI dhan28 for *boro* season were transplanted. Fertilizers were applied according to the recommendation of BRRI (2014). A spacing of 25 cm × 15 cm was maintained for both CT and ST with 2 or 3 seedlings hill<sup>-1</sup>. The crops were harvested at maturity from 3m × 3m each and then data were recorded. Grain yields were adjusted to 14% moisture content. Data were subjected to ANOVA using MSTAT-C and means separated by Duncan's Multiple Range Test.

## Results and discussions

### Effect of tillage practice on yield contributing characters and yield of rice

*Response of T. Aman and Boro Rice to Residue Retention Under Strip Tillage*

Yield contributing characters of rice were significantly affected due to different tillage practice except the plant height, panicle length, and thousand grain weight (Table 1). The highest numbers of effective tillers  $m^{-2}$  and numbers of fertile grains panicle $^{-1}$ , and the lowest numbers of non-effective tillers  $m^{-2}$  and numbers of sterile grains panicle $^{-1}$  were recorded from the ST compared to CT which attributed to higher yield (9% higher in *aman* and 13% higher in *boro*) for ST (Table 1). On the other hand, unpuddled rice transplanting by following ST produced higher BCR (around 25% in *aman* and 23% higher in *boro* compared to CT (Table 1).

Table 1. Effect of tillage practice on yield contributing characters and yield of rice

Tillage practice	Plant height (cm)	Effective tillers $m^{-2}$ (no)	Non effective tillers $m^{-2}$ (no)	Panicle length (cm)	Fertile grains panicle $^{-1}$ (no)	Sterile grains panicle $^{-1}$ (no)	1000-grain weight (gm)	Grain yield (t ha $^{-1}$ )	Benefit Cost Ratio
<i>Aman season</i>									
CT	110.42	209b	71a	24	139b	47a	30	5.18a	1.76b
ST	109.99	261a	44b	25	157a	29b	31	5.67b	2.21a
LSD <sub>(0.05)</sub>	NS	1.37	12.41	NS	5.48	2.55	0.41	0.22	0.13
CV (%)	2.74	12.67	11.71	2.40	3.47	2.27	1.32	0.34	4.72
<i>Boro season</i>									
CT	107.32	361b	77a	23.92	111b	35a	21.91	4.17b	2.16b
ST	105.60	382a	47b	24.39	132a	16b	23.00	4.70a	2.67a
LSD <sub>(0.05)</sub>	NS	4.60	3.00	NS	8.29	2.90	NS	0.09	0.03
CV (%)	4.60	1.20	5.68	3.84	5.14	8.88	6.83	2.10	1.24

In a column, figure with similar letter do not differ significantly whereas dissimilar letter differ significantly.

CT= Conventional tillage, ST= Strip tillage,

**Effect of residue retention on yield contributing characters and yield of rice**

Retention of 50% residue improved the numbers of effective tiller  $m^{-2}$  and the numbers of fertile grain panicle $^{-1}$  while declined the numbers of non-effective tiller  $m^{-2}$  and the numbers of sterile grain panicle $^{-1}$ , compared to no residue in both *aman* and *boro* season (Table 2).

Higher residue level yielded around 5% higher grains of Hybrid Krishan2 and 4% higher grains of BRR1 dhan28 rice which attributed to earned 9% higher BCR in both *aman* and *boro* season (Table 2).

Table 2. Effect residue level on yield contributing characters and yield of rice

Residue level	Plant height (cm)	Effective tillers $m^{-2}$ (no)	Non effective tillers $m^{-2}$ (no)	Panicle length (cm)	Fertile grains panicle $^{-1}$ (no)	Sterile grains panicle $^{-1}$ (no)	1000 grain weight (gm)	Grain yield (t ha $^{-1}$ )	Benefit Cost Ratio
<i>Aman season</i>									
R <sub>0</sub>	110.60	236b	53	24.59	148b	33a	31.70b	5.50b	2.61b
R <sub>50</sub>	109.52	265a	40	24.51	157a	29b	32.06a	5.76a	2.86a
LSD <sub>(0.05)</sub>	NS	0.79	NS	0.31	3.16	1.47	0.23	0.13	0.75
CV (%)	2.74	12.67	11.71	2.40	3.47	2.27	1.32	0.34	4.72

<i>Boro season</i>									
R <sub>0</sub>	104.90	373b	58b	24.39	100a	22a	22.71	4.52b	2.48b
R <sub>50</sub>	106.37	385a	46a	24.25	121e	17b	22.93	4.70a	2.69a
LSD <sub>(0.05)</sub>	NS	2.65	1.73	NS	4.78	1.67	NS	0.05	0.018
CV (%)	4.60	1.20	5.68	3.84	5.14	8.88	6.83	2.10	1.24

In a column, figure with similar letter do not differ significantly whereas dissimilar letter differ significantly.

R<sub>0</sub>= No residue, R<sub>50</sub>= 50% residue,

### Combination effect of tillage practice and residue level on yield contributing characters and yield of rice

Combination between tillage practice and residue level exerted significant effect on all the plant characters except plant height, panicle length and weight of thousand grain in both *aman* and *boro* season (Table 3). ST retained 50% residue produced the highest number of effective tillers m<sup>-2</sup>, and number of fertile grains panicle<sup>-1</sup>, and the lowest numbers of non-effective tiller m<sup>-2</sup> and number of sterile grains panicle<sup>-1</sup> for both in *aman* and *boro* season. CT or ST with residue yielded the higher values of these parameters compared to no residues. ST with residue yielded the highest grain yield leading to the highest BCR while CT without residue yielded the lowest grain yield consequently the lowest BCR both in *aman* and *boro* season.

Table 3. Combination effect of tillage practice and residue level on yield contributing characters and yield of rice

Tillage practice	Residue level	Plant height (cm)	Effective tillers m <sup>-2</sup> (no)	Non effective tillers m <sup>-2</sup> (no)	Panicle length (cm)	Fertile grains panicle <sup>-1</sup> (no)	Sterile grains panicle <sup>-1</sup> (no)	1000 grain weight (gm)	Grain yield (t ha <sup>-1</sup> )	Benefit Cost Ratio
<i>Aman season</i>										
CT	R <sub>0</sub>	109.30	207cd	78d	24.20	119d	53a	28.50	5.17cd	1.63c
	R <sub>50</sub>	111.55	211 c	63c	24.60	140c	43b	31.28	5.20c	1.76c
ST	R <sub>0</sub>	110.87	241b	49b	24.67	154b	29c	30.84	5.57b	2.76b
	R <sub>50</sub>	109.12	280a	35a	24.50	160a	26c	31.37	5.97a	3.08a
LSD <sub>(0.05)</sub>		NS	1.95	10.88	NS	5.76	3.60	NS	0.32	0.18
CV (%)		2.74	12.67	11.71	2.40	3.47	2.27	1.32	0.34	4.72
<i>Boro season</i>										
CT	R <sub>0</sub>	108.35	359	84a	24.35	100c	41a	21.60	4.12d	2.08d
	R <sub>50</sub>	106.30	363	70b	24.50	121b	30b	22.23	4.24c	2.24c
ST	R <sub>0</sub>	104.21	376	53c	24.40	129ab	18c	22.93	4.60b	2.56b
	R <sub>50</sub>	106.38	388	41d	24.20	139a	15c	23.07	4.81a	2.78a
LSD <sub>(0.05)</sub>		NS	6.50	4.25	NS	11.72	4.11	NS	0.13	0.045
CV (%)		4.60	1.20	5.68	3.84	5.14	8.88	6.83	2.10	1.24

In a column, figure with similar letter do not differ significantly whereas dissimilar letter differs significantly.

CT= Conventional tillage, ST= Strip tillage, R<sub>0</sub>= No residue, R<sub>50</sub>= 50% residue

The higher rice yields in ST obtained in this study are in the conformity with results of Mahajan *et al.* (2002) and Heatherly *et al.* (1994)

Residue converts to mineralized nutrients which causes sufficient crop growth and facilitates higher yield over no residue (Shrivastav, 2014 and Dahal, 2014). Straw for controlling weeds in different crops have been suggested by Devasinghe *et al.* (2011). Residues prevents weed growth and supplies organic matter for heterotrophic N fixing microorganisms, which could be utilized by succeeding crops consequently results the higher yield (Mendoza and Samson, 1999; Patnaik, 1978).

## Conclusion

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Considering the rice grain yield and BCR, it may be concluded that, unpuddled rice transplantation may be a good alternative to existing conventional practice. Farmers are likely to be benefited with the adoption of unpuddled system with the retention of crop residues in the field.

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