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Row orientation and weeding time effect on yield of *Aman* rice

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Abstract

The effect of row orientation and weeding time on growth, yield and yield attributes of transplanted Aman (T. Aman) rice *cv*. BRRI dhan41 were tested in the agronomy field laboratory of the Bangladesh Agricultural University, Mymensingh. The experiment was carried out from July to December 2017. It comprised three row orientations *viz.* east-west, north-south and haphazard planting, and four weeding times *viz.* no weeding, weeding at 20 days after transplanting (DAT), weeding at 40 DAT and weeding at 60 DAT. Plant height, total tillers per hill, effective tillers per hill, grains per panicle, grain and straw yields were greater in east-west and north-south row orientation than in haphazard planting being the highest in east-west row orientation. But within east-west and north-south row orientation, there was no significant difference on plant characters. The highest performance in yield attributes and yield was observed in weeding at 40 DAT and the lowest one was recorded in no weeding. Among the treatment combinations, the highest yield was observed in east-west row orientation with weeding at 40 DAT for BRRI dhan41.

Keywords: Row direction; Weeding; Yield; Aman rice

Introduction

Rice (*Oryza sativa* L.) is the principal food crop of Bangladesh and the agro-climatic conditions of Bangladesh are favourable for its year round cultivation. However, its per hectare yield of rice in Bangladesh is much lower compared to other rice growing countries like Australia, Japan, Korea, Pakistan and Thailand (FAO, 2018). The reasons for lower yield are manifolds: some are varietal and some are agronomical management. Due to the shortage of cultivable land, the scope of extensive cultivation of rice is very limited. Therefore, attempts should be made to increase the yield per unit area by applying improved technology and agronomical management practices. The yield of transplant *Aman* rice can be increased with the improved cultivation practices like proper row arrangement and controlling weeding time.

Among the cultural technologies, row orientation is one of the important components, manipulation of which is an essence for optimizing yield (Pandey *et al.*, 2013). Manipulating crop row orientation is a significant determinant of crop productivity and controlling weeds (Singh and Sharma, 2019). The maximum benefit from rice can be obtained from rice field if the row direction is optimum. Various experiments and works on row orientation of rice have been carried out in Bangladesh as well as in the world to find out the suitable row direction to get maximum yield (Alam *et al.*, 2015). Improper row direction may reduce the yield of rice up to 20-30% (Singh and Kaur, 2019). The correct row direction favours the plants to grow in their both aerial and underground parts through efficient utilization of solar radiation and nutrients (Hozayn *et al.*, 2012). Again,

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row orientation is an important factor to exhibit the potential yield of a variety and is needed to be considered during transplanting. A uniform distribution and proper orientation of plants over a cropped area are needed for greater light interception throughout the crop profile and maximum photosynthetic efficiency by all the leaves of a plant (Singh and Sharma, 2019). However, there is still a lack of knowledge on proper row-spacing and row direction required for maximal yield of rice varieties.

On the other hand, weeds are also considered as a major constraint among the various factors of reducing the rice yield. The experimental findings worldwide indicate that the yield loss due to weed was up to 32% in rice (Mola and Belachev, 2015). Therefore, proper weed management is essential for rice production in Bangladesh. The appropriate weeding regimes should be found out for the maximum yield of rice during cultivation. At the field level, proper row orientation and spacing could bring about this kind of benefit. Hence, timely weeding is necessary for higher grain yield and better economic return (Mola and Belachew, 2015). Therefore, planting direction must be studied in relation to weeding regime. Until recently, sufficient information in this regard is not available targeting the optimum planting direction and weeding regime for transplant *Aman* rice with special reference to BRRI dhan41 under the agroecological conditions of Bangladesh. Therefore, the present piece of research was undertaken to study the effect of row direction and weeding time on growth, and yield of transplant *Aman* rice *cv*. BRRI dhan 41.

Materials and methods

The experiment was carried out at the Field Laboratory, Department of Agronomy, Bangladesh Agricultural University, Mymensingh during the period from July to December 2017. Geographically, the experimental area is located at $24^{0}75$ N and $90^{0}50$ E at the elevation of 18 m (msl). Transplant *Aman* rice, variety BRRI dhan41 was used in the present experiment. The experiment consisted of three row orientation viz., East-West, North-South and haphzard (Farmer's practices), and four hand weedings *viz.,* No weeding, One weeding at 20 day after transplanting (DAT), One weeding at 40 DAT and One weeding at 60 DAT. The experiment was laid out in a randomized complete block design with three replications. The size of the unit plot was 4.0 × 2.5 m. Distances between block to block and plot to plot were one meter. Hill to hill and row to row distances were maintained at 15 cm and 20 cm, respectively. Urea, triple super phosphate (TSP), muriate of potash (MP), gypsum and zinc sulphate were used as source of nitrogen, phosphorus, potassium, sulphur and zinc, respectively. The dose of fertilizers was: urea 220, TSP 51, MP 60, gypsum 34 and zinc sulphate 5 kg ha^{-1} (BRRI, 2014). Total amount of TSP, MP, gypsum, borax and 33% of urea were applied at basal doses during final land preparation. The remaining 66% urea was top dressed in two equal splits at 20 and 55 days after transplanting. Thirty five day old seedlings were transplanted on 25 July 2015. Weeding was done manually as per experimental treatments. During weeding different weed species grown in the experiment at field which was collected and recorded. Panikachu, Mutha, Arail and Shama were the major weeds in the experimental field (BRRI, 2014). At harvest, ten hills were randomly selected from each plot and tagged for recording necessary data. After sampling, the whole plot was harvested and the data were converted into metric tons (mt) per hectare. The collected data were analyzed statistically following the analysis of variance (ANOVA) technique and the mean differences were adjudged by Duncan's Multiple Range Test (DMRT) using the statistical computer package program, MSTAT-C (Russell, 1986).

Table I. Effect of row orientation on morphological characters of *Amam* rice *cv.* BRRI dhan41

Row orientation	Plant height (cm)	Total tillers $hill^{-1}$ (no.)	Non-effective tillers $hill^{-1}$ (no.)	Panicle length (cm)
East-west	135.3 a	11.80 a	3.03 c	25.08
North-south	133.8 a	11.50 a	3.21 b	24.96
Haphazard†	130.4 b	10.71 b	3.42 a	24.86
F-test	**	**	*	NS
CV (%)	4.86	6.63	8.80	2.89

In a column, figures having the same letter (s) do not differ significantly as per DMRT; NS = Not significant;
*, ** = Significant at 5% and 1% level of probability, respectively; †: Farmers' practice

Results and discussion

Effects of row orientation on morphological characters

Row orientation had significant influence on plant height, number of total tillers and non-effective tillers except panicle length (Table I). Results revealed that plant height, total tillers and non-effective tillers per hill was greater in east-west and north-south row direction than in haphazard planting. East-west row direction yielded the highest values. But within east-west and north-south row orientation, there was no significant difference in the said parameters. Similar findings were also reported by Alam *et al.* (2015) in rice. They reported that plant height and tiller production per hill was greater east-west orientation than in north-south row orientation.

Effects of weeding time on morphological characters

The effect of weeding time on plant height and number of total tillers per hill was significant but there was no significant influence on number of non-effective tillers per hill and panicle length (Table II). The highest plant height (138.5 cm) and number of total tillers per hill (12.7 $hill^{-1}$) was observed in weeding at 40 DAT followed by weeding at 20 DAT. In contrast, no weeding showed the shortest plant height (124.4 cm) and lowest number of total tillers per hill (9.70 $hill^{-1}$). Results revealed that plant height and total number of tillers per hill was greater in all weeding plots than in control plot indicating weeding at any growth stages of rice has positive effect on growth and development. On the other hand, competition for nutrients, space and light in between weeds and rice crop was severe in unweeded plots and resulted in the reduced plant height. Similar results were also reported by Alam *et al*. (2015) in rice. Results further revealed that plant height was taller in all the weeded plots than in control plots and this indicated that weeding at any growth stages of rice has positive effect on growth and development. On the other hand, competition for nutrients, space and light in between weeds and rice plants was severe in unweeded plots that resulted in the reduction of plant height.

Effects of row orientation on grain yield and yield attributes

Row arrangement had significant effect on yield attributes and yield except 1000-grain weight and harvest index (Table III). Result revealed that number of effective tillers, grains per panicle, grain and straw yields were higher in east-west and north-south row direction than in haphazard planting with being the highest in east-west row direction. But within east-west and north-south row orientation, there was no significant difference in yield attributes and grain yield. The east-west planting direction had the greatest influence on the production of effective tillers per hill and grains per panicle while the haphazard planting had the least influence on the production of effective tillers per hill and grains per panicle. This response of the different row orientations might be due to that east-west orientation has the capacity to capture more solar radiation than N-S and haphazard planting which subsequently increased photosynthesis rate, particularly during high zenith angles on clear days. Such a higher rate of photosynthesis might have achieved in east-west orientation resulting in increased TDM thereby grain yield. Hozayn *et al.* (2012) observed that East-west direction working through increasing shading in between rows so affecting neighboring weeds. Alam *et al*. (2015) opined that row orientation had significant influence on grains per panicle in rice. Further, increased grain yield under E-W and N-S row orientation occurred due to the higher number of effective tillers per hill and grains per panicle compared to haphazard planting (Table III). Borger *et al*. (2010) reported that crop rows oriented at a

Table II. Effect of weeding time on morphological characters of *Amam* rice *cv.* BRRI dhan41

Weeding at	Plant height (cm)	Total tillers $hill^{-1}$ (no.)	Non-effective tillers $hill^{-1}$ (no.)	Panicle length (cm)
No weeding	124.4 b	9.70 c	3.19	24.60
20 DAT	133.6 a	12.05 a	3.31	24.82
40 DAT	138.5 a	12.70 a	3.21	25.17
60 DAT	134.5 a	10.60 b	3.17	25.04
F-test	**	**	NS	NS
CV (%)	4.86	6.63	8.80	2.89

In a column, figures having the same letter (s) do not differ significantly as per DMRT;
NS = Not-significant; ** = Significant at 1% level of probability

Table III. Effect of row orientation on yield and yield attributes of *Aman* rice *cv*. BRRI dhan41

Row orientation	Effective tillers $hill^{-1}$ (no.)	Grains $panicle^{-1}$ (no.)	Sterile spikelets $panicle^{-1}$ (no.)	1000-grain weight (g)	Grain weight $hill^{-1}$ (g)	Straw weight $hill^{-1}$ (g)	Grain yield (t ha^{-1})	Harvest index (%)
East-west	8.33 a	128.2 a	12.92 b	24.53	31.45 a	37.60 a	4.46 a	45.55
North-south	8.07 ab	123.0 ab	13.97 ab	24.46	30.09 ab	36.66 ab	4.36 a	45.10
Haphazard†	7.81 b	119.2 b	14.44 a	24.50	29.20 b	34.36 b	4.16 b	45.94
F-test	*	*	*	NS	*	*	*	NS
CV (%)	5.75	9.65	7.66	3.57	6.89	6.59	6.21	7.81

In a column, figures having the same letter (s) do not differ significantly as per DMRT; NS = Not-significant;
* = Significant at 5% level of probability; † : Farmers' practice

Table IV. Effect of weeding time on yield and yield attributes of *Aman* rice *cv*. BRRI dhan41

Weeding at	Effective tillers $hill^{-1}$ (no.)	Grains $panicle^{-1}$ (no.)	Sterile spikelets $panicle^{-1}$ (no.)	1000-grain weight (g)	Grain weight $hill^{-1}$ (g)	Straw weight $hill^{-1}$ (g)	Grain yield (t ha^{-1})	Harvest index (%)
No weeding	7.19 c	104.2 c	16.25 a	24.32	21.24 b	29.70 c	3.54 b	41.70
20 DAT	7.86 b	123.2 b	15.11 a	24.44	26.94 a	36.24ab	4.49 a	42.64
40 DAT	8.56 a	138.9 a	11.10 b	24.52	27.26 a	37.46 a	4.51 a	42.12
60 DAT	8.27 ab	122.2 b	12.93 b	24.45	25.68 a	35.10 b	4.28 a	42.25
F-test	**	**	**	NS	**	**	**	NS
CV (%)	5.75	9.65	7.66	3.57	6.89	6.59	6.21	7.81

In a column, figures having the same letter (s) do not differ significantly as per DMRT; NS = Not-significant;
** = Significant at 1% level of probability

right angle to sunlight (east-west direction) suppress weed growth through greater shading of weeds in the inter row spaces.

Effects of weeding time on grain yield and yield attributes

Weeding time had a profound effect upon grain yield and yield attributes except 1000-grain weight and the harvest index (Table IV). The highest number of effective tillers per hill (8.56) and grains per panicle (138.9) was observed of weeding at 40 DAT, resulting the highest grain yield (27.26 g $hill^{-1}$) followed by weeding at 20 DAT with same statistical rank. In contrast, the lowest number of effective tillers per hill (7.19 $hill^{-1}$) and grains per panicle (104.2 $panicle^{-1}$) as well as grain yield (21.24 g $hill^{-1}$) was recorded in no weeding plants. Mondal *et al*. (2013) reported weed interference decreased tiller number and grain weight that supported the present results. Similar results were also observed in case of straw and grain yields (Table IV). On the other hand, the greater sterile spikelets per $panicle^{-1}$ (16.25 $panicle^{-1}$) was recorded in no weeding plants than the weeding plants. Again, among the weeding treatments, weeding at 40 DAT showed the lowest sterile spikelets per $panicle^{-1}$ (11.10 $panicle^{-1}$). Crop and weed interactions largely involve the competition for light, water and nutrients (Mola and Belachew, 2015). Reduced number of grains per panicle under haphazard planting might be due to competition between weeds and rice plants for soil nutrients and solar energy resulting lower production of assimilates because of less photosynthesis which is not capable to supply available assimilates to the spikelets (Borger *et al*., 2010). Further, the grain yield of rice showed increasing trend with early weeding compared to late weeding. Late weeded rice field gave significantly the lower grain yield irrespective of early weeded. This result is supported by Mohammadi and Amiri

Table V. Interaction effect of row orientation and weeding time on grain yield and yield attributes of *Aman* rice *cv.* BRRI dhan41

Interaction (row orientation × weeding time)	Effective tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})
East-west × No weeding	7.53 d-f	110.5 g	15.17 a-c	24.35	3.81 e
East-west × Weeding at 20 DAT	8.07 cd	125.8 de	14.17 bc	24.53	4.77 bc
East-west × Weeding at 40 DAT	8.93 a	148.1 a	10.11 d	24.62	4.83 a
East-west × Weeding at 60 DAT	8.80 ab	128.4 cd	12.25 c	24.62	4.53 cd
North-south × No weeding	7.35 ef	102.1 h	16.28 a	24.28	3.53 e
North-south × Weeding at 20 DAT	8.00 c-e	125.5 de	15.25 ab	24.34	4.50 cd
North-south × Weeding at 40 DAT	8.53 abc	136.3 b	11.35 d	24.36	4.62 b
North-south × Weeding at 60 DAT	8.41 abc	120.2 ef	13.00 bc	24.80	4.38 de
Haphazard† × No weeding	7.00 f	100.0 h	17.30 a	24.35	3.29 e
Haphazard × Weeding at 20 DAT	7.82 c-e	118.4 f	15.92 ab	24.41	4.20 de
Haphazard × Weeding at 40 DAT	8.23 a-d	132.3 bc	11.82 d	24.55	4.39 b
Haphazard × Weeding at 60 DAT	8.20 b-d	118.1 f	13.55 bc	24.70	4.23 de
F-test	**	*	*	NS	*
CV (%)	5.75	9.65	7.66	3.57	6.21

In a column, figures having the same letter (s) do not differ significantly as per DMRT; NS = Not-significant;
*, ** = Significant at 5% and 1% level of probability, respectively; † : Farmers' practice

(2011) who stated that there is not much competition from weeds once the crop is well established but it is always important getting rid of all weeds when the crop is in the very early stages of vegetative growth. Din *et al.* (2016) reported that grain yield reduces due to delay in weeding as compared to early wedding that supported the present results.

Interaction of row orientation and weeding regime on yield attributes and grain yield

The interaction effect between row orientation and weeding time on grain yield and yield attributes were significant except 1000-grain weight (Table V). The highest number of effective tillers per hill, grains per panicle and grain yield was observed in east-west row direction with weeding at 40 DAT. In contrast, the lowest yield attributes and grain yield was recorded in no weeding with any row orientation.

Conclusion

Based on the results, it may be concluded that east-west planting direction with one weeding at 40 DAT appears to be the best among the treatments regarding growth, yield and yield attributes of BRRI dhan41 rice in South Asia.

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