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Short communication

DETERMINATION OF ROW SPACING BASED ON MORPHO-PHYSIOLOGICAL CHARACTERS IN AUS RICE

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ABSTRACT

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A field experiment was conducted at the field laboratory of the Bangladesh Agricultural University, Mymensingh, during the period from April to August 2011 to investigate the effect of variety and row spacing on morpho-physiological characters, yield attributes and yield of Aus rice. The experiment comprised of four Aus rice varieties *viz*., BR-26, BRRI dhan42, BRRI dhan43 and BRRI dhan48 and four row spacings *viz*., 15, 20, 25 and 30 cm. The hill to hill distance was 15 cm. The experiment was laid out in two factors randomized complete block design with three replications. Results revealed that plant height increased with decreasing row spacing while number of effective tillers, non-effective tillers and total tillers plant^{-1}, total dry mass hill^{-1}, absolute growth rate, relative growth rate, filled and unfilled grains hill^{-1} increased with increasing row spacing. However, in case of unit area basis, the seed and straw yield and harvest index (HI) was greater at closer row spacings than wider row spacings. The higher grain and straw yield per hectare and HI was observed in 15 and 20 cm row spacings with being the highest in 20 cm row spacing (3.42 and 5.68 t ha^{-1} for grain and straw yield, respectively). In contrast, the lowest seed and straw yield per hectare was recorded in 30 cm row spacing for lower accommodation of plants per unit area. The results indicated that 15 cm row spacing is optimum for BRRI dhan42 and BRRI dhan43, and 20 cm row spacing is optimum for BR-26 and BRRI dhan48 for getting maximum grain yield.

Key words: *row spacing, rice, yield*

INTRODUCTION

Rice (*Oryza sativa* L.) is the most extensively cultivated crop and the staple food of Bangladesh and occupied 75% of the total cultivated area. The yield of rice is much lower compared to other rice growing countries like Australia, Japan, Korea, Pakistan and Thailand (FAO 2007). The reasons for low yield are manifolds: some are varietal; some are climatic and some are agronomic management. The domestic production of this crop cannot entirely meet up the requirement of teeming hungry millions people of the country. Due to the shortage of land, the scope of its extensive cultivation is very limited. Therefore, attempts must be made to increase the yield per unit area by applying improved technology and management practices. The yield of transplant Aus rice can be increased with the improved cultivation practices like proper spacing with appropriate cultural practices.

Agronomic research, in general aims at improving cultural practices of crop varieties to realize optimum yield. Row spacing is one of the main factors that has an important role on growth and yield of rice. Optimum row spacing ensures proper growth of the aerial and underground parts of the plant through efficient utilization of solar radiation, nutrients, land as well as air spaces and water. There are two general concepts to describe the relationship between plant density and seed yield. Firstly, irrespective of plant spacing within and among rows, plant density must be such that the crop develops a canopy able to intercept more than 95% of the incoming solar radiation during reproductive growth and secondly, a nearly equidistant plant arrangement minimizes interplant competition and produces maximum seed yield. Baloach *et al.* (2002) reported that appropriate row spacing and cultivar is necessary for obtaining high yield and quality of rice. The optimum row spacing for higher yield may differ from cultivar to cultivar and location to location. Research report on effect of row spacing on Aus rice seed yield is scarce in Bangladesh. Therefore, the present study was undertaken to find out optimum row spacing for maximizing grain yield based on morpho-physiological attributes of recently released Aus rice varieties.

MATERIALS AND METHODS

The experiment was conducted at the experimental field of the Bangladesh Agricultural University, Mymensingh ($24^0 75''$ N and $90^0 50''$ E), Bangladesh during the period from April to August 2011. Four widely cultivated varieties namely BR-26, BRRI dhan42, BRRI dhan42 and BRRI dhan48 were used in the experiment. Four row spacings of 15, 20, 25 and 30 cm were considered in the experiment. Here we considered row spacing range 15-30 cm because of the farmers in Bangladesh are generally practice row spacing of 20-25 cm. Within row, the hill to hill distance was 15 cm. A split plot layout with three replications was used where variety was placed in the main plot and row spacing was placed in the sub-plot. The land was prepared properly with ploughing and laddering. The unit plot size was 3.0 m × 3.0 m. Distances between two blocks and between two plots were 1.0 and 0.5 m, respectively. A fertilizer dose of 75-60-34-5.0 kg ha^{-1} of TSP, MP, gypsum and zinc sulphate, respectively, was applied at the time of final land preparation. Urea was applied @ 200 kg ha^{-1} at three times equal splits at 15, 35 and 50 days after transplanting (BARC 2005). Thirty-day old seedlings were transplanted 10 April 2011 at the rate two seedlings hill^{-1} maintaining different spacings according to treatments.

Different intercultural operations such as weeding, irrigation and pesticide spray were done as and when necessary. To growth study, two harvests were made at 35 and 50 DAT. The second and third rows of each plot were used for sampling. Five hills from each plot were randomly selected and uprooted for obtaining data of necessary parameters. The plants were separated into leaves, stems and roots and the corresponding dry weights were recorded after oven dry at 80 ± 2 ^{0}C for 72 hours. The growth analyses like absolute growth rate and relative growth rate were analyzed according to Hunt (1978).

The yield contributing characters were recorded at harvest from ten competitive plants of each plot. Maturity period was counted when the grains turned into yellowish colour. The grain and straw yield was recorded from plot and converted into grain weight hectare^{-1}. Harvest index was determined as: (Grain yield plot^{-1} ÷ biological yield plot^{-1}) × 100. The collected data were analyzed statistically by using computer package programme, MSTAT-C (Russell 1986).

RESULTS AND DISCUSSION

Results revealed that plant height increased with decreasing row spacing while number of effective tillers, non-effective tillers and total tillers plant^{-1}, total dry mass (TDM) hill^{-1}, absolute growth rate (AGR) and relative growth rate (RGR) increased with increasing row spacing (Table 1). The highest plant height (101.8 cm) was observed in closer row spacing of 15 cm followed by 20 cm row spacing (99.4 cm) and the lower was recorded in wider row spacing of 25 and 30 cm (98.1 cm). The taller plant in densely populated plants might have resulted due to competition for sunlight than those of wider spacings. The highest number of effective tillers hill^{-1} (13.62), non-effective tillers hill^{-1} (3.99) and total tillers hill^{-1} (17.62) was observed in wider row spacing of 30 cm and the lowest was recorded in closer row spacing of 15 cm (10.08, 3.23 and 13.24 for effective, non-effective and total tiller number hill^{-1}, respectively). The highest TDM (27.84 g hill^{-1}), AGR (1.26 g hill^{-1} day^{-1}) and RGR (77.32 mg g^{-1} day^{-1}) was recorded in wider row spacing of 30 cm followed by 25 cm row spacing with same statistical rank. The lowest TDM (20.81 g hill^{-1}), AGR (0.91 g hill^{-1} day^{-1}) and RGR (70.45 mg g^{-1} day^{-1}) was recorded in closer spacing of 15 cm. Reduction in TDM hill^{-1} in closer row spacing might be due to increased number of plants per unit area. This increased number of plants per unit area exerted competition among plants for nutrients and light that caused a reduction in photosynthetic area (leaf area) resulting lower TDM production hill^{-1}. Similar result was also reported by Reddy *et al.* (2001) in rice. The authors reported that there was a decrease in TDM production hill^{-1} in closer spacing than wider spacing in rice.

For yield components, results showed that number of filled and unfilled grains panicle^{-1} and grain weight hill^{-1} increased with increasing row spacing while reverse trend was observed in grain and straw yield per hectare and harvest index (HI) (Table 2). The highest grain yield hill^{-1} was recorded in wider row spacing of 30 cm (34.78 g) due to increased number of effective tillers hill^{-1} (Table 1) and filled grains panicle^{-1}. However, in case of unit area basis, the seed yield and HI was greater at closer row spacing than wider row spacing.

Table 1. Effect of row spacing and variety on physiological parameters in Aus rice

Treatments	Plant height (cm)	Total dry mass hill^{-1} (g) at		Absolute growth rate at 35-50 DAP (g hill^{-1} d^{-1})	Relative growth rate (mg g^{-1} d^{-1})	Effective tillers hill^{-1} (no.)	Non-effective tillers hill^{-1} (no.)	Total tillers hill^{-1} (no.)
		35 DAT	50 DAT					
Row spacing								
15	101.8 a	7.17 d	20.81 c	0.91 c	70.45 c	10.08 d	3.23 b	13.24 d
20	99.4 ab	7.80 c	24.82 b	1.09 b	73.65 b	11.28 c	3.41 b	14.69 c
25	98.0 b	8.33 b	27.10 a	1.25 a	75.33 ab	12.27 b	3.83 a	16.11 b
30	98.1 b	8.87 a	27.84 a	1.26 a	77.32 a	13.62 a	3.99 a	17.62 a
F-test	**	**	**	**	*	**	**	**
Variety								
BR-26	102.2 a	8.84 b	29.13 b	1.35 b	75.59 a	14.68 a	3.28 c	17.89 a
BRRI dhan42	92.6 c	6.93 c	20.99 c	0.90 c	74.35 a	9.29 c	3.51 b	12.81 b
BRRI dhan43	99.9 b	6.60 d	18.53 d	0.80 d	71.69 b	9.56 c	4.01 a	13.57 b
BRRI djhan48	102.7 a	9.79 a	31.91 a	1.47 a	75.13 a	13.73 b	3.66 b	17.39 a
F-test	**	**	**	**	**	**	**	**
CV (%)	2.10	4.85	6.90	8.27	4.07	5.57	6.34	6.65

In a column, figures bearing same letter (s) do not differ significantly at P ≤ 0.05 by DMRT;
* and ** indicate significance at 5% and 1% level of probability, respectively

Table 2. Effect of row spacing and variety on yield attributes and yield grain in Aus rice

Treatments	Filled grains panicle^{-1} (no.)	Unfilled grains panicle^{-1} (no.)	1000-grain weight (g)	Grain weight hill^{-1} (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
Row spacing							
15	115.5 b	13.45 b	22.40	25.25 d	3.27 a	5.56 a	37.74 a
20	118.3 ab	14.37 ab	22.58	29.05 c	3.42 a	5.68 a	37.96 a
25	119.9 ab	13.70 b	22.73	31.98 b	3.07 b	5.20 b	37.56 a
30	121.4 a	15.17 a	22.49	34.78 a	2.48 c	4.67 c	34.87 b
F-test	*	**	NS	**	**	**	**
Variety							
BR-26	120.4	12.74 c	22.16 b	33.62 b	2.96 b	6.22 b	32.15 c
BRRI dhan42	116.8	12.24 c	21.18 c	22.55 d	2.58 c	4.22 c	37.74 b
BRRI dhan43	119.2	14.18 b	22.45 b	25.16 c	2.71 c	3.78 d	41.62 a
BRRI dhan48	118.7	17.53 a	24.40 a	39.75 a	3.97 a	6.88 a	36.62 b
F-test	NS	**	**	**	**	**	**
CV (%)	3.72	7.24	3.28	8.32	5.30	3.74	5.95

In a column, figures bearing same letter (s) do not differ significantly at $P \leq 0.05$ by DMRT; NS = Not significant; * and ** indicate significance at 5% and 1% level of probability, respectively

The higher grain and straw yield per hectare and HI was observed in 15 and 20 cm row spacings with being the highest in 20 cm row spacing. The yields were higher in 15 and 20 cm row spacings was because of increased number of plants per unit area although per plant yield was inferior in closer spacing. In contrast, the lowest seed and straw yield per hectare and HI was recorded in 30 cm row spacing for lower accommodation of plants per unit area.

The effect of variety on morpho-physiological, yield attributes and yield was significant (Tables 1-2). Results revealed that the variety BRRI dhan48 was superior in relation to plant height, TDM hill^{-1}, AGR, RGR, total tiller number hill^{-1} and 1000-grain weight which resulting the highest grain yield hectare^{-1} followed by BR-26. In contrast, the lowest above studied parameters were observed in BRRI dhan43 and resulting the lowest seed yield per hectare.

Table 3. Interaction effect of variety and row spacing on yield attributes and yield grain in Aus rice

Interaction	Filled grains panicle^{-1} (no.)	Unfilled grains panicle^{-1} (no.)	1000-grain weight (g)	Grain weight hill^{-1} (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
$V_1 \times S_1$	115.9 bc	13.20 c	22.16	28.27 ef	3.20 de	6.67 c	32.45 gh
$V_1 \times S_2$	119.0 abc	13.30 c	21.79	33.22 d	3.43 cd	6.80 bc	33.53 fgh
$V_1 \times S_3$	124.3 ab	13.20 c	22.80	35.99 c	2.90 ef	5.93 d	32.84 fgh
$V_1 \times S_4$	122.3 ab	11.27 d	21.90	36.98 c	2.33 h	5.50 e	29.76 h
$V_2 \times S_1$	112.3 c	11.27 d	20.92	18.49 k	2.93 ef	4.43 fg	39.97 a-d
$V_2 \times S_2$	116.8 abc	13.30 c	21.32	21.24 ij	2.90 f	4.53 f	39.03 a-e
$V_2 \times S_3$	118.0 abc	11.20 d	21.00	23.96 gh	2.60 g	4.13 gh	38.63 b-e
$V_2 \times S_4$	119.9 abc	13.20 c	21.48	26.51 fg	1.90 i	3.80 h	33.33 fgh
$V_3 \times S_1$	115.7 bc	14.27 c	22.12	20.81 jk	3.03 ef	4.00 h	43.08 a
$V_3 \times S_2$	118.9 abc	13.90 c	22.40	23.55 hi	2.93 ef	4.13 gh	41.56 abc
$V_3 \times S_3$	116.8 bc	10.93 d	22.90	26.02 fg	2.77 fg	3.80 h	42.16 ab
$V_3 \times S_4$	125.5 a	17.60 b	22.40	30.24 e	2.10 hi	3.20 i	39.66 a-d
$V_4 \times S_1$	118.1 abc	15.07 c	24.40	33.43 d	3.90 b	7.13 ab	35.45 efg
$V_4 \times S_2$	118.5 abc	16.97 b	24.80	38.20 c	4.40 a	7.27 a	37.70 cde
$V_4 \times S_3$	120.4 abc	19.47 a	24.20	41.96 b	4.00 b	6.93 abc	36.60 def
$V_4 \times S_4$	117.8 abc	18.60 ab	24.20	45.41 a	3.60 c	6.20 d	36.73 def
F-test	*	**	NS	*	*	*	*
CV (%)	3.72	7.24	3.28	8.32	5.30	3.74	5.95

In a column, figures bearing same letter (s) do not differ significantly at $P \leq 0.05$ by DMRT; NS = Not significant; * and ** indicate significance at 5% and 1% level of probability, respectively

V_1 = BR-26; V_2 = BRRI dhan42; V_3 = BRRI dhan43; V_4 = BRRI dhan48; S_1 = Row spacing 15 sm; S_2 = Row spacing 20 cm; S_3 = Row spacing 25 cm and S_4 = Row spacing 30 cm

The interaction effect of variety and row spacing on yield attributes and grain yield was significant except 1000-grain weight (Table 3). In case of unit area, the varieties BR-26 and BRRI dhan48 produced the highest yield in 20 cm row spacing with superior dry matter partitioning to economic yield. The grain yields of BRRI dhan42 and BRRI dhan43 were decreased with increasing row spacings and also decreased harvest index with increasing row spacing. Therefore, the optimum row spacing of BRRI dhan42 and BRRI dhan43 may be 15 cm for its lower canopy structure. In all the varieties, the wider spacings of 25 and 30 cm produced lower grain yield with poor dry matter partitioning to economic yield, with being the lowest in 30 cm row spacing.

CONCLUSION

In Aus season (April-August), 15 cm row spacing is optimum for BRRI dhan42 and BRRI dhan43, and 20 cm row spacing is optimum for BR-26 and BRRI dhan48 for getting maximum grain yield. However, more experiment should be conducted in different locations and seasons to draw a valid conclusion regarding the row spacing.

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