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Effect of plant population on the performance of transplant Aman rice var. BRRI Dhan 41

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ABSTRACT

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh from July to December 2004 to study the effect of plant population on the performance of transplant aman rice var. BRRI dhan41. Four hill spacings viz., 5 cm, 10 cm, 15 cm and 20 cm and four levels of seedlings hill^{-1} viz., 1, 2, 3 and 4 seedlings hill^{-1} were included in the experiment .Row spacing of 25cm was kept constant in all the treatments. The experiment was laid out in a randomized complete block design with three replications. The maximum grain yield was obtained from the hill spacing of 20 cm which was the consequence of highest number of total tillers hill^{-1}, effective tillers hill^{-1}, total grains panicle^{-1}, the maximum straw yield, biological yield and harvest index. Higher grain yields were obtained from the treatment 3 seedlings and 4 seedlings hill^{-1} which were identical with each other but significantly higher than 1 and 2 seedlings hill^{-1}. The highest straw yield was obtained from 4 seedlings hill^{-1} was the consequence of highest plant height and non-effective tillers hill^{-1}. The interaction between hill spacing and number of seedlings hill^{-1} was not significant for grain and straw yields. It may be concluded that BRRI dhan41 may be grown with 20 cm hill spacing with 3 or 4 seedlings hill^{-1}.

Key words: Plant population, performance, grain and straw yield, BRRI Dhan 41.

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INTRODUCTION

Rice is the leading cereal crop in the world and it is the staple food crop in Bangladesh. Rice covers an area of 11100 thousand ha in Bangladesh and the production is 38060 thousand metric tons with the average yield of 3429 kg ha^{-1} (FAO, 2003). Rice is extensively grown in Bangladesh in 3 seasons viz., *Aus, Aman* and *Boro* and it covers 80% of the total cultivable (AIS, 1996). *Aman* rice is grown in of 140.30 thousand acres, the production is 11521 thousand metric tons (BBS, 2004).

In Bangladesh, the yield of rice is quite low, 3.4 t ha^{-1} (FAO, 2003) compared to that other leading rice producing countries. Therefore, it is an urgent need to increase rice production through increasing yield. As per report of IRRI (1999) rice production must be increased by 70% over the next three decades to meet up the demand of the increasing population and to sustain global food security. The reasons for low yield of rice are manifold; some are varietal, some are technological and some are climatic. The newly introduced modern variety has higher yield potential as compared to existing other modern varieties.

Improved cultural practices can play an important role in augmenting yield of rice. In the commercial production of modern varieties, hill spacing and number of seedlings need to be optimized to increase growth efficiency through an improved canopy structure and to reduce labour required due to transplanting. Optimum plant density ensures plant growth properly (Miah et al., 1990).

Improper plant or hill spacing and number of seedlings adversely affect the normal physiological activities of the rice plant. On the contrary, sparsely populated fields with wide spacing lead to uneconomic utilization of space, profuse growth of weeds and pests, and reduction of grain yield. Hill spacing and number of seedlings hill^{-1} are the two important factors for rice production. So, it is necessary to determine the optimum hill spacing and number of seedlings hill and their appropriate combination for satisfactory yield.

The present study was, therefore, undertaken to find out the effect of different hill spacings, number of seedlings hill^{-1} and their interaction on the performance of transplant aman rice var. BRR1 dhan41.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh from July to December 2004 to study the effect of plant population on the performance of transplant *aman* rice var. BRRI dhan41. The experimental field was medium high land with silty loam soil having a pH value of 6.42 and moderate in organic matter content. The area was under the sub-tropical climate with moderately high temperature and heavy rainfall from April to September and low rainfall with moderately low temperature from October to March.

Plant material

BRRI dhan41, a recommended variety of transplant aman rice, developed by the Bangladesh Rice Research Institute was used as planting material. It is a photosensitive variety and it takes 148-153 days to mature. It attains a plant height of 115cm, its grains are medium bold and gives a grain yield of 4.5 t ha^{-1}.

The experiment

Two factors were considered in this experiment. Hill spacing at 5 cm (S1), 10 cm (S2), 15cm (S3) and 20 cm (S4). The row spacing of 25cm was kept constant. The Number of seedlings hill-1 was 4 which designed as 1 seedling (P1), 2 seedlings (P2), 3 seedlings (P3) and 4 seedlings (P4). The experiment was laid out in a randomized complete block design with three replications. Each block representing a replication was divided into 16 unit plots where the treatment combinations were allocated at random. The size of each unit plot was 10 m^2 (4.0 m x 2.50 m). The spacing between the replications and unit plots were 1.5 m and I m, respectively.

The seeds of BRRI dhan41 were collected from the Bangladesh Rice Research Institute, Joydebpur, Gazipur. Healthy seeds were selected by specific gravity method and soaked in water for 24 hours. These were then placed in gunny bags for sprouting for 72 hours.

The nursery bed for raising seedlings was prepared by puddling the soil. Sprouted seeds were sown uniformly by broadcast method on 5 July 2004. Care was taken to protect the seeds and seedlings in the nursery bed against birds.

The experimental field was opened prepared by the power tiller 10 days before transplanting. It was then puddled well with the help of country plough and ladder. Weeds and stubble were removed from the field.

The land was fertilized with urea, triple superphosphate, muriate of potash, gypsum and zinc sulphate at the rates of 175, 50, 80, 45 and 5 kg ha^{-1}, respectively as per recommendation of BRRI (2003). One third of urea and full dose of other fertilizers were applied as basal dose at the time of final land preparation. The rest amount of urea, was top dressed in two equal splits on 21 and 42 days after transplanting.

Twenty eight day old seedlings were transplanted on 3 August 2004 as per treatment. The row spacing of 25 cm remained constant in all the

treatments. Nursery bed was irrigated one day before uprooting of seedling to reduce mechanical injury to the roots of the seedlings. Gap filling was done after seven days of transplanting with seedlings from the same source. Weeding was done twice on 21 and 42 days after transplanting.

Harvesting of crop and data collection

The crop was harvested plot wise at full maturity on 9 December 2004 and threshed by pedal thresher and the fresh weights of grain and straw were recorded. The yields of grain and straw were sun dried properly and converted to ton ha^{-1}.

Five hills (excluding border hills) were selected at random prior to harvesting from each plot and uprooted for recording data on plant height, number of total tillers hill^{-1}, number of effective tillers hill^{-1}, number of non- effective tillers hill^{-1}, Panicle length, number of grains panicle^{-1}, number of sterile spikelets panicle^{-1}, weight of 1000 grains and grain yield, straw yield, biological yield and harvest index.

Analysis of data

The collected data were analysed statistically with the help of computer package MSTAT Programme. The differences among the treatment means were adjudged with Duncan's Multiple Range Test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

It is found that all the studied crop characters were significantly influenced by hill spacing except panicle length and 1000 grain weight. Number of seedlings hill^{-1} had significant effect on all the crop characters except 1000 grain weight. The effect of interaction of hill spacing and number of seedlings hill^{-1} was significant only for the plant height, total, effective and non-effective tillers hill^{-1}, grains panicle^{-1}, and sterile spikelets panicle^{-1}.

Effect of hill spacing

Plant height

The tallest plants produced in 15 cm hill spacing was significantly higher than those of identical plant heights produced in 5, 10 and 20cm hill spacings (Table 1). This trend of result is in agreement with the findings of Bhab et al. (1987).

Total tillers hill^{-1}

The highest number of total tillers hill^{-1} was produced by 20 cm hill spacing (Table 1). A regular trend of increase in number of total tillers hill^{-1} was observed with the increase in hill spacing from 5 to 20cm each with significant difference. Ayub et al. (1987) also found that number of total tillers hill^{-1} decreased with the increasing plant densities.

Effective tillers hill^{-1}

The maximum and minimum numbers of effective tillers hill-1 were observed in 20cm and 5cm, respectively. The trend of effect was exactly the same as exhibited in the number of total tillers hill^{-1}.

Non-effective tillers hill^{-1}

The highest number of non-effective tillers hill was observed with the hill spacing of 20 cm (Table 1). The 15 cm and 10 cm hill spacings were statistically similar in respect of non-effective tillers. The 10 cm and 5 cm hill spacings were also statistically similar in respect of non-effective tillers.

Grains panicle^{-1}

The number of total grains panicle^{-1} was found to be the maximum in hill spacing of 20 cm and the minimum in 5 cm hill spacing(Table 1). The trend of effect was exactly the same as exhibited in the number of total tillers hill^{-1}.

Sterile spikelets panicle-1

Table 1 showed that the highest number of sterile spikelets panicle-1 was recorded from 20 cm hill spacing while the lowest one was produced from 5 cm hill spacing. The trend of effect was exactly the similar as exhibited in the number of total tillers hill^{-1}.

Table 1
Effect of hill spacing on the crop characters of transplant aman rice var. BRRI dhan41.

Plant spacing (cm)	Plant height (cm)	Total tillers hill" [1] (no.)	Effective tillers hill' [1] (no.)	Non-effective tillers hill" [1] (no.)	Panicle length (cm)	Grains panicle-1	Sterile spikelets panicle-1 (no.)	1000-grain wt (g)	Grain yield (tha-1)	Straw yield (tha-1)	Biological yield (tha-1)	Harvest Index (%)
5	122.74 b*	5.32 d	3.42d	1.90c	24.82	140.33 d	21.42 d	24.67	3.94 c	6.99 c	10.93 d	35.89 b
10	122.74 b	6.95 c	4.89 c	2.06 bc	23.64	150.58 c	26.25 c	25.67	4.46 b	7.13 c	11.58 c	38.46 a
15	131.56 a	9.25 b	6.81 b	2.44 b	23.73	169.08 b	31.08 b	25.25	4.72 b	7.58 b	12.30 b	38.31 a
20	122.54 b	13.43 a	9.67 a	3.75 a	23.27	183. 50 a	44.83 a	26.92	5.00 a	8.41 a	13.41 a	37.20 a
CV(%)	5.60	9.11	9.90	22.29	8.34	6.73	5.01	9.14	7.14	4.62	4.93	3.94
Level of significance	0.01	0.01	0.01	0.01	NS	0.01	0.01	NS	0.01	0.01	0.01	0.01

*In a column, the means having the same letter(s) do not differ significantly ; NS = Not significant.

Grain yield

The grain yield increased with the increased hill spacing (Table 1). The highest grain yield was obtained from 20 cm hill spacing. The lowest grain yield was produced by 5 cm hill spacing. The 15 cm and 10 cm hill spacing were statistically similar in respect of grain yield. This study is in agreement with the studies of Shirakawa et al. (1992), Patel et al (1983), Pedroso and Mariot (1986), Gupta and Sharma (1991 suppl.), Rao and Reddy (1993), and Amir et al (1984).

Straw yield

From table 1, it is evident that the highest straw yield was produced by 20 cm hill spacing. The second highest straw yield was produced by 15 cm hill spacing and the 10 cm and 5 cm hill spacings were statistically similar in respect of straw yield (Table 1). A Similar trend of effect of spacing was observed by Rao and Raju (1987), Sarkar et al (1988), Shah et al (1991), and Karim et al (1987).

Biological yield

The highest biological yield (13.41 t ha^{-1}) was produced by the 20 cm hill spacing and it was significantly higher than every hill spacing. The lowest biological yield obtained from 5 cm hill spacing. The trend of effect as exactly the same as exhibited in the number of total tillers hill[-1].

Harvest index

The maximum harvest index (38.46%) was found from the hill spacing of 10 cm which was identical with 15 cm and 20 cm hill spacings. The lowest harvest index was observed in the 5 cm hill spacing (Table 1).

Effect of number of seedlings hill[-1]

Plant height

The tallest plant was observed in 4 seedlings hill[-1]. The second tallest plant was observed in 3 seedlings hill[-1] which was identically followed by the 2 seedlings hill[-1] (Table 2). Muhammad et al. (1987) reported that plant height, no. of grains m"[2] grain yield remained unaffected, due to variation in planting density.

Total tillers hill[-1]

The highest number of total tillers hill[-1] was counted in 3 seedlings hill[-1] which was statistically similar with that of 4 seedlings hill[-1] (Table 2). The lowest number of total tillers produced by the 1 number of seedling.

Effective tillers hill[-1]

The results indicate that the highest number of effective tillers hill[-1] was produced by 3 seedlings hill[-1] (Table 2). One seedling and 2 seedlings hill[-1] were statistically similar in respect of effective tillers hill[-1].

Non-effective tillers hill[-1]

The maximum number of non-effective tillers hill[-1] was produced in the 2 seedlings hill[-1] which was identical with 4 seedlings hill[-1] (Table 2). The lowest number in 1 seedlings hill[-1] which was identical with 3 seedlings hill[-1].

Panicle length

The maximum length of panicle was observed in the treatment with 4 seedlings hill[-1] and it was identical with that of 2 seedlings hill[-1] and 3 seedlings hill[-1] , but significantly higher than that of 1 seedling hill-1 . There was no significant difference between 1 seedlings hill[-1], 2 seedlings hill[-1] and 3 seedlings hill[-1] (Table 2).

Grains panicle[-1]

The maximum number of total grains panicle[-1] was observed in the treatment with 4 seedlings hill[-1]. The lowest number of total grains panicle[-1] was produced by the 1 seedling hill" (Table 2).

Sterile spikelets panicle[-1]

Table 2 shows that 4 seedlings hill[-1] produced the highest number of Sterile spikelets panicle[-1] which was statistically similar to that of 3 seedlings hill[-1]. The lowest Sterile spikelets panicle[-1] was found in 1 seedling hill[-1].

Grain yield

The highest grain yield was obtained from 4 seedlings hill which was statistically similar to that of 3 seedlings hill[-1]. Pande et al. (1987), BRRI (1991), Singh and Singh (1992) are in agreement with the results of the present study in respect of this parameter. The lowest grain yield was obtained from 1 seedling hill[-1] (Table 2).

Straw yield

The highest straw yield obtained from 4 seedlings hill[-1] which was identical with that of 3 seedlings hill[-1] (Table 2). There was no significant difference between 2 seedlings hill[-1] and 3 seedlings hill[-1]. The lowest straw yield was produced by the 1 seedling hill[-1].

Biological yield

Table 2 shows that the highest biological yield was recorded from 4 seedlings hill[-1] which was statistically similar with that of 3 seedlings hill-1. The higher biological yield might be due to the production of higher grain and straw yields in the 4 seedlings hill[-1].

Harvest index

From the table 2, it is evident that the highest harvest index was recorded from 4 seedlings hill[-1] which was statistically identical with 3 seedlings hill[-1]. The lowest harvest index was observed in 2 seedlings hill[-1] which was statistically similar with that of 1 seedling hill[-1].

Interaction effect of hill spacing and number of seedlings hill[-1]

Plant height

Results presented in table 3 indicates that the highest plant height (135.53 cm) was recorded in 15 cm × 1 seedling hill[-1] which was identically followed by that of 20 cm × 4 seedlings hill[-1] , 15 cm × 2 seedlings hill[-1], 10 cm × 4 seedlings hill[-1], 5 cm × 4 seedlings hill[-1] , 15 cm × 4 seedlings hill[-1], 5 cm × 3 seedlings hill[-1] , 10 cm × 3 seedlings hill[-1], 15 cm × 3 seedlings hill[-1] , 20 cm × 2 seedlings hill[-1] , 20 cm × 3 seedlings hill[-1]. The lowest plant height was observed from the 20 cm × 1 seedling hill[-1] which was statistically similar to that of 5 cm × 1 seedling hill[-1].

Total tillers hill[-1]

The highest number of total tillers hill[-1] was observed form the 20 cm × 4 seedlings hill[-1] which was statistically similar to that of 20 cm × 3 seedlings hill[-1]. The second highest number of total tillers hill[-1] was produced by the 20 cm × 2 seedlings hill[-1]. The lowest number of total tillers hill[-1] was produced by the 5 cm x 1 seedling hill[-1] which was statistically similar to that of 5 cm x 2 seedlings hill[-1] (Table 3).

Table 2
Effect of number of seedlings hill[-1] on crop characters of transplant aman rice var. BRRI dhan41.

Number of seedling hiir[-1]	Plant height (cm)	Total tillers hill[-1] (no.)	Effective tillers hill[-1] (no.)	Non-effective tillers hill[-1] (no.)	Panicle length (cm)	Grains panicle[-1]	Sterile spikelets panicle[-1] (no.)	1000-grain wt (g)	Grain yield (tha-1)	Straw yield (tha-1)	Biological yield (tha-1)	Harvest Index (%)
1	115.49 c*	6.83 c	4.94 c	1.89 b	22.48b	140.83 d	25.25 c	26.67	3.98 c	7.00 c	10.98 c	36.20 b
2	124.32 b	8.59 b	5.45 c	3. 14 a	23.87 ab	151.83 c	28.75 b	24.92	4.39 b	7.49 b	11.88 b	36.95 b
3	126.40 b	9.87 a	7.66 a	2.22 b	23.89ab	169.67 b	34.58 a	25.42	4.83 a	7.69 ab	12.53 a	38.54 a
4	133.36 a	9.65 a	6.75 b	2.90 a	25.22 a	181. 17 a	35.00 a	25.50	4.91 a	7.93 a	12.83 a	38.18 a
CV(%)	5.60	9.11	9.90	22.29	8.34	6.73	5.01	9.14	7.14	4.62	4.93	3.94
Level of significance	0.01	0.01	0.01	0.01	0.05	0.01	0.01	NS	0.01	0.01	0.01	0.01

*In a column, the means having the same letter(s) do not differ significantly
NS = Not significant

Table 3
Interaction effect of hill spacing and number of seedlings hill   on crop characters of transplant aman rice var. BRRI dhan41.

Plant spacing × Number seedlings hill[-1]	Plant height (cm)	Total tillers hill[-1] (no.)	Effective tillers hill'[-1] (no.)	Non-effective tillers hiir[-1] (no.)	Panicle length (cm)	Grains panicle-1	Sterile spikelets panicle[-1] (no)	1000-grain wt (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
5 cm x 1	11 0.28 cd	4.27h	2.83i	1.44e	22.87	1 26.67 h	16.67 j	24.67	3.50	6.33	9.83	35.11
5 cm x 2	11 8.90 bc	4.82 gh	2.60 i	2.22 bcde	23.02	139.67fgh	19.00ij	22.67	3.80	6.87	10.67	35.60
5 cm x 3	128.20 ab	6.25 efg	3.90h	2.35 bcde	25.78	1 45.00 defgh	23.33 h	25.67	4.17	7.17	11.33	36.73
5 cm x 4	133. 58 a	5.96fg	4.37 gh	1.59 de	27.63	150.00defg	26.67 g	25.67	4.30	7.60	11.90	36.12
10 cm x 1	1 10.28 cd	6. 13 efg	4.21 h	1.92de	22.65	138.33 gh	20.00 i	27.67	3.93	6.57	10.50	37.46
10 cm x 2	11 8.90 bc	6.64 def	4.49 gh	2. 16 bcde	22.95	143.67 efgh	23.00h	25.33	4.43	6.97	11.40	38.89
1 0 cm x 3	1 28.20 ab	7.89d	6.27 ef	1.62 de	23.90	157.6 defg	30.67 f	25.33	4.73	7.30	12.03	39.34
10 cm x 4	133. 58 a	7.13 def	4.60 gh	2.53 bcde	25.06	162.67 cde	31.33 f	24.33	4.73	7.67	12.40	38.17
1 5 cm x 1	135. 53 a	7.51 de	5.35 fg	2. 15 bcde	22.28	14 5. 67defgh	25.67gh	26.33	4.17	6.90	11.07	37.65
1 5 cm x 2	134.05 a	9.32c	6.1 1f	3.21 b	25.73	159.33 def	29.33 f	24.67	4.57	7.73	12.30	37.12
1 5 cm x 3	125.39ab	10.31 c	8.56c	1.75 de	24.51	179.67 bc	34.00 e	24.33	5.10	7.90	13.00	39.25
1 5 cm x 4	13 1.27 ab	9.85c	7.19de	2.66 bcd	22.38	191. 67 b	35.33 e	25.67	5.03	7.80	12.83	39.23
20 cm x 1	105. 89 d	9.42 c	7.36d	2.06 cde	22.12	1 52.67 defg	38.67 d	28.00	4.33	8.20	12.53	34.57
20 cm x 2	1 25.42 ab	13.58 b	8.59c	4.99 a	23.78	1 64.67 cd	43.67c	27.00	4.77	8.40	13.17	36.20
20 cm x 3	123.83ab	15.04 a	11.90a	3. 14 bc	21.36	196.33 b	50.33 a	26.33	5.33	8.40	13.73	38.83
20 cm x 4	135. 03 a	15.66 a	10.85b	4.81 a	25.81	220.33 a	46.67 b	26.33	5.57	8.63	14.20	39.21
CV(%)	5.60	9.11	9.90	22.29	8.34	6.73	5.01	9.14	7.14	4.62	4.93	3.94
Level of significance	0.01	0.01	0.01	0.01	NS	0.05	0.05	NS	NS	NS	NS	NS

*In a column, the means having the same letter(s) do not differ significantly; NS = Not significant

Effective tillers hill[-1]

The highest number of effective tillers hill[-1] was produced by the 20 cm × 3 seedlings hill[-1] and the second highest number of effective tillers hill[-1] was produced by the 20 cm × 4 seedlings hill[-1]. The lowest number of effective tillers hill[-1] was produced by the 5 cm x 1 seedling hill[-1] which was statistically similar to that of 5 cm × 2 seedlings hill[-1] (Table 3).

Non-effective tillers hill[-1]

The highest number of non-effective tillers hill[-1] was produced by the 20 cm × 2 seedlings hill[-1] which was statistically similar to that of 20 cm × 4 seedlings hill[-1] (Table 3). The lowest number of non-effective tillers hill[-1] was produced by the 5 cm × 1 seedling hill[-1] which was statistically similar to that of 5 cm × 4 seedlings hill[-1], 15 cm x 3 seedlings hill[-1], 10 cm × 3 seedlings hill[-1], 10 cm × 3 seedlings hill[-1] , 10 cm × 3 seedlings hill[-1], 10 cm × 1 seedling hill[-1], 20 cm × 1 seedling hill[-1] , 15 cm × 1 seedling hill[-1] , 10 cm × 2 seedlings hill[-1] , 5 cm × 2 seedlings hill[-1] , 5 cm × 3 seedlings hill[-1] and 10 cm × 4 seedlings hill[-1] .

Grains panicle[-1]

The highest number of total grains panicle[-1] was produced by the 20 cm × 4 seedlings hill[-1]. The lowest number of total grains panicle[-1] was produced by the 5 cm × 1 seedling which was statistically similar to that of 10 cm × 1 seedling hill[-1], 5 cm × 2 seedlings hill[-1], 10 cm × 2 seedlings hill[-1], 5 cm × 3 seedlings hill[-1], 15 cm × 1seedling hill[-1] .

Sterile spikelets panicle[-1]

The highest number of sterile spikelets panicle[-1] was recorded from 20 cm × 3 seedlings hill[-1]. The lowest number of sterile spikelets panicle[-1] was recorded from 5 cm x 1 seedling hill[-1] which was statistically similar to that of 5 cm × 2 seedlings hill[-1] (Table 3).

The transplant aman rice var. BRRI dhan41 may be profitably grown at 20 cm hill spacing with 3 to 4 seedlings hill[-1].

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