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*RESEARCH ARTICLE*

# EFFECT OF ROW SPACING ON YIELD OF SHORT DURATION TRANSPLANT AMAN RICE VARIETIES

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**ABSTRACT**

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during July to December 2015 to evaluate the effect of row spacing on the performance of three short duration transplant *Aman* rice varieties. The experiment consisted of three rice varieties *viz.* Binadhan-7, BRRI dhan39 and BRRI dhan49 and five row spacings *viz.* 15cm×15cm, 20cm×15cm, 25cm×15cm, 30cm×15cm, 35cm×15cm. The experiment was laid out in randomized complete block design with three replications. Results revealed that crop characters, yield contributing characters and yield were significantly influenced by variety, row spacing and their interaction. The highest plant height (112.31 cm), panicle length (24.74 cm), number of grains panicle$^{-1}$ (120.35) and biological yield (9.88 t ha$^{-1}$) were obtained in BRRI dhan39,while the highest number of total tillers hill$^{-1}$ (10.00), effective tillers hill$^{-1}$(8.35), grain yield (3.75 t ha$^{-1}$) and harvest index (41.10 %) were found in BRRI dhan49. In case of row spacing the tallest plant (107.70 cm), the highest number of effective tillers hill$^{-1}$ (9.23) were obtained at 35cm × 15cm row spacing, whereas the highest number of grains panicle$^{-1}$ (119.52), 1000-grain weight (24.87 g), grain yield (3.80 t ha$^{-1}$) and harvest index(40.29) were obtained at row spacing 25cm × 15cm. In case of interaction the highest grain yield (4.44 t ha$^{-1}$) and harvest index (46.20%) were obtained in BRRI dhan49 with the row spacing of 25cm × 15 cm. The experimental result concludes that BRRI dhan49 transplanted at 25cm × 15cm row spacing could be a promising practice in terms of grain yield.

**KEYWORDS**

Varieties, row spacing, transplant *Aman* rice, tillers, grain yield

## 1. INTRODUCTION

Rice (*Oryzae sativa* L.) is the staple food crop of Bangladesh and it plays absolutely a dominant role in the country's agriculture covering 89% of total cropped area with an average yield of 2.446 t ha$^{-1}$ [1]. In Bangladesh, there are three distinct classes of rice based mainly on the season of cultivation, namely *Aus*, *Aman* and *Boro* which are cultivated during the periods from April to July, August to December and January to May, respectively. Total rice production area is 1, 10, 00, 809 ha and production are 3, 38, 04, 000 tons [1]. The majority of rice areas are covered by *Aman* rice comprising 49.12% of the total rice producing area. Total *Aman* rice of the country covers an area of 55, 83, 252 hectares with a production of 1, 36, 56, 054 tons [1].

The horizontal expansion of rice growing area in Bangladesh is not possible due to high population pressure. On the contrary, the rice growing area is continuously declining due to rapid urbanization and industrialization. On the other hand, the demand of rice is increasing to ensure food security for increasing population. So, it is inevitable that the yield of rice should be increased. The growth and yield of rice depend on lot of factors like variety, seed and management practices. Success of cultivation is greatly depending on cropping pattern. Variety itself is the genetic factor which contributes a lot for producing yield and yield components of a particular crop. Yield components are directly related to the variety and the neighboring environments on which it grows. Existing cropping pattern can be improved by input a short duration transplant *Aman* rice variety. If a short duration T. *Aman* variety is input in a pattern (T.*Aman-mustard-boro*) other crop can get optimum time period for their growth and development. As a result, total production of a field increase.

The yield of short duration transplant *Aman* rice can be increased with the improved cultivation practices like proper spacing; especially row spacing is an important factor that greatly affects rice growth, yield and development. Among the cultural technologies, planting density is one of the important components, manipulation of which is an essence for optimizing yield [2].

The maximum benefit in respect of rice yield can be obtained where planting is done with proper spacing. Many research reports are available regarding the effect of spacing in conventionally transplanted rice cultivation in *Boro* season. Optimum row spacing ensures the plants to grow proper utilization of more solar radiation and nutrients. When planting density exceeds an optimum level, competition among plants for light, nutrients and water become severe stage. Consequently, the plant growth slows down and the grain yield decreases. Growth yield contributing characters and yield of rice were greatly influenced by spacing of planting [3,4]. Therefore, the farmers have to produce maximum rice from minimum land by maintaining proper row spacing. In view of the above discussion, the present study was undertaken with the objectives to find out suitable short duration T. *Aman* rice varieties to improve existing cropping pattern and rice yield with proper row spacing.

## 2. MATERIALS AND METHODS

### 2.1 Experimental site

The experiment was conducted at the Agronomy Field laboratory, Bangladesh Agricultural University, Mymensingh, which was located at 24$^0$75′ latitude and 90$^0$50′ longitude at mean altitude of 18 m above the

sea level belongs to the agro-ecological region of the Old Brahmaputra Floodplain (AEZ-9). The area is under the sub-tropical climate which is characterized by its heavy precipitation during the month from April to October and scanty precipitation occurred during the period from October to March.

### 2.2 Treatments and design of experiment

Two experimental factors were included in the study namely variety and spacing. Three varieties were (i) Binadhan-7, (ii) BRRI dhan39 and (iii) BRRI dhan49 and five levels of spacing were (i) 15 cm × 15 cm, (ii) 20 cm × 15 cm (iii) 25 cm × 15 cm, (iv) 30 cm × 15 cm and (v) 35 cm × 15 cm. The experiment was laid out in a randomized complete block design with three replications. The size of the each plot was 4.0 m × 2.5 m, having an area of 10 $m^2$. Each of the replications represented a block in the experiment. Fifteen treatment combinations were randomly assigned in each replication. Total number of plots was 45. A spacing of 0.75 m and 0.50 m was maintained in between the replications and unit plot, respectively.

### 2.3 Cultural operations

The experimental land was prepared with tractor drawn plough and country plough. One tractor ploughing was done on 5 August 2015 and another was done on 11 August 2015. The land was puddled thoroughly by ploughing and cross ploughing with a country plough and subsequently leveled by laddering. Weeds and stubble were removed from the field as much as possible after leveling. The lands were finally prepared, and the plots were laid out on 12 August 2015 according to the plan of experimental design. The experimental plots were fertilized with urea, triple super phosphate (TSP) muriate of potash (MOP), gypsum and zinc Sulphate as per recommendation prescribed for those varieties. One-third of urea and other fertilizers were broadcast and incorporated with the soil at the time of final land preparation. After 30 days of transplanting one-third of urea was applied at the time of active tillering stage and remaining quantity was applied before panicle initiation stage. Urea-TSP-MoP-Gypsum-Zinc Sulphate were used 160-130-60-85-15 kg ha-1, 210-125-90-85-15 kg $ha^{-1}$ and 240-120-140-140-14 kg $ha^{-1}$ for Binadhan-7, BRRI dhan39 and BRRI dhan49, respectively. The seedbeds were softened by application of water both in the morning and evening on the previous day before uprooting the seedling. Seedlings were uprooted without causing any mechanical injury to the roots and were kept in soft mud in shade. The age of the seedlings were 30 days in all cases. Transplanting of seedling of all varieties was done on 14 August 2015, maintaining five different spacing as per treatment specification. Transplanting was done on the same day with three seedlings $hill^{-1}$. After 10 days of transplantation dead seedlings were replaced carefully by transplanting fresh seedlings. During the whole growth period two hand weeding were done, first weeding was done at 25 days after transplanting (DAT) followed by second weeding at 50 DAT. The first supplemental irrigation was applied on 1 September 2015. The field was irrigated by flood irrigation method and steps were taken to maintain a constant level of standing water up to 7 to 10 cm in the field almost throughout the growing season. The field was, however drained out once a month and again finally drained out at hard dough stage of the grains to enhance maturity.

### 2.4 Harvesting and processing

Harvesting was done on different dates as and when different varieties become ready for harvest. Crop was harvested when 80% of the grain became golden in color. Five hills were randomly selected and uprooted prior to harvesting from each unit plot excluding boarder rows and central 1$m^2$. An area of one $m^2$ was selected in the middle portion of each plot to record the yield of grain and straw. The yields of grain and straw $plot^{-1}$ were recorded after threshing by pedal thresher; Winnowing and sun drying were done properly. The yield of grains was adjusted at 14% moisture content and converted to t $ha^{-1}$.

### 2.5 Data collection

Data on different yield components were recorded from five randomly selected hills from the whole plot. The grain and straw weight were expressed in gram (g) and converted to t $ha^{-1}$. The 1000-grain weight was taken from dried grain samples of each plot. Plant height was measured from selected plants, with the help of a meter scale, through the base of the plant to the tip of the leaf or panicle. The grain yield was measured from 1$m^{-2}$ areas in each plot (at 14% moisture level) and was converted into t $ha^{-1}$. The sun-dried straw was weighed from the same sample area harvested for grain yield and converted into t $ha^{-1}$. Grain yield and straw yield are combindly regarded as biological yield. The biological yield was calculated using the following formula.

Biological yield = grain yield + straw yield.

Harvest index is the relationship between grain yield and biological yield.

$$Harvest\ Index(\%) = \frac{Grain\ Yield + Straw\ Yield}{Grain\ Yield} \times 100$$

### 2.6 Statistical analysis

The collected data were compiled and tabulated in proper form and analyzed statistically. Analysis of variance was done following RCBD with the help of computer package MSTAT and the mean differences among the treatments were adjudged by Duncan's Multiple Range Test as laid out by [5].

## 3. RESULTS AND DISCUSSION

### 3.1 Effect of variety on yield contributing characters and yield

The variety has significant effect on the yield contributing characters and yield (Table 1, Figure 1). The tallest plant height (112.31 cm), number of grains $panicle^{-1}$ (120.35) and straw yield (6.58 t $ha^{-1}$) were obtained in BRRI dhan39.The highest number of total tillers $hill^{-1}$ (10.00), number of effective tillers $hill^{-1}$ (8.35), number of non-effective tillers $hill^{-1}$ (1.65), grain yield (3.75 t $ha^{-1}$) and harvest index (41.10 %) were found in BRRI dhan49. The highest panicle length (24.74 cm) was obtained in the variety BRRI dhan39 which was statistically identical with BRRI dhan49.The highest number of sterile spikelets $panicle^{-1}$ (19.25) and 1000-grain weight (25.25 g) were obtained from the variety Binadhan-7. The highest biological yield (9.88 t $ha^{-1}$) was obtained from the variety BRRI dhan39 which was at par with BRRI dhan49. The shortest plant height (99.37 cm), lowest number of total tillers $hill^{-1}$ (8.90), number of effective tillers $hill^{-1}$ (7.82), number of non-effective tillers $hill^{-1}$ (1.08) and harvest index (33.34 %) were recorded in BRRI dhan39.The lowest panicle length (23.78 cm),number of grains $panicle^{-1}$ (111.13), grain yield (3.02 t $ha^{-1}$, Figure 1) and biological yield (8.37 t $ha^{-1}$) were obtained in Binadhan-7.The lowest number of sterile spikelets $panicle^{-1}$ (13.50),1000-grain weight (23.65 g) and straw yield (5.34 t $ha^{-1}$) was obtained from BRRI dhan49. The varietal differences in plant height might be due to heredity or varietal character. The varietal differences in plant height might be due to heredity or varietal character. Similar results were also reported that plant height was differed due to varietal variation [6]. Similar trend of effective tillers $hill^{-1}$ due to varietal variation was reported elsewhere [7-10]. The probable reason of the variation in panicle length might be due to genetic makeup of these varieties which are influenced by heredity. Similar result was reported [8,9]. BRRI found that number of grains differed significantly due to variety [11]. Varietal difference regarding grains $panicle^{-1}$ was reported by elsewhere [6-8,12]. The difference in 1000-grain weights due to the genetic variation among the varieties [7,8]. Grain yield difference might be due to production potential of varieties for genetic characteristics. Grain yield differed due to varietal differences was also reported [7,8,10]. These results of straw yield were in conformity with that obtained by who reported the differences in straw yield among the varieties [13]. Similar results of harvest index were reported elsewhere [7,10,13]. According to study, a variety could give high yield if they have genetic potentiality [8,14].

**Table 1:** Effect of variety on yield contributing characters and yield of short duration transplant Aman rice varieties

| Variety | Plant height (cm) | Number of total tillers hill$^{-1}$ | Number of effective tillers hill$^{-1}$ | Number of non-effective tillers hill$^{-1}$ | Panicle length (cm) | Number of grains panicle$^{-1}$ | Number of sterile spikelets panicle$^{-1}$ | 1000-grain weight (g) | Biological yield (t ha$^{-1}$) | Harvest Index (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Binadhan-7 | 99.39b | 9.37b | 8.18ab | 1.19b | 23.78b | 111.13b | 19.25a | 25.25a | 8.37b | 36.06b |
| BRRI dhan39 | 112.31a | 8.90c | 7.82b | 1.08b | 24.74a | 120.35a | 17.56b | 24.61b | 9.88a | 33.34c |
| BRRI dhan49 | 99.37b | 10.00a | 8.35a | 1.65a | 24.59a | 113.48b | 13.50c | 23.65c | 9.10ab | 41.10a |
| CV (%) | 4.06 | 9.25 | 7.58 | 20.09 | 12.25 | 3.25 | 9.25 | 3.28 | 4.58 | 3.54 |
| Level of sig. | ** | ** | * | * | ** | ** | ** | ** | ** | ** |

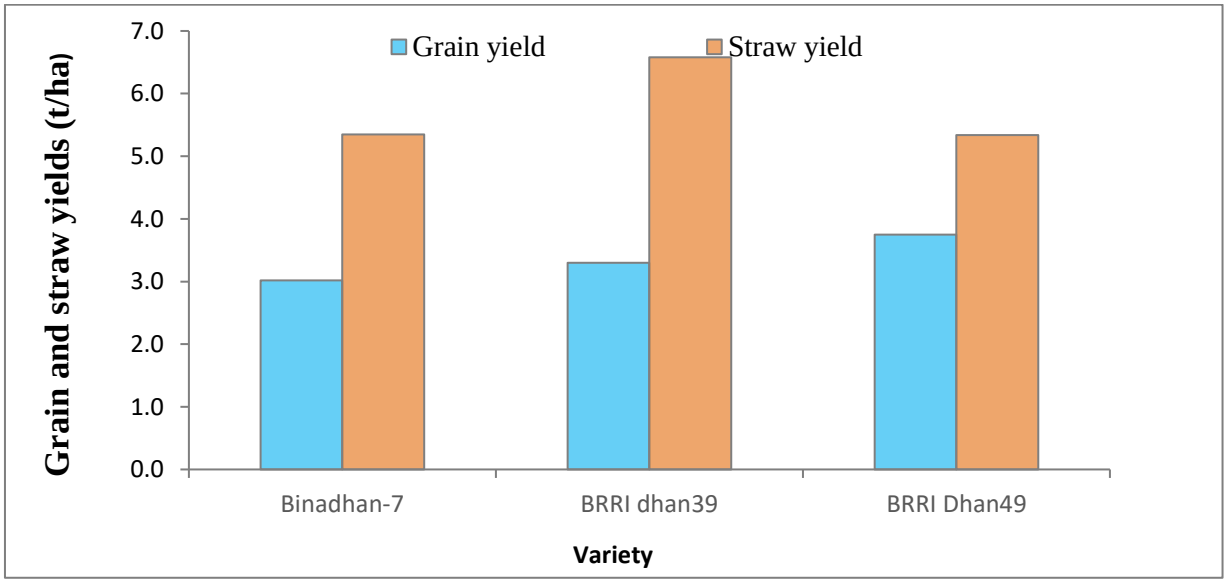


**Figure 1:** Relation between variety with grain yield and straw yield

### 3.2 Effect of row spacing on yield contributing characters and yield

The highest plant height (107.70 cm), numbers of total tiller hill$^{-1}$ (10.39) were obtained from the spacing 35cm × 15cm, whereas the lowest plant height (101.96 cm), numbers of total tiller hill$^{-1}$ (7.75) were observed in spacing 15 cm × 15 cm (Table 2). A similar result was also found due to different row spacing [15]. The highest number of effective tillers hill$^{-1}$ (9.23) was obtained from 35cm × 15cm row spacing which was statistically identical with row spacing of 30 cm × 15cm, 25cm ×15cmand the lowest one (7.47) from the spacing of 20cm × 15cm (Table 2). This result revealed that 35cm × 15cm spacing had the greatest opportunity to produce a greater number of effective tillers hill$^{-1}$. It might be due to the fact that the spacing 35cm × 15cm provided enough nutrients, light and air which played vital role in producing more effective tillers hill$^{-1}$.The highest number of grains panicle$^{-1}$ (119.52), grain yield (3.80 t ha$^{-1}$, Figure 2), biological yield (9.43 t ha$^{-1}$), harvest index (40.29) was obtained from 25cm × 15cm row spacing and the lowest number of grains panicle$^{-1}$ (111.65), biological yield (8.57 t ha$^{-1}$), harvest index (34.46) from the row spacing 15 cm × 15 cm and lowest grain yield (3.14 t ha$^{-1}$) was obtained from the row spacing 20cm × 15 cm (Table 2). A group researcher found that number of grains differed significantly due to variety [16,17]. The highest number of grains panicle$^{-1}$ was mainly responsible for this highest grain yield. The result revealed that row spacing 25 cm × 15 cm facilitate highest sunlight penetrate and help to maximization the use of natural resources. Similar result was reported elsewhere [10,18,19]. The result revealed that the closer row spacing had the greatest opportunity to reduce biological yield. It might be due to the fact that the closer row spacing provided lowest grain yield and straw yield which result in the lowest biological yield. Similar result was also reported by Sohel et al [20].

**Table 2:** Effect of row spacing on yield contributing characters and yield of short duration transplant *Aman* rice varieties

| Row spacing | Plant height (cm) | Number of total tillers hill$^{-1}$ | Number of effective tillers hill$^{-1}$ | Number of non-effective tillers hill$^{-1}$ | Panicle length (cm) | Number of grains panicle$^{-1}$ | Number of sterile spikelets panicle$^{-1}$ | 1000-grain weight (g) | Biological yield (t ha$^{-1}$) | Harvest Index (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 cm × 15 cm | 101.96b | 7.75c | 6.48c | 1.27 | 24.36 | 111.65c | 18.64a | 24.50 | 8.57c | 33.69c |
| 20 cm × 15 cm | 102.26b | 8.61b | 7.47b | 1.14 | 24.36 | 112.69bc | 17.77a | 24.50 | 9.19ab | 34.46c |
| 25 cm × 15 cm | 102.89b | 10.24a | 8.64a | 1.61 | 24.31 | 119.52a | 15.89b | 24.87 | 9.43a | 40.29a |
| 30 cm × 15 cm | 103.67b | 10.11a | 8.75a | 1.36 | 24.46 | 115.69b | 15.64b | 24.38 | 8.99b | 38.15b |
| 35 cm × 15 cm | 107.70a | 10.39a | 9.23a | 1.16 | 24.34 | 115.39b | 15.92b | 24.27 | 9.40a | 37.58b |
| CV (%) | 4.06 | 9.25 | 7.58 | 20.09 | 12.25 | 3.25 | 9.25 | 3.28 | 4.58 | 3.54 |
| Level of sig. | ** | ** | ** | NS | NS | ** | ** | NS | ** | ** |

In a column with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT) *= Significant at 5% level of probability; **= Significant at 1% level of probability; NS= Not significant

The highest number of sterile spikelets panicle$^{-1}$ (18.64) was obtained from the row spacing 15cm × 15cm which was statistically identical with row spacing of 20 cm × 15cm and the lowest one (15.64) from the row spacing 30cm × 15cm which was statistically identical with row spacing of 35 cm × 15cm, 25cm × 15cm (Table 2). The result revealed that closer row spacing had the greatest opportunity to produce sterile spikelets panicle$^{-1}$. The highest straw yield (6.05 t ha$^{-1}$) was obtained from the row spacing 20cm × 15cm and the lowest one (5.55 t ha$^{-1}$) was obtained from the row spacing 30cm × 15 cm (Figure 2). Similar result was reported by Hossain et al. [19]. The number of non-effective tillers hill$^{-1}$, 1000-grain weight was not significantly influenced by row spacing. Numerically highest number of non-effective tillers hill$^{-1}$ (1.61), 1000-grain weight (24.87 g) was obtained from the row spacing 25cm × 15cm and the lowest non-effective tillers hill$^{-1}$ (1.14) from the row spacing 20cm × 15cm and 1000 grains weight (24.27 g) was recorded from 35cm × 15cm row spacing. The result revealed that 25cm × 15cm row spacing had the greatest opportunity to reduce number of non-effective tillers hill$^{-1}$ and apparently 1000 grain weight increased with closer row spacing. It might be due to the fact that the row spacing 20cm × 15cm provided enough nutrients, light and air which played vital role in producing more effective tillers hill$^{-1}$1000 grain weight. Numerically longest panicle (24.46 cm) was produced by spacing 30cm × 15cm and the shortest one (24.31cm) was produced by 25cm × 15cm spacing.

Salahuddin et. al [21] reported that the maximum grain yield (4.22 t ha$^{-1}$) was observed at the spacing 25 cm × 10 cm closely followed by 25 cm × 15 cm (4.21 t ha$^{-1}$). Han and Chen [22] reported that the effective particles per unit area increased with increasing spacing, whereas the total grains panicle$^{-1}$, seed setting rate and yield decreased. The highest yield was recorded with a spacing of 16.7cm × 30 cm, followed by 23.3 cm × 23.3cm spacing. Rahman reported that the highest grain and straw yields of BR26 rice was obtained from 20 cm × 15 cm spacing due to the highest number of effective tillers m$^{-2}$ among the spacing of 20 cm × 15 cm [2]. 25 cm × 15 cm, 20 cm × 20 cm and 25 cm × 20 cm. Reddy reported that planting of rice at a closer spacing of 15 cm × 10 cm resulted in higher grain yields (40.66 and 50.33 q ha$^{-1}$ during 1996 and 1997, respectively) compared to normal planting at a spacing of 20 cm × 10 cm (35.93 and 48.11 q ha$^{-1}$ during 1996 and 1997, respectively) and recorded a mean increase of 7.6% higher grain yield over the normal spacing [23]. Geethadevi stated that higher grain yield (5.1 t ha$^{-1}$) was obtained with 20cm × 10cm spacing than in 20cm × 15cm spacing [24].

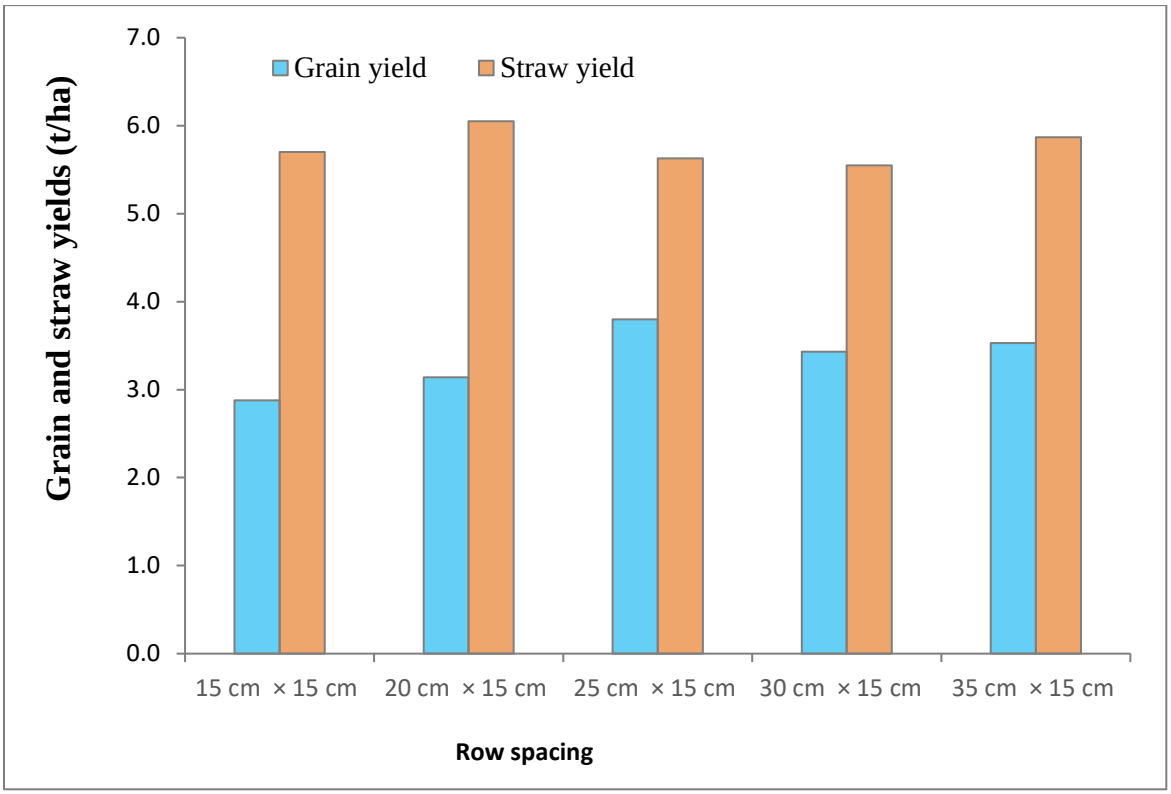


**Figure 2:** Relation between row spacing with grain yield and straw yield

### 3.3 Interaction effects of variety and row spacing on yield contributing characters and yield

The interaction between variety and row spacing had significant effect some important crop characters and yield. Plant height was significantly affected by interaction effect between variety and row spacing . The tallest plant (113.00 cm) was obtained in BRRI dhan39 with the row spacing 30cm × 15cm and the shortest plant height (95.83 cm) was obtained in BRRI dhan49 with the row spacing 20cm × 15cm. The highest number of total tillers hill$^{-1}$ (11.33), number of effective tillers hill$^{-1}$ (9.62) was obtained in BRRI dhan49 with the row spacing 30cm × 15 cm and 35cm × 15cm, respectively. The lowest number of total tillers hill$^{-1}$ (6.33) from BRRI dhan39, number of effective tillers hill$^{-1}$ (6.61) was obtained in BRRI dhan49 with the interaction of row spacing 15cm × 15cm. The highest number of grains panicle$^{-1}$ (127.92) was obtained in variety BRRI dhan39 with 25cm × 15cm row spacing which was statistically at par in BRRI dhan39 with 35 cm × 15 cm row spacing and the lowest grains panicle$^{-1}$ (109.80) was obtained in Binadhan-7 with 35cm × 15cm row spacing. The highest grain yield (4.44 t ha$^{-1}$) was recorded in variety BRRI dhan49 with the row spacing 25cm × 15cm on the other hand the lowest grain yield (2.58 t ha$^{-1}$) was obtained in Binadhan-7 with the interaction of row spacing 15cm × 15cm. The highest straw yield (7.29 t ha$^{-1}$) was obtained in BRRI dhan39 with the row spacing 20cm × 15cm and the lowest straw yield was recorded in BRRI dhan49 with the interacting row spacing of 25cm × 15cm. The highest biological yield (10.32 t ha$^{-1}$) was obtained in variety BRRI dhan39 with the row spacing 20cm × 15cm and the lowest biological yield was found in the variety Binadhan-7 with the row spacing of 15cm × 15cm. The highest harvest index (46.20%) was obtained in variety BRRI dhan49 with the row spacing of25cm × 15cm and the lowest harvest index (29.39) was obtained from the interaction between variety BRRI dhan39 and row spacing 20cm × 15cm. Sohel reported that for getting maximum grain yield from T. aman cultivation (cv. BRRI dhan41), spacing (25 cm × 20 cm) appeared as the best management practice [20]. Hosain found that T. aman varieties performed well with 20cm x 10cm spacing in the field and also with their yield [25].

**Table 3:** Effect of interaction between variety and row spacing on yield contributing characters and yield of short duration transplant Aman rice varieties

| Interaction (Variety × Spacing) | Plant height (cm) | Number of tillers hill$^{-1}$ | Number of effective tillers hill$^{-1}$ | Number of non-effective tillers hill$^{-1}$ | Panicle length (cm) | Number of grains panicle$^{-1}$ | Number of sterile spikelets panicle$^{-1}$ | 1000-grain weight (g) | Grain yield (t ha$^{-1}$) | Straw yield (t ha$^{-1}$) | Biological yield (t ha$^{-1}$) | Harvest Index (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $V_1 \times S_1$ | 97.29bcd | 8.92cde | 7.33efg | 1.58 | 23.80 | 110.02c | 21.47 | 25.63 | 2.58g | 5.17f | 7.75e | 33.36e |
| $V_1 \times S_2$ | 98.85bcd | 8.92cde | 7.67c-g | 1.25 | 23.84 | 111.75cde | 20.40 | 25.47 | 3.02ef | 5.67def | 8.68cd | 34.76cde |
| $V_1 \times S_3$ | 99.17bcd | 10.25abc | 8.42b-f | 1.83 | 23.77 | 113.52cde | 18.60 | 25.50 | 3.15ef | 5.27f | 8.42d | 37.42bc |
| $V_1 \times S_4$ | 101.25b | 9.08b-e | 8.50a-e | 0.58 | 23.72 | 110.57de | 17.27 | 24.97 | 3.12ef | 5.27f | 8.39d | 37.20bc |
| $V_1 \times S_5$ | 100.42bc | 9.67a-d | 8.98ab | 0.68 | 23.75 | 109.80e | 18.52 | 24.67 | 3.25e | 5.39ef | 8.63cd | 37.58bc |
| $V_2 \times S_1$ | 112.17a | 6.33f | 5.50e | 0.83 | 24.89 | 115.47cde | 19.49 | 24.57 | 2.83fg | 6.62b | 9.45b | 29.96f |
| $V_2 \times S_2$ | 112.08a | 8.25de | 7.50d-g | 0.75 | 24.80 | 116.28cde | 18.47 | 24.50 | 3.03ef | 7.29a | 10.32a | 29.39f |
| $V_2 \times S_3$ | 111.49a | 9.75a-d | 8.66a-d | 1.09 | 24.97 | 127.92a | 16.62 | 24.73 | 3.82bc | 6.45bc | 10.27a | 37.26bc |
| $V_2 \times S_4$ | 113.00a | 9.92a-d | 8.33b-f | 1.58 | 24.26 | 118.32bc | 16.47 | 24.63 | 3.09ef | 6.10cd | 9.19bc | 33.61de |
| $V_2 \times S_5$ | 112.83a | 10.25abc | 9.08ab | 1.17 | 24.75 | 123.78ab | 16.78 | 24.60 | 3.71cd | 6.45bc | 10.15a | 36.50bcd |
| $V_3 \times S_1$ | 96.42cd | 8.00e | 6.61g | 1.39 | 24.40 | 109.48e | 14.95 | 23.30 | 3.22e | 5.30ef | 8.52d | 37.74bc |
| $V_3 \times S_2$ | 95.83d | 8.67cde | 7.25fg | 1.42 | 24.43 | 110.03e | 14.43 | 23.53 | 3.37de | 5.21f | 8.58d | 39.23b |
| $V_3 \times S_3$ | 98.00bcd | 10.73ab | 8.83abc | 1.90 | 24.19 | 117.12cd | 12.45 | 24.37 | 4.44a | 5.17f | 9.60b | 46.20a |
| $V_3 \times S_4$ | 96.75cd | 11.33a | 9.42ab | 1.92 | 25.39 | 118.20bc | 13.18 | 23.53 | 4.09b | 5.29ef | 9.38b | 43.63a |
| $V_3 \times S_5$ | 109.85a | 11.25a | 9.62a | 1.63 | 24.52 | 112.58cde | 12.46 | 23.53 | 3.64cd | 5.77de | 9.40b | 38.68b |
| CV (%) | 4.06 | 9.25 | 7.58 | 20.09 | 12.25 | 3.25 | 9.25 | 3.28 | 5.80 | 5.47 | 4.58 | 3.54 |
| Level of sig. | ** | * | * | NS | NS | * | NS | NS | ** | ** | ** | ** |

In a column with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly ( as per DMRT)Variety : V1= Binadhan-7, V2= BRRI dhan39, V3= BRRI dhan49 Row Spacing : S1= 15 cm × 15 cm, S2= 20 cm × 15 cm, S3= 25 cm × 15 cm, S4= 30 cm × 15 cm , S5= 35 cm × 15 cm*= Significant at 5% level of probability; **= Significant at 1% level of probability; NS= Not significant

The interaction between variety and row spacing exert non-significant effect on number of non-effective tillers hill$^{-1}$, panicle length, number of sterile spikeletspanicle$^{-1}$, 1000-grains weight. However, numerically the highest number of non-effective tillers hill$^{-1}$ (1.92) was obtained in BRRI dhan49 with the interaction of row spacing 30cm × 15 cm and the lowest number of non-effective tillers hill$^{-1}$(0.58) was obtained in Binadhan-7 with the interaction of row spacing 30cm × 15 cm. (Table 3). Numerically the highest panicle length (25.39 cm) was obtained in BRRI dhan49 with the interaction effect of row spacing 30cm × 15cm and the lowest panicle length (23.72) was obtained in Binadhan-7 with 30cm × 15cm row spacing [26,27]. Numerically the highest number of sterile spikeletspanicle$^{-1}$ (21.47), weight of 1000-grains (25.63 g) was obtained in variety Binadhan-7 with 15cm × 15cm row spacing and the lowest number of sterile spikelets panicle$^{-1}$ (12.45) from the variety BRRI dhan49 with 25cm × 15cm row spacing and 1000-grains weight (23.30) was obtained in BRRI dhan49 with 15cm × 15cm row spacing.

The results showed that each variety of short duration aman rice has a different response to row spacing which determines the yield of rice crops. The plant/row spacing facilitates the plants for optimum growth and development without experiencing too much competition for growth elements, such as water, nutrients and sunlight. The right spacing is important for the optimum sunlight utilization for photosynthesis and yield improvement. Pratiwi reported that plant varieties express their growth potential in wider plant spacing [28]. A group research observed that the optimum growth of vegetative organs and roots obtained from optimum plant spacing by utilizing more sunlight and nutrients results high yield [29].

## 4. CONCLUSIONS

Results revealed that BRRI dhan49 produced the highest grain yield compare to other tested varieties. The highest grain yield of short duration varieties was obtained when transplanted at the spacing 25cm × 15 cm. As a short duration variety, BRRI dhan49 gave the highest grain yield along with the spacing 25cm × 15 cm. Therefore, BRRI dhan49 cultivated at the spacing 25cm × 15cm appears as the promising practice in terms of grain yield.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper.

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