EFFECT OF SPACINGS ON THE YIELD AND YIELD ATTRIBUTES OF TRANSPLANTED AMAN RICE CULTIVARS IN MEDIUM LOWLAND ECOSYSTEM OF BANGLADESH

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ABSTRACT

A study was conducted at medium low land of Agronomy Field laboratory, Patuakhali Science and Technology University, Bangladesh during the year 2008. Three spacings (5×15, 15×20 and 15×25 cm\(^2\)) were tried to determine the yield and yield attributes of five transplanted aman rice cultivars namely Mothamota, Lalmota, Lalchicon, BRRI dhan41 and BRRI dhan44. Among the cultivars BRRI dhan44 produced the highest grain yield (5.03t/ha), number of filled grains per panicle (97.67), number of total grains per panicle (106.11) and harvest index (48.75%). Among the spacings, 15×20 cm\(^2\) performed better for grain yield (3.66 t/ha), number of productive tillers per hill (5.13), number of total grains per panicle (91.80), number of filled grains per panicle (84.40) and harvest index (45.50%). Interaction effect of variety and spacing showed that variety BRRI dhan44 excelled in grain yield (5.36 t/ha) and harvest index (49.35%) at the spacing of 15×20 cm\(^2\). So variety BRRI dhan44 at medium spacing of 15×20cm\(^2\) is recommended for higher grain yield in medium lowland ecosystem of Bangladesh.

KEYWORDS: Oryza sativa; cultivars; agronomic characters; spacing; Bangladesh.

INTRODUCTION

Rice (Oryza sativa L.) is a major cereal of Bangladesh. During the year 2007-2008 rice covered an area of 10575 thousand hectares with a production of 28931 thousand m.tons (5). The climate and soil of Bangladesh are favourable for rice production throughout the year. The average yield of rice in Bangladesh is around 2.74 tons per hectare (6) which is much
lower than the world average of 4.25 tons per hectare (6). Peoples of Bangladesh have been facing acute shortage of rice yield for a long time. The horizontal expansion of rice area in the country is not possible due to increasing population pressure. Various studies showed that variety is an important genetic factor which contributes a lot for producing higher yield of a particular crop. An optimum plant density is an important factor to achieve higher yield from different rice varieties (21). Yield components are directly related to the variety and the surrounding environments. So, the only option left to increase rice production is vertical expansion where use of improved varieties and optimum spacing is most productive means. When the plant spacing exceeds an optimum level, competition among plants for light and nutrients becomes severe. Consequently the plant growth slows down and grain yield decreases. The optimum hill spacing was found to be well designated to obtain high yield (1). Tillering habit and production of spikelets per plant depend, to a great extent, on the spacing of transplanting which is responsible for variation in rice yield. Wider row spacing increases rice yield (22) and it linearly increases the performance of individual plants (8). Narrow spacing (10x20 cm^2) gave the highest yield and yield components of Giza 177 rice cultivar compared with 20x20cm^2 or 30x20cm^2 spacings (23). The wider spacing produced higher number of tillers at maximum tillering stage (25). However, more wider spacing minimized yield due to more weed and pest infestation as well as lower number of population in a unit area.

Ecosystem is an important factor for rice production. The growth and development of rice plant depends on spacing and ecosystem. The farmers of southern part of Bangladesh do not maintain proper planting distance and they use higher seed rate. Due to lowland area only local varieties are being cultivated instead of modern varieties in southern part of our country. The farmers are trying to cultivate HYV in highland instead of using medium lowland which is very little amount. So the farmers are not getting proper yield due to lack of proper information on spacing and ecosystem selection. The present study was undertaken to find out the appropriate plant spacing of five transplanted (T.) aman rice varieties in medium lowland ecosystem.

**MATERIALS AND METHODS**

Three spacings viz. 15 x 15 cm^2 (S1), 15 x 20 cm^2 (S2) and 15 x 25 cm^2 (S3) were tried on five T. aman rice varieties viz. Mothamota (V1), Lalmota (V2), Lalchicon (V3), BRRI dhan41 (V4) and BRRI dhan44 (V5). Layout system was
factorial randomized complete block design with three replications in a plot measuring 4 x 2.45 cm².

Seedlings were raised in well-prepared seedbed. The seed rate for nursery bed was 30 kg per hectare. The sprouted seeds of varieties were sown uniformly on well prepared nurseries on 14th July, 2008. Transplanting of seedlings was done on 27th August. All agronomic practices were adopted according to the common recommendations for this crop. Data were collected following standard procedure. The grain yield was measured from one square meter area in each plot and were converted into tons per hectare.

The sun-dried straw was weighed from the same sample area harvested for grain yield and converted into tons per hectare. The biological yield was calculated using the following formula:

\[
\text{Biological yield} = \text{Grain yield} + \text{straw yield}
\]

Harvest index was calculated on the basis of adjusted grain and straw yield using the formula recommended by Gardner et al. (10).

\[
\text{Harvest index} (\%) = \left(\frac{\text{Grain yield}}{\text{Biological yield}}\right) \times 100
\]

Analysis of variance for different characters was done using MSTAT-C software. The treatment means were compared using Duncan's multiple range test (DMRT) at 5 percent level of significance (12).

**RESULTS AND DISCUSSION**

**Effect of variety on plant characteristics**

**Number of productive tillers per hill:** Number of productive tillers per hill was significantly influenced by single effect of variety (Table 1). Modern variety BRRI dhan44 produced the highest number of productive tillers (5.67) against minimum by local variety Mothamota (4.33). The result further revealed that cultivar BRRI dhan44 had better inherent capacity to produce more productive tillers. The results also confirm that modern variety performed better than traditional variety for this trait. These results agree to those of Babiker (7), Hossain et al. (13) and Uddin et al. (29).
Table 1. Effect of varieties on the yield and yield contributing characters of T. aman rice.

<table>
<thead>
<tr>
<th>Variety</th>
<th>No. of productive tillers/hill</th>
<th>No. of total grains/panicle</th>
<th>Number of filled grains/panicle</th>
<th>Grain yield (t/ha)</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mothamota</td>
<td>4.33e</td>
<td>76.89d</td>
<td>63.33d</td>
<td>2.38d</td>
<td>41.27d</td>
</tr>
<tr>
<td>Lalmota</td>
<td>5.22b</td>
<td>83.44c</td>
<td>77.56c</td>
<td>3.36c</td>
<td>41.06d</td>
</tr>
<tr>
<td>Lalchicon</td>
<td>4.44d</td>
<td>70.78e</td>
<td>63.00e</td>
<td>2.33e</td>
<td>44.42c</td>
</tr>
<tr>
<td>BRRI dhan41</td>
<td>4.89c</td>
<td>102.22 b</td>
<td>95.33b</td>
<td>3.79b</td>
<td>47.84b</td>
</tr>
<tr>
<td>BRRI dhan44</td>
<td>5.67a</td>
<td>106.11a</td>
<td>97.67a</td>
<td>5.03a</td>
<td>48.75a</td>
</tr>
</tbody>
</table>

Level of significance: * * * *

CV (%) 12.62 7.73 7.70 2.58

Figures in a column, having the same letter (s) do not differ significantly (p = 0.05).

Number of total grains per panicle: Single effect of variety was significant in respect of number of total grains per panicle (Table 1). Among the varieties BRRI dhan44 topped the list (106.11). The lowest number of total grains per panicle was produced by Lalchicon (70.78). Lalmota as well as BRRI dhan41 proved as intermediate in this trait (83.44 and 102.22) which differed significantly from each other. The results reflect that modern variety BRRI dhan44 performed better than local varieties. Some earlier workers (4, 13, 18, 27) also reported that number of grains differed significantly due to varieties.

Number of filled grains per panicle: The data (Table 1) showed significant differences in number of filled grains per panicle. BRRI dhan44 excelled significantly (97.67). Lalchicon produced the lowest (63.00) (Table 1). Variation in filled grains per panicle was observed due to genotypic differences of varieties. Similar results were reported by earlier workers (3, 4, 13, 27).

Grain yield: Variety had significant effect on grain yield (Fig. 1). Among the varieties, BRRI dhan44 produced higher grain yield (5.03 t/ha) followed by BRRI dhan41 (3.79) (Table 1, Fig. 1). The lowest grain yield (2.33 t/ha) was obtained from Lalchicon (2.33 t). Better yield performance of BRRI dhan44 may be due to superior selected yield attributing traits of this variety. Almost similar results were obtained by different workers (2, 3, 13, 18, 19).
Effect of spacing on transplanted aman rice yield

Straw yield: BRRI dhan44 also produced significantly higher straw yield (5.28 t/ha) (Fig. 1) against the lowest by Lalchicon (2.94 t/ha). This might be due to varietal differences. Though the variety BRRI dhan44 gave more straw yield over others, yet straw yield is not a problem for the variety. It will increase the economic output of rice. Almost similar results were obtained by Alam et al. (3), Hossain et al. (13), Sohel et al. (28) and Uddin et al. (29).

Harvest index: Significantly higher harvest index (48.75%) was recorded in BRRI dhan44 against the lowest (41.06%) in Lalmota (Table 1). This is due to different genetic constitution of the varieties. Higher harvest index in variety BRRI dhan44 is due to its higher grain yield and lower straw yield which was achieved through better performance in most of yield attributing traits. Higher harvest index in modern varieties was also described earlier (3, 13, 18, 27).

Effect of spacing on plant characteristics

Number of productive tillers per hill: Number of productive tillers was significantly influenced by spacings (Table 2). The spacing 15 x 20 cm$^2$ produced the highest number of productive tillers (5.13) followed by 15 x 15 cm$^2$ (5.00) and 15 x 25 cm$^2$ (4.60). The results revealed that medium spacing performed better as compared to lower spacing where the plants did not get proper nutrition due to nutrient competition. In case of wider spacing, weed infestation was observed which caused competition in nutrients with plants. Similar results have also been reported by Jocob et al. (18), Sohel et al. (28) and Uddin et al. (29).
**Number of total grains per panicle**: Single effect of spacing was significant on number of total grains per panicle (Table 2). The data indicated that 15×20 and 15×25cm² spacings produced the highest number of total grains per panicle (91.80 each) against the lowest by 15×15cm² spacing (80.0). Plants at more spacing produced more grains per panicle due to higher nutrient achievement. Salahuddin et al. (21), Sohel et al. (28) and Uddin et al. (29) also found that more spacing produced more number of grains per panicle.

**Table 2. Effect of spacings on the yield contributing characters of T. aman rice.**

<table>
<thead>
<tr>
<th>Spacing (cm²)</th>
<th>No. of productive tillers/hill</th>
<th>No. of total grains/panicle</th>
<th>No. of filled grains/panicle</th>
<th>Grain yield (t/ha)</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15×15</td>
<td>5.00 b</td>
<td>80.07 b</td>
<td>70.67 c</td>
<td>3.59b</td>
<td>44.70 b</td>
</tr>
<tr>
<td>15×20</td>
<td>5.13 a</td>
<td>91.80 a</td>
<td>84.40 a</td>
<td>3.66a</td>
<td>45.50 a</td>
</tr>
<tr>
<td>15×25</td>
<td>4.60 c</td>
<td>91.80 a</td>
<td>83.06 b</td>
<td>2.88c</td>
<td>43.81c</td>
</tr>
<tr>
<td>Level of significance</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>CV (%)</td>
<td>12.62</td>
<td>7.73</td>
<td>7.70</td>
<td>7.89</td>
<td>2.58</td>
</tr>
</tbody>
</table>

Figures in a column, having the same letter (s) do not differ significantly (p = 0.05).

**Number of filled grains per panicle**: It was observed that spacing of 15×20 cm² excelled in number of grains per panicle (84.40). The lowest number of grains per panicle (70.67) was recorded in the closest spacing (15×15 cm²) (Table 2). Since fertility of spikelets and development of grains depend on environmental factors such as nutrients, moisture and light, wider spacing possibly facilitated to supply the more food materials, moisture and light for the plant and ultimately developed grains comparing to closer spacing. In case of higher spacing, weed infestation was another problem which caused competition in nutrients with plants. For this reason, medium spacing performed better. Hamid et al. (14), Rao et al. (24), Sohel et al. (28) and Uddin et al. (29) have also reported similar results.

**Grain yield**: Spacing had significant effect also on grain yield. The spacing of 15×20 cm² produced the highest grain yield (3.66 t/ha) while spacing 15×25 cm² produced the lowest (2.88 t/ha) (Table 2, Fig. 2). The results revealed that medium spacing produced better grain yield. This might be due to proper nutrient availability in crop. In closer spacing, plants suffered from inter species nutrient competition, whereas in case of wider spacing, plants suffered from intra species nutrient competition with weeds. The results agree to the findings of some earlier workers (20, 27, 28, 29).
**Straw yield:** Plants spaced at 15 × 15 cm² produced the highest straw yield (4.38 t/ha), while 15 × 25 cm² spacing produced the lowest (3.61 t/ha) (Fig. 2). The results revealed that closer spacing produced higher straw yield. This may be due to shading of leaves of one plant to another because shaded plants show more vegetative growth. Hamid et al. (14), Sohel et al. (28) and Uddin et al. (29) have also reported similar results.

![Fig 2](image)

**Harvest index:** Significantly higher (45.50%) harvest index was obtained from the spacing of 15 × 20 cm² (Table 2) followed by closer spacing of 15 × 15 cm² (44.7%). The lowest harvest index (43.81%) was obtained from higher spacing of 15×25 cm² (Table 2). The results revealed that medium spacing produced higher harvest index, which should be followed for higher benefit. Similar results have been reported earlier (14, 29).

**Interaction effect of variety and spacing**

**Number of productive tillers per hill:** Interaction effect of variety and spacing was significant on number of productive tillers. BRRI dhan44 at spacing of 15×20cm² produced more productive tillers per hill (6.30) while Lalchicon at spacing of 15×25cm² stood last (4.00) (Table 3). So, the variety BRRI dhan44 with medium spacing (15 × 20 cm²) is suggested for higher productive tillers. Almost similar results were obtained by Chris (9), Sohel et al (28) and Uddin et al. (29).
Table 3. Interaction effect of variety and spacing on the yield and yield contributing characters of T. aman rice.

<table>
<thead>
<tr>
<th>Interaction (variety × spacing)</th>
<th>Number of productive tillers/hill</th>
<th>Number of total grains/panicle</th>
<th>Number of filled grains/panicle</th>
<th>Grain yield (t/ha)</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V₁ × S₁</td>
<td>4.70 cde</td>
<td>65.00 g</td>
<td>50.00 e</td>
<td>2.66 fg</td>
<td>42.13 e</td>
</tr>
<tr>
<td>V₂ × S₁</td>
<td>6.00 ab</td>
<td>62.30 g</td>
<td>56.70 de</td>
<td>3.48 d</td>
<td>42.49 e</td>
</tr>
<tr>
<td>V₃ × S₁</td>
<td>5.00 bcd</td>
<td>72.30 efg</td>
<td>67.10 cd</td>
<td>3.01 ef</td>
<td>42.40 e</td>
</tr>
<tr>
<td>V₄ × S₁</td>
<td>4.30 de</td>
<td>95.70 abc</td>
<td>88.70 b</td>
<td>3.88 cd</td>
<td>47.68 abc</td>
</tr>
<tr>
<td>V₅ × S₁</td>
<td>5.00 bcd</td>
<td>105.00 ab</td>
<td>96.30 ab</td>
<td>4.94 ab</td>
<td>48.39 ab</td>
</tr>
<tr>
<td>V₁ × S₂</td>
<td>4.30 de</td>
<td>82.00 def</td>
<td>70.00 c</td>
<td>2.59 fgh</td>
<td>41.89 e</td>
</tr>
<tr>
<td>V₂ × S₂</td>
<td>5.30 abcd</td>
<td>94.00 bcd</td>
<td>88.00 b</td>
<td>4.41 c</td>
<td>42.44 e</td>
</tr>
<tr>
<td>V₃ × S₂</td>
<td>4.30 de</td>
<td>69.30 g</td>
<td>63.70 cd</td>
<td>2.16 hi</td>
<td>44.74 d</td>
</tr>
<tr>
<td>V₄ × S₂</td>
<td>6.30 abcd</td>
<td>106.30 ab</td>
<td>101.30 a</td>
<td>4.06 c</td>
<td>49.07 a</td>
</tr>
<tr>
<td>V₅ × S₂</td>
<td>4.00 a</td>
<td>107.30 a</td>
<td>99.00 ab</td>
<td>5.36 a</td>
<td>49.35 a</td>
</tr>
<tr>
<td>V₁ × S₃</td>
<td>4.00 a</td>
<td>83.70 cde</td>
<td>70.00 c</td>
<td>1.91 i</td>
<td>39.79 f</td>
</tr>
<tr>
<td>V₂ × S₃</td>
<td>4.30 de</td>
<td>94.00 bcd</td>
<td>88.00 b</td>
<td>2.46 gh</td>
<td>38.25 f</td>
</tr>
<tr>
<td>V₃ × S₃</td>
<td>4.00 e</td>
<td>70.70 fg</td>
<td>63.70 cd</td>
<td>1.81 i</td>
<td>45.71 cd</td>
</tr>
<tr>
<td>V₄ × S₃</td>
<td>5.00 bcd</td>
<td>104.70 ab</td>
<td>96.00 ab</td>
<td>3.44 de</td>
<td>46.77 bc</td>
</tr>
<tr>
<td>V₅ × S₃</td>
<td>5.70 abc</td>
<td>106.00 ab</td>
<td>97.70 ab</td>
<td>4.79 b</td>
<td>48.51 ab</td>
</tr>
</tbody>
</table>

CV % 12.62 7.73 7.70 7.89 2.58

V₁ = Mothamota, V₂ = Lalmota, V₃ = Lachicon, V₄ = BRRI dhan41, V₅ = BRRI dhan44, S₁ = (15 × 15) cm², S₂ = (15 × 20) cm², S₃ = (15 × 25) cm², NS = Non-significant, *Significant at 5% level of probability. Figures in a column having the same letter (s) do not differ significantly.

**Number of total grains per panicle:** Interaction effect of variety and spacing was also significant on total grains per panicle. Among combinations, the highest number of total grains per panicle (107.30) was noted in BRRI dhan44 at spacing of 15 × 20 cm² (V₅S₂) against the lowest (62.30) in Lachicon at spacing of 15 × 15 cm² (V₂S₁). This may be due to proper nutrient use in medium spaced condition by the variety BRRI dhan44. Almost similar results were demonstrated by Hu et al. (17), Salahuddin et al. (27) and Uddin et al. (29).

**Number of filled grains per panicle:** It was observed that number of filled grains per panicle was significantly higher in BRRI dhan41 at spacing of 15 × 20 cm² (V₄S₂) and the lowest (50.00) in Mothamota at spacing of 15 × 15 cm² (V₁S₁) (Table 3). This may be due to proper nutrient achievement in medium spaced condition by variety BRRI dhan41. Geethadevi et al. (11), Rashid and Khan (25) and Uddin et al. (29) observed similar results.
Fig. 3  Interaction effect of variety and spacing on grain and straw yields (t/ha -1) of rice. Vertical bar indicates significance at 5% level of probability.
Grain yield: The highest grain yield was produced by BRRI dhan44 at spacing of 15 × 20 cm² (5.36 t/ha) (V₅S₂) against the lowest in Lalchicon at spacing of 15 × 25 cm² (1.81 t/ha) (V₃S₂). More grain yield of BRRI dhan44 with medium spacing may be due to its better performance in most of the evaluated traits. These findings are compatible with Hossain (16) and Uddin et al. (29).

Straw yield: Significantly higher straw yield (5.61 t/ha) was produced in Lalmota at spacing of 15 × 20 cm² (V₂S₂) and the lowest (2.14 t/ha) in Lalchicon at spacing of 15 × 25 cm² (V₃S₃) (Fig. 3). The result reflects that local variety with medium spacing produced higher straw yield. Nearly similar results were demonstrated by Hossain (16), Sohel et al. (28) and Uddin et al. (29).

Harvest index: The data (Table 3) revealed that the highest harvest index (49.35%) in BRRI dhan44 at spacing of 15 × 20 cm² (V₂S₂) and the lowest (38.25%) (V₃S₃). The result showed that modern variety BRRI dhan44 with medium spacing produced higher harvest index. This may be due to proper nutrient, light absorption, less weed and pest infestation in this variety under medium spacing. Other scientists (26, 28, 29) also report similar results.

CONCLUSION

The study concludes that BRRI dhan44 performed better in most of the evaluating traits like grain yield, straw yield and number of productive tillers per hill. However, plants at medium spacing of 15×20cm² produced more grain yield, number of total grains per penicle, number of filled grains per penicle and number of productive tillers per hill. Among the combinations of variety and spacing, BRRI dhan44 produced higher grain yield at spacing of 15 × 20 cm². So, BRRI dhan44 with medium spacing can be suggested for medium lowland of coastal area of Bangladesh.

REFERENCES

Effect of spacing on transplanted aman rice yield


