EFFECT OF SPACING ON MORPHO-PHYSIOLOGICAL RESPONSE OF DIFFERENT T. AMAN RICE CULTIVARS UNDER COASTAL HIGH LAND ECOSYSTEM


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ABSTRACT

The study was conducted to determine the effect of spacing on morpho-physiological response of different T. Aman rice cultivars under coastal high land ecosystem. Assessment was done on plant height (cm), total tillers hill⁻¹, effective and non-effective tillers hill⁻¹, panicle length (cm), grains panicle⁻¹, unfilled spikelets panicle⁻¹, total spikelets panicle⁻¹, 1000-grain weight (g), grain yield (t ha⁻¹), straw yield (t ha⁻¹) and harvest index of the selected rice cultivars. Interaction effect revealed that the variety BRRI dhan44 produced the highest grain yield (4.83 t ha⁻¹) at the spacing of 15 cm×15 cm. The Variety BRRI dhan44 at low spacing (15 cm×15 cm) may be followed to get high yield in coastal high land ecosystem of Bangladesh.

Key words: Spacing, Morpho-physiology, Coastal high land, Ecosystem

INTRODUCTION

Rice (Oryza sativa, L.) is one of the most important cereal crops in the world. There are 111 rice growing countries in the world which occupies 146.5 million hectares and more than 90% in Asia. About 95% of the world rice is consumed in Asia. Rice production constitutes the major economic activity and key source in employment for the rural population of Bangladesh. Agriculture in Bangladesh is predominantly rice based and Bangladesh is the fourth rice growing country in the world. In Bangladesh, during 2007-2008 rice covered an area of 10575 thousand ha with production of 28931 thousand m tons (BBS, 2009). The climate and soil of Bangladesh are favorable for year around rice production. The average yield of rice in Bangladesh is around 2.74 t ha⁻¹ (BBS, 2009) which is much lower than the world average 4.25 t ha⁻¹ (FAO, 2007). In Bangladesh, peoples are facing acute shortage of rice for a long time. The horizontal expansion of rice area in the country is not possible due to increasing population pressure. Various experimental results showed variety is an important genetical 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. So, the only avenue left to increase the production of rice is through vertical expansion where use of improved varieties and optimum spacing are two of the most effective
means to increase the yield of transplant aman rice. Plant spacing is a focal fact for transplanted aman rice. When the plant spacing exceeds an optimum level, competition among plants for light and nutrients becomes severe. Consequently, the plant growth slows down and the grain yield decreases. Good plant spacing gives the right plant density, which is the number of plants, allowed on a given unit of land for optimum yield (Obi, 1991). The tillering habit and production of spikelets per plant depend to a great extent on the spacing of transplanting which is responsible for variation of yield in rice. Moreover, the plant spacing influences the physiology, availability of sunlight, leaf area index, nutrient to the plant. Thus, the plant to plant and row to row distances determine the plant population per unit area which has a direct effect on the yield of rice (Miah et al., 1990). Ecosystem is another important factor for rice production. The growth and development of rice plant depends on spacing and ecosystem. The farmers of southern part of our country do not maintain proper planting distance. As a result they used higher seed rate. The farmers are not getting proper yield due to lack of proper information of spacing and ecosystem selection. Mothamota, Lalmota, Lalchicon, BRRI dhan41 and BRRI dhan44 are widely cultivated in southern part of our country. The present study was therefore, undertaken to find out the appropriate plant spacing of five transplanted aman rice varieties in high land coastal ecosystem.

**MATERIALS AND METHODS**

A field experiment was carried out with five *T. aman* rice variety viz. Mothamota (V₁), Lalmota (V₂), Lalchicon (V₃), BRRI dhan41 (V₄), BRRI dhan44 (V₅) and three different spacing viz. 15×15 cm (S₁), 15×20 cm (S₂) and 15×25 cm (S₃) in a randomized complete block design with three replications to study the performances of different rice cultivars in different spacing under coastal high land ecosystem.

Seedlings were raised in well-prepared seedbed. Seeds of different cultivars were separately kept in water in bucket for 24 hours. Water-soaked seeds were then kept thickly in cloth bags. The seeds started sprouting after 48 hours and were suitable for sowing after 72 hours. Thereafter, the sprouted seeds of different varieties were sown uniformly on well-prepared nurseries on 14 July, 2008. Due care was taken to ensure the normal growth of the seedlings. Transplanting of seedling of all varieties was done on 27 August, 2008.

Routine agronomic practices were done according to the recommendation to grow a successful rice crop.

Plant height was measured from 10 tagged hills for each unit plot, with the help of meter scale from the base of the plant to the tip of the panicle. Number of total tiller hill⁻¹ was recorded through counting tillers number from the randomly selected 10 plants per unit plot.

Effective tillers hill⁻¹, non effective tillers hill⁻¹, panicle length were recorded at harvest from 10 selected hills plot⁻¹.

Numbers of grains panicle⁻¹, number of unfilled spikelets panicle⁻¹, total spikelets panicle⁻¹ were counted from main culm of 20 randomly selected panicles from each plot.

The weight of 1000 grain was measured from taking samples of each unit plot and the grain yield was measured from 1 m² area in each plot, which was then converted into t ha⁻¹.

The sun-dried straw was weighed from the same sample area harvested for grain yield and converted again into t ha⁻¹.

The biological yield (grain + straw) was measured and the harvest index was calculated on the basis of adjusted grain and straw yield using the following formula (Gardner et al., 1985).

\[
\text{Grain yield} \\
\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield (grain + straw)}} \times 100
\]

Analysis of variance for different characters were done by using MSTAT-C statistical program. The treatment means were compared using
Duncan's Multiple Range Test (DMRT) at 5% level of significance (Gomez and Gomez, 1984).

**RESULTS AND DISCUSSION**

**Plant height:**

Plant height did not significantly influenced by single effect of variety (Table 1) and spacing (Table 2) but there were difference among those. Among the variety, Lalchicon produced the tallest plant (147.03 cm) where as BRRI dhan41 produced the shortest plant (82.90 cm). This may be due to genetic variability. Among the spacing, shorter spacing 15×25 cm produced the tallest plant (122.82 cm). The spacing 15×15 cm produced the shortest plant (117.32 cm). Interaction effect of variety and spacing was significant (Table 3). The tallest plant height obtained (150.40 cm) Lalchicon at the spacing of 15 × 15 cm and lowest (80.70 cm) of BRRI dhan41 at the spacing of 15×25 cm. The similar results were reported by Intikhab-Syed (2007).

**Number of total tillers hill⁻¹:**

Single effect of variety (Table 1) and plant spacing (Table 2) was significant in respect of Number of total tillers hill⁻¹. Among the five varieties, Lalmota produced the maximum number of total tillers hill⁻¹ (9.33). The minimum number of total tillers hill⁻¹ was produced by BRRI dhan41 and Mothamota (7.33). There was gradual increase of tillers hill⁻¹ with the widening of plant spacing. It was observed that, the spacing 15×25 cm produced the highest number of total tillers hill⁻¹ (9.40) and the closest spacing (15×15 cm) produced the least

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**Table 1:** Effect of variety on the yield contributing characters of transplanted aman rice in coastal high land ecosystem.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Plant height (cm)</th>
<th>Number of total tillers hill⁻¹</th>
<th>Number of effective tillers hill⁻¹</th>
<th>Panicle length (cm)</th>
<th>Number of filled grainpanicle⁻¹</th>
<th>Total number of grainpanicle⁻¹</th>
<th>1000 grain weight (g)</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mothamota</td>
<td>141.60</td>
<td>7.33 d</td>
<td>4.00 d</td>
<td>20.06</td>
<td>60.33 d</td>
<td>70.00 d</td>
<td>27.78</td>
<td>41.06 d</td>
</tr>
<tr>
<td>Lalmota</td>
<td>134.33</td>
<td>9.33 a</td>
<td>5.00 b</td>
<td>22.34</td>
<td>74.44 c</td>
<td>83.56 c</td>
<td>25.81</td>
<td>40.92 e</td>
</tr>
<tr>
<td>Lalchicon</td>
<td>147.03</td>
<td>7.67 c</td>
<td>4.00 d</td>
<td>21.26</td>
<td>60.00 e</td>
<td>67.33 e</td>
<td>23.80</td>
<td>41.15 c</td>
</tr>
<tr>
<td>BRRI dhan41</td>
<td>82.90</td>
<td>7.33 d</td>
<td>4.67 c</td>
<td>25.00</td>
<td>90.78 b</td>
<td>99.56 b</td>
<td>23.77</td>
<td>48.33 b</td>
</tr>
<tr>
<td>BRRI dhan44</td>
<td>94.40</td>
<td>9.00 b</td>
<td>5.33 a</td>
<td>24.16</td>
<td>91.89 a</td>
<td>101.11 a</td>
<td>25.48</td>
<td>48.43 a</td>
</tr>
</tbody>
</table>

Level of significance NS * NS * NS * NS *

CV (%) 2.14 10.53 12.82 3.41 7.74 7.38 2.07 2.13

* Significant at 5% level of probability, NS. = Non Significant

In a column, figures having the same letter (s) do not differ significantly

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**Table 2:** Effect of spacing on the yield contributing characters of transplanted aman rice in high land coastal ecosystem.

<table>
<thead>
<tr>
<th>Spacing (cm)</th>
<th>Plant height (cm)</th>
<th>Number of total tillers hill⁻¹</th>
<th>Number of effective tillers hill⁻¹</th>
<th>Panicle length (cm)</th>
<th>Number of filled grainpanicle⁻¹</th>
<th>Total number of grainpanicle⁻¹</th>
<th>1000 grain weight (g)</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 × 15 cm</td>
<td>117.32</td>
<td>7.13 c</td>
<td>4.73 b</td>
<td>21.95</td>
<td>75.60 c</td>
<td>66.80 c</td>
<td>25.25</td>
<td>44.80 b</td>
</tr>
<tr>
<td>15 × 20 cm</td>
<td>120.02</td>
<td>7.87 b</td>
<td>4.87 a</td>
<td>23.29</td>
<td>89.93 a</td>
<td>80.80 a</td>
<td>25.30</td>
<td>44.86 a</td>
</tr>
<tr>
<td>15 × 25 cm</td>
<td>122.82</td>
<td>9.40 a</td>
<td>4.20 c</td>
<td>22.45</td>
<td>87.40 b</td>
<td>78.87 b</td>
<td>25.42</td>
<td>42.27 c</td>
</tr>
</tbody>
</table>

Level of Significance NS * NS * NS * NS *

CV (%) 2.14 10.53 12.82 3.41 7.38 7.74 2.07 2.13

* Significant at 5% level of probability, NS = Non significant

In a column, figures having the same letter (s) do not differ significantly
number of total tillers hill$^{-1}$ (7.13). In wider spaced plants received more nutrient, moisture and light which led the plants to produce more tillers plant$^{-1}$. Total number of tillers hill$^{-1}$ was significantly influenced by the interaction between variety and spacing (Table 3). It was observed that the highest number of total tillers hill$^{-1}$ (11.30) was produced in the combination of BRRI dhan44 at the spacing of 15×25 cm and the lowest number of total tillers hill$^{-1}$ (6.30) was produced in the combination of BRRI dhan41 at the spacing of 15×15 cm. A similar result was reported by Patel (2000).

**Number of effective tillers hill$^{-1}$:**

Number of effective tillers hill$^{-1}$ was significantly influenced by single effect of variety (Table 1) and spacing (Table 2). Among the variety, modern variety BRRI dhan44 produced the highest number of effective tillers hill$^{-1}$ (5.33) and local variety Lalchicon and Mothamota produced the minimum number of effective tillers hill$^{-1}$ (4.00). In case of spacing, the spacing 15×20 cm produced the highest number of effective tillers hill$^{-1}$ (4.87). The spacing 15×25 cm produced the lowest number of effective tillers hill$^{-1}$ (4.20). Interaction of variety and spacing produced the significantly highest number of effective tillers hill$^{-1}$ (6.00) in the combination of BRRI dhan44 at the spacing of 15×20 cm and the lowest number of effective tillers hill$^{-1}$ (3.30) was produced in Lalchicon at the spacing of 15×25 cm. Similar results were demonstrated by Chris (2002).

**Panicle length:**

The panicle length did not significantly varied but there was difference among the variety (Table 1) and spacing (Table 2). BRRI dhan41 produced the longest panicle (25.00 cm). The shortest panicle was observed by local variety Mothamota (20.06 cm). This is due to different genotypic constitution. In case of spacing, the highest (23.29 cm) panicle length was obtained at spacing of 15×20 cm. The panicle length was the smallest (21.95 cm) at the closest spacing of 15×15 cm. Interaction between variety and spacing had no significant effect on panicle length (Table 3). It was observed that the highest length of panicle (26.40 cm) was produced in $S_2V_4$ (BRRI dhan41 at the spacing of 15×20 cm) and the shortest length of panicle (19.73 cm) was produced in $S_1V_1, S_3V_1$ combination (Mothamota at the spacing of 15×15 cm and 15×25 cm). Almost similar results were demonstrated by Mustapha (2000).

**Number of total grains panicle$^{-1}$:**

Single effect of variety and spacing was significant in respect of number of total grains panicle$^{-1}$ (Table 1 and 2). Among the variety, BRRI dhan44 produced the highest number of total grains panicle$^{-1}$ (101.11). The lowest number of total grains panicle$^{-1}$ produced by Lalchicon (67.33). This is due to genotypic difference. In case of spacing, the spacing 15×20 cm produced the highest (89.93) number of total grains panicle$^{-1}$ (Table 2). The lowest number of total grains panicle$^{-1}$ (75.60) was produced by the spacing 15×15 cm. Interaction effect of variety and spacing had significant in respect of this. Among the combinations, highest number of total grains panicle$^{-1}$ (107.67) was produced in $S_2V_4$ (BRRI dhan41 at the spacing of 15×20 cm) and the lowest number of total spikelets panicle$^{-1}$ (58.67) was produced in $S_1V_1$ (Mothamota at the spacing of 15×15 cm). Almost similar results were demonstrated by Hu *et al.* (1997).

**Number of filled grains panicle$^{-1}$:**

Single effect of variety and spacing was significant in respect of number of filled grains panicle$^{-1}$ (Table 1 and 2). Interaction effect of variety and spacing was also significant (Table 3). Among the variety, BRRI dhan44 gave significantly the highest number of filled grains panicle$^{-1}$ (91.89). Whereas, Lalchicon produced the lowest (60.00) number of grains panicle$^{-1}$ (Table 1). This may be due to genotypic difference. It was observed that spacing 15×20 cm produced the highest (80.80) number of grains panicle$^{-1}$ (Table 2). The lowest number of grains panicle$^{-1}$ (66.80) produced in the closest spacing 15×15 cm (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 of more food materials, moisture and light for the plant and ultimately for development of grain comparing to closer spacing. It was observed that the highest number of grains panicle$^{-1}$ (107.67) was produced in $S_2V_4$ (BRRI dhan41 at the spacing of $15 \times 20$ cm) and the lowest number of grains panicle$^{-1}$ (58.67) was produced in $S_1V_1$ (Mothamota at the spacing of $15 \times 15$ cm), which was statistically identical to $S_1V_2$ Lalmota at the spacing of $15 \times 15$ cm (Table 3). Geethadevi et al. (2000) reported the similar results.

**1000-grain weight (g):**

Among the variety, Mothamota variety produced the highest (27.78 g) 1000-grain weight (Table 1). The lowest 1000-grain weight (23.77g) was produced by BRRI dhan41. This may be due to the varietal differences. Spacing had no significant effect on 1000 grain weight (Table 2). Interaction effect of variety and spacing had no significant effect on 1000-grain weight (Table 3). It was observed that the highest weight of (27.89 g) 1000-grain was produced in $S_3V_1$ (Mothamota at the spacing of $15 \times 25$ cm) and the lowest weight of (23.70 g) 1000 grain was produced in $S_3V_4$ (BRRI dhan41 at the spacing of $15 \times 15$ cm). Similar results were reported by Gupta and Sharma (1991).

**Grain yield:**

Variety had significant effect on grain yield (Fig 1). In this study, BRRI dhan44 produced the highest (4.30 t ha$^{-1}$) grain yield (Fig 1). The lowest (2.01 t ha$^{-1}$) grain yield was obtained from Lalchicon (Fig 1). BRRI dhan41 produced the second highest grain yield (3.45 t ha$^{-1}$). The spacing, $15 \times 15$ cm produced the highest grain yield (3.48 t ha$^{-1}$) and spacing $15 \times 25$ cm produced the lowest (2.28 t ha$^{-1}$) grain yield (Fig 2). The interaction of variety and spacing had significant effect on grain yield (Table 3). It was observed that the highest (4.83 t ha$^{-1}$) grain yield was produced in $S_2V_5$ (BRRI dhan44 at the spacing of $15 \times 15$ cm) and the lowest weight of (1.28 t ha$^{-1}$) grain yield was produced in $S_3V_3$ (Lalchicon at the spacing of $15 \times 25$ cm). A similar result was demonstrated by Hossain (2005).

![Grain yield - Straw yield - Biological yield](image.png)

*Fig 1*: Effect of variety on grain and straw yield (t ha$^{-1}$) of rice. Vertical bar indicates significance at 5% level of probability.
Straw yield:

Single effect of variety and spacing was significant in respect of straw yield (Fig 1 and 2). Among the variety, Lalmota produced the significantly highest (4.60 t ha\(^{-1}\)) straw yield (Fig 1). Lalchikon produced the lowest straw yield (2.83 t ha\(^{-1}\)). In case of spacing, a spacing of 15×15 cm produced the highest straw yield (4.22 t ha\(^{-1}\)) and 15×25 cm produced the lowest (3.05 t ha\(^{-1}\)) straw yield (Fig 2). It might be attributed due to higher number of plants in wide hill spaced plots. Interaction between variety and spacing had significant effect on straw yield (Fig 3). It was observed that the highest (5.40 t ha\(^{-1}\)) straw yield was produced in S\(_2\)V\(_2\) (Lalmota at the spacing of 15×20 cm) and the lowest weight of (2.06 t ha\(^{-1}\)) straw yield was produced in S\(_3\)V\(_3\) (Lalchikon at the spacing of 15×25 cm). Similar results were reported by Hossain (2002).

Harvest index:

Variety and spacing had significant effect on harvest index (Table 1 and 2). Among the variety, BRRIdhan44 produced the highest harvest index (48.43%) and the lowest (40.92%) was obtained from Lalmota (Table 1). This is due to different genetic constitution. From single effect of spacing, it was found that 15×20 cm spacing was best (44.86%) among the other spacing (Table 2). The lowest (42.27%) harvest index was obtained from the spacing 15×25 cm (Table 2). This result revealed that higher harvest index was obtained from lower spacing. So, higher spacing should be followed for higher benefit. The interaction of variety and spacing showed significant effect on harvest index (Table 3). It was observed that the highest harvest index (48.92%) was produced in S\(_2\)V\(_5\) (BRRIdhan44 at the spacing of 15×20 cm) and the lowest harvest index (38.24%) was produced in S\(_3\)V\(_3\) (Lalchikon at the spacing of 15×25 cm). Similar results were demonstrated by Reddy et al. (2001).

From the above discussion, it was found that BRRIdhan44 produced the highest (4.30 t ha\(^{-1}\)) grain yield. Lalmota produced the highest (4.60 t ha\(^{-1}\)) straw yield and Lalmota produced the highest number of total tiller hill\(^{-1}\) (9.33). BRRIdhan44 produced the highest number of effective tiller hill\(^{-1}\) (5.33) and BRRIdhan44 produced the highest number of total grain panicle\(^{-1}\) (101.11). BRRIdhan44 produced the highest number of filled grain

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**Fig 2**: Effect of spacing on grain and straw yield (t ha\(^{-1}\)) of rice. Vertical bar indicates significance at 5% level of probability.
At the spacing of 15×15 cm plant produced the highest grain yield (3.48 t ha⁻¹) and at the spacing of 15×25 cm plant produced the lowest straw yield (2.28 t ha⁻¹). At the spacing of 15×25 cm plant produced the highest number of total tiller hill⁻¹ (9.40) and 15×15 cm spacing plant produced the lowest no. of total tiller hill⁻¹ (7.13). Among the combinations of variety and spacing, BRRI dhan44 produced the highest grain yield (4.79 t ha⁻¹) at spacing of 15×20 cm and Lalmota produced the highest straw yield (5.40 t ha⁻¹) at the spacing of 15×20 cm. So, the variety BRRI dhan44 with spacing of 15×20 cm is suggested to cultivate in the high land of coastal area of Bangladesh.

Fig 3: Interaction effect of variety and spacing on grain and straw yield (t ha⁻¹) of rice. Vertical bar indicates significance at 5% level of probability.


Republic of Bangladesh. Dhaka. pp. 36-47.