Morphological Characteristics and Yield Components of Rapeseed in Response to Different Nitrogen and Boron Levels


Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
Department of Agricultural Extension, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
The United Graduate School of Agricultural Sciences, Ehime University, 3-5-7 Tarami, Matsumaya, Ehime 790-8556, Japan

Abstract: The experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Bangladesh September 2011 to February 2012 to examine the response of nitrogen and boron on growth, yield attributes and yield of rapeseed cv. BARI Sarisha-14. The experiment consisted four levels of nitrogen (N₀:0, N₁:60, N₂:120 and N₃:180 kg N/ha) and three levels of boron (B₀:0, B₁:1 and B₂:2 kg/ha) using randomized complete block design (RCBD) with 3 replications. The maximum plant height, number of leaves, number of primary branches, length of inflorescence, number of siliquae, seed weight of 100 siliquae, seed yield plant⁻¹, seed yield ha⁻¹ was found from N₂ (87.5 cm, 23.4 plant⁻¹, 6.7 plant⁻¹, 33.7 cm, 26.1 plant⁻¹, 10.7 g, 5.4 g, 1.5 t, respectively) for nitrogen levels; B₁ (83.7 cm, 22.7 plant⁻¹, 6.0 plant⁻¹, 33.4 cm, 25.4 plant⁻¹, 10.4 g, 5.2 g, 1.5 t, respectively) for boron levels and N₂B₁ (88.9 cm, 26.9 plant⁻¹, 7.4 plant⁻¹, 35.7 cm, 27.5 plant⁻¹, 11.9 g, 6.5 g, 1.8 t, respectively) for combinations. From growth and yield point of view, it is apparent that the combination of N₂P₂ was suitable for rapeseed cultivation.

Key words: Brassica campestris · Growth · Yield · N and B

INTRODUCTION

Rapeseed (Brassica campestris L.) is the major oilseed crop in Bangladesh. Nitrogen nutrition of this crop is important to its productivity; optimum requirement of this major nutrient is relatively high and has been shown to vary from soil to soil. Both growth and yield of rapeseed are enhanced significantly by doses of nitrogen fertilizer. Nitrogen supports the plant with rapid growth, increasing seed and fruit production and yield of mustard [1-5]. In addition, the deficiency of N causes stunted or slow growth, slender fibrous stems and the classic yellowing of the leaves which reduces the seed yield of crops including mustard [6]. Separately, excessive use of N increases the vegetative growth thus food production may be impaired and delayed maturity [7]. Boron is required by plants in small quantities that involve several physiological and biochemical processes in plants [8-11]. Seed set failure is a major reason for lower yield of Rabi crops and this problem can be attributed to B deficiency, as reported in mustard [12, 13]. Considering above point, current study has been undertaken to investigate the growth and yield of rapeseed variety BARI sarisha with different levels of nitrogen and boron.

MATERIALS AND METHODS

An experiment was carried out at Sher-e-Bangla Agricultural University Farm, Dhaka-1207, Bangladesh from September 2011 to February 2012 to study the response of nitrogen and boron on growth, yield and yield attributes of rapeseed cv. BARI Sarisha-14. Seed was collected from the Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. Before sowing germination test was done in the laboratory and percentage of germination was over 95%.

Corresponding Author: H. Mehraj, The United Graduate School of Agricultural Sciences, Ehime University, 3-5-7 Tarami, Matsumaya, Ehime 790-8556, Japan
The recommended doses of TSP, MP, Gypsum and ZnSO₄ were added to the soil of experimental field along with different levels of Nitrogen (N) and Boron (B). However any N or B fertilizers were not applied to control plot. Experiment consisted four levels of nitrogen viz. N₀ = 0 kg N/ha, N₁ = 60 kg N/ha, N₂ = 120 kg N/ha, N₃ = 180 kg N/ha and three levels of boron viz. B₀ = 0 kg B/ha, B₁ = 1 kg B/ha and B₂ = 2 kg B/ha using Randomized Complete Block Design (RCBD) with 3 replications. The unit plot area was 3 m x 1.5 m and distance between blocks was 1 m and plots were 0.5 m, while plant spacing was 30 cm X 5 cm. TSP (160 kg/ha), MP (110 kg/ha), Gypsum (160 kg/ha) and ZnSO₄ (7.5 kg/ha) were applied. Half of urea and total amount of all other fertilizers of each plot were applied and incorporated into soil during final land preparation. Rest of the urea was top dressed after 30 days of sowing (DAS). Sowing was done in rows 30 cm apart @ 8 kg/ha. As a preventive measure of aphid infestation, Malathion 57 EC @ 2 ml/L of water was applied twice first at 25 DAS and second at 50 DAS. The seeds were separated from the plants by beating the bundles with bamboo sticks on threshing floor. Seeds and stovers thus collected were dried in the sun for couple of days. Dried seeds and stovers of each plot was weighed and subsequently converted into yield kg/ha. Ten (10) plants from each plot were selected as random and were tagged for the data collection. The sample plants were uprooted prior to harvest and dried properly in the sun. The seed yield and stover yield per plot were recorded after cleaning and drying those properly in the sun. Data were collected on plant height (cm), leaves plant⁻¹, primary branches plant⁻¹, secondary branches plant⁻¹, length of main inflorescence (cm), siliquae on the main inflorescence, seed weight of 100 siliquae (g), yield (t/ha) and harvest index (%). Collected data were statistically analyzed using MSTAT-C computer package programme and difference between treatments was assessed by Least Significant Difference (LSD) test at 5% level of significance [14].

RESULTS AND DISCUSSION

Plant Height: Different levels of N influenced the height of rapeseed plant significantly. The tallest plant was recorded with N₀ (87.46 cm) while shortest from N₀ (74.2 cm) at 60 DAS (Fig. 1a). These findings are in agreement with those of Singh et al. [15], Tripathi and Tripathi [16]. Similar findings were reported by Tomar et al. [17], Ali and Ullah [18], Shamsuddin et al. [19], Ali and Rahman [20]; Hassan and Rahman [21]. Plant height increased with increasing levels of boron up to higher level. The tallest plant was found from B₂ (83.7 cm), while the shortest from B₀ (80.5 cm) at 60 DAS (Fig. 1b). These results suggested that B has no contribution to elongation of the axis of the plant during growth period. These results are in agreement with the findings of Moniruzzaman et al. [22], who reported that B failed to increase plant height of broccoli. The combined use of N and B had significant effect on plant height. The tallest plant was found in NₓB₁ (88.9 cm), whereas the shortest from NₓB₀ (72.9 cm) at 60 DAS (Fig. 2). Plant height was increased significantly with successive increase in nitrogen up to 120 kg/ha [23]. The N increased plant height but B could not show any effect on plant height of rapeseed separately. All together these results indicated that plant height of rapeseed was increased with combined use of nitrogen and boron.

![Fig 1: Plant height responses of rapeseed to different (a) N levels and (b) B levels at different DAS](image-url)
Fig 2: Interaction effect of N and B on the height of rapeseed plant at different days after sowing (DAS)
Here; N₀ = without nitrogen, N₁ = 60 kg N/ha, N₂ = 120 kg N/ha, N₃ = 180 kg N/ha, B₀ = without boron, B₁ = 1 kg B/ha, B₂ = 2 kg B/ha

Fig 3: Responses of number of leaves of rapeseed to different (a) N levels and (b) B levels at different DAS

Number of Leaves: A good number of leaves indicated better growth and development of crop. It is also possibly related to the yield of rapeseed. The greater number of leaf, the greater the photosynthetic area which may result higher seed yield. The N showed significant variation in the number of leaves. The maximum numbers of leaves were found from N₁ (23.4/plant), while the minimum from N₀ (17.7/plant) at 60 DAS (Fig. 3a). These indicated that the number of leaves/plant was increased with increasing N levels; those are consistent with Patil et al. [24] findings. The highest number of leaves was found from B₂ (22.7/plant) while lowest from B₀ (19.1/plant) at 60 DAS (Fig. 3b). So, B has important role on increasing number of rapeseed leaves. Significant variation in the number of leaves was found among the different combinations of the N and B levels. The maximum number of leaves was found from N₁B₂ (26.9/plant), while the minimum from N₀B₀ (17.7/plant) at 60 DAS (Fig. 4). These results indicated that the combined use of N along with B can increase leaf number as well as leaf area of rapeseed plant.

Number of Primary Branches: The maximum number of primary branches was found from N₁ (6.7/plant), while the minimum from N₀ (4.2/plant) at 60 DAS (Fig. 5a). N fertilizer application had no significant effect on number of primary branches per plant of rapeseed [25] and the highest number of branches/plant with 120 kg N fertilizer application had no significant effect on number of primary branches/plant [25] and the highest number of branches/plant with 120 kg N ha⁻¹[26, 17, 18]. Altogether, it suggested that N involve in initiating primary branches by sprouting lateral buds of rapeseed plants. The highest number of branches was obtained from B₂ (6.0/plant) and lowest from B₀ (5.4/plant) at 60 DAS. It was observed that with the increase of B, number of branches per plant also increase a certain level. The interaction between N and B was found significant on number of primary branches. The maximum number of branches was found in N₁B₂ (7.4/plant), whereas the lowest in N₀B₀ (3.7/plant) at 60 DAS. Significant effect of nitrogen on number of primary branches/plant [27] and the result of this study suggested that N and B form together primary branches of rapeseed plants.
Fig 4: Interaction effect of N and B on number of leaves of rapeseed at different days after sowing (DAS)
Here; N₀ = without nitrogen, N₁ = 60 kg N/ha, N₂ = 120 kg N/ha, N₃ = 180 kg N/ha, B₀ = without boron, B₁ = 1 kg B/ha, B₂ = 2 kg B/ha

Fig 5: Responses of number of primary branches of rapeseed to different (a) N levels and (b) B levels at different DAS

Fig 6: Interaction effect of N and B on number of primary branches of rapeseed at different days after sowing (DAS)
Here; N₀ = without nitrogen, N₁ = 60 kg N/ha, N₂ = 120 kg N/ha, N₃ = 180 kg N/ha, B₀ = without boron, B₁ = 1 kg B/ha, B₂ = 2 kg B/ha

**Length of Inflorescence:** The longest inflorescence was found from N₁ (33.7 cm) which was statistically identical with N1 (33.3 cm), while the shortest from N₀ (30.9 cm) at 80 DAS (Fig. 7a). There was no significant difference among the B treatments in the length of inflorescence. However, the longest inflorescence was found from B₂ (33.4 cm) followed by B₁ (32.7 cm), whereas the shortest from B₀ (31.1 cm) at 80 DAS (Fig. 7b). The longest inflorescence was found from N₁B₀ (35.7 cm), whereas the shortest from N₁B₂ (30.0 cm) at 80 DAS (Fig. 8).
Fig 7: Responses of length of inflorescences of rapeseed to different (a) N levels and (b) B levels at different DAS

Fig 8: Interaction effect of N and B on length of inflorescences of rapeseed at different days after sowing (DAS)

Here; N₀ = without nitrogen, N₁ = 60 kg N/ha, N₂ = 120 kg N/ha, N₃ = 180 kg N/ha, B₀ = without boron, B₁ = 1 kg B/ha, B₂ = 2 kg B/ha

**Number of Siliquae:** Number of siliquae plant⁻¹ is one of the most important yield contributing characters in rapeseed. N levels, B levels and their combinations showed significant variation in number of siliquae plant⁻¹. The maximum number of siliquae was found from N₁ (26.1 plant⁻¹), while N₀ produced the minimum number of siliquae (22.2 plant⁻¹) (Table 1). Similar result also obtained by Shukla et al. [2, 28], Shing et al. [15] on rapeseed. The maximum number of siliquae was produced in B₂ (25.4 plant⁻¹), while the minimum in B₀ (22.8 plant⁻¹) (Table 2). These results are in conformity with those obtained by Islam and Sharker [29]; Dutta and Uddin [30]; Dutta et al. [31], who have observed increased number of siliquae plant⁻¹ of rapeseed by increasing rate of B. The maximum number of siliquae was found in N₀B₂ (27.5 plant⁻¹), whereas the minimum from N₀B₀ (20.6 plant⁻¹) (Table 3).

**Seed Weight of 100 Siliquae:** N levels, B levels and their combinations showed significant variation in the seed weight of 100 siliquae. The maximum seed weight of 100 siliquae was found from N₁ (10.7 g) which was statistically similar with N₁ and N₂, whereas the minimum from N₀ (8.2 g) (Table 1). The maximum seed weight of 100 siliquae was found in B₂ (10.4 g) which was statistically identical with B₁ while the minimum was produced in B₀ (9.0 g) (Table 2). The maximum seed weight of 100 siliquae was found in N₁B₁ (11.9 g) whereas minimum from N₀B₀ (6.8 g) (Table 3). These results indicated that the combined use of N and B has strong role on increasing the seed weight of 100 siliquae other than N and B along.

**Seed Yield:** N levels, B levels and their combinations showed significant variation in seed yield plant⁻¹. The maximum seed yield was found from N₁ (5.4 g plant⁻¹ and 1.5 tha⁻¹) which was statistically similar with N₀ and N₁, whereas the minimum from N₀ (3.1 g plant⁻¹ and 1.0 tha⁻¹) (Table 1). Seed yield was increased with increasing rates of N fertilizer up to 120 kg/ha and then declined. Higher seed weight plant⁻¹ was also obtained with the same N rate as reported by Singh et al. [32],
Table 1: The effect of N on yield contributing character and yield of rapeseed

<table>
<thead>
<tr>
<th>N levels</th>
<th>Siliquae seed weight (g)</th>
<th>Seed yield (g plant⁻¹)</th>
<th>Seed yield (t/ha)</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N₀</td>
<td>22.2 b</td>
<td>8.2 b</td>
<td>3.1 b</td>
<td>1.0 b</td>
</tr>
<tr>
<td>N₁</td>
<td>23.5 ab</td>
<td>10.5 a</td>
<td>4.3 a</td>
<td>1.2 ab</td>
</tr>
<tr>
<td>N₂</td>
<td>26.1 a</td>
<td>10.7 a</td>
<td>5.4 a</td>
<td>1.5 a</td>
</tr>
<tr>
<td>N₃</td>
<td>24.7 ab</td>
<td>9.9 a</td>
<td>4.8 a</td>
<td>1.4 ab</td>
</tr>
<tr>
<td>LSD (n=0)</td>
<td>3.3</td>
<td>1.1</td>
<td>1.1</td>
<td>0.4</td>
</tr>
<tr>
<td>CV (%)</td>
<td>8.9</td>
<td>14.3</td>
<td>10.1</td>
<td>11.7</td>
</tr>
</tbody>
</table>

X In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

Y N₀ = without nitrogen, N₁ = 60 kg N/ha, N₂ = 120 kg N/ha, N₃ = 180 kg N/ha, B₀ = without boron, B₁ = 1 kg B/ha, B₂ = 2 kg B/ha

Table 2: The effect of B on yield contributing character and yield of rapeseed

<table>
<thead>
<tr>
<th>B levels</th>
<th>Siliquae seed weight (g)</th>
<th>Seed yield (g plant⁻¹)</th>
<th>Seed yield (t/ha)</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B₀</td>
<td>22.8 b</td>
<td>9.0 b</td>
<td>3.6 b</td>
<td>1.0 b</td>
</tr>
<tr>
<td>B₁</td>
<td>24.2 ab</td>
<td>10.1 a</td>
<td>4.5 ab</td>
<td>1.3 ab</td>
</tr>
<tr>
<td>B₂</td>
<td>25.4 a</td>
<td>10.4 a</td>
<td>5.2 a</td>
<td>1.5 a</td>
</tr>
<tr>
<td>LSD (n=0)</td>
<td>2.1</td>
<td>1.0</td>
<td>1.5</td>
<td>0.1</td>
</tr>
<tr>
<td>CV (%)</td>
<td>8.9</td>
<td>14.3</td>
<td>10.1</td>
<td>11.7</td>
</tr>
</tbody>
</table>

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Y B₀ = without nitrogen, B₁ = 1 kg B/ha, B₂ = 2 kg B/ha

Table 3: Interaction effect of N and B on yield contributing characters, yield and harvest index of rapeseed

<table>
<thead>
<tr>
<th>N and B combinations</th>
<th>Siliquae seed weight (g)</th>
<th>Seed yield (g plant⁻¹)</th>
<th>Seed yield (t/ha)</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N₀B₀</td>
<td>20.6 d</td>
<td>6.8 c</td>
<td>2.0 d</td>
<td>0.9 f</td>
</tr>
<tr>
<td>N₀B₁</td>
<td>22.8 bcd</td>
<td>8.6 bc</td>
<td>3.5 cd</td>
<td>1.0 f</td>
</tr>
<tr>
<td>N₀B₂</td>
<td>23.3 abcd</td>
<td>9.3 abc</td>
<td>3.9 c</td>
<td>1.1 ef</td>
</tr>
<tr>
<td>N₀B₃</td>
<td>20.8 cd</td>
<td>10.8 ab</td>
<td>3.6 cd</td>
<td>1.0 f</td>
</tr>
<tr>
<td>N₁B₁</td>
<td>24.8 abc</td>
<td>11.0 ab</td>
<td>4.7 bc</td>
<td>1.5 cde</td>
</tr>
<tr>
<td>N₁B₂</td>
<td>24.9 abc</td>
<td>9.6 ab</td>
<td>4.7 bc</td>
<td>1.4 bcd</td>
</tr>
<tr>
<td>N₁B₃</td>
<td>26.5 ab</td>
<td>9.4 abc</td>
<td>4.8 abc</td>
<td>1.2 def</td>
</tr>
<tr>
<td>N₂B₀</td>
<td>23.4 abcd</td>
<td>10.7 ab</td>
<td>4.9 abc</td>
<td>1.5 abc</td>
</tr>
<tr>
<td>N₂B₁</td>
<td>27.5 a</td>
<td>11.9 a</td>
<td>6.5 a</td>
<td>1.8 a</td>
</tr>
<tr>
<td>N₂B₂</td>
<td>23.3 bcd</td>
<td>8.8 bc</td>
<td>3.8 c</td>
<td>1.0 ef</td>
</tr>
<tr>
<td>N₂B₃</td>
<td>24.7 abc</td>
<td>10.2 ab</td>
<td>4.9 abc</td>
<td>1.5 bcd</td>
</tr>
<tr>
<td>N₃B₀</td>
<td>26.0 ab</td>
<td>10.7 ab</td>
<td>5.7 ab</td>
<td>1.6 ab</td>
</tr>
<tr>
<td>LSD (n=0)</td>
<td>3.6</td>
<td>2.4</td>
<td>1.5</td>
<td>0.3</td>
</tr>
<tr>
<td>CV (%)</td>
<td>8.9</td>
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Tateja et al. [33]. Further increase in N level beyond 120 kg/ha could not improve the seed yield. These results are consistent with the N-induced increase of growth parameters (Fig. 1a, 3a, 5a and 7a) along with number of siliquae plant⁻¹, seed weight of 100 siliquae and seed weight plant⁻¹ (Table 1). The higher seed yield/ha was also obtained with the same N rate reported by Sing and Prasad [34], Singh et al. [15], Shukla et al. [2, 28]. Therefore, N can enhance the seed yield (t/ha) of rapeseed variety BARI sarisha 14. The maximum seed yield was found in B₂ (5.2 g plant⁻¹ and 1.5 tha⁻¹), while the minimum from B₀ (3.6 g plant⁻¹ and 1.0 tha⁻¹) (Table 2). Similarly, Islam and Sarkar [29] reported that application of B increased significantly number of siliquae plant⁻¹, number of seeds silica⁻¹ and seed weight of rapeseed. This result showed that the yield of mustard increased gradually with the higher doses of B fertilizer. Sakal et al. [35], Sinha et al. [36], Banuels et al. [37] obtained a similar result by applying 1 to 2 kg B/ha. Malewar et al. [38] found that seed yield significantly increased with each levels of B. Interestingly, this result is consistent with the B-induced increase of growth parameters (Fig. 1b, 3b, 5b and 7b) along with number of siliquae plant⁻¹, seed weight of 100 siliquae and seed weight plant⁻¹ (Table 2).
Therefore, higher dose of B can increase seed yield of rapeseed. Maximum seed weight was found in N, B (6.5 g plant⁻¹ and 1.8 tha⁻¹) whereas minimum from N, B (2.0 g plant⁻¹ and 0.9 tha⁻¹) (Table 3).

**Harvest Index:** N levels, B levels and their combinations had significant effect on the harvest index of mustard. The maximum harvest index was found from N₅ (55.2%), while the minimum from N₀ (48.7%) (Table 1). Shrivastava *et al.* [39] found a similar result in their experiment. The highest harvest index was obtained from B₅ (53.0%), while the minimum from B₀ (50.6%) (Table 2). The highest harvest index was obtained from N, B₅ (57.5%), whereas the lowest from N, B₀ (46.3%) (Table 3).

**CONCLUSION**

Growth and seed yield contributing parameters of rapeseed are related with N and B application. Combined use of 120 kg N/ha and 2 kg B/ha along with recommended doses of other fertilizer would be beneficial to increase the seed yield of rapeseed variety BARI sarisha 14 under the climatic condition of Sher-e-Bangla Agricultural University, Dhaka.

**REFERENCES**