

Selection of Suitable Rapeseed and Mustard Varieties in Saline Prone Area in Bangladesh

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Abstract

The experiment was conducted with twenty-four rapeseed and mustard varieties at the Agricultural Research Station, Bangladesh Agricultural Research Institute (BARI), Benarpota, Satkhira, Bangladesh, to identify suitable varieties for saline-prone areas. The experimental station was situated at 22.716° North latitude and 89.075° East longitude in the southwestern part of Bangladesh with an elevation of 3.96 meters above sea level. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. It was conducted consecutively for two years during the *Rabi* seasons (October to March) in 2017-2018 to 2018-2019. The lowest salinity of the field was recorded at the seed sowing period, and it was found to be the highest at the harvesting period. The salinity level was 3.5 to 12.6 and 2.9 to 11.4 dS m⁻¹ during the consecutive two years. Among the varieties, twelve were *Campestris* (BARI Sarisha-14, BARI Sarisha-15, Binasarisha-10, Binasarisha-6, BARI Sarisha-9, BARI Sarisha-17, Binasarisha-2, Binasarisha-1, Satkhira local, Tori-7 (control), BARI Sarisha-12, and Kalyania), seven *Napus* (BARI Sarisha-13, Binasarisha-4, Binasarisha-9, Binasarisha-3, Binasarisha-5, BARI Sarisha-7, BARI Sarisha-8), and five varieties from the *Juncea* group (BARI Sarisha-11, Binasarisha-7, Binasarisha-8, BARI Sarisha-16, BARI Sarisha-10). Out of the tested varieties, BARI Sarisha-16 (V₁₈) produced the highest seed yield in saline soil at Satkhira, Bangladesh, and BARI Sarisha-11 (V₁₅), Binasarisha-8 (V₁₆) pro-

vided a statistically similar seed yield to BARI Sarisha-16 (V₁₈). So these three varieties might be better for cultivation in the coastal saline soil of Bangladesh.

Keywords

Rapeseed and Mustard, Leaf Area Index (LAI), Crop Growth Rate (CGR), Seed Yield and Salinity

1. Introduction

Salinity is a barrier to crop production, while salinity-affected areas are expanding in Bangladesh. To increase oilseed production in saline soils, a useful tactic could be developed for salinity-tolerant mustard varieties [1]. In the recent past, ordinary crop production has become very difficult due to the changing degree of salinity in some areas and further infiltration of saline water. Salinity creates adverse environmental and hydrological conditions that limit regular crop production. A higher level of soil salinity affects elementary physiological and metabolic processes; hence, seed germination, seedling establishment, vegetative and reproductive growth are hampered, leading to reduced economic yield associated with poor quality of produce [2]. Higher salt tolerance is exhibited by amphidiploid Brassica species like *B. carinata*, *B. juncea*, and *B. napus* compared to their diploid progenitors, *B. oleracea*, *B. nigra*, and *B. rapa* [3].

Soil salinity is one of the major abiotic stress factors affecting the production and quality of food crops worldwide, limiting the growth and development as well as the yield potential of crop plants [4] [5]. Plant height, leaf area, total dry matter, number of siliqua per plant, number of seeds per siliqua, 1000-seed weight, and harvest index were decreased with the increase of salinity compared to control [6].

Agriculture is a major economic sector of Bangladesh. Over 30% of cultivable land in Bangladesh is in the coastal area. Approximately 1.1 million ha of arable land out of 2.86 million ha is affected by varying degrees of salinity in coastal and offshore lands [7]. Oilseed crops play an important role in the economy of Bangladesh. Mustard is the top-ranking oilseed crop. It covers about 78% of the total oilseed acreage and 62% of the total production [8]. Rapeseed-mustard is a major oilseed crop in Bangladesh. It contributes a lion's share to the total edible oil production in the country. Rapeseed and mustard cover 66.48% of the area of total oil crops [9].

Rapeseed and mustard are under the family Cruciferae, Brassica genus, and they have many species like *campestris*, *juncea*, *napus*, *nigra*, and *alba* etc. It is a thermosensitive as well as a photosensitive crop. It is also the third most important edible oil source in the world after soybean and palm [10]. About 13.2% of the world's edible oil supply comes from mustard¹.

Rapeseed and mustard are considered as *Rabi* crops in Bangladesh, and their sowing time is from mid-October to the last week of November. In non-saline

¹Food and Agriculture Organization of the United Nations (FAO), FAO Production Yearbook, 2005.

areas of Bangladesh, crops are grown consecutively in *Kharif-I*, *Kharif-II*, and *Rabi* seasons. It is very difficult to adjust rapeseed and mustard in the existing cropping pattern of non-saline areas. During the *Rabi* season, most of the farmers in the area cultivate high-value vegetable crops and *Boro* rice, so there is little scope to increase the area of rapeseed and mustard. Moreover, vast areas of the coastal and coastal saline regions (about 70%) remain fallow in the *Rabi* and *Kharif-I* season due to salinity and the late release of land, but we cannot bring the land under mustard cultivation in spite of the existing huge deficit of oil. There are many factors responsible for the fallow condition and low productivity of land in the late *Rabi* and *Kharif-I* seasons in coastal saline areas. One of the main factors is the lack of salt-resistant crops and their varieties. Genotypes play an important role in crop production, and the potential yield of a genotype within the genetic limit is determined by its environment [11]. So, varietal trials against soil salinity are essential to select salt-tolerant rapeseed and mustard varieties. In the coastal region, mustard is sown late; as a result, optimum growth is hampered. Considering the above circumstances, the present research program was carried out to select suitable rapeseed and mustard variety(ies) for the coastal saline area of Bangladesh.

2. Materials and Methods

2.1. Description of the Experimental Site

Location

The experiment was conducted at the Agricultural Research Station, Bangladesh Agricultural Research Institute (BARI), Benarpota, Satkhira, Bangladesh. This station lies at 22.716° North latitude and 89.075° East longitude in the southwestern part of Bangladesh, at an elevation of 3.96 meters above sea level. The experimental field belongs to Agro-ecological Zone-11, High Ganges River Floodplain.

2.2. Soil Characteristics of the Experimental Site

The experimental field was medium-high land. The soil texture of the experimental field was clay. Chemical composition of soil of experiment field during 2017-'18 to 2018-'19.

| Particulars | Values | |
|--------------------------------------|----------|----------|
| | 2017-'18 | 2018-'19 |
| Soil pH | 7.9 | 8.3 |
| Organic matter (%) | 2.40 | 2.63 |
| Total nitrogen (%) | 0.139 | 0.152 |
| Available phosphorus (ppm) | 30.19 | 4.54 |
| Exchangeable potassium (me/100 soil) | 0.26 | 0.56 |
| Available sulphur (ppm) | 37.13 | 18.67 |
| Available zinc (ppm) | 1.51 | 0.53 |
| Available boron (ppm) | 0.98 | 1.87 |

2.3. Climate of the Experimental Site

The experimental area is located under a subtropical climate, which is characterized by moderately high temperatures and heavy rainfall during the *Kharif* season (April-September), and low rainfall with moderately low temperatures during the *Rabi* season (October-March). The experiment was conducted consecutively for two years during the *Rabi* seasons (October to March) from 2017-2018 to 2018-2019. Twenty four varieties were used in the experiment such as V_1 = BARI Sarisha-14, V_2 = BARI Sarisha-15, V_3 = Binasarisha-10, V_4 = Binasarisha-6, V_5 = BARI Sarisha-9, V_6 = BARI Sarisha-17, V_7 = Binasarisha-2, V_8 = Binasarisha-1, V_9 = Satkhira local, V_{10} = BARI Sarisha-13, V_{11} = Binasarisha-4, V_{12} = Binasarisha-9, V_{13} = Binasarisha-3, V_{14} = Binasarisha-5, V_{15} = BARI Sarisha-11, V_{16} = Binasarisha-7, V_{17} = Binasarisha-8, V_{18} = BARI Sarisha-16, V_{19} = Tori-7 (control), V_{20} = BARI Sarisha-7, V_{21} = BARI Sarisha-8, V_{22} = BARI Sarisha-10, V_{23} = BARI Sarisha-12 and V_{24} = Kalyania.

Design of experiment: The experiment was conducted in a Randomized Complete Block Design (RCBD) with three replications. All the treatments were randomly allocated to the respective plots. There were 24 unit plots of 3.0 m × 2.5 m.

Fertilizer application: The crops were fertilized with 115-36-50-32-2.5-2.5 kg ha⁻¹ of N-P-K-S-Zn-B in the form of urea, triple superphosphate, muriate of potash, gypsum, zinc sulphate, and boric acid, respectively.

Date of sowing: The seeds were shown on 17 November 2017 and 16 November 2018.

2.4. Intercultural Operations

Thinning, weeding, irrigation were done accordingly, and plant protection measures were taken from time to time.

Determination of soil salinity: Soil samples were collected at 10 days intervals from the date of sowing to harvesting for determining salinity of experiment field. The collected soil samples were dried and crushed. The crushed soil and water were mixed in a 500 ml volumetric flask at 1:5 ratio (50 g soil and 250 ml water) then it was shaken by the electrical shaker for 30 minutes. After shaking it was kept 30 minutes for filtration, the filtered water was taken in a test tube and measured EC_{1:5} by the EC meter (H18733). The observed reading was recorded, and ECe was calculated as follows:

$$ECe = EC_{1:5} \times 5$$

Crop growth rate (CGR): The amount of dry matter accumulation by plants of per unit land area and time is referred to as CGR and expressed as g m⁻² day⁻¹.

$$CGR = \frac{W_2 - W_1}{GA(t_2 - t_1)} \text{ g m}^{-2} \text{ day}^{-1}$$

Here,

GA = Ground area occupied by the plants at sampling;

W_1 = First dry weight;

W_2 = 2nd dry weight;

t_1 = Time of 1st dry weight;

t_2 = Time of 2nd dry weight.

Leaf area index (LAI):

The leaf area of all plant samples was measured with the help of graph paper. Then, the leaf area index (LAI) was calculated by using following formula:

$$\text{LAI} = \frac{\text{Total leaf area (m}^2\text{)}}{\text{Ground area covered (m}^2\text{)}}$$

Mortality (%): Plant population was counted after final thinning and before harvesting of an area of m² and difference was converted in percent.

Parameters studied:

To investigate the field performance, yield, and yield attributes of different rapeseed and mustard varieties, the following parameters were studied.

i) Mortality; ii) Days to 50% flowering; iii) Leaf area index (LAI); iv) Crop growth rate (CGR); v) Days to maturity; vi) Plant height (cm); vii) Number of primary branches plant⁻¹; viii) Number of siliquae plant⁻¹; ix) Number of seeds siliqua⁻¹; x) 1000 seed weight (g); xi) Seed yield (t ha⁻¹); xii) Stover yield (t ha⁻¹); xiii) Biological yield (t ha⁻¹); xiv) Harvest index (%).

Statistical analysis of data:

The collected data of the experiment were statistically analyzed using the MSTAT-C software program. The means of all the treatments were calculated, and analysis of variance (ANOVA) for data of different parameters was performed by the F-variance test. The treatment means were evaluated by Duncan's Multiple Range Test (DMRT) at the 5% level of significance.

3. Results and Discussion

3.1. Salinity of the Experimental Field

During the crop growing period, soil salinity was recorded at 10-day intervals. The lowest salinity of the field was recorded at the seed sowing period, and it was found to be the highest at the harvesting period. The salinity level was 3.5 to 12.6 and 2.9 to 11.4 dS m⁻¹ during 2017-'18 and 2018-'19, respectively.

3.2. Mortality of Different Rapeseed and Mustard Varieties

The lowest mortality rate during the crop growth was recorded as 6% and 7%, in three varieties, such as BARI Sarisha-13, BARI Sarisha-16, and BARI Sarisha-8, indicating resistant to salinity. The highest mortality (18%) was observed in Bin-asarisha-1 (V8) in both years due to greater susceptibility to salinity.

Days to 50% flowering: A significant difference was observed among the rapeseed and mustard varieties with regard to days to 50% flowering during 2017-'18 and 2018-'19. The days to 50% flowering ranged from 31.00 to 53.00 and 33.33 to 56.33 in 2017-'18 and 2018-'19, respectively (**Table 1**). The maximum days to 50% flowering required were 53.00 and 56.33 days, attained by the variety BARI Sari-

sha-16 (V₁₈), which was statistically similar to BARI Sarisha-11 (V₁₅), Binasarisha-7 (V₁₆), Binasarisha-8 (V₁₇), and BARI Sarisha-10 (V₂₂), and these were 51.67, 55.33; 51.00, 55.00; 50.00, 54.00; and 50.00, 51.00 days in 2017-'18 and 2018-'19, respectively.

Days to maturity: Days to maturity significantly varied among the tested varieties, and it exhibited a similar trend in both years. The rapeseed and mustard varieties took time to reach maturity, ranging from 69.00 to 106.30 and 68.33 to 107.30 days during 2017-'18 and 2018-'19, respectively (**Table 1**). The lowest maturity period, 69.00 days, was recorded with the Satkhira local (V₉), and it was statistically similar to Tori-7 (V₁₉), which was 70.00 days. During 2018-'19, BARI Sarisha-11 (V₁₅) attained the highest days to maturity, 107.3 days, and it was statistically similar to BARI Sarisha-10 (V₂₂).

Table 1. Days to 50% flowering and days to maturity of rapeseed and mustard varieties during the 2017-'18 and 2018-'19 cropping seasons in the coastal saline area of Bangladesh.

| Treatments | Days to 50% flowering | | Days to maturity | |
|-----------------|-----------------------|-----------|------------------|------------|
| | 2017-'18 | 2018-'19 | 2017-'18 | 2018-'19 |
| V ₁ | 40.00 b | 40.33 e-g | 84.00 c | 80.33 ef |
| V ₂ | 41.33 b | 41.67 ef | 85.67 c | 87.00 e |
| V ₃ | 41.00 b | 44.67 c-f | 84.67 c | 81.00 ef |
| V ₄ | 40.67 b | 42.33 d-f | 91.67 bc | 87.67 de |
| V ₅ | 40.00 b | 48.33 b-e | 87.00 c | 83.33 ef |
| V ₆ | 42.00 b | 49.67 a-d | 86.67 c | 81.67 ef |
| V ₇ | 40.33 b | 41.33 e-g | 91.67 bc | 88.00 de |
| V ₈ | 41.00 b | 44.67 c-f | 92.67 bc | 88.00 c-e |
| V ₉ | 33.67 cd | 33.33 g | 69.00 d | 68.33 fg |
| V ₁₀ | 38.00 bc | 38.67 fg | 98.33 ab | 95.00 a-e |
| V ₁₁ | 36.00 b-d | 39.33 fg | 98.33 ab | 94.67 a-e |
| V ₁₂ | 38.00 bc | 38.00 fg | 98.33 ab | 94.67 a-e |
| V ₁₃ | 39.00 bc | 39.67 fg | 98.67 ab | 94.00 a-e |
| V ₁₄ | 40.00 b | 41.67 ef | 98.33 ab | 95.33 b-e |
| V ₁₅ | 51.67 a | 55.33 ab | 106.30 a | 107.30 a |
| V ₁₆ | 51.00 a | 55.00 ab | 105.00 a | 105.30 a-c |
| V ₁₇ | 50.00 a | 54.00 ab | 104.30 a | 105.00 a-d |
| V ₁₈ | 53.00 a | 56.33 a | 106.00 a | 105.00 a-d |
| V ₁₉ | 31.00 d | 33.33 g | 70.00 d | 69.33 g |
| V ₂₀ | 39.00 bc | 40.00 fg | 98.00 ab | 94.67 a-e |
| V ₂₁ | 39.00 bc | 40.33 e-g | 97.00 ab | 94.67 a-e |
| V ₂₂ | 50.00 a | 51.00 a-c | 104.30 a | 106.70 ab |
| V ₂₃ | 40.00 b | 41.33 e-g | 89.00b c | 87.33 e |

Continued

| | | | | |
|-----------------------|---------|-----------|---------|---------|
| V ₂₄ | 41.00 b | 44.33 c-f | 87.00 c | 89.33 b |
| S \bar{x} | 1.79 | 2.41 | 0.31 | 5.51 |
| Level of significance | ** | ** | * | * |
| CV (%) | 7.48 | 9.51 | 5.61 | 9.90 |

** = Significance at the 1% level of probability and * = Significance at the 5% level of probability.

Leaf area index (LAI): The tested rapeseed and mustard varieties showed a significant difference with respect to leaf area index (LAI) during 2017-'18 and 2018-'19 (Tables 2-3). During 2017-'18, the highest LAI of 20-day-old plants, 0.56, was recorded from BARI Sarisha-16 (V₁₈), which was statistically similar to the other 19 varieties except Binasarisha-5 (V₁₄), Binasarisha-3 (V₃), Satkhira local (V₉), and Tori-7 (V₁₉). At the same time, the lowest LAI, 0.16, was recorded from Binasarisha-5 (V₁₄), which was statistically at par with Satkhira local (V₉) and Tori-7 (V₁₉). During 2018-'19, the maximum LAI of 20-day-old plants, 0.90, was found in the same variety, BARI Sarisha-16 (V₁₈), and it was followed by BARI Sarisha-11 (V₁₅), Binasarisha-2 (V₇), Binasarisha-8 (V₁₇), and Binasarisha-7 (V₁₆), with values of 0.71, 0.70, 0.68, and 0.65, respectively.

Table 2. Leaf area index (LAI) at 20, 30, and 40-day-old plants of rapeseed and mustard varieties during the 2017-'18 and 2018-'19 cropping seasons in the coastal saline area of Bangladesh.

| Treatments | LAI at 20 days | | LAI at 30 days | | LAI at 40 days | |
|-----------------|----------------|----------|----------------|----------|----------------|----------|
| | 2017-'18 | 2018-'19 | 2017-'18 | 2018-'19 | 2017-'18 | 2018-'19 |
| V ₁ | 0.38 a-c | 0.59 b-d | 1.22 b-f | 1.46 b-e | 1.40 e-h | 1.67 e-h |
| V ₂ | 0.40 a-c | 0.68 bc | 1.41 b | 1.69 b | 1.68 b-d | 2.00 b-d |
| V ₃ | 0.47 ab | 0.66 bc | 1.37 bc | 1.64 bc | 1.50 d-h | 1.79 d-h |
| V ₄ | 0.46 ab | 0.60 b-d | 1.27 b-e | 1.52 b-d | 1.50 d-h | 1.79 d-h |
| V ₅ | 0.38 a-c | 0.49 b-e | 1.22 b-f | 1.46 b-e | 1.40 e-h | 1.67 e-h |
| V ₆ | 0.49 ab | 0.61 bcd | 1.11 d-f | 1.33 de | 1.35 h | 1.60 gh |
| V ₇ | 0.46 ab | 0.70 b | 1.27 b-e | 1.52 b-d | 1.50 d-h | 1.79 d-h |
| V ₈ | 0.46 ab | 0.65 bc | 1.27 b-e | 1.52 b-d | 1.50 d-h | 1.79 d-h |
| V ₉ | 0.20 cd | 0.27 e | 1.00 f | 1.20 e | 1.32 h | 1.57 h |
| V ₁₀ | 0.42 a-c | 0.55 b-e | 1.37 bc | 1.65 bc | 1.65 c-e | 1.96 b-e |
| V ₁₁ | 0.41 a-c | 0.54 b-e | 1.30 b-e | 1.57 b-d | 1.45 d-h | 1.73 d-h |
| V ₁₂ | 0.40 a-c | 0.51 b-e | 1.20b-f | 1.45 b-e | 1.43 e-h | 1.70 d-h |
| V ₁₃ | 0.27 b-d | 0.46 b-e | 1.15c-f | 1.38 c-e | 1.36 gh | 1.62 f-h |
| V ₁₄ | 0.16 d | 0.31 de | 1.07 ef | 1.29 de | 1.31 h | 1.57 h |
| V ₁₅ | 0.54 a | 0.71 b | 1.65 a | 1.97 a | 1.89 b | 2.25 b |

Continued

| | | | | | | |
|-----------------------|----------|----------|----------|----------|----------|----------|
| V ₁₆ | 0.50 a | 0.65 bc | 1.31 b-e | 1.57 b-d | 1.60 c-g | 1.91c-g |
| V ₁₇ | 0.52 a | 0.68 bc | 1.43 b | 1.72 b | 1.79 bc | 2.13 bc |
| V ₁₈ | 0.56 a | 0.90 a | 1.79 a | 2.14 a | 2.15 a | 2.56 a |
| V ₁₉ | 0.21 cd | 0.37 c-e | 0.95 f | 1.10 e | 1.22 h | 1.47 h |
| V ₂₀ | 0.41 a-c | 0.53 b-e | 1.34 b-d | 1.54 b-d | 1.61 c-f | 1.86 c-h |
| V ₂₁ | 0.40 a-c | 0.52 b-e | 1.30 b-e | 1.50 b-d | 1.43 e-h | 1.68 d-h |
| V ₂₂ | 0.48 ab | 0.63 bc | 1.26 b-e | 1.51 b-d | 1.38 f-h | 1.64 e-h |
| V ₂₃ | 0.53 a | 0.58 b-d | 1.41 b | 1.69 b | 1.68 b-d | 1.94 c-f |
| V ₂₄ | 0.52 a | 0.57 b-e | 1.37 bc | 1.64 bc | 1.50 d-h | 1.79 d-h |
| S \bar{x} | 0.065 | 0.090 | 0.070 | 0.090 | 0.073 | 0.10 |
| Level of significance | ** | ** | ** | ** | ** | ** |
| CV (%) | 21.45 | 21.79 | 9.45 | 9.87 | 8.34 | 9.25 |

Crop growth rate (CGR): A significant difference was found among the tested varieties with respect to crop growth rate (CGR) during 2017-'18 and 2018-'19. In the case of 20 - 30, 30 - 40, 40 - 50, and 50 - 60 day-old plants, the highest CGR was recorded by BARI Sarisha-16 (V₁₈) in both years with values of 4.01, 3.93; 4.33, 4.22; 5.42, 5.22; and 6.12, 6.32 g m⁻² day⁻¹, respectively. Likewise, plants of all ages gave the lowest CGR by Satkhira local (V₉) in both years with values of 2.26, 2.18; 2.70, 2.58; 3.16, 3.30; and 3.66, 3.39 g m⁻² day⁻¹, respectively (**Table 4** and **Table 5**).

Table 3. Leaf area index (LAI) at 50 and 60 days old plants of rapeseed and mustard varieties during the 2017-'18 and 2018-'19 cropping seasons in the coastal saline area of Bangladesh.

| Treatments | LAI at 50 days | | LAI at 60 days | |
|-----------------|----------------|----------|----------------|----------|
| | 2017-'18 | 2018-'19 | 2017-'18 | 2018-'19 |
| V ₁ | 1.62 d-f | 1.94 c-f | 1.12 d-f | 1.26 e-g |
| V ₂ | 1.85 bc | 2.21 bc | 1.36 b-d | 1.53 cd |
| V ₃ | 1.82 b-d | 2.17 bc | 1.32 b-e | 1.47 de |
| V ₄ | 1.72 c-e | 2.06 b-e | 1.22 c-e | 1.36 d-g |
| V ₅ | 1.62 d-f | 1.94 c-f | 1.12 d-f | 1.29 e-g |
| V ₆ | 1.54 ef | 1.85 d-f | 1.09 d-f | 1.17 gh |
| V ₇ | 1.72 c-e | 2.06 b-e | 1.22 c-e | 1.31 d-g |
| V ₈ | 1.72 c-e | 2.06 b-e | 1.22 c-e | 1.41 d-f |
| V ₉ | 1.05 g | 1.23 g | 0.85 f | 1.01 h |
| V ₁₀ | 1.81 b-d | 2.14 bc | 1.33 b-e | 1.52 cd |
| V ₁₁ | 1.78 b-d | 2.10 b-d | 1.27 c-e | 1.46 de |
| V ₁₂ | 1.69 c-e | 1.99 c-f | 1.16 de | 1.33 d-g |

Continued

| | | | | |
|-----------------------|----------|----------|----------|----------|
| V ₁₃ | 1.56 ef | 1.84 d-f | 1.08 d-f | 1.20 f-h |
| V ₁₄ | 1.47 f | 1.74 f | 1.06 ef | 1.21 f-h |
| V ₁₅ | 2.18 a | 2.57 a | 1.57 b | 1.79 b |
| V ₁₆ | 1.75 c-e | 2.08 b-e | 1.29 b-e | 1.47 de |
| V ₁₇ | 1.98 b | 2.33 b | 1.49 bc | 1.72 bc |
| V ₁₈ | 2.29 a | 2.67 a | 1.83 a | 2.16 a |
| V ₁₉ | 1.02 g | 1.20 g | 0.85 f | 0.99 h |
| V ₂₀ | 1.78 b-d | 2.10 b-d | 1.29 b-e | 1.45 de |
| V ₂₁ | 1.75 c-e | 2.06 b-e | 1.25 c-e | 1.36 d-g |
| V ₂₂ | 1.55 ef | 1.81 ef | 1.14 de | 1.36 d-g |
| V ₂₃ | 1.85 bc | 2.21 bc | 1.36 b-d | 1.53 cd |
| V ₂₄ | 1.82 b-d | 2.17 bc | 1.32 b-e | 1.44 de |
| S \bar{x} | 0.07 | 0.08 | 0.08 | 0.08 |
| Level of significance | ** | ** | ** | ** |
| CV (%) | 6.67 | 7.01 | 11.90 | 9.82 |

Table 4. Crop growth rate (CGR) of 20 - 30 and 30 - 40-day-old plants of rapeseed and mustard varieties during the 2017-'18 and 2018-'19 cropping seasons in the coastal saline area of Bangladesh.

| Treatments | Crop growth rate (g m ⁻² day ⁻¹) | | | |
|-----------------|---|----------|--------------|----------|
| | 20 - 30 days | | 30 - 40 days | |
| | 2017-'18 | 2018-'19 | 2017-'18 | 2018-'19 |
| V ₁ | 2.73 a-d | 2.47 e-h | 3.12 e-h | 3.18 e-i |
| V ₂ | 2.68 a-d | 2.68 c-h | 2.85 gh | 2.85 g-i |
| V ₃ | 2.42 cd | 2.42 f-h | 2.81 gh | 2.81 g-i |
| V ₄ | 2.44 cd | 2.44 f-h | 3.39 c-g | 3.67 b-e |
| V ₅ | 2.36 cd | 2.29 gh | 2.80 gh | 2.71 hi |
| V ₆ | 3.09 a-d | 2.75 c-g | 2.91 gh | 3.23 e-h |
| V ₇ | 2.82 a-d | 2.59 d-h | 3.31 d-g | 3.22 e-h |
| V ₈ | 2.87 a-d | 2.57 d-h | 3.32 d-g | 3.32 e-g |
| V ₉ | 2.26 d | 2.18 h | 2.70 h | 2.58i |
| V ₁₀ | 2.67 a-d | 2.34 f-h | 3.65 b-e | 3.50 d-f |
| V ₁₁ | 2.98 a-d | 2.98 cd | 3.60 b-f | 3.60 c-e |
| V ₁₂ | 2.96 a-d | 2.96 c-e | 3.65 b-e | 3.65 b-e |
| V ₁₃ | 3.17 a-d | 3.17 bc | 3.55 b-f | 3.55 de |
| V ₁₄ | 2.99 a-d | 2.99 cd | 3.88 a-d | 3.99 a-d |
| V ₁₅ | 3.91 ab | 3.67 ab | 3.91 a-c | 3.97 a-d |
| V ₁₆ | 3.45 a-d | 3.47 ab | 4.00 ab | 3.98 a-d |

Continued

| | | | | |
|-----------------------|----------|----------|----------|----------|
| V ₁₇ | 3.77 a-c | 3.55 ab | 3.96 a-c | 4.15 ab |
| V ₁₈ | 4.01 a | 3.93 a | 4.33 a | 4.22 a |
| V ₁₉ | 2.39 cd | 2.29 gh | 3.02 f-h | 2.70 hi |
| V ₂₀ | 2.91 a-d | 2.83 c-f | 3.17 e-h | 3.02 f-i |
| V ₂₁ | 3.02 a-d | 3.02 cd | 3.57 b-f | 3.17 e-i |
| V ₂₂ | 3.72 a-c | 3.52 ab | 4.11 ab | 4.11 a-c |
| V ₂₃ | 2.50 b-d | 2.40 f-h | 2.83 gh | 2.83 g-i |
| V ₂₄ | 3.41 a-d | 3.03 cd | 2.86 gh | 2.86 g-i |
| S \bar{x} | 0.31 | 0.18 | 0.30 | 0.30 |
| Level of significance | ** | ** | ** | ** |
| CV (%) | 7.8 | 9.03 | 14.06 | 13.54 |

Table 5. Crop Growth Rate (CGR) of 40 - 50 and 50 - 60 day-old plants of rapeseed and mustard varieties during the 2017-'18 and 2018-'19 cropping seasons in the coastal saline area of Bangladesh.

| Treatments | Crop Growth Rate (g m ⁻² day ⁻¹) | | | |
|-----------------|---|----------|--------------|----------|
| | 40 - 50 days | | 50 - 60 days | |
| | 2017-'18 | 2018-'19 | 2017-'18 | 2018-'19 |
| V ₁ | 3.76 c-g | 3.76 e-h | 4.32 e-h | 4.32 g-i |
| V ₂ | 3.62 e-g | 4.10 d-g | 4.12 e-h | 4.12 h-j |
| V ₃ | 3.69 d-g | 3.69 e-h | 4.19 e-h | 4.19 h-j |
| V ₄ | 3.69 d-g | 3.69 e-h | 4.19 e-h | 4.19 h-j |
| V ₅ | 3.63 e-g | 3.63 f-h | 4.13 e-h | 4.13 h-j |
| V ₆ | 3.40 e-g | 3.72 e-h | 3.90 f-h | 4.06 h-j |
| V ₇ | 3.56 e-g | 3.46 gh | 3.74 gh | 3.90 ij |
| V ₈ | 3.24 fg | 3.34 gh | 4.06 e-h | 4.77 e-g |
| V ₉ | 3.16 g | 3.30 h | 3.66 h | 3.39 j |
| V ₁₀ | 4.38 b-e | 4.53 b-d | 5.08 b-e | 5.08 de |
| V ₁₁ | 4.26 b-f | 4.26 c-f | 4.96 b-e | 4.96 d-f |
| V ₁₂ | 4.16 b-g | 4.16 d-g | 4.86 b-f | 4.86 d-f |
| V ₁₃ | 3.77 c-g | 3.77 e-h | 4.47 d-h | 4.47 f-h |
| V ₁₄ | 4.29 b-e | 4.29 c-f | 4.99 b-e | 4.99 d-f |
| V ₁₅ | 4.93 ab | 4.39 c-e | 5.84 ab | 6.14 ab |
| V ₁₆ | 4.82 ab | 5.24 ab | 5.83 ab | 5.80 bc |
| V ₁₇ | 4.71 a-c | 4.90 a-c | 5.61 a-c | 5.23 de |
| V ₁₈ | 5.42 a | 5.22 a | 6.12 a | 6.32 a |
| V ₁₉ | 3.56 e-g | 3.62 f-h | 4.06 e-h | 3.77 ij |
| V ₂₀ | 4.68 a-d | 4.68 b-d | 4.20 e-h | 5.38 cd |

Continued

| | | | | |
|-----------------------|----------|----------|----------|----------|
| V ₂₁ | 4.06 b-g | 4.06 d-h | 4.76 c-g | 4.76 e-g |
| V ₂₂ | 4.94 ab | 4.94 a-c | 5.72 a-c | 5.84 a-c |
| V ₂₃ | 3.70 c-g | 3.70 e-h | 5.38 a-d | 4.20 h-j |
| V ₂₄ | 4.27 b-e | 3.56 f-h | 4.77 c-g | 4.06 h-j |
| S \bar{x} | 0.15 | 0.16 | 0.22 | 0.16 |
| Level of significance | ** | ** | ** | ** |
| CV (%) | 9.27 | 8.10 | 12.98 | 11.95 |

Plant height: The plant height showed a significant difference among the rapeseed and mustard varieties during 2017-'18 and 2018-'19, and it ranged from 40.20 to 134.90 cm and 63.13 to 159.20 cm in both years, respectively (**Table 6**). The tallest plants, 134.90 and 159.20 cm, were obtained with the variety BARI Sarisha-16 (V₁₈) in both years, followed by BARI Sarisha-10 (V₂₂), BARI Sarisha-11 (V₁₅), and Binasarisha-7 (V₁₆) with values of 134.00, 136.0; 127.00, 135.10; and 120.40, 133.80 cm, respectively. At the same period, the shortest plants, 40.20 and 63.13 cm, were acquired by Satkhira local (V₉) in both years, respectively, which were followed by Tori-7 (V₁₉), BARI Sarisha-14 (V₁), and Binasarisha-10 (V₃) with values of 54.67, 63.53; 58.07, 74.07; and 66.77, 76.40 cm, respectively.

Table 6. Plant height and branches per plant of rapeseed and mustard varieties during the 2017-18 and 2018-19 cropping seasons in the coastal saline area of Bangladesh.

| Treatments | Plant height (cm) | | Number of branches per plant ⁻¹ | |
|-----------------|-------------------|-----------|--|----------|
| | 2017-'18 | 2018-'19 | 2017-'18 | 2018-'19 |
| V ₁ | 58.07 h | 74.07 ij | 3.83 i-k | 4.00 hi |
| V ₂ | 79.15 de | 88.77 d-i | 4.50 g-j | 5.73 d-g |
| V ₃ | 66.77 e-h | 76.40 h-j | 5.80 c-e | 4.49 g-i |
| V ₄ | 86.00 cd | 97.60 c-f | 5.13 e-h | 4.41 g-i |
| V ₅ | 87.30 cd | 92.90 c-g | 5.66 c-f | 5.03 e-h |
| V ₆ | 63.53 f-h | 84.40 e-i | 5.50 d-g | 3.86 hi |
| V ₇ | 91.17 cd | 99.67 c-e | 2.50 lm | 4.43 g-i |
| V ₈ | 90.70 cd | 108.00 c | 5.10 e-h | 3.96 hi |
| V ₉ | 40.20 i | 63.13 j | 2.23 m | 3.03 i |
| V ₁₀ | 76.27 d-g | 89.07 d-i | 3.46 j-l | 5.15 e-h |
| V ₁₁ | 78.37 d-f | 85.33 d-i | 5.96 c-e | 6.06 d-f |
| V ₁₂ | 62.10 gh | 78.80 g-i | 3.73 i-k | 4.96 f-h |
| V ₁₃ | 90.00 cd | 89.80 d-h | 4.63 f-i | 3.69hi |
| V ₁₄ | 82.30 cd | 83.67 g-i | 5.00 e-h | 5.00 e-h |
| V ₁₅ | 127.00 ab | 135.10 b | 6.80 a-c | 7.90 b |
| V ₁₆ | 120.40 ab | 133.80 b | 7.16 ab | 7.66 bc |

Continued

| | | | | |
|-----------------------|-----------|-----------|----------|----------|
| V ₁₇ | 118.00 b | 121.40 b | 7.56 ab | 9.03 a |
| V ₁₈ | 134.90 a | 159.20 a | 7.73 a | 10.17 a |
| V ₁₉ | 54.67 h | 63.53 j | 2.40 lm | 3.40 i |
| V ₂₀ | 91.43 cd | 91.43 d-h | 3.03 k-m | 4.53 g-i |
| V ₂₁ | 97.90 c | 97.90 c-f | 4.23 h-j | 4.23 g-i |
| V ₂₂ | 134.00 a | 136.00 b | 6.50 b-d | 6.80 b-d |
| V ₂₃ | 81.93 c-e | 97.97 c-f | 4.50 g-j | 5.10 e-h |
| V ₂₄ | 97.37 c | 100.40 cd | 6.46 b-d | 6.46 c-e |
| S \bar{x} | 4.81 | 4.67 | 0.36 | 0.45 |
| Level of significance | * | ** | ** | ** |
| CV (%) | 9.48 | 8.28 | 12.42 | 14.18 |

Table 7. Siliquae per plant and seeds per siliqua of rapeseed and mustard varieties during the 2017-'18 and 2018-'19 cropping seasons in the coastal saline area of Bangladesh.

| Treatments | No. of siliquae plant ⁻¹ | | No. of seeds siliqua ⁻¹ | |
|-----------------|-------------------------------------|-----------|------------------------------------|-----------|
| | 2017-'18 | 2018-'19 | 2017-'18 | 2018-'19 |
| V ₁ | 54.77 i | 57.67 h | 23.43 a-c | 24.68 ab |
| V ₂ | 60.70 hi | 69.10 e-h | 21.80 a-f | 19.92 d-g |
| V ₃ | 77.60 fg | 89.00 e-g | 17.37 e-h | 16.60 h-j |
| V ₄ | 84.37 e-g | 91.10 ef | 22.33 a-d | 20.84 d-g |
| V ₅ | 95.33 d-f | 58.10 h | 17.17 f-h | 14.32 ij |
| V ₆ | 101.00 de | 94.50 de | 21.57 a-f | 21.63 d-f |
| V ₇ | 58.33 hi | 81.90 e-h | 21.77 a-f | 22.47 cd |
| V ₈ | 56.51 hi | 65.00 f-h | 23.13 a-c | 23.50 bc |
| V ₉ | 47.43 i | 56.40 h | 13.33 h | 12.12 k |
| V ₁₀ | 78.03 fg | 95.00 de | 22.30 a-d | 22.79 bc |
| V ₁₁ | 54.33 i | 66.30 f-h | 22.40 a-d | 23.00 cd |
| V ₁₂ | 56.70 hi | 66.70 f-h | 22.00 a-e | 22.19 c-e |
| V ₁₃ | 54.87 i | 117.50 cd | 26.03 a | 27.31 a |
| V ₁₄ | 74.03 gh | 117.90 cd | 24.23 ab | 23.63 b |
| V ₁₅ | 137.70 b | 160.50 ab | 20.30 b-e | 19.19 e-h |
| V ₁₆ | 121.20 bc | 141.00 bc | 19.57 b-g | 19.01 e-h |
| V ₁₇ | 122.70 bc | 135.10 c | 19.27 c-g | 18.47 f-i |
| V ₁₈ | 159.50 a | 171.00 a | 20.13 b-f | 19.17 e-h |
| V ₁₉ | 54.00 i | 56.83 h | 15.10 gh | 13.18 jk |
| V ₂₀ | 58.00 hi | 81.80 e-h | 22.40 a-d | 19.93 d-g |
| V ₂₁ | 55.17 i | 68.53 e-h | 24.27 ab | 24.95 ab |

Continued

| | | | | |
|-----------------------|-----------|-----------|-----------|-----------|
| V ₂₂ | 109.10 cd | 128.6 c | 15.50 gh | 18.12 g-i |
| V ₂₃ | 88.00 e-g | 87.93 e-g | 18.00 d-g | 16.37 h-j |
| V ₂₄ | 94.00 d-f | 62.90 gh | 21.17 b-f | 17.73 g-i |
| S \bar{x} | 5.57 | 8.05 | 1.48 | 1.00 |
| Level of significance | ** | ** | ** | ** |
| CV (%) | 11.84 | 15.07 | 11.74 | 8.39 |

Branches per plant: There was significant variation observed in the number of branches plant⁻¹ of rapeseed and mustard varieties during 2017-'18 and 2018-'19. It ranged from 2.23 to 7.73 and 3.03 to 10.17 branches per plant in both years (Table 6). In 2017-'18, the maximum number of branches plant⁻¹, 7.73, was found in variety BARI Sarisha-16 (V₁₈), and it was followed by the varieties Binasarisha-8 (V₁₇), Binasarisha-7 (V₁₆), and BARI Sarisha-11 (V₁₅) with values of 7.56, 7.16, and 6.80, respectively.

During 2018-19, the maximum number of branches plant⁻¹ 10.17 was recorded with the same variety BARI Sarisha-16 (V₁₈), which was statistically at par with Binasarisha-8 (V₁₇) and followed by BARI Sarisha-11 (V₁₅) and Binasarisha-7 (V₁₆), with branch numbers of 9.03, 7.90, and 7.66, respectively.

Siliquae per plant: The number of siliquae per plant varied significantly among the rapeseed and mustard varieties during 2017-'18 and 2018-'19. The number of siliquae per plant ranged from 47.43 to 159.50 and 56.40 to 171.00 in both years, respectively (Table 7).

Number of seeds per siliqua: The tested rapeseed and mustard varieties showed a significant difference in respect of the number of seeds siliqua⁻¹, and it ranged from 13.33 to 26.03 and 12.12 to 27.31 during 2017-'18 and 2018-'19, respectively (Table 7). In 2017-'18, the maximum number of seeds siliqua⁻¹, 26.03, was obtained with Binasarisha-3 (V₁₃), followed by BARI Sarisha-8 (V₂₁) and Binasarisha-5 (V₁₄), having values of 24.27 and 24.23, respectively.

Table 8. Thousand seed weight and seed yield of rapeseed and mustard varieties during the 2017-'18 and 2018-'19 cropping seasons in the coastal saline area of Bangladesh.

| Treatments | 1000 seed weight (g) | | Seed yield (t ha ⁻¹) | |
|----------------|----------------------|----------|----------------------------------|----------|
| | 2017-'18 | 2018-'19 | 2017-'18 | 2018-'19 |
| V ₁ | 2.92 | 3.02 | 0.79 h-k | 0.88 j-l |
| V ₂ | 2.92 | 2.92 | 0.82 h-k | 0.89 j-l |
| V ₃ | 3.25 | 3.25 | 0.91 g-i | 1.02 h-j |
| V ₄ | 2.92 | 2.85 | 0.88 g-j | 0.98 i-k |
| V ₅ | 2.35 | 2.78 | 0.95 g-i | 1.11 g-i |
| V ₆ | 3.25 | 3.25 | 1.08 e-h | 1.16 f-i |
| V ₇ | 3.25 | 3.25 | 0.60 j-l | 0.73 lm |

Continued

| | | | | |
|-----------------------|-------|-------|----------|----------|
| V ₈ | 2.92 | 3.25 | 0.66 i-l | 0.81 kl |
| V ₉ | 2.92 | 3.08 | 0.49 l | 0.62 m |
| V ₁₀ | 2.92 | 3.25 | 1.17 c-g | 1.20 gh |
| V ₁₁ | 2.25 | 2.35 | 0.89 g-i | 1.08 g-i |
| V ₁₂ | 2.92 | 3.02 | 1.04 d-h | 1.20 f-h |
| V ₁₃ | 2.92 | 3.25 | 1.22 c-f | 1.31 d-f |
| V ₁₄ | 2.92 | 3.38 | 1.27 c-e | 1.35 d-f |
| V ₁₅ | 3.25 | 3.25 | 1.55 ab | 1.63 ab |
| V ₁₆ | 3.25 | 3.35 | 1.32 a-d | 1.47 b-d |
| V ₁₇ | 3.25 | 3.43 | 1.40 a-c | 1.60 a-c |
| V ₁₈ | 3.25 | 3.45 | 1.57 a | 1.69 a |
| V ₁₉ | 2.92 | 3.05 | 0.56 kl | 0.63 m |
| V ₂₀ | 2.92 | 3.02 | 0.99 e-h | 1.31 d-f |
| V ₂₁ | 3.25 | 3.15 | 0.95 f-i | 1.27 e-g |
| V ₂₂ | 3.25 | 3.28 | 1.32 a-d | 1.44 c-e |
| V ₂₃ | 2.92 | 2.88 | 0.96 f-i | 1.21 f-h |
| V ₂₄ | 2.92 | 2.80 | 1.02 e-h | 1.25 e-g |
| S \bar{x} | 0.28 | 0.22 | 0.09 | 0.06 |
| Level of significance | ns | ns | ** | ** |
| CV (%) | 16.03 | 12.38 | 15.06 | 9.11 |

Thousand seed weight: There was no significant difference among the rapeseed and mustard varieties with regard to 1000 seed weight during the two consecutive experimental years. The 1000 seed weight ranged from 2.25 to 3.25 and 2.35 to 3.45 g during 2017-'18 and 2018-'19 (Table 8). Although the 1000 seed weight showed a non-significant difference, in the first year, the maximum 1000 seed weight of 3.25 g was found in nine varieties, viz. BARI Sarisha-16 (V₁₈), Binasarisha-8 (V₁₇), Binasarisha-7 (V₁₆), BARI Sarisha-11 (V₁₅), Binasarisha-2 (V₇), BARI Sarisha-17 (V₆), BARI Sarisha-8 (V₂₁), BARI Sarisha-10 (V₂₂), and Binasarisha-10 (V₃).

Table 9. Stover yield and biological yield of rapeseed and mustard varieties during the 2017-'18 and 2018-'19 cropping seasons in the coastal saline area of Bangladesh.

| Treatments | Stover yield (t ha ⁻¹) | | Biological yield (t ha ⁻¹) | |
|----------------|------------------------------------|----------|--|----------|
| | 2017-'18 | 2018-'19 | 2017-'18 | 2018-'19 |
| V ₁ | 1.79 h-k | 1.89 ij | 2.58 i-k | 2.78 jk |
| V ₂ | 1.94 g-j | 2.09 hi | 2.77 h-j | 2.98 i-k |
| V ₃ | 2.09 f-i | 2.14 hi | 3.01 f-i | 3.15 h-j |

Continued

| | | | | |
|-----------------------|----------|----------|----------|----------|
| V ₄ | 2.05 f-i | 2.17 g-i | 2.93 g-i | 3.15 h-j |
| V ₅ | 2.19 f-h | 2.26 f-h | 3.14 f-i | 3.36 g-i |
| V ₆ | 2.43 d-g | 2.41 e-h | 3.51 d-g | 3.58 f-h |
| V ₇ | 1.53 jk | 1.60 j-l | 2.13 kl | 2.33 lm |
| V ₈ | 1.64 i-k | 1.75 jk | 2.30 j-e | 2.56 kl |
| V ₉ | 1.02 k | 1.12 l | 1.51 l | 1.74 m |
| V ₁₀ | 2.80 b-e | 2.79 b-d | 3.98 c-e | 3.99 d-f |
| V ₁₁ | 2.28 f-h | 2.26 f-h | 3.18 fi | 3.34 g-i |
| V ₁₂ | 2.56 c-f | 2.58 d-f | 3.60 d-f | 3.78 e-g |
| V ₁₃ | 2.89 b-d | 2.80 b-d | 4.11 b-d | 4.12 de |
| V ₁₄ | 2.98 bc | 2.93 bc | 4.25 bc | 4.29 cd |
| V ₁₅ | 3.40 a | 3.31 a | 4.96 a | 5.04 ab |
| V ₁₆ | 3.29 ab | 3.10 b | 4.69 ab | 4.92 ab |
| V ₁₇ | 3.01 bc | 3.42 a | 4.34 bc | 4.70 bc |
| V ₁₈ | 3.50 a | 3.45 a | 5.16 a | 5.21 a |
| V ₁₉ | 1.15 k | 1.25 kl | 1.71 kl | 1.88 m |
| V ₂₀ | 2.37 e-g | 2.67 c-e | 3.36 e-h | 3.98 d-f |
| V ₂₁ | 2.28 f-h | 2.55 d-f | 3.23 f-h | 3.82 d-g |
| V ₂₂ | 3.13 ab | 2.80 b-d | 4.45 bc | 4.24 de |
| V ₂₃ | 2.30 fg | 2.35 e-h | 3.26 f-h | 3.56 f-h |
| V ₂₄ | 2.42 d-g | 2.49 d-g | 3.44 e-g | 3.75 e-g |
| S \bar{x} | 0.15 | 0.10 | 0.20 | 0.15 |
| Level of significance | ** | ** | ** | ** |
| CV (%) | 10.98 | 7.14 | 9.93 | 7.15 |

Seed yield: The seed yield (t ha^{-1}) significantly differed among the tested rape-seed and mustard varieties during 2017-'18 and 2018-'19. The seed yield ranged from 0.49 to 1.57 and 0.62 to 1.69 t ha^{-1} (Table 8). In both years, the same variety BARI Sarisha-16 (V₁₈) produced the maximum seed yield with values of 1.57 and 1.69 t ha^{-1} , which was statistically similar to BARI Sarisha-11 (V₁₅) and Binasarisha-8 (V₁₇), including values of 1.55, 1.63 and 1.40, 1.60, respectively. The lowest seed yield, 0.49 and 0.62 t ha^{-1} , was recorded by Satkhira local (V₉), which was statistically similar to Tori-7 (V₁₉) with values of 0.56 and 0.63 t ha^{-1} . At the same time, 1.32, 1.47 and 1.32, 1.44 t ha^{-1} seed yield was recorded by Binasarisha-7 (V₁₆) and BARI Sarisha-10 (V₂₂), respectively. [12] reported BARI Sarisha-18 and BARI Sarisha-16 as suitable for coastal areas in Bangladesh. [13] observed reduced seed yield of mustard with increased salinity levels.

Table 10. Harvest index (%) of rapeseed and mustard during the 2017-'18 and 2018-'19 cropping seasons in the coastal saline area of Bangladesh.

| Treatments | Harvest index (%) | |
|-----------------------|-------------------|-----------|
| | 2017-'18 | 2018-'19 |
| V ₁ | 30.99 | 32.08 a-d |
| V ₂ | 29.99 | 30.00 cd |
| V ₃ | 30.69 | 32.23 a-d |
| V ₄ | 29.90 | 31.06 a-d |
| V ₅ | 30.27 | 32.88 a-c |
| V ₆ | 30.89 | 32.44 a-d |
| V ₇ | 28.26 | 31.33 a-d |
| V ₈ | 28.60 | 31.74 a-d |
| V ₉ | 27.07 | 31.16 a-d |
| V ₁₀ | 29.57 | 30.08 b-d |
| V ₁₁ | 28.17 | 32.40 a-d |
| V ₁₂ | 29.35 | 31.73 a-d |
| V ₁₃ | 29.72 | 31.87 a-d |
| V ₁₄ | 29.70 | 31.58 a-d |
| V ₁₅ | 30.38 | 32.40 a-d |
| V ₁₆ | 29.64 | 34.09 a |
| V ₁₇ | 30.30 | 29.87 cd |
| V ₁₈ | 30.57 | 32.47 a-d |
| V ₁₉ | 27.81 | 29.59 d |
| V ₂₀ | 29.56 | 32.91 a-c |
| V ₂₁ | 29.33 | 33.25 ab |
| V ₂₂ | 29.65 | 33.86 a |
| V ₂₃ | 29.39 | 34.09 a |
| V ₂₄ | 29.67 | 33.50 a |
| S \bar{x} | 1.79 | 0.94 |
| Level of Significance | ns | * |
| CV (%) | 10.48 | 5.06 |

Stover yield: A significant difference was observed among the rapeseed and mustard varieties with regard to stover yield ($t\ ha^{-1}$), which ranged from 1.02 to 3.50 and 1.12 to 3.45 $t\ ha^{-1}$ during 2017-'18 and 2018-'19, respectively (**Table 9**).

Biological yield: The biological yield ($t\ ha^{-1}$) significantly differed among the tested rapeseed and mustard varieties during 2017-'18 and 2018-'19. It ranged from 1.51 to 5.16 and 1.74 to 5.21 $t\ ha^{-1}$, respectively (**Table 9**). In both years, the same variety BARI Sarisha-16 (V₁₈) produced the maximum biological yield of

5.16 and 5.21 t ha⁻¹, which was statistically similar to BARI Sarisha-11 (V₁₅) and Binasarisha-7 (V₁₆), including the values of 4.96, 5.04 and 4.69, 4.92 t ha⁻¹, respectively.

Harvest index (%): The harvest index (%) of tested varieties showed a non-significant difference in 2017-'18, but it showed significant difference in 2018-'19 (Table 10). During 2018-'19, the maximum harvest index (%) of 34.09 was found from two varieties, viz. Binasarisha-7 (V₁₆) and BARI Sarisha-12 (V₂₃). At the same time, the lowest harvest index (%) of 29.59 was recorded by Tori-7 (V₁₉). [6] showed decreased harvest index (HI) with increased salinity levels.

Regression studied: From the regression analysis (Figures 1-2), it was evident that seed yield (t ha⁻¹) was significantly and positively associated with number of siliquae plant⁻¹ (R² = 0.64 and 0.66) in both years.

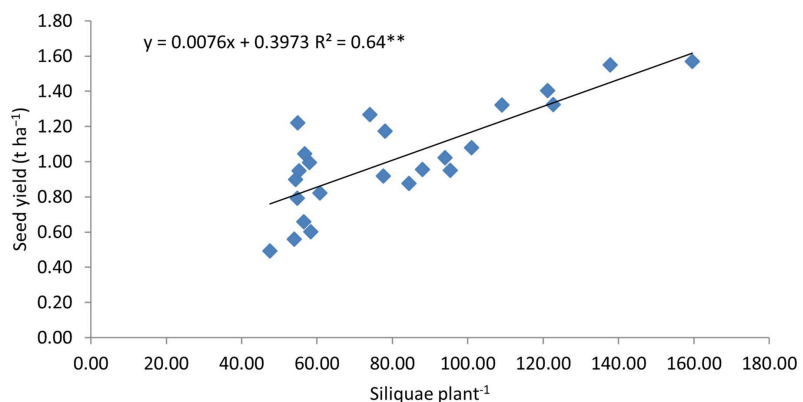


Figure 1. Relationship between seed yield (t ha⁻¹) and siliquae per plant of different rapeseed and mustard varieties during 2017-'18.

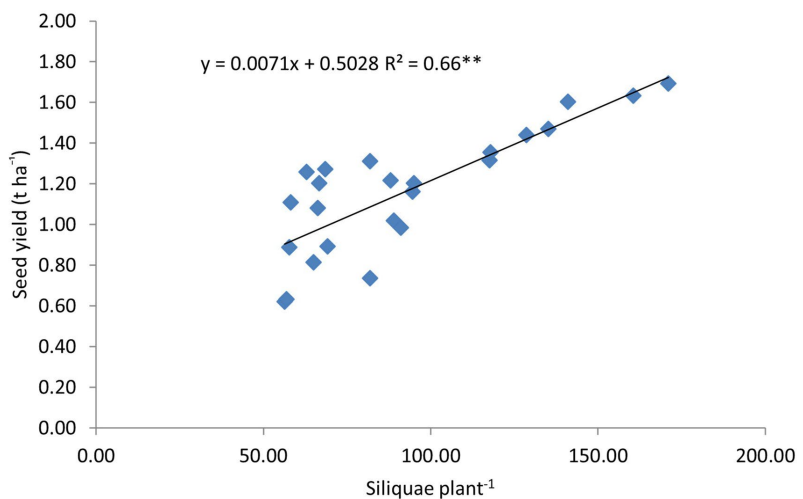


Figure 2. Relationship between seed yield (t ha⁻¹) and siliquae per plant of different rapeseed and mustard varieties during 2018-'19.

4. Discussion

During the crop growing period, the lowest mortality of 6% and 7% was found in

three varieties viz. BARI Sarisha-13, BARI Sarisha-16, and BARI Sarisha-8, which might be due to their salinity resistance. The highest mortality (18%) was recorded by Binasarisha-1 (V_8) in both years because of its greater susceptibility to salinity.

The tested varieties showed a significant difference in respect of leaf area index (LAI) and crop growth rate (CGR). The highest LAI of 20, 30, 40, 50 and 60 days old plant was recorded from BARI sarisha-16 (V_{18}), and its statistically similar LAI was found in BARI Sarisha-11 (V_{15}) and Bina sarisha-8 (V_{17}). The same variety, BARI sarisha-16 (V_{18}), also gained the highest CGR at the age of 30 - 40 days, 40 - 50 days and 50 - 60 days except for 20 - 30 days. It might be due to its tolerance against soil salinity. The result was supported by the findings of [14].

The lowest LAI and CGR were recorded from *Brassica campestris* spp, Tori-7 (V_{19}) and Satkhira local (V_9). Significant differences were found among the varieties with regard to plant height (cm) and branches plant⁻¹ during 2017-18 and 2018-19. The highest plant height (134.90 and 159.20 cm) and number of branches plant⁻¹ (7.73 and 10.17) were attained with *Brassica juncea* cv. BARI Sarisha-16 (V_{18}) in both years. This was probably due to its greatest tolerance to soil salinity. The lowest height (40.20 and 63.13 cm) and branches plant⁻¹ (2.23 and 3.03) were recorded from Satkhira local (V_9) in two consecutive years of the experiment; it was perhaps highly susceptible to soil salinity. The result was in agreement with the findings of [15], who worked on fertility and salinity interactions on growth and yield of Indian mustard (*Brassica juncea*) and reported that plant height was significantly affected by salinity and *Brassica juncea* cv. Rh-30 attained the highest plant height.

In recent times, morphophysiological traits have been observed at the germination stage not only with the aim of screening for salt tolerance but also to determine a reliable trait or indicator in different species. It is crucial to identify an effective and reliable trait for the assessment and screening of salt-tolerant lines for breeding salt-tolerant varieties. It would be one step forward for plant breeders to screen a large number of germplasm at the seedling stage itself [16].

Among the 24 varieties, the maximum siliqua per plant (159.50 and 171.00) was found in BARI Sarisha-16 (V_{18}), which was statistically similar to Binasarisha-8 (V_{17}) with values of 122.70 and 135.10, and the lowest siliquae plant⁻¹ (47.43 and 56.40) was recorded by Satkhira local (V_9) in consecutive two years of experimentation. The result was probably influenced by the salinity of the field and varietal inherent characteristics. The result was supported by the report of [17].

BARI Sarisha-16 (sp.-*Brassica juncea*) produced the highest yield, which might be due to its highest days to maturity, CGR, number of branches plant⁻¹, siliquae plant⁻¹, and 1000 seed weight. This result was in agreement with the findings obtained by [18]. In the trial of sowing dates BARI Sarisha-16, BARI Sarisha-13 and BARI Sarisha-14 by [19] BARI Sarisha-16 was found suitable for saline prone area of Bangladesh.

The lowest seed yield attained by Satkhira local might be due to its lowest days to maturity, number of branches plant⁻¹, and siliquae plant⁻¹, but it was not highly

susceptible to salinity because its mortality was 8% and 9%, while the highest mortality, 18%, was recorded from Binasarisha-1 in both years, respectively. So, it might be concluded that Satkhira local obtained the lowest yield due to the combined effect of varietal inheritance and soil salinity. Significant variations were accounted for among the genotypes and treatments for all the characters, such as data on days to first flowering, plant height, leaf area, days to maturity, number of seeds siliqua, 1,000 seed weight, and seed yield plant were recorded [1].

5. Conclusion

Among the tested twenty-four rapeseed and mustard varieties, BARI Sarisha-16 (V₁₈) produced the highest seed yield in saline soil at Satkhira, Bangladesh, and BARI Sarisha-11 (V₁₅), Binasarisha-8 (V₁₇) provided a statistically similar seed yield to BARI Sarisha-16 (V₁₈). Therefore, these three varieties might be better for cultivation in coastal saline soil of Bangladesh.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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