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Effect of Salinity Stress on Growth and Yield Component of Different Mustard Varieties in Bangladesh

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Abstract

Soil salinity is a major constraint affecting crop yield and quality. Among oilseed crops in Bangladesh, mustard is the most important. A study was conducted during the 2021–2022 rabi season at the net house of the Agricultural Botany Department, Patuakhali Science and Technology University (PSTU), to identify salt-tolerant mustard genotypes based on physiological responses, growth, and yield parameters. Six mustard genotypes (V1 = BARI Sarisha-11, V2 = BARI Sarisha-14, V3 = BARI Sarisha-15, V4 = BARI Sarisha-16, V5 = Binasarisha-4, and V6 = Binasarisha-9) were tested under four salinity levels (S0 = 0, S1 = 4, S2 = 6, and S3 = 8 dS m^{-1}). Salinity stress negatively affected physiological traits and seed yield across all genotypes. Leaf area and total dry matter (TDM) decreased under salinity, ultimately reducing yield. However, V4 (BARI Sarisha-16) and V2 (BARI Sarisha-14) exhibited better tolerance, maintaining higher growth and yield. BARI Sarisha-16 had the highest leaf area (452.8 cm^2), TDM (9.58 g $plant^{-1}$), plant height (120.5 cm), siliqua count (106.3 per plant), seeds per siliqua (15.66), 1000-seed weight (3.78 g), and seed yield (4.19 g per plant) under control conditions, followed by BARI Sarisha-14. In contrast, BARI Sarisha-15 and Binasarisha-4 exhibited the lowest growth and yield at the highest salinity level. Overall, BARI Sarisha-16 and BARI Sarisha-14 demonstrated superior salt tolerance and could be recommended for cultivation in the saline-prone coastal regions of Bangladesh.

Keywords: Growth, Mustard, Stress, Salinity, Yield

Introduction

Among the oilseed crops grown in Bangladesh, rapeseed/mustard (*Brassica spp.*) holds the first position in acreage and production. It covers an area of more than 68% of the country's oilseed production crop (BBS, 2022). It constitutes an important source of edible oil and is grown under diverse agro-ecological situations. These crops are usually sown from mid-October to the last week of November. Currently, in Bangladesh, about 9882 tons of mustard is being produced from an area of 8875 ha with an average yield of 1.15 t ha^{-1} (BBS, 2022). In the coastal saline areas, it is very difficult to adjust the sowing time of mustard with the country's general recommendation due to the late harvest of Aman rice and high soil salinity level during the crop establishment stage (Sattar and Mutsaers, 2004). Most of the southern districts of the country are under saline zones which cover an area of 25-30% of the total cultivable land (SRDI, 2012).

The issue of salinity stresses poses a continuous and enduring threat to field crops and is widely acknowledged as a significant limitation on global agricultural productivity. It has contrary effects on the plant life cycle, including seed germination, seedling establishment and development, vegetative and reproductive growth, and crop survival (Zhu, 2016; Shah et al., 2007; Islam et al., 2019). In Bangladesh, about 2.85 million hectares are of seaside land of which about one million hectares are salt-stressed (SRDI, 2012; Howlader et al., 2018). Saline soils are vastly contained in Na^+ and Cl^- particles which makes water unavailable and negatively impacts crop growth. High salt concentrations adversely affect plant development and growth through various pathways, including water stress, nutritional disorders, ion toxicity, oxidative stress, alterations to metabolic processes, cell membrane disorganization, and reduced cell expansion and division (Hossain et al., 2010; Munns, 2002). One of the most detrimental effects of salinity stress is the accumulation of Na+ and Cl ions in tissues of plants exposed to soils with high NaCl concentrations. Entry of both Na+ and Cl into the cells causes' severe ion imbalance and the excess uptake of them might cause significant physiological disorder(s). Generation of reactive oxygen species (ROS) like singlet oxygen, superoxide radical, hydrogen peroxide, and hydroxyl radicals exposed to salinity stress causes injury to plants. The genotypes which produce more ROS scavenging enzymes under stress can be considered as comparatively tolerant genotype.

Though soil salinity is the most dominant factors limiting crop production in the coastal areas of Bangladesh during dry season, salt-tolerant rapeseed/mustard can bring substantial changes in the agricultural practices in those saline soils. Genetic variations in salt tolerance exist in the glycophytes, and the degree of salt tolerance varies with plant species and varieties within a species. There also exist differences in sensitivity to salinity among Brassica cultivars which need to be found out in a systematic study. Therefore, the present study was conducted to find the tolerant mustard varieties based on tolerance of physiological and yield parameters.

Materials and Methods

A pot experiment was conducted in the net house of Department of Agricultural Botany, PSTU, Dumki, Patuakhali during the rabi season of 2021-2022 to investigate the effect of different concentration of salt stress imposed on different mustard varieties. Six selected mustard varieties (V_1= BARI Sarisha-11, V_2 = BARI Sarisha-14, V_3 = BARI Sarisha-15, V_4 = BARI Sarisha-16, V_5 = Binasarisha-4 and V_6 = Binasarisha-9) were tested at four levels of salinity (S_0 = 0, S_1 = 4, S_2 = 6 and S_3 =8 dS m^{-1}). Salinity was imposed at 20 days after sowing by adding NaCl solution. Salt solution was prepared by dissolving calculated amount of Lab grade NaCl with pond water. Salt solution was applied with an increment of 2 dS m^{-1} every alternate day until desired salinity levels were attained. In the control treatment, pond water was used which salinity level was 0.2 dS m^{-1}. Salinity levels were maintained by monitoring and adding salt solution when required up to maturity. The experiment was laid out in a Factorial Randomized Complete Block design with 5 replications. Plastic pots (top dia: 25 cm, bottom dia: 18 cm and height 25 cm; 12 kg soil) were filled up with soil and cowdung (4:1). Seeds were sown in each pot on 12 November, 2021. Fertilizers were applied @100-30-80-20-3-1 kg ha^{-1} NPKSZnB. Half of N and all other fertilizers were applied as basal and the remaining N was applied at 20 days after sowing (DAS). Irrigation was done as and when required for maintaining adequate soil moisture. After emergence plants were thinned to three plants in each pot. Plants from three pots were sampled for leaf area and dry matter measurement at different growth stages. Sampled plants were separated into leaf, stem, and siliqua depending on growth stages. Leaf area was measured by an automatic area meter (LI-3100 C; LI-Cor, USA). Plant parts were dried in an oven for 72 hours at 70ºC and dry weight was recorded. At harvest yield and yield components data were collected from three pots and analyzed statistically and mean separation was done by LSD test at 5% level of significance using data processing software.

Results and discussion

Leaf area and dry matter production

Effect of salinity

In respect of leaf area and total dry matter content plant^{-1}, there was a significant variation was observed among the different level of salinity **(Fig. 1** and **2)**. However, decreasing trend in leaf area was found in both 40 DAS to 60 DAS with the increasing of salinity level. At 40 DAS, the highest leaf area (369.4 dS m^{-1}) was found in no salinity whereas lowest leaf area (168.8 dS m^{-1}) was found in highest level of salinity (6 dS m^{-1}). At 60 DAS, highest leaf area (442.5 dS m^{-1}) was found in no salinity and lowest leaf area (182.5 dS m^{-1}) in highest level of salinity. In respect of total dry matter content, significant variations were found among the different level of salinity. At 40 DAS, the highest total dry matter (7.20 g plant^{-1}) was found in no salinity whereas lowest leaf area (4.70 g plant^{-1}) was found in highest level of salinity (6 dS m^{-1}). At 60 DAS and during final harvest, highest total dry mater (9.68 g plant^{-1}) was found in no salinity and lowest dry matter content (5.83 g plant^{-1}) in highest level of salinity. In general leaf area was reduced with increased salinity levels irrespective of the genotypes. Salinity-induced osmotic stress is considered responsible for the reduced leaf area in Canola and wild mustard (Huang and Redmann, 1995). Furthermore, high salinity is known to induce ionic stress, which causes premature abscission and senescence of adult leaves, thus reducing the available photosynthetic area (Munns, 2002).

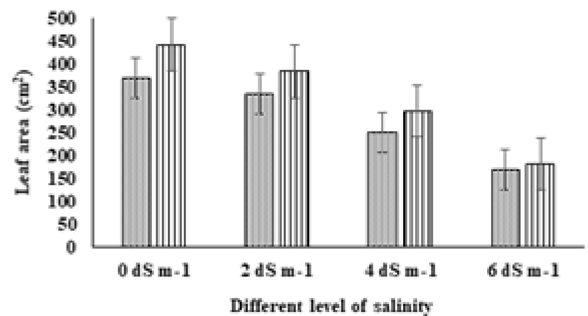

Fig. 1. Effect of different level of salinity on leaf area of mustard

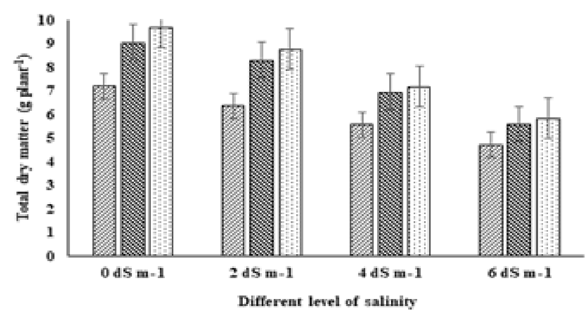

Fig. 2. Effect of different level of salinity on leaf area of mustard

Effect of different varieties

Leaf area plant^{-1} of different mustard differed significantly at different days after sowing **(Fig. 3** and **4)**. At both 40 DAS and 60 DAS, the maximum leaf area was observed in BARI Sarisha-16 (366.5 cm^2 and 439.5 cm^2), which was identical with BARI Sarisha-14 whereas the minimum leaf area was recorded from BARI Sarisha-11. For total dry matter content, at 40 DAS BARI Sarisha-16 (7.19 g plant^{-1}) gave the highest result which was followed by BARI Sarisha-14 while the minimum total dry matter content was found in BARI Sarisha-11. Similar trend was recorded at 60 DAS and during the harvest.

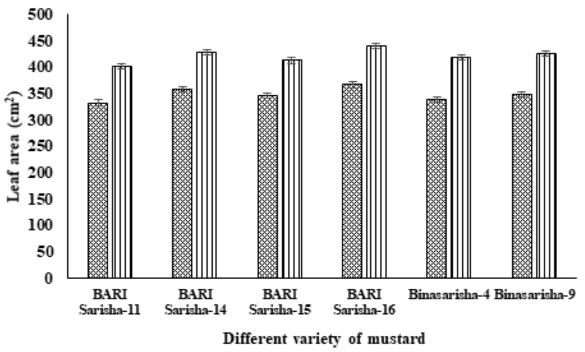

Fig. 3. Effect of different variety of mustard on leaf area

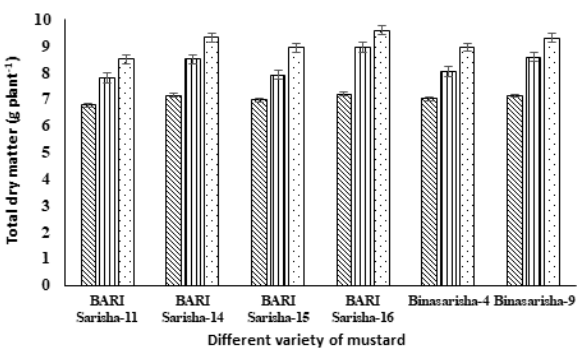

Fig. 4. Effect of different variety of mustard on total dry matter

Combined effect of salinity level and mustard varieties

In combined effect, at 40 DAS, the highest leaf area (392.4 cm^2) was found in V_4 (BARI Sarisha-16) in combination with no salinity which was followed by V_2 (BARI Sarisha-14) (378.2 cm^2) and statistically identical result (372.3 cm^2) was found in S_0V_6 treatment combination **(Table 1)**. With increasing the level of salinity leaf area was minimized. The lowest leaf area (150.4 cm^2) was recorded from variety V_1 (BARI Sarisha-11) with highest level of salinity. At 60 DAS, the highest leaf area (452.8 cm^2) was recorded in V_4 (BARI Sarisha-16) in no salinity induced plant where minimum leaf area was recorded from the variety V1 (BARI Sarisha-11) with highest level of salinity (193.5 cm^2).

Total dry matter production of the genotypes was significant at 40 DAS under control conditions, although comparatively higher values were observed in V_4 (7.22 g plant^{-1}) and V2 (7.14 g plant^{-1}) and the lowest (6.92 g plant^{-1}) in V_1 in no salinity condition. At 60 DAS under no salinity condition, highest total dry matter production was counted from V_4 (9.08 g plant^{-1}) and lowest (5.33 g plant^{-1}) was found in V3 (BARI Sarisha-15). At harvest under no salinity condition, total dry matter production as found highest (9.58 g plant^{-1}) which was followed by BARI Sarisha-14 and Binasarisha-4 gave the lowest (5.43 g plant^{-1}) total dry matter content. Dry weight per plant was adversely affected by increasing levels of salinity. Dry matter production which is considered as an index of photosynthetic activity (Essa and Al-Ani, 2001) was reduced under saline conditions. Reduction in total dry matter accumulation under saline conditions was also reported by Shamsul et al. (2011) in Indian mustard (*Brassica juncea*).

Table 1. Interaction effect of salinity level and different mustard varieties on leaf area and total dry matter content

Salinity × varieties	Leaf area (cm^2)		Total dry matter (g plant^{-1})		
	40 DAS	60 DAS	40 DAS	60 DAS	Harvest
S_0V_1	343.5	412.5	6.92	8.42	9.13
S_0V_2	378.2	429.0	7.14	8.97	9.44
S_0V_3	351.0	415.0	7.03	8.63	9.29
S_0V_4	392.4	452.8	7.22	9.08	9.58
S_0V_5	353.9	420.0	6.97	8.54	9.30
S_0V_6	372.3	433.4	7.10	8.72	9.49
S_1V_1	317.0	371.0	6.20	7.60	8.50
S_1V_2	324.5	378.9	6.32	7.77	8.71
S_1V_3	313.2	354.0	6.18	7.63	8.43
S_1V_4	332.8	389.5	6.35	7.88	8.77
S_1V_5	320.0	367.0	6.15	7.54	8.44
S_1V_6	326.5	374.8	6.27	7.72	8.67
S_2V_1	226.5	278.5	5.43	6.70	7.02
S_2V_2	243.7	289.5	5.49	6.82	7.15
S_2V_3	236.0	280.0	5.33	6.56	6.94
S_2V_4	255.5	294.3	5.57	6.95	7.20
S_2V_5	226.0	267.9	5.40	6.60	6.95
S_2V_6	247.3	279.0	5.49	6.82	7.10
S_3V_1	156.9	193.5	4.51	5.43	5.50
S_3V_2	171.8	208.2	4.63	5.50	5.77
S_3V_3	150.4	182.5	4.42	5.33	5.60
S_3V_4	178.5	218.0	4.68	5.64	5.85
S_3V_5	160.9	192.8	4.37	5.40	5.43
S_3V_6	168.0	202.5	4.55	5.55	5.66
$LSD_{0.05}$	22.4	28.02	1.12	1.07	0.93
CV (%)	6.8	7.57	8.5	7.88	5.5

S_0 = 0, S_1 = 4, S_2 = 6 and S_3 =8 dS m^{-1}; V1= BARI Sarisha-11, V_2 = BARI Sarisha-14, V_3 = BARI Sarisha-15, V_4 = BARI Sarisha-16, V_5 = Binasarisha-4 and V_6 = Binasarisha-9; DAS = Days after sowing; CV = Co-efficient of variation; $LSD_{0.05}$=Leased Significant Difference at 5% level of significance.

Yield and yield contributing characters

Effect of different levels of salinity

The most common undesirable effect of salinity on the crop of Brassica is the reduction in plant height, component characters of yield as well as deterioration of the product quality (Zamani et al., 2010). Salinity stress significantly affected yield and yield contributing characters of mustard varieties **(Table 2)**. Plant height was significantly reduced due to salinity stress. The tallest plant was recorded in control (117.5 cm) condition while the shortest in 6 dS m^{-1} salinity treatment (92.5 cm). Days to maturity is one of major character for suitable variety selection of mustard. With the gradual advancement of salinity maturity duration is decreased gradually due to the mustard plants facing salinity stress. The lowest maturity duration (81.7) was found from highest level of salinity (6 dS m^{-1}) on the other hand highest maturity duration (83.7) was recorded from zero salinity condition. Siliquaplant-1 was significantly reduced due to salinity stress, the highest number was observed in the control (106.6) condition which was followed by the lowest level of salinity (2 dS m^{-1}) salinity level and the lowest (79.5) was recorded in highest level of salinity (6 dSm^{-1}). A negative effect of salinity on the number of siliqua plant^{-1} of Indian mustard was also observed by Kripa et al. (2011). The highest number of seeds siliqua^{-1} was found in the control conditions (14.67) and the lowest (11.33) in 6 dS m^{-1} salinity. These results corroborate the findings of Ahmad (2010). Reduced seed size was observed due to salinity stress. The highest 1000-seed weight was found in the control conditions (3.77 g) which was significantly higher than others and the lowest (2.79 g) in highest level of salinity. This finding is supported by Kripa et al. (2011).

Table 2. Effect of different level of salinity on growth and yield components of mustard

Salinity level	Plant height (cm)	Days to maturity	No. of siliqua plant^{-1}	No. of seeds siliqua^{-1}	1000-seed weight
0 dS m^{-1}	117.5	83.7	106.6	14.67	3.77
2 dS m^{-1}	108.3	82.4	97.5	14.0	3.38
4 dS m^{-1}	102.0	82.0	88.8	12.67	3.04
6 dS m^{-1}	92.5	81.7	79.5	11.33	2.79
LSD $_{0.05}$	5.85	1.42	6.42	1.72	0.24
CV (%)	7.20	5.50	10.13	6.30	8.56

CV = Co-efficient of variation; LSD$_{0.05}$=Leased Significant Difference at 5% level of significance.

Effect of mustard varieties

Genotypes showed significant difference in plant height **(Table 3)**. The tallest plant was found in BAI Sarisha-16 (125.3 cm) which was significantly higher than all other genotypes while the shortest plant (104.0) was recorded in BARI Sarisha-15. In case of days to maturity, short duration variety was BARI Sarisha-14 (82.6 days) which was followed by BARI Sarisha-16 (84.3). Siliqua plant^{-1} of the genotypes also varied significantly. The highest number of silique plant^{-1} was recorded in BARI Sarisha-16 (112.22) and the lowest siliqua plant^{-1} was recorded in BARI Sarisha-11 (92.35) genotype. The number of seeds siliqua^{-1} of the genotypes differed significantly. The highest number of seeds siliqua^{-1} was observed in the same variety (15.18) which were significantly higher than other genotypes and the lowest value was observed in BARI Sarisha-11 (11.44). The seed size of the genotypes varied significantly. The highest 1000-seed weight was recorded in BARI Sarisha-16 (3.78 g) which was significantly higher than others and the lowest was recorded in BARI Sarisha-15 (3.50 g).

Table 3. Effect of different mustard varieties on growth and yield components

Varieties	Plant height (cm)	Days to maturity	No. of siliqua plant^{-1}	No. of seeds siliqua^{-1}	1000-seed weight
BARI Sarisha-11	113.0	88.0	92.35	11.44	3.53
BARI Sarisha-14	110.0	82.6	109.25	13.02	3.67
BARI Sarisha-15	104.0	91.0	98.50	12.50	3.50
BARI Sarisha-16	125.3	84.3	112.22	15.18	3.78
Binasarisha-4	106.8	85.0	104.57	13.57	3.59
Binasarisha-9	117.0	84.6	108.0	14.33	3.70
LSD $_{0.05}$	5.67	1.67	6.29	1.43	0.17
CV (%)	8.50	3.80	8.70	7.53	9.60

CV = Co-efficient of variation; LSD$_{0.05}$=Leased Significant Difference at 5% level of significance

Combined effect of mustard varieties and different level of salinity

In combined effect, plant height was significantly influenced among the varieties with different levels of salinity throughout the growing period **(Table 4)**. BARI Sarisha-16 with no salinity (S_0V_4) scored the tallest plant (120.5 cm) which was statistically identical with BARI Sarisha-11 (120.2 cm) while the lowest was recorded from Binasarisha-4 with highest level of salinity (S_3V_5) (87.5 cm) which was statistically similar (87.6) with BARI Sarisha-11 with highest salinity (S_3V_1). Variation of plant height was occurred due to the genetic makeup of the varieties. Akhter (2005) also found the variation of plant height among the different varieties. Similar variation of plant height among rapeseed/mustard varieties was also reported by many scientists (Ahmed et al., 2017; Roy, 2007). Yeasmin (2013) disagreed with this finding who reported that varietal effect was insignificant on plant height. Short duration variety (81.0 days) was recorded in BARI Sarisha-14 with highest level of salinity (S_3V_2) which was statistically similar with BARI Sarisha-16, Biasarisha-4 and Binasarisha-9 with different level of salinity.

Maximum days required to maturity (92.2) was observed in BARI Sarisha-15 with no salinity. Among the varieties and salinity concentration, number of siliqua plant^{-1} differed significantly. Maximum number of siliqua plant^{-1} (106.3) was recorded in BARI Sarisha-16 with no salinity which was followed by Binasarisha-9 while the minimum (72.9) was recorded from Binasarisha-4 with highest level of salinity (S_3V_5). Number of siliqua plant^{-1} is the result of genetic makeup of the crop and environmental conditions (Sana et al., 2003). The findings of Akhter (2005), Roy (2007) and Mamun et al. (2014) are in conformity with the results of this finding that the number of siliqua plant^{-1} of mustard was significantly affected by the varieties.

Number of seeds siliqua^{-1} was significantly influenced due to the varietal difference and different salinity level. The maximum number of seeds siliqua^{-1} (15.66) was resulted in BARI Sarisha-16 with no salinity which was on parity with BARI Sarisha-14 whereas the minimum (12.10) was recorded from BARI Sarisha-15 with highest level of salinity (S_3V_3). Variation in seeds siliqua^{-1} among the varieties and salinity concentration was in conformity with Mamun et al. (2014), who found the highest seeds silique^{-1} in BARI Sarisha-13 and the lowest seeds siliqua^{-1} in BARI Sarisha-15 and these results are in agreement with the findings of Zakaria (2007) and Gurjar and Chauhan (2011). But the results are in contradiction with Roy (2007) who found the highest seeds siliqua^{-1} in improved BRI Sarisha-14 and the lowest number of seeds siliqua^{-1} in SAU Sarisha-1.

There was a significant variation among the varieties and salinity on weight of 1000. Weight of 1000 seeds was higher (3.78 g) in BARI Sarisha-16 which was statistically at par with BARI Sarisha-14 and Binasarisha-9 in zero salinity condition while Binasarisha-4 with highest level of salinity (S_3V_5) produced the lowest 1000 seed weight (2.92 g). The result of this finding was in conformity with that of Mamun et al. (2014). They also observed that BARI Sarisha-13 had the highest 1000 seed weight (4.00 g) whereas the lowest one (2.82 g) was found in SAU Sarisha3. The 1000-seed weight is the stable part of yield and it varied from variety to variety which is in agreement with that of Mondal and Wahab (2001). It might be attributed to disturbed absorption of moisture and nutrients, limited formation of photosynthates and their lesser translocation towards seeds resulting reduction in seed weight.

Table 4. Interaction effect of mustard varieties and different level of salinity on growth and yield attributes

Salinity × genotypes	Plant height (cm)	Days to maturity	No. of siliqua plant^{-1}	No. of seeds siliqua^{-1}	1000-seed weight
S_0V_1	116.2	89.0	102.6	14.20	3.45
S_0V_2	113.5	82.5	98.7	15.10	3.67
S_0V_3	109.8	92.2	101.8	13.56	3.34
S_0V_4	120.5	84.0	106.3	15.66	3.78
S_0V_5	110.3	82.5	97.8	14.50	3.54
S_0V_6	116.5	84.7	103.5	14.80	3.67
S_1V_1	110.2	87.5	94.3	13.23	3.24
S_1V_2	108.7	81.6	97.5	14.42	3.56
S_1V_3	104.5	90.2	90.4	13.02	3.32
S_1V_4	113.8	83.0	96.8	14.56	3.65
S_1V_5	104.5	82.0	92.0	13.94	3.43
S_1V_6	108.2	83.8	97.0	14.19	3.56
S_2V_1	101.5	87.6	84.6	12.97	3.12
S_2V_2	98.5	81.5	86.0	13.67	3.45
S_2V_3	101.7	88.5	80.6	12.32	3.23
S_2V_4	106.8	82.5	88.2	13.96	3.48
S_2V_5	97.5	82.0	82.0	12.78	3.20
S_2V_6	101.3	82.2	84.8	13.49	3.40
S_3V_1	87.6	86.0	77.0	12.34	2.79
S_3V_2	90.5	81.0	78.9	13.02	3.10
S_3V_3	92.3	86.6	75.6	12.10	2.90
S_3V_4	93.4	81.5	78.0	13.18	3.25
S_3V_5	87.5	81.6	72.9	12.43	2.98
S_3V_6	92.0	82.0	75.0	12.76	3.14
LSD $_{0.05}$	4.85	0.93	5.49	0.49	0.56
CV (%)	7.50	8.67	10.25	4.67	5.50

S_0 = 0, S_1 = 4, S_2 = 6 and S_3 =8 dS m^{-1}; V1= BARI Sarisha-11, V_2 = BARI Sarisha-14, V_3 = BARI Sarisha-15, V_4 = BARI Sarisha-16, V_5 = Binasarisha-4 and V_6 = Binasarisha-9; DAS = Days after sowing; CV = Co-efficient of variation; $LSD_{0.05}$=Leased Significant Difference at 5% level of significance.

Effect of mustard varieties and salinity levels on seed yield

Seed yield was also reduced due to salinity stress and the highest seed yield (4.12 gplant^{-1}) was recorded in the control condition and the lowest (2.50 gplant^{-1}) in 6 dS m^{-1} salinity **(Fig. 5)**. Seed yield plant^{-1} of the genotypes varied significantly. The highest seed yield (4.10) was found in V4 (BARI Sarisha-16) which significantly higher than others. But the lowest yield was observed in BARI Sarisha-11 **(Fig. 6)**. Interaction effect of genotype and salinity showed significant influence on seed yield plant-1 **(Fig.7)**. Under control conditions, the seed yield of V4 and V2 were identical. At 6 dS m^{-1} salinity the maximum seed yield was found in V4 which was identical with V2, V6 and V5 but significantly higher than V1 and V3. The lowest yield was found in V4 genotype **(Fig. 6)**. Salinity may reduce the crop yield by upsetting the water and nutritional balance of plants (Francois, 1994; Islam et al., 2001). The poor seed yield under saline environment was attributed to salt induced shrinkage and even complete damage of chloroplast, decrease in photosynthates in the phloem and water deficiency in the growing region (Flowers et al, 1991). According to Ashraf et al. (1999) the reduction in seed yield may also be due to decreasing assimilates production associated with decreased plant size and yield.

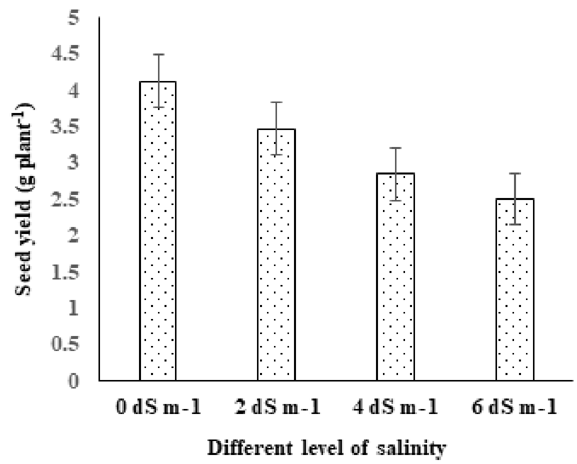

Fig. 5. Effect of different level of salinity on seed yield of mustard

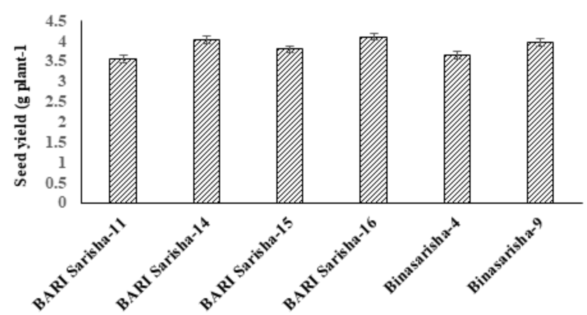

Fig. 6. Effect of different variety of mustard on seed yield

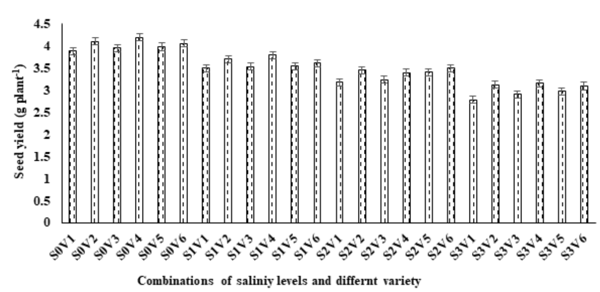

Fig. 7. Interaction effect of different level of salinity and mustard verities on seed yield

Conclusion

The impact of salinity stress on various mustard cultivars was assessed during both the vegetative and reproductive stages. In the presence of stressful conditions results revealed that mustard varieties BARI Sarisha-16 and BARI Saisha-14 were comparatively salt-tolerant as evaluated based on seed yield and important physiological parameters. The result of this study revealed that the growth, yield and yield attributes of mustard varied substantially among the tested varieties and different level of salinity used in this experiment yet no significant variation in phenological parameters. Considering the productivity, BARI Sharisha-16 is suitable and can be recommended for cultivation in the medium highland of Patuakhali region of southern Bangladesh. The findings of this study contribute to the advancement of our understanding regarding plant responses to salt-induced stress. These findings are particularly useful for the cultivation of mustard-rapeseed varieties in coastal areas of Bangladesh.

References

Ahmed, Z. and Kashem, M. A. 2017. Performance of mustard varieties in haor area of Bangladesh, *Bangladesh Agronomy Journal*, 20 (1), 1-5.

Akhter, S. M. M. 2005. Effect of harvesting time on shattering, yield and oil content of rapeseed and mustard. MS Thesis, Sher-e-Bangla Agriculture University, Dhaka, Bangladesh.

Ashraf, M. Y., Waheed, R. A. Bhatti, A. Baig, S. A. and Aslam, Z., 1999. Salt tolerance potential in different *Brassica species*: Growth studies. P. 119-125. In: Harndy, A., H. Lieth, M. Todorovic and M. Moscheuko. (eds.) Halophyte Use in Different Climates II. Backhuy Pubs. Leiden, The Netherlands.

BBS (Bangladesh Bureau of Statistics), 2022. Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning, Govt. of the Peoples Republic of Bangladesh.

Essa, A.T. and Al-Ani, D.H. 2001. Effect of salt stress on the performance of six soybean genotypes. *Pakistan. J. Biol. Sci.* 4: 175-177.

Flowers, T. J., Hajibagheri, M. A. and Yeo, A. R. 1991. Ion accumulation in the cell walls of rice plants growing under saline conditions: evidence for the Oertli hypothesis. *Plant Cell Environ.* 14:319–325.

Francois, L.E. 1994. Growth, seed yield, and oil content of canola grown under saline environments. *Agron. J.* 86(2):233-237.

Gurjar, B. S. and Chauhan, D. V. S. 2011. Yield attributes and seed yield of Indian mustard (*Brassica juncea*) as influenced by varieties, fertility levels and spacing in Harsi Command area. *Indian Journal of Agronomy*, 42(1), 142-144.

Hossain, M.A., Hasanuzzaman, M. and Fujita, M. 2010. Up-regulation of antioxidant and glyoxalase systems by exogenous glycinebetaine and proline in mungbean confer tolerance to cadmium stress. *Physiol. Mol. Biol. Plants,* 16: 259–272.

Huang, J. and Redmann, R.E. 1995. Physiological responses of Canola and wild mustard to salinity and contrasting calcium supply. *J. Plant Nutr.* 18(9): 1931-1949.

Islam, M.R., Bhuiyan, M.A.R. Prasad, B. and Quddus, M.A. 2001. Salinity effect on yield and component characters in rapeseed and mustard varieties. *J. Biol. Sci.* 1(9):840-842.

Islam, M.R., Bhuiyan, M.A.R., Prasad, B. and Quddus, M.A. 2019. Salinity effect on yield and component characters in rapeseed and mustard varieties. *J. Biol. Sci.* 1(9):840-842.

Kripa, S., Parihar, S.K.S., Kuldeep, K., Kant, D. and Arun, K. 2011. Relative salt tolerance of Indian mustard (*Brassica juncea*) genotypes in relation to germination, growth and seed yield. *J. Oilseed Brassica.* 2(2): 76-82.

Mamun, F., Ali, M. H., Chowdhury, I. F., Hasanuzzaman, M. and Matin, M. A. 2014. Performance of rapeseed and mustard varieties grown under different planting density. *Sci. Agri.* 8(2), 70-75.

Mondal, M. R. I. and Wahab, M. A. 2001. Production technology of oilseeds. Oilseed Res. Centre, Bangladesh Agril. Res. Inst., Joydebpur, Gaziprur. pp. 6-24.

Munns, R. 2002. Comparative physiology of salt and water stress. *Plant Cell Environ.* 25: 239-250.

Roy, L. R. 2007. Influence of weeding on growth and yield of rapeseed varieties. M.S. Thesis, SAU, Dhaka, Bangladesh.

Sana, M., Ali, A., Malik, M. A., Saleem, M. F. and Rafiq, M. 2003. Comparative yield potential and oil contents of different canola cultivars (*Brassica napus* L.). *Pakistan Journal of Agronomy,* 2(1), 1-7.

Sattar, S.A., Mutsaers, H.J.W. 2004). Agriculture in southeastern coastal chars of Bangladesh. Char Development and Settlement Project II. Technical Report No. 2004, 12(1):49.

Shah, S.H. 2007. Effects of salt stress on mustard as affected by gibberellic acid application. *Gen. Appl. Plant Physiol.* 33(1-2): 97-10.

Shamsul, H., Mir, B.A., Wani, A.S., Hasan, S.A., Mohd, I. and Aqil, A. 2011. Screening of salt-tolerant genotypes of *Brassica juncea* based on photosynthetic attributes. *J. Plant Interactions,* 6(1): 225-229.

SRDI, 2012. Saline soils of Bangladesh. Soil Resources and Development Institute. Ministry of Agriculture, Farmgate, Dhaka-1215.

Yeasmin, M. 2013. Effect of inflorescence-top cutting on the yield and yield attributes of mustard varieties under different sowing times. M.S. Thesis, SAU, Dhaka, Bangladesh.

Zakaria, A. K. M. and Jahan, M. H. 2007. Annual Report for the year of 2005-06. Rural Development Academy, Bogura, Bangladesh. Pp. 25-35.

Zamani Z., Nezami, M.T. Habibi, D. and Khorshidi, M.B. 2010. Effect of quantitative and qualitative performance of four canola cultivars (*Brassica napus* L.) to salinity conditions. *Adv. Environ. Biol.* 4(3): 422-427.

Zhu, X.J., Gao, C.J., Xong, S.L., Zhou, Y.H., Shi, K.A.I. and Yu, J.Q. 2016. Role of H_2O_2 dynamics in brassinosteroid-induced stomatal closure and opening in *Solanum lycopersicum*. *Plant Cell Environ.* 37: 2036–2050.