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Heterosis in Intervarietal *Brassica* Hybrids Grown under Saline Condition

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Abstract: The experiment was conducted in pot culture from November 1998 to March 1999 at the Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh. Eighteen *B. campestris* hybrids and their 6 parents were tested for saline tolerance. The genotypes were grown in earthen pots. Mixture of soil and cowdung in 3:1 ratio was the growth media. Sodium chloride was used as the sources of salt. Two salinity levels viz., 1.43 and 12.00 dS m⁻¹ EC were maintained. There were three replications in each treatment. The genotypes were grown up to maturity and the characters germination percentage, days to germination, plant height at 25, 35 and 45 days, days to flowering, plant height at harvest, days to maturity and seed yield/plant were studied. The analysis of variance showed that variation due to salinity levels, genotypes and interaction between salinity levels and genotypes were significant for the experiment. Comparing the mean values of 12 dS m⁻¹ EC with that of the control i.e., 1.43 dS m⁻¹ EC it was observed that effect of higher salinity level on different characters was very sharp in the experiment. At higher salinity level germination percentage decreased, days to germination increased, plant height decreased, days to flowering and maturity increased and seed yield/plant decreased. It was further observed that effect of salinity was more prominent up to flowering stage then it was gradually decreased probably due to watering which was necessary to raise the plants. Heterosis was estimated over mid-parent and better parent. Out of 324 heterosis values, 54 were desirable and significant over mid-parent and 39 over better parent. On the basis of desirable and significant heterotic values over mid-parent the hybrids were scored for the characters germination percentage, days to germination, plant height at 25, 35 and 45 days and days to flowering and then ranked. On the basis of rank position the hybrids Sampad x M-395, M-91, x M-27, Dholi x M-27, M-395 x M-91, Dholi x M-395, M-18 x Sampad, M-91 x M-18, M-27 x Dholi and M-27 x M-91 were found to be promising against salinity.

Key words: *Brassica*, heterosis, saline condition

INTRODUCTION

Rapeseed and mustard is the third important oil crop of the world after soybean and palm^[1]. It is the top-most edible oil crop of Bangladesh. It covers about 61.2% of the total oilseed acreage and contributes 52.6% of the total production^[2]. In Bangladesh, more than 30% of the cultivable area is in the coastal belt. Out of 2.85 million ha of coastal and off-shore land mass, about 0.83 million ha are affected by different degrees of salinity^[3]. Moreover, the salt affected area is increasing day by day. Rice is the major crop cultivated in those areas. After harvesting Aman rice, a vast area of land remains either unused or covered by some minor crops at marginal level of production practices. Mustard and rapeseed cultivation in those areas is limited mostly due to non-availability of suitable varieties.

Bangladesh is facing a huge shortage in edible oils. The local production covers about 40% of the country demand. But it has little scope to increase the acreage of the crop in the present cropping pattern and growing areas. As a result the country is spending more than 800 crore Taka every year to import edible oils and oilseeds. However, the saline affected areas of the country may be utilized for increased production of the crop by developing varieties resistant to salinity and grows well in late planting.

MATERIALS AND METHODS

The experiment was conducted in pot culture during the period from November 1998 to March 1999 at the Department of Genetics and Plant Breeding,

Bangladesh Agricultural University, Mymensingh. Eighteen *B. campestris* hybrids were tested against their six parents for saline tolerance. The genotypes were grown in earthen pots. Soil plus cowdung approximately in 3:1 was the growth media. Sodium chloride was used as the sources of salt. The genotypes were tested at 1.43 (Farm soil salinity level) and 12.00 dS m⁻¹ EC level. There were three replications in each treatment. Ten seeds per pot were sown by making holes and keeping more or less equal distances from each other. After 15 days of sowing, all the remaining seedlings of each pot were removed keeping only three for recording data. The plants were allowed to grow up to maturity. Weeding, watering and spraying of insecticide and fungicide were done according to need to raise the crop plants. The characters germination percentage, days to germination, plant height at 25, 35 and 45 days after sowing, days to flowering, days to maturity, plant height at harvest and seed yield/plant were recorded.

RESULTS AND DISCUSSION

The results revealed that variation due to salinity levels, genotypes and interaction between salinity levels and genotypes were significant for all the characters studied. It was further observed that there were a wide range of variation between the control (1.43 dS m⁻¹ EC) and the treatment (12.00 m⁻¹ EC) for all the genotypes and characters studied (Table 1). The deviation of the treatment mean over the control expressed in percent increased or decreased have been estimated (Table 2). It was observed that at 12.00 dS m⁻¹ EC level, germination percentage was decreased (3.2 to 76.5%), days to germination increased (34.3 to 113.6%), plant height at 25, 35 and 45 days decreased (36.3 to 73.7, 17.1 to 63.7 and 38.6 to 71.5%) and days to flowering increased (12.0 to 49.1%). It was further observed that effect of salinity was decreased gradually with the advancement of time and plant growth. This was due to watering which was necessary to raise the crop plants. Thus, the deviation between the treatment and the control were less for plant height at harvest, days to maturity and seed yield per plant. Sinha^[4] and Kumar^[5] found lower germination percentage at higher salinity levels in rapeseed and mustard. In the same crop Sinha^[4], Shannon^[6], Thakral *et al.*^[7] and Ashraf *et al.*^[8] found that plant height was decreased at the higher salinity level. Thakral *et al.*^[7] also found that seed yield was decreased at the higher salinity level in the *B. campestris* parents and hybrids.

Heterosis was estimated over the mid-parent and better-parent values (Table 3). In most of the cases the hybrids showed poor performance than their parents. In

case of germination percentage positive heterosis was desirable. Only the cross SampadxM-395 was successful in this character. It was observed that most of the hybrids took more days to germinate than their parents but negative heterosis was desirable in this character. The more successful hybrids in this character were M-91xM-27, M-91xM-18, DholixM-27, M-395xM-91 and DholixM-395. In plant height, positive heterosis was desirable. It was measured at 25, 35 and 45 Days. Considering these three days together the crosses SampadxM-18, M-18xSampad, DohlixM-395, DholixM-27, M-395xM-91, M-91xM-27 and M-27xM-91 were the more successful ones. In case of days to flowering, most of the hybrids were late than their parents but negative heterosis was desirable. In this character only the cross Sampad xM-395 showed negative and significant heterosis over the mid-parent. For plant height at harvest positive heterosis was desirable. The crosses M-91xM-18, M-18xM-91, M-91xM-27 and M-27xM-91 were more successful in this character. Generally higher salinity level increased the maturity period than the control. So, negative heterosis was desirable in this character. The cross SampadxM-395 and M-18, xSampad exhibited significant negative heterosis over the mid-parent value. In case of seed yield/plant, positive heterosis was desirable and the crosses M-395xM-91, M-91xM-395 and DholixM-395 were the more successful ones.

It was observed that all the hybrids did not perform well in respect of salt tolerance. So, attempt has been taken to identify the comparatively more desirable hybrids. This was done by scoring the hybrids on the basis of significant desirable heterotic values over the mid parent. For example, in case of days to germination, negative heterosis was desirable and among 18 hybrids, seven showed significant and negative result. The highest negative heterosis was obtained in the cross M-91xM-27. So, the cross M-91xM-27, was scored 1. The second highest negative heterosis was in the cross M-91xM-18. So, this was scored 2, The hybrids which did not show desirable i.e. negative and significant heterotic results were scored 18. Accordingly the hybrids have been scored for the characters germination percentage, days to germination, plant height at 25, 35 and 45 days to flowering. The characters plant height at harvest, days to maturity and seed yield/plant have been excluded from this scoring because of lower effect of salinity at the later of plant growth. However, on the basis of scores for individual characters, average score and rank position have been made (Table 4). According to the Table 4, the hybrids SampadxM-395, M-91xM-27, Dholi x M-27, M-395-M-91, Dholi x M-395, M-18x Sampad, M-91xM-18, M-27xDholi and M-27xM-91 were found to be more promising against salinity. Selection out of these hybrids

Table 1: Analysis of variance for different characters of *B. campestris* parents and hybrids grown under saline condition

S.O.V	Degree of freedom	Mean squares with level of significance								
		Germination percentage	Days to germination	Plant height at 25 days (cm)	Plant height at 35 days (cm)	Plant height at 45 days (cm)	Days to flowering	plant height at harvest (cm)	Days to maturity	Seed yield/plant (g)
Replication	2	71.50	0.25	0.08	1.03	0.87	3.06	9.30	0.84	0.09
Factor A (Salinity levels)	1	18677.80***	531.30***	3264.20***	3141.30***	39156.20***	5043.96***	957.63***	1161.70***	34.30***
Factor B (Genotypes)	23	1616.90***	2.85**	10.40***	52.40***	98.93***	35.22***	559.43***	45.07***	1.93*
A×B	23	511.10***	1.63*	6.31**	47.99***	113.44***	19.60***	308.60***	12.80**	1.60**
Error	94	77.20	0.21	0.30	1.08	3.20	1.03	7.91	0.66	0.05
CV%		13.75	5.60	4.28	4.92	4.20	2.03	3.13	3.20	9.80

*, ** and *** indicate significant at 5, 1 and 0.1% level, respectively

Table 2: Effect of salinity on different morphological characters of *B. campestris* and *B. juncea* parents and hybrids

Parents and hybrids	Germination percentage	Days to germination	Plant height at 25 days (cm)	Plant height at 35 days (cm)	Plant height at 45 days (cm)	Days to flowering	Plant height at harvest (cm)	Days to maturity	Seed yield/plant (g)
	% decreased over the control	% increased over the control	% decreased over the control	% decreased over the control	% decreased over the control	% increased over the control	% increased or decreased over the control	% increased over the control	% increased or decreased over the control
Sampad	-14.3	+113.6	-56.2	-48.1	-61.8	+34.0	+7.5	+11.7	-4.6
Dholi	-18.1	+78.2	-56.5	-41.7	-58.5	+33.6	+6.6	+8.8	+3.3
M-91	-17.3	+71.2	-58.7	-47.3	-56.8	+28.2	-1.9	+2.6	-4.4
M-395	-19.9	+70.7	-52.5	-44.2	-45.1	+21.8	-0.5	+8.8	-6.9
M-18	-46.1	+105.3	-67.6	-43.6	-71.5	+32.0	-5.2	+9.6	-36.1
M-27	-21.7	+62.1	-56.6	-51.1	-70.0	+43.5	-3.9	+6.3	-53.9
SampadxM-395	-3.5	+60.0	-36.3	-32.9	-42.7	+12.0	-12.3	+1.7	-38.7
M-395xSampad	-22.2	+70.2	-58.8	-63.7	-43.5	+16.3	-16.3	+3.3	-24.1
SampadxM-18	-57.8	+80.6	-65.8	-51.6	-69.5	+33.8	+14.2	+10.6	-71.4
M-18xSampad	-10.0	+34.3	-44.5	-17.1	-54.7	+25.9	-5.8	+9.6	-71.1
SampadxM-27	-30.0	+50.0	-67.2	-49.8	-65.2	+21.1	-35.8	+2.9	-46.2
M-27xSampad	-24.0	+36.1	-51.0	-25.5	-55.5	+24.6	-18.2	+5.8	-50.0
Dholi x M-395	-15.9	+54.4	-40.5	-20.3	-43.0	+20.8	+11.3	+5.8	+8.1
M-395xDholi	-19.9	+55.4	-41.2	-39.2	-60.8	+21.4	+0.4	+4.8	+25.7
DholixM-18	-56.6	+76.1	-73.7	-60.8	-71.3	+39.5	-8.5	+2.8	-60.2
M-18xDholi	-33.3	+58.9	-66.7	-41.8	-64.1	+27.0	-9.9	+2.9	-69.2
DholixM-27	-44.4	+49.1	-43.3	-21.8	-50.4	+22.7	-4.5	+2.9	-43.5
M-27xDholi	-60.6	+45.6	-52.0	-38.1	-48.5	+20.2	-8.1	+3.8	-31.3
M-91xM-395	-42.7	+59.4	-55.0	-40.6	-40.8	+16.4	-13.3	+4.9	-28.2
M-395xM-91	-30.0	+56.1	-45.6	-40.3	-46.0	+21.5	-14.5	+0.9	+4.5
M-91xM-18	-3.2	+47.5	-57.2	-49.3	-57.4	+46.8	-3.7	+2.8	-34.0
M-18xM-91	-76.5	+64.6	-70.0	-47.8	-62.9	+49.1	-18.1	+4.2	-41.9
M-91xM-27	-3.6	+35.5	-46.0	-26.9	-38.6	+25.0	+9.3	+5.9	-40.8
M-27xM-91	-57.1	+108.7	-46.0	-17.2	-53.4	+23.5	-0.6	+2.8	-79.2

Table 3: Percent heterosis for different characters of the *B. campestris* hybrids grown under saline condition

Hybrids	Germination %		Days to germination		Plant height at 25 days (cm)		Plant height at 35 days (cm)		Plant height at 45 days (cm)	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
Sampad x M-395	+42.1***	+34.9**	-8.80*	-6.38	+47.09***	+46.15***	+22.51***	+20.91**	+22.63***	+20.99**
M-395 x Sampad	+10.5	+4.9	+0.52	+3.19	-9.67*	-10.25*	+143.04***	+139.86***	+1.74	+0.38
Sampad x M-18	-49.9***	-55.5***	+6.20	+19.15***	-15.60**	-26.92***	-17.28**	-20.26**	+3.58	-14.90*
M-18 x Sampad	+12.5	0.0	-10.90**	0.00	+27.40***	+10.25*	+18.64**	+14.37*	+28.87***	+5.88
Sampad x M-27	-61.2***	-61.2***	+1.50	+8.51	-18.95***	-20.51***	-2.49	-10.45	+6.12	-8.23
M-27 x Sampad	+5.5	+5.5	-2.50	+4.25	+21.57***	+19.23***	+12.45*	+3.06	+7.48	-7.06
Dholi x M-395	+10.5	+4.9	-10.66**	-10.20*	+33.33***	+20.87***	+32.43***	+31.54***	+26.65***	+25.47***
M-395 x Dholi	+5.2	0.0	+2.54	+3.06	+12.00***	+9.09*	-14.18*	-14.56*	+20.98***	-21.72**
Dholi x M-18	-37.5**	-44.5***	+9.80**	+20.40***	-30.77***	-38.35***	-21.79***	-23.13**	-11.83	-28.83***
M-18 x Dholi	-12.5	-22.2	+7.90*	+18.36***	-18.50***	-27.40***	-13.49*	-14.96*	-12.29	-29.21
Dholi x M-27	-16.7	-16.7	-14.15***	-10.20*	+25.67***	+24.00***	+33.09***	+24.48**	+30.24***	+10.48
M-27 x Dholi	-38.8***	-38.8**	-3.41	+1.02	+12.20**	+10.67*	+22.90***	+14.96*	+38.18***	+17.22*
M-91 x M-395	-27.3**	-33.4***	+2.00	+3.03	-5.88	-6.49	+0.69	-2.68	+11.11	+6.87
M-395 x M-91	-4.5	-12.5	-11.00**	-10.10*	+29.41***	+28.57***	+22.22***	+18.12**	+29.76***	+24.80***
M-91 x M-18	+42.2***	+12.5***	-17.43***	-10.89**	+24.81***	+9.21*	+10.32	+9.15	+39.40***	+16.94*
M-18 x M-91	-79.0***	-83.4***	-1.83	+5.94	-15.78***	-26.31***	+9.60	+8.45	+21.67**	+2.07
M-91 x M-27	-23.8*	-33.4***	-19.28***	-16.83***	+52.33***	+51.31***	+56.35***	+50.35***	+64.01***	+45.04***
M-27 x M-91	-42.8***	-50.0***	+14.42	+17.82	+17.88***	+17.10***	+43.82***	+38.13***	+22.43**	+8.26

Table 3: Continued

Hybrids	Days to flowering		Plant height at harvest (cm)		Days to maturity		Seed yield/plant (g)	
	MP	BP	MP	BP	MP	BP	MP	BP
SampadxM-395	-5.70*	-0.57	-2.12	-2.53	-0.91	+0.39	-26.60**	-28.14***
M-395xSampad	+5.52*	+11.25***	-8.36*	-8.75*	+1.30	+2.64	-24.77*	-26.35*
SampadxM-18	+1.38	+4.96	+18.92***	+7.98*	0.00	+0.97	-48.60***	-50.29***
M-18xSampad	+1.19	+4.77	+14.93***	+4.36	-0.96	0.00	-47.36***	-49.10***
SampadxM-27	-2.33	-0.19	-12.85***	-21.38***	+1.94	+3.96	-6.62	-11.37
M-27xSampad	+1.21	+3.43	+8.25*	-2.34	+4.85	+6.93**	+9.15	-3.59
DholixM-395	-2.58	+1.11	+3.86	-4.27	+5.21*	+5.57*	+25.47**	+0.76
M-395xDholi	-2.94	+0.74	-9.75***	-16.81***	+5.21*	+5.57*	+3.77	-16.67*
DholixM-18	+5.90*	+7.96**	+3.01	-13.34***	+4.85	+4.85	-20.47*	-36.74***
M-18xDholi	+5.72*	+7.77**	+9.52**	-7.83**	+0.97	+0.97	-33.33***	-46.96***
DholixM-27	-1.56	-0.92	+4.78	-12.36***	+2.94	+3.96	+15.94*	-9.09
M-27xDholi	-3.77	-3.15	+1.91	-14.76***	+4.90	+5.94*	+11.11	-12.88
M-91xM-395	+3.97	+6.90*	+6.65	+2.32	+2.41	+3.62	+67.74***	+62.50***
M-395xM-91	-0.97	+1.82	+19.07***	+14.24***	+1.45	+2.64	+93.55***	+87.50***
M-91xM-18	+4.95*	+6.00*	+34.43***	+26.40***	+3.99	+2.85	+6.54	+4.48
M-18xM-91	+17.01***	+18.18***	+26.12***	+18.59***	+3.32	+4.17	-0.65	-2.56
M-91xM-27	-1.73	-1.46	+37.67***	+28.58**	+4.03	+5.94*	-1.33	-1.33
M-27xM-91	+4.28	+4.57	+39.02***	+29.85***	+4.03	+5.94*	-63.33***	-63.33***

*, ** and *** indicate significant at 5, 1 and 0.1% level, respectively

Table 4: Scoring the hybrids of *B. campestris* for different characters under saline condition

Hybrids	Germination percentage	Days to germination	Plant height at 25 days	Plant height at 35 days	Plant height at 45 days	Days of flowering	No. of desirable scores	Average score	Rank position
SampadxM-395	1	7	2	7	8	1	6	4.33	1
M-395xSampad	18	18	18	1	18	18	1	15.17	
SampadxM-18	18	18	18	18	18	18	0	18.00	
M-18xSampad	18	5	5	9	6	18	4	10.17	5
SampadxM-27	18	18	18	18	18	18	0	18.00	
M-27xSampad	18	18	8	10	18	18	2	15.00	
DholixM-395	18	6	3	5	7	18	4	9.50	4
M-395xDholi	18	18	11	18	18	18	1	16.83	
DholixM-18	18	18	18	18	18	18	0	18.00	
M-18xDholi	18	18	18	18	18	18	0	18.00	
DholixM-27	18	3	6	4	4	18	4	8.83	3
M-27xDholi	18	18	10	6	3	18	3	12.17	7
M-91xM-395	18	18	18	18	18	18	0	18.00	
M-395xM-91	18	4	4	8	5	18	4	9.50	4
M-91xM-18	18	2	7	18	2	18	3	10.83	6
M-18xM-91	18	18	18	18	10	18	1	16.67	
M-91xM-27	18	1	1	2	1	18	4	6.83	2
M-27xM-91	18	18	9	3	9	18	3	12.50	8
No. of desirable scores	1	7	11	10	10	1			

in the subsequent generations may produce some desirable segregants against salinity.

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