

Combining Ability for Vigour Characters under Normal and Saline Environments in Ethiopian Mustard

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Abstract Combining ability analysis of 6 x 6 diallel of Ethiopian mustard (*Brassica carinata* A. Braun) for germination per cent, speed of germination and seedling vigour under normal and two saline environments (125 and 175 meq l⁻¹) revealed that both additive and non-additive type of gene effects were involved in the inheritance of these characters. The predictability ratio indicated greater importance of non-additive type of gene actions, whereas additive genetic effect was important for per cent germination under 125 m l⁻¹ salinity level. BC₂ and HC₇ were the best general combiners. The crosses BC₂ x C6YS7B and HC 15 x HC 2 were the best combinations for all the three characters over the environments.

Key words Ethiopian mustard, combining ability, salinity, seedling vigour, germination

Rapeseed and mustard are generally grown in dryland conditions which are manifested with soil salinity and alkalinity problem. More than 7 million hectares land of the country has gone out of cultivation due to salinity and alkalinity problems (Abrol & Bhumbra 1971). To combat the problem of salinity, breeding for salt tolerance may provide a cost effective short term solution. *Brassica carinata* A. Braun has been reported to perform better than other *Brassica* species under late sown, rainfed and saline conditions (Malik 1990). Study on combining ability in this species was, therefore, undertaken to get information on proper choice of parents for hybridization and to formulate a systematic breeding programme to produce potential crosses.

Material and Methods

A half diallel set (excluding reciprocals) was developed by crossing six parents, three tolerant (BC 2, HC 7, HC 15) and three susceptible to salinity (HC 2, C6YS7B and CAR 5). The F₁s and parents were grown in replicated design in petriplates of 9" diameter having salt solution of 0 (E₁), 125 meq l⁻¹ (E₂) and 175 (meq l⁻¹) (E₃) chloride dominated salts.

The data on per cent germination were recorded as per procedure for testing seeds (ISTA 1985). The normal seedlings were counted daily

and the speed of germination was calculated as per method of Maguire (1962). Root and shoot length of five randomly selected seedlings were measured after eight days of placing seeds for germination, the same were dried at 80°C for 24 hours and weighed. The seedling vigour was calculated : Seedling vigour = (Root length + Shoot length) x Seedling dry weight.

The combining ability was analysed following Griffing's (1956) Method 2, Model 1.

Results and Discussion

The mean squares due to general combining ability analysis (gca) were significant for all three characters in all the three environments. Mean squares due to specific combining ability (sca) were significant for all the characters in all the environments except for per cent germination in E₂ (Table 1). This showed that both additive and non-additive gene effects were responsible for these characters.

In present model an idea about the relative importance of gca and sca in determining the progeny performance was obtained by calculating general predictability ratio on the basis of gca and sca equivalent components of mean squares. Closer the ratio to unity, greater the predictability based on gca alone. The estimates of this ratio in this study were far from the unity in all the

Table 1 General and specific combining ability analysis for seedling vigour characters in Ethiopian mustard

Source of variation	d.f.	Mean squares								
		Germination per cent			Speed of germination			Seedling vigour		
		E ₁	E ₂	E ₃	E ₁	E ₂	E ₃	E ₁	E ₂	E ₃
General combining ability	5	60.131*	147.731*	211.261*	0.018*	0.036*	0.036*	266.668*	400.830*	312.381*
Specific combining ability	15	20.791*	30.947	89.173*	0.037*	0.016	0.030*	461.787*	735.493*	524.201*
Error	40	13.212	19.625	21.375	0.0005	0.0003	0.0004	3.931	4.014	2.491
Predictability ratio		0.607	0.739	0.412	0.107	0.362	0.231	0.231	0.119	0.129

* Significant at $P = 0.05$ E₁, E₂ & E₃ = 0, 125 ml⁻¹ and 175 ml⁻¹ salinity levels

environments except for germination per cent in E₂ (125 m l⁻¹ salinity) indicating that for these characters the performance of crosses can be predicted mainly on the basis of sca components. There was preponderance of non-additive genetic components controlling these traits. Similar results were reported by Kumar & Yadav (1985) in *Brassica campestris* for seed yield and other yield components on alkaline soils.

None of the parents was a good general combiner for germination per cent in all the environments (Table 2). However, BC 2 in both saline environments, HC 7 in E₂ and HC 15 in E₃ were the good general combiners for this trait. The parent BC 2 for speed of germination and HC 15 for seedling vigour were consistently good general combiners in all the environments. Other good general combiners were HC 7 and

HC 15 in both saline environments for speed of germination and HC 7 (E₁ and E₂), BC 2 (E₂), C6YS7B (E₁) for seedling vigour.

None of the crosses exhibited consistent behaviour over the environments with respect to sca effects for per cent germination. Two crosses viz; BC 2 x C6YS7B and HC 15 x HC 2 showed significant positive sca effects in both the stress environments. For speed of germination, seven crosses behaved consistently over the environments with respect to positive and negative significant sca effects. Out of these, six crosses namely; BC 2 x C6YS7B, BC 2 x CAR 5, HC 7 x C6YS7B, HC 15 x HC 2, HC 15 x C6YS7B and C6YS7B x CAR 5 exhibited significant positive sca effects. Eight cross combinations, viz, BC 2 x C6YS7B, HC 7 x HC 15, HC 7 x HC 2, HC 7 x C6YS7B, HC 15 x HC 2, HC 15 x C6YS7B, HC 15 x

Table 2 Estimates of general combining ability effects for germination per cent and seedling characters under three environments, in Ethiopian mustard

Parents	Germination per cent			Speed of germination			Seedling vigour		
	E ₁	E ₂	E ₃	E ₁	E ₂	E ₃	E ₁	E ₂	E ₃
BC 2	2.387	3.197*	5.370*	0.715*	0.091*	0.081*	-0.910	4.279*	0.858
HC 7	3.156	4.734*	1.281	-0.053*	0.013*	0.020*	2.681*	8.619*	9.048*
HC 15	0.851	0.892	5.800*	0.020	0.040*	0.073*	3.649*	4.323*	5.533*
BC 2	-2.899	-2.520	-1.609	-0.045*	-0.102*	-0.052*	-10.723*	-9.437*	-4.743*
C6YS7B	-3.576*	-7.195*	-7.234*	0.035*	-0.041*	-0.067*	5.501*	-0.740	-4.273*
CAR 5	0.082	0.895	-3.608	-0.012	-0.001	-0.054*	-0.202*	-7.045*	-6.423*
S.E. (gi)	1.730	1.430	1.492	0.007	0.006	0.006	0.634	0.647	0.509
S.E. (gi-gj)	1.871	2.215	2.311	0.011	0.009	0.010	0.991	1.002	0.789

* Significant at $P = 0.05$

CAR 5 and C6YS7B x CAR 5 were consistent for significant positive sca effects over the environments. Thus these crosses were desirable for vigorous seedlings.

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