Heterosis And Combining Ability For Seed Yield, It's Components And Some Physiological Characters In Rapeseed (*Brassica napus* L.)

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Background

In Iran, cultivation of spring rapeseed varieties has recently extended in warm dry-lands in rotation with wheat to boost the edible oil production (Pourdad 2007). Heterosis is the superior performance of F1 hybrids relative to the mid-parent value (MPV) or to the better parent. Many studies have estimated the extent of heterosis for seed yield. The results indicated significant level of heterosis i.e. 13 to 91 percent in *B. juncea* (Kumar et al.1990; Verma et al. 1998; Pathak et al. 2002) 25 to 110 percent in *B. campestris* (Dhillon et al.1996; Varshney and Rao 1997; Yadav et al. 1998) and 10 to 72 percent in *B. napus* (Rai1995; Tsaftaris 1995). Brandle and McVetty (1989) reported high-parent heterosis reaching 120% for seed yield in *B. napus.* Identification of combinations with strong yield heterosis is the most important step in developing crop hybrids. Generally, parents with a higher general combining ability and long genetic distance can produce a hybrid with better yield performance (Cox & Murphy, 1990; Boppenmaier *et al.,* 1993; Diers *et al.,* 1996).

Objective

The aims of the present study were: i) identification of the levels of heterosis for seed yield, its components and few physiological traits; ii) identify the best combiners and their crosses on the basis of their general and specific combinig ability for seed yield.

Methods

The rapeseed genotypes used in this study were nine advanced genotypes were selected from rapeseed (*Brassica napus* L.)breeding program in Dry-land Agricultural Research Institute of Iran (DARI) which included Parade, Kristina, Option500, Modena, Ceres, Heraled, Kvintell, Licord and Pastill were crossed in a half diallel fashion in 2004-05. F_1 seed of all the crosses and parents were planted in a randomized complete block design with three replications during 2005-06. Each plot included two rows with 2 m long and 30 cm row spacing. Fertilizer application was 50 kg N ha-1 and 50 kg P2O5 ha-1.The data were recorded for number of pods plant^{-1}, number of seeds pod^{-1}, 1000-seed weight, seed yield plot^{-1}, Relative water loss (RWL), Cellular membrane stability (CMS) and Leaf Chlorophyl content. The data were subjected to analysis of variance according to Steel and Torrie (1984). GCA and SCA effects were computed using Griffing (1956) method and heterosis calculated according Feher (1987).

Results

The Results of analysis of variance (Table 1) showed that genotypic mean squares values indicated significant differences (P <0.01) among parental lines and their hybrids for all the traits studied except relative water loss (RWL) at 0.05 level. The genetic variation attributable to GCA were significant for all traits except relative water loss (RWL) and Leaf Chlorophyll content and SCA were highly significant for all the traits under studied except RWL (Table 2). The GCA to SCA variance ratio exhibited that all the traits were pre-dominantly controlled by non-additive type of gene action except seed yield and Cellular membrane stability (CMS). Therefore, selection might be fruitful for the improvement of the seed yield and CMS. Licord was good general combiner for seed yield plot^{-1}, 1000-seed weight, leaf chlorophyll content and CMS but it proved poor general combiner for number of pods plant^{-1} and RWL (Table has not been shown). The cross "Pastill×Ceres" gave the best positive SCA effect with the highest mean values for seed yield plot^{-1}.

The magnitude of heterosis was variable for the different traits and cross combinations (Table 3). The largest heterosis was observed for seed yield. The range of F_1s mid-parent heterosis (MPH) and high-parent heterosis (HPH) for seed yield were from -2.24 to 107.7 and from -8.89 to 76.06, respectively. Number of seeds pod^{-1}, RWL and leaf chlorophyl content had low MPH with a maximum of 7.88, 18.42 and 15.38%, respectively. These traits also had low HPH with a maximum of 5.24, 15.38 and 14.96%, respectively.

The results of this study showed that there was high variation among hybrids for different traits. In case of seed yield wide range of heterosis observed so that, heterosis breeding can be an effective method to improve seed yield in present rapeseed genotypes.

Table1. Analysis of variance, mean, minimum and maximum of rapeseed genotypes traits

		Mean of squares						
SOV	**df**	**Cellular membrane stability**	**Leaf Chlorophyll content**	**Relative water loss**	**Pods per plant**	**Seeds per pod**	**1000 seeds weight (g)**	**Seed yield per plot (g)**
Replication	2	0.017^{ns}	2.33^{ns}	0.057^{ns}	13214.11**	69.683**	0.878**	613751.26**
Genotype	44	0.036**	25.36**	0.021*	745.27**	6.534**	0.109**	46816.72**
Error	88	0.011	13.577	0.019	135.88	2.203	0.058	6646.820
mean		16.58	40.45	27.92	126.9	25.1	3.44	793.53
minimum		38.93	27.46	2.85	77	19.4	2.9	296
maximum		2	50.9	73.03	189.25	32.2	5.4	1217

Table2. Combining ability analysis (mean squares) for some characters of rapeseed genotypes

SOV	**df**	**Pods per plant**	**Seeds per pod**	**1000 seeds weight (g)**	**Seed yield per plot (g)**	**Relative water loss**	**Leaf Chlorophyll content**	**Cellular membrane stability**
GCA	8	1032.66**	6.535*	0.158**	44270.79**	104.51^{ns}	13.05^{ns}	0.061**
SCA	36	755.26**	4.818**	0.101*	15017.03**	148.38^{ns}	32.21**	0.028**
Error	88	138.09	2.205	0.06	7229.63	115.29^{ns}	12.58	0.012
MSGCA/MSSCA		1.3^{ns}	1.35^{ns}	1.56ns	2.84**	-	-	2.19*

Table 3. Estimation of mid-parent heterosis(MPH) and high-parent heterosis(HPH) in rapeseed hybrids for four traits.

F1s	Seeds per pod		Seed yield		Leaf Chlorophyll content		Relative water loss	
	HPH%	MPH%	HPH%	MPH%	HPH%	MPH%	HPH%	MPH%
1× 2	-6.83**	-5.03**	6.5**	14**	-12.97**	-11.56**	-11.36**	-9.3**
1×3	-14.39*	12.74**	4.6**	9.3*	-1816**	-15.7**	-11.36**	-3.7**
1× 4	-3.68**	-1.81**	-2.4	12**	-7.45**	-4.58**	-11.36**	-6.02**
1×5	-10.27**	-8.76**	4.6**	13.5**	-6.42**	-7.75**	2.27	5.88**
1×6	-8.75**	-2.17**	5.8**	32.8**	11.12**	5.46**	-6.82**	-4.65**
1× 7	-19.95**	-16.41**	8.7**	16.4**	3.88**	0.66	-6.82**	-6.49**
1× 8	-11.66**	-11.49**	14.4**	14.5**	7.24**	2.17**	-9.09**	-5.88**
1 × 9	-1.65	3.67**	10.2**	56.1**	3.48**	1.97**	-4.55**	-2.33**
2 × 3	-0.98	-0.98*	7.5**	10.2**	-20.98**	-19.89**	-4.76**	1.27**
2 × 4	-9.51**	-6.02**	28**	18**	-1.89**	2.74**	-7.14**	-3.7**
2 × 5	-1.52**	2.02*	19.4**	21.1**	-13.48**	-10.85**	-7.14**	-6.02**
2× 6	-11**	-2.88**	43.8**	70.9**	-11.36**	-5.4**	-2.38**	-2.38**
2× 7	-5.37**	-7.73**	27.2**	27.1**	-4.28**	0.24	-11.9**	-1.33**
2 × 8	-8.35**	-1.62**	12.6**	20.6**	-14.86**	-9.46**	7.14**	8.43**
2 × 9	-5.12**	1.83**	16.9**	58.6**	-8.26**	-5.43**	-7.14**	-7.14**
3 × 4	-12.93**	-9.56**	18.1**	30.3**	-9.63**	-4.12**	15.38**	18.42**
3 × 5	-8.05**	-4.74**	13.3**	36.6**	-2.48**	1.83**	-4.88**	0
3 × 6	-11.22**	-3.13**	25.4**	52.2**	-10.54**	-3.3**	-7.14**	-1.27**
3 × 7	12.76**	-10.58**	29.9**	33.2**	-3.21**	2.69**	5.41**	11.43**
3× 8	1.22**	3.36**	4.8**	9.6**	-8.94**	-1.91**	-2.44**	2.56**
3 × 9	-11.69**	-5.21**	26.6**	74.6**	-21.56**	-18.06**	-7.14**	-1.27**
4× 5	5.24*	5.52**	7.1**	13.9**	-11.06**	-9.55**	-4.88**	-2.5**
4 ×6	2.48	7.88	6.5**	18.4**	0.66	2.68**	-7.14**	-3.7**
4 × 7	-9.51**	-3.76*	5.8**	14**	-5.04*	6.45**	-7.69**	0
4 × 8	-5.26**	-3.6**	-4.7	9.5**	-5.04**	-3.49**	-14.63**	12.5**
4 × 9	-5.4**	-2.11**	16.5**	49.9**	0.32	1.96**	-4.76**	-1.23**
5× 6	-14.09**	-9.34**	1.3	18.9**	-0.38	3.3**	-7.14**	-6.02**
5 × 7	-13.63**	-8.37**	14.2	15.8**	0.46	2.15**	-2.44**	8.11**
5× 8	-14.89**	-13.62**	-1.9**	6.5	0.35	3.68**	-7.32**	-7.32**
5× 9	1.05	4.83**	26.8**	70.4**	2.81**	2.76**	-11.9**	-10.84**
6 × 7	-16.8**	-7.16**	27.1**	51**	-11.71**	-9.94**	-2.38**	9.33**
6 × 8	-2.8**	4.02**	-6	18.1**	14.96**	15.39**	-14.29**	-13.25**
6 × 9	3.11**	4.96**	76**	107.8**	-27.57**	-24.94**	-11.9**	-11.9**
7 × 8	12.53**	-8.5**	-8.9	-2.3	1.72	3.38**	-4.88**	5.41**
7 ×9	12.06**	-3.33**	34.1**	82**	1.96	3.62**	-16.66**	-6.67**
8× 9	-4.2**	0.8	8.4**	53.6**	-0.27	3**	0	1.2**

* and ** indicate significant at the 0.05 and 0.01 probability levels, respectively.

1= Parade, 2=Kristina, 3=Option500, 4=Modena, 5=Ceres, 6=Heraled, 7=Kvintell, 8=Licord and 9=Pastill