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Full Length Article

Combining Ability Studies in Rapeseed (*Brassica napus*)

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ABSTRACT

A 5 x 5 diallel cross of (*Brassica napus*) was evaluated using combining ability analysis. Data were recorded from F_1 generation for plant height, primary branches plant^{-1}, silique length, siliques plant^{-1}, seeds silique^{-1}, 1000-seed-weight and seed yield plant^{-1}. Mean Squares for all the traits except for 1000-seed weight were found highly significant for all the characters. RBN 96040 proved good general combiner for all the traits studied. KS-75 proved good general combiner for all the traits except plant height and primary branches plant^{-1}. The cross "RBN 96040/RBN 96038" was the best specific combiner for all the traits studied followed by "RBN 96038//DGL/SHIRALEE" which proved good specific combiner for most of the traits including seed yield plant^{-1}.

Key Words: Combining ability analysis; Seed yield improvement; *Brassica napus* L.

INTRODUCTION

Rapeseed (*Brassica napus* L.) is very popular among the farmers due to better canola quality of oil. Out crossing in *B. napus*, occurs up to 16%. Genetic mechanism for commercial hybrids seed production may be an effective method of increasing production. Alloplasmic *B. juncea* and *B. napus* have been obtained based on *B. oxyrrhina*, *Trachystoma balli*, *Moricondia arvensis*, *Diplotaxis siifolia* and *Sinapis alba* cytoplasm. Male sterility was found stable and coupled with high seed fertility (Prakash & Chopra, 1988; Rao & Shivanna, 1996; Prakash & Kirti, 1997). However, lack of stable fertility restoration mechanism has hampered the exploitation of these CMS systems for producing commercial hybrid seed. Critical studies on gene action on yield and yield components in *Brassica* are very few. Likewise, the variances of general and specific combining ability are related to the type of gene action involved. Variance for GCA includes additive portion, while that of SCA includes non-additive portion of total variance arising largely from dominance and epistatic deviations (Malik *et al.*, 2004).

Studies on combining ability have been done earlier (Amrithadevarathinam *et al*., 1976; Sachan & Singh, 1988; Wani & Srivastava, 1989; Diwakar & Singh, 1993; Thakur & Sagwal, 1993; Bhateria *et al.*, 1995; Kumar *et al*., 1997; Singh *et al.*, 2002). Most of the studies showed significant GCA and SCA effects for yield and its component characters indicating that both additive and non-additive gene action were important in the inheritance of these traits. Earlier breeders concluded in their research that with the changes in environment gene effects for different traits contributing to yield or yield itself changes in *B. napus* L. So for different environment one has to suggest different selection criteria for the improvement in the yield. For those traits that are controlled by additive gene action, simple selection in early segregating generation is suggested, whereas for those traits controlled by non-additive gene action selection in later segregating generation would be more effective (Cheema & Sadaqat, 2004).

MATERIALS AND METHODS

Five genotypes of (*Brassica napus* L.) viz. KS-75, RBN 96040, RBN 96038, "DGL/SHIRALEE" and "RAINBOW/DGL//SHIRALEE" were crossed in a complete diallel fashion. F_0 seed of all the crosses excluding reciprocals was planted in a quadruplicate randomized complete block design during 2002 - 03. A single 4 m long row was taken as an experimental treatment. The seed were dibbled by keeping plant-to-plant and row-to-row distances of 15 cm and 45 cm, receptively. Two seeds hole^{-1} were sown, later thinned to single seedling site^{-1}. Fertilizer was applied at sowing time at the rate of 75 kg DAP and 50 kg urea acre^{-1}. All other agronomic practices were kept similar. Ten guarded plants from each row were taken at random. The data were recorded for plant height, number of primary branches plant^{-1}, silique length, number of siliques plant^{-1}, number of seeds silique^{-1}, 1000-seed weight and seed yield plant^{-1}. The data were subjected to analysis of variance according to Steel and Torrie (1984). GCA and SCA effects were computed (Griffing, 1956) using method-2 model-1.

RESULTS AND DISCUSSION

Present investigations were planned to find out good combining parents for various traits in five genotypes and to select the outstanding hybrids with respect to their good specific combining effects for further yield improvement. Analysis of variance (genotypic mean squares) revealed the presence of significant variability among all the genotypes studied for all the traits except 1000 seeds weight. The genetic variation attributable to GCA and SCA were highly significant for all the traits studied (Sheoran *et al.*, 2000; Singh *et al.,* 2002; Tuncturk & Ciftci, 2007) except 1000-

Table I. Mean squares due to genotypes, general combining ability and specific combining ability in rapeseed

SOV	df	Plant Height	Primary branches plant^{-1}	Silique length	Siliques plant^{-1}	Seeds silique^{-1}	1000-seed weight	Seed yield plant^{-1}
		(a) Mean square due to						
Genotypes	24	808.06**	6.24**	1.28**	11571.36**	23.25**	0.26^{NS}	25.05**
Error	72	64.14	0.3952	0.1878	215.706	2.0434	0.2238	0.2604
GCA	4	378.2076**	1.4225**	0.1191^{NS}	2723.983 **	3.6158**	0.0338^{NS}	10.1035**
SCA	10	131.5375**	1.6136**	0.4007**	2960.39**	6.6796**	0.0762^{NS}	4.7251**
Error	42	16.0349	0.09881	0.0470	53.9264	0.5109	0.0551	0.0651
		(b) Genetic components of variance due to						
GCA	-	51.7390	0.1891	0.0103	381.4366	0.4436	-0.00304	1.4340
SCA	-	115.5026	1.5148	0.3537	2906.458	6.1687	0.0211	4.6600
GCA/SCA variance ratio	-	0.4480	0.1248	0.0292	0.1312	0.0719	-0.1439	0.3077

**=P<0.01, and NS=Non significant

Table II. Estimates of general combining ability effects and mean values of the parents (in parenthesis) in rapeseed

Parent	Plant Height	Primary branches plant^{-1}	Silique length	Siliques plant^{-1}	Seeds silique^{-1}	1000-seed weight	Seed yield plant^{-1}
KS75	-4.2724	-0.1714	0.1229	13.0879	0.7757	-0.0161	1.6325
	(158.10)	(5.25)	(7.38)	(108.20)	(22.60)	(3.36)	(7.16)
RBN96040	7.0387	0.5757	0.1121	27.5629	0.4186	0.0421	0.6258
	(184.90)	(8.40)	(6.73)	(215.70)	(20.05)	(3.28)	(6.47)
RBN96038	0.6888	-0.0449	-0.0031	-1.8241	-0.0842	-0.0045	-0.0501
	(178.35)	(4.85)	(7.18)	(109.75)	(17.35)	(2.83)	(3.01)
"DGL/SHIRALEEE"	-10.0363	0. 3150	-0.0057	-6.6372	-0.6850	-0.0776	-1.5589
	(145.75)	(6.95)	(6.35)	(139.85)	(16.90)	(2.77)	(2.72)
"RAINBOW//DGL/ SHIRALEE"	0.3816	-0.4243	-0.1986	-15.7729	0.3329	0.0964	-0.1974
	(170.75)	(6.75)	(6.73)	(165.90)	(20.50)	(3.59)	(6.00)
S.E. (Gi)	1.3537	0.1063	0.0733	2.4825	0.2416	0.0794	0.0863

Bold values show the significance of the parents in breeder's view.

Table III. Estimates of specific combining ability effects (SCA) given in upper rows and mean values of crosses in lower row in a 5 × 5 diallel cross of rapeseed

Cross	Plant Height	Primary branches plant^{-1}	Silique length	Siliques plant^{-1}	Seeds plant^{-1}	1000 seed weight	Seed yield plant^{-1}
KS75/ RBN96040	0.8121	-0.9952	-0.0083	42.7810	1.4024	-0.4389	2.0457
	182.15	6.500	7.35	264.43	24.20	2.67	11.06
KS75/ RBN96038	16.285	1.8298	0.2595	96.5595	2.4631	0.2154	2.520
	197.47	8.30	7.48	272.40	24.00	3.23	10.41
KS75//"DGL/SHIRALEE"	*2.4371*	1.2155	-0.0655	24.1060	-1.5441	-0.0668	1.9104
	166.70	8.45	7.18	211.55	20.15	2.92	8.74
KS75/3/"RAINBOW// DGL/SHIRALEE"	4.3193	1.2548	-0.1976	34.4917	-1.2119	-0.0333	-0.7461
	179.00	7.75	6.85	212.80	21.50	3.20	7.45
RBN96040/RBN96038	10.5264	1.0619	-0.3298	17.9595	*0.4952*	*0.1196*	1.6932
	203.03	8.13	6.88	208.28	*21.68*	*3.30*	8.76
RBN96040/3/"RAINBOW//DGL/SHIRALEE"	*3.0011*	*0.1976*	1.6452	16.7310	1.4881	0.2575	-2.1914
	178.58	*8.03*	8.88	218.65	22.83	3.05	3.63
RBN96040/3/"RAINBOW//DGL/SHIRALEE"	1.1582	-0.8188	-0.0619	-36.6333	1.3952	-0.1689	1.5396
	187.15	6.20	6.98	156.15	23.75	3.08	8.73
RBN96038// "DGL/SHIRALEE"	4.7764	0.4976	-0.2389	0.3345	2.7738	*0.1268*	1.7354
	180.2	7.30	6.85	156.45	22.85	*3.00*	6.43
RBN96038/3/"RAINBOW//DGL/SHIRALEE"	-3.5914	-1.0131	0.0810	-45.3298	-0.5941	-0.1346	-0.4586
	182.25	5.05	6.98	101.65	20.50	3.00	5.60
DGL/SHIRALEE/3/ "RAINBOW//DGL/SHIRALEE"	15.2832	-0.6774	*0.18095*	14.5667	3.9488	-0.0018	0.3843
	184.2	6.15	*7.10*	173.15	25.20	3.10	5.39
SE. S ij	1.748	0.137	0.095	3.205	0.319	0.102	0.114
SE Sii- Sjj	3.707	0.291	0.201	6.799	0.662	0.217	0.236

Bold values show the significance of the crosses in the breeder's view seed weight. The GCA to SCA variance ratio exhibited that all the traits were pre-dominantly controlled by non-additive type of gene action (Yadav, 1996). Therefore, selection might be fruitful for the improvement of the traits in late segregating generations in genotypes, which had highly significant genotypic mean squares. However, among the traits studies plant height and seed yield had comparatively better fixable variation due to higher GCA/SCA variance ratio but selection for 1000 seed weight would not bring about significant improvement due to non-significant variation existed in genotypic mean square (Table I). The GCA/SCA variance ratio for all the traits depicted that these were controlled by non-additive type of gene action (Table I). As anticipated yield components usually showed a preponderance of GCA variances compared to SCA variances (Labana *et al*., 1978; Dhillon *et al*., 1990). Diallel mating design has been extensively used to analyze the combining ability effects of *B. napus* L. genotypes and also to provide information regarding genetic mechanisms controlling seed yield and other traits Such concerted breeding efforts need critical evaluation of parents looking for their good combining ability to get synthetics development (Sood *et al*., 2000). KS-75 was a good general combiner for silique length, siliques plant^{-1}, seeds silique^{-1} and seed yield plant^{-1} and performed better for these traits but it proved poor general combiner for plant height and primary branches plant^{-1} with poor performance Therefore, it may be utilized for reducing height with better yield as taller plants so that the crop may not lodge in wind storm. RBN 96040 was found good general combiner for all the traits studied except 1000-grain weight along with their better mean performances. RAINBOW//DGL/SHIRALEE" proved good general combiner for plant height and seeds plant^{-1}. Similarly RBN 96038 was found good general combiner for plant height and "DGL/SHIRALEEE" for primary branches plant^{-1} only. RBN 96040 and RAINBOW//DGL/SHIRALEE" were found similar in their performance but different in their combining ability. In this case preference would be given to RBN 96040 for utilization in crossing program due to better combing ability effects. Keeping in view combining ability along with overall performance of the genotypes, Ks-75 and RBN 96040 were declared best general combiners (Table II) for utilization in breeding program.

Specific combining ability affects are explained in Table III. The cross "KS75/RBN 96040" gave positive SCA effect with higher mean values for Siliques plant^{-1}, seeds silique^{-1} and seed yield plant^{-1} and it involved two good general combining parents. The cross "KS75/RBN 96038" showed better SCA effects with better mean values for all the traits studied. It involved one good general combining parent "KS-75". The cross "KS75//DGL/SHIRALEE" proved good specific combiner for plant height, primary branches plant^{-1}, siliques plant^{-1} and seed yield plant^{-1}, while "KS75/3/RAINBOW//DGL/SHIRALEE" was found good specific combiner for plant height, primary branches plant^{-1} and siliques plant^{-1}. "RBN 96040/RBN 96038" was found good specific combiner for plant height, branches plant^{-1}, siliques plant^{-1} seeds silique^{-1} and seed yield plant^{-1}. "RBN 96040/3/RAINBOW//DGL/SHIRALEE" found good specific combiners for all the traits except for seed yield plant^{-1}. "RBN 96040/3/RAINBOW//DGL/SHIRALEE" exhibited good specific combining ability for seeds silique^{-1} and seed yield plant^{-1}. Similarly "RBN 96038//DGL/SHIRALEE" showed good specific combining ability for plant height, primary branches plant^{-1}, seeds plant^{-1} and seed yield plant^{-1}. While the cross "RBN 96038/3/RAINBOW//DGL/SHIRALEE" was proved good general combiner for none of the trait. The cross "DGL/SHIRALEE/3/RAINBOW//DGL/SHIRALEE" depicted good specific combining ability for plant height, silique length, siliques plant^{-1} and seed yield plant^{-1}. KS75/RBN 96040" had both good general combining parents with better mean performance. So it was expected to exhibit best performance for seed yield. Other crosses having one good combining parent were "KS75/RBN 96038", KS75//"DGL/SHIRALEE", "KS75/3/RAINBOW// DGL/SHIRALEE", "RBN 96040/RBN 96038", RBN 96040/3/"RAINBOW//DGL/SHIRALEE" and "RBN 96040 /3/"RAINBOW//DGL/SHIRALEE" may also be good specific combiner and used for commercial hybrids using cms lines as it proved good specific combiner. Other crosses did not involve good combining parent and had no worth regarding to yield improvement in segregating generations. Therefore such crosses had least interest for the breeders.

CONCLUSION

The genotypes RBN 96040 followed by KS-75 proved good general combiner for seed yield improvement and the cross "RBN96040/RBN96038" was found the best specific combiner for all the traits studied.

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