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Short Communication

Combining ability analysis for seed yield and its components over environments in Indian colza (*Brassica rapa* L. var. yellow *sarson*)

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The knowledge of combining ability is useful to assess the nicking ability of parents in self-pollinated crops and at the same time elucidate the nature and magnitude of gene actions involved. Since combining ability variances for environments influence quantitative characters, the present study has been carried out over environments to obtain more precise estimates for seed yield and related characters in yellow *sarson* (*Brassica rapa* L.).

Twenty lines of yellow *sarson viz.* NDYS-38, NDYS-44, NDYS-9502, NDYS-9503, NDYS-9506, NDYS-9508, NDYS-9509, Binoy, MYSL-203-2, YSC-26, YSC-32, YSC-53, YSC-56, YSC-58, NRCY-5, NRCY-7, YST-151, MYSL-204, RAUDYS-81-9 and BIO-YS-1 were crossed with two testers NDYS-2 and SSK-92-13 during 1999-2000. Twenty-two parents along with 40 crosses (F_1s) were grown in Randomized Block Design with three replications by sowing on 25th October 2000 for first environment (E_1) at CRS Masodha and on 26th October 2000 for second environment (E_2) at GPB Research Farm Kumarganj under irrigated conditions and on 14th November 2000 at CRS Masodha under late sown conditions for third environment (E_3). The parents and F_1S were sown in single row of 3 m long, spaced at 30 cm apart. The distance of 10 cm between plants within rows was maintained by thinning of densely grown plants after 15-20 days of sowing. One non-experimental row was sown on both sides of each replication to avoid border effect. Recommended package of practices were followed to raise the good crop.

Data were recorded on five randomly selected competitive plants of each entry for primary branches/plant (PB), siliquae/plant (SP), seeds/siliqua (SS), 1000-seeds/weight (TW), biological yield/plant (BY), harvest index (HI), seed yield/plant (SY) and oil content (OC). Line × tester analysis was done environment-wise and also on pooled basis [1].

The analysis of variance for combining ability over environments revealed highly significant mean squares due to environments indicating sufficient diversity among test environments. The mean squares due to lines × testers, lines and testers for all the characters, except SS and TW due to latter were highly significant indicating the importance of both additive and non-additive gene effects. Significant and larger magnitude of females × environments than males × environments for all the characters except TW revealed that genetic differences among females were more susceptible to environmental fluctuations than that of males. The higher order interaction (females × males × environments) emerged significant for all the characters indicating thereby that expression of hybrids and that of *sca* was considerably influenced by environments.

The higher magnitude of σ^2s than σ^2g revealed greater significance of non-additive genetic variance for SP, BY, TW, SY, HI and OC in all the three environments as well as on pooled basis (Table 1). For PB and SS the relative importance of σ^2g was higher than σ^2s on pooled basis, which was not consistent in different environments. The estimates of degree of dominance and earlier reports also showed the greater significance of non-fixable effects for all the characters except PB and SS.

The parents, which showed significant *gca* effects in desirable direction, at least in two environments or in one environment as well as on pooled basis were considered as promising. Amongst parents, NDYS-38 and NRCY-5 exhibited high *gca* for SY in two environments as well as on pooled basis, while the parents NDYS-9503, NDYS-9506, NDYS-9508, Binoy, MYSL-203-2, NRCY-7, MYSL-204 and RAUDYS-81-9 showed high *gca* in one environment plus on pooled basis. Of these NDYS-9503, NDYS-9508 and NRCY-7 were also good combiners for OC and BY. The lines YSC-53 and YSC-56 showed high *gca* for oil content in all the environments as well as on pooled basis.

Table 1. Variance components and degree of dominance for metric traits in yellow *sarson*

Variance components	Environments	Characters							
		PB	SP	SS	TW	BY	SY	HI	OC
$\sigma^2 s$	E-I	0.29	76.31	–0.39	0.02	30.92	0.93	2.02	0.90
	E-2	0.70	39.22	2.87	0.15	16.04	0.69	0.62	1.48
	E-3	0.50	73.81	0.58	0.01	10.76	0.58	1.06	2.45
	Pooled	0.12	20.48	0.53	0.03	5.95	0.29	0.45	0.92
$\sigma^2 g$	E-I	0.96	57.40	2.14	0.01	7.51	0.21	0.40	0.27
	E-2	0.15	13.96	1.22	0.04	3.99	0.10	0.34	0.02
	E-3	0.01	35.01	2.18	0.01	1.83	0.04	0.10	0.12
	Pooled	0.19	4.94	1.55	–0.01	1.18	0.02	0.09	0.01
DOD	E-I	0.39	0.81	0.30	1.17	1.43	1.50	1.58	1.30
	E-2	1.53	1.19	1.08	1.45	1.41	1.82	0.96	6.13
	E-3	2.08	1.02	0.37	1.17	1.71	2.76	2.33	3.20
	Pooled	0.56	1.44	0.41	1.73	1.59	2.69	1.58	6.78

Overall the lines NDYS-9503, NDYS-9508, NRCY-7 and MYSL-204 were identified as most promising donors for SY together with OC and two or more key components such as seeds per siliqua, siliquae per plant and biological yield for their use in conventional breeding programme.

Besides, the lines NDYS-938, NDYS-9506, MYSL-203-2, NRCY-5 and RAUDYS-81-9 were also found desirable for use in breeding for high SY. The lines YSC-58 for PB, Binoy, YSC-56, YSC-58 and MYSL-204 for SP; NDYS-38, NDYS-44, NDYS-9503 and RAUDYS-81-9 for SS; NRCY-5 for BY; and YSC-53 and YSC-56 for OC displayed significant desirable *gca* in all the environments as well as on pooled basis indicating stability in *gca* status of these parents. Thus these parents could be considered most outstanding for component breeding.

The magnitude and direction of *sca* effects were not consistent over environments, suggesting the need for multi-environmental testing of material to evolve widely adapted variety. For SY, the cross NDYS-38 × NDYS-2 showed significant *sca* effects over all the environments as well as on pooled basis. The crosses NDYS-44 × SSK92-13 and BIO-YS-1 × NDYS-2 expressed consistency in *sca* effects in three cases (E_1, E_2, P) and crosses YSC-53 × NDYS-2, YSC-58 × SSK-92-13 and NDYS-9502 × NDYS-2 in two cases (E_1 or E_3, P). Of these crosses, NDYS-44 × SSK-92-13, NDYS-9502 × NDYS-2 and YSC-58 × NDYS-2 exhibited high *sca* effects for OC as well. Five of the six high *sca* crosses for SY, involved low × low *gca* parents which indicated the lack of additive gene effects for seed yield but were highly responsive to environments in heterozygous state due to non-additive effects [2]. Involvement of low × low *gca* parents in heterotic crosses was also reported earlier [3]. The cross NDYS-38 × NDYS-2 having high *sca* effects involved high × low general combiners for SY may be expected to throw transgressive segregates and merit exploitation in breeding programmes. As both additive and non-additive effects played significant role in the inheritance of different characters, their simultaneous exploitation through biparental mating [4] or diallel selective mating [5] is advocated.

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