Indian J. Genet., 52 (3): 275–279 (1992)

COMBINING ABILITY ANALYSIS FOR HARVEST INDEX, SEED YIELD AND IMPORTANT COMPONENT CHARACTERS IN OPIUM POPPY (*PAPAVER SOMNIFERUM* L.)

V. S. KANDALKAR, H. PATIDAR AND K. B. NIGAM

Kailash Nath Katju College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya Mandsaur 458001

(Received: October 25, 1991; accepted: December 10, 1991)

ABSTRACT

Genetics of harvest index, seed yield and other components was studied following 8 x 8 half diallel analysis in F_1 and F_2 generations of opium poppy. Combining ability analysis showed both additive and nonadditive type of gene action playing significant role in controlling the expression of all the characters studied. Number of capsules/plant, capsule weight, leaves/plant, and seed yield were predominantly under the control of nonadditive gene action in F_1 generation. Harvest index, husk yield and capsule diameter were predominantly under control of additive type of gene action in both the generations and capsule weight in F_2 generation. The best general combining parents were IC 128 for seed yield and UO 185 and NBRI 3 for harvest index. MOP 539 x NBPGR 1, MOP 507 x NBPGR 1, IC 128 x UO 185 and NOP 4 x UO 185 showed good specific cross combinations for high seed yield and high harvest index.

Key words: Harvest index, seed yield, gene action, opium poppy.

In addition to opium yield in opium poppy, seed yield is also an important trait since it adds to the income of opium poppy growers in India. Recently, seed prices have increased considerably due to reduction of opium poppy growing area and increasing demand of seeds for domestic purpose. But very little efforts have been taken up in breeding for high seed yield and its components. Although the importance of harvest index as a component of economic yield realised by plant breeders [1-3], no information is available on genetic composition of breeding material in opium poppy in India. Genetics of harvest index by taking seed yield as an economic character has not yet been worked out in opium poppy. In the present investigation, therefore combining ability for harvest index, seed yield and other components was analysed in opium poppy.

MATERIALS AND METHODS

Eight diverse genotypes of opium poppy viz., MOP 539, MOP 507, MOP 278, IC 128, NBPGR 1, NBRI 3, NOP 4 and UO 185 were crossed in half diallel mating design. F_1 progenies were raised to obtain F_2 generation in Rabi 1988. Twenty eight F_1s, 28 F_2s and 8 parents were raised in randomized block design with two replications in rabi 1989. Plants in 2 rows plot of parents and F_1s and 4 rows plot of F_2s were spaced 30 cm between rows and 8–10 cm within rows. The recommended agronomical practices were followed for raising the crops. The data were recorded on randomly selected competitive 5 plants in parents and F_1 and 40 plants in F_2 for number of capsules/plant, capsule weight, capsule diameter, number of leaves/plant, husk yield, harvest index and seed yield. Harvest index was calculated as the ratio of seed yield to biological yield and presented in percentage. Harvest index were subjected to angular transformation before statistical analysis. The data were subjected to combining ability in F_1 and F_2 generations following Method II and Model I of [4].

RESULTS AND DISCUSSION

Significant variation was recorded for harvest index, seed yield and all components studied suggesting enough genetic diversity among the parents, F_1s and F_2s for these traits. Combining ability analysis revealed that general combining ability (gca) was significant for all the characters in both F_1 and F_2 generations except capsules/plant, husk and seed yield/plant in F_2 generation (Table 1), indicating importance of additive gene action for all the traits. Variance due to gca was increased in F_2 generation for capsule weight and capsule diameter, suggested that genetic variability observed in both the generations was predominantly associated with additive gene action. Specific combining ability variance (sca) were also significant for all the characters in F_1 generation and capsule weight, capsule diameter and harvest index in both the generations, suggesting importance of nonadditive

Table 1. Combining ability analysis (M.S.S.) for seed yield and its components in F_1 and F_2 generation of opium poppy

Source of variation		d.f.	Capsules per plant	Capsule weight	Capsule diameter	Leaves per plant	Husk yield per plant	Harvest index (seed)	Seed yield per plant
Gca	F_1	7	0.037*	0.534**	1.34**	3.68*	0.413**	10.4**	0.544*
	F_2	7	0.010	0.728**	1.89**	3.07*	0.116	3.5**	0.153
Sca	F_1	28	0.042**	1.017**	1.25**	5.66**	0.245*	5.9**	0.919**
	F_2	28	0.017	0.417*	1.05*	1.76	0.162	3.1*	0.297
Error		63	0.020	0.195	0.56	1.88	0.097	1.2	0.270

*, **Significant at 5 and 1% levels, respectively.

components of genetic variation in the control of respective traits. Relative magnitude of sca variance was higher than gca variance for capsules/plant, capsule weight, leaves/plant and seed yield in F_1 generation indicating predominance of nonadditive gene action in the inheritance of these traits. The sca variances reduced considerably for all the characters in F_2 generation. This may be attributed to inbreeding depression and g x e interaction. Predominance of additive variance was reported for different traits [5, 6] whereas predominance of nonadditive variance was also observed for capsule number, husk yield [7, 8]. If there was predominance of repulsion phase linkage, additive genetic variance could increase as the generations were advanced and if the linkage phase was predominantly coupling, additive genetic variance could decrease [9].

The estimates of gca effects also suggested the importance of additive gene action for all the characters in different parents (Table 2). IC 128 was recorded to be the best general combiner for seed yield, husk yield and capsules/plant in F_1 generation. NBRI 3 and UO 185 were desirable general combiners for harvest index in F_1 generation. MOP 507 was a poor combiner for this trait in both the generations. Gca effects were significant in desirable direction in MOP 507 for capsule diameter in F_1 and F_2 generation and capsule weight and husk yield only in F_1 generation, MOP 278 for capsule diameter in F_2 generation and UO 185 for number of leaves/plant in F_1 generation. NOP 4 was a poor combiner over both the generations for capsule weight. The

Table 2. General combining ability (gca) effects and mean performance (m) for seed yield and its components in F_1 and F_2 generations of opium poppy

Parent	Capsules/plant		Capsule weight			Capsule diameter			Leaves per plant			Husk yield		Harvest index			Seed yield per plant	
	gca (F_1)	m	gca F_1	gca F_2	m	gca F_1	gca F_2	m	gca F_1	gca F_2	m	gca (F1)	m	gca F_1	gca F_2	m	gca (F_1)	m
MOP 539	–0.055	1.1	–0.19	0.31*	4.5	0.015	–0.24	10.8	–0.137	1.06**	14.7	–0.057	2.1	–0.403	–0.021	26.8	–1.272**	2.6
MOP 507	–0.045	1.0	0.28*	0.13	4.6	0.505**	0.67**	12.3	0.142	0.35	13.0	0.182*	2.7	–1.934**	–0.887**	19.6	–0.062	2.1
MOP 278	–0.053	1.1	0.11	0.25	3.7	0.395	0.60**	12.2	0.082	–0.52	9.8	–0.257**	1.6	–0.473	–0.138	23.1	–0.232	2.1
IC 128	0.115**	1.0	–0.16	0.05	3.4	0.165	–0.03	10.9	0.312	–0.27	10.5	0.312**	2.4	–0.227	0.462	23.9	0.387**	2.2
NBPGR 1	0.035	1.0	–0.03	–0.15	3.3	–0.365	–0.51**	8.8	–0.337	–0.67	9.8	0.022	2.4	0.206	–0.826**	19.5	0.057	1.5
NBRI 3	–0.035	1.0	0.16	0.16	3.7	0.145	0.11	11.3	–0.517	–0.23	9.8	–0.275**	1.6	1.239**	0.608	26.8	0.217	2.6
NOP 4	–0.005	1.0	–0.30*	–0.34*	2.6	–0.395	–0.26	9.3	–0.497	–0.50	9.8	–0.277**	1.6	0.460	0.275	24.7	–0.142	1.5
UO 185	0.045	1.0	0.14	–0.41**	3.0	–0.435	–0.34	9.0	1.052**	0.23	11.5	0.102	2.0	1.144**	0.527	25.3	0.087	1.8
SE (g_{ii})	0.042		0.13	0.13		0.221	0.221		0.410	0.41		0.092		0.323	0.323		0.154	

*, **Significant at 5 and 1% level of significance, respectively.

parents possessing high mean performance for husk yield, capsule diameter and capsule weight in general proved to be good general combiners for these traits. In such cases additive gene action is more important and choice of the parent may be done on their high mean performance. However, there was no association between the mean performance and gca effects of parents for seed yield, harvest index, leaves/plant and capsules/plant which was due to nonadditive gene action. Choice of the parents should therefore be based only on gca effects instead of performance. Inconsistent results of gca effects over generations for all the characters may be attributed to genotype x environment interaction. In the present material, parents which were good general combiners for both seed yield and harvest index could not be identified. This may be due to long selection history for high opium yield rather than seed yield although these parents were bred for both seed yield and latex yield.

The sca effects were calculated for the characters showing significant sca variances in F_1 and F_2 generations (Table 3). MOP 539 x NBPGR 1, MOP 507 x NBPGR 1, IC 128 x UO

Table 3. Crosses showing significant sca effects for high seed yield and harvest index along with sca effects for other characters in opium poppy

Cross	Capsules/ plant	Capsule weight		Capsule diameter		Leaves/ plant	Husk/ plant		Harvest index		Yield/ plant
	F_1	F_1	F_2	F_1	F_2	F_1	F_1	F_2	F_1	F_2	F_1
MOP 539 x NBPGR 1	0.08	0.80*	–0.48	0.99**	–0.75	0.37	–0.10	–0.39**	5.41**	–0.78	0.73**
MOP 539 x NBRI 3	0.25**	–0.49	0.41	1.28**	0.63	–0.95	–0.05	0.77**	–4.31**	–0.01	–0.10
MOP 539 x UO 185	–0.11	–0.07	0.38	–0.44	1.18**	–0.02	–0.08	0.72**	–4.70**	–1.32	0.27
MOP 507 x NBPGR 1	0.04	–0.07	–0.40	0.47	0.74	–0.71	0.64	–0.20	2.67**	0.70	1.05**
MOP 278 x NOP 4	0.13*	1.67**	0.37	1.11	0.06	2.11**	0.70**	–0.04	0.31	0.03	0.86**
IC 128 x NBRI 3	0.03	1.78**	0.07	0.80	–0.18	1.30	1.18**	–0.04	0.56	–0.19	1.44**
IC 128 x NOP 4	–0.08	–0.16	1.68**	0.84	0.39	1.78	–0.37*	0.50**	–1.60	–1.90	1.10**
IC 128 x UO 185	0.29**	0.00	0.64	0.88*	0.77	2.73*	0.15	0.21	2.22**	2.05	1.57**
NBPGR 1 x NOP 4	–0.01	0.31	–0.73	1.17**	0.67	0.73	–0.18	0.45**	0.01	0.52	0.63**
NBPGR 1 x UO 185	0.15**	0.61	–0.16	1.11**	0.25	0.38	–0.26	–0.34*	0.23	2.65**	0.20
NBRI 3 x UO 185	0.22**	1.78**	–0.37	0.90*	0.13	0.86	1.19**	–0.19	2.90**	–4.20**	0.34
NOP 4 x UO 185	0.21**	0.29	0.13	0.44	1.20**	–0.96	0.04	–0.14	3.29**	1.52	0.60*
SE (S_{ij})	0.06		0.40		0.41	1.24	0.17	0.99	—	—	0.29
Promising crosses@	9	6	3	11	5	3	7	5	5	1	8

*, **Significant at 5 and 1% levels, respectively.

@Crosses with significant sca in desirable direction.

185 and NOP 4 x UO 185 were good specific cross combinations for high seed yield and favourable harvest index along with one or more characters indicating promise in heterosis breeding. MOP 278 x NOP 4, IC 128 x NBRI 3, IC 128 x NOP 4 and NBPGR 1 x NOP 4 were good specific cross combinations for seed yield in F_1 generation along with one or more other characters. This indicates sca effects in seed yield and harvest index may be attributed to sca effects in components characters. Inconsistent sca effects over generations for all the characters may be attributed to inbreeding depression in F_2 generation and genotype x environment interaction. To exploit both the additive and nonadditive type of gene action in the present material biparental mating in F_2 generation through direct and indirect selection for component traits like capsule weight, capsule diameter, number of leaves/plant, husk yield and harvest index in advance generations would be desirable.

REFERENCES

1. L. M. Jeswani. 1986. Breeding strategies for the improvement of pulse crops. Indian J. Genet., **46**: 267–280.

2. H. K. Jain. 1986. Eighty years of post-Mendelian breeding for crop yield. Nature of selection pressures and future potential. Indian J. Genet., **46**: 30–53.

3. S. K. Sharma, V. P. Singh and R. K. Singh. 1987. Harvest index as a criterion for selection in wheat. Indian J. Genet., **47**: 119–123.

4. B. Griffing. 1956. Concept of general and specific combining ability in relation to diallel crossing systems. Aust. J. Biol. Sci., **9**: 463–493.

5. H. C. Saini and U. S. Kaicker. 1982. Combining ability analysis for opium yield in opium poppy (*Papaver somniferum* L.). South Indian Hort., **30**: 32–36.

6. U. S. Kaicker and B. Chaudhary. 1982. Heterosis and combining ability in opium poppy. Herba Hung., **21**: 59–70.

7. J. R. Sharma, R. K. Lal, H. O. Mishra and S. Sharma. 1988. Heterosis and gene action for important traits in opium poppy (*Papaver somniferum* L.). Indian J. Genet., **48**: 261–266.

8. H. C. Saini. 1988. Performance of exotic x indigenous crosses for combining ability over environment in opium poppy (*Papaver somniferum* L.). III. Husk yield. Indian J. Genet., **48**: 359–365.

9. H. F. Robinson. 1966. Quantitative genetics in relation to breeding on the centennial of Mendelism. Indian J. Genet., **26A**: 171–187.