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Genetic Analysis for Yield and Yield Attributes in Safflower

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ABSTRACT

Estimates of gene effects based on generation mean analysis were obtained for seven quantitative characters in four crosses of safflower. Results indicated the presence of additive, dominance and epistatic gene effects. Among non allelic interactions, dominance x dominance (l) interaction was of greater magnitude than main gene effects for all most all the characters indicating the importance of heterosis breeding to utilize non additive gene effects. The additive gene effects (d) also contributed significantly for different traits like number of seeds per capitulum and test weight in cross Manjira x SSF 658; for plant height, number of seeds per capitulum, test weight and seed yield in cross TSF-1 x SFS 9920 and for number of capitula per plant in cross TSF-2 x ASD-07-09. Selection in segregating generations of these crosses will be effective for development of varieties possessing more number of capitula per plant, seeds per capitulim and test weight. However, to exploit additive as well as non additive gene effects reciprocal recurrent selection procedure may be adopted.

Key words : Gene effects, Generation mean, Gene action, Safflower.

Safflower (*Carthamus tinctorius* L.) is an important edible oil seed crop grown in dry lands during *rabi* season. Multiple pathways involving different yield contributing characters influence seed yield. Hence, seed yield can also be improved through improvement of yield contributing characters (Solanki and Joshi, 2000). The estimation of gene effects involved in the inheritance of yield contributing or quantitative characters are helpful in planning breeding programmes. Though gene effects for seed yield and other traits have been estimated in safflower, information on epistatic gene effects is negligible. Thus in the present investigation, genetic parameters *viz*, additive, dominance and epistatic gene effects were estimated through generation mean study for seven quantitative traits in four crosses of safflower.

MATERIAL AND METHODS

The experimental material comprised of six generations *viz.*, P_1, P_2, F_1, F_2, BC_1 and BC_2 of four crosses namely Manjira x SSF 658, Sagarmuthyalu x GMU 1946, TSF-1 x SFS 9920 and TSF-2 x ASD-07-09 were grown separately in a randomized block design with two replications. In each replication parents and crosses were randomized separately, P1, P2 and F1 were grown in two rows of 5m length. The inter and intra row spacing followed was 45 cm and 20cm, respectively. Plant population in segregating generations was varying from 50 to 200 plants. The crop was raised as per standard practices for rainfed crop. Observations on individual plants were recorded for seven quantitative characters *i.e.,* days to 50% flowering, days to maturity, plant height (cm), number of capitula per plant, number of seeds per capitu, test weight (g) and seed yield (kg ha^{-1}) . The data were subjected to different biometrical techniques *viz.*, scaling test (Mather and Jinks, 1982) and generation mean analysis by Hayman's six parameter model (Hayman, 1958).

RESULTS AND DISCUSSION

Significant scaling test for different traits was observed in almost all the crosses indicating the presence of digenic or higher order interactions. The non significant scaling test (Table 1) indicated the absence of non allelic interactions for number of seeds per capitula and test weight in cross Manjira x SSF 658; number of capitula per plant and number of seeds per capitulum in cross Sagarmuthyalu x GMU 1946; test weight in cross TSF 1 x SFS 9920 and number of capitula per plant for cross TSF 2 x ASD 07-09. Thus inheritance of these characters in the above referred crosses could be explained on the basis of simple additive dominance model. The estimates of genetic parameters m, d and h in these crosses indicated that both additive (d) and dominance (h) gene effects were responsible for the inheritance of these traits. Absence of non- allelic interaction for some yield contributing characters was also reported by Solanki *et al* (2003).

Table 1. Scaling test, components of variance and interaction effects for seven traits in four safflower crosses

Character	Scaling test				Interaction effects					
	A	B	C	D	M	d	h	i	j	l
Manjira x SSF 658										
Days to 50% flowering	-2.38	-3.42**	0.37	3.12	86.17**	-0.18	-16.17**	-6.00**	1.00	11.58**
Days to maturity	-4.68**	-5.57**	-7.00**	1.32	113.58**	-6.32**	-13.57**	-3.33	1.00	13.84**
Plant height (cm)	-7.68**	-10.53**	3.42	10.82**	107.31**	1.72	-52.83**	-21.34**	3.00	39.67**
Number of capitula per plant	-3.63**	-4.84**	-6.23**	0.33	16.00**	-	-4.00**	-0.67	0.67	8.00**
Number of seeds per capitulum	-4.70	-3.52	-9.38	-2.67	16.32**	1.47**	11.38**	5.48	3.57	-1.63
Test weight (g)	-0.03	-0.65	-1.08	-0.21	4.80**	0.33**	0.67**	0.42	0.65	0.23
Seed yield (kg ha^{-1})	-43.66**	-63.67**	-609.33**	-251.00*	257.67**	-0.33	976.66**	502.00**	20.00	-394.66*
Sagarmuthyalu x GMU 1946										
Days to 50% flowering	-2.33	-4.33**	-4.00**	1.33	84.00**	1.00	-11.33**	-2.66	2.00	9.33**
Days to maturity	-4.33	-8.33**	-10.00**	1.33	115.00**	0.00	-16.33**	-2.66	4.00	15.33**
Plant height (cm)	-8.33**	-12.33**	-9.33**	5.66**	102.33**	-1.00	-40.66**	-11.33**	4.00	32.00**
Number of capitula per plant	-	1.00	-4.33	-2.67	7.83**	-1.50**	14.16**	5.33	-1.00	-6.33
Number of seeds per capitulum	-0.67	-3.00	-5.66	-1.00	17.83**	-0.16**	4.16**	2.00	2.33	1.66
Test weight (g)	0.35	0.23	-0.50**	-0.54**	3.47**	-0.35	3.16**	1.08**	0.12	-1.67**
Seed yield (kg ha^{-1})	71.67**	55.00**	-454.00**	-290.33**	152.33**	-136.0*	1374.3**	580.67**	16.67	-707.33*
TSF 1 x SFS 9920										
Days to 50% flowering	1.00	-	7.00**	3.00**	86.83**	1.16	-12.16**	-6.00**	1.00	5.00**
Days to maturity	-2.00	5.00**	2.33	-0.33	110.16**	1.16	3.50**	0.67	-7.00**	-3.67**
Plant height (cm)	-9.00**	-1.00	-14.00**	-2.00	87.00**	4.00**	-6.33**	4.00**	-8.00**	6.00**
Number of capitula per plant	-7.67**	-12.66**	1.66	11.00**	37.16**	2.50	-50.16**	-22.00**	5.00	42.33**
Number of seeds per capitulum	-13.33**	-8.67**	-32.68**	-5.42**	16.47**	8.58**	-1.49	10.58**	-4.37	11.63**
Test weight (g)	-0.04	1.67	-2.54	-2.07	1.50**	0.73**	8.72**	4.15	-17.0	-5.76
Seed yield (kg ha^{-1})	-545.12**	-262.17**	-406.58**	200.19**	1283.8**	176.47**	-1527.5*	-401.91*	-283.0**	1209.5**
TSF 2 x ASD-07-09										
Days to 50% flowering	-1.57	-3.48	3.62	4.00**	87.66**	-2.10	-16.53**	-8.12**	2.00	12.67**
Days to maturity	-2.42	-2.58	2.67	3.49**	117.00**	-2.53	-15.64**	-7.68**	-	12.00**
Plant height (cm)	-2.00	-4.82**	-4.38**	1.34	92.00**	0.63	-8.42**	-2.37	2.58	9.64**
Number of capitula per plant	-0.67	-2.53	-4.30	-0.62	16.00**	0.58**	3.67**	1.42	1.58	1.38
Number of seeds per capitulum	-3.63	2.42	-5.58**	-2.42	17.58**	1.90	9.40**	4.63**	-6.92**	-2.87
Test weight (g)	-0.67	0.02	-0.49**	-0.12	5.23**	-	0.78**	0.24	-0.29	0.01
Seed yield (kg ha^{-1})	-85.00**	-12.32	-54.58**	21.67	913.16**	7.16	-88.42**	-43.20**	-72.68**	141.00**

*- Significant at 5% level, ** - Significant at 1% level

The estimates of genetic parameters for different yield contributing traits in cross Manjira x SSF 658 revealed that additive gene effects (d) governed the inheritance of number of seeds per capitula and test weight. Epistatic gene effect, additive x additive (i) was important for seed yield in this cross. For the characters, days to 50% flowering, days to maturity, plant height and number of capitula per plant, dominance x dominance (l) was more pronounced than additive gene effects in this cross.

Dominance gene effects (h) governed the inheritance of all the traits except days to 50% flowering, days to maturity and plant height in the cross Sagramuthyalu x GMU 1946. Non- allelic interaction, additive x additive (i), was involved in the inheritance of test weight and seed yield. Epistatic interaction dominance x dominance (l), was observed for the expression of days to 50% flowering, days to maturity, plant height, test weight and seed yield in this cross.

Additive gene effects (d) governed the inheritance of most of the yield contributing characters *i.e.,* plant height, number of capitula per plant, number of seeds per capitulum, test weight and seed yield in the cross TSF 1 x SFS 9920. Dominance gene effects influence the inheritance of days to maturity. Epistatic interaction additive x additive was responsible for plant height and number of seeds per capitulum. However, non-allelic gene effect, dominance x dominance (l), controlled the inheritance of all the traits except test weight for this cross.

The cross TSF 2 x ASD-07-09, exhibited dominance gene effects for the inheritance of all the traits except number of capitula per plant where it was found to be controlled by additive gene effects (d). Epistatic gene effect, additive x additive (i), influenced the inheritance of number of seeds per capitulum. Non allelic interaction, dominance x dominance (l), controlled the inheritance of days to 50% flowering, days to maturity, plant height and seed yield in this cross. These results were in agreement with Solanki *et al.* (2007).

The role of non- allelic interactions as indicated by scaling test was not confirmed by estimates of genetic parameters for number of capitula per plant in the cross Sagarmuthyalu x GMU 1946 and days to 50% flowering in the cross TSF 1 x SFS 9920. It might be due to the presence of higher order interactions for the inheritance of this trait. The magnitude of epistatic interaction *viz.,* dominance x dominance (l) gene effects for most of the traits was higher in almost all the crosses under study. Such non additive gen effects may be exploited by heterosis breeding. Additive gene effects observed in the inheritance of important yield contributing characters like number of seeds per capitulum and test weight in cross Manjira x SSF 658 and TSF 1 x SFS 9920 and number of capitula per plant in cross TSF 2 x ASD-07-09 can be utilized in breeding programmes.

Complementary type of gene action observed in cross Manjira x SSF 658 for test weight;, for number of seeds per capitulums in cross Sagarmuthyalu x GMU 1946 and for number of capitula plant height and test weight in cross TSF 2 x ASD-07-09 and these can be utilized in plant breeding programme. Duplicate type of gene action was observed for other traits which is difficult to exploit in breeding programmes.

It is therefore concluded that heterosis breeding may be used where large magnitude of non fixable gene effects are observed. A sizable amount of additive gene effects observed in the crosses indicated that segregating generations of crosses Manjira x SSF 658 and TSF 1 x SFS 9920 may be handled to develop varieties possessing more number of capitula per plant, number of seeds per capitulum and test weight. Such of varieties are likely to provide higher seed yield. Considering importance of additive as well as non additive gene effects observed in the present study, reciprocal recurrent selection may be used to exploit both types of gene effects.

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