Madras Agric. J., 98 (7-9): 216-218, September 2011
https://doi.org/10.29321/MAJ.10.100280

Heterosis and Inbreeding Depression in Safflower, *Carthamus tinctorius* L.

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Heterosis and inbreeding depression in 10 crosses derived from 7 diverse parents and genetic variability studies in safflower was carried out during rabi 2009-10. The experimental material comprising of 20 populations and 7 parents for eight different quantitative characters revealed considerable amount of genetic variation for all the characters studied. Most of the characters were less influenced by the environment as minor differences were recorded between genotypic and phenotypic coefficients of variation. High heritability with high genetic advance was observed for number of capsules per plant, number of seeds per capitulum, test weight and seed yield which might be due to additive gene effects. Heterosis and inbreeding depression was observed positive in direction for most of the characters studied. Maximum heterosis was recorded for number of seeds per capitulum followed by number of capitula per plant and seed yield.

Key words: Safflower, heterosis, inbreeding depression

Safflower, *Carthamus tinctorius* L. is an important rabi oilseed crop of deccan plateau region of India. It is grown mostly under rainfed conditions in residual soil moisture with low inputs. Improvement of genetic architecture of any crop depends upon the presence of nature and extent of genetic variability. The selective advantage of any population depends upon an amount of heritable variability present in the population. Heritability estimates are useful in understanding the pattern of inheritance of quantitative traits and genetic advance is also a useful measure to predict gain in specified selection intensity.

In the present study another objective was to assess the extent of heterosis present in F_1 hybrids and to know the possibility of exploiting heterosis in hybrid breeding programme (Dubey and Singh, 1968). Another aim was to find out whether there is a relationship between high heterosis in F_1 and superior segregants in F_2. The extent of heterosis and inbreeding depression can also give an idea about the genetic control of a particular character.

Materials and Methods

Seven divergent parents *viz*., HUS 305, A1, Manjira, TSF-1, Sagarmuthyalu, GMU 1946 and GMU 2914-15 and 10 F_1 and 10 F_2 populations were grown in randomized complete block design with three replications at Agricultural Research Station, Tandur during rabi, 2009-10. These crosses were selected from the crosses developed in earlier years by adopting the mating system of line x tester. The parents and F_1s were grown in single rows, the row length being 5m. A row to row distance of 45 cm and plant to plant distance of 20 cm was maintained. Five competitive plants were randomly tagged in the parents and F_1s and twenty plants were tagged in the F_2s of all the ten crosses to record observations on yield traits. Genetic parameters of variation, heterosis over better parent and inbreeding depression for all the characters were estimated (Johnson *et al.*, 1955; Grafius, 1959; Allard, 1960).

Results and Discussion

High genotypic coefficient of variation were observed for number of capitula per plant and number of seeds per capitulum which indicative of the presence of considerable amount of genetic variability in the experimental material for these characters (Table 1). Heritability estimates were high for all the characters except days to 50% flowering, days to maturity, plant height and oil content. High heritability coupled with high genetic advance along with high genotypic as well as phenotypic coefficients of variation observed for number of capitula per plant, number of seeds per capitulum and seed yield might be due to additive gene effects which indicate a good scope for improvement of these traits. The results of the study are in agreement with the findings of earlier workers Ramachandram and Goud (1982).

Heterosis over better parent and inbreeding depression expressed in percentage over mean estimated for each character are presented in Table 2. All the crosses except Nira x GMU 1702, HUS-305 x GMU 1946 and Sagarmuthyalu x GMU 1946 showed heterosis for days to 50% flowering ranging from -0.81% to 8.94%. All the crosses showed

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Table 1. Estimates of genetic parameters for seed yield and component traits in safflower

Character	Mean	Range Min	Range Max	SEm	GCV (%)	PCV (%)	h^2(bs)	GA (% of mean)
Days to 50%flowering	80.25	74	85	0.78	3.68	4.05	0.82	6.90
Days to maturity	110.54	104	116	0.75	2.76	3.00	0.84	5.23
Plant height (cm)	78.86	70	85	0.94	4.94	5.35	0.85	9.38
Number of capitula per plant	25.12	15	36	1.08	19.17	20.57	0.86	36.81
Number of seeds per capitulum	27.56	16	39	1.38	24.54	26.03	0.88	47.65
Test weight (g)	4.81	4.14	5.73	0.11	9.13	10.10	0.81	17.03
Seed yield (kg/ha)	995.12	730	1280	59.95	11.67	15.65	0.74	17.52
Oil content (%)	22.51	18.7	25.23	0.86	6.83	9.51	0.71	1.46

positive inbreeding depression. However the cross HUS-305 x GMU 1946 showed no inbreeding depression as majority of the segregants of this cross had the same flowering duration as their hybrid. All the crosses expressed positive heterosis for days to maturity except three crosses *viz*., Nira x GMU 1702, HUS-305 x GMU 1946 and Sagarmuthyalu x GMU 1702 showed negative heterosis. Positive inbreeding depression was observed for all the crosses for this character as majority of the segregates mature earlier than their hybrids. Ragab and Friedt (1992) also reported similar results in safflower.

Majority of the crosses showed positive heterosis and inbreeding depression for plant height except for cross Nira x GMU 1702, HUS-305 x GMU 1702, Manjira x GMU 1946 and Sagarmuthyalu x GMU 1946 which showed negative heterosis for this trait. Such population with positive estimates for the above genetic parameters will provide much scope for selection for dwarf types. For all the crosses heterosis and inbreeding depression for number of capitula per plant and number of seeds per capitulum were in positive direction. High inbreeding depression was recorded for number of capitula per plant and number of seeds per capitula. A close

Table 2. Estimates of heterosis over better parent and inbreeding depression for seed yield and component traits in safflower

Cross	Days to 50% flowering		Days to maturity		Plant height (cm)		Number of capitula per plant		Number of seeds per capitulum		Test weight (g)		Seed yield (kg/ha)		Oil content (%)	
	Het (BP)	ID%	Het (BP)	ID%	Het (BP)	ID%	Het (BP)	ID%	Het (BP)	ID%	Het (BP)	ID%	Het (BP)	ID%	Het (BP)	ID%
Nira x GMU 1702	-1.63	1.65	-1.19	1.20	-2.89	5.53	14.67*	12.79	19.48*	16.30	-2.75	3.39	-3.13	-3.23	5.34	5.07
Nira x GMU 1946	2.52	0.41	1.83	0.30	4.47*	12.06**	5.33	0.00	19.48*	14.13	12.95**	13.92*	10.49	7.89	4.47	8.98
HUS 305 x GMU 1702	1.63	6.00**	1.19	4.41**	-2.07	5.06	10.13	9.20	49.37**	34.75**	-4.74	5.84	13.01	3.71	4.37	3.76
HUS 305 x GMU 1946	-1.23	0.00	-0.60	0.30	1.22	5.22**	35.44**	34.58**	49.37**	38.14*	1.96	-6.79	-30.49**	-28.12	4.70	1.74
Manjira x GMU 1702	0.00	9.35**	0.30	7.12**	2.89	4.82*	7.59	36.47**	36.36**	44.76**	13.06**	20.06**	-3.38	24.47**	9.16	3.44
Manjira x GMU 1946	8.94**	3.99**	7.38**	3.72*	-4.07*	-2.54	10.13	48.28**	40.26**	37.96**	28.05**	12.93*	-7.52	11.41*	8.41	8.17**
A-1 x GMU 1702	2.03	10.36**	1.79	7.89**	3.31	0.00	20.00**	25.00**	36.99**	29.00*	1.99	12.53*	5.20	10.79	7.67	19.04*
A-1 x GMU 1946	7.08**	4.67*	5.45**	3.74*	0.41	7.69**	20.00**	21.43**	61.64**	58.47**	-1.04	2.03	7.52	-0.17	10.32*	23.13**
Sagarmuthyalu x GMU 1702	-0.81	7.79*	-0.89	5.41*	2.48	8.87**	72.22**	40.86**	58.21**	47.17**	13.20**	22.83**	27.08*	28.54**	-0.85	19.40**
Sagarmuthyalu x GMU 1946	7.56**	4.55	5.71**	3.60	-4.07*	1.27	41.27**	38.20**	32.39**	39.36**	8.37*	4.35	45.62**	36.80**	7.83	21.66**

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

relationship between heterotic response and inbreeding depression was observed for these traits in majority of the crosses studied. Similar results were also reported by the earlier workers Patil *et al.* (2004).

For test weight the heterosis over better parent ranged from -4.74% (HUS-305 x GMU 1702) to 28.05% (Manjira x GMU 1946) and inbreeding values ranged from -6.79% (HUS-305 x GMU 1946) to 22.83% (Sagarmuthyalu x GMU 1702). The value of heterosis for seed yield ranged from -30.49% in cross HUS-305 x GMU 1946 to 45.62% in the cross Sagarmuthyalu x GMU 1946. The inbreeding depression values varied from -28.12% in the cross HUS-305 x GMU 1946 to 36.80% in the cross Sagarmuthyalu x GMU 1946. A close relationship between heterotic response and inbreeding depression for seed yield was observed in these crosses. The cross A-1 x GMU 1946 manifested high seed yield and non significant inbreeding depression suggesting the preponderance of additive gene action and as such single plant selection following pedigree method could be effective. These results are in agreement with the earlier findings of Anjani (1997). Heterosis for seed yield in safflower was reflected through heterosis in number of capital per plant, number of seeds per capitula and test weight in crosses Sagarmuthyalu x GMU 1702 and Sagarmuthyalu x GMU 1946. For oil content positive heterosis coupled with positive inbreeding depression was observed for all the crosses except for the cross Sagarmuthyalu x GMU 1702 which showed negative non significant heterosis over better parent.

These studies could help the breeder to concentrate on only a few promising crosses rather than handling many, since superior crosses showing heterosis were also to throw superior segregants. The improvement of safflower yields would be possible by adopting scheme of intermating in the F_2 and resulting generation may be advantageous.

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Received: August 8, 2011; Accepted: September 19, 2011