Selection strategy for yield improvement in safflower involving spiny and nonspiny types

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Abstract:
Diverse F_3 populations of spiny and nonspiny safflower cross combinations along with their parents were evaluated for yield and yield traits. The variation due to genotypes was significant for the majority of characters studied. The mean and range values were high in spiny x non-spiny types of crosses for these characters. The broad sense heritability values were of higher magnitude except for days to 50 percent flowering and days to maturity. Higher magnitude of PCV and GCV coupled with the highest estimates of GAM for capitula per plant, seeds per capitulum,100 seed weight, oil content, hull content and harvest index were directly related to seed yield in spiny x non spiny types of crosses. The potential of cross combinations can be assessed based on number of superior segregants among the progeny in the cross combinations. As such 416 spiny progeny from spiny x spiny crosses, 453 non-spiny from spiny x non spiny and 198 non spiny progeny from nonspiny x nonspiny crosses were selected against non spiny check NARI-6. Similarly,six progenies from spiny x non spiny and 10 progeny from non spiny x non spiny populations were chosen by comparing them with spiny check A1. Thus,the present study clearly indicated the possibility of developing superior nonspiny genotypes from spiny x non spiny crosses. This offers a greater scope for isolating superior segregants with combination of array of characters that would serve as a better source of material for further improvement of the crop.

Key words: Selection – nonspiny – genotypes - variation

Introduction

Safflower (*Carthamus tinctorius L.*) an ancient oilseeds crop is known for its quality of oil and for drought tolerance. India occupies an area of 0.387 m.hectares with a production of 1.57 m.tonnes and productivity of 450 kg/ha. India is the largest producer of safflower in the world, however there has been a trend to decrease area, production and productivity during the last decade and this is a matter of concern. The main reasons for this are the absence of stable and remunerative market prices and harvesting problems due to spiny genotypes.

Knowledge of association of quality and plant morphological traits will enable the breeders to select the parents for affecting crosses and further to suggest about direction and intensity of selection for improving productivity related traits. The present study was planned to know the knowledge of the magnitude of genetic variability and nature of interrelationship among different characters for identifying productive non-spiny lines (Patil and Deshmukh, 1998).

Materials and Methods

Among the genotypes used for experimentation, three were released for cultivation (A-300, A-1 and A-2) and others were stabilized lines from advanced generations (AS-98-29, BIP-2 and EC-408475-1) all of which are spiny in nature. The non-spiny genotypes NARI-6 and JSI-121 were released varieties, while PBNS-40 was an advanced breeding line. Crosses of the spiny x non-spiny (A-1 X NARI-6, A-1 X PBNS-40, A-1 X JSI-121, A-2 X NARI-6, A-2 X PBNS-40 and A-2 X JSI-121) were affected. These F_2 lines were advanced to obtain F_3 generation in Rabi 2006. Each F_3 population was grown in five rows of 5m in length. The seeds were dibbled at a distance of 45 cm between rows and 20cm within the row. The recommended package of practices was followed to raise a good and healthy crop.

Observations were recorded on 125 plants in each F_3 generation. Eleven quantitative traits viz., days to 50% flowering, days to maturity, plant height, number of capitula / plant, number of seeds/ capitulum,100 seed weight, volume weight, oil content, hull content, harvest index and seed yield/plant were recorded. The data was subjected to statistical analysis (by using the formula given by Weber and Moorthy(1952).to work out variability parameters.

Results and Discussion

A wide range of variation was observed in the F_3 populations for most of the characters. The group means of the top 10 progenies of spiny x spiny, spiny x nonspiny and nonspiny x nonspiny (Table 1) are not significantly different to each other for all the traits except seed yield / plant. The mean seed yield of spiny x nonspiny cross were lower than that of spiny x spiny and nonspiny x nonspiny mean seed yield values. This indicates that spiny x nonspiny crosses that were designed to recombine the desirable features of spiny and nonspiny types are equally promising as that of spiny x spiny crosses for all the quantitative traits except yield (Nimbkar, 2006).

The detailed characterization of the top 10 progenies in respect of each of these three groups of crosses for yield and other component traits is summarized in Table 2. It is clear from this data that it is possible to develop high yielding nonspiny types with desireable performance in the component traits in spiny x nonspiny groups of crosses. Since nine of the 10 top progenies in this groups turned out to be non spiny types. This indicates that equivalent yield potential can be achieved with nonspiny genotypes..

Higher phenotypic coefficient of variation (PCV) was observed for the characters studied as compared to the genetic coefficient of variation (GCV). It indicates the presence of environmental influences in the expression of the characters (Table3). Lower values of GCV and PCV were observed for characters viz., days to 50 percent flowering, days to maturity and volume weight. While, plant height, oil content and hull content showed very narrow differences between phenotypic and genotypic coefficient of variation (Deokar and Patil, 1978). High heritability is an indication of presence of a higher proportion of fixable additive variance in the genotypes (Thombre and Joshi 1977, Mathur et al., 1976 and Malleshappa 2000). Heritability estimates are of much use to the breeder, as it indicates the efficiency with which a genotype can be evaluated by its phenotypic and genotypic expression. High genetic advance measured as percent over mean for number of capitula/plant was observed in all the types but it was high for number of seeds/capitula in spiny x nonspiny type. Moderate genetic advance in percentage over mean for the characters viz., plant height and 100 seed weight were observed in all the three types. The genetic advance was low to moderate and coupled with high heritability indicates the predominance of non additive gene action (Deokar and Patil 1980 and Patil et al.,1992). Low genetic advance was seen for days to 50 % flowering, days to maturity and oil content associated with moderate heritability indicating that these characters have low response to selection.

The potential of cross combinations can be assessed based on number of superior segregants among the progenies in the cross combinations. The number of segregant crosses over two checks i.e. A-1 (spiny type) and NARI-6 (nonspiny type) are given in Table 4. It indicates that spiny x non-spiny type of crosses are generated as been as 453 nonspiny type of progenies numerically superior over NARI-6 and as been as 13 progenies numerically higher even spiny check variety A-1. Where as 161 and 6 progenies are significantly superior over NARI-6 and A-1 respectively. However, the spiny x spiny crosses have excelled in generating as been as 172 progenies over A-1 and 416 progenies numerically superior over NARI-6,where as 54 and 177 progenies are significantly superior over A1 and NARI-6 respectively. In non spiny x non spiny type of crosses 10 and 91 progenies are significantly superior over A-1 and NARI-6 respectively.

It is evident that by hybridization different groups of genotypes of safflower there is the potential to create desirable combinations of triats. The effect is not always cumulative which may depend upon many factors such as the genetic architecture of the trait, the type of cross, the population size studied and genetic diversity of the crosses. Developing a nonspiny type with high yield potentiality compared to A-1 and with desirable features like disease resistance assumed greater significance in the present scenario in order to popularize safflower and recapture the area lost under this crop.

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Table 1. The group means of Top 10 progenies of SXS, SXNS and NSXNS crosses for different traits in F_3 progenies of safflower

Sl.No.	Characters	SXS type	SX NS type	NSXNS type
1	Days to 50% flowering	84.5[a]	83.4[a]	85[a]
2	Days to maturity	121.6[a]	120.8[a]	122 .10[a]
3	Plant height	62.8[a]	65.8[a]	73.2[a]
4	No. of capitula/plant	27.1[a]	24.3[a]	30.4[a]
5	No. of seeds/capitulum	25.2[a]	31.2[a]	28.6[a]
6	100 seed weight	5.83[a]	5.23[a]	5.53[a]
7	Volume weight	661.6[a]	674.4[a]	672.4 4[a]
8	Oil content	29.79[a]	29.87[a]	29.96[a]
9	Hull content	51.77[a]	50.5[a]	50.11[a]
10	Harvest index	31.9[a]	31.99[a]	34.09[a]
11	:Seed yield/ plant	40.57[a]	37.18[b]	41.25[a]

a= Non significant difference between groups

b= Significant difference between groups

Table 2.Characterization of top 10 progenies in 3 groups of crosses for seed yield and other component traits in F_3 progenies of safflower

Sl.No	Days to 50% flowering	Days to maturity	Plant height	No. of capitula/plant	No.seeds/ capitulum	100 seed weight	Volume weight	Oil content	Hull content	Harvest index	Seed yield/ plant	Type
SXS type												
1	83	118	65	26	23	6.26	664	28.10	53.40	34.00	42.61	S
2	85	120	72	28	25	6.00	672	29.70	49.80	32.01	42.01	S
3	83	122	69	30	25	5.57	660	30.20	52.50	29.45	41.50	S
4	84	124	51	33	22	6.15	652	29.90	56.30	31.50	41.21	S
5	85	125	50	19	41	5.83	656	31.20	50.20	38.20	41.12	S
6	88	123	69	17	38	4.88	652	28.50	48.10	41.60	41.10	S
7	83	119	83	27	23	6.05	540	32.10	52.10	23.91	40.15	S
8	84	120	56	25	20	5.95	684	30.10	53.00	26.10	40.10	S
9	85	122	60	44	20	5.55	660	28.80	47.90	25.40	38.31	S
10	85	123	53	22	15	6.01	676	29.30	54.40	36.80	37.45	S
SXNS type												
1	84	120	57	38	21	4.53	680	28.70	51.60	23.50	37.48	NS
2	83	119	76	21	25	4.55	672	30.40	49.80	38.41	37.45	NS
3	82	118	91	18	33	5.06	712	29.80	45.10	28.64	37.41	NS
4	83	121	72	17	36	4.83	664	29.90	55.30	33.98	37.33	NS
5	84	123	69	28	30	6.10	684	31.50	50.20	35.21	37.31	NS
6	84	122	55	24	28	5.80	664	32.00	49.50	29.80	37.10	NS
7	83	120	53	34	29	5.61	680	28.30	51.40	31.20	37.02	NS
8	82	120	62	25	26	5.83	672	27.90	50.80	37.53	36.98	NS
9	85	124	70	20	41	4.85	644	29.90	52.80	27.20	36.90	NS
10	84	121	54	18	43	5.18	672	30.30	48.50	34.40	36.83	NS
NSXNS type												
1	82	119	65	33	21	5.81	672	28.40	48.50	38.51	42.51	NS
2	84	121	78	28	25	6.10	656	29.50	50.10	40.16	42.30	NS
3	85	122	85	35	33	4.95	684	31.30	51.20	29.37	42.05	NS
4	88	124	91	41	36	5.33	676	29.90	49.20	35.50	42.00	NS
5	86	124	58	29	33	5.58	664	32.30	50.30	42.10	41.72	NS
6	84	124	66	22	28	6.05	680	30.10	51.70	28.84	41.15	NS
7	83	119	73	31	29	5.91	688	28.90	54.30	30.08	41.01	NS
8	85	121	71	27	26	4.99	672	28.30	52.10	34.27	40.98	NS
9	87	125	69	30	41	5.06	676	29.80	42.80	32.18	39.60	NS
10	86	123	76	28	43	5.51	664	31.10	50.90	29.91	39.20	NS

DFF: days to 50% flowering, DM: days to maturity, PH: plant height, NCP: no.of capitula/plant, NSC: no. of seeds/capitula.HSW:100 seed weight VW: volume weight, OC: oil content, HC: hull content, HI: harvest index and SYP: seed yield/ plant

Table 3. GCV and PCV values a best in each category of crosses for different traits in F_3 progenies of safflower

Sl. No	Chara cters	SXS type							S X NS type						
		Crosses	Mean	Range	GCV	PCV	h^2	GAM	Crosses	Mean	Range	GCV	PCV	h^2	GAM
1	DFF	A1x98-29	83.84	82-88	0.34	1.51	18.9	0.56	A1xNARI-6	85.82	82-88	1.52	1.77	73.2	2.67
2	DM	A1x98-29	121.52	117-125	1.05	2.09	53.6	1.89	A1xPBNS-40	122.16	117-125	1.11	1.99	54.9	68.6
3	PH	A2 xEC-408475-1	67.72	55-110	15.42	15.66	98.9	30.25	A2xNARI-6	79.04	55-110	21.66	21.74	99.3	44.45
4	NCP	A1x98-29	25.58	6-58	53.86	54.25	97.3	95.23	A1 X JSI-121	28.02	6-58	58.32	58.57	99.2	89.96
5	NSC	A1xBIP-2	29.36	9-53	39.89	40.29	97.0	82.45	A1xNARI-6	29.72	1-54	50.70	50.94	99.1	103.97
6	HSW	A1x98-29	5.37	2.01-6.3	19.54	19.83	98.0	41.20	A1xPBNS-40	5.60	2.45-6.7	22.47	22.71	98.8	45.75
7	VW	A2 X A300	695.2	672-712	1.21	1.63	98.0	1.85	A2xNARI-6	684	652-712	1.79	2.05	85.3	3.22
8	OC	A1xBIP-2	31.27	26.9-31.3	3.05	3.56	92.3	5.23	A1xPBNS-40	31.05	26.2-31.8	7.18	7.25	98.5	14.64
9	HC	A2 xEC-408475-1	53.23	44-54.4	5.36	5.44	97.0	9.32	A1xPBNS-40	51.23	34.6-53	9.61	9.69	98.3	19.64
10	HI	A1 XA300	32.49	2-52.4	39.74	39.88	99.3	83.56	A1 X JSI-121	38.15	9.5-50	48.13	56.06	96.3	85.15
11	SYP	A1x98-29	22.37	5.26-40	42.07	42.30	98.9	87.23	A1xNARI-6	21.45	10.14-36.9	39.17	39.77	98.2	79.48

Contd…

Sl. No	Chara cters	NS X NS type						
		Crosses	Mean	Range	GCV	PCV	h^2	GAM
1	DFF	NARI-6x JSI-121	84.2	83-88	0.69	1.10	40.0	0.91
2	DM	NARI-6xPBNS-40	120.9	117-125	1.08	1.43	57.6	1.70
3	PH	NARI-6xPBNS-40	76.76	59-100	12.87	13.03	97.5	26.19
4	NCP	NARI-6xPBNS-40	22.56	10-56	45.71	46.08	98.4	93.42
5	NSC	NARI-6xPBNS-40	28.94	15-60	32.54	32.96	97.5	66.17
6	HSW	NARI-6x JSI-121	4.40	2.69-6.13	19.26	19.58	96.7	39.06
7	VW	NARI-6xPBNS-40	658.94	652-984	3.79	3.80	97.8	5.20
8	OC	NARI-6x JSI-121	31.47	27.2-32.9	6.28	6.30	99.4	12.90
9	HC	NARI-6xPBNS-40	48.23	33-56.2	8.52	8.55	99.4	17.49
10	HI	NARI-6x JSI-121	28.76	11.2-54.6	37.58	37.84	98.6	76.87
11	SYP	NARI-6x JSI-121	17.86	4.96-42.51	46.14	46.48	98.5	94.35

Table 4. Frequency of superior progenies for seed yield in F_3 progenies of safflower

Crosses	No. of progenies superior over A-1(spiny)						No. of progenies superior over NARI-6 (Non spiny)					
	Numerically			Significantly			Numerically			Significantly		
	No. of progenies	Type		No. of progenies	Type		No. of progenies	Type		No. of progenies		
		S	NS		NS	S		S	NS		S	NS
SXS Type												
A1x98-29	21	21	-	6	-	6	53	53	-	25	25	-
A1xBIP-2	33	33	-	8	-	8	71	71	-	31	31	-
A1 XA300	45	45	-	13	-	13	93	93	-	40	40	-
A2x98-29	-	-	-	-	-	-	35	35	-	15	15	-
A2 xEC-408475-1	25	25	-	12	-	12	63	63	-	21	21	-
A2 X A300	48	48	-	15	-	15	101	101	-	45	45	-
Total	172	172	-	54	-	54	416	416	-	177	177	-
SXNS Type												
A1xNARI-6	-	-	-	-	-	-	64	5	59	19	1	18
A1xPBNS-40	11	1	**10**	6	**6**	-	125	8	**117**	53	4	**49**
A1 X JSI-121	3	-	3	-	-	-	93	6	87	39	2	37
A2xNARI-6	-	-	-	-	-	-	58	2	56	20	0	20
A2xPBNS-40	-	-	-	-	-	-	78	4	74	23	0	23
A2 XJSI-121	-	-	-	-	-	-	61	1	60	14	0	14
Total	14	1	13	6	-	-	479	26	453	168	7	161
NSXNS Type												
NARI-6xPBNS-40	-	-	-	-	-	-	-	-	-	-	-	-
NARI-6x JSI-121	21	-	-	10	10	-	115	-	115	58	-	58
PBNS-40x JSI-121	-	-	21	-	-	-	83	-	83	33	-	33
Total	21	-	21	10	10	-	198	-	198	91	-	91