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Original Research Article

Combining Ability Analysis for Yield and Yield Contibuting Traits in Safflower (*Carthamus tinctorious* L.)

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Line x Tester Analysis, Safflower, Combining ability, GCA, SCA

A B S T R A C T

The present studywas undertaken to estimate the combining ability effects in safflower genotypes to find out the high yielding cross combinations. The evaluation of 4 CMS lines females and 7 testers males. The set of 11 parents out of four females NARI 50-1, PBNS-58, PBNS-86 and SSF-687, seven males NARI-34 SPS-46, GMU-2924, GMU-1115, VB-19-3, GMU-3718, GMU-2758, SSF-691 and their 28 crosses along with one check Bhima were evaluated in randomized block design with three replications at the field of Oilseeds Research Unit, Dr. PDKV, Akola during rabi 2013-2014. Among the female parents SSF-687(8.65) and PBNS-58(6.28) were found to be good combiners for yield and most of the yield contributing characters. The male parents SSF-691(25.66) and NARI-34 SPS-46 (21.06) exhibited highly significnat gca effects for seed yield per plant and most of yield contributing characters.The cross NARI-50-1 x AKS GMU-2924(43.93) recorded the highest and highly significant sca effect for seed yield per plant (g) followed by PBNS-58 x GMU 1115(34.79) and SSF-687 x GMU-3718 (14.31). Considering the per se performance, gca effects of parents, sca effects of the five crosses viz., NARI 50-1 x AKS GMU-2924, NARI-50-1 x SSF-691, PBNS-58 x NARI 34 SPS 46, PBNS-58 x GMU-1115, SSF-687 x GMU-3718 were identified as promising cross combinations for further improvement programme in safflower.

Introduction

Safflower (*Carthamus tinctorius* L.) is an important multipurpose *rabi* oilseed crop of India and other countries of recent introduction. India is the largest producer of safflower in the world. Safflower is usually considered to be a self-pollinated crop. Classen (1950) however reported that the extent of cross pollination varies from 8 to 20 per cent depending mainly on insect activity and wind. Though several high yielding varieties were released, still low productivity of safflower crop is the main challenge to the researchers because immense potential of crop yet to be exploited.

Proper choice of parent based on their combining ability effects is prerequisite for the breeding programme. In this view the present investigation was under taken to determine the GCA and SCA for various traits related to yield and yield contributing traits safflower.

Materials and Methods

The experimental material comprised of four CMS lines (NARI 50-1; PBNS-58, PBNS-86, SSF-687) and seven testers (NARI-34 SPS-46, GMU-2924, GMU-1115, VB-19-3, GMU-3718, GMU-2758, SSF-691) were crossed in Line x Tester design (Kempthorne, 1957) to obtain 28 crosses. The set of 11 parents i.e. four females, seven males and their 28 crosses along with one check Bhima were evaluated in randomized block design with three replications at the field of Oilseeds Research Unit, Dr. Panjabrao Deshmukh krishi vidyapeeth, Akola during rabi 2011-2012. The data was recorded on the characters days to 50 per cent flowering and days to maturity on plot basis. Plant height (cm), number of primary branches per plant, number of capitulas per plant, capitulum diameter (cm), number of seeds per capitulum, 100 seed weight (g), seed yield per plant (g) and Oil content(%) on plant basis. Character was subjected to analysis of variance using technique suggested by Panse and Sukhatme (1967) and combining ability was calculated.

Results and Discussion

The variance due to males was highly significant for seed yield per plant and oil content. The variance due to female x males was highly significant for days to 50% flowering number of primary branches per plant, number of capitulas per plant, capiulum diameter, number of seeds per capitulum, 100 seed weight, seed yield per plant and oil content. This indicated the presence of significant differences between males and females in Table 1.

The significant gca effects of the parents in desirable direction for various characters as depicted by the parents revealed that none of the parents was found to be have significant desirable gca effect simultaneously for all characters.

However, among female parents SSF-687 showed significant gca effects for seed yield per plant and also for most of the yield contributing characters, such as 100 seed weight, oil content, number of seeds per capitulas, number of capitulas per plant, number of primary branches per plant, plant height and days to 50% flowering. The PBNS-58 was found gca effects for days to 50% flowering and seed yield per plant. Among the male NARI-34 SPS-46 was found to possess significant gca effect for most of yield contributing characters such as capitulum diameter, seed yield per plant and oil content. The male parent SSF-691 was found to possess significant gca effect for days to 50% flowering, number of capitulas per plant, number of seeds per capitulas and seed yield per plant. The female SSF-687 PBNS-58 and the male NARI-34 SPS 46, SSF-691 were identified as best general combiners for yield related traits. The male and females revealed differences from one another in respect to other gca effects for all the characters indicating genetic variability among them for these characters in (Table 2). Similar results were reported earlier by Pandya and Patil (1994), Parmeshwarappa*et al*. (1995).

The highest desirable sca effect was observed for days to 50% flowering in NARI-50-1 x SSF-691 (-2.53), for plant height in NARI-50-1 x AKS GMU-2924 (12.09) for number of primary branches per plant in PBNS-58 x GMU-1115 (3.54) for number of capitulas per plant in NARI-50-1 x AKS GMU-2924 (16.28) for capitulum diameter in SSF-687 x SSF-691 (0.61) for number of seeds per capitulum in PBNS 58 x GMU-1115 (4.10) for 100 seed weight in NARI-50-1 x NARI-34 SPS 46 (0.67) for seed yield per plant x NARI-34 SPS 46

(0.67) for seed yield per plant in NARI-50-1 X AKS GMU-2924 (43.93) and for oil content in SSF-687 x GMU -3718 (2.05).A few crosses viz., NARI-50-1 x AKS GMU 2924, NARI-50-1 x SSF-691, PBNS-58 x NARI-34 SPS 46, PBNS 58 x GMU-1115, PBNS-86 x VB-19-3 and SSF-687 x GMU-3718 showed significant sca effects for days to 50% flowering, plant height, number of primary branches per plant, number of capitulas per plant, number of seeds per capitulas, 100 seed weight and seed yield per plant and were considered as best specific cross combinations in (Table 3).

It was observed that the crosses with high specific combining ability for seed yield had also high general combining ability effects for one or more other yield components suggesting that the improvement in seed yield could be obtained by improving its component characters. The cross SSF-687 x GMU-3718 showed the highest sca effect for seed yield and height of plant, number of primary branches, number of capitulas per plant and 100 seed weight with good gca effects for one of the parent. Similar results were reported by Deokar and Patil (1980) and Patil*et al*. (1992), Pandya *et al*. (1990).

The promising crosses showing high mean performance, high sca effects and involving good general combiners could be successfully exploited for hybrid vigour. Table 4 showed five promising cross combinations. These crosses were identified on the basis of mean performance, sca effects and good gca effects for one of the parent. The cross PBNS-58 X NARI 34 SPS 46 followed by PBNS-58 X GMU-1115 showed high seed yield over check Bhima by 70.22 per cent and 60.28 per cent respectively. The parents SSF-691, PBNS-58, NARI- 34 SPS 46 and SSF 687 which significantly high gca effects may be suggested to includes in the further crossing programme in safflower for development of populations.

These crosses should be utilized in future breeding programme of safflower to identify most promising once.

Table.1 Analysis of variance for various characters

Sources of variation	df	Days to 50 % flowering	Days to maturity	Plant height (cm)	No. of primary branches per plant	No. of capitulas per plant	Capitulum diameter (cm)	No. of seeds per capitulum	100 seed weight (g)	Seed yield per plant(g)	Oil content (%)
		1	2	3	4	5	6	7	8	9	10
Replications	2	0.65	5.37	18.44	1.75	0.62	0.11**	4.59	0.33	63.40	0.41
Treatments	38	48.06**	12.35**	200.58**	13.81**	219.63**	0.25**	23.00**	1.09**	2413.41**	6.75**
Parents	10	20.83	12.42	148.20	24.97**	292.09**	0.52**	20.91**	2.28*8	3802.39**	2.31
Crosses	27	52.06**	11.54*	115.06	9.09**	200.74**	0.15**	24.48**	0.69**	1787.71**	8.56**
Parents Vs crosses	1	212.46**	33.70*	3033.38**	29.69**	4.93	0.02	3.95	0.01	5417.79**	2.34
Error	76	12.85	6.48	90.51	0.87	4.72	0.01	4.99	0.12	129.31	1.66

Note: * - Significant at 5 % level of significance**- Significant at 1 % level of significance

Table.2 Estimates of general combining ability effects of parents

Parents	Days to 50 % flowering	Days to maturity	Plant height (cm)	No. of primary branches per plant	No. of capitulas per plant	Capitulum diameter (cm)	No. of seeds per capitulum	100 seed weight (g)	Seed yield per plant(g)	Oil content (%)
	1	2	3	4	5	6	7	8	9	10
Females (Lines)										
NARI 50 – 1	1.20**	-0.74	3.42 *	-0.73 **	-0.20	0.08 **	0.14	-0.01	-1.73	0.01
PBNS – 58	-1.37**	0.60	-4.87 **	0.07	-2.40 **	0.01	-0.97 *	-0.44 **	6.28 **	-0.61 *
PBNS – 86	-0.94*	-0.79	-2.26	0.05	-2.45 **	-0.12 **	-1.41 **	0.19 **	-13.20 **	-0.30
SSF – 687	1.11**	0.93	3.70*	0.61 **	5.06 **	0.03	2.24 **	0.26 **	8.65 **	0.89 **
SE(gi)	0.41	0.57	1.65	0.15	0.45	0.02	0.44	0.07	1.63	0.23
CD at 5 %	0.83	1.15	3.31	0.30	0.90	0.04	0.89	0.14	3.28	0.47
CD at 1%	1.10	1.53	4.41	0.40	1.20	0.06	1.19	0.19	4.36	0.63
Males (Testers)										
NARI–34 SPS 46	1.88 **	0.91	-0.55	0.38	-1.89 **	0.11 **	-0.91	-0.27 **	21.06 **	1.38 **
GMU – 2924	-2.36 **	0.57	1.43	-0.22	-0.89	-0.02	-0.66	-0.14	-16.44 **	-0.15
GMU – 115	-1.62 **	-0.18	2.64	-0.77 **	-1.25 *	0.04	0.51	0.15	-3.18	-0.61
VB – 19 -3	3.04 **	-2.18 **	-4.78 *	0.40	-0.83	0.04	1.09	0.31 **	-14.56 **	0.90 **
GMU – 3718	-2.04 **	1.07	0.50	-0.06	-1.00	-0.20 **	-0.76	0.16	-8.16 **	-2.50**
GMU – 2758	2.46 **	0.74	2.00	0.15	-3.54 **	-0.03	-1.42 *	0.17	-4.37 *	0.87 **
SSF – 691	-1.37 *	-0.93	-1.24	0.12	9.41 **	0.06	2.14 **	-0.39 **	25.66 **	0.10
SE (gj)	0.55	0.76	2.19	0.20	0.60	0.03	0.59	0.09	2.16	0.31
CD AT 5 %	1.10	1.52	4.38	0.40	1.19	0.06	1.18	0.19	4.33	0.62
CD AT 1 %	1.46	2.03	5.84	0.53	1.59	0.08	1.57	0.25	5.77	0.83

Table.3 Estimates of specific combining ability effects for crosses

Sr. No.	Crosses	Days to 50 % flowering	Days to maturity	Plant height (cm)	No. of primary branches per plant	No. of capitulas per plant	Capitulum diameter (cm)	No. of seeds per capitulum	100 seed weight (g)	Seed yield per plant(g)	Oil content (%)
		1	2	3	4	5	6	7	8	9	10
1	NARI 50-1X NARI 34 SPS 46	2.21 *	1.24	-2.09	-0.30	-4.91 **	0.09	0.91	0.67 **	-18.28 **	-0.16
2	NARI 50-1X AKS GMU 2924	-4.53 **	-0.43	12.09**	2.58 **	16.28 **	0.02	4.08 **	0.44 *	43.93 **	0.38
3	NARI 50-1X GMU 1115	2.38 *	-1.01	-2.82	-1.96 **	-7.79 **	-0.12 *	-2.98 *	-0.18	-14.32 **	0.32
4	NARI 50-1X VB 19-3	4.71**	-0.68	-6.39	-2.00 **	-6.86 **	-0.10	-3.36 **	-0.31	-10.35 *	0.83
5	NARI 50-1X GMU -3718	2.79 *	-0.93	-4.41	-1.23 **	-5.06 **	0.15 *	-0.15	-0.50 **	-9.73 *	-2.05 **
6	NARI 50-1X GMU 2758	-5.03**	0.07	6.10	0.81 *	-0.20	0.07	0.15	-0.27	-4.40	0.63
7	NARI 50-1X SSF 691	-2.53 *	1.74	-2.47	2.11 **	8.56 **	-0.10	1.35	0.16	13.16 **	0.03
8	PBNS 58 X NARI 34 SPS 46	-6.21 **	-0.76	4.11	-0.80 *	3.01 *	-0.13 *	-0.53	-0.30	19.59 **	0.55
9	PBNS 58 X AKS GMU 2924	-0.96	0.57	-5.67	-0.68	-4.36 **	0.14 *	0.80	-0.51 **	-38.19 **	-0.31
10	PBNS 58 X GMU 1115	-0.71	-2.01	-1.03	3.54 **	12.89 **	0.11	4.10 **	0.16	34.79 **	-1.54 *
11	PBNS 58 X VB 19-3	-1.05	1.66	-3.18	-2.01 **	-1.51	0.26 **	0.78	-0.04	4.60	-0.14
12	PBNS 58 X GMU-3718	0.70	-1.26	4.93	-1.03 *	-2.08	-0.00	-2.34	0.43 *	-12.52 **	1.33**
13	PBNS 58 X GMU 2758	8.20 **	1.07	-4.12	0.01	1.07	0.04	0.45	-0.02	8.65	0.10
14	PBNS 58 X SSF 691	0.04	0.74	4.97	0.98 *	-9.03 **	-0.43 **	-3.27 **	0.27	-16.93 **	0.01
15	PBNS 86 X NARI- 34 SPS 46	1.69	2.29	-1.08	1.80 **	0.93	0.08	0.75	-0.25	-2.78	1.32 *
16	PBNS 86 X AKS GMU-2924	0.27	-1.38	-5.75	-0.73	-4.45 **	0.08	-0.80	-0.16	-4.6	-0.67
17	PBNS 86 X GMU 1115	-0.81	2.37	4.09	-0.31	-2.95 *	0.12 *	-0.97	0.19	-7.56	-0.31
18	PBNS 86 X VB 19-3	-3.81 **	-0.30	4.17	1.77 **	-1.00	0.04	3.21 **	0.26	9.96 *	-0.21
19	PBNS 86 X GMU 3718	1.27	1.12	-0.57	0.04	0.08	-0.20 **	0.30	0.01	7.93	-1.33 *
20	PBNS 86 X GMU 2758	0.77	-2.21	-1.85	-1.77 **	0.16	-0.04	-1.01	0.35	-10.59 *	0.68
21	PBNS 86 X SSF 691	0.61	-1.88	0.99	-0.80 *	7.22 **	-0.08	-1.50	0.67 **	7.64	0.52
22	SSF 687 X NARI 34 SPS 46	2.31 *	-2.76	-0.94	-0.68	0.96	-0.03	-1.14	-0.39 *	1.47	-1.71 **
23	SSF 687 X AKS GMU-2924	5.22 **	1.24	-0.67	-1.16 **	-7.46 **	-0.24 **	-4.08 **	-0.12	-1.14	0.60
24	SSF 687 X GMU 1115	-0.86	0.66	-0.24	-1.27 **	-2.151	-0.10	-0.15	0.22	-12.91 **	1.54 *
25	SSF 687 X VB 19-3	0.14	-0.68	5.41	2.24 **	9.38 **	-0.20 **	-0.64	-0.16	-4.22	-0.47
26	SSF 687 X GMU 3718	-4.77 **	1.07	0.06	2.22 **	7.05 **	0.05	2.18	0.09	14.31 **	2.05 **
27	SSF 687 X GMU 2758	-3.94 **	1.07	-0.13	0.94 *	-1.04	-0.07	0.41	0.06	6.34	-1.42 *
28	SSF 687 X SSF 691	1.89	-0.60	-3.48	-2.28 **	-6.75 **	0.61 **	3.41 **	-0.06	-3.87	-0.58
29	SE (Sij)	1.09	1.52	4.37	0.40	1.19	0.06	1.18	-0.04	4.32	0.62
30	SE (Sij-Skl)	1.55	2.15	6.19	0.57	1.68	0.08	1.66	0.19	6.11	0.88
31	SE(Sij-Sik)	1.31	1.82	5.23	0.48	1.42	0.07	1.40	0.27	5.17	0.74
32	CD AT 5 %	2.19	3.05	8.77	0.80	2.39	0.11	2.36	0.23	8.67	1.24
33	CD AT 1 %	2.92	4.06	11.68	1.07	3.18	0.15	3.14	0.38	11.54	1.66

* - Significant at 5 % level of significance
** - Significant at 1 % level of significance

Table.4 Yield performance, gca effects and sca effects in promising crosses

Sr. No.	Crosses	Seed yield per plant (g)	sca effects	gca effects of parents	Significant gca effects for other characters in desirable direction	Significant sca effects for other characters in desirable direction
1	PBNS -58 X NARI- 34-SPS 46	161.25**	19.59**	6.28** X 21.06** H H	$P_{1:}$ 1,9 $P_{2:}$ 6,9,10	1,5,9
2	PBNS -58 X GMU- 1115	152.21**	34.79**	6.28** X -3.18** H L	$P_{1:}$ 1,9 $P_{2:}$ 1	1, 4,5,7,9
3	SSF-687 X GMU -3718	129.13**	14.31**	8.65** X -8.16** H L	$P_{1:}$ 3,4,5,7,8,9,10 $P_{2:}$ 1	1, 4,5,9,10
4	NARI -50-1 X SSF- 691	151.43**	13..16**	-1.73** X 25.66** L H	$P_{1:}$ 3,6 $P_{2:}$ 1,5,7,9	1,4,5,9
5	NARI -50-1 X AKS GMU-2924	140.09**	43.93**	-1.73** X -16.44** L L	$P_{1:}$ 3,6 $P_{2:}$ 1	1,3,4,5,7,8,9

H : High gca
L : Low gca
P_1 & P_2 : Female parent and male parent of the concerned cross, respectively
* : Significant at 5 % level of significance
** : Significant at 1 % level of significance

1. Days to 50 % flowering
2. Days to maturity
3. Plant height (cm)
4. No. of primary branches per plant
5. No. of capitulas per plant
6. Capitulum diameter (cm)
7. No. of seeds per capitulas
8. 100 seed weight (g)
9. Seed yield per plant (g)
10. Oil content (%)

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