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Combining Ability Studies in Sunflower (*Helianthus annuus* L.)

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A B S T R A C T

The present investigation entitled "Combining Ability Studies in Sunflower (*Helianthus annuus* L.)" was undertaken with objective to estimate the gca and sca effect for seed yield and its components in sunflower. The experiment material under study consisted of four CMS lines and eight restorer lines, crossed in LxT model to produce 32 hybrids during *Summer*- 2017-18. The experiment material were evaluated for 10 observations in sunflower *viz.*, day to 50 percent flowering, day to maturity, plant height (cm), head diameter (cm), seed filling percentage (%), 100 seed weight (g), volume weight (g/100ml), hull content (%), seed yield per plant (g) and oil content (%). Among the parent CMS-343 was good general combiner for early flowering, days to maturity, volume weight, hull content and oil content followed by CMS-62 and CMS-89-1 for seed yield contributing characters. Among the male parents PSMOO-108 was good general combiner for plant height, seed yield per plant, early flowering, early maturity and 100 seed weight followed by NSH-312, MRHA-2 and CSFR-99. Based on the sca effect of the hybrids, CMS-89-1 x NSH-312 was found promising for early flowering, early maturity while CMS-343 x PSMOO-108 were found for volume weight, early flowering, early days to maturity. The cross CMS- 62 x CSFR-99 for volume weight and 100 seed weight while CMS-62 x PSCIM-165 and CMS-234 x PSFRMM-140 for early maturity, early flowering. These crosses showed the highest sca effects for different characters.

Introduction

The sunflower (*Helianthus annuus* L.) an important oil seed crop is a large annual crop for its edible oil and edible fruits. The plant was first domesticated in America but it is extensively grown in Russia, Argentina, France, Spain, USA, China and India. It has taken prime position in the oilseed economy both at global and national level. It is rich source of edible oil (40 to 45%) and is considered as good quality oil from health point of view, due to high concentration of polyunsaturated fatty acids (55 to 60% linoleic acid, 25 to 30% oleic acid), which are known to reduce the risk of coronary disease by reducing the cholesterol in blood plasma. The importance of sunflower as an oilseed crop in India is of very recent origin and dates back to four decades.

A landmark in hybrid sunflower breeding was the discovery of cytoplasmic male sterility by Leclereq (1969) and the restorer genes in wild types and obsolete sunflower cultivars. In India, heterosis breeding was initiated in early seventies (Sindagi *et al.,* 1976). Seetharam (1977) observed substantial heterosis over better parent for yield and yield components in crosses involving CMS lines and restorers. Combining ability analysis provides information on nature and magnitude of gene effects on yield and yield contributing character (Sprauge and Tatum, 1942)

Keeping this background information in mind the present investigation was undertaken to assess the extent of combining ability in relation to genetic diversity of four CMS and eight fertility restorer lines by employing line × tester analysis.

Materials and Methods

The present study on combining ability in sunflower (*Helianthus annuus* L.) was conducted during kharif-2018 at Agriculture Botany Farm, College of Agriculture, Pune. The crossing programme was carried out during *Summer*-2017-18. The experimental material for study include 4 CMS lines (CMS-234, CMS-62, CMS-89-1, CMS-343) and 8 restorer lines (NSH-312, PSCIM-165, PSMOO-108, PSFRMM-140, MRHA-2, AKSF-345, AKSF-12, CSFR-99) to produce 32 hybrids along with 2 checks (Phule Raviraj and MDSFH-411) in RBD design (Panse and Sukhatme, 1967) and combining ability testing procedure based on Kempthorne (1957).

Results and Discussion

The combining ability is the ability of the parent to transfer its superiority to it's off spring and is two types i.e. GCA and SCA. The parents were classified as good, average and poor combiner based on estimates of general combining ability effects. Summarized account of gca and sca effects of parents and crosses for different characters has been worked out. None of the parental line was good combiner for all the studied traits.

General and specific combining ability effects help to select the good parent and hybrids, respectively. The gca effects of 12 parents (4 CMS lines and 8 testers) for 10 traits indicated that the CMS-343 was good general combiner for early flowering (-1.948), days to maturity (-1.833), volume weight (1.392), hull content (-0.749) and oil content (1.057). CMS-62 was good combiner for early flowering (-0.781), days to maturity (-0.833), volume weight (1.900) and hull content (-0.799). The line CMS-89-1 was good general combiner for seed yield per plant (2.398), head diameter (0.840) and 100-seed weight (0.207).

Among the testers PSMOO-108 showed good general combiner for plant height (-4.350), seed yield per plant (2.353), early flowering (-0.656), early maturity (-0.417) and 100 seed weight (0.248). The restorer line NSH-312 was good general combiner for plant height (-5.733), early maturity (-2.250), early flowering (-1.990) and head diameter (0.915) while MRHA-2 found good general combiner for plant height (-3.217), early maturity (-1.167) and early flowering (-1.073). Restorer CSFR-99 was good general combiner for head diameter (1.965), 100 seed weight (0.058), and hull content (-0.152) while PSFRMM-140 registered good general combiner only for 100 seed weight (0.124) and hull content (-1.824). The restorer line AKSF-345 showed high gca effect for head diameter (1.365), oil content (0.928) and hull content (-0.101). Similar findings and were reported by Ortegonn and Escoed (1993), Sindagi *et al.,* (1976), Kadkol *et al.,* (1984),

Gangappa *et al.*, (1997), Bhat and Singh (2000), Radhika *et al.*, (2001), Shinde *et al.*, (2016), Ingle *et al.*, (2017), Singh *et al.*, (2018) (Table 1–3).

Table.1 Estimates of general combining ability (GCA) effect in sunflower lines for ten characters

Characters	CMS-234	CMS- 62	CMS-343	CMS-89-1	CD @ 5%
Days to 50 % flowering	0.969*	-0.781**	-1.948**	1.760**	0.797
Days to maturity	1.00*	-0.833**	-1.833**	1.667**	0.819
Plant height	-11.508**	3.908	0.833	6.767	4.023
Head diameter (cm)	-0.069**	-0.177**	-0.594**	0.840**	0.4734
Seed filling (%)	-0.408**	-0.791**	1.036	0.164	1.999
100 Seed weight	-0.033**	-0.157**	-0.017**	0.207**	0.119
Volume weight(g/100ml)	-2.285**	1.900**	1.392*	-1.008**	1.007
Hull content (%)	0.531*	-0.799**	-0.749**	1.017**	0.691
Seed yield / plant	-0.796**	-2.598**	0.996	2.398**	1.046
Oil content (%)	0.970**	-0.880**	1.057**	-1.147**	0.621

** and* indicates significant at 1% and 5%, respectively

Table.2 Estimates of general combining ability (GCA) effects in sunflower testers for ten characters

Characters	NSH-312	PSCIM-165	PSMOO-108	PSFRMM-140	MRHA-2	AKSF-345	AKSF-12	CSFR-99	CD @ 5%
Days to 50% flowering	-1.990**	0.260	-0.656**	1.510*	-1.073**	1.344*	0.177	0.427	1.727
Days to maturity	-2.250**	0.333	-0.417**	1.500*	-1.167**	1.333	0.333	0.333	1.158
Plant height	-5.733**	0.833	-4.350**	-0.217**	-3.217**	4.683	6.283	1.717	5.689
Head diameter (cm)	0.915**	-0.469**	-1.669**	-1.902**	-0.919**	1.365**	0.715*	1.965**	0.669
Seed filling (%)	0.860	0.341	1.415	-1.173**	1.099	-1.710**	-0.269**	-0.564**	2.828
100 Seed weight	-0.118**	0.042*	0.248**	0.124**	-0.253**	-0.051**	-0.052**	0.058**	0.169
Volume weight(g/100ml)	-0.743**	-0.819**	-0.079**	1.247	-1.143**	1.032	1.295	-0.789**	1.425
Hull content (%)	-0.288**	1.738**	0.183	-1.824**	0.523	-0.101**	0.919	-0.152**	0.971
Seed yield / plant	-0.541**	0.989	2.353*	1.385	-2.634**	0.873	-1.699**	-0.725**	1.479
Oil content (%)	-0.164**	-1.322**	-0.030**	-0.005**	0.328	0.928*	0.520	-0.255**	0.878

** and* indicates significant at 1% and 5%, respectively

Table.3 Estimates of specific combining ability (SCA) effects in sunflower crosses for ten characters

Sr. No.	Characters	Days to 50% Flowering	Days to maturity	Plant Height (cm)	Head Diameter (cm)	Seed Filling (%)	100 Seed Weight (g)	Volume Weight (g/100ml)	Hull Content (%)	Seed yield/ Plant(g)	Oil Content (%)
1	CMS-234 xNSH-312	1.781	1.667	-0.225	-0.631	-2.495	0.428*	0.695	-1.823	-1.712	-0.661
2	CMS-234xPSCIM165	1.198	1.083	-8.792	0.352	1.520	0.214	-0.645	-0.400	-1.812	-0.103
3	CMS-234 x PSMOO-108	-1.885	-1.500	-1.275	1.019	1.513	-0.062	0.941	-1.305	2.174	0.805
4	CMS-234 x PSFRMM-140	-2.719*	-3.083**	-5.275	0.919	-1.753	0.282	-0.831	-0.401	4.232**	0.914
5	CMS-234 x MRHA-2	-1.135	-0.750	8.525	0.469	1.009	-0.768**	-1.645	5.062**	0.992	0.180
6	CMS-234 x AKSF-345	2.115	1.750	-3.908	-0.615	0.484	0.124	2.130	1.826	1.157	1.547
7	CMS-234 x AKSF-12	0.281	0.417	7.758	-1.365*	-0.283	-0.122	0.004	-2.901**	-1.674	-2.478**
8	CMS-234 x CSFR-99	0.365	0.417	3.192	-0.148	0.005	-0.095	-0.649	-0.060	-3.358*	-0.203
9	CMS-62 x NSH-312	0.865	0.833	0.692	-1.390*	0.048	-0.558**	1.370	5.860	1.841	0.189
10	CMS-62 x PSCIM-165	-2.719*	-2.750*	3.992	0.127	0.460	0.067	-1.820	2.100*	1.914	1.147
11	CMS-62 x PSMOO-108	3.865**	4.000**	-3.292	1.927**	-2.785	0.475**	-5.297**	-1.228	-2.247	-0.145
12	CMS-62 x PSFRMM-140	-0.635	-0.250	4.508	0.694	-1.096	-0.498**	0.464	1.899	-3.218*	0.197
13	CMS-62 x MRHA-2	-0.719	-0.583	5.042	1.177	0.609	-0.301	2.934*	-1.698	0.724	-0.203
14	CMS-62 x AKSF-345	-0.135	0.250	-1.392	-1.106	1.407	0.041	-3.268*	-2.274*	-1.927	-0.570
15	CMS-62 x AKSF-12	-0.969	-1.750	3.075	-1.056	2.850	0.438*	2.172	-3.218	2.562	-0.028

Sr. No.	Characters	Days to 50% Flowering	Days to maturity	Plant Height (cm)	Head Diameter (cm)	Seed Filling (%)	100 Seed Weight (g)	Volume Weight (g/100ml)	Hull Content (%)	Seed Yield/ Plant(g)	Oil Content (%)
16	CMS-62 x CSFR-99	0.448	0.250	-6.625	-0.373	-1.192	0.342*	3.446*	-1.440	0.352	-0.586
17	CMS-343 x NSH-312	0.365	0.167	9.567	1.160	-2.192	0.302	-2.059	-2.187*	0.104	0.484
18	CMS-343 X PSCIM-165	-0.885	-1.083	3.067	-1.056	-6.044*	-0.165	1.651	-0.201	0.524	-0.724
19	CMS-343 x PSMOO-108	-2.635*	-2.333*	-5.350	-1.656*	2.198	-0.341*	4.765**	-1.282	-1.477	0.184
20	CMS-343 x PSFRMM-140	3.865**	4.083**	-6.883	-1.090	5.190	-0.297	1.802	0.079	-0.639	-1.274
21	CMS-343 x MRHA-2	-0.219	-0.583	-15.883**	-0.873	-0.168	0.553**	-1.465	-0.702	-1.953	1.093
22	CMS-343 x AKSF-345	-1.635	-1.750	3.883	0.510	-0.367	0.018	0.694	2.482	0.593	-8.807
23	CMS-343 x AKSF-12	2.198	2.250	-0.783	1.760*	1.812	-0.335	0.057	1.505	2.618	1.168
24	CMS-343 x CSFR-99	-1.052	-0.750	12.383*	1.244	-0.492	0.265	-5.445**	0.306	0.231	-0.124
25	CMS-89-1 x NSH- 312	-3.010**	-2.667*	-10.033	0.860	4.576	-0.172	-0.005	-1.850	-0.233	-0.011
26	CMS-89-1 x PSCIM-165	2.406*	2.750*	1.733	0.577	4.065	-0.109	0.815	-1.500	-0.626	-0.320
27	CMS-89-1 x PSMOO-108	0.656	-0.167	9.917	-1.290	-0.926	-0.072	-0.409	3.815	1.550	-0.845
28	CMS-89-1 x PSFRMM-140	-0.510	-0.750	7.650	-0.523	-2.341	0.513**	-1.435	-1.577	-0.375	0.164
29	CMS-89-1 x MRHA-2	2.073	1.919	2.312	-0.773	-1.450	0.516**	0.175	-2.661	0.237	-1.070
30	CMS-89-1 xAKSF-345	-0.344	-0.250	7.417	1.210	-1.525	-0.183	0.444	-2.034	0.177	-0.170
31	CMS-89-1 x AKSF-12	-1.510	-0.912	-10.050	0.660	-4.379	0.018	-2.233	4.613	-3.505*	1.339
32	CMS-89-1 x CSFR-99	0.240	0.083	-8.950	-0.723	1.980	-0.512**	2.648	1.194	2.775	0.194
	CD @ 5%	**2.255**	**2.317**	**11.377**	**1.339**	**5.656**	**0.339**	**2.849**	**1.954**	**2.959**	**1.756**

The sca effect of the hybrids CMS-89-1 x NSH-312 were found promising for early flowering (-3.010) and early maturity (-2.667) while CMS-343 x PSMOO-108 for volume weight (4.765), early flowering (-2635) and days to maturity (-2.333). The cross CMS- 62 x CSFR-99 was found promising for volume weight (3.446) and 100 seed weight (0.342). The cross CMS-62 x PSCIM-165 for early maturity (-2.750), early flowering (-2.719) while cross CMS-234 x PSFRMM-140 was found promising for early maturity (-3.083), and early flowering (-2.719). These crosses showed the highest sca effects for different characters. Similar findings were reported by Dua and Yadava, (1983), Ashoka *et al.*, (2000), Aydin and Goksoy, (2006), Binodh *et al.*, (2008), Dingra *et al.*, (2010), Ghaffari *et al.*, (2011), Shrishaila *et al.*, (2017), Vishwanath K.S., (2003).

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