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RESEARCH PAPER

Economic heterosis study in sunflower (*Helianthus annuus* L.) for seed and oil yield in newly developed hybrids

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Abstract : Present investigation was carried out to spot out the best hybrid combinations giving high degree of useful heterosis for economic traits like seed and oil yield in sunflower for identification of some superior sunflower hybrids. Economic/Standard heterosis is the measure of heterosis in terms of superiority over the standard check (s) / hybrid (s). The degree of heterosis varied for important useful characters among different crosses. Presence of high heterosis in certain crosses and low in others suggested that the nature of gene action varied with genetic architecture of the parents. A total of 17 sunflower hybrids along with the three national checks, LSFH-171, KBSH-53 and DRSH-1 were evaluated in a Randomized Block Design during *Rabi*-2017-18 and 2018-19 at Nimpith centre. For oil yield (kg/ha), the highest standard heterosis was observed in sunflower hybrid CMS-852A x RHA-138-2 which oil yield was recorded 25.4 per cent higher against LSFH-171, 20.4 per cent higher against KBSH-53 and 26.2 per cent higher against DRSH-1, respectively. The significant economic/standard heterosis were also observed in experimental sunflower hybrids *viz.*, CMS-852A x EC-601971 for oil yield, 23.3 per cent higher than LSFH-171, 18.4 per cent higher than KBSH-53, 24.1 per cent higher against DRSH-1, respectively, CMS -853A x EC623025 for oil yield, 19.1 per cent higher than LSFH-171, 14.4 per cent higher than KBSH-53, 19.9 per cent higher against DRSH-1, respectively, CMS-853 A x EC 623023 for oil yield , 19.1 per cent higher than LSFH-171, 14.4 per cent higher than KBSH-53, 19.9 per cent higher against DRSH-1, respectively and CMS-852A x EC-601957 for oil yield, 19.0 per cent higher than LSFH-171, 14.3 per cent higher than KBSH-53, 19.8 per cent higher against DRSH-1, respectively.

Key Words : Sunflower, Economic heterosis, Seed yield, Oil yield

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INTRODUCTION

Sunflower (*Helianthus annus* L.) is the fourth important oilseed crop in the world. It belongs to the genus *Helianthus,* family Asteraceae. Sunflower seeds contain 38 to 42 per cent edible oil which is used for culinary purposes. Sunflower oil is considered as premium oil as compared to other vegetable oils because of its light yellow colour, flavour, high smoke point and high level of linoleic acid (55–60%). Sunflower was introduced to India in 1969 from USSR for its distinct advantages *viz.,* photo insensitivity, wider adaptability, short duration, better oil quality with high polyunsaturated fatty acid content (PUFA) and high seed multiplication ratio. However, its large scale cultivation was started from 1972 onwards with the introduction of Russian varieties. In India, sunflower is cultivated over an area of 5.2 lakh hectares with a production and productivity of 3.35 lakh tonnes and 0.64 t ha^{-1}, respectively (Anonymous, 2018). Sunflower is being grown over 70 per cent of area across Karnataka, Maharashtra and Andhra Pradesh. It occupies an area of about 3.6 lakh hectare with a production of 2.1 lakh tonnes and productivity of 0.57 t ha^{-1} in Karnataka (Anonymous, 2017). Exploitation of heterosis on commercial for a particular locally requires isolation of suitable inbred and development of hybrids. To accomplish this task, one has to know the genetic diversity of the available germplasm and the combining ability of the parents. For improving the yield potential of varieties and hybrids, the decision should be made on the choice of the right parent for hybridization. In addition to ascertaining overall specific combining ability status of cross combinations, it is also equally important to ascertain the overall heterotic status of the cross combinations across the traits. The overall heterotic status of the cross combinations is estimated as like the same method followed for overall specific combining ability status based on the rank sum of hybrid (mid-parent heterosis) across the traits compared with the final norm for the heterosis.

MATERIAL AND METHODS

This was conducted during *Rabi* season of 2017-18 and 2018-2019. Experimental materials (CMS A with respective maintainer and Restorer lines) were collected from ICAR-IIOR, Hyderabad India and other AICRP-Co-ordinating Centre through AICRP-System, on the basis of their diverse origin, growth habit, phenology and adaptation. Thirteen sunflower genotypes (4 CMS lines and 9 Restorer lines) were grown in a Randomized Complete Block Design with 2 replications in a plot size of 1.8 m x 3.0 m. Each plot contained three rows with spacing of 60 cm x 30 cm.

Hybridization programme:

The hybridization programme was undertaken in 2017 and 2018 at *Kharif* season at AICRP-Sunflower, Nimpith centre. Hybridization was started at the onset of flowering among the parents based on flowering synchrony. The female lines used in this hybridization programme were Cytoplasmic Male Sterile lines (CMS). Pollination of selected CMS flowers were carried out by collecting pollen from heads which were already bagged prior to flowering. The bagging was done a day before over male and female flowers to prevent contamination and to avoid spilling the pollen. Pollen grains were applied by a camel hair brush which were dipped in the pollen and gently drawn over the receptive surface of the stigmas at morning from 9 A.M. to 11 A.M. The pollination was repeated for five to six days (in alternate days) in each of the combination to ensure sufficient seed set. After pollination, again flowers were bagged and tagged properly keeping till harvesting.

Field evaluation:

All the F_1s, (newly developed hybrids) and their parents (17F_1/hybrids were developed by using 4 CMS lines and 9 testers) were evaluated along with the three National check hybrids LSFH-171, KBSH-53 and DRSH-1 in a Randomized Complete Block Design with three replications in a plot size of 3.0 m x 3.0 m in two consecutive years (2017-18 and 2018-19) at AICRP-Sunflower, Nimpith centre. All the agronomic practices were followed periodically as per the recommendation for sunflower crop. The data was recorded in ten randomly selected plants from each plot of all replications on the following characters *viz.*, days to 50 per cent flowering, plant height at harvest (cm), head diameter per plant (cm), seed weight per head (g), 100-seed weight (g), husk weight (g) and hull content (%), volume weight (seed weight in gram per 100 ml) and oil content (%). The seed yield (kg/ha), oil percentage and oil yield (kg/ha) were estimated on plot basis. The mean values were subjected to statistical analysis.

RESULTS AND DISCUSSION

Heterosis breeding has been commercially exploited in sunflower and is expected to enhance productivity further. Heterosis is the increase or decrease in vigour of F_1 over its mid or better parental value. One of the objectives of present study was to estimate the extent of heterosis for various characters and to isolate promising hybrids over standard check hybrids for seed yield and oil content for commercial exploitation. For our purposes, we will define heterosis or hybrid vigour as the difference between the hybrid and the mean of the two parents (Falconer and Mackay, 1996) that is mid-parent heterosis and better-parent heterosis which is preferred in some circumstances, particularly in self-pollinated crops, for which the goal is to find a better hybrid than either of the parents. The nature and magnitude of heterosis for seed yield and its component characters is helpful in heterosis breeding. The maximum utilization of heterosis is possible when the variance due to both additive and non-additive gene actions are fully exploited since they play a significant role in determining the magnitude of expression of yield and its component.

Main objectives of estimation of economic heterosis in the present investigation was to spot out the best combination of parent giving high degree of useful heterosis for seed yield and other yield attributing character for their prospects for future use in sunflower breeding programme. Heterosis was measured as per cent increase or decrease of F_1 over standard check hybrid (Standard heterosis) for all the characters. Apart from indicating gene interaction, the measurement of heterosis over better parental value has relatively less importance than standard heterosis. Therefore, it is better to measure heterosis in terms of superiority over the standard check hybrid rather than over better parent. In the present investigation the degree of heterosis varied from cross to cross for all the characters. Considerably high heterosis in certain crosses and low in the others suggested that the nature of gene action varied with the genetic architecture of the parents. *Per se* performance of the newly developed hybrids were presented as under Table 1. The results on economic heterosis for twelve different yield attributing characters and best superior hybrids for twelve different yield attributing characters were presented as under Table 2.

Standard/Economic heterosis:

Main objectives of estimation of economic heterosis in the present investigation was to spot out the best combination of parent giving high degree of useful heterosis for seed yield and other yield attributing character for their prospects for future use in sunflower breeding programme. Heterosis was measured as per cent increase or decrease of F_1 over standard check hybrid (Standard heterosis) for all the characters. Apart

Table 1 : Performance of sunflower hybrids at Nimpith centre, for yield and yield attributing traits during *Rabi*- (2017-18 and 2018-19 pulled)

Cross combination	Plant height (cm)	Head diameter (cm)	50% flowering	Seed yield (kg/ha)	100-seed wt. (g)	Oil content (%)	Oil yield (kg/ha)
CMS-853 A x EC 623023	168	14.5	72.5	2168	5.4	37.5	813.4
CMS 852 A x RHA-138-2	164	15.4	73.6	2282	5.6	37.5	855.8
CMS-852A x EC-601971	171	15.4	72.2	2209	5.0	38.1	841.6
CMS-853 A x EC623025	178	14.9	71.7	2197	6.1	37.0	812.9
CMS-853 A x EC601957	172	15.2	69.4	2165	6.5	37.0	801.1
CMS-10A x EC-601725	158	14.7	67.0	2044	5.5	38.0	776.7
PET-89-1A x EC-601916	146	14.5	69.8	2188	4.7	37.8	827.1
P-2-7-1A x EC-601751	156	15.2	71.7	2149	5.0	37.5	805.9
CMS -207A x EC623023	145	14.6	69.4	1975	4.6	36.2	715.0
CMS-852A x EC-601957	162	14.5	70.8	2152	5.0	37.8	812.3
PET-89-1A x EC-601751	146	14.8	67.5	1978	5.5	38.5	761.5
CMS-850A x EC603027	138	14.3	67.9	1868	5.9	37.3	696.8
CMS-10A x EC-623027	136	13.5	69.8	1770	4.6	38.6	683.2
CMS-103 A x EC-601725	150	14.0	69.8	1894	5.5	35.5	672.4
CMS-852A x EC-601725	146	13.8	69.8	1822	5.7	37.2	677.8
CMS-207A x EC-601725	155	13.6	67.9	1815	5.0	36.5	662.5
CMS 10A x EC601751	141	13.5	69.8	1770	5.3	38.2	676.1
LSFH-171 (C)	184	15.3	78.5	2120	5.5	32.2	682.6
KBSH-53 (C)	180	15.2	76.5	1996	5.1	35.6	710.6
DRSH-1 (C)	174	14.7	74.2	1746	5.8	39.0	678.2
G. Mean	157.68	14.57	70.82	2029.58	5.34	37.05	751.86
C.D. (P=0.05)	-	-	-	124.2	-	-	35.4
C.V. (%)	-	-	-	9.4	-	-	8.8

Table 1A : Seed yield and oil yield of new sunflower hybrids including national checks in SHT and MLT in 2017-18 and 2018-19 at Nimpith

Cross combinations	Seed yield (kg/ha)			Seed yield (kg/ha)					Oil yield (kg/ha)	
	2018-19 SHT and MLT	2017-18 SHT and MLT	Over the years	SHT-2017-18	MLT-2017-18	SHT-2018-19	MLT-2018-19	Over the years	2018-19 SHT and MLT	2017-18 SHT and MLT
CMS-852 A x RHA-138-2	2466	2536	2501	2589	2336	2556	2452	932	910	954
CMS-853 A x EC623025	2376	2441	2409	2495	2251	2452	2356	887	866	908
CMS-853 A x EC601957	2255	2405	2330	2308	2197	2348	2314	861	824	897
CMS-852A x EC-601971	2352	2454	2403	2458	2240	2423	2384	914	885	942
CMS-853 A x EC 623023	2248	2409	2329	2312	2178	2408	2250	874	835	913
CMS-852A x EC-601957	2246	2388	2317	2350	2136	2356	2284	877	841	912
PET-89-1A x EC-601751	2137	2198	2168	2204	2066	2212	2162	826	806	846
CMS-10A x EC-601725	2145	2271	2208	2208	2068	2218	2098	836	803	868
PET-2-7-1A x EC-601751	2125	2242	2184	2160	2064	2293	2074	839	808	870
LSFH-171 (C)	2232	2356	2294	2308	2196	2409	2179	739	711	766
KBSH-53(C)	2142	2218	2180	2194	2056	2289	2071	777	756	798
DRSH-1(C)	1790	1932	1861	1880	1696	1954	1768	723	688	757
S.E. ±	64.5	56.5	59.6	56.5	51.8	48.5	40.7	23.8	21.7	22.7
C.D. (P=0.05)	192.4	168.2	178.4	166.8	153.7	142.6	134.5	71.5	64.8	66.8
C.V. (%)	9.6	9.1	9.4	9.3	9.2	9.1	8.6	8.8	8.5	9.2

from indicating gene interaction, the measurement of heterosis over better parental value has relatively less importance than standard heterosis. Therefore, it is better to measure heterosis in terms of superiority over the standard check hybrid rather than over better parent. In the present investigation the degree of heterosis varied from cross to cross for all the characters. Considerably high heterosis in certain crosses and low in the others suggested that the nature of gene action varied with the genetic architecture of the parents. *Per se* performance of the newly developed hybrids were presented as under Table 1. The results on economic heterosis for seed yield (kg/ha) and oil yield (kg/ha) for the superior hybrids were presented in Table 2.

A total of 17 sunflower hybrids along with the three national checks, LSFH-171, KBSH-53 and DRSH-1 were evaluated in a Randomized Block Design with three replications in a plot size of 3.0 m x 3.0 m. The data pertaining to seed yield and other yield attributing traits along with the check hybrids are presented in Table 1. The trial was carried out during *Rabi*-2017-18 and 2018-19 at Nimpith centre. The best cross combination for

Table 2: Seed yield and oil yield superiority over KBSH-53, LSFH-171 and DRSH-1

Cross combination	Seed yield (kg/ha)	Over LSFH-171	Over KBSH-53	Over DRSH-1	Oil yield (kg/ha)	Over LSFH-171 (%)	Over KBSH-53 (%)	Over DRSH-1 (%)
CMS 852 A x RHA-138-2	2282	7.6	14.3	30.7	855.8	25.4	20.4	26.2
CMS-852A x EC-601971	2209	4.2	10.7	26.5	841.6	23.3	18.4	24.1
CMS -853A x EC623025	2197	3.6	10.1	25.8	812.9	19.1	14.4	19.9
CMS-853 A x EC 623023	2168	2.3	8.6	24.2	813.4	19.2	14.5	19.9
CMS-853 A x EC601957	2165	2.1	8.5	24.0	801.1	17.4	12.7	18.1
CMS-852A x EC-601957	2149	1.4	7.7	23.1	812.3	19.0	14.3	19.8
CMS-10A x EC-601725	2044	-3.6	2.4	17.1	776.7	13.8	9.3	14.5
PET-2-7-1A x EC-601751	2018	-4.8	1.1	15.6	776.9	13.8	9.3	14.6
PET-89-1A x EC-601751	1978	-6.7	-0.9	13.3	761.5	11.6	7.2	12.3
LSFH-171 (C)	2120	-	-	-	682.6	-	-	-
KBSH-53(C)	1996	-	-	-	710.6	-	-	-
DRSH-1(C)	1746	-	-	-	678.2	-	-	-

semi-dwarf plant height coupled with good seed yield (kg/ha), high oil content and oil yield (kg/ha) were observed in CMS-852A x RHA-138-2 (seed yield of 2282 kg/ha, 37.5 per cent oil content and oil yield of 855.8 kg/ha); CMS-853A x EC-623025 (seed yield of 2197 kg/ha, 37.0% oil content and oil yield of 812.9 kg/ha), CMS-852A x EC-601971 (seed yield of 2209 kg/ha, 38.1% oil content and oil yield of 841 kg/ha), CMS-853A x EC-601957 (seed yield of 2165 kg/ha, oil content 37.1% and oil yield of 801 kg/ha); CMS-853A x EC-623023 (seed yield of 2168 kg/ha, oil content 37.5% and oil yield of 813 kg/ha) and CMS-852A x EC-601957 (seed yield of 2149 kg/ha, oil content 37.8% oil yield of 812 kg/ha), P-2-7-1A x EC-601751(seed yield of 2149 kg/ha, oil content 37.5% and oil yield of 805 kg/ha), respectively in comparison with the best national check hybrids LSFH-171 (seed yield of 2120 kg/ha, 32.2% oil content and oil yield of 682.6 kg/ha), KBSH-53 (seed yield of 1996 kg/ha, 35.6% oil content and oil yield of 710 kg/ha) and DRSH-1 (seed yield of 1746 kg/ha, 39.0% oil content and oil yield of 678 kg/ha).

Across the season in Station Hybrid Trial, the highest standard heterosis for oil yield was observed in sunflower hybrid CMS-852A x RHA-138-2 for oil yield (kg/ha) which oil yield was recorded 25.4 per cent higher against LSFH-171, 20.4 per cent higher against KBSH-53 and 26.2 per cent higher against DRSH-1, respectively. The significant economic/standard heterosis were also observed in experimental sunflower hybrids *viz.*, CMS-852A x EC-601971 for oil yield, 23.3 per cent higher than LSFH-171, 18.4 per cent higher than KBSH-53, 24.1 per cent higher against DRSH-1, respectively, CMS -853A x EC623025 for oil yield, 19.1 per cent higher than LSFH-171, 14.4 per cent higher than KBSH-53, 19.9 per cent higher against DRSH-1, respectively, CMS-853 A x EC 623023 for oil yield, 19.1 per cent higher than LSFH-171, 14.4 per cent higher than KBSH-53, 19.9 per cent higher against DRSH-1, respectively and CMS-852A x EC-601957 for oil yield, 19.0 per cent higher than LSFH-171, 14.3 per cent higher than KBSH-53, 19.8 per cent higher against DRSH-1, respectively.

Prevalence of significant standard heterosis for seed yield has also been reported by Manivannan *et al.* (2015) and Sawant *et al*. (2007a and b). Attaining higher standard heterosis for seed yield in the experimental hybrids with the use of CMS lines /tester lines have also been made by Meena *et al.* (2013); Chandra *et al.* (2013) and Supriya *et al.* (2017). The significant positive heterosis of hybrids based on diverse CGMS system over national check hybrid KBSH-44 was also reported by Ambati (2010) and Nandini *et al.* (2017). The presence of significant positive heterosis among the newly developed sunflower hybrid sand superiority of *H. praecox* based hybrids was also in line with studies by Nandini *et al.* (2017) and Tyagi *et al.* (2013).

Parameshwarappa *et al*. (2008) and Mohanasundaram *et al.* (2010) noticed the standard heterosis of for seed yield and for oil content. Prevalence of significant standard heterosis for seed yield has also been reported by Thakare *et al.* (2015). Attaining higher standard heterosis for seed yield in the experimental hybrids with the use of CMS lines /tester lines have also been made by Meena *et al.* (2013) ; Chandra *et al.* (2013) and Supriya *et al.* (2017). Attaining higher standard heterosis for seed yield and most of the yield contributing traits in the experimental hybrids with the use of diverse CMS lines have also been made by Nandini *et al.* (2017) and Manivannan *et al.* (2015). Standard heterosis over best check *i.e.* DRSH-1 for seed yield and oil content Rathi *et al.* (2016). The results regarding standard heterosis of diverse CMS lines based hybrids showed varied extent of magnitude and direction of heterosis for the crosses for each trait. Similar findings were reported by Tyagi *et al.* (2013). The results regarding economic heterosis of diverse CMS lines based hybrids showed varied extent of magnitude and direction of heterosis for the crosses for each trait. Similar findings were reported by Nandini *et al.* (2017) and Lakshman *et al.* (2018).

Conclusion:

From the study it may be concluded that the sunflower hybrids *viz.*, CMS-852A x RHA-138-2, CMS-852A x EC-601971, CMS -853A x EC623025, CMS-853 A x EC 623023, may be promoted for AICRP Multilocation trial/Co-ordinated trial for further evaluating their performance in Eastern India due to their superiority for oil yield (kg/ha) over the best national check sunflower hybrids over the environments and over the years.

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REFERENCES

Ambati, Divya (2010). Genetic analysis of diverse sources of CMS on fertility restoration, heterosis and combining ability in sunflower (*Helianthus annuus* L.) M.Sc. (Ag.) Thesis, University of Agricultural Sciences, Dharwad, Karnataka, India.

Chandra, B.S., Ranganatha, A.R.G. and Kumar, S. (2013). Heterosis studies for yield and it's components in sunflower hybrids over locations. *Madras Agric. J.,* **100** (13):23-29.

Falconer, D.S. and Mackay, T.F.C. (1996). *Introduction to quantitative genetics*. Longman House, Essex.

Lakshman, S.S., Chakrabarty, N.R. and Kole, P.C. (2018). Economic heterosis for seed and oil yield in sunflower (*Helianthus annuus* L.) hybrids over locations in heterosis breeding West Bengal. *Indian Agriculturist*., **62** (1 & 2): 1-8.

Manivannan, N., Chandirakala, R. and Abirami, S. (2015). Evaluation of new CMS lines for heterosis breeding in sunflower (*Helianthus annuus* L.). *Adv. Life Sci.,* **5** (5): 1909-1912.

Meena, C.R., Meena H.P. and Snha, B. (2013). Fertility restoration, combining ability effects and heterosis in sunflower (*Helianthus annuus* L.) using different CMS sources. *Chilean J. Agric. Res.,* **17** (99): 101-104.

Mohansundaram, K., Manivannan, N. and Vindhaiyavarman, P. (2010). Combining ability analysis for seed yield and its components in sunflower (*Helianthus annuus* L.). *Elec. J. Pl. Breed.,* **4** : 864-865.

Nandini, C., Shadakshari, Y. G., Pushpa, D., Puttarangaswamy, K.T. and Kumar, V. (2017). Genetic diversity analysis in diversified cms and restorer lines in sunflower (*Helianthus annuus* L.). *Internat.J.Curr.Microbiol.App.Sci*., **6** (10): 3185-3189.

Parameshwarappa, K.G., Jalandhar, Ram and Lingaraju, B.S. (2008). Heterosis and combining ability for seed yield, oil content and other agronomic traits involving mutant restorer lines in sunflower (*Helianthus annuus* L.). *J. Oilseeds Res.,* **25** (1): 8-12.

Rathi, S.R., Nichal, S.S., Vaidya, E.R., Ratnaparkhi, R.D. and Janjal, S.M. (2016). Combining ability for yield contributing traits and oil content in sunflower (*Helianthus annuus* L.). *Internat. J. Trop. Agric*., **34** (4): 1043-1049.

Sawant, P.H., Manjare, M.R. and Kankal, V.Y. (2007a). Heterosis for seed yield and its components in sunflower (*Helianthus annuus* L.). *J. Oilseeds Res.,* **24**: 313-314.

Sawant, P.H., Manjare, M.R. and Kankal, V.Y. (2007b). Combining ability studies of few male sterile lines and restorers in sunflower. *J. Oilseeds Res.,* **24** : 315-16.

Supriya, S.M., Kulkarni, V.V., Ranganatha, C.N. and Suresha, P.G. (2017). Quantitative analysis of oil yield and its components in newly developed hybrids of sunflower (*Helianthus annuus* L.). *Internat. J. Curr. Microbiol. App. Sci.,* **6** (8) : 3088-3098.

Thakare, S. U., Nichal, S.S., Ingle, A. U. and Tayade, S.D. (2015). Heterosis studies for yield contributing traits and oil content in sunflower (*Helianthus annuus* L.). *Trends in Bio-sci.,* **8** (12) : 3010-3017.

Tyagi, N., Dhillon, S.K. and Bajaj, R.K. (2013). Estimates of heterosis for oil content in sunflower (*Helianthus annuus* L.).*16th Punjab Science Congress.* pp. 72.

WEBLIOGRAPHY

Anonymous (2017). *https://www.sunflowernsa.com/stats/worldsupply.*

Anonymous (2018). *https://www.sunflowernsa.com/stats/worldsupply.*

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