Biological Forum – An International Journal **15(6): 25-29(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Heterosis Studies for Yield and Yield contributing Components in Sunflower (*Helianthus annuus* L.)

S.C. Nagrale[1*], S.B. Sakhare[2], P.V. Yadgirwar[3], S.S. Nichal[4] and P.V. Jadhav[5]
[1]Ph.D. Scholar, Department of Agricultural Botany (Genetics and Plant Breeding), PGI, PDKV, Akola (Maharashtra), India.
[2]Associate Professor, Department of Agricultural Botany (Genetics and Plant Breeding), PGI, PDKV, Akola (Maharashtra), India.
[3]Head of agricultural Research Station, Yavatmal, Dr. PDKV, (Maharashtra), India.
[4]Associate Professor, Regional Research Centre, Dr. PDKV, Amravati (Maharashtra), India.
[5]Assistant Professor, Department of Agricultural Biotechnology, PGI, Dr. PDKV, Akola, Maharashtra, India.

(Corresponding author: S.C. Nagrale)*
(Received: 06 April 2023; Revised: 8 May 2023; Accepted: 20 May 2023; Published: 20 June 2023)
(Published by Research Trend)

ABSTRACT: The present experimental material consist of four CMS lines and nine testers which were crossed in line × tester mating design to estimate the average heterosis, heterobeltosis and standard heterosis over the check LSFH171 for seed yield and Its important yield contributing traits in sunflower. The resulting 36 hybrids and 13 parents along with check *viz.*, LSFH-171 were evaluated in randomized block design with three replications at Agricultural Research Station, Yavatmal. A broad range of heterotic variation observed for all the five yield and yield contributing parameters and it was ranged from -17.94% to 195.69%, 30.51% to 132.42% and -40.61% to 68.90% over the average heterosis, heterobeltiosis and standard heterosis over check LSFH-171 respectively for seed yield per plant. 28, 20 and 10 hybrids displayed positive and significant heterosis over the mid parent, better parents and standard check (LSFH-171) respectively and top three hybrids *viz.*, ARM – 250 A × PKV- 103 R, CMS- 17 A × PKV-106 R and ARM – 250 A × PKV 106 R manifested highest magnitude heterosis over the mid parent, better parents and standard check (LSFH-171) for seed yield and these hybrids also showed significant heterosis for head diameter, 100 seed weight and seed filling percentage. Hence, these identified hybrids could be use for exploitation of heterosis after evaluating and testing with large multilocations trials.

Keywords: Sunflower, heterosis, hybrid, line × tester, yield.

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an important edible oilseed crop in India and it seed contains 38 to 42% oil and 23% protein (Ailwar *et al.*, 2020; Nagrale *et al.*, 2022). It grow in different agro climatic zones in India due to wider adaptability, photothermo-insensitivity, high yield potential, high oil content, drought tolerance, short duration, easy cultivation, responsiveness to better management practices, suitability to fit in to different cropping systems and patterns and remunerative market price (Rathi *et al.*, 2019; Debaeke *et al.*, 2017). Maximizing production is the major goal of any crop improvement programme. Improvement in sunflower is difficult because of self incompatibility mechanism associated out-breeding nature. Hence high percentage of empty seeds are the major constraints in sunflower production. To overcome these constraints plant breeders have focused their attention towards exploitation of hybrids through heterosis breeding. The discovery of cytoplasmic male sterility (Leclercq, 1969) and fertility restoration system (Kinman, 1970) is considered to be the milestone in the hybrid-breeding era of cultivated sunflower. According to our need sunflower hybrids are more uniform at maturity, more stable, highly self fertile with maximum yield performance (Seetharam, 1979; Kaya and Atakisi 2004). Hence, the present studied was carried out to estimate average, heterobeltosis and standard heterosis in 36 hybrids obtained from 5 CMS lines and 9 restorers.

MATERIALS AND METHOD

The present research conducted at Agricultural Research Station, Yavatmal during *Kharif*-2019 and *Kharif*-2020 seasons. Crossing programme adopting using line × tester mating design (Kempthorne, 1957) and the parental material consisting of four CMS lines

(AKSF -10 – 1 – 1A, CMS – 302A, CMS – 17A and ARM – 250A) and nine testers (GP_6961, GP_61075, GP_6389, GP_62902, AK – 1R, 856 R, PKV – 103R, 298 – 1R and PKV – 106R). The resultant 36 hybrids along with their 13 parents and one check *viz.* LSFH-171 were evaluated in randomized block design. Each plot consisted of two rows of 3.0 meter length with a spacing of 60 cm between rows and 30 cm between plants. Observations were recorded in each entry on randomly selected three plants for five importance yield contributing characters *viz.* days to maturity, head diameter (cm), 100 seed weight(g), seed filling (%), seed yield per plant (g).

RESULTS AND DISCUSSION

The pooled heterosis (%) over mid parent, better parent and standard heterosis for five importance traits in sunflower presented in Table 1 and 2 in *kharif*-2019 and *kharif*-2020 seasons. Fourteen, twenty and twenty-five hybrids recorded negative significant heterosis over the mid-parent, better parent and standard heterosis over the check LSFH-171 in desired direction and range was observed to be from -5.24% to 6.35%, -5.86% to 4.89% and -5.52% to 1.10% for days to maturity respectively. The hybrids showing highest significant negative heterosis were CMS - 17 A × 298- 1R (-5.52%), ARM – 250 A × AK- 1R (-5.52%) and AKSF -10-1-1A × Gp_6389 (-5.34%) over the check LSFH-171 for days to maturity. Similar result were reported by earlier worker i.e, Janjal *et al.* (2016); Ailwar *et al.* (2020); Lakshman *et al.* (2020) for negative heterosis for days to maturity.

Larger head diameter is an important yield contributing traits and thus positive heterosis desirable for this character. Out of 36 hybrids, 14, 9 and 12 hybrids exhibited significant positive heterosis over the mid-parent, better parent and standard heterosis over the check LSFH-171 for head diameter respectively. The hybrid ARM – 250 A × PKV- 103 R (40.69%) expressed the highest significant positive relative heterosis for head diameter followed by CMS - 302 A × AK- 1R (38.31%) and CMS- 17 A × PKV-106 R (32.39%). The hybrids showing maximum heterobeltiosis for head diameter were CMS - 302 A × AK- 1R (25.75%), CMS- 17 A × PKV-106 R (23.13%) and ARM – 250 A × PKV- 103 R (23.11%). The top three hybrids showing maximum heterosis over the check LSFH-171 were observed to be ARM – 250 A × PKV- 103 R(24.64%), CMS- 17 A × PKV-106 R(22.56%), CMS - 302 A × AK- 1R(22.19%), AKSF -10-1-1A × 856R (21.66%) and AKSF -10-1-1A × Gp_42902(19.79%). Habib *et al.* (2006); Sujatha and Reddy (2009) observed positive significant heterosis for head diameter and seed yield.

Heavier weight of seed is an also important yield parameter in sunflower breeding, hence positive significant heterosis desirable. For 100 seed weight heterotic variation observed from-15.90% to 71.71%,-24.02% to 57.69% and -34.29% to 18.02% and twenty-seven, sixteen and seven hybrids noted significant and positive heterosis in desirable direction over the average heterosis, Heterobeltiosis and standard heterosis over the check LSFH-171 respectively. The hybrids ARM – 250 A × PKV- 103 R (71.71%), CMS – 302 A × PKV-106 R (51.99%) and ARM – 250 A × PKV 106 R (49.61%) exhibited highest positive significant average heterosis. Heterobeltiosis for 100 seed weight was highest in hybrid ARM – 250 A × PKV- 103 R (57.69%) followed by ARM – 250 A × PKV 106 R (48.92%) and CMS - 302 A × AK- 1R (47.93%). The top three hybrids ARM – 250 A × PKV- 103 R (18.02%), ARM – 250 A × PKV- 103 R (11.46%) and ARM – 250 A × Gp_6389(7.74%) recorded highest magnitude of significant positive heterosis over the check LSFH-171 for 100 seed weight. Habib *et al.* (2006); Sapkale *et al.* (2016) reported highest average heterosis and heterobeltiosis for 100 seed weight

Highest seed filling percentage would ultimately cause high seed setting, ultimately higher seed yields, therefore positive significant heterosis are considered to be desirable. Average heterosis, heterobeltiosis and Standard heterosis over the check LSFH-171 for seed filling percentage per head ranged from -13.57% to 43.35%, -16.29% to 33.37% and 24.22% to 9.59% respectively. Twenty-nine hybrids exhibited positive significant average heterosis and the hybrid ARM – 250 A × PKV- 103 R (43.35%) ranked first followed by the hybrids CMS- 17 A × PKV-106 R (42.54%) and AKSF -10-1-1A × 856R (41.01%). The hybrid, CMS- 17 A × PKV-106 R (33.37%) recorded highest percentage of heterobeltiosis followed by ARM – 250 A × PKV- 103 R (30.69%) and AKSF -10-1-1A × 856R (27.96%). Six hybrids showed significant and positive standard heterosis over the check LSFH-171 in desired direction and the best three hybrids showing highest significant heterosis over the check LSFH-171 for seed filling percentage were ARM – 250 A × PKV- 103 R (9.59%), CMS- 17 A × PKV-106 R (9.24%) and CMS - 302 A × AK- 1R (8.89%).

Positive significant heterosis recorded by Ingle *et al*. (2015); Ailwar *et al.* (2020).

Maximum seed yield is the prime goal of crop improvement programme hence 28, 20 and 10 hybrids displayed positive and significant heterosis and it was ranged from -17.94% to 195.69%, 30.51% to 132.42% and -40.61% to 68.90% over the average heterosis, heterobeltiosis and standard heterosis over check LSFH-171 respectively. The top three hybrids showing highest magnitude heterosis over the mid parent, better parents and standard check LSFH-171 were ARM – 250 A × PKV- 103 R (195.69%, 132.42% and 68.90%), CMS- 17 A × PKV-106 R (156.69%, 119.83% and 55.12%) and ARM – 250 A × PKV 106 R (150.40%, 111.85% and 53.95%). Result of positive significant heterosis for yield and most of the yield contributing traits (head diameter, 100 seed weight, volume weight, seed filling percentage and seed yield) collaborated with the findings of Sapkale *et al.* (2015); Depar *et al.* (2017); Kale *et al.* (2019); Ailwar *et al.* (2020); Lakshman *et al.* (2020).

Table 1: Pooed heterosis (%) over mid-parent (H_1), and better parent (H_2) in sunflower hybrids for five important yield contributing traits.

Sr. No.	Hybrids	Days to maturity		Head Diameter(cm)		100 Seed weight (g)		Seed Filling percentage (%)		Seed yield per plant (g)	
		H_1	H_2	H_1	H_2	H_1	H_2	H_1	H_2	H_1	H_2
1.	AKSF -10-1-1A × Gp$_6$961	-2.69 **	-4.03 **	-6.32 *	-11.29 **	5.76 **	-5.01 **	1.49	-1.04	31.41 **	16.76 *
2.	AKSF -10-1-1A × Gp$_6$1075	-5.24 **	-5.68 **	-29.72 **	-34.98 **	-10.76 **	-23.39 **	-13.57 **	-16.29 **	-17.94 *	-20.33 *
3.	AKSF -10-1-1A × Gp$_6$389	-3.84 **	-5.86 **	14.64 **	11.45 **	8.39 **	-9.90 **	19.23 **	18.93 **	64.95 **	57.63 **
4.	AKSF -10-1-1A × Gp$_4$2902	0.46	-0.37	15.42 **	13.44 **	23.29 **	9.05 **	28.15 **	18.86 **	103.06 **	82.21 **
5.	AKSF -10-1-1A × AK- 1R	1.82 **	-2.75 **	-11.75 **	-22.64 **	18.77 **	14.59 **	7.08 *	-1.88	20.27 *	-6.26
6.	AKSF -10-1-1A × 856R	-2.94 **	-3.11 **	25.06 **	15.21 **	7.80 **	2.92	41.01 **	27.96 **	122.21 **	82.30 **
7.	AKSF -10-1-1A × PKV-103 R	-1.39 *	-2.20 **	-23.56 **	-34.29 **	24.45 **	17.95 **	9.97 **	-0.26	26.71 **	-3.4
8.	AKSF -10-1-1A × 298 – 1 R	-2.59 **	-3.48 **	-2.23	-14.69 **	28.15 **	27.61 **	26.99 **	16.49 **	51.92 **	23.56 **
9.	AKSF -10-1-1A × PKV 106 R	-1.21 *	-2.56 **	13.72 **	2.95	16.38 **	13.05 **	33.59 **	22.98 **	85.96 **	52.01 **
10.	CMS - 302 A × Gp$_6$961	1.34 *	-0.56	-7.80 **	-9.11 **	17.14 **	2.18	12.50 **	6.14 *	31.10 **	12.77
11.	CMS - 302 A × Gp$_6$1075	-1.33 *	-4.07 **	-8.82 **	-12.27 **	16.90 **	-2.36	5.77 *	5.56 *	16.53 *	9.13
12.	CMS - 302 A × Gp$_6$389	4.06 **	2.87 **	-22.33 **	-23.33 **	10.98 **	-10.13 **	8.56 **	5.2	10.15	1.6
13.	CMS - 302 A × Gp$_4$2902	-1.53 *	-3.91 **	-9.56 **	-11.70 **	8.68 **	-6.59 **	-0.5	-10.54 **	8.57	-5.73
14.	CMS - 302 A × AK- 1R	6.35 **	4.89 **	38.31 **	25.75 **	48.36 **	47.93 **	34.82 **	19.80 **	133.45 **	77.20 **
15.	CMS - 302 A × 856R	1.80 **	-1.29	-32.74 **	-35.58 **	6.44 **	-1.53	2.99	-9.33 **	-12.82	-30.51 **
16.	CMS - 302 A ×PKV – 103R	-0.38	-2.79 **	27.00 **	13.13 **	42.19 **	39.19 **	24.39 **	9.44 **	65.50 **	23.00 **
17.	CMS - 302 A × PKV – 298-1R	0.29	-2.05 **	-12.74 **	-21.04 **	-3.3	-6.82 **	-5.79 *	-16.20 **	-6.94	-26.44 **
18.	CMS – 302 A × PKV-106 R	4.22 **	2.26 **	-10.24 **	-15.57 **	51.99 **	42.99 **	17.14 **	4.56	38.36 **	9.9
19.	CMS - 17 A × Gp$_6$961	4.61 **	2.64 **	-6.21 *	-8.63 **	12.06 **	10.37 **	7.06 **	6.21 *	29.64 **	21.37 *
20.	CMS - 17 A × Gp$_6$1075	0.01	-2.77 **	-11.60 **	-15.93 **	-7.07 **	-12.96 **	-4.46	-9.01 **	17.68 *	14.49
21.	CMS - 17 A × Gp$_6$389	2.51 **	1.34	7.96 **	7.86 *	-15.90 **	-24.02 **	18.67 **	16.33 **	57.12 **	55.36 **
22.	CMS - 17 A × Gp$_4$2902	1.34 *	-1.12	-16.07 **	-17.07 **	-10.48 **	-13.32 **	9.27 **	3.03	20.27 *	13.78
23.	CMS - 17 A × AK- 1R	2.18 **	0.78	-19.75 **	-27.82 **	17.32 **	3.44	12.33 **	4.61	44.40 **	17.50 *
24.	CMS - 17 A × 856R	-1.23 *	-4.23 **	-21.24 **	-25.43 **	-1.72	-6.49 **	9.96 **	1.38	17.07*	0.64
25.	CMS - 17 A × PKV – 103R	-0.38	-2.79 **	18.56 **	4.5	3.26	-10.40 **	28.01 **	17.96 **	94.97 **	54.92 **
26.	CMS - 17 A × PKV – 298-1R	-2.01 **	-4.29 **	16.64 **	4.42	32.62 **	21.23 **	31.59 **	22.67 **	87.59 **	59.80 **
27.	CMS- 17 A × PKV-106 R	2.50 **	0.56	32.39 **	23.13 **	30.93 **	22.48 **	42.54 **	33.37 **	156.69 **	119.83 **
28.	ARM – 250 A × Gp$_6$1075	-1.21 *	-2.39 **	-14.21 **	-17.11 **	-1.38	-8.66 **	6.30 *	4.25	14.22	5.49
29.	ARM – 250 A × Gp$_6$961	0.46	0.18	-12.97 **	-17.88 **	-2.62	-13.94 **	-3.71	-7.25 **	10.27	8.84
30.	ARM – 250 A × Gp$_6$389	1.78 **	-0.18	5.99 *	5.2	19.47 **	2.1	25.30 **	24.26 **	96.50 **	95.85 **
31.	ARM – 250 A × Gp$_4$2902	0.65	0	-11.93 **	-12.25 **	10.10 **	0.36	15.58 **	7.79 **	40.39 **	31.00 **
32.	ARM – 250 A × AK- 1R	-1.44 *	-5.70 **	-0.42	-11.10 **	14.51 **	6.98 **	11.57 **	2.79	27.84 **	2.86
33.	ARM – 250 A × 856R	-3.49 **	-3.49 **	-1.05	-7.04 *	39.41 **	37.55 **	30.34 **	18.89 **	64.45 **	39.66 **
34.	ARM – 250 A × PKV- 103 R	1.57 **	0.92	40.69 **	23.11 **	71.71 **	57.69 **	43.35 **	30.69 **	195.69 **	132.42 **
35.	ARM – 250 A × 298 – 1 R	-1.11	-1.84 **	18.11 **	4.95	13.84 **	10.56 **	17.78 **	8.62 **	58.81 **	33.66 **
36.	ARM – 250 A × PKV 106 R	1.21 *	0	18.78 **	9.61 **	49.61 **	48.92 **	37.16 **	26.95 **	150.40 **	111.85 **
	SE(m)±	0.54	0.62	0.37	0.43	0.08	0.09	1.23	1.43	1.0966	1.2663
	CD (5%)	1.06	1.22	0.74	0.85	0.16	0.19	2.44	2.82	2.1681	2.5035
	CD (1%)	1.40	1.61	0.98	1.13	0.21	0.25	3.22	3.72	2.8638	3.3068

*, **- significant at 5% and 1% level respectively

Table 2: Pooed standard heterosis (H3) (%) over the check LSFH-171 in sunflower hybrids for five important yield contributing traits.

Sr. No.	Hybrids	Days to maturity	Head Diameter(cm)	100 Seed weight (g)	Seed Filling percentage (%)	Seed yield per plant (g)
		H_3	H_3	H_3	H_3	H_3
1.	AKSF -10-1-1A × $Gp_6$961	-3.50 **	-6.32 *	-16.60 **	-16.04 **	-7.5
2.	AKSF -10-1-1A × $Gp_6$1075	-5.16 **	-31.33 **	-25.29 **	-24.22 **	-36.88 **
3.	AKSF -10-1-1A × $Gp_6$389	-5.34 **	17.70 **	-4.92 **	1.41	24.88 **
4.	AKSF -10-1-1A × $Gp_4$2902	0.18	19.79 **	-0.85	0.84	44.36 **
5.	AKSF -10-1-1A × AK- 1R	-2.21 **	-18.31 **	-19.88 **	-16.76 **	-25.73 **
6	AKSF -10-1-1A × 856R	-2.58 **	21.66 **	-20.86 **	8.56 **	44.43 **
7.	AKSF -10-1-1A × PKV- 103 R	-1.66 *	-30.61 **	-17.53 **	-15.38 **	-23.47 **
8.	AKSF -10-1-1A × 298 – 1 R	-2.95 **	-9.91 **	-10.01 **	-1.17	-2.1
9.	AKSF -10-1-1A × PKV 106 R	-2.03 **	8.72 **	-16.16 **	4.34	20.43 **
10.	CMS - 302 A × $Gp_6$961	-2.76 **	-11.69 **	-10.28 **	-3.53	-3.62
11.	CMS - 302 A × $Gp_6$1075	-4.42 **	-14.76 **	-4.79 **	-4.06	-6.73
12.	CMS - 302 A × $Gp_6$389	-0.92	-23.54 **	-5.17 **	-4.38	-13.17 *
13.	CMS - 302 A × $Gp_4$2902	-4.97 **	-9.95 **	-15.07 **	-18.69 **	-19.43 **
14.	CMS - 302 A × AK- 1R	-1.29	22.19 **	-3.28 *	8.89 **	51.44 **
15.	CMS - 302 A × 856R	-1.1	-37.41 **	-24.28 **	-17.59 **	-40.61 **
16.	CMS - 302 A ×PKV – 103R	-3.87 **	9.93 **	**	-0.53	5.13
17.	CMS - 302 A × PKV – 298-1R	-3.31 **	-23.27 **	-34.29 **	-23.83 **	-37.13 **
18.	CMS – 302 A × PKV-106 R	0 .01	-17.96 **	6.04 **	-4.97 *	-6.08
19.	CMS - 17 A × $Gp_6$961	0.37	-9.05 **	-3.09 *	-13.00 **	-14.36 *
20.	CMS - 17 A × $Gp_6$1075	-3.13 **	-16.31 **	-15.12 **	-17.63 **	-14.58 *
21.	CMS - 17 A × $Gp_6$389	-2.39 **	7.57 *	-19.82 **	-0.81	12.15
22.	CMS - 17 A × $Gp_4$2902	-2.21 **	-15.43 **	-21.19 **	-15.61 **	-19.71 **
23.	CMS - 17 A × AK- 1R	-5.16 **	-28.15 **	-11.92 **	-14.32 **	-17.09 **
24.	CMS - 17 A × 856R	-4.05 **	-25.77 **	-20.37 **	-16.96 **	-28.98 **
25.	CMS - 17 A × PKV – 103R	-3.87 **	4.02	-23.71 **	-3.38	9.32
26.	CMS - 17 A × PKV – 298- 1R	-5.52 **	3.94	3.23 *	0.48	12.76 *
27.	CMS- 17 A × PKV-106 R	-1.66 *	22.56 **	4.29 **	9.24 **	55.12 **
28.	ARM – 250 A × $Gp_6$1075	-2.21 **	-16.08 **	-19.80 **	-12.58 **	-23.34 **
29.	ARM – 250 A × $Gp_6$961	0.37	-16.87 **	-16.08 **	-16.04 **	-18.80 **
30.	ARM – 250 A × $Gp_6$389	0.01	6.51 *	7.74 **	5.95 *	42.33 **
31.	ARM – 250 A × $Gp_4$2902	0.18	-10.52 **	-8.75 **	-9.62 **	-4.8
32.	ARM – 250 A × AK- 1R	-5.52 **	-10.00 **	-19.93 **	-13.81 **	-25.25 **
33.	ARM – 250 A × 856R	-3.31 **	-5.89	5.77 **	-0.31	1.49
34.	ARM – 250 A × PKV- 103 R	1.1	24.64 **	18.02 **	9.59 **	68.90 **
35.	ARM – 250 A × 298 – 1 R	-1.66 *	6.25 *	-17.25 **	-8.92 **	-2.87
36.	ARM – 250 A × PKV 106 R	0.18	10.97 **	11.46 **	6.45 **	53.95 **
	SE(m)±	0.62	0.43	0.09	1.43	1.27
	CD (5%)	1.22	0.85	0.19	2.82	2.50
	CD (1%)	1.61	1.13	0.25	3.72	3.31

CONCLUSIONS

In the present study top three hybrids ARM – 250 A × PKV- 103 R, CMS- 17 A × PKV-106 R and ARM – 250 A × PKV 106 R were found to be highest heterotic over the checks LSFH-171 and also showed highest magnitude of average heterosis and heterobeltosis. Hence, these hybrids can be commercially exploited using heterosis breeding after its evaluation in multilocation trials.

Acknowledgments. The author highly thankful to Agricultural Research Station, Yavatmal and Oilseed Research Unit, Dr. PDKV, Akola for providing the land, seed material and other necessary cooperation during conducting Ph.D. Research work.
Conflict of Interest. None.

REFERENCES

Ailwar, B. P., Ghodke, M. K. and Tathe, R. G. (2020). Heterosis for yield and yield contributing traits in sunflower (*Helianthus annuus* L.). *Electronic Journal of Plant Breeding, 11*(3), 950-953.

Depar, S. M., Baloch, J., Kumbhar, M. B. and Chachar, Q. D. (2017). Heterotic performance of F_1 hybrids for phenological, yield, oil and protein traits of sunflower. *Pak. J. Agril. Engg., Vet. Sci., 33*(1), 12-22.

Debaeke, P., Bedoussac L., Bonnet C., Bret-Mestries E., Seassau C., Gavaland A., Raffaillac D., Tribouillois H., Vericel, G. and Justes, E. (2017). Sunflower crop: environmental-friendly and agroecological. *Oilseed Fat Crop Lipid, 24* (3).

Habib, H., Mehdi, S. S., Rashid, A., lqbaf, S. and Anjurn, M. A. (2006). Heterosis Studies in Sunflower (*Helianthus Annuus* L.) Crosses For Agronomic Traits And Oil Yield Under Faisalabad Conditions. *Pak. J. Agric. Sci., 43* (3-4).

Ingle, A. U., Nichal, S. S., Vaidya, E. R., Ratnaparkhi, R. D. and Kathale, M. N. (2015). Heterosis for seed yield, its components and oil content in sunflower (*Helianthus annuus* L.). *Trends in Bio sciences, 8*(16), 4352-4364.

Janjal, S. M.,Vaidya, E. R., Nichal, S. S., Ratnaparkhi, R. D. and Rathi, S. R. (2016). Heterosis studies in sunflower (*Helianthus annuus* L.). *Advances in Life Sciences, 5*(21), 10049-100455.

Kempthorne, O. (1957). An introduction to Genetic Statistics. The Iowa University Press, pp. 18-23.

Kaya, Y. and Atakisi, I. K. (2004). Combining ability analysis of some yield characters of sunflower (*Helianthus annuus* L.). *Helia*, *27,* 75-84.

Kinman, M. L. (1970). New development in the USDA and state experiment station, sunflower breeding programme. *In: Proc. of the 4th International Sunflower Conference,* Memphis, Tenness, USA, pp 181-183.

Leclercq, P. (1969). Line sterile cytoplasmique chezk tournesol. *Ann. Amelior Planta, 19,* 99-106.

Lakshman, S. S., Chakrabarty, N. R., Godke M. K. and Kole, P. C. (2020). Heterosis Study in Sunflower hybrids for yield attributing traits in high salinity condition for identification of superior sunflower hybrids for coastal saline belts. *European Journal of Experimental Biology*, *10*(1).

Kale, P. P., Vaidya, E. R., Fatak S. U. and Nichal, S. S. (2019). Combining ability analysis for seed yield, its components and oil content in sunflower (*Helianthus annuus* L.). *International journal of chemical studies, 7*(1), 1130-1134.

Nagrale, S. C., Sakhare, S. B., Fatak S. U. and Nichal. S. S. (2022). Combining ability studies for morphological traits in sunflower (*Helianthus annuus* L.). *Biological Forum – An International Journal*, *14*(3), 589-593.

Rathi, S. R., Nichal, S. S., Janjal, S. M., and Gawande, S. M. (2019). Detection of promising hybrids on the basis of standard heterosis and combining ability in sunflower (*Helianthus annuus* L.). *Multilogic in Science*, *29*(9), 235-240.

Seetharam, A., Kusumakumari, P., Patil, N. M. and Singagi, S. S. (1977). Performance of hybrids of sunflower produced by means of cytoplasmic male sterility. *SABRAO J., 9*, 51-55.

Sujatha, M. and Reddy, A. V. (2009). Heterosis and combining ability for seed yield and other yield contributing characters in sunflower (*Helianthus annuus* L.). *J. Oilseeds Res*., *26*(1), 21-31.

Sapkale, R. B., Shinde, S. R. and Pawar, R. M. (2016). Heterosis studies in sunflower (*Helianthus annuus* L.), *Internat. J. Plant Sci.*, *11*(1), 22-27.

How to cite this article: S.C. Nagrale, S.B. Sakhare, P.V. Yadgirwar, S.S. Nichal and P.V. Jadhav (2023). Heterosis Studies for Yield and Yield contributing Components in Sunflower (*Helianthus annuus* L.). *Biological Forum – An International Journal, 15*(6): 25-29.