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HETEROSIS STUDIES FOR VARIOUS YIELD-ATTRIBUTING TRAITS IN *SESAMUM INDICUM* L.

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ABSTRACT

This study focused on sesame and aimed to assess heterosis in seed yield and associated traits, including days to 50% flowering, days to maturity, plant height (cm), effective branches per plant, number of capsules per plant, capsule length (cm), leaf area (cm^2), seeds per capsule, 1000-seed weight (g), oil content percentage, and seeds per plant (g). Crosses were established using diallel analysis (excluding reciprocals) involving eight parents, resulting in 28 F_1 hybrids, along with one standard check (GT-5). The experiment was conducted in three replications using a Randomized Block Design (RBD) at the Research Farm of Niger Research Station, Navsari Agricultural University, Vanarasi, Tal. Vansda, Dist. Navsari during the Rabi-summer seasons of 2020–21 and 2021–22. The analysis of variance based on the experimental design revealed significant variations in the genotypes for each trait, indicating a substantial level of genetic diversity within the material. The differences observed between the parents and hybrids were also significant for all traits, underscoring the uniqueness of each character in both parents and hybrids. Significant mean sum of squares for parents vs. hybrids and check vs. hybrids were observed for each trait, indicating the presence of mean heterosis across all characters. Several crosses exhibited notably better parent heterosis and standard heterosis in seed yield per plant and other desirable characteristics. Better parent heterosis ranged from -35.17 percent (AT-338 × JLS-2611) to 62.45 percent (AT-360 × ASRT-9), demonstrating a wide range of improvements. Standard heterosis varied from -43.15 percent (LT-15-28 × JLS-2611) to 30.06 percent (JLS-2420 × LT-15-28). The crosses JLS-2420 × LT-15-28 (30.06 %), AT-338 × AT-360 (23.81%), AT-360 × LT-15-28 (23.21%) and AT-360 × ASRT-9 (22.32%) exhibited the highest heterobeltiosis and standard heterosis for seed yield and other desirable traits. These promising hybrids warrant further evaluation to harness heterosis benefits, contingent on identifying suitable hybrid seed production technology in future breeding programs.

Key words : Sesame, Half diallel, Better parent heterosis, Standard heterosis, Seed yield.

Introduction

Sesame, an ancient and pivotal oilseed crop, holds significant importance in Indian agriculture. Oilseed crops, crucial to India's economy, make the country the world's leading producer in both total area and production. Sesame, cultivated year-round across *kharif*, semi-*Rabi*, *Rabi* and summer seasons, spans approximately 19.47 lakh hectares with a total production of 8.66 lakh tons and productivity of 413 kg/ha. Ranking sixth among oilseed crops in India, it follows mustard, groundnut, soybean, cotton seed and sunflower. Key sesame-producing states include West Bengal, Uttar Pradesh, Rajasthan, Madhya Pradesh, Andhra Pradesh, Orissa, Tamil Nadu, Gujarat, and Telangana. Gujarat, with over 1.94 lakh hectares, contributes significantly to the national production, particularly in districts like Amareli, Bhavnagar, Surendranagar, Rajkot, Jamnagar and Kutch, yielding 0.97 lakh tonnes at a productivity rate of 395 kg/ha (Anonymous, 2021). To introduce variability in sesame, hybridization stands recognized as a valuable method for enhancing yield and other essential traits. The careful selection of parents and breeding techniques by plant breeders plays a pivotal role in generating promising varieties through hybridization. Evaluating the genetic value of germplasm becomes the initial step for plant breeders in choosing parents for hybridization programs, aiming to produce high-quality segregates. Heterotic hybrids, exhibiting desirable transgressive segregates in advanced generations have been instrumental in sustaining the yellow revolution and meeting the country's growing domestic and export demands in the twenty-first century. Sesame's unique characteristics make it an ideal candidate for hybrid seed production. The commercial-scale exploitation of heterosis in autogamous crops has led to the development of high-yielding hybrids, proving to be a vital genetic tool for enhancing yield potential. The estimation of additive and non-additive gene actions through this technique aids in gauging the potential for commercial exploitation of heterosis and guides breeding programs in segregating generations to isolate pure lines among the progenies of successful hybrids. Various mating patterns are employed in breeding programs to select superior parents and investigate trait inheritance genetics. Diallel analysis, a systematic method widely applied in crop plants, tests genotype performance in hybrid combinations and characterizes the gene actions controlling quantitative traits (Griffing, 1956). Considering this, the present research in sesame with objective; to know the *per se* performance of parents and hybrids and study the nature of magnitude of heterosis for seed yield and its component characters.

Materials and Methods

Nine sesame parents, including AT-377, DS-10, AT-338, AT-360, JLS-2611, ASRT-9, JLS-2420, LT-15-28 and GT-5 (check), along with their set of 37 genotypes comprising eight parents, 28 F_1 hybrids and the check variety GT-5 were planted in a Randomized Block Design (RBD) with three replications at the Research Farm of Niger Research Station, Navsari Agricultural University, Vanarasi, Tal. Vansda, Dist. Navsari during *Rabi*-summer, 2020-21 for the development of crosses and an experimental material was evaluated during *Rabi*-summer, 2021-22. Vanarasi-396580, India. Parent seeds were obtained through selfing, and F_1 hybrid seeds were produced using a half-diallel technique. Observations were recorded for eleven characters, including flowering and maturity duration, plant height, branches, capsules per plant, capsule length, leaf area, seeds per capsule, 1000-seed weight, oil content percentage, and seeds per plant. Statistical analyses were conducted on the mean performance of hybrids and parents for multiple characters. The significance of each character was determined through analysis of variance using the Panse and Sukhatme (1985) methodology. The formula for calculating better parent heterosis (BP) adhered to the techniques outlined by Fonseca and Patterson (1968) and Meredith and Bridge (1972) for standard heterosis.

Results and Discussion

The analysis of variance conducted for the experimental design revealed significant variations among genotypes for all assessed traits, indicating a notable level of genetic diversity within the utilized material. Significant differences between the parents and hybrids were observed for all traits studied, suggesting distinctive characteristics in both parents and hybrids across the board. The mean sum of squares attributed to parents *vs*. hybrids and check *vs*. hybrids were significant for all traits, indicating the presence of mean heterosis. Certain crosses exhibited considerably better parent heterosis and standard heterosis, particularly in seed yield per plant and other key characteristics. Notably, crosses such as JLS-2420 × LT-15-28 (30.06%), AT-338 × AT-360 (23.81%), AT-360 × LT-15-28 (23.21%) and AT-360 × ASRT-9 (22.32%) displayed promising results for seed yield per plant. These specific crosses merit further evaluation to fully harness heterosis or consider their inclusion in future breeding programs to obtain desirable segregants for the development of superior genotypes.

Days to 50% flowering

Early flowering in sesame is considered advantageous, with significant and desirable (negative) estimates of superior parent and standard heterosis. Better parent heterosis for days to 50% flowering ranged from -12.02 (AT-377 × LT-15-28) to 11.21 (DS-10 × AT-360). Ten out of the 28 hybrids exhibited significant and negative better parent heterosis. Standard heterosis estimates relative to check GT-5 ranged from -7.70 (DS-10 × ASRT-9) to 26.80 (AT-338 × AT-360) percent. Only one of the 28 hybrids demonstrated considerable and negative standard heterosis. These findings align with the research of Jeeva *et al*. (2020) and Nehra *et al.* (2021), affirming a significant degree of heterosis favoring earliness in the desired direction.

Days to maturity

Early maturity is a desirable trait in sesame. Among the 28 hybrids, four exhibited significant and negative better parent heterosis for days to maturity. The heterosis over the better parent ranged from -6.35 (DS-10 × ASRT-9) to 11.64 (AT-338 × AT-360) percent. Additionally, three out of 28 hybrids displayed significant and negative standard heterosis, when compared to the check variety GT-5. Conventional heterosis estimations over GT-5 varied

Table 1 : Analysis of variance for experimental design for different traits in sesame.

Source ofvariation	df	Days to 50% flowering	Days to maturity	Plant height (cm)	Effective branches per plant	Capsules per plant	Capsule length (cm)
Replications	2	2.17	1.07	101.45	0.42	136.89	0.04
Genotypes	36	22.19 **	49.15 **	193.80 **	1.28 **	632.28 **	0.09 **
Parents	7	9.40 **	35.41 **	87.47 *	0.30 *	167.86 *	0.08 **
Hybrids	27	24.31 **	55.36 **	208.70 **	1.40 **	690.19 **	0.09 **
P. *vs.* Hy.	1	62.07 **	13.37 *	562.83 **	5.56 **	2646.54 **	0.06 *
Check *vs.* Hybrids	1	14.64 *	13.37 **	166.35 *	0.58 *	305.82 *	0.10 *
Error	72	2.27	3.36	40.14	0.14	71.56	0.01
Total	110	8.79	18.30	91.54	0.52	256.26	0.04

Source of variation	df	Leaf area (cm^2)	Seeds per capsule	1000-seed weight (g)	Oil content (%)	Seed yield per plant (g)
Replications	2	7.61	41.49	0.01	5.11	1.53
Genotypes	36	18.40 **	112.76 **	0.11 **	22.20 **	16.99 **
Parents	7	8.29 *	60.70 **	0.04 **	7.92 **	6.01 *
Hybrids	27	20.84 **	126.87 **	0.13 **	25.95 **	20.06 **
P. *vs.* Hy.	1	28.46 **	117.19 *	0.18 **	36.71 **	19.06 **
Check *vs.* Hybrids	1	13.49 *	91.19 *	0.04 *	6.59 *	8.66 *
Error	72	3.34	17.59	0.01	1.65	2.12
Total	110	8.34	49.17	0.04	8.44	6.98

* Significant at 5% level, ** Significant at 1% level.

from -6.70 (DS-10 × ASRT-9) to 15.36 (AT-338 × AT-360) percent. These findings are consistent with the research of Kumar *et al*. (2012), Vavdiya *et al.* (2013), and Kumari and Ganesamurthy (2017), which also reported a high degree of heterosis favoring early maturity.

Plant height (cm)

Among the 28 crossings, five displayed a considerable and positive heterotic effect over the better parent, while fourteen hybrids exhibited a significant and positive heterotic effect over the standard check. The estimated better parent heterosis for this trait ranged from -16.00 percent (ASRT-9 × JLS-2420) to 15.13 percent (AT-338 × LT-15-28). The hybrid AT-338 × LT-15-28 demonstrated the most favorable parent heterosis (15.13%), followed by DS-10 × AT-338 (14.24%) and DS-10 × ASRT-9 (12.97%). Conventional heterosis estimates for this trait ranged from -12.47 percent (ASRT-9 × JLS-2420) to 19.79 percent (AT-360 × JLS-2611). AT-360 × JLS-2611 exhibited the highest significant and positive standard heterosis (19.79%), followed by AT 338 × LT-15-28 (19.26%) and AT-377 × JLS-2611 (18.38%). Similar findings were reported for plant height in sesame by Mothilal and Ganesan (2005), Kumar *et al*. (2012), Karthickeyan *et al*. (2017), Jeeva *et al*. (2020) and Nehra *et al*. (2021).

Effective branches per plant

Among the 28 crosses, eleven hybrids exhibited significant and positive heterosis over the superior parent. The range of improved parent heterosis varied from -37.63 (AT 377 × DS-10) to 54.25 (ASRT-9 × JLS-2420) percent. In terms of standard heterosis, fifteen hybrids outperformed GT-5 by a considerable and favorable margin, ranging from -34.51 (AT-338 × AT-360) to 53.49 (ASRT-9 × JLS-2420) percentage. These results are consistent with the findings of Govindarasu *et al.*(2001), Misra *et al*. (2008), Vavdiya *et al*. (2013), Karthickeyan *et al*. (2017), Abd-elsaber *et al*. (2019), Jeeva *et al*. (2020) and Nehra *et al*. (2021) in sesame, especially regarding effective branches per plant.

Capsules per plant

Nine out of the 28 hybrids under study exhibited substantial and positive improved parent heterosis for capsules per plant. The significant parent heterosis for

Table 2 : Percent better parent heterosis (BP) and standard heterosis (SH) for different traits.

S. no.	Hybrids	Days to 50% flowering		Days to maturity		Plant height		Effective branches per Plant		Capsules per Plant		Capsule length	
		BP	SH	BP	SH	BP	SH	BP	SH	BP	SH	BP	SH
1.	AT-377 × DS-10	-1.08	-2.18	0.69	0.32	-2.22	3.71	-37.63 **	-31.10 **	-33.63**	-20.41	-1.81	3.79
2.	AT-377 × AT-338	-0.61	9.58 **	-0.98	0.33	1.71	7.87	0.99	11.56	11.27	33.43 **	-10.78 **	1.89
3.	AT-377 × AT-360	-9.45 **	-0.17	1.74	3.08	-14.57 **	-7.29	-13.25	-4.16	-42.65 **	-31.23 **	-5.77	-0.40
4.	AT-377 × ASRT-9	-11.36 **	-2.42	-1.06	0.24	6.46	12.92 *	-27.66 **	-20.09	1.32	21.50	7.69 *	13.83 **
5.	AT-377 × JLS-2420	-3.83	5.93	-1.17	0.14	6.43	12.88 *	9.22	20.66	3.91	24.61 *	-1.84	6.53
6.	AT-377 × LT-15-28	-12.02 **	-3.01	-5.85 **	-5.86 **	-1.85	4.10	11.61	23.29 *	-20.30 *	-4.42	2.59	10.60 **
7.	AT-377 × JLS-2611	-2.03	4.74	-0.64	0.67	7.59	18.38 **	-31.61 **	-21.15	-4.29	14.78	-1.21	4.41
8.	DS-10 × AT-338	10.80 **	9.57 **	8.72 **	8.32 **	14.24 **	17.39 **	20.98	27.73 *	7.03	24.05 *	-7.60 *	5.53
9.	DS-10 × AT-360	11.21 **	9.98 **	2.35	1.97	0.93	9.53	-2.46	2.98	10.46	12.51	-7.67 *	-4.29
10.	DS-10 × ASRT-9	-6.66 *	-7.70 *	-6.35 **	-6.70 **	12.97 *	14.36 **	9.31	15.40	-10.19	-8.53	-1.72	2.74
11.	DS-10 × JLS-2420	5.06	3.89	2.91	2.53	-15.94 **	-12.40 *	13.68	20.03	-3.68	-0.31	-2.89	5.37
12.	DS-10 × LT-15-28	-4.33	-5.39	-5.48 **	-5.83 **	1.38	5.02	38.31 **	46.03 **	22.51 *	24.77 *	8.55 *	17.02 **
13.	DS-10 × JLS-2611	5.49	4.32	1.36	0.99	5.60	16.20 **	22.42 *	41.14 **	57.27 **	63.24 **	1.88	3.00
14.	AT-338 × AT-360	10.06 **	26.80 **	11.64 **	15.36 **	-5.7	2.37	-35.75 **	-34.51 **	32.84 **	53.97 **	-0.76	13.33 **
15.	AT-338 × ASRT-9	0.32	10.44 **	3.00	5.17 **	12.25 *	15.35 **	37.03 **	39.68 **	36.72 **	58.47 **	-5.77	7.61 *
16.	AT-338 × JLS-2420	-2.73	7.14 *	-2.61	0.64	8.80	13.37 *	12.07	14.24	21.68 *	41.04 **	1.92	16.39 **
17.	AT-338 × LT-15-28	-6.18 *	4.70	2.63	2.62	15.13 **	19.26 **	22.80 *	25.18 *	19.67	38.71 **	-1.89	12.04 **
18.	AT-338 × JLS-2611	0.19	7.11	2.26	4.02 *	6.02	16.65 **	30.64 **	50.61 **	0.23	16.17	-4.46	9.11 *
19.	AT-360 × ASRT-9	-7.07 *	2.30	0.61	2.73	1.91	10.59	38.64 **	37.96 **	33.31 **	23.83 *	-5.51	-1.22
20.	AT-360 × JLS-2420	-4.16	5.56	-4.64 **	-0.22	-3.16	5.09	48.13 **	42.02 **	46.79 **	51.92 **	6.93	16.39 **
21.	AT-360 × LT-15-28	-10.51 **	-0.13	10.03 **	10.02 **	1.68	10.34	21.49	17.94	22.82	14.67	2.33	10.32 **
22.	AT-360 × JLS-2611	-4.34	2.27	0.14	1.86	8.87	19.79 **	6.91	23.26 *	8.45	12.56	5.45	9.11 *
23.	ASRT-9 × JLS-2420	-0.43	9.61 **	0.27	2.39	-16.00 **	-12.47 *	54.25 **	53.49 **	58.70 **	64.24 **	4.93	13.87 **
24.	ASRT-9 × LT-15-28	-11.13 **	-2.16	1.21	1.20	-1.75	1.77	6.27	5.75	-3.16	-9.58	1.69	9.63 *
25.	ASRT-9 × JLS-2611	2.12	9.18 **	4.59 **	6.39 **	-1.29	8.61	28.54 **	48.19 **	-15.99	-12.80	6.97	11.79 **
26.	JLS-2420 × LT-15-28	-5.67 *	3.89	-0.41	-0.42	11.10 *	15.77 **	46.40 **	42.13 **	21.96	26.22 *	-15.11 **	-7.86 *
27.	JLS-2420 × JLS-2611	5.22	12.50 **	4.07 *	5.86 **	4.67	15.17 **	17.21	35.12 **	36.52 **	41.70 **	-9.66 **	-1.95
28.	LT-15-28 × JLS-2611	-9.62 **	-3.37	0.33	0.32	4.90	15.42 **	25.19 *	44.32 **	20.91	25.50 *	2.14	10.11 **
	SEd	**1.23**	**1.23**	**1.50**	**1.50**	**5.17**	**5.17**	**0.31**	**0.31**	**6.91**	**6.91**	**0.10**	**0.10**
	CD @ 5%	**2.41**	**2.41**	**2.93**	**2.93**	**10.14**	**10.14**	**0.61**	**0.61**	**13.54**	**13.54**	**0.20**	**0.20**
	CD @ 1%	**3.17**	**3.17**	**3.86**	**3.86**	**13.47**	**13.47**	**0.80**	**0.80**	**17.82**	**17.82**	**0.26**	**0.26**
	Minimum	**-12.02**	**-7.70**	**-6.35**	**-6.70**	**16.00**	**-12.47**	**-37.63**	**-34.51**	**-42.65**	**-31.23**	**-15.11**	**-7.86**
	Maximum	**11.21**	**26.80**	**11.64**	**15.36**	**15.13**	**19.79**	**54.25**	**53.49**	**58.70**	**64.24**	**8.55**	**17.02**

Table 2 continued...

S. no.	Hybrids	Leaf area (cm^2)		Seeds per capsule		1000-seed weight (g)		Oil content (%)		Seed yield per plant	
		BP	**SH**	**BP**	**SH**	**BP**	**SH**	**BP**	**SH**	**BP**	**SH**
1.	AT-377 × DS-10	1.50	8.68 *	12.31 *	15.03 *	-3.40	-2.22	3.83	-2.40	4.36	-7.44
2.	AT-377 × AT-338	8.41 *	16.08 **	-4.17	11.32	7.24 **	8.56 **	12.03 **	1.12	-33.33 **	-35.12 **
3.	AT-377 × AT-360	5.07	12.51 **	-3.15	5.87	3.97	10.67 **	6.50 **	3.45	30.87 *	16.07
4.	AT-377 × ASRT-9	-6.28	0.35	16.39 **	19.22 **	-13.26 **	-7.67 **	-0.99	-5.74 *	-16.11	-25.60 *
5.	AT-377 × JLS-2420	-4.01	2.78	-8.66	8.91	6.95 *	9.44 **	15.22 **	4.66	1.68	-9.82
6.	AT-377 × LT-15-28	-11.97 **	-5.74	0.08	2.51	3.07	4.33	-4.66	-5.32 *	5.03	-6.85
7.	AT-377 × JLS-2611	7.75 *	16.30 **	-12.29 *	-3.37	7.29 **	9.56 **	7.41 **	4.35	-13.76	-23.51 *
8.	DS-10 × AT-338	7.56 *	12.16 **	-9.47	5.17	-3.76	-3.22	10.11 **	3.50	-31.80 **	-33.63 **
9.	DS-10 × AT-360	5.25	9.34 *	-24.91 **	-17.92 **	-7.29 **	-1.33	0.58	-2.30	43.87 **	8.33
10.	DS-10 × ASRT-9	1.59	-0.18	21.42 **	19.43 **	-1.36	5.00	-16.64 **	-20.64 **	-14.29	-37.50 **
11.	DS-10 × JLS-2420	-6.35	-1.87	-2.06	16.79 **	3.91	6.33 *	-3.49	-9.28 **	13.77	-6.55
12.	DS-10 × LT-15-28	0.60	1.13	4.93	5.74	3.91	3.33	-1.02	-1.75	-22.71	-37.20 **
13.	DS-10 × JLS-2611	-0.65	8.68 *	-10.55	-1.46	8.60 **	10.89 **	-7.40 **	-10.04 **	-4.07	-36.90 **
14.	AT-338 × AT-360	8.73 *	13.38 **	-15.32 **	-1.63	-7.41 **	-1.44	-5.30 *	-8.01 **	27.22 *	23.81 *
15.	AT-338 × ASRT-9	-3.77	0.35	-5.84	9.38	3.34	10.00 **	-9.30 **	-13.65 **	-19.57	-21.73 *
16.	AT-338 × JLS-2420	2.96	7.89 *	1.18	20.66 **	-7.06 *	-4.89	10.45 **	0.33	11.93	8.93
17.	AT-338 × LT-15-28	-5.35	-1.30	3.95	20.76 **	9.17 **	9.78 **	-6.48 **	-7.17 **	-19.57	-21.73 *
18.	AT-338 × JLS-2611	1.09	10.58 **	-13.41 *	0.59	17.08 **	19.56 **	-1.14	-3.95	-35.17 **	-36.90 **
19.	AT-360 × ASRT-9	-4.75	-1.04	15.84 **	26.58 **	-9.71 *	-3.89	-10.07 **	-12.64 **	62.45 **	22.32 *
20.	AT-360 × JLS-2420	10.07 **	14.19 **	4.10	24.14 **	-3.44	2.78	9.66 **	6.52 **	-21.74	-35.71 **
21.	AT-360 × LT-15-28	14.58 **	19.04 **	15.38 **	26.08 **	6.68 *	13.56 **	0.00	-0.74	51.65 **	23.21 *
22.	AT-360 × JLS-2611	-0.58	8.75 *	-9.87	-0.70	9.29 **	16.33 **	10.36 **	7.22 **	-14.62	-35.71 **
23.	ASRT-9 × JLS-2420	-6.06	-1.57	-3.96	14.52 *	-9.08 **	-3.22	2.24	-2.66	29.71 *	6.55
24.	ASRT-9 × LT-15-28	9.93 *	10.52 **	1.24	2.02	-6.16 *	-0.11	6.94 **	6.16 **	-18.32	-33.63 **
25.	ASRT-9 × JLS-2611	-0.48	8.87 *	4.41	15.03 *	2.30	8.89 **	2.52	-0.40	2.86	-25.00 *
26.	JLS-2420 × LT-15-28	-9.28 *	-4.93	17.53 **	40.14 **	1.52	3.89	-2.68	-3.40	58.33 **	30.06 **
27.	JLS-2420 × JLS-2611	-2.19	6.99	-8.08	9.60	5.75 *	8.22 **	1.11	-1.77	21.74	0.00
28.	LT-15-28 × JLS-2611	-3.67	5.37	11.33	22.66 **	-2.30	-0.56	0.17	-0.57	-30.04 *	-43.15 **
SEd		**5.17**	**5.17**	**0.31**	**0.31**	**0.08**	**0.08**	**1.05**	**1.48**	**1.19**	**1.19**
CD @ 5%		**10.14**	**10.14**	**0.61**	**0.61**	**0.16**	**0.16**	**2.06**	**2.06**	**2.33**	**2.33**
CD @ 1%		**13.47**	**13.47**	**0.80**	**0.80**	**0.22**	**0.22**	**2.71**	**2.71**	**3.07**	**3.07**
Minimum		**16.00**	**-12.47**	**-37.63**	**-34.51**	**-13.26**	**-7.67**	**-16.64**	**-20.64**	**-35.17**	**-43.15**
Maximum		**15.13**	**19.79**	**54.25**	**53.49**	**17.08**	**19.56**	**15.22**	**7.22**	**62.45**	**30.06**

* Significant at 5% level, ** Significant at 1% level.

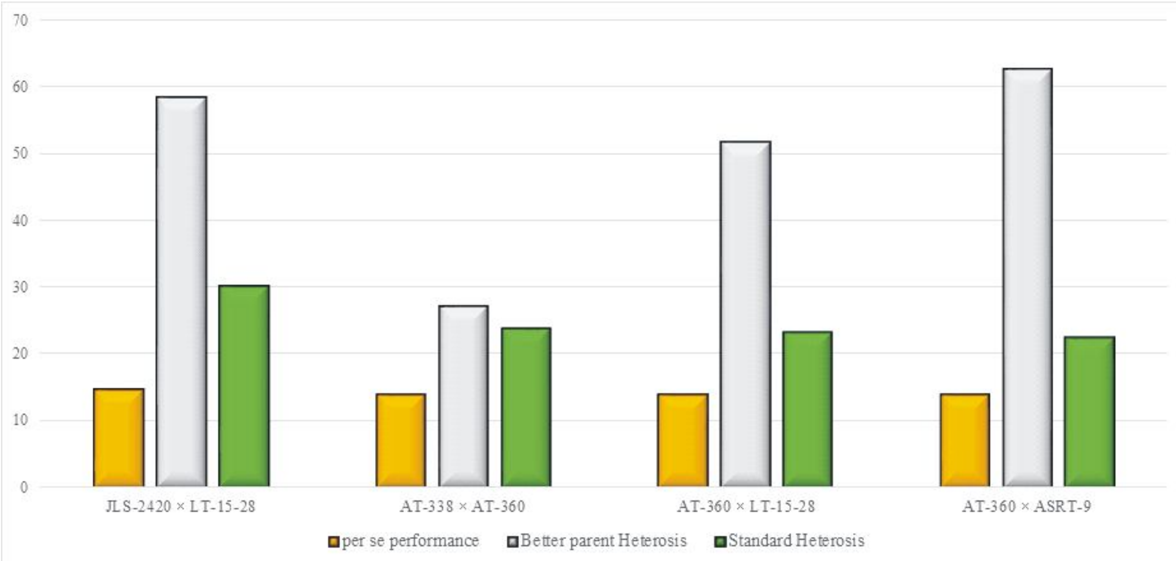

Fig. 1 : *Per se* performance of top four crosses along with per se performance of better parent heterosis and standard heterosis for seed yield in sesame.

Table 3 : Magnitude of better parent heterosis (BP %) and standard heterosis (SH %) in sesame.

S. no.	Characters	Range of heterosis (%)		Number of crosses with significant heterosis			
		BP (%)	SH (%)	BP (%)	BP (%)	SH (%)	SH (%)
				+Ve	-Ve	+Ve	-Ve
1.	Days to 50% flowering	-12.02 to 11.21	-7.70 to 26.80	3	10	9	1
2.	Days to maturity	-6.35 to 11.64	-6.70 to 15.36	5	4	7	3
3.	Plant height (cm)	-16.00 to 15.13	-12.47 to 19.79	5	3	14	2
4.	Effective branches per Plant	-37.63 to 54.25	-34.51 to 53.49	11	4	15	2
5.	Capsules per Plant	-42.65 to 58.70	-31.23 to 64.24	9	3	15	1
6.	Capsule length (cm)	-15.11 to 8.55	-7.86 to 17.02	2	5	14	1
7.	Leaf area (cm^2)	-11.97 to 14.58	-5.74 to 19.04	7	2	15	0
8.	Seeds per capsule	-24.91 to 21.42	-17.92 to 40.14	6	4	13	1
9.	1000-seed weight (g)	-13.26 to 17.08	-7.67 to 19.56	9	7	13	1
10.	Oil content %	-16.64 to 15.22	-20.64 to 7.22	9	6	3	9
11	Seed yield per plant (g)	-35.17 to 62.45	-43.15 to 30.06	7	4	4	13

total capsules per plant ranged from -42.65 (AT-377 × AT-360) to 58.70 (ASRT-9 × JLS-2420) percent. Regarding standard heterosis, fifteen of the 28 hybrids demonstrated significant and positive heterosis over the standard check GT-5. Notably, significant standard heterosis ranged from -31.23 (AT-377 × AT-360) to 64.24 (ASRT-9 × JLS-2420) percentage points. These findings are in line with previous research by Gaikwad and Lal (2011), Karthickeyan *et al*. (2017), Chauhan *et al*. (2019) and Jeeva *et al.* (2020) concerning capsules per plant.

Capsule length (cm)

Among the 28 hybrids subjected to testing, only two exhibited substantial and positive better parent heterosis for capsule length. The better parent heterosis estimations ranged from -15.11 percent (JLS-2420 × LT-15-28) to 8.55 percent (DS-10 × LT-15-28). Standard heterosis for capsule length varied from -7.86% (JLS-2420 × LT-15-28) to 17.02% (DS-10 × LT-15-28). However, fourteen hybrids demonstrated significant and positive standard heterosis. Earlier investigations by Kumar *et al*. (2012), Vavdiya *et al*. (2013), Abd-elsaber *et al*. (2019) and Jeeva *et al*. (2020) yielded analogous findings concerning sesame capsule length.

Leaf area (cm^2)

Among the 28 hybrids subjected to testing, seven displayed significant and favorable improvement in parent heterosis for leaf area. The better parent heterosis estimations ranged from -11.97% (AT-377 × LT-15-28) to 14.58% (AT-360 × LT-15-28). Standard heterosis for leaf area varied from -5.74% (AT-377 × LT-15-28) to

Table 4 : Four most heterotic crosses (standard heterosis) for seed yield per plant along with *per se* performance and their heterotic effects for component characters in sesame.

S. no.	Crosses	Mean seed yield per plant (g)	Seed yield per plant (g)	Days to 50% flowering	Days to maturity	Plant height (cm)	Effective branches per plant
1.	JLS-2420 × LT-15-28	14.57	30.06 **	3.89	-0.42	15.77 **	42.13 **
2.	AT-338 × AT-360	13.87	23.81 **	26.80 **	15.36 **	2.37	-34.51 **
3.	AT-360 × LT-15-28	13.80	23.21 **	-0.13	10.02 **	10.34	17.94
4.	AT-360 × ASRT-9	13.70	22.32 **	2.30	2.73	10.59	37.96 **

S. no.	Crosses	Capsules per plant	Capsule length (cm)	Leaf area (cm^2)	Seeds per capsule	1000-seed weight (g)	Oil content (%)
1.	JLS-2420 × LT-15-28	26.22 *	-7.86 *	-4.93	40.14 **	3.89	-3.40
2.	AT-338 × AT-360	53.97 **	13.33 **	13.38 **	-1.63	-1.44	-8.01 **
3.	AT-360 × LT-15-28	14.67	10.32 **	19.04 **	26.08 **	13.56 **	-0.74
4.	AT-360 × ASRT-9	23.83 **	-1.22	-1.04	26.58 **	-3.89	-12.64 **

*Significant at 5% level, **Significant at 1% level.

Table 5 : Comparison of top four promising crosses based on *per se* performance for yield per plant, BP (%), SH (%) and significant heterotic effects.

Hybrids	*per se* performance	Better parent Heterosis	Standard Heterosis	Significant heterosis for other characters over better parent	Significant heterosis for other characters over standard check
JLS-2420 × LT-15-28	14.57	58.3 **	30.06 **	DFF, EFP, PH, EBP, CL, LA, SPC	PH, EBP, CPP, CL, SPC
AT-338 × AT-360	13.87	27.2 **	23.81 **	DFF, DM, EBP, CPP, LA, SPC, SW, OC	DFF, DM, EFP, CPP, CL, LA, OC
AT-360 × LT-15-28	13.80	51.6 **	23.21 **	DFF, DM, LA, SPC, SW	DM, CL, LA, SW, SPC
AT-360 × ASRT-9	13.70	62.5 **	22.32 **	DFF, EBP, CPP, SPC, SW, OC	EBP, CPP, SPC, OC

BP (%): Better parent heterosis **DFF:** Days to 50% flowering **SH (%):** Standard heterosis **DM:** Days to maturity
SCA: Specific combining ability **PH:** Plant height (cm) **EBP:** Effective branches per plant **CPP :** Capsules per Plant
CL: Capsule length (cm) **LA:** leaf area (cm^2) **SPC:** seeds per capsule **SW:** 1000-seed weight (g)
OC: Oil content **SYP:** Seed yield per plant.

19.04% (AT-360 × LT-15-28). Notably, fifteen out of the 28 hybrids exhibited considerable and positive standard heterosis.

Seeds per capsule

Six hybrids exhibited significant and positive better parental heterosis, with the percentage ranging from -24.91 (DS-10 × AT-360) to 21.42 (DS-10 × ASRT-9) percent among the 28 hybrids. Regarding conventional heterosis, 13 out of the 28 hybrids demonstrated substantial and positive heterosis over the standard check GT-5 for seeds per capsule. Standard heterosis varied from -17.92 (DS-10 × AT-360) to 40.14 (JLS-2420 × LT-15-28) percent. These findings align with previous research by Misra et al. (2008), Gaikwad and Lal (2011), Chauhan *et al.* (2019) and Jeeva *et al.* (2020) regarding seeds per capsule in sesame.

1000-seed weight (g)

Nine out of 28 hybrids exhibited positive and significantly better parent heterosis, ranging from -13.26 (AT-377 × ASRT-9) to 17.08 (AT-338 × JLS-2611) percent. Additionally, among the 28 hybrids, 13 demonstrated positive and substantial standard heterosis over the standard check GT-5, ranging from -7.67 (AT-377 × ASRT-9) to 19.56 (AT-338 × JLS-2611) percent. Similar findings were observed in the studies conducted by Kumar *et al*. (2012), Vavdiya *et al*. (2013) and Nehra *et al*. (2021) for 1000-seed weight in sesame.

Appendix I

S. no.	Genotypes	Days to 50% flowering	Days to maturity	Plant height (cm)	Effective branches per plant	Capsule per plant	Capsule length (cm)
1	AT 377	44.49	95.28	100.26	3.03	72.02	2.89
2	DS 10	42.00	93.69	95.69	2.92	61.17	2.57
3	AT 338	44.27	97.18	97.14	2.80	69.61	3.12
4	AT 360	48.11	104.44	102.58	2.15	49.10	2.83
5	ASRT 9	44.59	96.02	86.34	2.73	55.78	2.86
6	JLS 2420	45.73	98.40	98.50	2.62	62.15	2.97
7	LT-15-28	43.38	94.03	97.92	2.66	56.07	2.95
8	JLS 2611	44.89	95.65	104.01	3.23	62.33	2.76
Parental Mean		**44.68**	**96.84**	**97.80**	**2.77**	**61.03**	**2.87**
9	AT 377 × DS 10	40.16	94.33	98.03	1.89	47.80	2.84
10	AT 377 × AT 338	44.99	94.34	101.97	3.06	80.13	2.79
11	AT 377 × AT 360	40.99	96.93	87.63	2.63	41.30	2.72
12	AT 377 × ASRT 9	40.06	94.27	106.73	2.19	72.97	3.11
13	AT 377 × JLS 2420	43.49	94.17	106.70	3.31	74.83	2.91
14	AT 377 × LT-15-28	39.82	88.52	98.40	3.39	57.40	3.02
15	AT 377 × JLS 2611	43.00	94.67	111.90	2.17	68.93	2.85
16	DS 10 × AT 338	44.98	101.86	110.97	3.51	74.50	2.88
17	DS 10 × AT 360	45.15	95.89	103.53	2.83	67.57	2.62
18	DS 10 × ASRT 9	37.90	87.74	108.10	3.17	54.93	2.81
19	DS 10 × JLS 2420	42.65	96.41	82.80	3.30	59.87	2.88
20	DS 10 × LT-15-28	38.84	88.56	99.27	4.01	74.93	3.20
21	DS 10 × JLS 2611	42.83	94.96	109.83	3.88	98.03	2.82
22	AT 338 × AT 360	52.06	108.48	96.77	1.80	92.47	3.10
23	AT 338 × ASRT 9	45.34	98.90	109.03	3.84	95.17	2.94
24	AT 338 × JLS 2420	43.98	94.64	107.17	3.14	84.70	3.18
25	AT 338 × LT-15-28	42.98	96.50	112.73	3.44	83.30	3.06
26	AT 338 × JLS 2611	43.98	97.82	110.27	4.14	69.77	2.98
27	AT 360 × ASRT 9	42.00	96.61	104.53	3.79	74.37	2.70
28	AT 360 × JLS 2420	43.34	93.83	99.33	3.90	91.23	3.17
29	AT 360 × LT-15-28	41.00	103.46	104.30	3.24	68.87	3.02
30	AT 360 × JLS 2611	41.99	95.79	113.23	3.39	67.60	2.98
31	ASRT 9 × JLS 2420	45.00	96.28	82.73	4.22	98.63	3.11
32	ASRT 9 × LT-15-28	40.17	95.16	96.20	2.90	54.30	3.00
33	ASRT 9 × JLS 2611	44.82	100.05	102.67	4.07	52.37	3.06
34	JLS 2420 × LT-15-28	42.65	93.64	109.43	3.90	75.80	2.52
35	JLS 2420 × JLS 2611	46.19	99.54	108.87	3.71	85.10	2.68
36	LT-15-28 × JLS 2611	39.67	94.33	109.10	3.96	75.37	3.01
Hybrid Mean		**42.86**	**95.99**	**103.29**	**3.31**	**72.94**	**2.93**
General Mean		**43.20**	**96.12**	**101.87**	**3.18**	**70.01**	**2.91**
37	**GT-5**	**41.02**	**94.04**	**94.52**	**2.75**	**60.06**	**2.73**
SEm±		**0.87**	**1.06**	**3.66**	**0.22**	**4.88**	**0.07**
CD		**2.45**	**2.98**	**10.31**	**0.62**	**13.77**	**0.21**
CV %		**3.49**	**1.91**	**6.22**	**11.97**	**12.08**	**4.37**

Appendix I continued...

Appendix I continued...

S. no.	Genotypes	Leaf area (cm^2)	Seed per capsule	1000 seed weight (g)	Oil content (%)	Seed yield per plant (g)
1	AT 377	40.99	55.55	3.04	39.68	9.93
2	DS 10	37.61	53.34	2.82	41.72	6.43
3	AT 338	39.92	63.00	3.02	40.06	10.90
4	AT 360	39.77	59.28	3.19	43.11	8.43
5	ASRT 9	36.99	52.64	3.19	42.26	8.17
6	JLS 2420	40.11	64.67	3.07	40.32	9.20
7	LT-15-28	38.48	54.65	2.98	44.06	9.10
8	JLS 2611	41.87	59.75	3.06	43.12	7.37
Parental Mean		**39.47**	**57.86**	**3.05**	**41.79**	**8.69**
9	AT 377 × DS 10	41.60	62.38	2.93	43.32	10.37
10	AT 377 × AT 338	44.43	60.37	3.26	44.88	7.27
11	AT 377 × AT 360	43.07	57.41	3.32	45.91	13.00
12	AT 377 × ASRT 9	38.41	64.65	2.77	41.84	8.33
13	AT 377 × JLS 2420	39.34	59.06	3.28	46.45	10.10
14	AT 377 × LT-15-28	36.08	55.59	3.13	42.02	10.43
15	AT 377 × JLS 2611	44.52	52.40	3.29	46.32	8.57
16	DS 10 × AT 338	42.93	57.04	2.90	45.94	7.43
17	DS 10 × AT 360	41.85	44.51	2.96	43.36	12.13
18	DS 10 × ASRT 9	38.21	64.77	3.15	35.22	7.00
19	DS 10 × JLS 2420	37.56	63.34	3.19	40.27	10.47
20	DS 10 × LT-15-28	38.71	57.35	3.10	43.61	7.03
21	DS 10 × JLS 2611	41.60	53.44	3.33	39.93	7.07
22	AT 338 × AT 360	43.40	53.35	2.96	40.83	13.87
23	AT 338 × ASRT 9	38.41	59.32	3.30	38.33	8.77
24	AT 338 × JLS 2420	41.30	65.43	2.85	44.53	12.20
25	AT 338 × LT-15-28	37.78	65.49	3.29	41.20	8.77
26	AT 338 × JLS 2611	42.33	54.55	3.59	42.63	7.07
27	AT 360 × ASRT 9	37.88	68.64	2.88	38.77	13.70
28	AT 360 × JLS 2420	43.71	67.32	3.08	47.28	7.20
29	AT 360 × LT-15-28	45.57	68.37	3.41	44.06	13.80
30	AT 360 × JLS 2611	41.63	53.85	3.49	47.59	7.20
31	ASRT 9 × JLS 2420	37.68	62.11	2.90	43.20	11.93
32	ASRT 9 × LT-15-28	42.31	55.33	3.00	47.12	7.43
33	ASRT 9 × JLS 2611	41.67	62.38	3.27	44.21	8.40
34	JLS 2420 × LT-15-28	36.39	76.00	3.12	42.87	14.57
35	JLS 2420 × JLS 2611	40.95	59.44	3.25	43.60	11.20
36	LT-15-28 × JLS 2611	40.33	66.52	2.98	44.13	6.37
Hybrid Mean		**40.70**	**60.37**	**3.14**	**43.19**	**9.70**
General Mean		**40.37**	**59.66**	**3.12**	**42.92**	**9.52**
37	**GT-5**	**38.28**	**3.00**	**44.38**	**11.20**	**11.20**
SEm±		**1.05**	**2.42**	**0.06**	**0.74**	**0.84**
CD		**2.97**	**6.83**	**0.17**	**2.09**	**2.37**
CV %		**4.52**	**7.03**	**3.28**	**3.00**	**15.30**

Mean values of parents, hybrids and checks for different characters under study in Sesame.

Oil content (%)

Among the 28 hybrids, nine exhibited positive and significant parent heterosis, ranging from -16.64 (DS-10 × ASRT-9) to 15.22 (AT-377 × JLS-2420) percent. Additionally, three hybrids within the same group displayed positive and substantial standard heterosis over the standard check GT-5, ranging from -20.64 (DS-10 × ASRT-9) to 7.22 (AT-360 × JLS-2611) percent. These findings are consistent with the results reported by Thiyagu *et al.* (2007), Banerjee and Kole (2011), Kumar *et al.* (2012) and Chauhan *et al.* (2019) concerning sesame oil content.

Seed yield per plant (g)

Seven hybrids exhibited significant and positive heterosis over the better parent, while four hybrids demonstrated significant and positive heterosis over the standard check. The improved parent heterosis estimates ranged from -35.17% (AT-338 × JLS-2611) to 62.45% (AT-360 × ASRT-9). Likewise, standard heterosis varied from -43.15% (LT-15-28 × JLS-2611) to 30.06% (JLS-2420 × LT-15-28). These results are consistent with previous findings reported by Govindarasu *et al.* (2001), Manivan and Ganesan (2001), Mothilal and Ganesan (2005), Anuradha *et al.* (2008), Raghunaiah *et al*. (2008), Gaikwad and Lal (2011), Jadhav and Mohrir (2013), Durga *et al*. (2015), Pawar *et al.* (2016), Karthickeyan *et al.* (2017), Kumari and Ganesamurthy (2017), Karande *et al.* (2018) and Raikwar (2018).

Conclusion

The available data reveal substantial diversity in the material concerning seed yield and its components. The influence of non-additive genetic variations was pronounced in the inheritance of all traits studied, including days to 50% flowering, days to maturity, plant height, effective branches per plant, capsules per plant, capsule length, leaf area, seeds per capsule, 1000-seed weight, oil content, and seed output per plant. This suggests that non-additive genetic variance plays a significant role, indicating that heterosis breeding could be a more effective approach for enhancing these traits in sesame. Additionally, crossings exhibiting high seed and oil yield, along with substantial heterosis and heterobeltiosis, should be strategically utilized through the pedigree approach to generate desirable transgressive segregants with elevated seed yield and increased oil content. The hybrids displayed significantly better parent heterosis and standard heterosis across various traits. Notably, 7 and 4 cross combinations exhibited significant positive better parent heterosis and standard heterosis, respectively, for seed yield per plant. The better parent heterosis and standard heterosis ranges for seed yield were -35.17 to 62.45 and -43.15 to 30.06, respectively, per plant. AT-360 × ASRT-9 (62.45%) and JLS-2420 × LT-15-28 (30.06%) demonstrated the most notable parent and standard heterosis for seed yield. These hybrids warrant further evaluation to harness the full potential of heterosis once suitable traits are identified.

Conflict of interest

The authors do not have any conflict of interest.

Author contributions

Naresh Chaudhary, Dr. P. K. Jagtap and Dr. V. B. Patel conceived and designed the experiment. Naresh Chaudhary, V.B. Rana, Rutvik J. Joshi, and D. P. Patel collected the data. Naresh Chaudhary, M. R. Prajapati, Hemali Pandya and V.B. Rana performed the analysis. Naresh Chaudhary and M. R. Prajapati wrote the research article.

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References

Abd-elsaber, A., MW Sh. Mahmoud and Attia M.A. (2019). Heterosis and combining ability for seed yield and its components in sesame. *Egypt. J. Plant Breed*., **23(5)**, 955– 969.

Anonymous (2021). *Directorate of economics and statistics*, Govt. of India

Anuradha, T. and Reddy G.L. (2008). Study of heterosis and inbreeding depression in Sesame. *Agric. Sci. Digest.*, **28(3)**, 157-164.

Banerjee, P.P. and Kole P.C. (2011). Heterosis, inbreeding depression and genotypic divergence for some physiological parameters in Sesame (*Sesamum indicum* L.). *J. Crop Improv.*, **25(1)**, 11-25.

Chauhan, B.B., Gami R.A., Prajapati K.P., Patel J.R. and Patel R.N. (2019). Study of *per se* performance and heterosis for seed yield and component traits in sesame (*Sesamum indicum* L.). *Cur. Agri. Res. J.*, **7(3)**, 408.

Durga, G.V., Babu D.R., Ahamed M.L. and Rao D.S. (2015). Heterosis and combining ability in sesame (*Sesamum indicum* L.). *Madr. Agri. J.*, **102**, 18-21.

Fonseca, S. and Patterson F.L. (1968). Hybrid vigour in a seven parent diallel cross in common wheat (*Triticum aestivum* L.). *Crop Sci*., **8**, 85-88.

Gaikwad, K.B. and Lal J.P. (2011). Heterosis and inbreeding depression in Sesame (*Sesamum indicum* L.). *Cur. Adva. in Agri. Sci. (An International Journal)*, **3(1)**, 54-56.

Govindarasu, R., Subramanian M. and Ramamoorthi N. (2001). Heterotic expression in sesame. *Madr. Agri. J.*, **86(7-9)**, 479-481.

Griffing, B. (1956). A generalised treatment of the use of diallel crosses in quantitative inheritance. *Hered.*, **10**, 31-50.

Jadhav, R.S. and Mohrir M.N. (2013). Heterosis studies for quantitative traits in sesame (*Sesamum indicum* L.). *Elect. J. Plant Breed*., **4(1)**, 1056-1060.

Jeeva, G.; Saravanan, K. and Sowmiya, C. A. (2020). Assessment of combining ability and standard heterosis through diallel analysis in sesame (*Sesamum indicum* L.). *Electr. J. Plant Breed*., **11(02)**, 386-391.

Karande, G.R., Yamgar S.V., Waghmode A.A. and Wadikar P.B. (2018). Exploitation of heterosis for yield and yield contributing character in sesame (*Sesamum indicum* L.). *Int. J. Curr. Microbiol. App. Sci*., **7(2)**, 299-308.

Karthickeyan, S., Vasline Y.A. and Saravanan K. (2017). Combining ability and heterosis for seed yield in sesame (*Sesamum indicum* L.). *Plant Archives*, **17(2)**, 1707-1710.

Kumar, P., Madhusudan K., Nadaf H.L., Patil R.K. and Deshpande S.K. (2012). Combining ability and gene action studies in inter-mutant hybrids of sesame (*Sesamum indicum* L.). *Karnataka J. Agric. Sci*., **25(1)**, 1-4.

Kumari, B. Meena and Ganesamurthy K. (2017). Study on the exploitation of heterosis in sesame (*Sesamum indicum* L.). *Electr. J. Plant Breed.*, **8 (2)**, 712-717.

Manivan, N. and Ganesan J. (2001). Performance of sesame hybrids in multilocation trial. *Madras Agri. J*., **88 (7-9)**, 427-430.

Meredith, W. and R. R.B. (1972). Heterosis and gene action in cotton, *Gossypium hirsutum* l.

Misra, R.C., Mishra H.P., Sahu P.K. and Das P.K. (2008). Heterosis and its relationship with combining ability, parental diversity and *per se* performance in sesame. *Agric. Sci. Digest*., **28(4)**, 254-257.

Mothilal, A., Ganesan K.N. and Varman P.V. (2005). Heterosis studies in sesame (*Sesamum indicum* L.). *Agri. Sci. Digest*., **25(1)**, 74-76.

Nehra, A., Gothwal D.K., Jeeterwal R.C., Puniya S.S., Gupta D. and Ahmad S. (2021). The study of heterosis for seed yield and its attributes in sesame (*Sesamum indicum* L.) under normal environmental conditions of Rajasthan. *Pharma. Innov. J.*, **10(10)**, 175-179.

Panse, V.G. and Sukhatme P.V. (1985). *Statistical methods for agricultural workers*. ICAR, New Delhi. Pp. 47

Pawar, A.K., Aher B.M., Desale C.S., Desai A.S. and Monpara B.A. (2016). Heterosis and combining ability in Sesame (*Sesamum indicum* L.). *Adva. Life Sci*., **5(4)**, 2231-235.

Raghunaiah, E., Kishan G.A. and Ansari N.A. (2008). Combining ability and heterosis for yield and yield components in sesame (*Sesamum indicum* L.). *J. Res. Angr*., **36(2-3)**, 9-16.

Raikwar, R.S. (2018). Heterosis for seed yield and its contributing attributes in Sesame (*Sesamum indicum* L.). *IJCS*, **6 (4)**, 2684-2687.

Thiyagu, K., Kandasamy G., Manivannan N. and Muralidharan V. (2007a). Studies on heterosis in genetically diverse lines of cultivated sesame (*Sesamum indicum* L.). *Madras Agric. J*., **94(7-12)**, 162-167.

Vavdiya, P.A., Dobariya K.L., Babariya C.A. and Sapovadiya M.V. (2013). Heterosis for seed yield and its components in sesame (*Sesamum indicum* L.). *Electr. J. Plant Breed*., **4(3)**, 1246-1250.