



# Assessing the Magnitude of Heterosis for Yield and its Component Traits in Sesame (*Sesamum indicum* L.)

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

The present study was conducted to assess the magnitude of heterosis in 28 sesame hybrids derived from a Line x Tester mating design involving four female and seven male genotypes, along with their 11 parents and one standard check (JLT-408). The experiment was carried out during Rabi 2024–25 at the Experimental Farm, Department of Genetics and Plant Breeding, College of Agriculture, Latur. Observations were recorded on seed yield and associated traits. Analysis of variance revealed significant differences among parents and crosses for key traits including plant height, number of capsules per plant, 1000 seed weight, seed yield per plant and oil content. Several hybrids, notably TBS-07 x TS-24, TBS-02 x TS-20, TBS-09 x TS-20, TBS-09 x TS-24 and TBS-10 x V-22, exhibited high standard heterosis over the standard check JLT-408 for seed yield

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and other yield related traits. The identification and selection of such high heterotic hybrids with superior per se performance can be considered a promising strategy for genetic improvement in sesame.

**Keywords:** *Sesame; heterosis; line x tester; hybrids; standard check.*

## 1. INTRODUCTION

Sesame (*Sesamum indicum* L.) is one of the oldest oilseed crops cultivated in India, known for its high oil content and adaptability to marginal environments. Sesame belongs to the *Pedaliaceae* family which comprises 16 genera and about 36 species and the order *Tubiflorae*. It is an annual, diploid and predominantly self-pollinated crop with chromosome number  $2n = 2x = 26$ . In the financial year 2022-23, India recorded a total sesame seed production of 8.02 lakh tonnes, showing a slight increase from 7.89 lakh tones in the previous year (Anonymous 2023). Sesame, often referred to as the "Queen of oilseeds," is valued for its high quality oil which is rich in oleic acid (43%), linoleic acid (35%), palmitic acid (11%) and stearic acid (7%) along with natural antioxidants (Ashri, 1998).

Sesame's characteristics such as epipetalous flowers, ease of emasculation and pollination, high seed production per flower, low seed rate and a high multiplication ratio enhance the potential for heterosis breeding in sesame (Jadhav and Mohir, 2013). A small amount of heterosis observed in individual yield components may collectively exert additive or synergistic effects, ultimately enhancing overall yield performance (Sasikumar and Sardana, 1990). Hence, the present investigation was conducted to assess the magnitude of heterosis for yield and its component traits in sesame.

## 2. MATERIALS AND METHODS

The present study was conducted at Experimental Farm of Department of Genetics and Plant Breeding, College of Agriculture, Latur (VNMKV Parbhani) during *Rabi* 2024-25. The study included eleven parents distributed as four lines *viz.*, TBS-02, TBS-07, TBS-09 and TBS-10 and seven testers *viz.*, TS-24, TS-20, V-22, TKG-22, R-33, R-22 and TBS 12-1. For estimation of standard heterosis JLT-408 was used as check. The parents were crossed in line x tester mating design to produce 28 hybrids. The spacing of 60 cm between rows and 15 cm between plants was adopted for crossing programme in *Kharif* 2024. The resulting 28 hybrids along with 11 parents and standard check JLT-408 were evaluated in

*Rabi* 2024-25 in randomized block design (RBD) with two replications. Each plot consists of row length of 3 m. All required agronomic practices were carried out to maintain good crop stand. Observations were recorded on randomly selected five plants in each row entry for all ten characters *viz.*, days to 50 % flowering, days to maturity, plant height (cm), number of branches per plant, number of capsule per plant, number of seeds per capsule, length of capsule (cm), 1000 seed weight (g), seed yield per plant (g) and oil content (%). Standard error and critical difference at 1 and 5 per cent levels of significance were calculated by using the formula given by Panse and Sukhatme, (1985). Per cent heterosis was estimated for all the characters under study over better parent and over the standard check (Rai, 1979).

## 3. RESULTS AND DISCUSSION

Analysis of variance (Table 1) revealed that significant differences present for all ten traits in treatments indicating presence of significant variation among them. The significant differences among parents and crosses were reported for traits plant height, number of capsules plant, 1000 seed weight, seed yield per plant and oil content. Highly significant interaction between crosses and parents indicating that heterosis could be exploited for such traits.

The magnitude of heterobeltiosis and standard heterosis was observed for ten characters as shown in Table 2. The crosses exhibiting significant negative heterotic effects for days to 50 % flowering and days to maturity are considered as desirable. Otherwise positive heterosis is desirable for remaining traits. Among 28 crosses, TBS-09 x TS 24 manifested highest significant negative heterosis over better parent. A similar result was earlier reported by Patel et al. (2016). While none of the hybrid showed standard heterosis over check JLT-408. Similar kinds of results were found for character days to maturity. The cross, TBS-09 x R-33 recorded highest significant heterosis over better parent and cross combinations *viz.*, TBS-02 x R-22, TBS-02 x TS-20, TBS-07 x R-33, TBS-09 x R-33 expressed standard heterosis over check JLT-408 for character plant height.

**Table 1. Analysis of variance for ten quantitative traits in sesame**

Source of Variation	d.f.	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	No. of branches per plant	No. of capsule per plant	No. of Seed per capsule	Length of capsule (cm)	1000 Seed weight (g)	Seed yield per plant (g)	Oil Content (%)
Replications	1	1.28	5.12	28.32	0.23	17.64	12.72	0.06	0.01	0.07	0.07
Treatments	38	26.66**	55.13**	155.56**	0.97**	233.94**	196.52**	0.05*	0.14*	4.74**	6.83**
Parents	10	16.28**	15.33	74.17**	1.41	274.02**	26.67	0.0165	0.03*	4.65**	6.40**
Lines	3	11.00	28.50	18.33	1.35	300.67**	7.89	0.0154	0.04	0.31**	9.23**
Testers	6	21.28**	2.73	102.82**	1.24	277.45	38.91**	0.0198	0.02	7.00**	4.49**
Lines v/s Testers	1	2.10	51.43	69.82	2.67	173.47**	9.57**	0.0001	0.01	3.52**	9.33**
Parents v/s Crosses	1	23.22**	739.87**	98.69	0.31	380.54**	58.71**	0.26**	0.0015	0.45**	14.13**
Crosses	27	30.64	44.50	187.81**	0.83	213.67**	264.53**	0.05**	0.18**	4.94**	6.72**
Error	38	3.38	2.57	11.16	0.06	6.18	4.01	0.02	0.02	0.14	0.34

\*and \*\* indicated significance at 5 and 1 percent level, respectively

**Table 2. Estimation of heterosis over better parent (BP) and standard check (SC) JLT-408 for ten characters in sesame**

Sr. No.	Name of Crosses	Days to 50% flowering		Days to maturity		Plant height (cm)		Number of branches per plant	
		BP	SC	BP	SC	BP	SC	BP	SC
1	TBS-02 x TS-24	1.56	20.37 **	-2.34	2.90 *	6.44 *	6.44	-27.12 **	-13.21
2	TBS-02 x TS-20	7.14 *	30.56 **	-1.53	-2.49	10.07 **	10.07 **	-54.55 **	56.60 **
3	TBS-02 x V-22	-12.40 **	12.04 **	-10.89 **	-0.41	-17.44 **	-17.44 **	-18.06 *	7.55
4	TBS-02 x TKG-22	1.67	0.93	-8.95 **	-0.83	-15.49 **	-15.49 **	-16.95 *	-7.55
5	TBS-02 x R-33	-4.1	12.04 **	-9.73 **	0	-0.75	-0.75	-11.86	15.09
6	TBS-02 x R-22	-3.88	10.19 **	-7.00 **	0.41	2.78	10.35 **	-25.42 **	-11.32
7	TBS-02 x TBS 12-1	-1.67	13.89 **	-3.95 **	-1.24	1.31	1.31	-28.81 **	-20.75 *
8	TBS-07 x TS-24	-7.03 *	13.89 **	-16.41 **	5.39 **	-21.86 **	-25.79 **	57.89 **	22.64 *
9	TBS-07 x TS-20	-11.90 **	12.04 **	-14.18 **	-1.24	-5.99	-10.73 **	-9.09	15.09
10	TBS-07 x V-22	-6.20 *	5.56	-8.56 **	-2.07	-11.59 **	-16.04 **	-29.17 **	-7.55
11	TBS-07 x TKG-22	-0.81	1.85	-4.67 **	2.90 *	-0.1	-5.13	-21.05 *	-15.09
12	TBS-07 X R-33	5.69	4.63	-3.50 **	-1.24	14.34 **	8.58 *	-19.30 *	20.75 *
13	TBS-07 x R-22	9.30 **	2.78	-8.56 **	5.39 **	-20.07 **	-14.18 **	45.61 **	0
14	TBS-07 x TBS 12-1	-1.63	4.63	-5.14 **	2.90 *	1.38	-3.73	0	-7.55
15	TBS-09 x TS-24	-14.84 **	19.44 **	-7.72 **	2.49	2.3	-4.48	-20.97 *	37.74 **
16	TBS-09 x TS-20	-5.47	17.59 **	-7.66 **	3.32 *	0.8	-5.88	-20.78 **	26.42 **
17	TBS-09 x V-22	-7.75 **	5.56	-6.56 **	2.49	1.8	-4.94	-34.72 **	15.09
18	TBS-09 x TKG-22	-3.91	11.11 **	-8.11 **	3.32 *	14.29 **	6.72 *	-32.26 **	11.32
19	TBS-09 x R-33	-3.91	13.89 **	-1.93	0	15.48 **	7.84 *	4.84	7.55
20	TBS-09 x R-22	-6.20 *	18.52 **	-8.11 **	7.47 **	-6.60 *	0.28	-1.61	16.98
21	TBS-09 x TBS 12-1	-10.94 **	8.33 *	-8.88 **	4.98 **	3.9	-2.99	-20.97 *	73.58 **
22	TBS-10 x TS-24	-14.06 **	18.52 **	-3.13 *	6.22 **	-6.35	-9.84 **	-51.09 **	3.77
23	TBS-10 x TS-20	-10.32 **	16.67 **	-8.81 **	8.30 **	2.52	-1.31	-30.43 **	45.28 **
24	TBS-10 x V-22	-13.95 **	19.44 **	-1.17	6.64 **	4.26	0.37	-42.39 **	35.85 **
25	TBS-10 x TKG-22	-3.42	4.63	-3.50 **	6.64 **	-3.68	-7.28 *	-46.74 **	-22.64 *
26	TBS-10 x R-33	5.74	12.96 **	-3.89 **	6.64 **	2.91	-0.93	-20.65 **	-11.32
27	TBS-10 x R-22	-1.55	19.44 **	-3.11 *	6.64 **	-6.17 *	0.75	-27.17 **	-28.30 **
28	TBS-10 x TBS 12-1	-2.56	7.41 *	-2.37	4.98 **	-6.3	-9.79 **	-33.70 **	-22.64 *
	<b>S.E(±)</b>	1.84	1.77	1.6	1.48	3.34	3.46	0.24	0.23

\*and \*\* indicated significance at 5 and 1 percent level, respectively

Table 2. Estimation of heterosis over better parent (BP) and standard check (SC) JLT-408 for ten characters in sesame (*continued...*)

Sr. No.	Name of Crosses	Number of capsules per plant		Number of seeds per capsule		Length of capsule (cm)		1000 seed weight (g)	
		BP	SC	BP	SC	BP	SC	BP	SC
1	TBS-02 x TS-24	-29.62 **	-29.65 **	-17.05 **	0	-7.74	-9.21	1.95	16.01 **
2	TBS-02 x TS-20	-49.10 **	37.31 **	83.45 **	-2.21	-9.03	12.41	-10.93 *	-9.91
3	TBS-02 x V-22	-50.71 **	10.61	-37.50 **	-5.15	-7.19	4.89	-7.49	-8.23
4	TBS-02 x TKG-22	-19.87 **	-16.85 **	-26.62 **	-24.63 **	-6.25	3.01	-5.56	-9.15
5	TBS-02 x R-33	-6.32	36.11 **	-8.63 *	-8.09	-3.81	8.27	11.58 *	-6.4
6	TBS-02 x R-22	-34.94 **	-30.42 **	-6.04	4.23	-6.43	9.4	-4.3	-3.81
7	TBS-02 x TBS 12-1	-33.80 **	7.11	-12.95 **	2.94	-4.17	11.65	5.41	-10.06 *
8	TBS-07 x TS-24	-23.13 **	-3.83	-28.67 **	10.48 *	-26.60 **	4.14	8.87	16.62 **
9	TBS-07 x TS-20	-36.07 **	-10.28	-13.15 **	-3.86	-0.35	5.26	12.24 *	-3.51
10	TBS-07 x V-22	-45.64 **	-5.03	-24.75 **	2.94	-5.82	5.26	-0.75	-5.95
11	TBS-07 x TKG-22	-17.05 *	-26.26 **	-3.32	-8.09	0.7	2.26	-8.16	13.57 **
12	TBS-07 X R-33	-21.87 **	0.66	3.03	-17.10 **	-16.44 **	11.65	18.17 **	3.35
13	TBS-07 x R-22	62.14 **	-28.45 **	-10.74 **	-9.56 *	-3.86	6.39	-12.31 *	8.69
14	TBS-07 x TBS 12-1	30.62 **	-29.87 **	-1.53	-14.71 **	-2.45	6.02	-5.49	3.51
15	TBS-09 x TS-24	-13.54 *	17.83 **	-28.32 **	6.62	-7.74	9.77	-14.37 **	6.1
16	TBS-09 x TS-20	17.47 **	0.98	-7.41	6.62	-0.35	11.28	-11.78 *	5.34
17	TBS-09 x V-22	-47.22 **	-27.68 **	-4.22	6.99	-0.34	7.89	-9.34	-15.24 **
18	TBS-09 x TKG-22	11.38 *	-13.57 *	3.7	2.21	2.77	8.27	-15.23 **	1.37
19	TBS-09 x R-33	0	-15.32 *	11.30 **	-5.88	-4.15	6.77	9.91 *	-5.03
20	TBS-09 x R-22	-6.71	-3.83	-12.25 **	-0.74	-9.97	8.65	-9.05	6.1
21	TBS-09 x TBS 12-1	-1.25	41.79 **	3.7	-4.41	-3.11	14.29 *	-11.35 *	3.66
22	TBS-10 x TS-24	-47.99 **	-18.49 **	-12.59 **	5.15	-10.53 *	11.65	9.56	-3.81
23	TBS-10 x TS-20	-29.01 **	15.86 *	-15.86 **	-1.47	-2.3	6.77	-1.17	4.57
24	TBS-10 x V-22	-49.54 **	31.84 **	-16.89 **	8.82	-6.91	9.77	4.85	1.83
25	TBS-10 x TKG-22	-50.54 **	-35.01 **	-10.77 **	-13.24 **	-7.24	6.02	-0.15	-2.9
26	TBS-10 x R-33	-16.90 **	-9.96	9.85 *	-2.94	-3.95	8.65	2.35	-1.83
27	TBS-10 x R-22	-28.78 **	-37.75 **	-2.68	9.56 *	-4.82	16.92 *	1.62	2.74
28	TBS-10 x TBS 12-1	-49.00 **	-20.02 **	11.07 **	-3.68	-5.59	7.52	-18.24 **	-2.9
	<b>S.E(±)</b>	2.48	2.68	2	2.34	0.15	0.16	0.17	0.15

\*and \*\* indicated significance at 5 and 1 percent level, respectively

Table 2. Estimation of heterosis over better parent (BP) and standard check (SC) JLT-408 for ten characters in sesame (*continued...*)

Sr. No.	Name of Crosses	Seed yield per plant (g)		Oil content (%)	
		BP	SC	BP	SC
1	TBS-02 x TS-24	-24.66 **	-38.92 **	-2.06	-5.64 **
2	TBS-02 x TS-20	67.40 **	23.34 **	0.73	-8.52 **
3	TBS-02 x V-22	-52.60 **	-3.52	-1.9	-6.52 **
4	TBS-02 x TKG-22	-37.62 **	-14.47	-9.20 **	-10.53 **
5	TBS-02 x R-33	-13.91	2.7	-0.95	-5.72 **
6	TBS-02 x R-22	-41.83 **	-32.79 **	-2.72 *	-5.00 **
7	TBS-02 x TBS 12-1	-25.18 **	-28.95 **	-2.82 *	-12.37 **
8	TBS-07 x TS-24	40.30 **	27.47 **	-10.74 **	-1.65
9	TBS-07 x TS-20	-25.20 **	-28.13 **	-3.09 *	-11.31 **
10	TBS-07 x V-22	-49.15 **	-26.98 **	-3.34 **	-3.68 *
11	TBS-07 x TKG-22	-59.80 **	-34.01 **	0.83	-8.31 **
12	TBS-07 x R-33	-30.64 **	-19.71 *	-0.74	-7.37 **
13	TBS-07 x R-22	37.79 **	-34.01 **	-2.36	-7.41 **
14	TBS-07 x TBS 12-1	9.56	-19.71 *	-7.11 **	-4.87 **
15	TBS-09 x TS-24	58.78**	22.00 **	-6.34 **	-4.25 **
16	TBS-09 x TS-20	46.17**	22.51 **	-0.28	1.16
17	TBS-09 x V-22	-44.42 **	-29.76 **	-6.67 **	-4.42 **
18	TBS-09 x TKG-22	-15.79 *	-22.40 **	-8.79 **	-6.86 **
19	TBS-09 x R-33	51.07 **	-11.94	3.46 *	-8.43 **
20	TBS-09 x R-22	-14.83	-15.62 *	-5.35 **	-9.52 **
21	TBS-09 x TBS 12-1	-13.47	-6.87	-4.28 **	0.48
22	TBS-10 x TS-24	-29.15 **	-29.03 **	-8.75 **	-4.47 **
23	TBS-10 x TS-20	-22.68 **	3.84	-7.82 **	-5.46 **
24	TBS-10 x V-22	45.44 **	20.93 **	-9.05 **	1.8
25	TBS-10 x TKG-22	-13.78 *	-57.97 **	-5.33 **	-3.93 **
26	TBS-10 x R-33	30.99 **	-28.54 **	-4.71 **	-4.94 **
27	TBS-10 x R-22	33.01 **	-61.00 **	0.67	-6.30 **
28	TBS-10 x TBS 12-1	-24.58 **	-43.01 **	-5.02 **	0.63
	<b>S.E(±)</b>	0.38	0.44	0.58	0.64

\*and \*\* indicated significance at 5 and 1 percent level, respectively

**Table 3. Heterosis of the best five crosses on the basis of their per se performance for seed yield per plant and contributing traits in sesame**

Sr. No.	Crosses	Per se performance for seed yield per plant (g)	Heterobeltois (%)	Standard heterosis (%)	Desirable significant positive standard heterosis
01	TBS-07 x TS-24	7.80	40.30 **	27.47 **	NBPP, NSPC and 1000 SW
02	TBS-02 x TS-20	7.69	67.40**	23.34**	NBPP and NCPP
03	TBS-09 x TS-20	7.58	46.17**	22.51**	NBPP
04	TBS-09 x TS-24	7.47	58.78**	22.00**	NBPP and NCPP
05	TBS-10 x V-22	7.39	45.44 **	20.93 **	NBPP and NCPP

*\*and \*\* indicated significance at 5 and 1 percent level, respectively  
 NBPP - Number of branches per plant; NCPP - Number of capsules per plant  
 NSPC - Number of seeds per capsule; 1000 SW - 1000 seed weight*

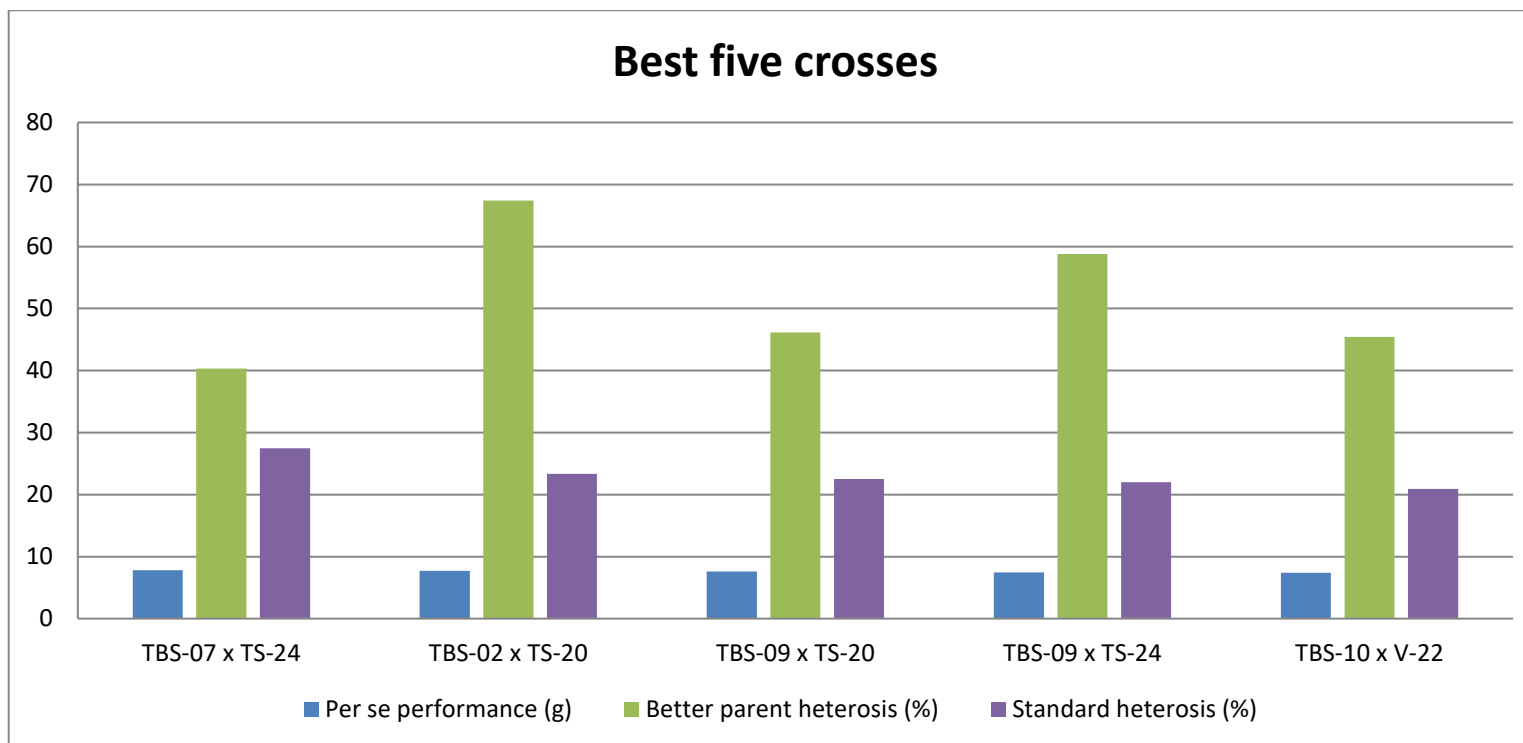


Fig. 1. Best five crosses

Similar results were found by Disowja et al. (2021). For number of branches per plant the cross, TBS-07 x TS-24 exhibited highest significant positive heterosis over a better parent. While, the cross TBS-09 x TBS 12-1 expressed highest significant heterosis followed by TBS-02 x TS-20 and TBS-10 x TS-20 over standard check. Similar results were found by Jeeva et al. (2020). For character number of capsules per plant the highest significant heterobeltiosis recorded by TBS-07 x R-22 whereas, the cross TBS-09 x TBS 12-1 showed highest significant standard heterosis over check. Similar results were earlier reported by Kumar et al., Tavadare et al. (2022).

Among 28 crosses, the cross TBS-02 x TS-20 exhibited highest significant heterosis over better parent and none of cross exhibited significant and positive figure over standard check except cross TBS-07 x TS-24 and TBS-10 x R-22 for character number of seed per capsule. For the length of capsule, out of 28 none of cross manifested significant positive heterosis. Similarly, all crosses failed to express significant and positive effect over standard check JLT 408. The significant and positive figure of heterobeltiosis observed for the crosses TBS-07 x R-33, TBS-07 x TS-20 and TBS-02 x R-33 for character 1000 seed weight. Whereas, only three crosses viz., TBS-07 x TS-24, TBS-02 x TS-24 and TBS-07 x TKG-22 expressed significant standard heterosis over check. Similar results were earlier reported by Sundari and Kamala (2012), Pavan (2023). For character seed yield per plant, heterobeltiosis range varied from - 59.80 (TBS-07 x TKG-22) to 67.40 (TBS-02 x TS-20) percent. Heterobeltiosis expressed highest significant for the cross, TBS-02 x TS-20, with TBS-09 x TS-24, TBS-09 x R-33, TBS-09 x TS-20 ranking next. While, the highest standard heterosis 27.47 percent was depicted by the cross TBS-07 x TS-24 among all crosses. Furthermore, crosses TBS-02 x TS-20, TBS-09 x TS-2, TBS-09 x TS-24 and TBS-10 x V-22 also manifested highest significant heterosis over check JLT-408. These results were in agreement with the results of Beniwal et al. (2018), Sirohi et al. (2020), Oza et al. (2020). For quality determining character oil content the highest significant heterobeltiosis observed only by cross TBS-09 x R-33. Whereas, all crosses failed to express significant and positive effect over standard check JLT-408 for oil content. These results were similar with Virani et al. (2017) for oil content in sesame.

Hybrids exhibiting high heterosis for seed yield, along with superior per se performance and significant positive heterosis for other yield contributing traits, were identified in the present investigation (Table 3). Hence, selecting such hybrids based on either their individual performance or the extent of heterotic expression can serve as a dependable strategy for future genetic enhancement in sesame.

#### 4. CONCLUSION

Choosing hybrids based on the level of heterosis expressed or their individual performance can be a reliable approach for future genetic improvement in sesame. The high heterotic combination are expected for future better transgressive segregants. The promising best hybrids identified with high heterosis can play an important role in future sesame breeding efforts. These combinations may give rise to transgressive segregants with improved yield and adaptability. By using such hybrids in selection and crossing programs, breeders can accelerate the development of better performing sesame varieties suited to diverse growing conditions.

#### DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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