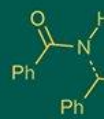


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Heterotic potential for seed yield and its components in sesame (*Sesamum indicum* L.)

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Abstract

Sesame (*Sesamum indicum* L.) is a vital global oilseed crop, yet its productivity is often bottlenecked by a narrow genetic base. Exploiting heterosis offers a viable strategy to achieve significant quantum jumps in seed yield. This study aimed to estimate the magnitude of heterosis for seed yield and its component traits to identify superior cross-combinations for commercial exploitation and varietal improvement. A 9x9 half-diallel mating design was executed during the *Kharif* 2025 season, generating 36 crosses. The 46 genotypes (9 parents, 36 hybrids, and 1 standard check, TLT-10) were evaluated using a randomized design. Data were recorded on ten quantitative traits. Heterosis was estimated over the mid-parent, better-parent, and standard check. Significant heterotic effects were observed across all evaluated traits. For earliness, RT-54 × JLT-408 and JLT-408 × TS-14-A exhibited highly significant negative standard heterosis for days to 50 per cent flowering (-12.88%) and maturity (-6.22%), respectively. The hybrid TS-111 × TS-14-A displayed exceptional standard heterosis for number of capsules per plant (34.22%). For seed yield per plant, the cross TS-111 × TS-11-2 registered the highest standard heterosis (33.05%) and maximum per se performance (9.41 g). Other notable hybrids for seed yield included TS-14-A × RT-346 (32.70%) and TS-11-2 × RT-346 (32.48%). Additionally, TS-11-2 × TS-14-A recorded the highest standard heterosis (9.66%) for oil content. The elite cross-combinations TS-111 × TS-11-2, TS-14-A × RT-346, and TS-11-2 × RT-346 demonstrated outstanding per se performance and significant standard heterosis (>32%). These hybrids hold immense potential for direct commercial cultivation or as base populations for isolating transgressive segregants to break current yield plateaus.

Keywords: Sesame, half-diallel, heterosis, per se performance and yield-attributing traits

1. Introduction

Sesame (*Sesamum indicum* L.) often called the "Queen of Oilseeds" and commonly known as Til (Hindi/Marathi), Tai (Gujrat), Tili (Punjab), Nuvulu (telugu), Ellu (Tamil), Rasi (Orissa). It is one of the oldest domesticated crop, with a history spanning over 3,000 years. In 2025 continues to be a vital global crop with production estimated to reach approximately 9.26 million tonnes by 2040 and a market value projected at \$13.8 billion this year. Sudan currently leads global production followed closely by India, Myanmar and other significant producers include Tanzania, Nigeria, and Ethiopia. Indian market prices saw a downward trend in early 2025 due to weak global demand and heavy competition from African producers. India is a global leader in sesame exports, particularly for high-quality white, black, and hulled varieties. Major growing states include Gujarat, West Bengal, Rajasthan, and Uttar Pradesh (Anonymous 2025) ^[1].

Sesame is an important source of edible oil, protein, vitamins and other nutritionally valuable compounds. Sesame oil is highly valued because of its excellent oxidative stability, desirable fatty acid composition and nutritional quality. The crop is particularly important in India because of its suitability to diverse agro-climatic conditions, relatively low input requirement and adaptability to rainfed farming. Despite its importance, the productivity of sesame remains comparatively low. Seed yield is a complex quantitative trait influenced by several component traits and by environmental conditions. Traits such as number of branches per plant, number of capsules per plant, capsule length, number of seeds per capsule, 1000-seed weight, plant height and days to maturity contribute to variation in seed yield. Therefore,

improvement of seed yield through conventional selection alone may be difficult because of the complex inheritance and strong environmental influence on yield.

Exploitation of heterosis provides an effective approach for improving productivity, particularly when substantial genetic diversity exists among the parental lines. In sesame, considerable variability is available in germplasm for yield and its component traits, providing opportunities for identifying superior hybrids.

Therefore, understanding the magnitude and direction of heterosis for both seed yield and its component traits is essential for a successful breeding programme. In light of this, the present study was undertaken to estimate the heterotic potential of various cross combinations, with the primary objective of identifying the high-yielding hybrids for future commercial exploitation and varietal improvement in sesame.

2. Materials and Methods

The parental material was consisting of nine genotypes viz., TS-110, TS-102, RT-54, TS-111, TS-11-2, JLT 408, TS-14-A, TS-1, RT-346 obtained from Oilseed Research Station, Latur were used for development of new crosses during *Kharif* season 2025. The 9x9 half diallel without reciprocal crossing was affected and total 36 crosses were obtained from parental materials. The experimental material was consisted 46 genotypes comprising 9 parents, 36 crosses and 1 check (TLT-10) which were raised in randomized block design with two replications for the study.

Five representative plants per genotype in each replication were selected randomly, tagged and observations were recorded on these plants for different characters i.e. Days to 50 per cent flowering, Days to maturity, Plant height (cm), Number of branches per plant, Number of capsules per plant, Number of seeds per capsule, Capsule length (cm), 1000 seed weight (g), Seed yield per plant (g) and Oil Content (per cent).

The average data collected for all traits were analysed on a replication-wise mean basis. The statistical analysis was performed to assess heterosis for various quantitative characters in sesame (*Sesamum indicum* L.) are computed as the percentage increase or decrease of the hybrid over the mid-parent (MP), better-parent (BP), and, frequently, a commercial standard check (SC). The methodologies established by Turner (1953) and Hayes *et al.* (1955) are standard, well-documented procedures in plant breeding, including oilseed crops such as sesame, to calculate these values.

3. Results

The magnitude of heterosis expressed as per cent increase or decrease in the hybrids over the mid parent, better parent of respective cross and over standard check for different traits under study. The heterosis in a desirable direction is highly valuable for exploiting hybrid vigor. The estimated values for all the traits are summarized in Table 1.

Early flowering is considered as highly desirable. The hybrids showing significant negative heterosis for this trait are considered as superior. The heterobeltiosis and standard heterosis for F_1 varied from -6.56 (JLT 408 x TS-14-A) to 13.64 (RT-54 x TS-1) per cent and -12.88 (RT-54 x JLT-408) to 7.65 (TS-110 x TS-111) per cent respectively. The cross RT-54 x JLT-408 (-8.30%) expressed highest significant negative heterosis over mid parent followed by

JLT-408 x TS-14-A (-6.97%) and TS-102 x TS-11-2 (-6.26%). The cross combination JLT-408 x TS-14-A (-6.56%) exhibited highest significant negative heterosis over better parent followed by crosses RT-54 x JLT-408 (-5.31%) and TS-102 x TS-11-2 (-4.21%). While, cross RT-54 x JLT-408 (-12.88%) was recorded significant negative heterosis over standard check followed by crosses RT-54 x RT-346 (-11.40%) and JLT-408 x TS-14-A (-8.41%) for days to 50 per cent flowering. (Chaudhari *et.al.*)^[2, 3]

Early maturity is an important trait to escape terminal stress, hence heterosis in a negative direction is preferred. The heterosis over mid parent for days to maturity differed from -7.48 (TS-102 x RT-346) to 13.80 (TS-11-2 x TS-14-A) per cent and over standard check TLT 10, it covered a range of -6.22 (JLT-408 x TS-14-A) to 14.34 (TS-102 x TS-1) per cent. The cross TS-102 x RT-346 (-7.48%) recorded maximum significant negative heterosis over better parent followed by cross TS-110 x TS-14(-4.68%). While, the cross JLT-408 x TS-14-A (-6.22%) was showed highest significant negative heterosis over standard check followed by RT-54 x TS-11-2 (-5.17%) for this trait. (Chauhan *et.al.* & Dela *et.al.*)^[4, 5]

Tallness in plant height is desirable. Thus, cross exhibiting a significant positive heterotic effect is desirable. The cross RT-54 x RT-346 (26.68%) showed highest significant positive heterosis over mid parent followed by JLT-408 x RT-346 (25.29%). Whereas, the cross combination RT-54 x RT-346 (22.71%) recorded maximum significant positive heterosis over better parent followed by cross combination JLT-408 x RT-346 (20.87%). While, the cross JLT-408 x RT-346 (21.45%) showed highest significant positive heterosis over standard check followed by TS-110 x TS-14-A (21.35%) for plant height. (Ghule *et.al.* & Kumar *et.al.*)^[7, 9]

The number of branches per plant is a vital parameter influencing the overall capsule bearing capacity. Number of branches in plant is desirable trait hence positive heterotic effect is desirable. The extent of heterosis ranged from -33.64 (TS-14-A x TS-1) to 35.34 (TS-111 x TS-11-2) per cent to over mid parent, from -30.84 per cent (JLT-408 x TS-14-A) to 35.34 per cent (TS-111 x TS-11-2) over better parent and from -32.14 (TS-102 x TS-111) to 23.82 (TS-110 x TS-14-A) per cent over standard check TLT-10. The cross TS-111 x TS-11-2 (35.34) demonstrated the highest significant positive heterosis over better parent followed by RT-54 x TS-111 (23.28%). For standard heterosis, TS-110 x TS-14-A (23.82%) was found superior followed by RT-54 x TS-111 (22.48%). (Lal *et.al.* & Monpara *et.al.*)^[10, 11, 12]

One of the most crucial traits that is directly associated to an increase in yield per unit area is the number of capsules per plant, hence a considerably favourable heterosis effect is greatly desired for this trait. The cross TS-111 x TS-14-A (43.72%) displayed highest significant positive heterosis over mid parent followed by JLT-408 x RT-346 (43.23%). The cross combination TS-111 x TS-14-A (42.42%) have been found with the highest significant positive heterosis over better parent followed by TS-102 x RT-54 (33.99%). Whereas, the cross combination TS-111 x TS-14-A (34.22%) displayed highest significant positive heterosis over standard check followed by TS-111 x RT-346 (29.10%) and JLT-408 x RT-346 (29.10%). From all the 36 hybrids under the study crosses The cross JLT-408 x RT-346 (12.78%) depicted significant positive heterosis over better parent, followed by TS-111 x RT-346 (10.63%). For

standard heterosis, JLT-408 x RT-346 (18.14%) resulted in significantly positive heterosis followed by TS-11-2 x RT-346 (17.00%). (Parimala *et.al.* & Patel *et.al.*)^[15, 16, 17].

A larger capsule length correlates with higher seed accommodation. While considering heterosis over mid parent RT-54 x TS-111 (40.34%) cross showed highest positive significance and ranking second was TS-110 x RT-54 (39.72%). The cross TS-110 x RT-54 (37.16%) followed by RT-54 x TS-111 (31.85%) exhibited the highest significant positive heterosis over better parent, while TS-102 x RT-54 (20.92%) and RT-54 x TS-11-2 (19.15%) displayed the maximum standard heterosis. (Patel *et.al.* & Sankar *et.al.*)^[16, 17, 18].

Test weight is a significant yield-contributing factor; hence heterosis in a positive direction is preferred. The cross TS-102 x RT-54 (27.76%) subsequently RT-54 x JLT-408 (24.18%) was recorded maximum significant positive heterosis over mid parent. TS-102 x RT-54 (25.00%) followed by RT-54 x JLT-408 (18.60%) assessed heterobeltiosis. While, the crosses TS-111 x TS-14-A (26.47%) along with RT-54 x TS-111 (26.45%) were showed highest significant positive heterosis over standard check for this trait. (Parimala *et.al.* & Patel *et.al.*)^[15, 16, 17].

Seed yield is the ultimate economic objective; hence heterosis in a positive direction is highly preferred. The cross TS-102 x TS-14-A (40.35%) showed highest significant positive heterosis over mid parent accompanied by crosses TS-110 x TS-14-A (39.88%) and JLT-408 x RT-346 (31.88%). Whereas, the cross combination TS-102 x TS-14-A (30.31%) thereafter TS-110 x TS-14-A (29.67%) and TS-14-A x RT-346 (22.77%) recorded maximum significant positive heterosis over better parent for seed yield per plant. While, the cross TS-111 x TS-11-2 (33.05%) showed highest significant positive heterosis over standard check succeeded by TS-14-A x RT-346 (32.70%) and TS-11-2 x RT-346 (32.48%) for this trait. (Oza *et.al.* & Nehra *et.al.*)^[13, 14].

The cross TS-11-2 x TS-14-A (12.56%) expressed highest significant positive heterosis over mid parent followed by RT-54 x TS-11-2 (11.69%) and TS-11-2 x RT-346 (11.29%). Over the standard check, the cross TS-102 x RT-54 (11.69%) recorded the highest significant positive heterosis followed by TS-11-2 x RT-346 (8.23%) for oil content.

4. Best heterotic crosses and their per se performance for seed yield in sesame

From the comprehensive evaluation of standard heterosis Table 2, negative heterosis is highly desirable for days to 50

per cent flowering and days to maturity to develop early-maturing sesame varieties. The cross RT-54 x JLT-408 exhibited highly significant standard heterosis for early flowering (-12.88%), while JLT-408 x TS-14-A recorded the highest significant standard heterosis for early maturity (-6.22%). This indicates that these specific combinations possess favorable dominant alleles for earliness, making them suitable for developing short-duration cultivars.

Significant positive heterosis was observed for key morphological and yield-contributing traits. For plant height, RT-54 x RT-346 and JLT-408 x RT-346 demonstrated the highest heterobeltiosis (22.71%) and standard heterosis (21.45%), respectively. The number of branches and capsules per plant are primary determinants of final yield. The hybrid TS-111 x TS-11-2 recorded the highest heterobeltiosis for branches per plant (35.34%), whereas TS-111 x TS-14-A showed exceptional superiority for capsules per plant over both the better parent (42.42%) and standard check (34.22%).

Furthermore, significant positive heterosis was recorded for seed metrics. JLT-408 x RT-346 exhibited the highest standard heterosis for the number of seeds per capsule (18.14%). For 1000-seed weight (test weight), TS-102 x RT-54 displayed substantial heterobeltiosis (25.00%), while multiple crosses, including RT-54 x TS-111, demonstrated high standard heterosis (up to 26.45%), indicating a strong genetic basis for bolder seed size.

Seed yield per plant, being a complex polygenic trait, showed pronounced heterotic effects. The hybrid TS-111 x TS-11-2 registered the highest standard heterosis for seed yield (33.05%), closely followed by TS-14-A x RT-346 (32.77%). For oil content, which determines the commercial value of the crop, TS-102 x RT-54 exhibited the highest heterobeltiosis (10.53%), while TS-11-2 x TS-14-A showed the highest standard heterosis (9.66%).

An evaluation of the top five heterotic crosses (Table 3) reveals that TS-111 x TS-11-2 is the most outstanding hybrid, recording the highest per se seed yield (9.41 g/plant) alongside significant heterobeltiosis (19.64%) and standard heterosis (33.05%). This is closely followed by TS-14-A x RT-346 (9.39 g/plant yield; 32.70% standard heterosis) and TS-11-2 x RT-346 (9.34 g/plant yield; 32.48% standard heterosis). Crucially, the superiority of these top crosses in seed yield is simultaneously supported by desirable manifestations in multiple yield components, including Plant Height (PH), Number of Branches (NB), Number of Capsules (NC), Seeds per Capsule (SPC), Test Weight (TW), and Oil Content (OC).

Table 1: a) Heterosis (per cent) over Mid Parent (MP), Better Parent (BP) & Standard Check (SC) in sesame

Crosses	Days to 50 per cent flowering			Days to maturity		
	MP	BP	SC	MP	BP	SC
TS-110 x TS-102	-4.80*	-3.76	-2.39	3.15	3.38	11.67**
TS-110 x RT-54	0.15	6.49*	-2.04	4.13	8.82**	8.30**
TS-110 x TS-111	6.76**	9.82**	7.65**	4.61	8.78**	9.30**
TS-110 x TS-11-2	-2.30	0.96	-1.91	-2.30	3.92	0.00
TS-110 x JLT-408	4.30*	7.29**	5.16*	9.46**	15.96**	12.45**
TS-110 x TS-14-A	-1.50	0.87	-0.26	-0.37	5.44	2.45
TS-110 x TS-1	3.48	3.87	7.65**	-4.68*	-2.77	5.48
TS-110 x RT-346	4.03	9.01**	3.10	9.65**	15.74**	13.01**
TS-102 x RT-54	-3.27	1.68	-6.45*	-5.91*	-1.90	-2.36
TS-102 x TS-111	-1.41	0.30	-1.69	3.62	7.51**	8.02**
TS-102 x TS-11-2	-6.26**	-4.21	-6.93**	9.09**	15.78**	11.41**
TS-102 x JLT-408	0.06	1.80	-0.22	5.39*	11.39**	8.02**

TS-102 x TS-14-A	-1.96	-0.70	-1.81	-5.56*	-0.29	-3.11
TS-102 x TS-1	-0.51	0.96	2.40	3.55	5.85*	14.34**
TS-102 x RT-346	7.74**	11.64**	5.58*	-7.48**	-2.56	-4.86
RT-54 x TS-111	5.65*	9.10**	0.37	-0.51	-0.04	-0.51
RT-54 x TS-11-2	4.57*	7.50**	-1.10	-3.11	-1.45	-5.17
RT-54 x JLT-408	-8.30**	-5.30	-12.88**	-0.90	0.41	-2.63
RT-54 x TS-14-A	0.54	4.30	-4.05	6.09*	7.38*	4.34
RT-54 x TS-1	6.46**	13.64**	4.55	-0.84	5.78*	5.28
RT-54 x RT-346	-5.02*	-3.69	-11.40**	7.75**	8.79**	6.23*
TS-111 x TS-11-2	2.02	2.48	-0.44	11.72**	14.19**	9.88**
TS-111 x JLT-408	-0.35	-0.35	-2.33	-2.43	-0.67	-3.68
TS-111 x TS-14-A	3.41	3.87	1.80	-1.23	0.45	-2.39
TS-111 x TS-1	3.80	7.20**	5.07*	1.33	7.57**	8.07**
TS-111 x RT-346	-0.11	1.70	-3.81	1.12	2.58	0.17
TS-11-2 x JLT-408	-1.60	-1.16	-3.97	11.99**	12.43**	8.18**
TS-11-2 x TS-14-A	2.48	3.39	0.45	13.80**	14.36**	10.05**
TS-11-2 x TS-1	-2.50	1.15	-1.73	0.44	9.11**	4.99
TS-11-2 x RT-346	0.99	2.36	-3.19	-0.52	0.22	-3.57
JLT-408 x TS-14-A	-6.97**	-6.56*	-8.42**	-3.39	-3.29	-6.22*
JLT-408 x TS-1	-0.82	2.42	0.39	3.63	12.10**	8.70**
JLT-408 x RT-346	-1.17	0.62	-4.83	-1.46	-1.12	-4.12
TS-14-A x TS-1	0.43	3.25	2.09	3.56	11.90**	8.74**
TS-14-A x RT-346	-2.58	-0.36	-5.77*	11.96**	12.23**	9.06**
TS-1 x RT-346	4.39*	9.82**	3.86	3.13	11.16**	8.53**
SE	1.2221	1.4112	1.4112	2.5688	2.9661	2.9661
CD at 5per cent	2.4615	2.8423	2.8423	5.1737	5.9741	5.9741
CD at 1per cent	3.2871	3.7956	3.7956	6.9089	7.9777	7.9777

*and ** indicated significance at 5 and 1 per cent level, respectively

Table 1: b) Heterosis (per cent) over Mid Parent (MP), Better Parent (BP) & Standard Check (SC) in sesame

Crosses	Plant height (cm)			Number of branches per plant		
	MP	BP	SC	MP	BP	SC
TS-110 x TS-102	-4.00	-5.17	-2.51	-17.68*	-22.13*	-27.08**
TS-110 x RT-54	-0.57	-6.89	-6.62	-9.63	-12.30	-12.72
TS-110 x TS-111	4.52	3.56	3.86	-24.23**	-27.00**	-31.65**
TS-110 x TS-11-2	13.19**	13.08*	13.62**	32.14**	27.31**	19.21*
TS-110 x JLT-408	7.80	7.69	8.21	-13.74	-17.54*	-15.33
TS-110 x TS-14-A	20.65**	20.31**	21.35**	24.84**	18.22*	23.82**
TS-110 x TS-1	11.55**	9.23	14.30**	-12.16	-17.36*	-12.23
TS-110 x RT-346	14.14**	10.21*	10.53*	-11.09	-14.12	-13.70
TS-102 x RT-54	21.47**	12.45*	15.60**	28.16**	17.87*	17.29*
TS-102 x TS-111	-0.91	-3.01	-0.29	-20.31*	-21.80*	-32.14**
TS-102 x TS-11-2	-1.14	-2.26	0.48	5.75	3.76	-9.95
TS-102 x JLT-408	-3.33	-4.42	-1.74	-7.31	-15.95*	-13.70
TS-102 x TS-14-A	14.90**	13.82**	17.00**	29.81**	16.67*	22.19**
TS-102 x TS-1	8.43*	7.48	12.46*	-6.28	-16.28*	-11.09
TS-102 x RT-346	18.20**	12.78*	15.94**	-10.99	-18.51*	-18.11*
RT-54 x TS-111	23.12**	16.29**	14.49**	31.52**	23.11**	22.51**
RT-54 x TS-11-2	21.27**	13.46**	14.01**	27.85**	19.67*	19.09*
RT-54 x JLT-408	-5.86	-11.92*	-11.50*	-13.02	-14.36	-12.07
RT-54 x TS-14-A	15.49**	7.85	8.79	15.50*	12.62	17.94*
RT-54 x TS-1	4.07	-4.43	0.00	-16.89*	-19.51*	-14.52
RT-54 x RT-346	26.68**	22.71**	14.59**	20.07**	19.48*	20.07*
TS-111 x TS-11-2	18.02**	16.83**	17.39**	35.34**	35.34**	17.46*
TS-111 x JLT-408	-7.14	-8.08	-7.63	-6.66	-13.89	-11.58
TS-111 x TS-14-A	21.38**	19.92**	20.97**	22.32**	11.84	17.13*
TS-111 x TS-1	6.37	3.23	8.02	-5.83	-14.44	-9.14
TS-111 x RT-346	22.89**	19.73**	17.87**	23.34**	14.94	15.50
TS-11-2 x JLT-408	4.33	4.33	4.83	-7.70	-14.84	-12.56
TS-11-2 x TS-14-A	5.18	4.98	5.89	24.36**	13.71	19.09*
TS-11-2 x TS-1	-0.52	-2.49	2.03	-21.22**	-28.42**	-23.98**
TS-11-2 x RT-346	22.10**	17.79**	18.36**	24.91**	16.40*	16.97*
JLT-408 x TS-14-A	-6.67	-6.85	-6.04	-30.16**	-30.84**	-27.57**
JLT-408 x TS-1	-3.44	-5.36	-0.97	-16.59*	-17.97*	-12.89
JLT-408 x RT-346	25.29**	20.87**	21.45**	16.75*	15.51	18.60*
TS-14-A x TS-1	8.60*	6.65	11.59*	-33.64**	-34.10**	-30.02**
TS-14-A x RT-346	17.98**	13.60**	14.59**	-0.48	-2.49	2.12
TS-1 x RT-346	1.49	-3.97	0.48	-5.13	-7.68	-1.96
SE	4.4256	5.1103	5.1103	0.2114	0.2441	0.2441
CD at 5per cent	8.9137	10.2927	10.2927	0.4257	0.4916	0.4916
CD at 1per cent	11.9031	13.7446	13.7446	0.5685	0.6564	0.6564

*and ** indicated significance at 5 and 1 per cent level, respectively

Table 1: c) Heterosis (per cent) over Mid Parent (MP), Better Parent (BP) & Standard Check (SC) in sesame

Crosses	Number of capsules per plant			Number of seed per capsule		
	MP	BP	SC	MP	BP	SC
TS-110 x TS-102	-10.43	-13.03	-29.53**	-5.88	-7.55	-3.51
TS-110 x RT-54	-22.25**	-26.85**	-36.67**	-18.63**	-21.15**	-15.38*
TS-110 x TS-111	2.13	-7.58	-12.90*	-12.53*	-14.50*	-9.88
TS-110 x TS-11-2	20.80**	6.02	7.14	7.66	4.24	12.06*
TS-110 x JLT-408	-13.06*	-13.95	-32.94**	-8.33	-9.09	-6.93
TS-110 x TS-14-A	38.89**	26.73**	17.27**	11.34*	8.83	14.72*
TS-110 x TS-1	25.34**	22.34**	-1.92	-11.13*	-15.24**	-5.98
TS-110 x RT-346	22.20**	6.67	9.17	-4.58	-6.44	-1.99
TS-102 x RT-54	38.42**	33.99**	15.99**	8.03	6.55	14.34*
TS-102 x TS-111	0.73	-6.33	-11.73*	-25.76**	-26.13**	-22.13**
TS-102 x TS-11-2	5.63	-4.84	-3.84	7.75	6.18	14.15*
TS-102 x JLT-408	21.26**	18.95**	-3.62	-3.90	-4.82	-0.66
TS-102 x TS-14-A	42.51**	33.64**	23.67**	9.55*	9.01	14.91*
TS-102 x TS-1	22.96**	22.32**	-0.90	-10.37*	-13.01*	-3.51
TS-102 x RT-346	4.88	-6.04	-3.84	-25.34**	-25.48**	-21.94**
RT-54 x TS-111	33.73**	28.28**	20.90**	7.68	6.73	14.53*
RT-54 x TS-11-2	33.87**	24.27**	25.59**	6.34	6.25	14.22*
RT-54 x JLT-408	-25.73**	-29.43**	-38.91**	-15.67**	-17.61**	-11.59*
RT-54 x TS-14-A	32.26**	28.00**	18.44**	8.75	7.79	15.67**
RT-54 x TS-1	-5.37	-8.87	-21.11**	-14.36**	-15.75**	-6.55
RT-54 x RT-346	34.99**	24.58**	27.51**	4.16	2.92	10.45
TS-111 x TS-11-2	25.44**	21.22**	22.49**	8.12	7.07	15.10*
TS-111 x JLT-408	-18.02**	-25.11**	-29.42**	-4.94	-6.31	-1.23
TS-111 x TS-14-A	43.72**	42.42**	34.22**	10.19*	10.19	16.15**
TS-111 x TS-1	-12.59*	-19.12**	-23.77**	-28.71**	-30.48**	-22.89**
TS-111 x RT-346	31.34**	26.15**	29.10**	10.98*	10.63	16.62**
TS-11-2 x JLT-408	3.40	-8.43	-7.46	-2.62	-4.95	2.18
TS-11-2 x TS-14-A	21.37**	16.26**	17.48**	7.23	6.18	14.15*
TS-11-2 x TS-1	11.65*	0.12	1.17	-11.13*	-12.50*	-2.94
TS-11-2 x RT-346	16.67**	15.94**	18.66**	10.25*	8.83	17.00**
JLT-408 x TS-14-A	-20.45**	-26.73**	-32.20**	-8.59	-9.91	-5.03
JLT-408 x TS-1	-3.98	-5.32	-24.09**	-2.40	-6.16	4.09
JLT-408 x RT-346	43.23**	26.15**	29.10**	14.08**	12.78*	18.14**
TS-14-A x TS-1	17.28**	9.45	1.28	-16.59**	-18.66**	-9.78
TS-14-A x RT-346	26.91**	20.83**	23.67**	10.98*	10.63	16.62**
TS-1 x RT-346	2.69	-8.44	-6.29	1.10	-1.71	9.02
SE	2.297	2.6523	2.6523	2.6083	3.0119	3.0119
CD at 5per cent	4.6264	5.3421	5.3421	5.2535	6.0662	6.0662
CD at 1per cent	6.178	7.1337	7.1337	7.0154	8.1007	8.1007

*and ** indicated significance at 5 and 1 per cent level, respectively

Table 1: d) Heterosis (per cent) over Mid Parent (MP), Better Parent (BP) & Standard Check (SC) sesame

Crosses	Length of capsule (cm)			1000 Seed weight (g)		
	MP	BP	SC	MP	BP	SC
TS-110 x TS-102	8.49	-4.03	-7.09	8.14	6.41	7.10
TS-110 x RT-54	39.72**	37.16*	6.03	7.58	6.95	4.19
TS-110 x TS-111	21.83	12.50	-1.06	-6.30	-15.17**	1.94
TS-110 x TS-11-2	27.74*	9.97	13.48	14.19*	13.82*	11.61
TS-110 x JLT-408	14.29	2.26	-3.55	20.95**	16.16**	22.90**
TS-110 x TS-14-A	32.20**	19.08	10.64	7.42	-6.92	23.71**
TS-110 x TS-1	19.92	8.02	0.35	23.70**	18.38**	15.32*
TS-110 x RT-346	17.01	3.68	0.00	-5.38	-12.73*	0.65
TS-102 x RT-54	38.90**	24.91*	20.92	27.76**	25.00**	25.81**
TS-102 x TS-111	13.63	8.42	4.96	-7.09	-14.63**	2.58
TS-102 x TS-11-2	1.06	-2.06	1.06	5.36	4.01	4.68
TS-102 x JLT-408	2.04	0.73	-2.48	7.50	4.88	10.97
TS-102 x TS-14-A	21.87*	19.41	15.60	8.01	-5.10	26.13**
TS-102 x TS-1	6.17	4.03	0.71	0.68	-5.13	-4.52
TS-102 x RT-346	14.13	13.92	10.28	-17.55**	-22.80**	-10.97
RT-54 x TS-111	40.34**	31.85*	15.96	16.84**	5.23	26.45**
RT-54 x TS-11-2	32.02**	15.46	19.15	-13.20*	-13.98*	-15.65*
RT-54 x JLT-408	19.42	8.65	2.48	24.18**	18.60**	25.48**
RT-54 x TS-14-A	34.58**	23.28	14.54	-6.69	-19.54**	6.94
RT-54 x TS-1	16.67	6.87	-0.71	-2.52	-6.20	-9.68

RT-54 x RT-346	31.02**	18.01	13.83	18.45**	8.67	25.32**
TS-111 x TS-11-2	15.77	7.22	10.64	15.30**	4.70	25.81**
TS-111 x JLT-408	-5.84	-9.02	-14.18	-4.64	-10.34*	7.74
TS-111 x TS-14-A	22.75*	19.47	10.99	-0.05	-4.84	26.47**
TS-111 x TS-1	5.49	2.67	-4.61	4.86	-8.72	9.68
TS-111 x RT-346	11.54	6.62	2.84	6.71	4.56	25.65**
TS-11-2 x JLT-408	-6.10	-10.14	-7.27	-5.54	-8.99	-3.71
TS-11-2 x TS-14-A	12.30	6.70	10.11	8.80	-5.46	25.65**
TS-11-2 x TS-1	-6.33	-11.00	-8.16	-4.14	-8.55	-10.32
TS-11-2 x RT-346	11.37	7.73	11.17	15.53**	6.88	23.26**
JLT-408 x TS-14-A	4.55	3.76	-2.13	-22.16**	-30.10**	-7.10
JLT-408 x TS-1	6.44	5.64	-0.35	18.87**	9.45	15.81*
JLT-408 x RT-346	22.30*	20.96	16.67	12.04*	7.41	23.87**
TS-14-A x TS-1	7.82	7.82	0.18	-1.16	-17.48**	9.68
TS-14-A x RT-346	24.72*	22.43	18.09	1.62	-5.10	26.13**
TS-1 x RT-346	2.62	0.74	-2.84	7.97	-4.34	10.32
SE	0.2741	0.3166	0.3166	0.1637	0.189	0.189
CD at 5per cent	0.5522	0.6376	0.6376	0.3297	0.3807	0.3807
CD at 1per cent	0.7373	0.8514	0.8514	0.4402	0.5083	0.5083

*and ** indicated significance at 5 and 1 per cent level, respectively

Table 1: e) Heterosis (per cent) over Mid Parent (MP), Better Parent (BP) & Standard Check (SC) in sesame

Crosses	Seed yield per plant (g)			Oil Content (per cent)		
	MP	BP	SC	MP	BP	SC
TS-110 x TS-102	1.32	1.16	-13.19	2.04	0.26	-1.33
TS-110 x RT-54	-24.21*	-33.44**	-24.75*	3.93*	3.18	1.54
TS-110 x TS-111	-15.65	-25.38*	-17.02	-2.51	-3.02	-3.54
TS-110 x TS-11-2	21.22*	8.76	17.09	7.41**	5.43*	3.76
TS-110 x JLT-408	-24.77*	-25.33*	-35.18**	0.95	-0.03	0.33
TS-110 x TS-14-A	39.88**	29.67**	29.86**	8.18**	7.27**	7.37**
TS-110 x TS-1	15.32	13.92	-0.14	-2.12	-4.26	-5.78**
TS-110 x RT-346	2.71	-8.01	-0.57	0.27	-0.38	-0.67
TS-102 x RT-54	29.67**	14.05	28.94**	11.69**	10.53**	7.20**
TS-102 x TS-111	-36.79**	-44.01**	-37.73**	-5.32**	-7.45**	-7.95**
TS-102 x TS-11-2	-5.28	-14.89	-8.37	4.35*	4.23	-0.99
TS-102 x JLT-408	11.09	10.46	-4.11	5.18**	2.36	2.73
TS-102 x TS-14-A	40.35**	30.31**	30.50**	9.60**	6.80**	6.91**
TS-102 x TS-1	-0.74	-1.78	-13.90	-2.73	-3.18	-8.03**
TS-102 x RT-346	-11.19	-20.34*	-13.90	2.43	0.00	-0.29
RT-54 x TS-111	18.03*	17.06	32.34**	7.56**	6.23**	5.65*
RT-54 x TS-11-2	19.41*	16.56	31.77**	10.83**	9.57**	6.27**
RT-54 x JLT-408	-26.40**	-34.94**	-26.45*	0.25	-1.43	-1.07
RT-54 x TS-14-A	21.89*	14.93	29.93**	9.74**	8.04**	8.14**
RT-54 x TS-1	-33.29**	-40.78**	-33.05**	6.31**	4.74*	1.59
RT-54 x RT-346	18.73*	16.12	31.28**	8.18**	6.70**	6.40**
TS-111 x TS-11-2	21.58*	19.64*	33.05**	10.41**	7.81**	7.23**
TS-111 x JLT-408	-6.45	-16.71	-7.38	-2.82	-3.26	-2.91
TS-111 x TS-14-A	23.49**	17.35	30.50**	7.38**	7.04**	7.14**
TS-111 x TS-1	-41.94**	-48.09**	-42.27**	-7.09**	-9.59**	-10.08**
TS-111 x RT-346	19.02*	17.35	30.50**	8.27**	8.13**	7.82**
TS-11-2 x JLT-408	-26.19**	-33.33**	-28.23*	-3.41	-6.10**	-5.76*
TS-11-2 x TS-14-A	26.89**	22.46*	31.84**	12.56**	9.57**	9.67**
TS-11-2 x TS-1	-29.85**	-36.36**	-31.49**	2.87	2.52	-2.84
TS-11-2 x RT-346	22.81*	22.57*	32.48**	11.29**	8.54**	8.23**
JLT-408 x TS-14-A	24.28*	16.01	16.17	-3.25	-3.38	-3.03
JLT-408 x TS-1	-13.82	-14.24	-24.82*	-1.90	-4.95*	-4.61*
JLT-408 x RT-346	31.88**	18.90	28.51**	7.89**	7.54**	7.93**
TS-14-A x TS-1	-1.13	-7.29	-7.16	-0.56	-3.53	-3.44
TS-14-A x RT-346	27.45**	22.77*	32.70**	7.86**	7.65**	7.76**
TS-1 x RT-346	10.00	-0.39	7.66	-1.07	-3.84	-4.12
SE	0.6466	0.7466	0.7466	0.8714	1.0062	1.0062
CD at 5per cent	1.3022	1.5037	1.5037	1.755	2.0265	2.0265
CD at 1per cent	1.739	2.008	2.008	2.3436	2.7061	2.7061

*and ** indicated significance at 5 and 1 per cent level, respectively

Table 2: Best five hybrids over better parents and standard check

Sr. No.	Character	Better Parent		Standard Check	
		Cross	Value (per cent)	Cross	Value (per cent)
1	Days to 50 per cent flowering	JLT-408 x TS-14-A	-6.56*	RT-54 x JLT-408	-12.88**
		RT-54 x JLT-408	-5.31	RT-54 x RT-346	-11.40**
		TS-102 x TS-11-2	-4.21	JLT-408 x TS-14-A	-8.41**
		TS-110 x TS-102	-3.76	TS-102 x TS-11-2	-6.93**
		RT-54 x RT-346	-3.70	TS-102 x RT-54	-6.45*
2	Days to maturity	JLT-408 x TS-14-A	-3.29	JLT-408 x TS-14-A	-6.22*
		TS-110 x TS-1	-2.77	RT-54 x TS-11-2	-5.17
		TS-102 x RT-346	-2.56	TS-102 x RT-346	-4.86
		TS-102 x RT-54	-1.90	JLT-408 x RT-346	-4.11
		RT-54 x TS-11-2	-1.45	TS-111 x JLT-408	-3.68
3	Plant height (cm)	RT-54 x RT-346	22.71**	JLT-408 x RT-346	21.45**
		JLT-408 x RT-346	20.87**	TS-110 x TS-14-A	21.35**
		TS-110 x TS-14-A	20.31**	TS-111 x TS-14-A	20.97**
		TS-111 x TS-14-A	19.92**	TS-11-2 x RT-346	18.36**
		TS-111 x RT-346	19.73**	TS-111 x RT-346	17.87**
4	Number of branches per plant	TS-111 x TS-11-2	35.34**	TS-110 x TS-14-A	23.78**
		TS-110 x TS-11-2	27.18**	RT-54 x TS-111	22.48**
		RT-54 x TS-111	23.28**	TS-102 x TS-14-A	22.15**
		RT-54 x TS-11-2	19.67*	RT-54 x RT-346	19.87*
		RT-54 x RT-346	19.48*	TS-110 x TS-11-2	18.89*
5	Number of capsules per plant	TS-111 x TS-14-A	42.42**	TS-111 x TS-14-A	34.22**
		TS-102 x RT-54	33.99**	TS-111 x RT-346	29.10**
		TS-102 x TS-14-A	33.64**	JLT-408 x RT-346	29.10**
		RT-54 x TS-111	28.28**	RT-54 x RT-346	27.51**
		RT-54 x TS-14-A	28.00**	RT-54 x TS-11-2	25.59**
6	Number of seed per capsule	JLT-408 x RT-346	12.78*	JLT-408 x RT-346	18.14**
		TS-111 x RT-346	10.63	TS-11-2 x RT-346	17.00**
		TS-14-A x RT-346	10.63	TS-111 x RT-346	16.62**
		TS-111 x TS-14-A	10.20	TS-14-A x RT-346	16.62**
		TS-102 x TS-14-A	9.01	TS-111 x TS-14-A	16.16**
7	Length of capsule (cm)	TS-110 x RT-54	37.16*	TS-102 x RT-54	20.92
		RT-54 x TS-111	31.85*	RT-54 x TS-11-2	19.15
		TS-102 x RT-54	24.91*	TS-14-A x RT-346	18.09
		RT-54 x TS-14-A	23.28	JLT-408 x RT-346	16.67
		TS-14-A x RT-346	22.43	RT-54 x TS-111	15.96
8	1000 Seed weight (g)	TS-102 x RT-54	25.00**	RT-54 x TS-111	26.45**
		RT-54 x JLT-408	18.60**	TS-111 x TS-14-A	26.45**
		TS-110 x TS-1	18.54**	TS-102 x TS-14-A	26.13**
		TS-110 x JLT-408	16.16**	TS-14-A x RT-346	26.13**
		TS-110 x TS-11-2	13.82*	TS-102 x RT-54	25.81**
9	Seed yield per plant (g)	TS-102 x TS-14-A	30.31**	TS-111 x TS-11-2	33.05**
		TS-110 x TS-14-A	29.75**	TS-14-A x RT-346	32.77**
		TS-14-A x RT-346	22.83*	TS-11-2 x RT-346	32.48**
		TS-11-2 x RT-346	22.57*	RT-54 x TS-111	32.34**
		TS-11-2 x TS-14-A	22.53*	TS-11-2 x TS-14-A	31.91**
10	Oil Content (per cent)	TS-102 x RT-54	10.53**	TS-11-2 x TS-14-A	9.66**
		TS-11-2 x TS-14-A	9.57**	TS-11-2 x RT-346	8.21**
		RT-54 x TS-11-2	9.57**	RT-54 x TS-14-A	8.13**
		TS-11-2 x RT-346	8.54**	JLT-408 x RT-346	7.92**
		TS-111 x RT-346	8.13**	TS-111 x RT-346	7.81**

* Significant at 5 per cent level, ** Significant at 1 per cent level

Table 3: Best heterotic crosses and their *per se* performance for seed yield per plant and related traits in sesame

Sr. No.	Crosses	Seed yield per plant (g)	Better parent heterosis (per cent)	Standard heterosis (per cent)	Desirable Traits
1	TS-111 x TS-11-2	9.41	19.64*	33.05**	PH, NB, NC, SPC, TW, OC
2	TS-14-A x RT-346	9.39	22.77*	32.70**	DF, PH, NC, SPC, TW, OC
3	TS-11-2 x RT-346	9.34	22.57*	32.48**	PH, NB, NC, SPC, TW, OC
4	RT-54 x TS-111	9.33	17.06	32.34**	PH, NB, NC, SPC, TW, OC
5	TS-11-2 x TS-14-A	9.29	22.46*	31.84**	NB, NC, SPC, TW, OC

Significant at 5 per cent level, ** Significant at 1 per cent level

Whereas,		
DF = Days to 50 per cent flowering	NC = No. of Capsule per plant	TW = 1000-seed weight
DM = Days to maturity	SPC = Seed per capsule	SYP = Seed yield / plant
PH = Plant height	CL = Capsule length	OC = Oil content
NB = Number of Branches		

5. Conclusion

The study demonstrates that substantial hybrid vigor exists in sesame for seed yield, oil content, and their contributing biometric traits. The cumulative effect of favorable heterosis in primary yield components particularly the number of capsules per plant and test weight directly translated to elevated total seed yield. The crosses TS-111 × TS-11-2, TS-14-A × RT-346, and TS-11-2 × RT-346 were identified as the most promising elite hybrids, exhibiting high per se performance and highly significant standard heterosis (>32%). These specific cross-combinations possess immense potential for direct commercial exploitation in heterosis breeding programs or for deriving superior transgressive segregants in advanced filial generations to break the current yield plateau in sesame.

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