The Pharma Innovation Journal 2023; 12(11): 2347-2350

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(11): 2347-2350

www.thepharmajournal.com
Received: 15-08-2023
Accepted: 22-10-2023

PM Salunke
Department of Genetics and Plant Breeding, College of Agriculture, Latur, Maharashtra, India

PB Wadikar
Associate Professor, Department of Genetics and Plant Breeding, College of Agriculture, Latur, Maharashtra, India

KS Rathod
Department of Genetics and Plant Breeding, College of Agriculture, Latur. Maharashtra, India

AP Ghadage
Department of Genetics and Plant Breeding, College of Agriculture, Latur. Maharashtra, India

YD Chibhade
Department of Genetics and Plant Breeding, College of Agriculture, Latur. Maharashtra, India

Corresponding Author:
PM Salunke
Department of Genetics and Plant Breeding, College of Agriculture, Latur, Maharashtra, India

Identification of superior crosses for Heterosis of seed yield and its attributing traits in sesame (*Sesamum indicum* L.)

PM Salunke, PB Wadikar, KS Rathod, AP Ghadage and YD Chibhade

Abstract
The present investigation entitled "Identification of superior crosses for heterosis of seed yield and its attributing traits in sesame (*Sesamum indicum* L.)" to study heterosis in 21 hybrids obtained by crossing 7 x 3 genotypes in L x T fashion and their 7 lines, 3 testers and 1 standard check were evaluated in RBD with 2 replications during *Rabi* 2022-23 at ATS, Latur. The magnitude of heterosis for seed yield per plant was varied from -18.45 and -19.75 percent (TBS-07 x V-18) to 68.72% and 50.13% (TS-13 x V-22) over mid parent and better parent respectively, from -27.59% (TBS-07 x V-18) to 39.08% (TS-11 x V-22) over the check AKT-101. The crosses, TS-11 x V-22 (32.97, 43.53, 39.08%) and TS-13 x V-22 (50.13, 68.72 and 33.11%) recorded highest magnitude of significantly positive heterosis over mid parent, better parent and standard check AKT-101 respectively, for seed yield per plant.

Keywords: Superior, sesame, heterosis, crosses, *Sesamum indicum* L.

Introduction
Sesame is commonly known as Til (Marathi), Tili (Punjab), Nuvulu (Telegu), Tai (Gujarat), Rassi (Orissa), Ellu (Tamil) beside this gingelly, simsim, sesamum, benniseed. India ranks first in sesame production followed by China, Myanmar, Sudan, Uganda. Sesame belongs to order Tubiflorae and family Pedaliaceae. The chromosome number of sesames is 2n= 26. Sesame is self-pollinated crop. Sesame, like groundnut, rapeseed, and mustard, is an important oilseed crop in India. It can be cultivated in three seasons: *kharif*, semi-*rabi* and *summer*. Sesame is cultivated throughout the country during the *kharif* season, but only in Maharashtra (Nagpur, Bhandara and Chandrapur districts), Madhya Pradesh and Chhattisgarh during the semi-*rabi* season. In the peninsular area and West Bengal, sesame is cultivated in rice fallow or followed by short-duration pulses during *rabi* and *summer*. Sesame seed contain approximately 50 percent oil, 25 percent protein and 15 percent carbohydrate. Its seed is rich in vitamin A, E, B complex and contain mineral like phosphorus, iron, calcium, zinc, magnesium, and potassium. Its oil contains an antioxidant called sesamol which impart high degree of resistance against oxidative rancidity.

Materials and Methods
The experimental material was consisting of 7 lines (TBS-02, TBS-05, TBS-06, TBS-07, TS-11, TS-13, TS-14) and 3 testers (V-18, V-21, V-22) obtained from Oilseed Research Station, Latur including 1 check variety (AKT-101). The experiment was laid out in a randomized block design with two replications at ATS, Latur during late *Rabi*-2022-23. The data recorded for ten characters on five plants from each treatment in each replication at different growth stages of crop and average value for plant were worked out. Heterosis over mid parent, better parent and standard check for seed yield per plant and yield contributing traits were calculated based on procedure given by Kempthorne (1957) [5].

Results and Discussion
The data investigated on different characters for various entries were averaged and subjected to statistical analysis of variance Table no.1 revealed that treatments, parents and crosses, were found highely significant for most of characters indicating presence of considerable amount of variability in the experimental material present in study. Similar result reported by Hassan and Sedeck (2015) [2] and Virani *et al.* (2017) [9].

Earliness is highly desirable for days to 50 percent flowering and days to maturity. The crosses exhibiting significant negative heterotic effects for this trait are considered as superior. Among the 21 crosses for days to flowering, TBS-06 x V-22 (-9.80%) over mid parent, the cross TBS-02 x V-18 and TBS-05 x V-18 (-11.54%) over better parent recorded highest significant negative heterosis. The cross TS-14 x V-22 (-6.95%) exhibited the highest significant negative heterosis over mid parent. The cross TS-14 x V-22, TS-14 x V-21 and TS-14 x V-18 (-7.62%) recorded highest significant negative heterosis over better parent. The eight crosses exhibited the significant positive heterosis over the check AKT-101.

Tallness in plant height is desirable. The cross exhibiting significant positive heterotic effect is desirable. Amongst the 21 hybrids evaluated three, two and nine hybrids recorded significant positive heterosis over mid parent, better parent, check AKT101 respectively for this trait. For plant height, the cross TBS-07 x V-22 (14.09, 12.07 and 16.73 percent) and TBS-05 x V-22 (10.90, 9.94 and 14.50 percent) showed highest magnitude of significantly positive heterosis over mid parent, better parent, and check AKT-101. Number of branches in plant is desirable trait hence positive heterotic effect is desirable. The cross TS-14 x V-22 (43.92% and 41.67%) exhibited the highest significant positive heterosis over mid parent and better parent respectively. The cross TS-11 x V-21 (44.44%) showed highest positive significant heterosis for number of branches per plant over check AKT-101. The crosses, TS-11 x V-22 (40.87, 31.71 and 62.00 percent), TBS-05 x V-22 (50.75, 40.19 and 50.00 percent), TS-11 x V-21 (34.23, 21.14 and 49.00 percent) TBS-07 x V-22 (28.25, 23.28 and 43.00 percent) TS-13 x V-22 (56.04, 32.71 and 42.00 percent) recorded highest magnitude of significantly positive heterosis over mid parent, better parent and standard check AKT-101 respectively for number of capsules per plant.

The cross combination, TS-11 x V-22 (14.67%) exhibited the highest significant positive heterosis over mid parent and the highest significant positive heterosis over the check AKT-101 was found in the cross TS-14 x V-18 (12.14%) for length of capsule. The extent of heterosis for number of seeds per capsule was varied from -12.58% and -15.08% (TS-13 x V-22) to 22.78% and 19.63% (TBS-02 x V-18) over mid parent and better parent respectively, from -13.77% (TBS-06 x V-21) to 13.11% (TS-14 x V-22) over the check AKT-101. The extent of heterosis for 1000 seed weight was ranged from -19.51, -34.01% and -18.55 (TBS-02 x V-21) to 12.33%, 9.03% and 27.11% (TS-13 x V-18) over mid parent, better parent and check AKT-101 respectively.

The magnitude of heterosis for seed yield per plant was varied from -18.45 and -19.75 percent (TBS-07 x V-18) to 68.72% and 50.13% (TS-13 x V-22) over mid parent and better parent respectively, from -27.59% (TBS-07 x V-18) to 39.08% (TS-11 x V-22) over the check AKT-101. Out of 21 crosses studied nine, eight, five crosses showed significant positive heterosis over mid parent, better parent, and checks AKT-101 respectively. The cross TS-13 x V-12 (68.72%) over mid parent, TS-13 x V-22 (88.57%), over better parent and TS-11 x V-22 (39.08%) over check AKT-101 recorded the highest significant positive heterosis. The cross, TS-14 x V-18 (16.63%, 11.79% and 23.17%) showed highest positive significant heterosis over mid parent and better parent and check AKT-101 respectively for oil content.

In this investigation out of 21 crosses evaluated four crosses and eleven crosses for days to 50 flowering showed desirable significant negative heterosis over mid parent and better parent respectively. The highest but non-significant magnitude of standard heterosis in desired direction occur in fourteen crosses. Out of 21 crosses evaluated for seven and thirteen crosses over mid parent and better parent for days to maturity showed desirable significant negative heterosis over mid parent better parent respectively. Significant negative mid parent and better parent heterosis for days to 50 flowering and days to maturity in sesame agreement with Karande *et al.* (2018) [4], Lal *et al.* (2020) [6], Ghule *et al.* (2021) [1], Sandhy *et al.* (2021) [8], Pateliya *et al.* (2022) [7].

In case of plant height (cm), number of branches per plant, length of capsule, number of seeds per capsule, 1000 seed weight (g), seed yield per plant (g) and oil content (%) positive heterosis were desirable. In this investigation out of 21 crosses evaluated, significant and positive heterosis over mid parent, better parent and standard heterosis were found in different crosses discus above. When heterosis significantly positive for this character were using heterosis breeding method is desirable. Similar result recorded by Karande *et al.* (2018) [4], Lal *et al.* (2020) [6], Ghule *et al.* (2021) [1], Sandhy *et al.* (2021) [8], Pateliya *et al.* (2022) [7] and Jadhav and Mohrir (2013) [3].

Table 1: Analysis of variance for combining ability for different ten characters including parents in sesame (*Sesamum indicum* L.).

Source of Variation	d.f.	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches per plant	No. of capsule per plant	Length Of capsule (cm)	No. of Seed per capsule	1000 Seed weight (g)	Seed yield per plant (g)	Oil Content (%)
Replications	1	5.225	0.790	7.455	0.003	34.129	0.047	0.612	0.016	2.088	0.299
Treatments	30	9.964 **	22.164 **	92.183 **	0.610 **	267.465 **	0.093 **	44.716 **	0.382 **	6.180 **	9.042 **
Parents	9	23.088 **	20.088 **	170.973 **	0.743 **	177.161 **	0.152 **	44.114 **	0.503 **	3.678 **	10.718 **
Lines	6	23.809 **	28.500 **	188.899 **	0.991 **	243.642 **	0.132 **	40.258 **	0.545 **	5.017 **	14.045 **
Testers	2	3.500	1.166	25.216	0.346 *	24.666	0.007	48.500 **	0.526 **	0.640	3.770 **
Lines v/s Testers	1	57.942 **	7.466	354.936 **	0.047	83.259 **	0.566 **	58.478 **	0.206 **	1.715	4.653 **
Parents v/s Crosses	1	5.516	55.230 **	5.607	0.842 **	1091.041 **	0.238 **	172.129 **	0.091 **	36.830 **	0.493
Crosses	20	4.280	21.445 **	61.057 **	0.538 **	266.923 **	0.059 **	38.617 **	0.342 **	5.773 **	8.715 **
Error	30	2.592	2.790	11.430	0.068	10.295	0.010	4.838	0.007	0.579	0.181

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

Table 2: Estimates of heterosis in percentage over mid parent (MP), better parent (BP) and standard check (SC) for ten characters in sesame (*Sesamum indicum* L.).

Sr. no.	Name of crosses	Days to 50 percent flowering			Days to maturity			Plant height (cm)		
		MP	BP	SC	MP	BP	SC	MP	BP	SC
1	TBS-02 X V-18	-2.13	-11.54 **	-5.15	-2.27	-4.90 **	0.00	6.10	1.20	8.07
2	TBS-02 X V-21	7.10 *	-1.01	1.03	-2.76	-5.83 **	0.00	0.61	-0.66	6.08
3	TBS-02 X V-22	2.67	-6.80 *	-1.03	-1.00	-4.35 *	2.06	5.35	4.05	11.11 *
4	TBS-05 X V-18	-5.64	-11.54 **	-5.15	-5.13 **	-5.37 **	0.00	1.19	-1.49	0.82
5	TBS-05 X V-21	-1.05	-5.05	-3.09	-3.65 *	-3.88 *	2.06	-0.74	-1.57	2.46
6	TBS-05 X V-22	-5.15	-10.68 **	-5.15	-5.83 **	-6.28 **	0.00	10.90 **	9.94 *	14.50 **
7	TBS-06 X V-18	-3.41	-4.81	2.06	-4.20 **	-4.90 **	0.00	-0.73	-8.92 *	5.73
8	TBS-06 X V-21	-1.00	-1.98	2.06	-0.74	-1.94	4.12 *	-2.90	-7.91 *	6.90
9	TBS-06 X V-22	-9.80 **	-10.68 **	-5.15	2.94	1.45	8.25 **	4.09	-1.26	14.62 **
10	TBS-07 X V-18	-3.13	-10.58 **	-4.12	-2.27	-4.90 **	0.00	0.73	-1.05	-0.58
11	TBS-07 X V-21	-0.53	-6.06	-4.12	-0.75	-3.88 *	2.06	-0.17	-1.91	2.11
12	TBS07 X V-22	0.52	-6.80 *	-1.03	-2.00	-5.31 **	1.03	14.09 **	12.07 **	16.73 **
13	TS-11 X V-18	-5.88 *	-7.69 *	-1.03	-0.24	-1.44	6.19 **	-0.12	-10.47 **	9.47 *
14	TS-11 X V-21	-0.50	-1.00	2.06	-1.20	-1.91	5.67 **	-4.93	-12.00 **	7.60
15	TS-11 X V-22	-7.39 *	-8.74 *	-3.09	0.96	0.48	8.25 **	9.35 **	1.24	23.80 **
16	TS-13 X V-18	-2.44	-3.85	3.09	0.00	-1.43	6.70 **	3.54	-10.09 **	18.30 **
17	TS-13 X V-21	0.00	-0.99	3.09	1.92	0.95	9.28 **	-11.56 **	-20.80 **	4.21
18	TS-13 X V-22	-2.94	-3.88	2.06	-0.72	-1.43	6.70 **	-6.92 *	-16.62 **	9.71 *
19	TS-14 X V-18	-7.46 *	-10.58 **	-4.12	-6.28 **	-7.62 **	0.00	0.54	-4.53	2.92
20	TS-14 XV-21	-4.08	-5.05	-3.09	-6.73 **	-7.62 **	0.00	-4.40	-6.05	1.29
21	TS-14 X V-22	-5.00	-7.77 *	-2.06	-6.95 **	-7.62 **	0.00	6.28	4.48	12.63 **
	S.E(+)	1.39	1.61	1.61	1.44	1.67	1.67	2.92	3.38	3.38

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

Table 2: Continued….

Sr. No.	Name of crosses	Number of branches per plant			Number of capsules per plant			Length of capsule (cm)		
		MP	BP	SC	MP	BP	SC	MP	BP	SC
				AKT-101`			AKT-101`			AKT-101`
1	TBS-02 X V-18	1.96	-18.75 *	-3.70	-4.52	-15.93 *	-5.00	3.43	-7.58 *	1.28
2	TBS-02 X V-21	3.06	-15.83	-6.48	-0.54	-7.07	-8.00	-1.16	-10.27 **	-5.11
3	TBS-02 X V-22	-11.63	-20.83	-29.63 **	24.35 **	12.15	20.00 **	-1.97	-12.06 **	-4.47
4	TBS-05 X V-18	25.93 **	6.25	25.93 *	12.20 *	1.77	15.00 *	2.41	-0.87	8.63 *
5	TBS-05 X V-21	28.08 **	11.00	23.33 *	13.09 *	9.09	8.00	1.84	0.30	6.07
6	TBS-05 X V-22	34.78 **	29.17 *	14.81	50.75 **	40.19 **	50.00 **	3.18	0.29	8.95 *
7	TBS-06 X V-18	14.75	9.37	29.63 **	8.15	5.00	26.00 **	-0.38	-5.54	3.51
8	TBS-06 X V-21	15.25	13.33	25.93 *	17.81 **	7.50	29.00 **	-4.15	-7.55 *	-2.24
9	TBS-06 X V-22	-13.21	-20.69 *	-14.81	10.13	4.17	25.00 **	-5.79 *	-10.29 **	-2.56
10	TBS-07 X V-18	-6.06	-8.82	14.81	-31.88 **	-32.76 **	-22.00 **	-1.98	-5.98	3.04
11	TBS-07 X V-21	-21.87 **	-26.47 **	-7.41	-14.42 *	-20.69 **	-8.00	-2.48	-4.83	0.64
12	TBS07 X V-22	20.69 *	2.94	29.63 **	28.25 **	23.28 **	43.00 **	6.56 *	2.65	11.50 **
13	TS-11 X V-18	-1.41	-10.26	29.63 **	5.08	0.81	24.00 **	0.66	-11.52 **	-3.04
14	TS-11 X V-21	13.04	0.00	44.44 **	34.23 **	21.14 **	49.00 **	8.97 **	-2.72	2.88
15	TS-11 X V-22	4.76	-15.38 *	22.22 *	40.87 **	31.71 **	62.00 **	14.67 **	1.18	9.90 **
16	TS-13 X V-18	5.08	-3.13	14.81	22.34 **	1.77	15.00 *	5.97 *	0.87	10.54 **
17	TS-13 X V-21	-14.91	-19.17 *	-10.19	2.30	-10.10	-11.00	7.02 *	3.63	9.58 **
18	TS-13 X V-22	41.18 **	33.33 **	33.33 **	56.04 **	32.71 **	42.00 **	3.38	-1.18	7.35 *
19	TS-14 X V-18	1.36	-12.50	3.70	28.96 **	4.42	18.00 *	5.01	2.33	12.14 **
20	TS-14 XV-21	1.41	-10.00	0.00	5.33	-10.10	-11.00	-1.60	-2.42	3.19
21	TS-14 X V-22	43.92 **	41.67 **	25.93 *	33.33 **	10.28	18.00 *	-3.53	-5.59	2.56
	S.E(+)	0.22	0.26	0.26	2.77	3.20	3.20	0.08	0.10	0.10

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

Table 2: Continued….

		MP	BP	SC	MP	BP	SC	MP	BP	SC
1	TBS-02 X V-18	22.78 **	19.63 **	4.92	5.25 *	-11.74 **	2.89	-1.09	-10.53	-21.84 *
2	TBS-02 X V-21	8.76 *	0.00	-0.82	-19.51 **	-34.01 **	-18.55 **	-5.41	-19.08 *	-19.54 *
3	TBS-02 X V-22	6.20	-4.13	-0.98	4.18	-5.68 *	-8.16 **	28.68 **	15.34	2.87
4	TBS-05 X V-18	4.85	-0.83	-2.46	4.21 *	0.68	17.37 **	-0.70	-6.25	-18.10
5	TBS-05 X V-21	4.90	4.46	3.61	-11.56 **	-16.84 **	2.63	16.23	3.47	2.87
6	TBS-05 X V-22	5.04	2.54	5.90	-15.45 **	-19.85 **	-12.89 **	57.13 **	46.91 **	31.03 **
7	TBS-06 X V-18	0.26	-1.31	-13.44 **	-8.79 **	-11.13 **	9.21 **	11.21	-1.28	11.21
8	TBS-06 X V-21	-6.35	-13.06 **	-13.77 **	-10.47 **	-10.66 **	10.26 **	10.03	3.57	16.67

9	TBS-06 X V-22	6.77	-2.70	0.49	-0.84	-11.13 **	9.21 **	15.60	3.57	16.67
10	TBS-07 X V-18	5.33	5.23	-7.70 *	-0.12	-4.97 *	10.79 **	-18.45 *	-19.75	-27.59 **
11	TBS-07 X V-21	8.17 *	1.82	0.98	-10.01 **	-16.63 **	2.89	-7.88	-12.14	-12.64
12	TBS07 X V-22	-2.41	-9.84 *	-6.89	4.94 *	1.00	6.32 *	28.12 **	27.39 *	14.94
13	TS-11 X V-18	4.31	1.87	-10.66 **	1.93	1.58	18.42 **	10.18	1.10	5.75
14	TS-11 X V-21	8.88 *	0.33	-0.49	-14.85 **	-17.48 **	1.84	22.82 **	19.78 *	25.29 **
15	TS-11 X V-22	4.39	-5.56	-2.46	0.74	-7.27 **	7.37 **	43.53 **	32.97 **	39.08 **
16	TS-13 X V-18	16.92 **	11.11 **	8.20 *	12.33 **	9.03 **	27.11 **	40.66 **	26.32 *	10.34
17	TS-13 X V-21	-3.25	-4.13	-4.92	-5.19 **	-10.45 **	10.53 **	2.72	-12.72	-13.22
18	TS-13 X V-22	-12.58 **	-15.08 **	-12.30 **	3.68	-2.16	7.37 **	68.72 **	50.13 **	33.91 **
19	TS-14 X V-18	8.25 *	1.98	1.15	9.50 **	4.06	21.32 **	48.70 **	31.58 **	14.94
20	TS-14 XV-21	3.31	3.31	2.46	-16.36 **	-22.60 **	-4.47	7.59	-9.83	-10.34
21	TS-14 X V-22	11.74 **	9.52 *	13.11 **	7.67 **	3.76	8.95 **	52.83 **	34.02 **	19.54 *
	S.E(+)	1.90	2.19	2.19	0.07	0.08	0.08	0.65	0.76	0.76

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

Table 2: Continued….

Sr. No.	Name of crosses	Oil content%		
		MP	BP	SC
1	TBS-02 X V-18	1.30	-0.44	0.59
2	TBS-02 X V-21	2.64 *	2.32 *	0.44
3	TBS-02 X V-22	2.12 *	-1.49	3.40 **
4	TBS-05 X V-18	-4.58 **	-8.45 **	0.66
5	TBS-05 X V-21	-2.85 **	-8.06 **	1.08
6	TBS-05 X V-22	-4.24 **	-6.41 **	2.90 *
7	TBS-06 X V-18	2.29 *	-0.22	0.81
8	TBS-06 X V-21	1.88	0.80	-1.06
9	TBS-06 X V-22	2.07 *	-2.25 *	2.60 *
10	TBS-07 X V-18	-0.77	-2.02	-1.01
11	TBS-07 X V-21	2.63 *	2.45 *	0.91
12	TBS07 X V-22	-0.83	-3.89 **	0.88
13	TS-11 X V-18	-7.91 **	-12.14 **	-2.25 *
14	TS-11 X V-21	3.56 **	-2.54 *	8.43 **
15	TS-11 X V-22	-3.39 **	-6.12 **	4.45 **
16	TS-13 X V-18	-2.02 *	-3.67 **	0.71
17	TS-13 X V-21	0.28	-2.79 *	1.63
18	TS-13 X V-22	-0.99	-1.19	3.72 **
19	TS-14 X V-18	16.63 **	11.79 **	23.17 **
20	TS-14 XV-21	-1.31	-6.70 **	2.80 *
21	TS-14 X V-22	-4.44 **	-6.70 **	2.80 *
	S.E(+)	0.36	0.42	0.42

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

Conclusion

Five crosses *viz*., TS-11 x V-22 (43.53, 32.97 and 39.08%), TS-13 x V-22(68.72,50.13 and 33.91%), TBS-05 x V-22(57.13, 46.91 and 31.03%), TS-11 x V-18 (22.82, 19.78 and 25.29%) and TS-11 x V-22 (52.83, 34.03 and 19.54%) expressed significant positive heterosis over mid parent, better parent and standard check AKT-101 respectively, for seed yield per plant. Biparental mating or recurrent selection breeding method used in these crosses for development of superior genotype for seed yield and yield attributing traits.

References

1. Ghule VB, Misal AM, Durge SM, Ghodake MK. Studies on heterosis in sesame (*Sesamum indicum* L.). The Pharma Innovation Journal. 2021;10(12):2523-2526.
2. Hassan MS, Sedeck FS. Combining ability and heterosis estimates in sesame. World Applied Sciences Journal. 2015;33(5):690-698.
3. Jadhav RS, Mohrir MN. Heterosis studies for quantitative traits in sesame. Electronic Journal of plant breeding. 2013;4(1):1056-1060.
4. Karande GR, Yamgar SV, Waghmode AA, Wadikar PB. Exploitation heterosis for yield and yield contributing character in sesame (*Sesamum indicum* L.). International Journal of Current Microbiology and Applied Science. 2018;7(2):299-308.
5. Kempthorne. Introduction to Genetic statistics John Wiley and Sonc. Inc., New York., Chapman and Hall, London; c1957.
6. Lal Jawahar J, Kuldeep Singh Dangi, Sudheer Kumar S. Genetic Analysis of Superior Crosses for Quantitative Traits in Sesame (*Sesamum indicum* L.). International Journal of Currant Microbiology and Applied Sciences. 2020;9(1):2564-2576.
7. Pateliya RV, Gohil VN, Akabari VR, Ramoliya CP, Vadher PA. Heterosis study fr seed yield and its component traits in black sesame (*Sesamum indicum* L.). Frontiers in Crop Improvement. 2022;10(1):593-601.
8. Sandhya HR, Madhusudan K, Raveendra HR, Sahana SR. Exploitation of Heterosis for Seed Yield and Quality Traits in Sesame (*Sesamum indicum* L.). Biological Forum - An International Journal. 2021;13(3b):155-160.
9. Virani MB, Vachhani JH, Kachhadia VH, Chavadhari RM, Mungala RM. Heterosis studies in sesame (*Sesamum indicum* L.). Electronic Journal of Plant Breeding. 2017;8(3):1006-1012.