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HETEROSIS STUDIES FOR YIELD ATTRIBUTING CHARACTER IN UPLAND COTTON (GOSSYPIUM HIRSUTUM L.)

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ABSTRACT:

A line × tester analysis was conducted to estimate the magnitude of heterosis in 32 cotton hybrids (*Gossypium hirsutum* L.) for yield and its component traits, using 45 entries comprising 32 hybrids, 12 parents, and 1 standard check hybrid (G. Cot. Hy. 14). Analysis of variance revealed significant differences among genotypes for all traits except ginning percentage, indicating sufficient variability among the parents for most traits. Significant heterobeltiosis effects were observed in seven hybrids: GSHV 172 × BGDS 1033 (35.11%), GSHV 172 × CPD 1501 (23.62%), GSHV 172 × TCH 1824 (44.96%), GSHV 172 × Suraj (21.67%), GSHV 172 × RAH 1069 (24.51%), GSHV 185 × RAH 1069 (24.39%), and GISV 310 × TCH 1716 (28.72%). Additionally, nine hybrids exhibited significant and positive standard heterosis, including GSHV 172 × BGDS 1033 (29.27%), GSHV 172 × CPD 1501 (27.83%), GSHV 172 × TCH 1824 (30.69%), GSHV 172 × RAH 1069 (37.64%), GSHV 173 × TCH 1824 (19.94%), GSHV 173 × CCH 15-1 (19.78%), GSHV 173 × RAH 1069 (47.03%), GSHV 185 × RAH 1069 (37.51%), and GISV 310 × TCH 1716 (20.38%). Crosses involving GSHV 172 or GSHV 185 as female parents consistently recorded significant positive heterosis for most yield-contributing traits. These findings suggest that GSHV 172 and GSHV 185 can serve as valuable female parents in heterosis breeding programs, pending further evaluation through multi-location trials.

KEYWORDS: Cotton, line x tester, Gossypium, heterosis, Seed cotton yield

INTRODUCTION:

Cotton (*Gossypium hirsutum* L.), often referred to as the "king of fiber," is a vital cash crop in India, significantly influencing the nation’s economy and social dynamics. While primarily cultivated for its fiber, cotton also holds substantial economic value as a major source of edible oil, protein, and various by-products. It is a critical raw material for India’s textile industry, meeting 70% of its requirements. Additionally, the cotton-based textile sector is a cornerstone of India’s export economy, contributing significantly to GDP growth. It is the largest revenue generator in terms of foreign exchange and provides direct or indirect employment to over 119 million people. There are four cultivated species of cotton: *Gossypium arboreum*, *Gossypium herbaceum*, *Gossypium hirsutum*, and *Gossypium barbadense*. Among these, *Gossypium hirsutum* dominates global cotton production, contributing about 90% of the total. India is the only country where all four species are cultivated on a commercial scale. Cotton is unique as it can be improved both through the development of high-performing varieties and the commercial exploitation of heterosis. Heterosis, or hybrid vigor, is the phenomenon where the F1 generation of two genetically diverse parents exhibits superior performance for specific traits compared to the mid-parent (relative heterosis), better parent (heterobeltiosis), or a standard check (standard heterosis). A key goal of plant breeding is to develop high-yielding varieties with desirable traits. In cotton, breaking the yield plateau requires identifying high-yielding hybrids that demonstrate significant economic heterosis. To achieve this, it is essential to harness genetic diversity and parental combining ability to develop hybrids with enhanced production potential. In the present study, a line × tester analysis was conducted to evaluate economic heterosis in seed cotton yield and other traits. Thirty-two upland cotton hybrids were developed by crossing four female parents (lines) with eight male parents (testers) using a line × tester mating design. The study aimed to identify the most heterotic crosses for improving yield and related traits.

MATERIAL AND METHODS

Forty-five specific crosses were undertaken during kharif 2016-2017 by using 12 parents of G. hirsutum *viz*., GSHV 172, GSHV 173, GSHV 185, GISV 310, BGDS 1033, CPD 1501, TCH 1716, TCH 1824, CCH 15-1, Suraj, RAH 1069 and TCH 321 with diverse origin. These hybrids along with one standard check G. COT. Hy. - 14 were grown in randomized block design with 3 replications at MCRS Surat, Navsari Agricultural University. Observations were recorded on five randomly selected plants for number of sympodia per plant, number of bolls per plant, boll weight (g), seed cotton yield per plant (g), ginning out turn (%), seed index (g) and lint index (g) and lint yield per plant (g). The useful heterosis (heterosis over best check) was estimated as per standard method.

RESULTS AND DISCUSSION:

The phenomenon of heterosis has proved to be the most important genetic tool in boosting the yield of self as well as cross pollinated crops and is considered as the most important breakthrough in the field of crop improvement. Heterosis may be positive or negative, depending on the magnitude of the hybrid mean value. The primary objective of heterosis breeding is to achieve a quantum jump in yield of crop plants. The data collected from the experimental material was subjected to analysis of variance and results obtained had been presented in Table 1. The analysis of variance revealed significant differences among the genotypes for all the characters. The mean squares due to genotypes were significant for all the characters except ginning percentage. Significant mean squares were observed among parents for all the characters indicate existence of sufficient variability among the parents except for ginning percentage (Table 1.2). This indicated that the material selected for the present investigation was quite appropriate for further genetical analysis as considerable amount of variability existed in the experimental material under study's. Perusal of data in table revealed that high heterosis was observed for almost all the traits. Range of mean values among the cross combination for seed cotton yield varied from 58.08 g (GSHV 173 x BGDS 1033) to 102.17 g (GSHV 173 x RAH 1069). The mean values for hybrids for average bolls/plant, the range of mean values among the hybrids was observed lowest in 15.92 (GSHV 185 x CPD 1501) and highest in 36.24 (GSHV 172 x BGDS 1033). The cross GSHV 172 x BGDS 1033 exhibited lowest average boll weight of 2.80 g while the cross, GSHV 173 x TCH 1824 recorded highest average boll weight 4.41 g (Table 1.2). As far as number of sympods is concerned, it ranged from 12.94 (GSHV 172 x BGDS 1033) to 29.96 (GSHV 173 x RAH 1069) (Table 1.2). Lint yield per plant ranged from 17.67 g (GSHV 173 x CPD 1501) to 35.27 g (GSHV 172 x RAH 1069). The highest value for this trait was recorded by the cross combination GSHV 173 x CPD 1501 (35.27 g), which was followed by GSHV 185 x RAH 1069 (34.73 g), GSHV 173 x RAH 1069 (32.60 g) (Table 1.4). Maximum ginning percentage among hybrids was exhibited by GSHV 173 x TCH 321 (40.79 %) followed by GISV 310 x BGDS 1033 (38.61 %) and GISV 310 x CCH 15-1 (36.11 %) as against of check G. Cot. Hy-14 (35.75 %) (Table 1.4). For seed index lowest value was observed for cross combination GISV 310 x TCH 321 (7.60 g) and highest value was observed for cross combination GSHV 172 x TCH 1824 (12.07 g) (Table

1.4). Mean value of lint index varied from 3.90 g (GISV 310 x TCH 321) to 7.23 g (GSHV 173 x TCH 321) (Table 1.5). For seed cotton yield, important aspect of cotton breeding, nine hybrids exhibited significant heterotic values. Most promising hybrids for seed cotton yield i.e, GSHV 172 x BGDS 1033 (29.27 %), GSHV 172 x CPD 1501 (27.83 %), GSHV 172 x TCH 1824 (30.69 %), GSHV 172 x RAH 1069 (37.64 %), GSHV 173 x TCH 1824 (19.94 %), GSHV 173 x CCH 15-1 (19.78 %), GSHV 173 x RAH 1069 (47.03 %), GSHV 185 x RAH 1069 (37.51 %) and GISV 310 x TCH 1716 (20.38 %). Most of these high heterotic cross combinations involve either GSHV 172 & GSHV 185 as female parent. Thus, these nine high heterotic hybrids along with the female parents GSHV 172 and GSHV 185 can be used to exploit high heterotic values for seed cotton yield. Sharma et al. (2016) [15], Arbad et al. (2017) [2], Chhavikant et al. (2017) [3], Dhamyanthi and Rathinavel (2017) [4], Lingaraja et al. (2017) [9] and Gohil et al. (2017) [6] also reported significant positive heterosis was observed for seed cotton yield. Maximum heterosis for boll number was shown by crosses 53.69 per cent (GSHV 172 x BGDS 1033). Heterosis for this trait was also reported by earlier workers Tuteja et al. (2014) [19] , Sawarkar et al. (2015) [14] , Ghevariya et al. (2016) [5] , Sonawane et al. (2015) [17] , Solanki et al. (2014) [16] , Kannan and Saravanan (2015) [7] , Sharma et al. (2016) [15] , Arbad et al. (2017) [2], Chhavikant et al. (2017) [3] and Lingaraja et al. (2017) [9]. For number of sympods, hybrids viz., 78.42 per cent (GSHV 173 x CPD 1501), GSHV 173 x RAH 1069 (67.08 %), GISV 310 x BGDS 1033 (64.75 %), GSHV 173 x Suraj (54.38 %) and GSHV 173 x TCH 1716 (46.55 %) hybrids exhibited significant and positive standard heterosis. Similar finding was reported by Nakum et al. (2014) [11], Patel et al. (2015), Kannan and Saravanan (2015) [7], Sharma et al. (2016) [15] Chhavikant et al. (2017) [3] and Devidas et al. (2017). The hybrid GSHV 172 x RAH 1069 (49.01 %) recorded the highest heterosis for lint yield per plant over standard check followed by GSHV 185 x RAH 1069 (46.76 %), GSHV 173 x RAH 1069, GSHV 173 x RAH 1069 (37.75 %) and GSHV 172 x TCH 1824 (36.76 %). The study of Pole et al. (2008) and Khan et al. (2009) [8] assembles with present study. The spectrum of variation for standard heterosis was varied from - 16.31 (GSHV 310 x TCH 321) to 55.15 (GSHV 173 x TCH 321) percent over G. Cot. Hy.14fot lint index. Three hybrids recorded significantly positive heterosis over G. Cot. Hy. 14 for lint index. These crosses are 173 x TCH 321 (55.15 %), GISV 310 x CCH 15-1 (29.76 %) and GSHV 172 x TCH 321 (26.11 %). The present findings were in close association with results reported by Pole et al. (2008) and Khan et al. (2009) [8]. For boll weight hybrids 20.82 per cent (GSHV 173 x TCH 1824), GSHV 173 x CPD 1501 (11.14 %), GSHV 173 x TCH 1824 (20.82 %), GSHV 173 x CCH 15-1 (15.80 %), GSHV 185 x CPD 1501 (13.06 %), GSHV 185 x RAH 1069 (9.95 %), GSHV 185 x TCH

321 (11.78 %) and GISV 310 x RAH 1069 (15.16 %) showed high heterosis. Similar finding was reported by Tuteja et al. (2014) [19], Pushpam et al. (2015) [13], Kanan and sarvanan (2015), Sharma et al. (2016) [15], Arbad et al. (2017) [2] and Chhavikant et al. (2017) [3]. Among all the characters studied, the lowest heterotic values were found for ginning out turn. The value of standard heterosis was ranged from -13.84 per cent (GSHV 185 x TCH 1716) to 14.09 per cent (GSHV 173 x TCH 321). Out of 32 crosses, none of the crosses had significant standard heterotic effect in positive direction. For seed index hybrid GSHV 172 x TCH 1824 (20.67 %) showed the maximum heterotic effect. Out of 32 crosses, one hybrid showed significant and positive standard heterosis i.e. GSHV 172 x TCH 1824 (20.67 %). Heterosis for this trait was also reported by the earlier workers Nakum et al. (2014) [11], Sawarkar et al. (2015) [14], Munir et al. (2016) [10] and pundir et al. (2017) [12]. The cross with maximum heterotic effect for lint index was GSHV 173 x TCH 321 (55.15 percent). Similar result was reported by Patel et al. (2014), Pushpam et al. (2015) [13], Nirania et al. (2014) [3], Chhavikant et al. (2017) [3] and Lingaraja et al. (2017) [9].

Table 1.1: Magnitude of heterosis over better parent (BP) and over standard check for days to Sympodia per plant and Balls per plant in tetraploid cotton (G. hirsutum L.)

Sr. No.	Crosses	Sympodia per plant		Balls per plant	
		BP	SC	BP	SC
1	GSHV 172 x BGDS 1033	-44.46 **	-27.83 **	64.11 **	53.69 **
2	GSHV 172 x CPD 1501	-10.4	16.42	-2.75	-8.00
3	GSHV 172 x TCH 1716	-25.00 **	-2.55	-8.53	-14.33 *
4	GSHV 172 x TCH 1824	-4.02	24.71 **	23.70 **	15.85 *
5	GSHV 172 x CCH 15-1	-14.95 *	10.50	-14.46	-19.89 **
6	GSHV 172 x Suraj	-29.62 **	-8.55	24.21 **	16.33 *
7	GSHV 172 x RAH 1069	-25.34 **	-2.99	0.71	11.55
8	GSHV 172 x TCH 321	-7.01	20.82 *	2.81	-3.72
9	GSHV 173 x BGDS 1033	-9.53	8.51	-46.65 **	-29.32 **
10	GSHV 173 x CPD 1501	83.11 **	78.42 **	-47.91 **	-30.99 **
11	GSHV 173 x TCH 1716	14.26 *	46.55 **	-38.68 **	-18.76 **
12	GSHV 173 x TCH 1824	23.77 **	44.62 **	-30.73 **	-8.23
13	GSHV 173 x CCH 15-1	31.12 **	30.88 **	-31.41 **	-9.13

14	GSHV 173 x Suraj	48.87 **	54.38 **	-21.23 **	4.35
15	GSHV 173 x RAH 1069	35.00 **	67.08 **	-11.38 *	17.40 *
16	GSHV 173 x TCH 321	11.61	-3.33	-25.58 **	-1.40
17	GSHV 185 x BGDS 1033	-25.34 **	25.82 **	-16.44 *	-21.80 **
18	GSHV 185 x CPD 1501	-32.00 **	14.59	-28.63 **	-32.49 **
19	GSHV 185 x TCH 1716	-34.15 **	10.97	5.68	-1.10
20	GSHV 185 x TCH 1824	-29.27 **	19.20 *	-16.28 *	-21.66 **
21	GSHV 185 x CCH 15-1	-31.24 **	15.88	-18.49 *	-23.72 **
22	GSHV 185 x Suraj	-46.05 **	-9.07	-17.78 *	-23.06 **
23	GSHV 185 x RAH 1069	-33.66 **	11.81	2.65	13.70 *
24	GSHV 185 x TCH 321	-29.48 **	18.85 *	-15.89 *	-21.29 **
25	GISV 310 x BGDS 1033	37.35 **	64.75 **	16.62 *	-2.62
26	GISV 310 x CPD 1501	-16.34 *	-5.74	-8.68	-13.61
27	GISV 310 x TCH 1716	12.05	43.71 **	6.53	-11.04
28	GISV 310 x TCH 1824	10.31	28.89 **	-3.57	-19.48 **
29	GISV 310 x CCH 15-1	16.22 *	30.94 **	11.53	-6.87
30	GISV 310 x Suraj	0.92	13.7	4.84	-12.45
31	GISV 310 x RAH 1069	-9.10	12.49	-30.06 **	-22.53 **
32	GISV 310 x TCH 321	-31.67 **	-23.02 **	4.57	-12.68
	S.Ed ±	1.52	1.52	1.61	1.61
	CD .05	3.04	3.04	3.21	3.21
	CD .01	4.04	4.04	4.26	4.26

*, ** significant at 5% and 1% levels, respectively

Table 1.2: Magnitude of heterosis over better parent (BP) and over standard check for Ball weight (g) and Seed cotton yield per plant (g) in tetraploid cotton (*G. hirsutum* L.)

Sr. No.	Crosses	Ball weight (g)		Seed cotton yield per plant (g)	
		BP	SC	BP	SC
1	GSHV 172 x BGDS 1033	-33.09 **	-23.20 **	35.11 **	29.27 **
2	GSHV 172 x CPD 1501	-4.68	7.95 *	23.62 **	27.83 **
3	GSHV 172 x TCH 1716	8.27 *	9.95 *	-1.47	-11.18
4	GSHV 172 x TCH 1824	-7.09	-3.11	44.96 **	30.69 **
5	GSHV 172 x CCH 15-1	16.42 **	8.77 *	-14.89	-23.27 *
6	GSHV 172 x Suraj	-9.78 *	-4.84	21.67 *	9.68
7	GSHV 172 x RAH 1069	6.15	7.21	24.51 **	37.64 **
8	GSHV 172 x TCH 321	6.19	0.27	1.13	-8.83
9	GSHV 173 x BGDS 1033	-4.69	9.41 *	-37.57 **	-16.42
10	GSHV 173 x CPD 1501	-1.85	11.14 **	-46.43 **	-28.29 **
11	GSHV 173 x TCH 1716	-20.14 **	-18.90 **	-34.91 **	-12.85
12	GSHV 173 x TCH 1824	15.85 **	20.82 **	-10.41	19.94 *
13	GSHV 173 x CCH 15-1	20.08 **	15.80 **	-10.53	19.78 *
14	GSHV 173 x Suraj	-15.76 **	-11.14 **	-17.35 *	10.65
15	GSHV 173 x RAH 1069	-6.78	-5.84	9.82	47.03 **
16	GSHV 173 x TCH 321	-14.20 **	-17.26 **	-32.83 **	-10.08
17	GSHV 185 x BGDS 1033	-14.03 **	6.30	-27.14 **	-19.65 *
18	GSHV 185 x CPD 1501	-8.57 **	13.06 **	-7.77	1.71
19	GSHV 185 x TCH 1716	-23.26 **	-5.11	2.32	12.83
20	GSHV 185 x TCH 1824	-19.28 **	-0.18	-28.31 **	-20.95 *
21	GSHV 185 x CCH 15-1	-12.92 **	7.67	-19.71 *	-11.46
22	GSHV 185 x Suraj	-13.52 **	6.94	-23.68 **	-15.84
23	GSHV 185 x RAH 1069	-11.08 **	9.95 *	24.39 **	37.51 **
24	GSHV 185 x TCH 321	-9.60 **	11.78 **	-15.5	-6.82
25	GISV 310 x BGDS 1033	-14.16 **	-1.46	2.96	-7.16
26	GISV 310 x CPD 1501	-15.16 **	-3.93	-11.51	-8.49
27	GISV 310 x TCH 1716	5.04	6.67	28.72 **	20.38 *

28	GISV 310 x TCH 1824	-1.49	2.74	-4.13	-10.35
29	GISV 310 x CCH 15-1	-7.43	-13.52 **	5.39	-1.45
30	GISV 310 x Suraj	0.95	6.48	7.88	0.89
31	GISV 310 x RAH 1069	14.01 **	15.16 **	-10.18	-0.71
32	GISV 310 x TCH 321	-0.68	-6.21	-1.1	-7.52
	S.Ed ±	0.14	0.14	6.09	6.09
	CD .05	0.28	0.28	12.18	12.18
	CD .01	0.37	0.37	16.19	16.19

*, ** significant at 5% and 1% levels, respectively

Table 1.3: Magnitude of heterosis over better parent (BP) and over standard check for Lint yield per plant (g) and Ginning percentage in tetraploid cotton (G. hirsutum L.)

Sr. No.	Crosses	Lint yield per plant (g)		Ginning percentage	
		BP	SC	BP	SC
1	GSHV 172 x BGDS 1033	29.20 **	29.01 **	-0.38	-2.53
2	GSHV 172 x CPD 1501	30.99 **	33.94 **	-1.5	-3.62
3	GSHV 172 x TCH 1716	-2.52	-12.96	-8.58	-3.89
4	GSHV 172 x TCH 1824	53.15 **	36.76 **	-1.71	-3.82
5	GSHV 172 x CCH 15-1	-4.42	-14.65	-14.05 *	-0.04
6	GSHV 172 x Suraj	17.67	5.07	-7.18	-4.12
7	GSHV 172 x RAH 1069	39.21 **	49.01 **	1.6	-0.59
8	GSHV 172 x TCH 321	7.57	-3.94	-1.57	-3.69
9	GSHV 173 x BGDS 1033	-30.36 **	-12.11	-0.8	-5.3
10	GSHV 173 x CPD 1501	-40.85 **	-25.35 **	-5.08	-7.14
11	GSHV 173 x TCH 1716	-31.58 **	-13.66	-13.21	-8.75
12	GSHV 173 x TCH 1824	-5.58	19.15 *	-3.7	-8.72
13	GSHV 173 x CCH 15-1	-3.13	22.25 **	-19.73 **	-6.65
14	GSHV 173 x Suraj	-11.72	11.41	-11.06	-8.12
15	GSHV 173 x RAH 1069	9.15	37.75 **	-4.41	-8.75
16	GSHV 173 x TCH 321	-12.39	10.56	18.55 *	14.09
17	GSHV 185 x BGDS 1033	-23.76 **	-17.75 *	8.41	3.88
18	GSHV 185 x CPD 1501	-3.79	3.80	-4.38	-6.46

19	GSHV 185 x TCH 1716	-11.23	-4.23	-18.05 *	-13.84
20	GSHV 185 x TCH 1824	-23.63 **	-17.61 *	1.02	-3.20
21	GSHV 185 x CCH 15-1	-12.92	-6.06	-16.28 *	-2.63
22	GSHV 185 x Suraj	-26.11 **	-20.28 *	-10.26	-7.30
23	GSHV 185 x RAH 1069	36.03 **	46.76 **	1.89	-2.37
24	GSHV 185 x TCH 321	-13.45	-6.62	-2.52	-6.19
25	GISV 310 x BGDS 1033	-3.42	3.52	2.35	7.99
26	GISV 310 x CPD 1501	-10.12	-3.66	-7.17	-2.05
27	GISV 310 x TCH 1716	11.7	19.72 *	-8.86	-3.84
28	GISV 310 x TCH 1824	-22.08 **	-16.48 *	-16.36 *	-11.75
29	GISV 310 x CCH 15-1	0.53	7.75	-13.15	1.01
30	GISV 310 x Suraj	-4.07	2.82	-9.46	-4.47
31	GISV 310 x RAH 1069	-6.96	-0.28	-13.49	-8.72
32	GISV 310 x TCH 321	-10.12	-3.66	-9.37	-4.37
	S.Ed ±	1.90	1.90	2.91	2.91
	CD .05	3.80	3.80	5.82	5.82
	CD .01	5.05	5.05	7.74	7.74

*, ** significant at 5% and 1% levels, respectively

Table 1.4: Magnitude of heterosis over better parent (BP) and over standard check for Seed index (g) and Lint index (g) in tetraploid cotton (G. hirsutum L.)

Sr. No.	Crosses	Seed index (g)		Lint index (g)	
		BP	SC	BP	SC
1	GSHV 172 x BGDS 1033	-15.84 *	-15.00 *	-0.42	2.36
2	GSHV 172 x CPD 1501	7.53	0.00	15.34	10.23
3	GSHV 172 x TCH 1716	2.15	-5.00	0.43	0.14
4	GSHV 172 x TCH 1824	29.75 **	20.67 **	28.10 *	25.54
5	GSHV 172 x CCH 15-1	-5.00	-5.00	-0.69	13.73
6	GSHV 172 x Suraj	-0.33	0.33	7.75	9.44
7	GSHV 172 x RAH 1069	-1.90	3.00	7.49	12.88
8	GSHV 172 x TCH 321	11.00	11.00	10.33	26.11 *
9	GSHV 173 x BGDS 1033	-9.56	10.33	21.16	24.54
10	GSHV 173 x CPD 1501	-26.50 **	-10.33	-5.36	-3.93

11	GSHV 173 x TCH 1716	-15.30 *	3.33	3.88	5.44
12	GSHV 173 x TCH 1824	-13.93 *	5.00	-0.35	1.14
13	GSHV 173 x CCH 15-1	-8.47	11.67	0.87	15.52
14	GSHV 173 x Suraj	-14.21 *	4.67	7.68	9.37
15	GSHV 173 x RAH 1069	-9.84	10.00	-1.29	3.65
16	GSHV 173 x TCH 321	-17.21 **	1.00	35.73 **	55.15 **
17	GSHV 185 x BGDS 1033	-2.90	0.33	15.03	18.24
18	GSHV 185 x CPD 1501	1.61	5.00	15.37	17.60
19	GSHV 185 x TCH 1716	1.61	5.00	-8.7	-6.94
20	GSHV 185 x TCH 1824	-3.23	0.00	4.98	7.01
21	GSHV 185 x CCH 15-1	1.61	5.00	2.06	16.88
22	GSHV 185 x Suraj	1.61	5.00	10.74	12.88
23	GSHV 185 x RAH 1069	0.32	5.33	3.81	9.01
24	GSHV 185 x TCH 321	-2.90	0.33	-10.01	2.86
25	GISV 310 x BGDS 1033	-15.84 *	-15.00 *	5.61	13.02
26	GISV 310 x CPD 1501	5.17	-5.00	9.09	16.74
27	GISV 310 x TCH 1716	5.17	-5.00	6.48	13.95
28	GISV 310 x TCH 1824	5.93	-4.67	-15.51	-9.59
29	GISV 310 x CCH 15-1	3.00	3.00	13.30	29.76 *
30	GISV 310 x Suraj	0.33	1.00	8.62	16.24
31	GISV 310 x RAH 1069	-13.02	-8.67	-11.83	-5.65
32	GISV 310 x TCH 321	-24.00 **	-24.00 **	-26.78 *	-16.31
	S.E (d) ±	0.73	0.73	0.60	0.60
	CD .05	1.46	1.46	1.20	1.20
	CD .01	1.95	1.95	1.60	1.60

*, ** significant at 5% and 1% levels, respectively

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Table 1.5: Analysis of variance (mean sum of squares) for experiment for various characters in tetraploid cotton (G. *hirsutum* L.)

Source of variation	d.f.	No. of sympodia per plant	No. of bolls per plant	Boll Weight (g)	Seed cotton yield / plant (g)	Lint yield/ plant (g)	Ginning percentage	Seed index (g)	Lint index (g)
Replicates	2	22.23 **	42.42 **	0.03	134.26	77.65 **	129.36 **	1.24	3.30 **
Treatments	43	58.04 **	71.21 **	0.47 **	861.89 **	101.65 **	14.20	2.43 **	1.03 **
Parents	11	52.33 **	110.23 **	0.53 **	1306.53 **	142.79 **	21.07	2.80 **	0.34
Parents (Line)	3	113.90 **	78.19 **	1.26 **	578.84 **	38.15 **	22.22	7.35 **	0.14
Parents (Testers)	7	24.54 **	85.11 **	0.24 **	1143.88 **	130.57 **	21.23	1.07	0.46
Parents (L vs T)	1	62.16 **	382.16 **	0.31 **	4628.18 **	542.30 **	16.53	1.23	0.05
Parents vs Crosses	1	26.98 **	166.50 **	0.00	4450.79 **	619.39 **	33.39	0.99	3.89 **
Crosses	31	61.06 **	54.29 **	0.46 **	588.35 **	70.35 **	11.14	2.34 **	1.18 **
Line Effect	3	190.48 *	134.92	0.27	498.34	81.38	3.48	6.76 *	0.45
Tester Effect	7	26.97	46.70	0.29	826.33	92.04	15.64	1.57	0.88
Line * Tester Eff.	21	53.93 **	45.30 **	0.55 **	521.88 **	61.55 **	10.74	1.97 **	1.39 **
Error	86	3.48	3.87	0.03	55.72	5.43	12.74	0.81	0.55

*, ** significant at 5% and 1% levels, respectively

CONCLUSION:

Recent investigations reveal a substantial degree of heterosis over the standard check, G. Cot. Hy. 14, across nearly all traits. Notably, the highest levels of heterosis were observed in specific traits, including seed cotton yield in the hybrid GSHV 173 x RAH 1069 (47.03%), boll number in GSHV 172 x BGDS 1033 (53.69%), and the number of sympods in GSHV 173 x CPD 1501 (78.42%). Among the most promising hybrids for seed cotton yield are GSHV 172 x BGDS 1033 (29.27%), GSHV 172 x CPD 1501 (27.83%), GSHV 172 x TCH 1824 (30.69%), GSHV 172 x RAH 1069 (37.64%), GSHV 173 x TCH 1824 (19.94%), GSHV 173 x CCH 15-1 (19.78%), GSHV 173 x RAH 1069 (47.03%), GSHV 185 x RAH 1069 (37.51%), and GISV 310 x TCH 1716 (20.38%). Most of these high-heterosis cross combinations feature either GSHV 172 or GSHV 185 as the female parent. Consequently, these nine highly heterotic hybrids, along with the female parents GSHV 172 and GSHV 185, present significant potential for enhancing seed cotton yield. These combinations, demonstrating heterosis for seed cotton yield and other key traits, can be effectively integrated into heterosis breeding programs following thorough evaluation in multi-location trials.

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