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GENETIC ANALYSIS OF HETEROSIS FOR YIELD AND QUALITY TRAITS IN TOMATO UNDER POLYHOUSE CONDITIONS

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ABSTRACT

Tomato (*Solanum lycopersicum* L.) productivity is often limited by biotic stresses and the use of low-performing cultivars, necessitating the development of superior hybrids. The present study was conducted during at SKUAST-Jammu, Chatha, under protected cultivation to assess heterosis and combining ability for yield and related traits in tomato. Fifteen lines and three testers were crossed using a Line × Tester design to produce 45 F_1 hybrids, which were evaluated along with parents and a commercial check under low-cost polyhouse conditions. Heterotic vigor was present for growth and yield characters among hybrids. Significant genetic variability was observed for all traits studied. Several hybrids exhibited desirable heterosis for fruit yield, fruit number, fruit size, and quality attributes. Negative heterosis for days to 50% flowering indicated the potential for developing early maturing hybrids. Hybrids such as Arka Abha × EC 521038, Roma × EC 521038, and Punjab Varkha Bahar-4 × EC 521038 performed well for yield, whereas Pusa Ruby × EC 521038 and CLN-2123-A1 Red × Punjab Sartaj were superior for quality traits. Heterosis breeding is used to improve yield quantity and quality of Tomato (*Solanum lycopersicum* L.) because traditional methods cannot be used to achieve this goal. The study demonstrates the usefulness of heterosis breeding for developing high-yielding tomato hybrids under protected conditions.
Keywords **:** Heterosis, Tomato hybrids, Line × Tester, Protected cultivation.

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most widely cultivated vegetable crops globally because of its high economic value, nutritional importance, and extensive use in the processing industry. The fruit is an important dietary source of antioxidants such as lycopene, β-carotene, and ascorbic acid, which are associated with several health-promoting properties (Osei *et al.*, 2020). However, tomato production is frequently constrained by various biotic and abiotic stresses, poor adaptability of cultivars, and the continued cultivation of low-yielding varieties, particularly in low-input production systems (Mwangi *et al.*, 2020). Furthermore, the highly perishable nature of tomato fruits results in considerable post-harvest losses, adversely affecting fruit quality, shelf life, and market value (Sinha *et al.*, 2019). These challenges emphasize the necessity for developing improved cultivars with enhanced yield potential, quality attributes, and post-harvest stability.

Exploitation of heterosis has become an effective breeding approach for improving yield and economically important traits in tomato, including earliness, fruit size, and quality characteristics. The magnitude of heterosis is largely influenced by the genetic diversity and compatibility among parental genotypes; therefore, the selection of suitable parents plays a critical role in hybrid breeding programmes (Kenneth, 2016). In this context, combining ability analysis is widely used to assess the breeding potential of parental lines and to identify promising hybrid combinations. The technique also provides valuable information on the nature and magnitude of gene action controlling quantitative traits by differentiating additive and non-additive genetic effects (da Costa *et al*., 2018). Earlier studies have demonstrated substantial variability in combining ability effects for yield and quality traits in tomato, suggesting the involvement of diverse genetic mechanisms in trait inheritance (Dharva *et al.,* 2018; Soresa *et al.,* 2020).

Among the available biometrical methods, the Line × Tester mating design is extensively employed for evaluating heterosis and combining ability in tomato breeding programmes. This approach facilitates the identification of superior parental lines and cross combinations suitable for hybrid development and commercial cultivation. Therefore, the present investigation was conducted to assess heterosis for yield and associated traits in tomato under protected cultivation conditions, with the objective of identifying promising parents and hybrid combinations for future crop improvement programmes.

Materials and Methods

Experimental site and growing conditions

The present investigation was conducted at the Experimental Farm of the Division of Vegetable Science and Floriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST–Jammu), Chatha, India, during the Rabi seasons. The experiment was carried out under low-cost polyhouse conditions to provide a semi-controlled growing environment. Standard agronomic practices and recommended plant protection measures were adopted uniformly for all experimental plots throughout the cropping period.

Plant material

A set of 24 tomato genotypes (*Solanum lycopersicum* L.) was initially screened for important agronomic traits. Based on their overall field performance, 15 genotypes were selected as lines and three as testers for hybridization studies. The lines comprised Pusa Ruby, Punjab Varkha Bahar-4, Marglobe, CLN-2123-A1-Red, Palam Pink, EC 249515, IIHR 2042, Punjab Ratta, EC 163383, EC 163611, IIVR BT-10, EC 163605, Roma, Kashi Chayan, and Arka Abha. The testers included EC 521038, Punjab Sartaj, and DVRT-2. The commercial hybrid Arka Rakshak was included as the standard check for comparison.

Development of F_1 hybrids

The selected parental genotypes were crossed in a Line × Tester mating scheme involving 15 lines and 3 testers, generating a total of 45 F_1 hybrids. Emasculation of flower buds was carried out during evening hours, one day before anthesis, to avoid self-pollination. Controlled pollination was performed manually during the morning period between 06:00 and 08:00 h. Fully mature fruits obtained from successful crosses were harvested, and seeds were extracted, washed, dried, and stored for subsequent evaluation.

Experimental design and crop management

The parental genotypes were evaluated using an augmented randomized block design, while the F_1 hybrids, parents, and standard check were assessed in a randomized complete block design (RCBD) with three replications. Seedlings were transplanted at a spacing of 60 cm × 45 cm. All intercultural operations, irrigation schedules, nutrient management practices, and plant protection measures were applied uniformly to ensure healthy crop growth and development.

Data recording

Data were recorded from five randomly selected plants in each treatment across all replications. Observations were taken for plant height, number of branches per plant, number of clusters per plant, number of fruits per cluster, average fruit weight, and fruit yield per plant. The mean values obtained for each trait were subjected to statistical analysis.

Statistical analysis

The recorded data were analyzed using analysis of variance (ANOVA) following the procedure outlined by Panse and Sukhatme (1967). Heterosis was estimated as relative heterosis, heterobeltiosis, and standard heterosis according to the methods described by Turner (1953) and Hayes *et al.* (1955). Combining ability analysis, including general combining ability (GCA) and specific combining ability (SCA), was performed using the Line × Tester method proposed by Kempthorne (1957). The proportional contribution of lines, testers, and their interactions to total genetic variation was estimated following Singh and Choudhary (1977).

Results and Discussion

Heterosis was estimated in 45 F_1 hybrids for sixteen agronomic and quality traits using mid-parent heterosis (MPH), better-parent heterosis (BPH), and standard heterosis over the commercial check 'Arka Rakshak'. Significant differences among genotypes were observed for all traits (Tables 1–8), indicating substantial genetic variability for effective selection and hybrid development. The heterotic response varied across crosses and traits, suggesting the involvement of both additive and non-additive gene effects. Additive effects are associated with the transmission of favorable alleles, whereas non-additive effects mainly arise from dominance and epistatic interactions (Mishra et al., 2017; Rakha and Sabry, 2019; Pattnaik *et al*., 2020a; Pattnaik *et al*., 2020b).

Most hybrids exhibited positive heterosis over parental means, reflecting substantial hybrid vigour for yield and related traits. Among the evaluated combinations, Arka Abha × EC 521038 (L15 × T1), Roma × EC 521038 (L13 × T1), and Punjab Varkha Bahar-4 × EC 521038 (L2 × T1) showed superior performance for yield traits and recorded high standard heterosis over the check hybrid. Likewise, Pusa Ruby × EC 521038 (L1 × T1) and CLN 2123 A1 Red × Punjab Sartaj (L4 × T2) expressed significant standard heterosis for quality attributes, particularly total soluble solids and lycopene content. These hybrids may therefore serve as promising candidates for commercial hybrid development under protected cultivation conditions.

Days to fifty per cent flowering

Mid-parent heterosis (MPH) for days to fifty per cent flowering ranged from −9.39% (L4 × T3) to 12.01% (L15 × T3), with eight hybrids showing significant negative heterosis. Better-parent heterosis (BPH) was highest in L4 × T3 (−14.59%), while twelve hybrids recorded significant negative values. Significant negative standard heterosis was observed in fifteen hybrids, with the maximum reduction in L8 × T1 (−13.41%). Negative heterosis for flowering time indicates earliness, a desirable trait in tomato breeding. Similar results were reported by Premalakshme *et al.* (2005), Singh *et al*. (2008), and Kathimba *et al*. (2022), who associated early flowering with non-additive gene action.

Plant height

Mid-parent heterosis (MPH) for plant height ranged from −65.13% (L2 × T2) to 98.50% (L15 × T1), with 28 hybrids exhibiting significant positive heterosis. Better-parent heterosis (BPH) varied from −69.30% to 86.41%, with the highest positive value recorded in L12 × T1. Standard heterosis was generally low, and the maximum value was observed in L15 × T1 (0.20%). Similar results were reported by Amin *et al*. (2017), Jadav *et al*. (2017), and Bhala *et al.* (2019). The wide variation among hybrids indicates considerable genetic divergence among parental lines and the involvement of both additive and dominance gene effects, as also reported by Afzal and Jindal (2016) and Tamta and Singh (2018). However, the low standard heterosis suggests that increased plant height may not directly contribute to higher yield performance.

Number of branches per plant

Mid-parent heterosis (MPH) for number of branches per plant ranged from −42.55% (L1 × T1) to 75.09% (L4 × T3), with eight hybrids exhibiting significant positive heterosis. Better-parent heterosis (BPH) varied from −49.60% to 57.47%, and three hybrids showed significant positive estimates. The highest standard heterosis was recorded in L15 × T1 and L5 × T2 (14.03% each). Similar findings were reported by Gowthami *et al.* (2022), Kumar *et al.* (2018), Chawsh and Arkwazee (2022), and Gabhale *et al.* (2024), indicating the importance of branching as an important yield-contributing trait in tomato.

Number of flowers per cluster

Mid-parent heterosis (MPH) for number of flowers per cluster ranged from −47.89% to 80.64%, with twelve hybrids showing significant positive effects. Better-parent heterosis (BPH varied from −58.71% to 27.59%, with six hybrids exhibiting significant values. Seventeen hybrids recorded positive standard heterosis, with the highest value observed in L15 × T1 (64.54%). Similar trends were reported by Chawsh and Arkwazee (2022) and Madhavi *et al.* (2023), highlighting the contribution of floral traits to yield improvement in tomato hybrids.

Number of fruits per truss

Mid-parent heterosis (MPH) for number of fruits per truss ranged from −70.08% to 43.61%, with seven hybrids exhibiting significant positive values. Better-parent heterosis (BPH) varied from −71.27% to 17.37%. The highest standard heterosis was observed in L13 × T1 (45.53%). These findings are in agreement with Singh *et al.* (2021), Kumar *et al.* (2013), and Singh *et al.* (2022), indicating the importance of fruit set and retention in determining yield performance in tomato hybrids.

Fruit set per cent

MPH ranged from −67.14% to 50.31%, while BPH ranged from −73.51% to 35.46%. The highest standard heterosis was observed in L13 × T1 (20.76%). Similar trends in fruit set heterosis have been reported in tomato. Singh *et al*. (2015) observed MPH from −60% to 55% and BPH from −70% to 38%, comparable to the present findings. Standard heterosis up to 21% has also been reported (Sharma & Verma, 2016), aligning with the highest heterosis observed in L13 × T1.

Number of truss per plant

The number of trusses per plant showed wide variation among hybrids, with MPH ranging from −39.09% to 61.52% and 20 crosses exhibiting significant positive heterosis, indicating the role of non-additive gene action. BPH was recorded up to 40.46%, with L7 × T3 showing the highest superiority over the better parent. Standard heterosis reached a maximum of 60.54% in L8 × T2, suggesting strong hybrid potential for this trait. Similar findings were reported by Amaefula *et al.* (2014). Overall, L7 × T3 and L8 × T2 were identified as promising crosses for improving truss number per plant.

Number of fruits per plant

Number of fruits per plant showed wide heterotic variation, with MPH ranging from −72.83% to 54.09% and 14 hybrids exhibiting significant positive heterosis. BPH varied from −75.21% to 18.80%. The cross Pusa Ruby × EC 521038 recorded the highest standard heterosis (42.05%), indicating its superiority for this trait. Similar findings were reported by Asati *et al*. (2007) and Kumari and Sharma (2011).

Average fruit weight

Average fruit weight showed considerable heterotic variation, with MPH ranging from −67.32% to 49.02%, and six hybrids exhibiting significant positive effects. BPH ranged from −73.00% to 42.24%, with the highest heterosis observed in L9 × T2. The maximum standard heterosis was recorded in L13 × T1 (8.02%). These findings are consistent with the reports of Shankar *et al.* (2014) and Kumari and Sharma (2011).

Fruit polar diameter

Fruit polar diameter exhibited moderate heterotic variation, with MPH ranging from −50.17% to 44.37%, and five hybrids showing significant positive effects. BPH reached a maximum of 43.36%, while the highest standard heterosis (4.20%) was recorded in the cross L15 × T1. These findings are consistent with previous reports (Shankar *et al.*, 2014; Dagade *et al.*, 2015).

Fruit equatorial diameter

Fruit equatorial diameter showed wide heterotic variation, with MPH ranging from −50.67% to 39.15%, and 17 hybrids exhibiting significant positive effects. BPH reached a maximum of 38.43%, while the highest standard heterosis (10.10%) was observed in the cross L15 × T1, indicating its superiority for this trait. These findings are consistent with previous reports (Tekkam *et al.*, 2021; Umesh & Patil, 2021; Metwally *et al*., 2015).

Fruit shape index

Fruit shape index showed limited heterotic variation, with only one hybrid expressing significant positive MPH (−17.35% to 13.04%). BPH ranged from −26.34% to 4.00%, while L8 × T2 recorded the highest standard heterosis (1.89%). Similar low to moderate heterosis for fruit shape index has been reported earlier (Tamta and Singh, 2018).

Fruit yield per plant

Fruit yield per plant exhibited considerable heterotic variability among the hybrids, with mid-parent heterosis (MPH) varying from −70.86% to 62.65%, of which six hybrids demonstrated significant positive heterotic effects. Better-parent heterosis (BPH) reached a maximum value of 50.54%, and the hybrids L8 × T2 and L15 × T1 emerged as promising combinations for enhanced yield performance. The highest standard heterosis was observed in L15 × T1 (27.24%), suggesting its superior commercial yield potential. The magnitude of heterosis observed for fruit yield may be attributed to the cumulative contribution of yield-associated component traits along with the predominance of non-additive gene action governing the trait. Comparable findings have also been documented by Asati *et al*. (2007), Singh *et al*. (2008), Kurian *et al*. (2001), Kumari and Sharma (2011), Pattnaik *et al*. (2020a, 2020b), Soresa *et al.* (2020), Kumar *et al.* (2013), Gautam *et al*. (2018). Furthermore, Afzal and Jindal (2016) emphasized the significant role of non-additive gene effects in the expression of fruit yield.

Fruit pericarp thickness

Fruit pericarp thickness showed wide heterosis in the present study (MPH: −77.38% to 61.99%; BPH: −81.55% to 52.04%), indicating strong non-additive gene action. Similar moderate to high heterotic variation for fruit structural traits in tomato was reported by Shankar *et al*. (2014), Asati *et al.* (2007), Dagade *et al.* (2015), and Tekkam *et al.* (2021). These studies also observed that only a few hybrids express positive standard heterosis for pericarp thickness, which agrees with the present finding where only L2 × T1 showed slight superiority (2.36%).

Total soluble solids

Total soluble solids (TSS) showed wide heterotic variation, with MPH ranging from −59.02% to 65.60% and 13 hybrids exhibiting significant positive effects. BPH varied from −64.55% to 44.37%. The cross L1 × T1 recorded the highest standard heterosis (14.83%), indicating its superiority for this trait. The simultaneous improvement in yield and quality traits highlights the scope for integrated breeding strategies for developing superior hybrids (Amaefula *et al.*, 2014; Yu *et al*., 2021).

Lycopene content

MPH ranged from −66.40% to 93.33%, with twenty-three hybrids showing significant positive heterosis. BPH was highest in L8 × T2 (77.50%), while maximum standard heterosis was recorded in L4 × T2 (76.34%). Overall, substantial heterotic effects were observed, indicating useful genetic divergence among the parents. These results are in agreement with Khar and Arti (2019), Singh *et al.* (2019), and Pavan *et al.* (2022).

Conclusion

The present investigation revealed substantial genetic variability and significant heterotic effects among tomato genotypes for yield and related traits, indicating strong potential for the exploitation of hybrid vigour in crop improvement. Both additive and non-additive gene actions influenced the inheritance of key traits, with non-additive effects playing a major role in the expression of heterosis for yield components. Several hybrid combinations performed better than the standard checks, particularly for yield and quality traits. Promising crosses such as Arka Abha × EC 521038, Roma × EC 521038, and Punjab Varkha Bahar-4 × EC 521038 showed superior yield performance, while Pusa Ruby × EC 521038 and CLN-2123-A1 Red × Punjab Sartaj were better for quality attributes. Overall, the study confirms that heterosis breeding is an effective strategy for improving yield, earliness, and quality in tomato. The identified superior hybrids and diverse parental material provide a useful genetic base for developing high-yielding and stable hybrids suitable for different agro-climatic conditions.

Table 1: Heterosis for Days to fifty per cent flowering and Plant height

Hybrids	Days to fifty per cent flowering			Plant height (cm)		
	MPH	BPH	SH	MPH	BPH	SH
L1 x T1 (Pusa Ruby x EC 521038)	1.26	-2.62	-11.76 **	58.05 **	44.83 **	-32.82 **
L1 x T2 (Pusa Ruby x Punjab Sartaj)	5.66 *	5.20	-4.67	-8.22	-25.09 **	-54.25 **
L1 x T3 (Pusa Ruby x DVRT-2)	8.62 **	0.89	6.60 *	69.34 **	42.88 **	-44.81 **
L2 x T1 (Punjab Varkha Bahar-4 x EC 521038)	-7.07 **	-13.38 **	-11.68 **	29.36 **	2.07	-18.10 **
L2 x T2 (Punjab Varkha Bahar-4 x Punjab Sartaj)	-6.78 **	-12.32 **	-10.60 **	-65.13 **	-69.30 **	-75.37 **
L2 x T3 (Punjab Varkha Bahar-4 x DVRT-2)	-4.32 *	-6.00 *	-0.68	12.34 *	-25.24 **	-40.02 **
L3 x T1 (Marglobe x EC 521038)	5.80 *	4.67	-5.75 *	59.89 **	57.24 **	-27.06 **
L3 x T2 (Marglobe x Punjab Sartaj)	0.19	0.07	-9.89 **	-0.33	-13.56 **	-47.21 **
L3 x T3 (Marglobe x DVRT-2)	-3.38	-10.52 **	-5.45 *	-0.93	-21.14 **	-64.63 **
L4 x T1 (CLN 2123 A1 Red x EC 521038)	6.35 *	3.27	-3.41	75.60 **	54.48 **	-28.34 **
L4 x T2 (CLN 2123 A1 Red x Punjab Sartaj)	3.76	1.71	-4.87	-22.26 **	-38.71 **	-62.57 **
L4 x T3 (CLN 2123 A1 Red x DVRT-2)	-9.39 **	-14.59 **	-9.75 **	8.74	-4.66	-66.41 **
L5 x T1 (Palam Pink x EC 521038)	-5.84 *	-11.35 **	-11.53 **	67.68 **	33.10 **	-38.26 **
L5 x T2 (Palam Pink x Punjab Sartaj)	2.22	-2.88	-3.08	73.86 **	25.73 **	-23.22 **
L5 x T3 (Palam Pink x DVRT-2)	0.09	-2.69	2.82	23.07 *	21.48	-66.89 **
L6 x T1 (EC 249515 x EC 521038)	8.84 **	4.69	-0.14	44.57 **	16.21 *	-46.09 **
L6 x T2 (EC 249515 x Punjab Sartaj)	-2.42	-5.26	-9.63 **	24.02 **	-9.37	-44.65 **
L6 x T3 (EC 249515 x DVRT-2)	-6.22 **	-10.77 **	-5.72 *	60.72 **	56.07 **	-56.01 **
L7 x T1 (IIHR 2042 x EC 521038)	3.92	1.69	-6.37 *	94.27 **	77.59 **	-17.62 **
L7 x T2 (IIHR 2042 x Punjab Sartaj)	5.64 *	4.35	-3.92	-8.04	-25.09 **	-54.25 **
L7 x T3 (IIHR 2042 x DVRT-2)	-6.96 **	-12.94 **	-8.01 **	29.00 **	9.08	-58.09 **
L8 x T1 (Punjab Ratta x EC 521038)	-5.51 *	-9.01 **	-13.41 **	9.02	2.94	-46.25 **
L8 x T2 (Punjab Ratta x Punjab Sartaj)	-1.03	-3.80	-8.45 **	-13.46 **	-19.73 **	-50.98 **
L8 x T3 (Punjab Ratta x DVRT-2)	-2.47	-7.31 **	-2.06	-39.07 **	-54.04 **	-76.01 **
L9 x T1 (EC 163383 x EC 521038)	-2.67	-4.05	-12.98 **	49.18 **	42.19 **	-27.22 **
L9 x T2 (EC 163383 x Punjab Sartaj)	4.99 *	4.49	-5.24 *	2.03	-6.23	-42.73 **

L9 x T3 (EC 163383 x DVRT-2)	3.50	-3.83	1.61	58.44 **	20.31 **	-38.42 **
L10 x T1 (EC 163611 x EC 521038)	5.84 *	-1.19	0.40	-3.95	-19.14 **	-45.13 **
L10 x T2 (EC 163611 x Punjab Sartaj)	8.55 **	2.26	3.91	6.70	1.37	-31.22 **
L10 x T3 (EC 163611 x DVRT-2)	0.15	-1.77	3.79	42.53 **	-0.85	-32.72 **
L11 x T1 (IIVR BT-10 x EC 521038)	1.60	-5.32 *	-3.41	17.94 **	12.34 *	-42.42 **
L11 x T2 (IIVR BT-10 x Punjab Sartaj)	8.28 **	1.82	3.87	4.24	-4.13	-41.45 **
L11 x T3 (IIVR BT-10 x DVRT-2)	5.95 **	4.12	10.01 **	-4.37	-27.42 **	-62.79 **
L12 x T1 (EC 163605 x EC 521038)	-4.24	-7.39 **	-12.65 **	89.70 **	86.41 **	-10.42 **
L12 x T2 (EC 163605 x Punjab Sartaj)	1.76	-0.66	-6.31 *	34.27 **	19.97 **	-26.74 **
L12 x T3 (EC 163605 x DVRT-2)	0.76	-4.65	0.75	62.34 **	26.02 **	-39.44 **
L13 x T1 (Roma x EC 521038)	-2.71	-5.37	-11.79 **	-2.62	-21.91 **	-40.01 **
L13 x T2 (Roma x Punjab Sartaj)	8.20 **	6.23 *	-0.97	-39.67 **	-45.86 **	-58.41 **
L13 x T3 (Roma x DVRT-2)	5.36 *	-0.84	4.78	16.75 **	-21.45 **	-39.66 **
L14 x T1 (Kashi Chayan x EC 521038)	3.14	-8.87 **	4.67	36.46 **	36.36 **	-36.66 **
L14 x T2 (Kashi Chayan x Punjab Sartaj)	10.89 **	-1.19	13.50 **	42.82 **	25.73 **	-23.22 **
L14 x T3 (Kashi Chayan x DVRT-2)	5.02 *	0.81	15.79 **	51.52 **	19.06 **	-44.69 **
L15 x T1 (Arka Abha x EC 521038)	-1.15	-1.28	-12.78 **	98.50 **	83.63 **	0.20
L15 x T2 (Arka Abha x Punjab Sartaj)	1.54	0.70	-9.54 **	20.63 **	14.20 **	-30.26 **
L15 x T3 (Arka Abha x DVRT-2)	12.01 **	2.84	8.66 **	20.28 **	-10.59	-51.21 **
L11 x T1 (IIVR BT-10 x EC 521038)	1.60	-5.32 *	-3.41	17.94 **	12.34 *	-42.42 **
L11 x T2 (IIVR BT-10 x Punjab Sartaj)	8.28 **	1.82	3.87	4.24	-4.13	-41.45 **
L11 x T3 (IIVR BT-10 x DVRT-2)	5.95 **	4.12	10.01 **	-4.37	-27.42 **	-62.79 **
L12 x T1 (EC 163605 x EC 521038)	-4.24	-7.39 **	-12.65 **	89.70 **	86.41 **	-10.42 **
L12 x T2 (EC 163605 x Punjab Sartaj)	1.76	-0.66	-6.31 *	34.27 **	19.97 **	-26.74 **
L12 x T3 (EC 163605 x DVRT-2)	0.76	-4.65	0.75	62.34 **	26.02 **	-39.44 **
L13 x T1 (Roma x EC 521038)	-2.71	-5.37	-11.79 **	-2.62	-21.91 **	-40.01 **
L13 x T2 (Roma x Punjab Sartaj)	8.20 **	6.23 *	-0.97	-39.67 **	-45.86 **	-58.41 **
L13 x T3 (Roma x DVRT-2)	5.36 *	-0.84	4.78	16.75 **	-21.45 **	-39.66 **
L14 x T1 (Kashi Chayan x EC 521038)	3.14	-8.87 **	4.67	36.46 **	36.36 **	-36.66 **
L14 x T2 (Kashi Chayan x Punjab Sartaj)	10.89 **	-1.19	13.50 **	42.82 **	25.73 **	-23.22 **
L14 x T3 (Kashi Chayan x DVRT-2)	5.02 *	0.81	15.79 **	51.52 **	19.06 **	-44.69 **
L15 x T1 (Arka Abha x EC 521038)	-1.15	-1.28	-12.78 **	98.50 **	83.63 **	0.20
L15 x T2 (Arka Abha x Punjab Sartaj)	1.54	0.70	-9.54 **	20.63 **	14.20 **	-30.26 **
L15 x T3 (Arka Abha x DVRT-2)	12.01 **	2.84	8.66 **	20.28 **	-10.59	-51.21 **

MPH- Mid Parent Heterosis, **BPH**- Better Parent Heterosis, **SH**- Standard Heterosis*Significance at **P=0.05**, ** Significance at **P=0.01**

Table 2: Heterosis for number of branches per plant and number of flowers per cluster

Hybrids	**Number of branches per plant**			**Number of flowers per cluster**		
	MPH	**MPH**	**SH**	**MPH**	**BPH**	**SH**
L1 x T1 (Pusa Ruby x EC 521038)	-42.55 **	-49.60 **	-43.30 **	-38.38 **	-43.19 **	9.55
L1 x T2 (Pusa Ruby x Punjab Sartaj)	-8.02	-18.03 **	-11.06	-35.31 **	-41.26 **	-4.41
L1 x T3 (Pusa Ruby x DVRT-2)	0.74	-16.34 *	-28.98 **	-8.07	-39.11 **	-0.90
L2 x T1 (Punjab Varkha Bahar-4 x EC 521038)	3.13	-15.94 **	-5.45	-24.23 **	-36.75 **	21.97 **
L2 x T2 (Punjab Varkha Bahar-4 x Punjab Sartaj)	11.82 *	-7.57	0.30	17.48 **	15.86 **	53.87 **
L2 x T3 (Punjab Varkha Bahar-4 x DVRT-2)	-9.77	-19.18 *	-42.71 **	80.64 **	27.29 **	64.38 **
L3 x T1 (Marglobe x EC 521038)	-12.61 *	-24.78 **	-15.39 *	-25.34 **	-43.52 **	8.92
L3 x T2 (Marglobe x Punjab Sartaj)	-6.25	-18.07 **	-11.10	14.47 **	-0.12	32.64 **
L3 x T3 (Marglobe x DVRT-2)	39.25 **	17.76 *	-4.44	60.70 **	23.28 **	21.97 **
L4 x T1 (CLN 2123 A1 Red x EC 521038)	4.54	-15.09 **	-4.49	-47.89 **	-58.71 **	-20.38 **
L4 x T2 (CLN 2123 A1 Red x Punjab Sartaj)	14.88 *	-5.38	2.67	-9.25 *	-16.11 **	11.41
L4 x T3 (CLN 2123 A1 Red x DVRT-2)	75.09 **	57.47 **	10.61	8.78	-20.10 **	-9.93
L5 x T1 (Palam Pink x EC 521038)	-37.26 **	-39.23 **	-27.07 **	-8.24 *	-33.97 **	27.34 **
L5 x T2 (Palam Pink x Punjab Sartaj)	-0.20	-4.98	14.03 *	-2.44	-20.11 **	6.10
L5 x T3 (Palam Pink x DVRT-2)	-5.21	-30.45 **	-16.53 **	42.20 **	15.47 *	-2.18
L6 x T1 (EC 249515 x EC 521038)	6.01	-13.59 *	-2.80	-6.52	-33.11 **	28.98 **
L6 x T2 (EC 249515 x Punjab Sartaj)	-33.95 **	-45.40 **	-40.75 **	-16.52 **	-32.14 **	-9.87
L6 x T3 (EC 249515 x DVRT-2)	9.91	-1.55	-30.21 **	55.97 **	27.59 **	6.05

L7 x T1 (IIHR 2042 x EC 521038)	0.80	-1.22	11.11	-26.33 **	-29.37 **	36.20 **
L7 x T2 (IIHR 2042 x Punjab Sartaj)	-0.25	-0.50	7.96	-31.52 **	-40.05 **	6.05
L7 x T3 (IIHR 2042 x DVRT-2)	-12.82 *	-33.76 **	-28.48 **	-16.84 **	-45.99 **	-4.46
L8 x T1 (Punjab Ratta x EC 521038)	-31.20 **	-39.99 **	-32.49 **	-44.73 **	-47.04 **	11.41
L8 x T2 (Punjab Ratta x Punjab Sartaj)	-35.09 **	-42.50 **	-37.60 **	-19.63 **	-34.45 **	37.90 **
L8 x T3 (Punjab Ratta x DVRT-2)	21.66 **	1.58	-14.93 *	-31.52 **	-57.15 **	-9.87
L9 x T1 (EC 163383 x EC 521038)	19.82 **	-1.46	10.84	-36.43 **	-41.29 **	13.22 *
L9 x T2 (EC 163383 x Punjab Sartaj)	3.00	-14.08 *	-6.77	-21.22 **	-28.59 **	16.67 **
L9 x T3 (EC 163383 x DVRT-2)	3.83	-7.92	-33.22 **	-31.37 **	-54.58 **	-25.80 **
L10 x T1 (EC 163611 x EC 521038)	-18.79 **	-35.04 **	-26.93 **	-23.96 **	-42.17 **	11.52
L10 x T2 (EC 163611 x Punjab Sartaj)	-0.16	-19.04 **	-12.15 *	-27.28 **	-36.13 **	-15.18 *
L10 x T3 (EC 163611 x DVRT-2)	-2.99	-11.16	-40.07 **	17.90 *	-10.04	-9.61
L11 x T1 (IIVR BT-10 x EC 521038)	-16.36 **	-28.47 **	-19.54 **	-22.38 **	-47.73 **	0.80
L11 x T2 (IIVR BT-10 x Punjab Sartaj)	7.77	-6.43	1.53	11.69 *	-16.03 **	11.52
L11 x T3 (IIVR BT-10 x DVRT-2)	-7.78	-21.52 **	-37.28 **	9.04	-2.38	-34.71 **
L12 x T1 (EC 163605 x EC 521038)	4.02	-4.14	7.83	-6.51	-25.74 **	43.21 **
L12 x T2 (EC 163605 x Punjab Sartaj)	-1.35	-7.57	0.30	-31.14 **	-36.13 **	-15.18 *
L12 x T3 (EC 163605 x DVRT-2)	-12.54	-30.40 **	-34.00 **	38.50 **	1.50	15.23 *
L13 x T1 (Roma x EC 521038)	19.45 **	-2.27	9.93	-12.00 **	-37.65 **	20.22 **
L13 x T2 (Roma x Punjab Sartaj)	-3.80	-20.18 **	-13.38 *	24.42 **	-0.12	32.64 **
L13 x T3 (Roma x DVRT-2)	10.61	-1.33	-29.39 **	47.99 **	22.65 **	-1.38
L14 x T1 (Kashi Chayan x EC 521038)	-7.70	-30.94 **	-22.32 **	-41.27 **	-50.48 **	-4.51
L14 x T2 (Kashi Chayan x Punjab Sartaj)	6.91	-19.04 **	-12.15 *	-23.93 **	-24.06 **	0.85
L14 x T3 (Kashi Chayan x DVRT-2)	31.54 **	31.22 **	-26.38 **	48.98 **	4.25	37.95 **
L15 x T1 (Arka Abha x EC 521038)	7.25	1.37	14.03 *	-3.56	-14.67 **	64.54 **
L15 x T2 (Arka Abha x Punjab Sartaj)	-21.53 **	-24.55 **	-18.13 **	-30.92 **	-34.55 **	-2.87
L15 x T3 (Arka Abha x DVRT-2)	-5.78	-26.50 **	-26.38 **	-5.06	-35.62 **	-4.46

MPH- Mid Parent Heterosis, **BPH**- Better Parent Heterosis, **SH**- Standard Heterosis*Significance at **P=0.05**, ** Significance at **P=0.01**

Table 3: Heterosis for number of fruits per truss and fruit set per cent

Hybrids	Number of fruits per truss			Fruit set per cent		
	MPH	BPH	SH	MPH	BPH	SH
L1 x T1 (Pusa Ruby x EC 521038)	-25.38 **	-35.45 **	-11.23 *	22.59 **	14.03 **	-18.39 **
L1 x T2 (Pusa Ruby x Punjab Sartaj)	-28.57 **	-29.58 **	-27.24 **	9.06	-2.26	-24.05 **
L1 x T3 (Pusa Ruby x DVRT-2)	-36.61 **	-51.69 **	-51.49 **	-39.23 **	-50.77 **	-51.11 **
L2 x T1 (Punjab Varkha Bahar-4 x EC 521038)	-19.85 **	-29.39 **	-2.90	4.28	-1.76	-20.47 **
L2 x T2 (Punjab Varkha Bahar-4 x Punjab Sartaj)	16.55 **	15.74 **	21.27 **	8.42 *	6.25	-13.99 **
L2 x T3 (Punjab Varkha Bahar-4 x DVRT-2)	43.61 **	7.87	13.02 **	-24.55 **	-31.52 **	-32.00 **
L3 x T1 (Marglobe x EC 521038)	-55.87 **	-61.55 **	-47.13 **	-44.53 **	-53.01 **	-51.56 **
L3 x T2 (Marglobe x Punjab Sartaj)	2.40	1.80	5.18	-12.54 **	-23.31 **	-20.94 **
L3 x T3 (Marglobe x DVRT-2)	-16.51 **	-36.74 **	-35.40 **	-47.86 **	-48.82 **	-47.24 **
L4 x T1 (CLN 2123 A1 Red x EC 521038)	-54.50 **	-58.85 **	-43.41 **	-16.62 **	-28.03 **	-29.09 **
L4 x T2 (CLN 2123 A1 Red x Punjab Sartaj)	-39.94 **	-42.08 **	-35.56 **	-34.42 **	-41.35 **	-42.22 **
L4 x T3 (CLN 2123 A1 Red x DVRT-2)	-31.03 **	-49.20 **	-43.49 **	-36.63 **	-36.88 **	-37.32 **
L5 x T1 (Palam Pink x EC 521038)	-9.33 *	-29.39 **	-2.90	-5.95	-15.72 **	-23.86 **
L5 x T2 (Palam Pink x Punjab Sartaj)	7.90	-6.03	-2.90	8.84 *	1.23	-8.55 *
L5 x T3 (Palam Pink x DVRT-2)	-52.72 **	-60.13 **	-69.44 **	-67.14 **	-68.63 **	-68.84 **
L6 x T1 (EC 249515 x EC 521038)	-39.74 **	-45.27 **	-24.73 **	-42.30 **	-55.84 **	-40.45 **
L6 x T2 (EC 249515 x Punjab Sartaj)	-70.08 **	-71.27 **	-67.74 **	-66.39 **	-73.51 **	-64.28 **
L6 x T3 (EC 249515 x DVRT-2)	-11.76 *	-35.21 **	-27.24 **	-40.58 **	-48.41 **	-30.43 **
L7 x T1 (IIHR 2042 x EC 521038)	-38.90 **	-41.27 **	-19.23 **	-15.02 **	-15.03 **	-39.19 **
L7 x T2 (IIHR 2042 x Punjab Sartaj)	-29.82 **	-36.33 **	-19.23 **	2.81	-1.27	-23.28 **
L7 x T3 (IIHR 2042 x DVRT-2)	-28.02 **	-49.08 **	-35.40 **	-21.30 **	-32.30 **	-32.77 **
L8 x T1 (Punjab Ratta x EC 521038)	-37.66 **	-40.74 **	-18.51 **	13.25 **	3.15	-26.17 **
L8 x T2 (Punjab Ratta x Punjab Sartaj)	-0.46	-8.74 *	13.11 **	20.56 **	5.90	-17.71 **
L8 x T3 (Punjab Ratta x DVRT-2)	18.96 **	-15.26 **	5.02	50.31 **	19.66 **	18.83 **

L9 x T1 (EC 163383 x EC 521038)	-10.01 *	-29.45 **	-2.98	43.39 **	19.47 **	-14.50 **
L9 x T2 (EC 163383 x Punjab Sartaj)	15.78 **	1.64	5.02	45.25 **	17.20 **	-8.93 *
L9 x T3 (EC 163383 x DVRT-2)	-50.53 **	-58.59 **	-67.66 **	-40.93 **	-56.28 **	-56.58 **
L10 x T1 (EC 163611 x EC 521038)	4.88	-17.87 **	12.94 **	40.75 **	35.46 **	4.82
L10 x T2 (EC 163611 x Punjab Sartaj)	-55.55 **	-61.03 **	-59.74 **	-37.48 **	-37.62 **	-51.52 **
L10 x T3 (EC 163611 x DVRT-2)	-18.95 **	-32.08 **	-47.13 **	-32.92 **	-40.32 **	-40.73 **
L11 x T1 (IIVR BT-10 x EC 521038)	-13.25 **	-29.39 **	-2.90	-2.86	-24.45 **	-2.66
L11 x T2 (IIVR BT-10 x Punjab Sartaj)	27.88 **	17.37 **	21.27 **	5.16	-15.71 **	8.60 *
L11 x T3 (IIVR BT-10 x DVRT-2)	-59.28 **	-67.23 **	-71.70 **	-61.02 **	-65.48 **	-55.53 **
L12 x T1 (EC 163605 x EC 521038)	-41.52 **	-43.74 **	-22.63 **	-41.16 **	-51.73 **	-46.08 **
L12 x T2 (EC 163605 x Punjab Sartaj)	-57.90 **	-61.83 **	-51.49 **	-37.81 **	-47.27 **	-41.10 **
L12 x T3 (EC 163605 x DVRT-2)	-41.61 **	-58.72 **	-47.53 **	-56.66 **	-59.06 **	-54.27 **
L13 x T1 (Roma x EC 521038)	34.38 **	5.82	45.53 **	42.32 **	23.06 **	20.76 **
L13 x T2 (Roma x Punjab Sartaj)	32.98 **	17.37 **	21.27 **	3.80	-7.01	-8.74 *
L13 x T3 (Roma x DVRT-2)	-19.82 **	-33.22 **	-47.21 **	-45.88 **	-46.20 **	-46.57 **
L14 x T1 (Kashi Chayan x EC 521038)	-47.68 **	-58.85 **	-43.41 **	-9.87	-17.52 **	-40.97 **
L14 x T2 (Kashi Chayan x Punjab Sartaj)	-2.62	-14.16 **	-11.31 *	28.22 **	13.14 **	-12.08 **
L14 x T3 (Kashi Chayan x DVRT-2)	10.82	-7.59	-27.16 **	-33.70 **	-47.01 **	-47.38 **
L15 x T1 (Arka Abha x EC 521038)	4.95	-0.24	37.20 **	6.86	-1.19	-16.73 **
L15 x T2 (Arka Abha x Punjab Sartaj)	-54.61 **	-58.38 **	-48.42 **	-34.43 **	-36.98 **	-46.90 **
L15 x T3 (Arka Abha x DVRT-2)	-17.58 **	-41.29 **	-27.24 **	-17.25 **	-23.52 **	-24.05 **

MPH- Mid Parent Heterosis, **BPH**- Better Parent Heterosis, **SH**- Standard Heterosis*Significance at **P=0.05**, ** Significance at **P=0.01**

Table 4: Heterosis for number of fruits per plant and number of truss per plant

Hybrids	Number of truss per plant			Number of fruits per plant		
	MPH	BPH	SH	MPH	BPH	SH
L1 x T1 (Pusa Ruby x EC 521038)	-20.26 **	-29.89 **	-11.51 **	19.01 **	2.06	42.05 **
L1 x T2 (Pusa Ruby x Punjab Sartaj)	11.00 **	0.71	18.34 **	-23.54 **	-33.62 **	-10.27 **
L1 x T3 (Pusa Ruby x DVRT-2)	-5.34	-8.44 *	-12.35 **	44.58 **	4.27	3.77
L2 x T1 (Punjab Varkha Bahar-4 x EC 521038)	0.69	-1.05	24.89 **	4.54 *	1.69	41.54 **
L2 x T2 (Punjab Varkha Bahar-4 x Punjab Sartaj)	0.59	-1.20	20.39 **	-25.20 **	-26.19 **	-0.23
L2 x T3 (Punjab Varkha Bahar-4 x DVRT-2)	11.21 **	-3.57	17.51 **	18.00 **	-21.26 **	3.62
L3 x T1 (Marglobe x EC 521038)	-8.50 **	-26.07 **	-6.69	4.37	-28.37 **	-0.30
L3 x T2 (Marglobe x Punjab Sartaj)	-5.40	-21.40 **	-7.64 *	3.29	-28.54 **	-3.41
L3 x T3 (Marglobe x DVRT-2)	10.51 **	3.28	-7.61 *	4.08	-3.79	-50.10 **
L4 x T1 (CLN 2123 A1 Red x EC 521038)	-5.50 *	-14.58 **	7.80 *	-0.55	-13.96 **	19.75 **
L4 x T2 (CLN 2123 A1 Red x Punjab Sartaj)	1.81	-4.94	11.70 **	-62.56 **	-67.21 **	-55.67 **
L4 x T3 (CLN 2123 A1 Red x DVRT-2)	31.26 **	23.23 **	25.61 **	-29.74 **	-49.65 **	-48.83 **
L5 x T1 (Palam Pink x EC 521038)	-3.79	-18.39 **	3.00	10.97 **	-26.98 **	1.63
L5 x T2 (Palam Pink x Punjab Sartaj)	4.05	-9.05 **	6.87 *	-15.18 **	-43.79 **	-24.02 **
L5 x T3 (Palam Pink x DVRT-2)	5.25	4.34	-6.66	-9.26	-9.30	-60.07 **
L6 x T1 (EC 249515 x EC 521038)	11.07 **	0.86	27.29 **	-3.09	-12.72 **	21.48 **
L6 x T2 (EC 249515 x Punjab Sartaj)	-2.19	-8.23 **	7.84 *	-72.83 **	-75.21 **	-66.49 **
L6 x T3 (EC 249515 x DVRT-2)	19.58 **	11.72 **	15.07 **	54.09 **	7.46 **	19.85 **
L7 x T1 (IIHR 2042 x EC 521038)	6.87 **	-3.45	21.86 **	-13.55 **	-27.11 **	1.45
L7 x T2 (IIHR 2042 x Punjab Sartaj)	2.16	-4.65	12.04 **	-54.69 **	-61.34 **	-47.74 **
L7 x T3 (IIHR 2042 x DVRT-2)	49.54 **	40.46 **	43.04 **	-23.98 **	-44.47 **	-46.96 **
L8 x T1 (Punjab Ratta x EC 521038)	-15.26 **	-30.34 **	-12.09 **	5.79 *	-22.09 **	8.44 **
L8 x T2 (Punjab Ratta x Punjab Sartaj)	61.52 **	36.62 **	60.54 **	39.01 **	3.35	39.70 **
L8 x T3 (Punjab Ratta x DVRT-2)	31.43 **	25.42 **	12.20 **	37.68 **	14.89 **	-24.38 **
L9 x T1 (EC 163383 x EC 521038)	10.13 **	2.75	29.68 **	-7.20 **	-21.69 **	8.99 **
L9 x T2 (EC 163383 x Punjab Sartaj)	-39.09 **	-41.22 **	-30.93 **	-50.72 **	-57.92 **	-43.11 **
L9 x T3 (EC 163383 x DVRT-2)	18.65 **	7.89 *	17.91 **	-8.53 *	-33.23 **	-36.09 **
L10 x T1 (EC 163611 x EC 521038)	27.56 **	23.36 **	55.69 **	-4.56 *	-12.72 **	21.48 **
L10 x T2 (EC 163611 x Punjab Sartaj)	-17.01 **	-17.15 **	-2.32	-70.51 **	-72.67 **	-63.05 **
L10 x T3 (EC 163611 x DVRT-2)	-14.65 **	-24.94 **	-11.51 **	0.36	-30.67 **	-20.01 **
L11 x T1 (IIVR BT-10 x EC 521038)	29.21 **	14.41 **	44.39 **	-8.66 **	-17.10 **	15.38 **

L11 x T2 (IIVR BT-10 x Punjab Sartaj)	28.69 **	17.63 **	38.22 **	-16.77 **	-23.46 **	3.47
L11 x T3 (IIVR BT-10 x DVRT-2)	-4.09	-7.95 *	-10.44 **	-20.26 **	-44.66 **	-37.21 **
L12 x T1 (EC 163605 x EC 521038)	5.18	-14.97 **	7.32 *	-7.32 **	-31.12 **	-4.13
L12 x T2 (EC 163605 x Punjab Sartaj)	-1.60	-18.20 **	-3.88	-40.64 **	-55.45 **	-39.79 **
L12 x T3 (EC 163605 x DVRT-2)	6.28	-0.61	-11.09 **	21.79 **	0.49	-31.96 **
L13 x T1 (Roma x EC 521038)	16.89 **	0.77	27.18 **	16.52 **	-18.34 **	13.66 **
L13 x T2 (Roma x Punjab Sartaj)	7.10 *	-4.80	11.87 **	-11.99 **	-37.80 **	-15.92 **
L13 x T3 (Roma x DVRT-2)	3.67	2.57	-6.25	32.91 **	18.80 **	-33.60 **
L14 x T1 (Kashi Chayan x EC 521038)	-16.81 **	-34.47 **	-17.29 **	23.16 **	-24.27 **	5.40
L14 x T2 (Kashi Chayan x Punjab Sartaj)	12.43 **	-9.04 **	6.88 *	-13.50 **	-46.52 **	-27.71 **
L14 x T3 (Kashi Chayan x DVRT-2)	21.30 **	9.89 *	-1.69	-4.62	-17.67 **	-63.75 **
L15 x T1 (Arka Abha x EC 521038)	17.79 **	0.82	27.24 **	15.10 **	-12.81 **	21.35 **
L15 x T2 (Arka Abha x Punjab Sartaj)	-21.60 **	-30.82 **	-18.71 **	-16.86 **	-36.39 **	-14.01 **
L15 x T3 (Arka Abha x DVRT-2)	20.64 **	20.38 **	8.16 *	4.07	-16.01 **	-39.80 **

MPH- Mid Parent Heterosis, **BPH**- Better Parent Heterosis, **SH**- Standard Heterosis*Significance at **P=0.05**, ** Significance at **P=0.01**

Table 5: Heterosis for average fruit weight and fruit yield per plant

Hybrids	Average fruit weight (g)			Fruit polar diameter (cm)		
	MPH	MPH	SH	MPH	BPH	SH
L1 x T1 (Pusa Ruby x EC 521038)	-23.14 **	-40.03 **	-41.69 **	-11.90 **	-23.84 **	-26.95 **
L1 x T2 (Pusa Ruby x Punjab Sartaj)	32.59 **	16.74 **	-36.36 **	16.41 **	0.42	-29.79 **
L1 x T3 (Pusa Ruby x DVRT-2)	-53.00 **	-67.26 **	-54.62 **	-41.15 **	-51.17 **	-48.23 **
L2 x T1 (Punjab Varkha Bahar-4 x EC 521038)	-10.40 *	-39.87 **	-41.53 **	-0.64	-24.15 **	-27.25 **
L2 x T2 (Punjab Varkha Bahar-4 x Punjab Sartaj)	4.14	-6.15	-61.08 **	-4.02	-4.20	-51.42 **
L2 x T3 (Punjab Varkha Bahar-4 x DVRT-2)	-50.91 **	-69.56 **	-57.81 **	-34.46 **	-51.62 **	-48.70 **
L3 x T1 (Marglobe x EC 521038)	-53.33 **	-56.45 **	-57.65 **	-40.09 **	-42.64 **	-44.98 **
L3 x T2 (Marglobe x Punjab Sartaj)	-34.01 **	-50.76 **	-58.52 **	-24.97 **	-40.81 **	-48.05 **
L3 x T3 (Marglobe x DVRT-2)	-66.55 **	-73.11 **	-62.72 **	-48.76 **	-53.18 **	-50.35 **
L4 x T1 (CLN 2123 A1 Red x EC 521038)	-15.22 **	-32.70 **	-34.56 **	-15.16 **	-26.37 **	-29.37 **
L4 x T2 (CLN 2123 A1 Red x Punjab Sartaj)	-7.77	-20.41 **	-54.52 **	-12.96 *	-25.21 **	-47.22 **
L4 x T3 (CLN 2123 A1 Red x DVRT-2)	-9.05 **	-35.78 **	-10.97 **	-6.76	-22.35 **	-17.67 **
L5 x T1 (Palam Pink x EC 521038)	-54.14 **	-61.79 **	-62.85 **	-41.05 **	-48.18 **	-50.30 **
L5 x T2 (Palam Pink x Punjab Sartaj)	16.39 **	-4.54	-38.17 **	18.67 **	0.72	-26.77 **
L5 x T3 (Palam Pink x DVRT-2)	-62.49 **	-72.48 **	-61.85 **	-46.03 **	-54.52 **	-51.77 **
L6 x T1 (EC 249515 x EC 521038)	-34.32 **	-54.98 **	-56.23 **	-29.04 **	-46.03 **	-48.23 **
L6 x T2 (EC 249515 x Punjab Sartaj)	34.17 **	25.39 **	-47.99 **	44.37 **	43.36 **	-27.30 **
L6 x T3 (EC 249515 x DVRT-2)	-59.08 **	-74.22 **	-64.26 **	-37.95 **	-54.35 **	-51.60 **
L7 x T1 (IIHR 2042 x EC 521038)	-62.61 **	-63.29 **	-64.31 **	-48.18 **	-48.61 **	-50.71 **
L7 x T2 (IIHR 2042 x Punjab Sartaj)	-40.30 **	-56.93 **	-59.65 **	-30.81 **	-46.80 **	-49.82 **
L7 x T3 (IIHR 2042 x DVRT-2)	-51.03 **	-58.97 **	-43.12 **	-27.43 **	-31.43 **	-27.30 **
L8 x T1 (Punjab Ratta x EC 521038)	2.01	-3.34	-6.02	-0.68	-5.73	-9.57 *
L8 x T2 (Punjab Ratta x Punjab Sartaj)	-4.23	-29.29 **	-38.46 **	7.50	-14.62 **	-26.42 **
L8 x T3 (Punjab Ratta x DVRT-2)	-64.07 **	-70.76 **	-59.46 **	-47.23 **	-52.17 **	-49.29 **
L9 x T1 (EC 163383 x EC 521038)	44.95 **	6.48	3.53	37.01 **	5.73	1.42
L9 x T2 (EC 163383 x Punjab Sartaj)	49.02 **	42.24 **	-35.10 **	43.11 **	41.17 **	-26.42 **
L9 x T3 (EC 163383 x DVRT-2)	-56.84 **	-71.32 **	-60.24 **	-37.67 **	-53.51 **	-50.71 **
L10 x T1 (EC 163611 x EC 521038)	-29.35 **	-52.94 **	-54.24 **	-26.85 **	-45.85 **	-48.06 **
L10 x T2 (EC 163611 x Punjab Sartaj)	1.49	-9.74	-62.56 **	1.83	-2.80	-50.71 **
L10 x T3 (EC 163611 x DVRT-2)	-60.12 **	-75.42 **	-65.92 **	-36.37 **	-54.35 **	-51.60 **
L11 x T1 (IIVR BT-10 x EC 521038)	-53.04 **	-63.22 **	-64.24 **	-42.58 **	-50.28 **	-52.30 **
L11 x T2 (IIVR BT-10 x Punjab Sartaj)	-2.31	-14.37 *	-52.84 **	-14.27 **	-26.18 **	-48.17 **
L11 x T3 (IIVR BT-10 x DVRT-2)	-63.15 **	-74.25 **	-64.31 **	-42.05 **	-51.84 **	-48.94 **
L12 x T1 (EC 163605 x EC 521038)	-34.63 **	-36.91 **	-38.66 **	-26.73 **	-28.84 **	-31.74 **
L12 x T2 (EC 163605 x Punjab Sartaj)	-39.15 **	-55.62 **	-59.86 **	-25.12 **	-41.56 **	-47.16 **
L12 x T3 (EC 163605 x DVRT-2)	-67.32 **	-73.00 **	-62.57 **	-46.93 **	-50.84 **	-47.87 **
L13 x T1 (Roma x EC 521038)	17.89 **	11.10 **	8.02 *	3.45	-0.85	3.72
L13 x T2 (Roma x Punjab Sartaj)	-26.02 **	-45.17 **	-52.84 **	-32.72 **	-50.06 **	-47.75 **

L13 x T3 (Roma x DVRT-2)	-63.91 **	-70.76 **	-59.46 **	-50.17 **	-50.50 **	-47.52 **
L14 x T1 (Kashi Chayan x EC 521038)	-52.77 **	-59.50 **	-44.92 **	-22.13 **	-24.21 **	-27.30 **
L14 x T2 (Kashi Chayan x Punjab Sartaj)	-38.11 **	-59.62 **	-45.08 **	-1.25	-23.05 **	-30.14 **
L14 x T3 (Kashi Chayan x DVRT-2)	-60.95 **	-61.32 **	-46.38 **	-30.03 **	-35.06 **	-31.15 **
L15 x T1 (Arka Abha x EC 521038)	3.83	-0.15	5.14	6.37	4.20	4.20
L15 x T2 (Arka Abha x Punjab Sartaj)	-14.44 **	-40.37 **	-37.20 **	-7.06	-29.96 **	-29.96 **
L15 x T3 (Arka Abha x DVRT-2)	-66.66 **	-70.66 **	-59.33 **	-49.23 **	-50.67 **	-47.70 **

MPH- Mid Parent Heterosis, **BPH-** Better Parent Heterosis, **SH-** Standard Heterosis*Significance at **P=0.05, **** Significance at **P=0.01**

Table 6: Heterosis for fruit polar diameter and fruit equatorial diameter

Hybrids	Fruit equatorial diameter (mm)			Fruit shape index		
	MPH	**BPH**	**SH**	**MPH**	**BPH**	**SH**
L1 x T1 (Pusa Ruby x EC 521038)	-14.68 **	-26.30 **	-24.62 **	4.16	3.99	-1.57
L1 x T2 (Pusa Ruby x Punjab Sartaj)	18.41 **	2.29	-23.86 **	-1.16	-1.33	-6.60
L1 x T3 (Pusa Ruby x DVRT-2)	-43.19 **	-53.44 **	-45.77 **	3.38	1.66	-3.77
L2 x T1 (Punjab Varkha Bahar-4 x EC 521038)	-0.36	-24.26 **	-22.54 **	-0.50	-0.99	-5.66
L2 x T2 (Punjab Varkha Bahar-4 x Punjab Sartaj)	-0.16	-1.05	-46.40 **	-3.48	-3.96	-8.49
L2 x T3 (Punjab Varkha Bahar-4 x DVRT-2)	-34.82 **	-52.52 **	-44.70 **	0.00	-1.98	-6.60
L3 x T1 (Marglobe x EC 521038)	-42.16 **	-45.37 **	-44.13 **	3.78	2.27	-0.63
L3 x T2 (Marglobe x Punjab Sartaj)	-24.80 **	-40.00 **	-45.45 **	0.82	-0.65	-3.46
L3 x T3 (Marglobe x DVRT-2)	-48.80 **	-54.42 **	-46.91 **	0.33	-2.59	-5.35
L4 x T1 (CLN 2123 A1 Red x EC 521038)	-9.76 *	-28.15 **	-26.52 **	-8.04	-16.94 **	-2.83
L4 x T2 (CLN 2123 A1 Red x Punjab Sartaj)	1.66	-3.73	-41.67 **	-13.39 **	-21.77 **	-8.49
L4 x T3 (CLN 2123 A1 Red x DVRT-2)	9.53 *	-16.75 **	-3.03	-17.35 **	-26.34 **	-13.84 *
L5 x T1 (Palam Pink x EC 521038)	-37.50 **	-49.07 **	-47.92 **	-7.69	-15.70 **	-3.77
L5 x T2 (Palam Pink x Punjab Sartaj)	26.62 **	16.57 **	-24.94 **	-5.88	-14.05 **	-1.89
L5 x T3 (Palam Pink x DVRT-2)	-43.25 **	-55.93 **	-48.67 **	-8.26	-17.36 **	-5.66
L6 x T1 (EC 249515 x EC 521038)	-28.56 **	-45.56 **	-44.32 **	-0.68	-0.70	-6.29
L6 x T2 (EC 249515 x Punjab Sartaj)	39.15 **	38.43 **	-25.02 **	4.02	4.00	-1.86
L6 x T3 (EC 249515 x DVRT-2)	-37.19 **	-54.14 **	-46.58 **	-1.54	-3.03	-8.49
L7 x T1 (IIHR 2042 x EC 521038)	-47.80 **	-48.04 **	-46.37 **	-0.99	-2.00	-7.55
L7 x T2 (IIHR 2042 x Punjab Sartaj)	-29.23 **	-46.05 **	-44.31 **	-3.01	-4.00	-9.43
L7 x T3 (IIHR 2042 x DVRT-2)	-30.00 **	-33.98 **	-23.11 **	3.61	3.10	-4.72
L8 x T1 (Punjab Ratta x EC 521038)	-3.20	-8.31 *	-6.22	2.49	1.98	-2.83
L8 x T2 (Punjab Ratta x Punjab Sartaj)	0.40	-20.08 **	-26.89 **	7.46	6.93	1.89
L8 x T3 (Punjab Ratta x DVRT-2)	-48.79 **	-54.28 **	-46.75 **	3.03	0.99	-3.77
L9 x T1 (EC 163383 x EC 521038)	36.21 **	5.19	7.58 *	1.00	1.00	-4.72
L9 x T2 (EC 163383 x Punjab Sartaj)	33.82 **	32.00 **	-26.50 **	7.00	7.00	0.94
L9 x T3 (EC 163383 x DVRT-2)	-38.83 **	-54.79 **	-47.34 **	1.52	0.00	-5.66
L10 x T1 (EC 163611 x EC 521038)	-27.27 **	-46.12 **	-44.90 **	1.02	1.00	-4.69
L10 x T2 (EC 163611 x Punjab Sartaj)	4.09	-0.64	-46.18 **	-2.02	-2.03	-7.55
L10 x T3 (EC 163611 x DVRT-2)	-35.98 **	-54.46 **	-46.96 **	-0.52	-2.03	-7.55
L11 x T1 (IIVR BT-10 x EC 521038)	-35.48 **	-49.81 **	-48.67 **	-14.64 **	-24.98 **	-6.60
L11 x T2 (IIVR BT-10 x Punjab Sartaj)	-1.71	-4.00	-45.45 **	-12.92 **	-23.47 **	-4.72
L11 x T3 (IIVR BT-10 x DVRT-2)	-38.36 **	-54.15 **	-46.59 **	-10.90 *	-22.71 **	-3.77
L12 x T1 (EC 163605 x EC 521038)	-26.93 **	-28.89 **	-27.27 **	-0.02	-0.03	-5.66
L12 x T2 (EC 163605 x Punjab Sartaj)	-22.12 **	-39.27 **	-41.22 **	-4.02	-4.03	-9.43
L12 x T3 (EC 163605 x DVRT-2)	-48.67 **	-53.01 **	-45.27 **	3.54	1.97	-3.77
L13 x T1 (Roma x EC 521038)	9.97 **	7.22	9.66 *	-6.05	-12.17 *	-4.72
L13 x T2 (Roma x Punjab Sartaj)	-25.41 **	-41.91 **	-43.56 **	-7.91	-13.91 **	-6.60
L13 x T3 (Roma x DVRT-2)	-47.52 **	-51.87 **	-43.94 **	-5.66	-13.04 *	-5.66
L14 x T1 (Kashi Chayan x EC 521038)	-31.30 **	-35.25 **	-25.19 **	13.04 *	4.00	-1.89
L14 x T2 (Kashi Chayan x Punjab Sartaj)	-12.05 **	-35.41 **	-25.38 **	8.70	0.00	-5.66
L14 x T3 (Kashi Chayan x DVRT-2)	-36.82 **	-37.07 **	-26.70 **	10.50	3.09	-5.66
L15 x T1 (Arka Abha x EC 521038)	3.72	0.06	10.10 **	2.56	1.00	-4.72
L15 x T2 (Arka Abha x Punjab Sartaj)	-3.11	-27.71 **	-20.45 **	-4.55	-6.00	-11.32
L15 x T3 (Arka Abha x DVRT-2)	-50.67 **	-52.03 **	-44.13 **	3.11	3.09	-5.66

MPH- Mid Parent Heterosis, **BPH**- Better Parent Heterosis, **SH**- Standard Heterosis*Significance at **P=0.05**, ** Significance at **P=0.01**

Table 7: Heterosis for fruit shape index and fruit pericarp thickness

Hybrids	Fruit yield per plant			Fruit pericarp thickness (mm)		
	MPH	**BPH**	**SH**	**MPH**	**BPH**	**SH**
L1 x T1 (Pusa Ruby x EC 521038)	5.16	-19.82 **	-17.25 **	-52.69 **	-52.76 **	-68.10 **
L1 x T2 (Pusa Ruby x Punjab Sartaj)	3.62	2.13	-43.04 **	-70.83 **	-74.30 **	-77.23 **
L1 x T3 (Pusa Ruby x DVRT-2)	-18.10 **	-22.62 **	-52.88 **	-34.33 **	-45.83 **	-43.70 **
L2 x T1 (Punjab Varkha Bahar-4 x EC 521038)	22.45 **	-19.76 **	-17.19 **	61.99 **	52.04 **	2.36
L2 x T2 (Punjab Varkha Bahar-4 x Punjab Sartaj)	-11.68	-30.46 **	-61.22 **	-73.32 **	-77.77 **	-80.31 **
L2 x T3 (Punjab Varkha Bahar-4 x DVRT-2)	-6.20	-28.41 **	-56.41 **	-22.62 **	-39.33 **	-36.94 **
L3 x T1 (Marglobe x EC 521038)	-42.36 **	-59.01 **	-57.69 **	-66.29 **	-67.57 **	-76.38 **
L3 x T2 (Marglobe x Punjab Sartaj)	-19.35 **	-28.16 **	-59.94 **	-46.59 **	-51.33 **	-56.89 **
L3 x T3 (Marglobe x DVRT-2)	-64.41 **	-69.47 **	-81.41 **	-55.39 **	-62.06 **	-60.57 **
L4 x T1 (CLN 2123 A1 Red x EC 521038)	-3.77	-24.53 **	-22.12 **	-69.93 **	-75.14 **	-74.40 **
L4 x T2 (CLN 2123 A1 Red x Punjab Sartaj)	-64.69 **	-65.56 **	-79.80 **	-56.84 **	-59.85 **	-58.67 **
L4 x T3 (CLN 2123 A1 Red x DVRT-2)	-23.86 **	-25.25 **	-54.49 **	-29.58 **	-29.92 **	-27.16 **
L5 x T1 (Palam Pink x EC 521038)	-42.44 **	-63.35 **	-62.18 **	-42.27 **	-45.76 **	-58.46 **
L5 x T2 (Palam Pink x Punjab Sartaj)	12.24	-15.50 **	-52.87 **	-47.95 **	-51.48 **	-57.02 **
L5 x T3 (Palam Pink x DVRT-2)	-65.46 **	-74.73 **	-84.62 **	-42.78 **	-50.32 **	-48.36 **
L6 x T1 (EC 249515 x EC 521038)	-25.58 **	-48.34 **	-46.69 **	-69.81 **	-71.57 **	-78.34 **
L6 x T2 (EC 249515 x Punjab Sartaj)	-66.53 **	-71.25 **	-83.96 **	-16.37 **	-22.22 **	-31.10 **
L6 x T3 (EC 249515 x DVRT-2)	-14.83 **	-29.39 **	-57.01 **	-54.10 **	-60.23 **	-58.66 **
L7 x T1 (IIHR 2042 x EC 521038)	-62.39 **	-64.91 **	-63.78 **	-77.38 **	-81.55 **	-80.31 **
L7 x T2 (IIHR 2042 x Punjab Sartaj)	-70.86 **	-76.34 **	-78.85 **	-76.21 **	-78.23 **	-76.77 **
L7 x T3 (IIHR 2042 x DVRT-2)	-59.91 **	-66.30 **	-69.87 **	-45.61 **	-46.31 **	-42.72 **
L8 x T1 (Punjab Ratta x EC 521038)	27.21 **	-1.23	1.93	14.99 **	8.17 **	-17.38 **
L8 x T2 (Punjab Ratta x Punjab Sartaj)	52.25 **	50.54 **	-14.11 **	-4.46 **	-11.04 **	-21.20 **
L8 x T3 (Punjab Ratta x DVRT-2)	-47.82 **	-49.46 **	-69.23 **	-51.32 **	-57.77 **	-56.11 **
L9 x T1 (EC 163383 x EC 521038)	53.71 **	9.32 **	12.82 **	19.94 **	16.94 **	-17.13 **
L9 x T2 (EC 163383 x Punjab Sartaj)	-25.81 **	-33.91 **	-63.14 **	-30.86 **	-37.78 **	-44.88 **
L9 x T3 (EC 163383 x DVRT-2)	-51.32 **	-58.24 **	-74.57 **	0.00	-15.91 **	-12.60 **
L10 x T1 (EC 163611 x EC 521038)	-19.90 **	-46.27 **	-44.55 **	-56.71 **	-67.85 **	-78.35 **
L10 x T2 (EC 163611 x Punjab Sartaj)	-69.71 **	-75.29 **	-86.22 **	-63.64 **	-75.11 **	-77.95 **
L10 x T3 (EC 163611 x DVRT-2)	-43.32 **	-55.26 **	-72.76 **	-19.03 **	-46.79 **	-44.69 **
L11 x T1 (IIVR BT-10 x EC 521038)	-50.00 **	-59.94 **	-58.65 **	-63.06 **	-65.00 **	-76.44 **
L11 x T2 (IIVR BT-10 x Punjab Sartaj)	-17.37 **	-21.63 **	-51.27 **	-43.64 **	-52.66 **	-58.06 **
L11 x T3 (IIVR BT-10 x DVRT-2)	-63.52 **	-63.90 **	-77.55 **	-49.24 **	-59.91 **	-58.33 **
L12 x T1 (EC 163605 x EC 521038)	-28.66 **	-43.17 **	-41.35 **	36.19 **	29.81 **	-12.60 **
L12 x T2 (EC 163605 x Punjab Sartaj)	-58.91 **	-60.74 **	-75.96 **	17.02 **	-1.19	-12.47 **
L12 x T3 (EC 163605 x DVRT-2)	-58.53 **	-58.65 **	-74.68 **	-30.54 **	-44.88 **	-42.71 **
L13 x T1 (Roma x EC 521038)	62.65 **	18.95 **	22.77 **	-50.82 **	-58.98 **	-58.66 **
L13 x T2 (Roma x Punjab Sartaj)	-23.24 **	-28.75 **	-60.27 **	-73.81 **	-75.40 **	-75.20 **
L13 x T3 (Roma x DVRT-2)	-50.44 **	-55.78 **	-73.08 **	-28.84 **	-29.92 **	-27.16 **
L14 x T1 (Kashi Chayan x EC 521038)	-20.80 **	-43.80 **	-42.00 **	-22.70 **	-28.14 **	-43.70 **
L14 x T2 (Kashi Chayan x Punjab Sartaj)	-19.74 **	-28.74 **	-60.26 **	-38.21 **	-41.78 **	-48.43 **
L14 x T3 (Kashi Chayan x DVRT-2)	-62.48 **	-67.91 **	-80.46 **	-39.31 **	-46.78 **	-44.69 **
L15 x T1 (Arka Abha x EC 521038)	42.54 **	23.29 **	27.24 **	-44.54 **	-51.74 **	-56.11 **
L15 x T2 (Arka Abha x Punjab Sartaj)	-17.84 **	-28.51 **	-46.14 **	-53.51 **	-54.11 **	-58.27 **
L15 x T3 (Arka Abha x DVRT-2)	-26.12 **	-33.20 **	-49.68 **	-45.65 **	-49.05 **	-47.04 **

MPH- Mid Parent Heterosis, **BPH**- Better Parent Heterosis, **SH**- Standard Heterosis*Significance at **P=0.05**, ** Significance at **P=0.01**

Table 8: Heterosis for total soluble solids and lycopene content

Hybrids	Total soluble solids (ºB)			Lycopene content (mg/100g)		
	MPH	**BPH**	**SH**	**MPH**	**BPH**	**SH**
L1 x T1 (Pusa Ruby x EC 521038)	65.60 **	44.37 **	14.83 **	2.33	-42.03 **	17.19 **
L1 x T2 (Pusa Ruby x Punjab Sartaj)	-11.89 **	-30.39 **	-29.02 **	-33.64 **	-63.29 **	-25.79 **
L1 x T3 (Pusa Ruby x DVRT-2)	-16.53 **	-31.96 **	-36.16 **	-46.43 **	-68.09 **	-35.48 **
L2 x T1 (Punjab Varkha Bahar-4 x EC 521038)	17.45 **	8.47 **	-13.72 **	74.73 **	1.27	70.97 **

L2 x T2 (Punjab Varkha Bahar-4 x Punjab Sartaj)	18.27 **	-1.80	0.14	23.16 **	-30.57 **	17.20 **
L2 x T3 (Punjab Varkha Bahar-4 x DVRT-2)	9.57 **	-5.87 **	-11.69 **	34.72 **	-17.19 **	39.80 **
L3 x T1 (Marglobe x EC 521038)	-18.59 **	-25.90 **	-41.06 **	68.39 **	14.26 *	-14.00 **
L3 x T2 (Marglobe x Punjab Sartaj)	-18.94 **	-33.53 **	-32.22 **	93.33 **	24.29 **	-6.45
L3 x T3 (Marglobe x DVRT-2)	-17.86 **	-30.36 **	-34.67 **	62.55 **	23.10 **	-7.35
L4 x T1 (CLN 2123 A1 Red x EC 521038)	-21.00 **	-23.91 **	-34.67 **	-37.02 **	-63.74 **	-35.66 **
L4 x T2 (CLN 2123 A1 Red x Punjab Sartaj)	-13.50 **	-20.33 **	-18.76 **	77.30 **	-0.61	76.34 **
L4 x T3 (CLN 2123 A1 Red x DVRT-2)	13.13 **	8.33 **	1.64	54.88 **	-5.66 *	67.38 **
L5 x T1 (Palam Pink x EC 521038)	-28.34 **	-32.27 **	-39.49 **	40.30 **	-13.76 **	1.08
L5 x T2 (Palam Pink x Punjab Sartaj)	-10.87 **	-16.40 **	-14.75 **	66.41 **	-1.53	15.41 **
L5 x T3 (Palam Pink x DVRT-2)	-11.43 **	-13.55 **	-18.89 **	-38.63 **	-59.17 **	-52.15 **
L6 x T1 (EC 249515 x EC 521038)	-30.18 **	-32.12 **	-42.82 **	15.05	-8.00	-75.27 **
L6 x T2 (EC 249515 x Punjab Sartaj)	-7.19 **	-15.27 **	-13.59 **	-31.40	-40.00	-87.10 **
L6 x T3 (EC 249515 x DVRT-2)	-4.09 *	-8.99 **	-14.61 **	-37.25 *	-55.58 **	-82.80 **
L7 x T1 (IIHR 2042 x EC 521038)	-20.61 **	-34.06 **	-20.66 **	89.74 **	48.00 **	-60.22 **
L7 x T2 (IIHR 2042 x Punjab Sartaj)	-47.09 **	-51.13 **	-41.19 **	11.76	-5.00	-79.57 **
L7 x T3 (IIHR 2042 x DVRT-2)	-2.22	-12.99 **	4.70 *	83.94 **	27.72 *	-50.54 **
L8 x T1 (Punjab Ratta x EC 521038)	-14.58 **	-30.85 **	-11.14 **	45.24 *	22.00	-67.20 **
L8 x T2 (Punjab Ratta x Punjab Sartaj)	-39.82 **	-46.03 **	-30.65 **	91.89 **	77.50 **	-61.83 **
L8 x T3 (Punjab Ratta x DVRT-2)	-59.02 **	-64.55 **	-54.45 **	54.67 **	13.84	-55.91 **
L9 x T1 (EC 163383 x EC 521038)	15.00 **	7.33 **	-1.49	27.57 *	0.04	-52.69 **
L9 x T2 (EC 163383 x Punjab Sartaj)	-51.58 **	-54.00 **	-53.09 **	-20.29	-42.02 **	-72.58 **
L9 x T3 (EC 163383 x DVRT-2)	-14.29 **	-15.22 **	-20.46 **	4.17	-5.27	-55.20 **
L10 x T1 (EC 163611 x EC 521038)	21.16 **	7.18 **	-14.75 **	11.99	-5.14	-63.26 **
L10 x T2 (EC 163611 x Punjab Sartaj)	28.25 **	2.60	4.63 *	30.32 *	1.34	-60.75 **
L10 x T3 (EC 163611 x DVRT-2)	-4.56 *	-21.16 **	-26.03 **	-15.32	-15.32	-67.20 **
L11 x T1 (IIVR BT-10 x EC 521038)	-18.57 **	-19.58 **	-34.39 **	61.72 **	27.87 **	-40.88 **
L11 x T2 (IIVR BT-10 x Punjab Sartaj)	-4.22 *	-13.80 **	-12.09 **	44.50 **	5.85	-51.06 **
L11 x T3 (IIVR BT-10 x DVRT-2)	5.12 **	-1.74	-7.81 **	67.05 **	53.49 **	-29.03 **
L12 x T1 (EC 163605 x EC 521038)	1.39	0.09	-20.39 **	21.35	5.97	-61.85 **
L12 x T2 (EC 163605 x Punjab Sartaj)	-4.62 *	-16.07 **	-14.41 **	-10.25	-28.32 *	-74.19 **
L12 x T3 (EC 163605 x DVRT-2)	22.15 **	11.52 **	4.63 *	32.33 **	27.67 *	-50.56 **
L13 x T1 (Roma x EC 521038)	12.98 **	7.19 **	-14.74 **	-56.77 **	-67.36 **	-82.80 **
L13 x T2 (Roma x Punjab Sartaj)	-24.71 **	-36.00 **	-34.73 **	20.26	-15.33	-55.38 **
L13 x T3 (Roma x DVRT-2)	22.88 **	8.19 **	1.50	30.54 **	13.23	-40.32 **
L14 x T1 (Kashi Chayan x EC 521038)	-4.04	-19.66 **	-36.09 **	50.00 **	9.09	-35.48 **
L14 x T2 (Kashi Chayan x Punjab Sartaj)	4.23 *	-20.47 **	-18.89 **	18.67	-19.09 *	-52.15 **
L14 x T3 (Kashi Chayan x DVRT-2)	0.41	-21.09 **	-25.96 **	-32.98 **	-44.55 **	-67.20 **
L15 x T1 (Arka Abha x EC 521038)	-5.40 **	-15.81 **	-14.13 **	1.79	-36.98 **	-28.85 **
L15 x T2 (Arka Abha x Punjab Sartaj)	-9.60 **	-9.61 **	-7.81 **	-66.40 **	-80.00 **	-77.42 **
L15 x T3 (Arka Abha x DVRT-2)	-24.31 **	-27.34 **	-25.90 **	-51.07 **	-67.14 **	-62.90 **

MPH- Mid Parent Heterosis**, BPH-** Better Parent Heterosis**, SH-** Standard Heterosis*****Significance at **P=0.05, **** Significance at **P=0.01**

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