Plant Archives Vol. 25, Supplement 1, 2025 pp.1910-1917 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-1.262

ASSESSMENT OF HETEROSIS AND COMBINING ABILITY FOR YIELD AND YIELD CONTRIBUTING TRAITS IN TOMATO GENOTYPES UNDER MID-HILL CONDITIONS

Sheetal Rana[1*], Satish Chandra Pant[1], Avantika Devrani[1], Imamuddin Shah[2] and Priyanka Panwar[2]

[1]Department of Vegetable Science, College of Horticulture, VCSG UUHF, Bharsar, Uttarakhand, India

[2]Department of Vegetable Science, College of Agriculture, GBPUA&T, Pantnagar, Uttarakhand, India.

*Corresponding author Email: sheetalrana022@gmail.com

(Date of Receiving : 26-09-2024; Date of Acceptance : 27-11-2024)

ABSTRACT

An experiment was carried out at the Vegetable Research and Demonstration Block, Department of Vegetable Science during the year 2018-19. The experimental material for the present study consisted of F_1 populations of five parents and ten crosses, developed by crossing these five diverse tomato lines in a half-diallel design. (Excluding reciprocals). All the parents and their hybrids along with the standard check (PS2255) were planted in a Randomized Complete Block Design with three replications for their evaluation. Significant heterobeltiosis and Standard heterosis was observed in a desirable direction for all the traits. Four crosses exhibited significant positive heterosis over better parent, mid parent and standard check. The Pant T-3 × Roma cross exhibited maximum heterosis over better parent (61.90%), and standard check (45.20%) followed by Roma × Arka Alok, Roma × LC-1 and LC-1 × Arka Alok for fruit yield per plant. Further, the parent Pant T-3 emerged as a good general combiner for days to first fruit harvesting, number of fruits per plant, equatorial diameter and fruit yield per plant. Whereas, Roma was identified as good general combiner for average fruit weight, fruit volume and polar diameter. The highest specific combining ability for fruit yield was shown by Pant T-3 × Roma. Whereas, different cross combinations showed the good specific combining ability effect in different yield and yield attributing traits in desirable direction.

***Keywords*:** GCA, SCA, hybrids, half-diallel and heterosis

Introduction

Tomato (*Solanum lycopersicum* L.) is a globally significant vegetable, vital to both food security and economic value. It ranks as the second most consumed vegetable worldwide after potatoes and ranks first among processing crops. Originating from the solanaceae family, tomato is not only important for their widespread culinary use but also for their rich composition of phytonutrients. Key bioactive compounds found in tomato include lycopene, β-carotene, α-tocopherol, polyphenols, and ascorbic acid, which contribute to their antioxidant properties (Saravanan *et al.*, 2003). These nutritional elements, coupled with the factors like cultivar type, environmental conditions, and production methods, influence the fruit's overall quality, including its uniform size, appealing red colour, good aroma and texture.

Tomato cultivation in India and across the world has seen extensive breeding efforts aimed at improving yield and quality. The introduction of hybrid breeding, particularly through the exploration of heterosis, has proven highly successful in increasing the yield potential of several cross-pollinated crops. Although tomato is predominantly a self-pollinating species, the scope for exploiting hybrid vigour remains significant. The extent and magnitude of heterosis, along with the ease of hybrid seed production, determine the commercial viability of tomato hybrids (Singh *et al.*, 2010). Further, the reproductive biology of tomato, characterized by the production of numerous seeds per fruit, provides favourable conditions for the manifestation of heterosis (Singh and Singh, 1993). Over the years, hybrid varieties of tomato have gained prominence due to their ability to tolerate biotic and abiotic stresses and their superior yield potential compared to pure line varieties. Tomato has become a staple “functional food” due to their nutrient-dense composition and widespread consumption. This has elevated the importance of developing high-yielding, stable varieties and F_1 hybrids to enhance the commercial cultivation of tomato, providing farmers with robust options for improved productivity.

Heterosis in tomato was first documented by Hedrick and Booth (1908), who observed its positive impact on yield and fruit number. Since then, heterosis has been extensively studied in tomato with focus on improving and enhancing yield components and quality traits (Ahmad *et al.*, 2011). However, commercially available tomato hybrids often lack processing qualities, limiting their use in value- added products (Pandiarana *et al.*, 2015). Given the increasing demand for tomato in both fresh consumption and processing industries, further exploration into hybrid development is essential to meet market demands. The presented study aims to evaluate the nature and extent of heterosis for yield and yield-attributing traits in tomatoes, contributing to the identification and development of high-performing hybrids suited for commercial cultivation.

Materials and Methods

Experimental site

The experiment was conducted at Vegetable Research and Demonstration Block, VCSG, UUHF, Bharsar, Uttarakhand. The experimental field was at 30.14° N latitude and 78.77° E longitude having elevation of 1,800 – 2,300 m from sea level.

Experimental material and design

The experiment utilized five diverse tomato parents, namely Pant T-3, Solan Lalima, Roma, LC-1, and Arka Alok. These parents were selected based on their genetic diversity and desirable traits for yield and quality related traits. The seeds of the selected parents were sown in October 2017, and the seedlings were transplanted in a polyhouse to facilitate crossing. The crossing was carried out in a half-diallel mating design, involving all possible combinations of the five parents excluding reciprocal crosses, to generate 10 F_1 hybrids. The flowers were emasculated and hand-pollinated to ensure successful hybridization. The seeds from these crosses were harvested between April and June 2018. In early autumn 2018, the seeds of the 10 F_1 crosses along with the five parental lines and a popular commercial check variety (PS-2255) were planted in the field and experiment was laid out in a randomized complete block design (RCBD) with three replications.

Data collection

Observations were recorded for various yield and yield-contributing traits *viz.,* days to 50% flowering, days to first fruit harvesting, number of fruits per plant, polar diameter (mm), equatorial diameter (mm), average fruit weight (g), fruit volume (mL) and fruit yield per plant (kg). Data collected from the experiment were statistically analysed to determine significance of differences among the genotypes for various traits and to estimate combining ability and heterosis.

Data analysis

Analysis of Variance (ANOVA) was performed with the help of O.P. Stat software as explained by the formula Gomez and Gomez (1983).

Results and Discussion

The character-wise results obtained have been presented here. The variance due to genotypes (crosses and parents) was significant at p=0.05 and p=0.01 for all the yield and its’ contributing traits are given under as and depicted in table no.1 and table no. 2:

Days to 50% flowering

The heterosis estimates over better parent (heterobeltiosis) and commercial check (standard heterosis) for days to 50% flowering revealed a wide range of variation among the cross combinations ranging from -13.03% in Solan Lalima × Roma to 19.85 % in Pant T-3 × Roma and -11.60% in Roma × LC-1 to 11.26% in Pant T-3 × Roma, respectively, demonstrating both positive and negative heterotic effects. For this trait negative heterosis is desirable, as earlier flowering can lead to earlier fruit set and potentially a longer growing period, which could be beneficial under certain agronomic conditions. Four cross combinations exhibited significantly negative heterosis over the better parent *viz.,* Solan Lalima × Roma (-13.03%), Roma × LC-1 (-11.60%), Roma × Arka Alok (-6.62%), LC-1 × Arka Alok (-3.75%). Whereas, six cross combinations showed significant positive heterosis over commercial check () *viz.,* Roma × LC-1 (-11.60%), Solan Lalima × Roma (-8.87%), Pant T-3 × Arka Alok (-8.53%), Pant T-3 × Solan Lalima (-5.12%), Roma × Arka Alok (-3.75%), LC-1 × Arka Alok (-3.75%) Among these, Solan Lalima × Roma and Roma × LC-1 showed the most pronounced significant negative heterobeltiosis and standard heterosis, indicating that these cross combination could be advantageous for breeding programs focused on earliness and can fit into short season or multi-cropping systems under mid-hill conditions. Conversely, two crosses exhibited significant positive heterosis over both the better parent and commercial check, indicating delayed flowering in comparison to the better parent and commercial check *viz.,* Pant T-3 × Roma (19.85% & 11.26 %) and Pant T-3 × LC-1 (17.65% and 9.21 %), respectively. Positive heterosis for this trait may be less desirable, particularly in regions where early maturity is key trait, but it could be still useful in breeding programs aiming for late maturity, extended vegetative growth or fruiting periods. Similar findings were also reported by Kulkarni (2003), Mahendrakar (2004) and Duhan *et al.* (2005).

The assessment of both General Combining Ability (GCA) and Specific Combining Ability (SCA) helps to identify the parents and crosses that can contribute to earlier flowering in progeny. Among the parental lines, Pant T-3 (-0.48) and Arka Alok (-0.71) exhibited non-significant negative GCA effects. These parents can be classified as average general combiners, as they contribute towards early flowering but not at statistically significant level. However, Roma (0.86) exhibited significant positive GCA effects, marking it as a poor general combiner for days to 50% flowering, as it would likely delay flowering in its progeny. Further, five crosses demonstrated significant negative SCA effects *viz.,* Roma × LC-1 (-11.52), Solan Lalima × Roma (-9.19), Pant T-3 × Arka Alok (-6.48), Pant T-3 × Solan Lalima (-4.19) and Roma × Arka Alok (-3.14) indicating their potential for earliness in flowering, hence considered as good specific combiners. Negative GCA and SCA effects were also obtained by Rupa *et al.* (2001), Kulkarni (2003), Singh *et al.* (2008) and Kumar *et al.* (2017).

Days to first fruit harvest

The evaluation of heterosis for days to first fruit harvest, the heterosis over better parent and commercial check ranged from -3.60% in Pant T-3 × Arka Alok to 20.21% in LC-1 × Arka Alok and -14.15% in Pant T-3 × Arka Alok to 8.87% in LC-1 × Arka Alok, respectively. Significant positive heterosis over better parent was observed in LC-1 × Arka Alok (20.21%) indicates that this cross combination exhibited delayed fruit harvest compared to its better parent, delayed fruit harvest might be undesirable in regions where early maturity is critical, this result could be valuable in situations where staggered harvesting or an extended growing period is beneficial for prolonged market availability. None of the cross combinations exhibited significant negative heterobeltiosis and standard heterosis which means early fruiting crosses like Pant T-3 × Arka Alok (-14.15 %) may have advantages for early market entry or for environments where shorter growing seasons limits the cultivation period but the difference was not statistically significant, and thus, may not represent a meaningful improvement in a practical breeding context. This result is in conformity with Dharva *et al.* (2018).

The evaluation of GCA and SCA effects revealed significant variations among the tomato parents and their cross combinations. The parents Pant T-3 (-6.08) and Solan Lalima (-6.50) exhibited significant negative GCA effects, indicating their status as good general combiners for this trait. Conversely, the other parents exhibited significant positive GCA effects, categorizing them as poor general combiners. Further, one cross combination demonstrated significant negative SCA effect *viz.,* Pant T-3 × Arka Alok (-11.19), indicating superior combining ability for early fruit harvesting. Whereas, Roma × Arka Alok (11.19) and LC-1 × Arka Alok (17.10) exhibited significant positive SCA effects, marking them as poor specific combiners. The result achieved from this experiment are in agreement with Sajjan (2001), Mahendrakar (2004) and Singh *et al.* (2008).

Number of fruits per plant

The heterosis estimates for number of fruits per plant (table no. 1) among the ten cross combinations revealed both positive and negative heterotic effects over the better parent and commercial check cultivar. The heterosis over better parent and commercial check ranged from -12.93% in the cross Solan Lalima × Arka Alok to 38.77% in Pant T-3 × Roma and -12.09% in Pant T-3 × Solan Lalima to 46.52% in Pant T-3 × Roma. Two hybrids showed significant positive heterosis over better parent and commercial check *viz.,* Pant T-3 × Roma (38.77% and 46.52 %) and Pant T-3 × Arka Alok (9.05% and 17.68 %), respectively, which highlights their potential for significantly increasing the number of fruits per plant compared to the better parent, hence making them favourable cross combination for improving yield related traits in tomato breeding. Further, their potential superiority over the commercial check can lead them for commercial cultivation if consistent performance is demonstrated across different environment. Negative heterosis, indicates reduced performance relative to the better parent and commercial check, which may limit the utility of these combinations for breeding programs targeting higher yield. Positive heterosis over better parent and check have also been reported by

Premalakshmee *et al.* (2005), Kumari *et al.* (2010), Kumar *et al.* (2017) and Dharva *et al.* (2018).

Among the parents, Pant T-3 (0.43), Roma (0.76) and Arka Alok (0.47) exhibited significant positive GCA effects, making them good general combiners for increasing the number of fruits per plant. Whereas, Solan Lalima (-1.00) and LC-1 (-0.66) displayed significant negative GCA effects, classifying them as poor general combiners. Further, Pant T-3 × Roma (5.37) and Pant T-3 × Arka Alok (1.52) exhibited significantly positive SCA effects, indicating that they are good specific combiners for enhancing the trait. However, Roma × Arka Alok (-1.53), Roma × LC-1 (-1.33), Pant T-3 × Solan Lalima (-1.28), Pant T-3 × LC-1 (-1.01), and Solan Lalima × Roma (-0.87) exhibited significant negative SCA effects, categorizing them as poor specific combiners. Similar results were also obtained by Mahendrakar (2004), Premalakshmee *et al.* (2005), Singh *et al.* (2010).

Average fruit weight

The extent of heterosis for average fruit weight over better parent and commercial check ranged from -6.05% in Pant T-3 × LC-1 to 2.72% in Solan Lalima × Roma and from -3.56% in Pant T-3 × LC-1 to 4.64% in Solan Lalima × Roma. Among the ten crosses evaluated, Solan Lalima × Roma was the only hybrid which showed significant positive heterosis over better parent and commercial check *viz.,* 2.72 % and 4.76 %, respectively, indicating, that this cross combination has the potential to outperform the better parent and commercial check. These findings of positive heterosis over better parent and check co-relate with the findings of Kumari *et al.* (2010), Gul *et al.* (2010), Ahmed *et al.* (2011) and Kumari and Sharma (2011).

Solan Lalima (0.29) and Roma (0.23) exhibited significant positive GCA effects among parents, indicating that they are good general combiner for average fruit weight. Conversely, LC-1 (-0.38) and Arka Alok (-0.20) showed significant negative GCA effects, classifying them as poor general combiners. Solan Lalima × Roma (1.16) exhibited significantly positive SCA effects, making it a good specific combiner whereas, Pant T-3 × LC-1 (-1.19) and Pant T-3 × Solan Lalima (-0.56) exhibited significant negative SCA effects, indicating them as poor specific combiners for this trait. The results for GCA and SCA are in accordance with the findings of Katkar *et al.* (2012), Shende *et al.* (2012), Saleem *et al.* (2013), Yadav *et al.* (2013), Kumar *et al.* (2013) and Agarwal *et al.* (2014).

Fruit volume (mL)

The study revealed the varying percentage of heterosis for fruit volume across the hybrid combinations when compared to both, the better parent and the commercial check which ranged from -7.97% in Solan Lalima × Arka Alok to 6.33% in Solan Lalima × Roma and -3.43% in Solan Lalima × Arka Alok to 7.76% in Solan Lalima × Roma, respectively. The result demonstrates (table no. 1) that both positive and negative heterosis for fruit volume can be observed, depending upon the genetic makeup of the crosses. Two cross-combination *viz.,* Solan Lalima × Roma (6.33%) and Pant T-3 × Solan Lalima (3.95%) exhibited significant positive heterosis over the better parent and four hybrid combinations *viz.,* Solan Lalima × Roma (7.76%), Pant T-3 × Solan Lalima (2.09%), Pant T-3 × Roma (1.49%), and LC-1 × Arka Alok (1.19%) showed significant positive heterosis over commercial check, indicating that these hybrids have potential to produce fruits with larger volumes than better parent and commercial check, which could be beneficial for yield improvement in commercial tomato production. These findings are in close association with the findings of Makani *et al.* (2013).

Roma (0.43) was proved to be good general combiner as it exhibited significant positive GCA effect for fruit volume. Further, Solan Lalima × Roma (2.77), exhibited significant positive SCA effects which determines its good specific combining ability. On contrary, Solan Lalima × Arka Alok (-2.06) showed significant negative SCA effects indicating its poor specific combining ability for this trait. The remaining cross combinations also possessed average specific combining ability but they exhibited non-significant positive SCA effects. Similar results for GCA and SCA are obtained with the findings of Sharma and Sharma (2010), Katkar *et al.* (2012), Shende *et al.* (2012), Saleem *et al.* (2013), Yadav *et al.* (2013), Kumar *et al.* (2013) and Agarwal *et al.* (2014).

Polar diameter (cm)

The extent of heterosis for the polar diameter revealed considerable variation across the ten tomato cross combinations when compared to better parent and commercial check cultivar, which ranged from -12.46% in Roma × LC-1 to 9.61% in Solan Lalima × Roma and -7.68% in Roma × LC-1 to 15.59% in Solan Lalima × Roma, respectively, indicating both positive and negative effects of hybridization on this trait. Two hybrid combinations *viz.,* Solan Lalima × Roma (9.61%) and Pant T-3 × Solan Lalima (4.53%) exhibited significant positive heterosis over the better parent. Further, Solan Lalima × Roma displayed the highest positive heterosis of 15.59 %, followed by LC-1 × Arka Alok with 2.65%, demonstrating that these hybrids outperformed the check variety in terms of fruit polar diameter. Significant positive heterosis in polar diameter could enhance the market appeal and commercial value of tomato hybrids. findings of significant positive heterosis over better parent and check are in line with the findings of by Gul *et al.* (2010), Islam *et al.* (2012), Singh *et al.* (2012) and Kumar and Singh (2016).

Roma (0.08) showed significant positive GCA effects whereas Pant T-3(-0.11) exhibited significant negative GCA effect. Cross Combination, Solan Lalima × Roma (0.45) had good specific combining ability as it possessed significant positive SCA effects. Whereas, Pant T-3 × LC-1 (-0.12), Roma × Arka Alok (-0.13) and Roma × LC-1(-0.33) exhibited significant negative SCA effects which indicated that they are poor specific combiners. The results with respect to GCA and SCA effects are similar to the findings of Chadha *et al.* (2001), Rai *et al.* (2003), Pandey *et al.* (2006) and Veer *et al.* (2006).

Equatorial diameter (cm)

The heterosis extent for equatorial diameter revealed both positive and negative heterotic effects when compared to the better parent and commercial check, which ranged from -17.02% in LC-1 × Arka Alok to 5.05% in Pant T-3 × Solan Lalima and -17.16% in Roma × Arka Alok to 1.36% in Solan Lalima × LC-1, respectively, indicating significant variability in the performance of the hybrids for this trait. Five cross combinations demonstrated significant positive heterosis over the better parent: Pant T-3 × Solan Lalima (5.05%), Solan Lalima × Roma (3.78%), Solan Lalima × Arka Alok (3.42%), Pant T-3 × Arka Alok (3.24%), and Pant T-3 × Roma (3.06%) and only one cross Solan Lalima × LC-1, exhibited significant positive heterosis over the check cultivar, with an increase of 1.36%. the identification of cross combination with significant positive heterosis is critical for developing high-yielding and commercially viable tomato varieties. The results in close agreement with the findings of Singh *et al.* (2006), Asati *et al.* (2007), Saleem *et al.* (2013) and Kumar and Singh (2016).

Among parents, Solan Lalima (0.12), Pant-T 3 (0.08) and LC-1 (0.08) were proved to be good general combiners as they exhibited significant positive GCA effects. Whereas, Arka Alok (-0.16) and Roma (-0.11) possessed significant negative GCA effects which indicates that they are poor general combiners for this trait. Further, cross combinations *viz.,* Pant T-3 × Akra Alok (0.24), Solan Lalima × Arka Alok (0.20), Pant T-3 × Roma (0.17) and Solan Lalima × Roma (0.15), which indicates that they have good specific combining ability. Pant T-3 × LC-1 (-0.18), Roma × Arka Alok (-0.18) and LC-1 × Arka Alok (-0.24) exhibited significant negative SCA effects determining their poor specific combining ability for this trait. Similar results with respect to GCA and SCA effects were obtained by Chadha *et al.* (2001), Kaur *et al.* (2002), and Pandey *et al.* (2006).

Fruit yield per plant (kg)

The heterosis analysis for fruit yield per plant revealed heterosis extent ranged from -25.11% in Solan Lalima × LC-1 to 61.90% in Pant T-3 × Roma over better parent and from -26.12% in Solan Lalima × LC-1 to 45.20% in Pant T-3 × Roma over commercial check. Out of the ten crosses, seven demonstrated significant positive heterosis over the better parent, indicating an improvement in fruit yield per plant. The most pronounced increase was observed in the Pant T-3 × Roma cross (61.90%), highlighting its potential for superior yield performance. Other crosses with significant positive heterosis include Solan Lalima × Roma, Pant T-3 × Arka Alok, Roma × Arka Alok, and LC-1 × Arka Alok, suggesting these combinations led to enhanced genetic expression of yield-related traits. Further, Pant T-3 × Roma (45.20 %), Roma × LC-1 (2.56%), LC-1 × Arka Alok (1.15%), and Roma × Arka Alok (0.64%) exhibited significant positive heterosis over the commercial check, indicating that these hybrids could surpass the commercial check in terms of fruit yield per plant. These findings are in close agreement with the findings of Kumari and Sharma (2011), Marbhal *et al.* (2016), Kumar and Singh (2016), Khan and Jindal (2016).

In parental lines, Pant T-3 (0.01) and Roma (0.07) were found to be good general combiners as they exhibited significant positive GCA effects. Solan Lalima (-0.06) was recorded as poor general combiner as it showed significant negative GCA effects. In the crosses, Pant T-3 × Roma (0.33), Solan Lalima × Arka Alok (0.12) and LC-1 × Arka Alok (0.09) had good specific combining ability as it exhibited significant positive SCA effects. Pant T-3 × LC-1 (-0.07), Pant T-3 × Arka Alok (-0.05) and Solan Lalima × LC-1 (-0.10) had significant negative SCA effects which determines their poor specific combining ability for this trait. similar results were observed by Katkar *et al.* (2012), Kumar *et al.* (2013), Saleem *et al.* (2013), Shankar *et al.* (2013) and Agarwal *et al.* (2014).

Conclusion

The results concluded that Top three cross combinations for fruit yield per plant as per their mean performance, Pant T-3 × Roma, Roma × LC-1 and LC-1 × Arka Alok also expressed significantly positive standard heterosis over check, these were also found effective cross combinations with high specific combining ability for economic traits hence these genotypes can be incorporated into hybrid breeding programmes for exploiting their genetic potential. Further they can be recommended for commercial cultivation in mid hill regions after being tested in multiple locations.

Table 1 : Heterotic response for metric traits

	Days to 50% flowering		Days to first fruit harvest		Number of fruits per plant		Polar diameter (cm)		Equatorial diameter (cm)		Average fruit weight (g)		Fruit volume (mL)		Fruit yield er plant (kg)	
Crosses	**BP**	**CC**	**BP**	**CC**	**BP**	**CC**	**BP**	**CC**	**BP**	**CC**	**BP**	**CC**	**BP**	**CC**	**BP**	**CC**
Pant T-3 × Solan Lalima	2.21	-5.12**	3.58	-12.64	-5.97**	-12.09**	4.53**	-0.37**	5.05**	0	-2.80**	-0.22	3.95**	2.09**	13.83**	-8.96**
Pant T-3 × Roma	19.85**	11.26**	1.91	-9.25	38.77**	46.52**	-7.30**	-2.25**	3.06**	-1.90**	-2.12**	0.48	0.15	1.49**	61.90**	45.20**
Pant T-3 × LC-1	17.65**	9.21**	9.11	-2.83	-4.35**	-7.90**	-10.95**	-6.92**	-9.42**	-6.02**	-6.05**	-3.56**	1.35	0.9	-12.99**	-14.34**
Pant T-3 × Arka Alok	-1.47	-8.53**	-3.6	-14.15	9.05**	17.68**	-4.36**	-1.29**	3.24**	-1.72**	-1.62**	0.99	-3.84**	0.9	4.79**	-16.01**
Solan Lalima × Roma	-13.03**	-8.87**	12.98	-4.72	-11.89**	-6.98**	9.61**	15.59**	3.78**	-1.21**	2.72**	4.64**	6.33**	7.76**	0.95	-9.73**
Solan Lalima × LC-1	2.05	2.05	7.16	-9.62	-2.42**	-6.04**	-4.49**	-0.17	-2.31**	1.36**	-2.49**	-0.67	0.9	0.45	-25.11**	-26.12**
Solan Lalima × Arka Alok	-2.32	0.68	13.65	-4.15	-12.93**	-6.04**	-2.91**	0.2	3.42**	-1.54**	-2.17**	-0.34	-7.97**	-3.43**	26.67**	-2.82**
Roma × LC-1	-11.60**	-11.60**	4.01	-2.08	-12.78**	-7.90**	-12.46**	-7.68**	-10.91**	-7.56**	0	0.17	-2.06**	-0.75	3.90**	2.56**
Roma × Arka Alok	-6.62**	-3.75**	14.58	3.77	-8.62**	-1.40**	-5.52**	-0.37**	-5.48**	-17.16**	0.46	0.6	-3.70**	1.04	12.38**	0.64**
LC-1 × Arka Alok	-3.75*	-3.75*	20.21**	8.87	-6.03**	1.4	-1.80**	2.65**	-17.02**	-13.89**	-1.38**	-1.22**	-3.56**	1.19**	2.60**	1.15**
C.D. at 5%	1.77		18.50		1.71		0.26		0.26		1.08		2.04		0.10	
CD at 1%	4.26		26.83		2.48		0.38		0.38		1.57		2.97		0.14	

Table 2 : General combining ability of parents

S.No.	Parents	Days to 50% Flowering	Days To First Fruit Harvesting	No. of Fruits Per Plant	Average Fruit Weight	Fruit Volume	Polar Diameter	Equatorial Diameter	Fruit Yield Per Plant (kg)
1	Pant T-3	-0.48	-6.08**	0.43**	0.06	-0.24	-0.11**	0.08**	0.01**
2	Solan Lalima	0.33	-6.50**	-1.00**	0.29*	-0.14	0.02	0.12**	-0.06**
3	Roma	0.86*	3.21**	0.76**	0.23*	0.43**	0.08**	-0.11**	0.07**
4	LC-1	0.00	6.30**	-0.66**	-0.38**	-0.30	-0.02	0.08**	0.00
5	Arka Alok	-0.71	3.07**	0.47**	-0.20*	0.26	0.03	-0.16**	-0.03
	SE (g_i)	0.480	1.804	0.171	0.108	0.202	0.026	0.028	0.008
	SE (g_i-g_j)	0.760	2.852	0.270	0.172	0.319	0.041	0.044	0.015

*, ** significant at 5% and 1% level, respectively.

Table 3 : Specific combining ability of hybrids.

S.No.	Parents	Days to 50% Flowering	Days To First Fruit Harvesting	No. of Fruits Per Plant	Average Fruit Weight	Fruit Volume	Polar Diameter	Equatorial Diameter	Fruit Yield Per Plant (kg)
1	Pant T-3 × Solan Lalima	-4.19**	1.05	-1.28**	-0.56*	0.90	0.07	0.02	0.03
2	Pant T-3 × Roma	11.29**	-2.67	5.37**	-0.23	0.07	-0.05	0.17**	0.33**
3	Pant T-3 × LC-1	10.14**	5.57	-1.01**	-1.19**	0.52	-0.12*	-0.18**	-0.07**
4	Pant T-3 × Arka Alok	-6.48**	-11.19**	1.52**	0.40	-0.03	0.02	0.24**	-0.05*
5	Solan Lalima × Roma	-9.19**	5.76	-0.87**	1.16**	2.77**	0.45**	0.15**	-0.03
6	Solan Lalima × LC-1	2.33	-6.00	0.69	-0.29	0.23	-0.01	0.07	-0.10**
7	Solan Lalima × Arka Alok	1.71	6.90	-0.45	-0.35	-2.06**	-0.05	0.20**	0.12**
8	Roma × LC-1	-11.52**	-2.38	-1.33**	0.09	-0.88	-0.33**	-0.05	0.00
9	Roma × Arka Alok	-3.14**	11.19**	-1.53**	0.07	-0.63	-0.13**	-0.18**	0.02
10	LC-1 × Arka Alok	-2.29	17.10**	0.29	-0.02	0.16	0.08	-0.24**	0.09**
	SE (s_{ij})	1.238	4.970	0.441	0.280	0.527	0.066	0.073	0.025
	SE (s_{ij}-s_{ik})	1.858	6.987	0.662	0.420	0.788	0.100	0.109	0.037

*, ** significant at 5% and 1% level, respectively.

Acknowledgement

I would like to thank my advisor Dr. S. C. Pant, for their invaluable guidance, encouragement and unwavering support throughout the course of this study. Their insights and expertise have been instrumental in the successful completion of this research. I am also grateful to VCSG, UUHF for providing the necessary facilities and resources required for this work. Special thanks to my colleagues Avantika Devrani, Imamuddin Shah and Priyanka Panwar for visualizing, collaboration, analysing and feedback during the research process.

Conflict of Interest: None

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