



Combining ability analysis for yield and quality traits in cherry tomato (*Solanum lycopersicum* var. *cerasiforme*)

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ABSTRACT

The present study was carried out to assess combining ability for horticultural traits in cherry tomato (*Solanum lycopersicum* L. var. *cerasiforme* Mill) during 2021–2023 at Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. A line $\times$ tester design involving 12 lines and 4 testers were crossed to develop 48 F₁ progenies. Significant variation was observed for yield and contributing traits. The $\sigma^2\text{GCA}/\sigma^2\text{SCA}$ ratio ranged from 0.02–1.55, indicating the predominance of non-additive gene action. Parental genotypes UHF-CT-L-14 (0.55), UHF-CT-L-16 (0.33) and UHF-CT-L-17 (0.53) emerged as superior general combiners for fruit yield/plant, while UHF-CT-L-22 and UHF-CT-L-24 were notable for quality attributes. Cross combinations, viz. UHF-CT-L-16 $\times$ Punjab Kesar Cherry (0.46), UHF-CT-L-13 $\times$ Punjab Red Cherry (0.56), UHF-CT-L-14 $\times$ Punjab Kesar Cherry (0.43) and UHF-CT-L-16 $\times$ Pusa Cherry Tomato-1 (0.43) exhibited significant SCA effects for fruit yield. The identified promising genotypes and their cross combinations may be utilised as valuable genetic resources for future cherry tomato breeding programmes.

Keywords: GCA, Gene action, Line $\times$ tester, SCA, Segregants

Cherry tomato (*Solanum lycopersicum* L. var. *cerasiforme* Mill) is an important and widely cultivated vegetable, valued for its nutritional quality and consumer preference (Jenkins 1948). Tomato exhibits wide variability in nutritional and quality traits (Lone *et al.* 2021). Although botanically a short-lived perennial, it is grown as an annual and is predominantly self-pollinated (Gonzalez *et al.* 2011). At present, tomato occupies around 7.37 lakh hectares with a production of 194.68 lakh tonnes (IHB 2025). Cherry tomatoes are small (10–30 g), round to slightly oval, rich in vitamin C and lycopene (Islam *et al.* 2012), and are well adapted to high humidity and tolerant to heat (Vidyadhar *et al.* 2014).

Genetic studies indicated that *cerasiforme* types are intermediates between wild and domesticated forms, exhibiting substantial variability for fruit quality traits (Miller and Tanksley 1990, Nesbitt and Tanksley 2002). This variability offers opportunities for selecting superior parents and developing high-yielding hybrids. Combining ability analysis, with estimation of general (GCA) and

specific combining ability (SCA), helps in understanding additive and non-additive gene action, respectively, and leads breeding strategies. The line $\times$ tester design is widely used to evaluate GCA and SCA, and to identify promising hybrids for crop improvement. Therefore, the present investigation was undertaken to estimate the general and specific combining ability of diverse cherry tomato genotypes for yield and quality traits, to elucidate the nature of gene action governing these traits, and to identify superior parents and cross combinations for their potential utilisation in future cherry tomato breeding programmes.

MATERIALS AND METHODS

Plant materials: The study was carried out during rainy (*kharif*) seasons of 2021–2023 at Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (30.8645°N, 77.1695°E; at an elevation of 1,275 m amsl), Himachal Pradesh. During the crop growth period (February–July, 2023), the mean temperature ranged from 14.70–23.82°C, relative humidity from 38.57–79.87%, and total monthly rainfall from 0.30–21.31 mm. The soil structure of the experimental site was observed as sandy loam to clay loam consisting of sand (46.09 %), silt (32.12%) and clay (25.01%) with pH varying from 6.85–7.04. The genetic material comprised of 16 genetically diverse parents, selected based on their performance for growth, yield, and

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Table 1 Details of the parental genotypes used in the hybridisation programme along with the standard check cultivar

Sr. no.	Name of the genotype
Line(s) sourced from UHF, Nauni, Solan (HP)	
1.	UHF-CT-L-13
2.	UHF-CT-L-14
3.	UHF-CT-L-15
4.	UHF-CT-L-16
5.	UHF-CT-L-17
6.	UHF-CT-L-18
7.	UHF-CT-L-19
8.	UHF-CT-L-20
9.	UHF-CT-L-21
10.	UHF-CT-L-22
11.	UHF-CT-L-23
12.	UHF-CT-L-24
Tester(s) sourced from ICAR-IARI, New Delhi and PAU, Ludhiana	
1.	Pusa Cherry Tomato-1 (T ₁)
2.	Punjab Kesar Cherry (T ₂)
3.	Punjab Red Cherry (T ₃)
4.	Punjab Sona Cherry (T ₄)
Standard check cultivar sourced from UHF, Nauni, Solan (HP)	
1.	Solan Red Round

fruit quality, including 12 lines and 4 testers (Table 1). The control in this study was ‘Solan Red Round’, a widely cultivated and regionally adapted variety.

Experimental setup: Genotypes were evaluated during *kharif*, 2021 to identify diverse parental genotypes, which were subsequently selfed for seed multiplication. Selected 12 lines and 4 testers were transplanted in a crossing block during *kharif*2022 (first week of April), and crosses were made as per line × tester design to obtain 48 F₁ hybrids. The hybrids along with parents and standard check were evaluated during summer 2023 in a randomised complete block design (RCBD) with three replications. Each experimental plot consisted of 18 plants at a spacing of 90 cm × 30 cm.

Traits analysis: Data on yield and its components

were recorded during plant growth and at harvest maturity on ten randomly selected plants per plot. Number of primary branches (NOPB) was recorded at final harvest, and plant height (PH; cm) was measured from soil surface to the tip of main stem. Number of fruits/cluster (NOFPC) was obtained from ten clusters, while fruit clusters/plant (NOFCPP) and fruits/plant (NOFPP) were counted from tagged plants during all pickings. Fruit Shape Index (FSI) was calculated as polar diameter to equatorial diameter from digital Vernier calliper (Roy and Choudhary 1972). Number of locules/fruit (NOLPF) and seeds/fruit (NOSPF) were recorded from transverse fruit section, and thousand seed weight (TSW; g) was measured from dried seeds. Harvest duration (HD) was noted as the interval from first to final harvest. Average fruit weight (AFW; g) and fruit yield/plant (FYPP; kg/plant) were obtained from each harvest. Ascorbic acid content (AA; mg/100 g) was estimated using the 2,6-dichlorophenol-indophenol titration, and Lycopene content (LC; mg/100 g) was determined spectrophotometrically at 503 nm (Ranganna 1986).

Statistical analysis: Data were analysed using ANOVA for RCBD (Panse and Sukhatme 1967). Line × tester analysis was performed as per Kempthorne (1957). General combining ability (GCA) and specific combining ability (SCA) were estimated as per Singh and Chaudhary (1977), and their significance was tested using their respective standard errors and t-tests at the 5% and 1% probability levels. The genetic components were estimated according to Dabholkar (1992) and Singh and Chaudhary (1977). All analysis was performed using R Core Team (2022).

RESULTS AND DISCUSSION

ANOVA indicated significant differences among parents, crosses, and parents vs. crosses for most traits (Table 2), showing substantial genetic variability. The GCA effects of lines were significant for most traits, whereas testers showed significance only for AFW, LC and NOSPF, suggesting differential parental contributions. SCA effects due to line × tester interaction was significant for all

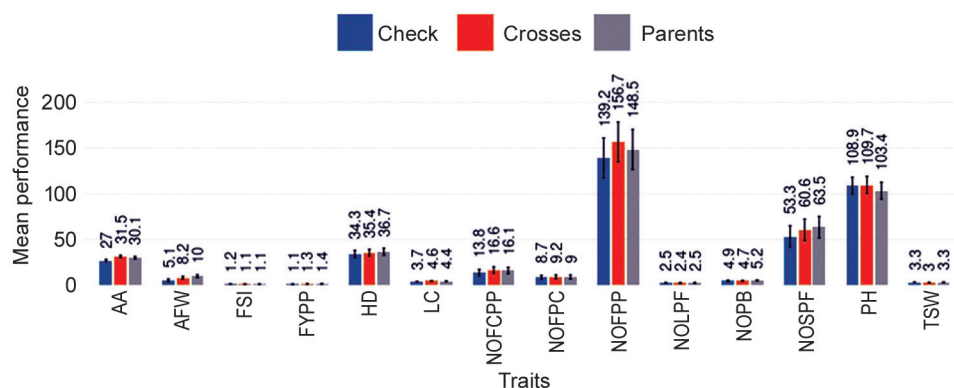


Fig. 1 Mean performance of parents, crosses and standard check.

NOPB, Number of primary branches; PH, Plant height; NOFPC, Number of fruits/cluster; NOFCPP, Number of fruit clusters/plant; NOFPP, Number of fruits/plant; FSI, Fruit shape index; NOLPF, Number of locules/fruit; HD, Harvest duration; NOSPF, Number of seeds/fruit; TSW, 1000 Seed weight; AFW, Average fruit weight; FYPP, Fruit yield/plant; AA, Ascorbic acid content; LC, Lycopene content.

traits, confirming the preponderance of non-additive gene action. The σ^2 GCA/ σ^2 SCA was less than unity for most characteristics, indicating non-additive genetic effects (Arti *et al.* 2023). The results are in conformity with Solieman *et al.* (2013), Pandiarana *et al.* (2015), Pujer and Badiger (2017), Bhalala and Acharya (2019), Rakha and Sabry (2019) and Reddy *et al.* (2020) in different genotypes of tomato. The mean performance is represented in Fig.1.

General combining ability effects: The identification of good general combiners across yield and its component traits highlights their potential to contribute favourable alleles in a cumulative manner. Such parents are particularly valuable in breeding programmes, as additive genetic effects can be effectively fixed in segregations. For number of primary branches, UHF-CT-L-23 (0.79), UHF-CT-L-24 (0.40) and UHF-CT-L-14 (0.31) were found to be good general combiners (Table 3). These results are in conformity with Reddy *et al.* (2023). For plant height, significant and desirable positive effects were recorded in UHF-CT-L-13 (7.65), UHF-CT-L-17 (6.32) and UHF-CT-L-24 (4.64) and these can be used for breeding tall cultivars whereas UHF-CT-L-17 (1.68), UHF-CT-L-16 (1.10) and UHF-CT-L-13 (0.92) showed significant positive GCA effects for number of fruits/cluster. For number of fruits/plant, highly significant positive effects were found in UHF-CT-L-13 (41.59), UHF-CT-L-17 (26.66) and UHF-CT-L-16 (21.41). Similar findings were reported by Sharma and Sharma (2013). For fruit shape index, desirable positive effects were shown by UHF-CT-L-21 (0.31), UHF-CT-L-18 (0.19) and UHF-CT-L-19 (0.13). Similar higher GCA effects were reported by Chandel *et al.* (2021).

For harvest duration, significant negative effects were recorded in UHF-CT-L-23 (-3.09), UHF-CT-L-13 (-2.84), and UHF-CT-L-17 (-2.67). For number of seeds/fruit, UHF-CT-L-20 (15.80) exhibited highly significant positive effect. Lines, UHF-CT-L-22 (0.38), UHF-CT-L-24 (0.29), and UHF-CT-L-15 (0.22) exhibited highly desirable GCA effects for 1000 seed weight. For average fruit weight, significant positive effects were shown by UHF-CT-L-14 (3.39), UHF-CT-L-17 (1.75), and UHF-CT-L-22 (1.51). These lines therefore can be used for developing cultivars with bigger fruits. Similar higher GCA effects were reported by Sharma and Sharma (2013).

Every breeding programme is aimed at achieving high fruit yield along with superior quality. The lines UHF-CT-L-14 (0.55), UHF-CT-L-17 (0.53), and UHF-CT-L-13 (0.40) were observed to be good general combiners for fruit yield. Similar positive GCA effects aligned with the findings reported by Katkar *et al.* (2012) and Alwan and Mohammed (2023). For ascorbic acid, lines UHF-CT-L-19 (4.89), UHF-CT-L-24 (4.43), and UHF-CT-L-15 (3.50) exhibited positive desirable GCA effects. For lycopene content, lines UHF-CT-L-22 (0.71), UHF-CT-L-14 (0.49) and UHF-CT-L-13 (0.40) exhibited significant positive effects.

Among testers, Punjab Red Cherry (0.03) and Punjab Sona Cherry (0.03) exhibited significant positive effects. Based on the estimates of GCA effects, the line UHF-

Table 2 Mean square estimates of line $\times$ tester and combining ability analysis for yield and contributing traits

Source of variance	df	NOPB	PH	NOFPC	NOFCPP	NOFPP	FSI	NOLPF	HD	AFW	FYPP	NOSPF	TSW	AA	LC
Genotype	63	1.37*	179.56*	6.97*	28.55*	4,119.14*	0.13*	0.13*	35.92*	28.20*	0.62*	614.93*	0.50*	58.21*	2.48*
Parents	16	1.25*	352.54*	8.88*	50.15*	2,941.5*	0.22*	0.13*	33.42*	67.20*	0.66*	547.48*	0.18*	57.65*	4.65*
Crosses	47	1.29*	115.87*	6.58*	20.38*	4,435.95*	0.09*	0.12*	37.78*	14.76*	0.60*	656.79*	0.52*	55.79*	1.65*
Parents vs. crosses	1	8.77*	951.90*	1.39	38.95*	4,052.68*	0.02*	0.34*	20.25	17.54*	0.01	10.51	4.65*	162.59*	4.34*
Lines	11	2.06*	245.15*	11.20*	26.45	6,468.34	0.28*	0.06	78.60*	40.77*	1.55*	1,222.69*	0.93*	210.35*	4.20*
Testers	3	2.53	86.87	4.70	8.42	1,112.07	0.08	0.11	14.71	31.64*	0.76	272.54*	0.12	18.67	2.17*
Line $\times$ tester	33	0.92*	75.43*	5.21*	19.45*	4,060.90*	0.04*	0.14*	26.28*	4.56*	0.27*	503.07*	0.42*	7.63*	0.75*
Error	94	0.09	34.22	1.97	4.89	198.04	0.01	0.07	3.28	1.16	0.05	62.64	0.02	0.71	0.02
σ^2 GCA	-	0.07	7.23	0.24	0.14	59.35	0.01	-0.004	2.02	1.88	5445.45	26.78	0.001	0.67	0.01
σ^2 SCA	-	0.27	14.23	1.15	4.91	1,292.71	0.01	0.022	6.89	1.21	6752.93	149.97	0.06	1.16	0.12
σ^2 GCA/ σ^2 SCA	-	0.26	0.51	0.21	0.03	0.06	0.79	-0.16	0.29	1.55	0.81	0.18	0.02	0.58	0.10

*, **, Significant at 5% and 1% level of significance, respectively.

NOPB, Number of primary branches; PH, Plant height; NOFPC, Number of fruits/cluster; NOFCPP, Number of seeds/fruit; NOFPP, Number of fruits/plant; FSI, Fruit shape index; NOLPF, Number of locules/fruit; HD, Harvest duration; NOSPF, Number of seeds/fruit; TSW, 1000 Seed weight; AFW, Average fruit weight; FYPP, Fruit yield/plant; AA, Ascorbic acid content; LC, Lycopene content.

Table 3 Estimation of general and specific combining ability effects of parents and hybrids for different traits in cherry tomato

Character	Top three lines based on GCA effects	Top three hybrids based on SCA effects	GCA SE (gi) lines	GCA CD (0.05) lines	GCA CD (0.01) lines	SE (SCA effect)	SCA CD (0.05) (*)	SCA CD (0.01) Sij) Sij) (**)
NOPB	UHF-CT-L-23 (0.79**), UHF-CT-L-24 (0.40**), UHF-CT-L-14 (0.31*)	UHF-CT-L-22 × Punjab Kesar Cherry (0.80**), UHF-CT-L-15 × Pusa Cherry Tomato-1 (0.74**), UHF-CT-L-18 × Punjab Sona Cherry (0.72**)	0.08	0.24	0.34	0.18	0.34	0.48
PH	UHF-CT-L-13 (7.65**), UHF-CT-L-17 (6.32**), UHF-CT-L-24 (4.64)	UHF-CT-L-17 × Punjab Kesar Cherry (10.70**), UHF-CT-L-14 × Punjab Sona Cherry (10.32**), UHF-CT-L-18 × Punjab Red Cherry (6.86*)	1.69	4.73	6.12	3.30	6.71	9.48
NOFPC	UHF-CT-L-17 (1.68**), UHF-CT-L-16 (1.10*), UHF-CT-L-13 (0.92)	UHF-CT-L-16 × Punjab Kesar Cherry (2.63**), UHF-CT-L-13 × Punjab Red Cherry (2.20*), UHF-CT-L-15 × Pusa Cherry Tomato-1 (1.99*)	0.40	1.07	1.41	0.76	1.61	2.27
NOFCPP	UHF-CT-L-24 (3.78**), UHF-CT-L-17 (0.81), UHF-CT-L-13 (0.60)	UHF-CT-L-24 × Punjab Sona Cherry (4.83**), UHF-CT-L-16 × Pusa Cherry Tomato-1 (3.94**), UHF-CT-L-15 × Punjab Sona Cherry (3.66**)	0.64	1.79	2.32	1.25	2.53	3.58
NOFPP	UHF-CT-L-13 (41.59**), UHF-CT-L-17 (26.66**), UHF-CT-L-16 (21.41**)	UHF-CT-L-24 × Punjab Sona Cherry (81.06**), UHF-CT-L-16 × Punjab Kesar Cherry (63.69**), UHF-CT-L-17 × Punjab Kesar Cherry (62.57**)	4.06	11.37	14.46	7.80	16.13	22.81
FSI	UHF-CT-L-21 (0.31**), UHF-CT-L-18 (0.19**), UHF-CT-L-19 (0.13**)	UHF-CT-L-17 × Punjab Red Cherry (0.24**), UHF-CT-L-21 × Punjab Sona Cherry (0.19**), UHF-CT-L-19 × Punjab Kesar Cherry (0.14**)	0.009	0.025	0.032	0.02	0.04	0.05
NOLPF	UHF-CT-L-13 (0.11), UHF-CT-L-15 (0.08), UHF-CT-L-19 (0.08)	UHF-CT-L-13 × Pusa Cherry Tomato-1 (0.41*), UHF-CT-L-23 × Punjab Red Cherry (0.41*), UHF-CT-L-16 × Punjab Sona Cherry (0.30*)	0.076	0.213	0.283	0.15	0.30	0.43
HD	UHF-CT-L-23 (-3.09**), UHF-CT-L-13 (-2.84**), UHF-CT-L-17 (-2.67**)	UHF-CT-L-19 × Pusa Cherry Tomato-1 (-5.72**), UHF-CT-L-23 × Punjab Red Cherry (-4.33**), UHF-CT-L-20 × Punjab Kesar Cherry (-4.05**)	0.523	1.913	2.532	1.36	2.08	2.93
NOSPF	UHF-CT-L-20 (15.80**), UHF-CT-L-17 (7.68*), UHF-CT-L-21 (6.67*)	UHF-CT-L-23 × Punjab Red Cherry (21.03**), UHF-CT-L-23 × Punjab Sona Cherry (19.01**), UHF-CT-L-13 × Pusa Cherry Tomato-1 (16.65**)	2.28	6.40	7.80	4.21	9.07	12.83
TSW	UHF-CT-L-22 (0.38**), UHF-CT-L-24 (0.29**), UHF-CT-L-15 (0.22**)	UHF-CT-L-20 × Punjab Sona Cherry (0.64**), UHF-CT-L-23 × Punjab Sona Cherry (0.48**), UHF-CT-L-21 × Pusa Cherry Tomato-1 (0.43**)	0.04	0.11	0.14	0.08	0.15	0.22
AFW	UHF-CT-L-14 (3.39**), UHF-CT-L-17 (1.75**), UHF-CT-L-22 (1.51**)	UHF-CT-L-13 × Punjab Sona Cherry (3.51**), UHF-CT-L-23 × Punjab Sona Cherry (2.42**), UHF-CT-L-16 × Pusa Cherry Tomato-1 (1.75**)	0.31	0.87	1.05	0.56	1.23	1.74

Contd.

Table 3 (Concluded)

Character	Top three lines based on GCA effects	Top three hybrids based on SCA effects	GCA SE (gi) lines	GCA CD (0.05) lines	GCA CD (0.01) lines	SE (SCA effect)	SCA CD (0.05) (*)	SCA CD (0.01) (Sij) Skj (**)
FYPP	UHF-CT-L-14 (0.55**), UHF-CT-L-17 (0.53**), UHF-CT-L-13 (0.40**)	UHF-CT-L-13 × Punjab Sona Cherry (0.56**), UHF-CT-L-16 × Punjab Kesar Cherry (0.46**), UHF-CT-L-14 × Punjab Kesar Cherry (0.43**)	0.06	0.17	0.22	0.12	0.25	0.35
AA	UHF-CT-L-19 (4.89**), UHF-CT-L-24 (4.43**), UHF-CT-L-15 (3.50**)	UHF-CT-L-24 × Pusa Cherry Tomato-1 (2.53**), UHF-CT-L-20 × Punjab Sona Cherry (2.27**), UHF-CT-L-23 × Punjab Kesar Cherry (2.28**)	0.24	0.68	0.87	0.47	0.97	1.37
LC	UHF-CT-L-22 (0.71**), UHF-CT-L-14 (0.49**), UHF-CT-L-13 (0.40**)	UHF-CT-L-24 × Pusa Cherry Tomato-1 (1.10**), UHF-CT-L-24 × Punjab Kesar Cherry (0.62**), UHF-CT-L-22 × Punjab Sona Cherry (0.50**)	0.04	0.11	0.14	0.07	0.15	0.21

*, **, Significant at 5% and 1% level of significance, respectively.

NOPB, Number of primary branches; PH, Plant height; NOFPC, Number of fruits/cluster; NOFCPP, Number of fruit clusters/plant; NOFPP, Number of fruits/plant; FSI, Fruit shape index; NOLPF, Number of locules/fruit; HD, Harvest duration; NOSPF, Number of seeds/fruit; TSW, 1000 Seed weight; AFW, Average fruit weight; FYPP, Fruit yield/plant; AA, Ascorbic acid content; LC, Lycopene content. GCA, General combining ability; SCA, Specific combining ability; SE, Standard error; CD, Critical difference.

CT-L-17 was the most promising for plant height, number of fruits/cluster, number of fruits/plant, fruit shape index, average fruit weight, fruit yield/plant and lycopene content. Among testers, Punjab Kesar Cherry was the most promising for fruit yield/plant, ascorbic acid and also for the lycopene content. Comparable results were also documented by Kumar *et al.* (2020), Huseynzade *et al.* (2020), Reddy *et al.* (2020), Bhandari *et al.* (2021), Liu *et al.* (2021), Izzo *et al.* (2022), Pattnaik *et al.* (2022) and Pavan *et al.* (2022). The identification of good general combiners across yield and its component traits highlights their potential to contribute favourable alleles in a cumulative manner. Such parents are particularly valuable in breeding programmes, as additive genetic effects can be effectively fixed in segregations. In addition, the expression of appreciable GCA effects for quality traits indicated that nutritional attributes can be improved alongside yield without compromising genetic stability.

Specific combining ability effects: Specific combining ability (SCA) effects are helpful for identifying specific crosses with desirable traits (Table 3). Among 48 cross combinations, the hybrid, UHF-CT-L-22 × Punjab Kesar Cherry (0.80) had maximum number of primary branches. For plant height cross combinations namely, UHF-CT-L-14 × Punjab Sona Cherry (10.32), UHF-CT-L-17 × Punjab Kesar Cherry (10.70), and UHF-CT-L-18 × Punjab Red Cherry (6.86) showed highest significant positive SCA effect. For number of fruit cluster/plant, UHF-CT-L-15 × Punjab Sona Cherry (3.66), UHF-CT-L-16 × Pusa Cherry Tomato-1 (3.94) and UHF-CT-L-24 × Punjab Sona Cherry (4.83) exhibited highly significant positive values for SCA effects. For number of fruits/plant, highest desirable SCA values were exhibited by UHF-CT-L-24 × Punjab Sona Cherry (81.06), UHF-CT-L-16 × Punjab Kesar Cherry (63.69), UHF-CT-L-17 × Punjab Kesar Cherry (62.57). Comparable positive SCA effects were also reported by Kaplex *et al.* (2026). For fruit shape index, positive and highly significant SCA effect was recorded in hybrids UHF-CT-L-17 × Punjab Red Cherry (0.24), UHF-CT-L-21 × Punjab Sona Cherry (0.19), and UHF-CT-L-19 × Punjab Kesar Cherry (0.14).

For harvest duration, negative SCA effect were desirable. Cross combinations, viz. UHF-CT-L-19 × Pusa Cherry Tomato-1 (-5.72), UHF-CT-L-23 × Punjab Red Cherry (-4.33), UHF-CT-L-20 × Punjab Kesar Cherry (-4.05) showed highest significance. Highest significant SCA effect for number of seeds/fruit were recorded in UHF-CT-L-23 × Punjab Red Cherry (21.03), UHF-CT-L-23 × Punjab Sona Cherry (19.01), and UHF-CT-L-13 × Pusa Cherry Tomato-1 (16.65). Comparable positive SCA effects were also reported by Bhalala and Acharya (2019) and Rakha and Sabry (2019). For 1000 seed weight, highly significant and positive SCA effect recorded in UHF-CT-L-20 × Punjab Sona Cherry (0.64), UHF-CT-L-23 × Punjab Sona Cherry (0.48), and UHF-CT-L-21 × Pusa Cherry Tomato-1 (0.43). Highest significant positive effects for average fruit weight were noted in UHF-CT-L-13 × Punjab Sona Cherry (3.51), UHF-CT-L-23 × Punjab Sona Cherry (2.42) and UHF-

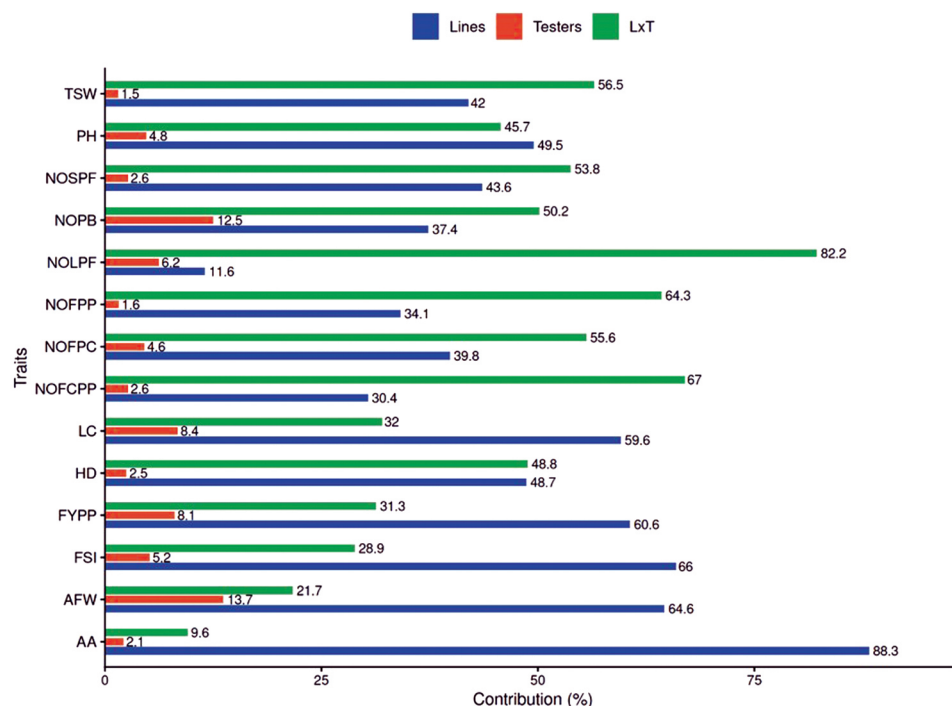


Fig. 2 Proportional contribution (%) of lines, testers and line $\times$ tester.

L $\times$ T, Line $\times$ tester; NOPB, Number of primary branches; PH, Plant height; NOFPC, Number of fruits/cluster; NOFCPP, Number of fruit clusters/plant; NOFPP, Number of fruits/plant; FSI, Fruit shape index; NOLPF, Number of locules/fruit; HD, Harvest duration; NOSPF, Number of seeds/fruit; TSW, 1000 Seed weight; AFW, Average fruit weight; FYPP, Fruit yield/plant; AA, Ascorbic acid content; LC, Lycopene content. GCA, General combining ability; SCA, Specific combining ability.

CT-L-16 $\times$ Pusa Cherry Tomato-1 (1.75). For fruit yield/plant, UHF-CT-L-13 $\times$ Punjab Sona Cherry (0.56), UHF-CT-L-16 $\times$ Punjab Kesar Cherry (0.46), and UHF-CT-L-14 $\times$ Punjab Kesar Cherry (0.43) recorded highest significant values. For ascorbic acid content, highest significant positive SCA effect was recorded in UHF-CT-L-24 $\times$ Pusa Cherry Tomato-1 (2.53), UHF-CT-L-23 $\times$ Punjab Kesar Cherry (2.28), and UHF-CT-L-20 $\times$ Punjab Sona Cherry (2.27). Similar positive SCA effects were also documented by Liu *et al.* (2021) and Pattnaik *et al.* (2022).

Similarly for lycopene content, significant SCA effect was noted in UHF-CT-L-24 $\times$ Pusa Cherry Tomato-1 (1.10), UHF-CT-L-24 $\times$ Punjab Kesar Cherry (0.62), and UHF-CT-L-22 $\times$ Punjab Sona Cherry (0.50). The SCA effects observed among the cross combinations for most traits clearly indicated the predominance of non-additive gene action, involving dominance and epistatic interactions. The occurrence of high SCA effects in only a limited number of crosses for traits such as plant height, fruit cluster traits and yield components suggested that superior performance was cross-specific rather than predictable from parental performance alone. Hybrids exhibiting consistently high SCA effects may therefore be considered as promising genetic combinations for further evaluation, while their parental combinations can serve as valuable genetic material for future hybrid development programmes. These results agree with the observation of Metwally *et al.* (2015),

Kumar and Gowda (2016), Jadav *et al.* (2017), Akram *et al.* (2019), Vekariya *et al.* (2019), Huseynzade *et al.* (2020), Kumar *et al.* (2020) and Pavan *et al.* (2022).

Proportional contributions of lines, testers and line $\times$ tester interactions: Lines proportional contribution ranged from NOLPF (11.60%) to AA (88.30%); for testers, it ranged from TSW (1.50%) to AFW (13.70%) and for the line $\times$ tester, from AA (9.60%) to NOLPF (82.20%) (Fig. 2). Overall, additive gene effect through lines were predominant for yield and quality traits, while non-additive effects were crucial for yield components, with testers contributing minimally. These results are in line with Verma *et al.* (2021) and Pavan *et al.* (2022) who reported similar outcomes in tomato.

The assessed cherry tomato genotypes exhibited wide genetic variations for horticultural traits and fruit yield useful for breeding programmes. Estimates of σ^2 SCA were higher in magnitude than σ^2 GCA (average) for all the characteristics, indicating the inheritance is conditioned by non-additive gene action (σ^2 D), and heterosis breeding would be an effective strategy for genetic improvement. Parental lines UHF-CT-L-14 and UHF-CT-L-17 were best general combiners for fruit yield and cross combinations, UHF-CT-L-13 $\times$ Punjab Sona Cherry, UHF-CT-L-16 $\times$ Punjab Kesar Cherry, UHF-CT-L-14 $\times$ Punjab Kesar Cherry and UHF-CT-L-16 $\times$ Pusa Cherry Tomato-1 were found to be good specific combiners for this trait. Based on non-additive effects, UHF-CT-L-14 $\times$ Punjab Kesar Cherry and UHF-CT-L-17 $\times$ Punjab Kesar Cherry emerged as promising cross combinations for yield and quality traits. These promising crosses should be evaluated further across multiple environments and seasons to assess their stability and performance. In addition, their segregating generations may be exploited to identify superior recombinants and develop improved pure lines or breeding populations for future cherry tomato improvement programmes.

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