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Suraj Luthra
Ph.D., Scholar, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

CN Ram
Professor & Head, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Lokesh Yadav
Ph.D., Scholar, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Chandroday Prakash Tiwari
Ph.D., Scholar, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Hradesh Shivhare
Ph.D., Scholar, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Shyam Prakash
Ph.D., Scholar, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Corresponding Author:
Suraj Luthra
Ph.D., Scholar, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Evaluation of the performance of parental lines and their F_1 hybrids for qualitative traits in cucumber (*Cucumis sativus* L)

Suraj Luthra, CN Ram, Lokesh Yadav, Chandroday Prakash Tiwari, Hradesh Shivhare and Shyam Prakash

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Abstract
The present investigation was conducted during *Zaid* seasons 2022-23 (Y1) and 2023-24 (Y2) to evaluate mean performance using Line x Tester mating design with thirteen diverse parents of cucumber. They were crossed in a Line x Tester mating design for generating experimental material. All thirteen parents and their 30 hybrids were grown in randomized block design with three replications. Observations were recorded for the six traits. The evaluation of parents and hybrids for six qualitative traits over two years and pooled data revealed significant variations. Punjab Naveen consistently exhibited high values among parents for dry matter and Ascorbic acid whereas, Khira -75 for total sugar respectively. Among hybrids NDCC-10 for TSS and NDCC-9 for total sugar were top performers respectively Among The findings highlight the potential of genotypes and hybrids in improving quality traits through various breeding programs.

Keywords: Cucumber, quality traits, reducing sugar, dry matter

Introduction
Cucumber (*Cucumis sativus* L.,) is an economically important member of the family cucurbitaceae and its grown commercially as a summer vegetable crop throughout the world for its immature and tender fruits, which are mainly consumed as a salad. It is believed to be originated in India (De Candolle, 1882; Bisht *et al*., 2004; Sebastian *et al*., 2010) [3, 16, 12] and has been cultivated for more than 3000 years. It is one of the oldest vegetable crops. A thermophillic and frost-sensitive crop, cucumber thrives in temperatures above 20 °C. It is rich in carbohydrates, vitamin B and P (Yawalkar, 1985) [15]. As per studies done by Alcazar and Gulick (1983) [17], it recorded that one hundred gram of edible cucumber fruits is reported to provide water – 96 g, carbohydrate - 2.2 g, fat - 0.1 g, protein - 0.6 g, Calcium – 12 mg, Iron - 0.3 mg, Magnesium – 15 mg and phosphorus – 24 mg, Vitamin A - 45IU, Niacin - 0.3 mg, Vitamin B1 and Vitamin B2 - 0.03 mg and 0.02 mg respectively, and Vitamin C – 12 mg. It is also used in Ayurvedic medicines based on the astringent and antipyretic properties of the fruit and oil extracted from seeds of cucumber reported to be associated with brain development. Cucumber is also very well established in the cosmetic industry, owing to its hydrating, soothing and healing properties.

In India, it is cultivated from plains to higher altitudes. In northern India, two crops are cultivated annually that is in spring-summer and kharif season, whereas in hilly areas it is cultivated in autumn summer. In India, the total production of cucumber is 16652 thousand MT from an area of 118,000 hectares with a productivity of 14.11 MT/ha (Anonymous 2021) [1].

Materials and Methods
The present investigation conducted during Zaid seasons 2022-23 (Y1) and 2023-24 (Y2) to study the heritability in narrow sense and genetic advance in percent of mean by using Line x Tester mating design at the Main Experiment Station (MES), Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Ayodhya (U.P.) India.

The experimental site is geographically, falls under humid, sub-tropical climate and is located in between 24.470 and 26.560 N latitude and 82.120 and 83.980 E longitude at an altitude of 113 m above the mean sea stratum in the Gangetic alluvial plains of Eastern Uttar Pradesh. The soil of experimental site was sandy loam with average fertility level with pH in the range of 7.5-8.5. The selected parental lines i.e.; Swarna Sheetal (L1), Pusa Uday (L2), Arka Veera (L3), Phule Shubhangi (L4), Khira 75 (L5), AAUC-2 (L6), uday (L7), NDCC-9 (L8), NDCC-10 (L9) and Solan Srijan (L10) and testers Punjab Naveen (T1), Pusa Barkha (T2) and Pant Kheera-1(T3) were crossed in Line x Tester cross combinations to get 30 F1's that were evaluated in randomized block design in three replications having each experimental unit of single row with spacing of 2.5 m x 0.5 m for the study of heritability in narrow sense and genetic advance in percent of mean. The mean of five plants was calculated and used for statistical analysis. Observations were recorded for six characters as follows total soluble solids (^{0}brix), ascorbic acid (mg/100 g fresh fruit), reducing sugars (%), non-reducing sugar (%), total sugars (%) and dry matter content in fruit (g/100 g). All the recommended agronomic package of practices and plant protection measures were followed to raise good crops.

Results

Per se performance of parents and hybrids, ranges and grand mean for all the seven quality traits over two years (Y1, Y2) and pooled has been presented in Table 1 the results are described below under the following heads:

TSS (^{o}Brix)

In Y1, TSS (^{o}Brix) ranged from 2.94 to3.91 ^{o}Brix for parents and 2.07 to 3.74 ^{o}Brix for hybrids. Pusa Uday (3.91 ^{o}Brix) found maximum for TSS (^{o}Brix) among the parents which was followed by NDCC-10 (3.79 ^{o}Brix), Pusa Barkha (3.33 ^{o}Brix) and Solan Srijan (3.29 ^{o}Brix). The best F_1 hybrid for TSS (^{o}Brix) was recorded for cross L9 xT1 (3.74 ^{o}Brix) followed by L8xT2 (3.74 ^{o}Brix), L3xT3 (3.51 ^{o}Brix) and L4xT3 (3.46 ^{o}Brix). Average over the parental mean (3.24 ^{o}Brix) and Average over the F_1 hybrid mean (3.05 ^{o}Brix) were more or less of the same order.

In Y2, TSS (^{o}Brix) ranged from 2.95 to 3.92 ^{o}Brix for parents and 2.01 to 3.71 ^{o}Brix for hybrids. Pusa Uday (3.92 ^{o}Brix) found maximum for TSS (^{o}Brix) among the parents which was followed by NDCC-10 (3.80 ^{o}Brix), Pusa Barkha (3.31 ^{o}Brix) and Solan Srijan (3.25 ^{o}Brix). The best F_1 hybrid for TSS (^{o}Brix) was recorded for cross L9XT1 (3.71 ^{o}Brix) followed by L8xT2 (3.71 ^{o}Brix), L3 xT1 (3.71 ^{o}Brix), L3 xT3 (3.51 ^{o}Brix) and L4 xT3 (3.46 ^{o}Brix). Average over the parental mean (3.24 ^{o}Brix) and Average over the F_1 hybrid mean (3.06 ^{o}Brix) were more or less of the same order.

In Pooled, TSS (^{o}Brix) ranged from 2.95 to 3.91 ^{o}Brix for parents and 2.04 to 3.72 ^{o}Brix for hybrids. Pusa Uday (3.91 ^{o}Brix) found maximum for TSS (^{o}Brix) among the parents which was followed by NDCC-10 (3.79 ^{o}Brix), Pusa Barkha (3.32 ^{o}Brix) and Solan Srijan (3.27 ^{o}Brix). The best F_1 hybrid for TSS (^{o}Brix) was recorded for cross L9xT1 (3.72 ^{o}Brix) followed by L8xT2 (3.72 ^{o}Brix), L3xT3 (3.50 ^{o}Brix) and L4xT3 (3.45 ^{o}Brix). Average over the parental mean (3.24 ^{o}Brix) and Average over the F_1 hybrid mean (3.06 ^{o}Brix) were more or less of the same order.

Ascorbic acid (mg/100 g)

In Y1, Ascorbic acid (mg/100 g) ranged from 3.20 to 4.29 mg/100 g for parents and 3.21 to 5.60 mg/100 g for hybrids. Solan Srijan (4.29 mg/100 g) found maximum for ascorbic acid (mg/100 g) among the parents which was followed by Punjab Naveen (4.26 mg/100 g), Pusa Barkha (4.21 mg/100 g) and Arka Veera (4.19 mg/100 g). The best F_1 hybrid for ascorbic acid (mg/100 g) was recorded for cross L10XT2 (5.60 mg/100 g) followed by L7xT1 (5.21 mg/100 g), L6XT1 (5.11 mg/100 g) and L7XT2 (5.11 mg/100 g). Average over the parental mean (3.93 mg/100 g) and Average over the F_1 hybrid mean 4.30 (mg/100 g) were more or less of the same order.

In Y2, Ascorbic acid (mg/100 g) ranged from 3.21 to 4.25 mg/100 g for parents and 3.21 to 5.60 mg/100 g for hybrids. Solan Srijan (4.25 mg/100 g) found maximum for ascorbic acid (mg/100 g) among the parents which was followed by Punjab Naveen (4.22 mg/100 g), Uday (4.20 mg/100 g) and NDCC-9 (4.18 mg/100 g). The best F_1 hybrid for ascorbic acid (mg/100 g) was recorded for cross L9XT1 (5.67 mg/100 g) followed by L10XT2 (5.65 mg/100 g) and L6xT1 (5.65 mg/100 g). Average over the parental mean (3.91 mg/100 g) and Average over the F_1 hybrid mean (4.35 mg/100 g) were more or less of the same order.

In Pooled, Ascorbic acid (mg/100 g) ranged from 3.21 to 4.27 mg/100 g for parents and 3.22 to 5.63 mg/100 g for hybrids. Solan Srijan (4.27 mg/100 g) found maximum for ascorbic acid (mg/100 g) among the parents which was followed by Punjab Naveen (4.24 mg/100 g), Pusa Barkha (4.20 mg/100 g) and Uday (4.19 mg/100 g). The best F_1 hybrid for ascorbic acid (mg/100 g) was recorded for cross L10XT2 (5.63 mg/100 g) followed by L6xT1 (5.38 mg/100 g), L5xT2 (5.34 mg/100 g) and L10xT3 (5.33 mg/100 g). Average over the parental mean (3.92 mg/100 g) and Average over the F_1 hybrid mean (4.32 mg/100 g) were more or less of the same order.

Reducing Sugar (%)

In Y1, Reducing Sugar (%) ranged from 0.34 to1.76% for parents and 0.12 to 1.76% for hybrids. Pusa Barkha (1.76%) found maximum for Reducing Sugar (%) among the parents which was followed by Punjab Naveen (1.41%), Pant Kheera-1 (0.84%) and Swarna Sheetal (0.79%). The best F_1 hybrid for Reducing Sugar (%) was recorded for cross L8XT1 (1.74%) followed by L4xT2 (1.37%), L2xT2 (1.36%) L7xT1 (1.36%) and L3xT3 (1.26%). Average over the parental mean (0.75%) and Average over the F_1 hybrid mean (0.85%) were more or less of the same order.

In Y2, Reducing Sugar (%) ranged from 0.34 to1.72% for parents and 0.11 to 1.74% for hybrids.Pusa Barkha (1.72%) found maximum for Reducing Sugar (%) among the parents which were followed by Punjab Naveen (1.41%), Pant Kheera-1 (0.86%) and Swarna Sheetal (0.79%). The best F_1 hybrid for Reducing Sugar (%) was recorded for cross L8XT1 (1.74%) followed by L4xT2 (1.41%), L5xT2 (1.36%), L1xT2 (1.36%), L2xT2 (1.36%) and L6xT3 (1.32%). Average over the parental mean (0.75%) and Average over the F_1 hybrid mean (0.83%) were more or less of the same order.

In Pooled, Reducing Sugar (%) ranged from 0.35 to 1.74% for parents and 0.11 to 1.74% for hybrids. Pusa Barkha (1.74%) found maximum for Reducing Sugar (%) among the parents which was followed by Punjab Naveen (1.41%), Pant Kheera-1 (0.85%) and Swarna Sheetal (0.78%). The

best F_1 hybrid for Reducing Sugar (%) was recorded for cross L8XT1 (1.74%) followed by L4xT2 (1.39%), L5xT2 (1.37%) and L3 X T3 (1.23%). Average over the parental mean (0.75%) and Average over the F_1 hybrid mean (0.84%) were more or less of the same order.

Non Reducing Sugar (%)

In Y1, non-reducing Sugar (%) ranged from 0.79 to 2.93% for parents and 0.82 to 4.05% for hybrids. NDCC-9 (2.93%) found maximum for non-reducing Sugar (%) among the parents which was followed by Khira -75 (2.81%), Solan Srijan (2.38%) and AAUC-2 (2.24%). The best F_1 hybrid for non-reducing Sugar (%) was recorded for cross L8XT2 (4.05%) followed by L10xT3 (3.95%), L9xT3 (3.83%) and L9xT2 (3.64%). Average over the parental mean (1.98%) and Average over the F_1 hybrid mean (2.25%) were more or less of the same order.

In Y2, non-reducing Sugar (%) ranged from 0.77 to 2.92% for parents and 0.81 to 4.06% for hybrids. NDCC-9 (2.92%) found maximum for non-reducing Sugar (%) among the parents which was followed by Khira -75 (2.82%), Solan Srijan (2.37%) and AAUC-2 (2.23%). The best F_1 hybrid for non-reducing Sugar (%) was recorded for cross L8XT2 (4.06%) followed by L10xT3 (3.94%), L9xT3 (3.84%) and L9xT2 (3.64%). Average over the parental mean (1.97%) and Average over the F_1 hybrid mean (2.25%) were more or less of the same order.

In Pooled, non-reducing Sugar (%) ranged from 0.78 to 2.93% for parents and 0.81 to 4.05% for hybrids. NDCC-9 (2.93%) found maximum for non-reducing Sugar (%) among the parents which was followed by Khira -75 (2.81%), Solan Srijan (2.38%) and AAUC-2 (2.24%). The best F_1 hybrid for non-reducing Sugar (%) was recorded for cross L8xT2 (4.05%) followed by L10xT3 (3.94%), L9xT3 (3.84%) and L9xT2 (3.64%). Average over the parental mean (1.98%) and Average over the F_1 hybrid mean (2.25%) were more or less of the same order.

Total Sugar (%)

In Y1, total Sugar (%) ranged from 2.25 to 3.45% for parents and 2.18 to 4.85% for hybrids. AAUC-2 (3.45%) found maximum for total Sugar (%) among the parents which was followed by NDCC-10 (3.27%), Solan Srijan (3.06%) and Uday (2.87%). The best F_1 hybrid for total sugar (%) was recorded for cross L8XT2 (4.85%) followed by L10xT3 (4.82%), L9xT2 (4.30%) and L7xT1 (4.16%). Average over the parental mean (2.72%) and Average over the F_1 hybrid mean (3.09%) were more or less of the same order. In Y2, total Sugar (%) ranged from 2.27 to 3.47% for parents and 2.22 to 4.86% for hybrids. AAUC-2 (3.47%) found maximum for total Sugar (%) among the parents which was followed by NDCC-10 (3.27%), Solan Srijan (3.07%) and Uday (2.89%). The best F_1 hybrid for total sugar (%) was recorded for cross L8XT2 (4.86%) followed by L10xT3 (4.81%), L9xT2 (4.32%) and L8xT1 (4.19%). Average over the parental mean (2.72%) and Average over the F_1 hybrid mean (3.09%) were more or less of the same order.

In Pooled, Total Sugar (%) ranged from 2.26 to 3.46% for parents and 2.20 to 4.85% for hybrids. Khira-75 (3.46%) found maximum for total Sugar (%) among the parents which was followed by NDCC-9 (3.27%), Solan Srijan (3.06%) and Uday (2.88%). The best F_1 hybrid for total sugar (%) was recorded for cross L8XT2 (4.85%) followed by L10xT3 (4.81%), L9xT2 (4.31%) and L8xT1 (4.17%). Average over the parental mean (2.72%) and Average over the F_1 hybrid mean (3.09%) were more or less of the same order.

Dry Matter (%)

In Y1, dry matter (%) ranged from 4.36 to 5.87% for parents and 4.14 to 5.97% for hybrids. Pusa Barkha (5.87%) found maximum for dry matter (%) among the parents which was followed by Punjab Naveen (5.85%), Phule Subhangi (5.68%) and Khira-75 (5.16%). The best F_1 hybrid for dry matter (%) was recorded for cross L7XT1 (5.97%) followed by L7xT3 (5.87%), L4xT1 (5.69%) and L10xT2 (4.88%). Average over the parental mean (4.99%) and Average over the F_1 hybrid mean (4.83%) were more or less of the same order.

In Y2, dry matter (%) ranged from 4.40 to 5.70% for parents and 4.13 to 5.98% for hybrids. Punjab naveen (5.70%) found maximum for dry matter (%) among the parents which was followed by Phule Subhangi (5.68%), Pusa Barkha (5.60%) and Khira-75 (5.16%). The best F_1 hybrid for dry matter (%) was recorded for cross L7XT1 (5.97%) followed by L7xT3 (5.88%), L4xT1 (5.67%) and L1xT2 (5.01%). Average over the parental mean (4.96%) and Average over the F_1 hybrid mean (4.81%) were more or less of the same order.

In pooled, dry matter (%) ranged from 4.38 to 5.77% for parents and 4.14 to 5.98% for hybrids. Punjab naveen (5.77%) found maximum for dry matter (%) among the parents which was followed by Pusa Barkha (5.74%), Phule Subhangi (5.68%), and Khira-75 (5.16%). The best F_1 hybrid for dry matter (%) was recorded for cross L7xT1 (5.98%) followed by L7xT3 (5.88%), L4xT1 (5.68%) and L1xT2 (5.04%). Average over the parental mean (4.97%) and Average over the F_1 hybrid mean (4.82%) were more or less of the same order. Similar findings also reported by Bisht *et al.* (2023) [2], Dhiman *et al.* (2017) [4], Idehen *et al.* (2021) [5], Kumar *et al.* (2013) [8], Kumar *et al.* (2019) [7], Prathyusha *et al.* (2020) [11]. Detailed data represented in Table 1.

Table 1: Mean performance, general mean, range, coefficient of variation, critical difference and standard error for six quality characters of line × tester set of 30 F1's and their 13 parents along with 1 Check variety in cucumber over two years (Y1 = 2023, Y2 = 2024**) and pooled.**

Characters	TSS (Brix)			Ascorbic acid (mg/100)			Reducing sugar (%)		
Line	**Y1**	**Y2**	**Pooled**	**Y1**	**Y2**	**Pooled**	**Y1**	**Y2**	**Pooled**
Swarna Sheetal	3.09	3.08	3.09	3.09	3.08	3.09	3.09	3.08	3.09
Pusa Uday	3.91	3.92	3.91	3.91	3.92	3.91	3.91	3.92	3.91
Arka Veera	2.97	2.96	2.97	2.97	2.96	2.97	2.97	2.96	2.97
Phule Shubhangi	3.10	3.11	3.11	3.10	3.11	3.11	3.10	3.11	3.11
Khira 75	3.29	3.25	3.27	3.29	3.25	3.27	3.29	3.25	3.27
AAUC-2	2.94	2.95	2.95	2.94	2.95	2.95	2.94	2.95	2.95
Uday	3.20	3.21	3.20	3.20	3.21	3.20	3.20	3.21	3.20
NDCC-9	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25

NDCC-10	3.79	3.80	3.79	3.79	3.80	3.79	3.79	3.80	3.79
Solan Srijan	3.29	3.25	3.27	3.29	3.25	3.27	3.29	3.25	3.27
Tester									

Punjab Naveen	2.96	2.97	2.96	4.26	4.22	4.24	1.41	1.41	1.41
Pusa Bharkha	3.33	3.31	3.32	4.21	4.18	4.20	1.76	1.72	1.74
Pant Kheera-1	3.02	3.05	3.03	4.19	4.17	4.18	0.84	0.86	0.85
Average	3.24	3.24	3.24	3.93	3.91	3.92	0.75	0.75	0.75
Min	2.94	2.95	2.95	3.20	3.21	3.21	0.34	0.34	0.35
Max	3.91	3.92	3.91	4.29	4.25	4.27	1.76	1.72	1.74
Hybrids									
L1xT1	3.18	3.17	3.17	4.13	4.12	4.13	0.37	0.36	0.36
L1xT2	2.44	2.48	2.46	3.92	3.90	3.91	1.35	1.36	1.36
L1xT3	2.47	2.41	2.44	4.19	4.17	4.18	0.72	0.71	0.72
L2xT1	2.07	2.01	2.04	3.22	3.26	3.24	1.15	1.10	1.13
L2xT2	3.18	3.15	3.16	3.92	3.90	3.91	1.36	1.36	1.36
L2xT3	3.27	3.21	3.24	3.21	3.27	3.24	0.86	0.81	0.84
L3xT1	3.07	3.71	3.39	4.11	4.17	4.14	0.63	0.61	0.62

L3xT2	3.10	3.11	3.11	3.93	3.91	3.92	0.49	0.49	0.49
L3xT3	3.51	3.48	3.50	4.26	4.24	4.25	1.26	1.20	1.23
L4xT1	2.49	2.45	2.47	3.23	3.21	3.22	0.88	0.84	0.86
L4xT2	2.87	2.81	2.84	4.12	4.18	4.15	1.37	1.41	1.39
L4xT3	3.46	3.44	3.45	4.52	4.58	4.55	0.88	0.82	0.85
L5xT1	2.43	2.41	2.42	3.68	3.64	3.66	0.97	0.93	0.95
L5xT2	2.91	2.95	2.93	5.02	5.67	5.34	1.38	1.36	1.37
L5xT3	3.11	3.12	3.11	4.99	4.97	4.98	1.16	1.15	1.16
L6xT1	3.03	3.04	3.03	5.11	5.65	5.38	0.57	0.58	0.58
L6xT2	3.42	3.43	3.43	3.99	3.89	3.94	1.18	1.14	1.16
L6xT3	2.50	2.49	2.49	4.55	4.56	4.56	0.87	0.86	0.86
L7xT1	2.78	2.75	2.76	5.21	5.22	5.21	1.36	1.32	1.34
L7xT2	2.93	2.91	2.92	5.11	5.11	5.11	1.05	1.05	1.05
L7xT3	2.30	2.29	2.30	4.98	4.99	4.98	0.56	0.53	0.54

L8xT1	2.87	2.85	2.86	4.92	4.95	4.93	1.74	1.74	1.74
L8xT2	3.74	3.71	3.72	4.95	4.97	4.96	0.82	0.80	0.81
L8xT3	2.54	2.51	2.53	4.88	4.89	4.89	0.68	0.67	0.67
L9xT1	3.74	3.71	3.72	5.01	5.67	5.34	0.31	0.30	0.30
L9xT2	2.81	2.79	2.80	4.98	4.95	4.97	0.68	0.68	0.68
L9xT3	2.77	2.75	2.76	4.82	4.85	4.83	0.32	0.33	0.32
L10xT1	2.51	2.57	2.54	4.86	4.86	4.86	0.12	0.11	0.11
L10xT2	3.14	3.15	3.15	5.60	5.65	5.63	0.63	0.62	0.63
L10xT3	3.21	3.27	3.24	5.01	5.65	5.33	0.88	0.87	0.87
Check (NS-404)	3.40	3.48	3.44	4.99	4.99	4.99	0.59	0.57	0.58
Mean	3.05	3.06	3.06	4.30	4.35	4.32	0.85	0.83	0.84
Min	2.07	2.01	2.04	3.21	3.21	3.22	0.12	0.11	0.11
Max	3.91	3.92	3.91	5.60	5.67	5.63	1.76	1.74	1.74
SE(d)	0.06	0.06	0.04	0.10	0.09	0.06	0.02	0.03	0.02
C.D.	0.13	0.12	0.09	0.19	0.17	0.12	0.04	0.06	0.04
C.V.	2.57	2.33	1.75	2.76	2.40	1.74	3.25	4.12	2.83

Characters	**Non Reducing Sugar (%)**			**Total Sugar%**			**Dry Matter%**		
Line	**Y1**	**Y2**	**Pooled**	**Y1**	**Y2**	**Pooled**	**Y1**	**Y2**	**Pooled**
Swarna Sheetal	2.04	2.04	2.04	2.81	2.83	2.82	4.69	4.67	4.68
Pusa Uday	1.56	1.54	1.55	2.30	2.29	2.29	4.79	4.79	4.79
Arka Veera	2.16	2.17	2.16	2.51	2.51	2.51	4.74	4.73	4.73
Phule Shubhangi	1.88	1.87	1.87	2.62	2.59	2.61	5.68	5.68	5.68
Khira 75	2.81	2.82	2.81	3.45	3.47	3.46	5.16	5.16	5.16
AAUC-2	2.24	2.23	2.24	2.58	2.58	2.58	4.69	4.90	4.80
Uday	2.20	2.20	2.20	2.87	2.89	2.88	4.36	4.40	4.38
NDCC-9	2.93	2.92	2.93	3.27	3.27	3.27	4.67	4.70	4.68
NDCC-10	1.91	1.90	1.91	2.27	2.28	2.27	4.75	4.80	4.78
Solan Srijan	2.38	2.37	2.38	3.06	3.07	3.06	4.98	4.80	4.88
Tester									
Punjab Naveen	1.42	1.41	1.42	2.82	2.82	2.82	5.85	5.70	5.77
Pusa Bharkha	0.79	0.77	0.78	2.53	2.49	2.51	5.87	5.60	5.74
Pant Kheera-1	1.42	1.41	1.42	2.25	2.27	2.26	4.67	4.50	4.59
Average	1.98	1.97	1.98	2.72	2.72	2.72	4.99	4.96	4.97

Min	0.79	0.77	0.78	2.25	2.27	2.26	4.36	4.40	4.38
Max	2.93	2.92	2.93	3.45	3.47	3.46	5.87	5.70	5.77

Hybrids									
L1xT1	2.79	2.78	2.79	3.16	3.14	3.15	4.15	4.14	4.14
L1xT2	1.23	1.22	1.23	2.58	2.58	2.58	5.07	5.01	5.04
L1xT3	2.44	2.43	2.43	3.15	3.14	3.14	4.68	4.65	4.66
L2xT1	1.20	1.19	1.20	2.35	2.29	2.32	4.81	4.81	4.81
L2xT2	1.52	1.51	1.51	2.87	2.86	2.87	4.66	4.67	4.67
L2xT3	2.13	2.14	2.13	2.97	2.95	2.97	4.31	4.31	4.31
L3xT1	2.14	2.15	2.14	2.76	2.76	2.76	4.88	4.88	4.88
L3xT2	2.28	2.29	2.29	2.76	2.78	2.77	4.14	4.13	4.14
L3xT3	1.01	1.08	1.05	2.26	2.28	2.27	4.80	4.70	4.75
L4xT1	1.76	1.75	1.76	2.63	2.58	2.61	5.69	5.67	5.68
L4xT2	0.82	0.81	0.81	2.18	2.22	2.20	4.78	4.79	4.79
L4xT3	1.41	1.41	1.41	2.27	2.23	2.25	4.74	4.73	4.74
L5xT1	1.54	1.54	1.54	2.49	2.47	2.48	4.68	4.68	4.68
L5xT2	0.89	0.90	0.89	2.26	2.26	2.26	4.16	4.16	4.16
L5xT3	1.22	1.21	1.22	2.37	2.36	2.36	4.69	4.70	4.70
L6xT1	3.05	3.04	3.05	3.62	3.62	3.62	4.36	4.35	4.36
L6xT2	2.81	2.81	2.81	3.97	3.96	3.97	4.67	4.68	4.67
L6xT3	1.98	1.99	1.98	2.84	2.84	2.84	4.75	4.76	4.76

L7xT1	2.81	2.82	2.82	4.16	4.14	4.15	5.97	5.98	5.98
L7xT2	1.83	1.82	1.82	2.87	2.87	2.87	4.85	4.85	4.85
L7xT3	3.13	3.13	3.13	3.67	3.66	3.67	5.87	5.88	5.88
L8xT1	2.41	2.45	2.43	4.14	4.19	4.17	4.67	4.68	4.68
L8xT2	4.05	4.06	4.05	4.85	4.86	4.85	4.15	4.15	4.15
L8xT3	3.01	3.07	3.04	3.68	3.74	3.71	5.08	5.01	5.04
L9xT1	3.35	3.36	3.36	3.65	3.66	3.66	4.68	4.66	4.67
L9xT2	3.64	3.64	3.64	4.30	4.32	4.31	4.81	4.80	4.80
L9xT3	3.83	3.84	3.84	4.15	4.17	4.16	4.67	4.65	4.66
L10xT1	3.55	3.54	3.55	3.66	3.65	3.66	4.31	4.30	4.30
L10xT2	3.26	3.26	3.26	3.87	3.88	3.88	4.88	4.87	4.87
L10xT3	3.95	3.94	3.94	4.82	4.81	4.81	4.14	4.13	4.14
Check (NS-404)	3.41	3.40	3.40	4.00	3.97	3.99	4.80	4.79	4.80
Mean	2.25	2.25	2.25	3.09	3.09	3.09	4.83	4.81	4.82
Min	0.82	0.81	0.81	2.18	2.22	2.20	4.14	4.13	4.14
Max	4.05	4.06	4.05	4.85	4.86	4.85	5.97	5.98	5.98
SE(d)	0.08	0.06	0.05	0.07	0.06	0.05	0.10	0.10	0.07
C.D.	0.15	0.11	0.09	0.15	0.12	0.09	0.21	0.19	0.13
C.V.	4.17	3.03	2.55	2.89	2.40	1.82	2.62	2.45	1.72

Conclusion

In conclusion, the comprehensive analysis of parental and hybrid performance across seven quality traits over two years reveals significant insights into the genetic potential and variability within the studied genotypes. Across traits such as TSS, ascorbic acid, reducing sugar, non-reducing sugar, total sugar, and dry matter, notable variations were observed both within and between parent varieties and their hybrids. The highest values for these traits were consistently recorded by specific genotypes, highlighting their potential for selection and breeding purposes. The findings underscore the importance of genetic diversity in enhancing crop quality attributes, thus contributing to future breeding strategies aimed at developing superior varieties. Further research in this direction could facilitate the development of crops that meet diverse consumer preferences and nutritional needs.

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