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Mean Performance of the Parents and Hybrids for Yield and Yield Contributing Traits in Tomato

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ABSTRACT

The present investigation conducted at Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, during rabi season 2023-24 & 2024-25 to evaluate 67 genotypes (11 parents, 55 hybrids and 1 check variety) in a Randomized Complete Block Design (RBD) with three replications for quantitative traits. Significant genetic variability was observed among hybrids, with several demonstrating early flowering and maturity compared to Kashi Aman. Superior hybrids, including $P_1 \times P_6$, $P_4 \times P_7$, and $P_6 \times P_7$, exhibited remarkable early maturity, improved vegetative growth, and greater fruit numbers per cluster and plant. Hybrids like $P_4 \times P_7$ and $P_3 \times P_8$ showed superior fruit weight and thicker pericarps, enhancing marketability. Highest yields were recorded in hybrids $P_5 \times P_{10}$, $P_1 \times P_6$, and $P_4 \times P_7$, significantly outperforming the check variety.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the world's most popular fruit-vegetable crops, extensively cultivated globally due to its adaptability, high yield potential, and diverse culinary uses in both fresh and processed forms. It is a predominantly self-pollinated crop, although cross-pollination of up to 5% has been documented (Muthukumar et al., 2017). Belonging to the Solanaceae family, tomato has a diploid chromosome number of 2n = 24 and comprises annual or short-lived perennial herbaceous plants. It typically exhibits day-neutral growth and thrives best in warm-season conditions.

Globally, tomato is grown on approximately 5.41 million hectares, yielding about 192.31 million metric tons, with an average productivity of 35.53 metric tons per hectare (Anonymous, 2024). India stands third in global tomato production, following China and the USA. In India, tomato cultivation covers an area of 854 thousand hectares, resulting in a total production of approximately 21.32 million metric tons and an average productivity of 24.97 metric tons per hectare (Anonymous, 2024). The leading tomato-producing states in India include Andhra Pradesh, Madhya Pradesh, Karnataka, West Bengal, Maharashtra, Uttar Pradesh, Haryana, Punjab, Gujarat, and Bihar, collectively contributing approximately 90% of the national production. Among these, Uttar Pradesh ranks sixth, cultivating tomato on an area of 23.50 thousand hectares, producing 940.12 thousand metric tons, with a productivity of 40.00 metric tons per hectare (Anonymous, 2024).

With growing consumer demand and increasing industrial requirements, there is a pressing need for the continuous development of superior tomato varieties and hybrids that can meet present-day challenges. Today, tomato cultivation has evolved into a significant segment of the global horticultural industry, economically exploited under various environmental conditions. Success in breeding superior tomato cultivars critically depends on the assessment of genetic variability and the efficient selection of suitable parental lines exhibiting desirable characteristics. Most economically significant traits in tomato—such as yield, fruit quality, and adaptability—are polygenic and substantially influenced by environmental factors, complicating the determination of their inheritance patterns. Thus, accurately distinguishing between genetic and environmental variation is essential for effective breeding strategies.

Improving tomato productivity through traditional breeding methods provides sustainable, affordable, and eco-friendly solutions. Hybrids developed from genetically diverse parental lines typically exhibit increased hybrid vigor, often outperforming their parents regarding yield, early maturity, and fruit quality traits. High yield potential, enhanced fruit quality, improved nutritional attributes, and better processing characteristics have become primary targets of tomato breeding programs globally. Therefore, understanding the nature and magnitude of variability, gene action, combining ability, heterosis, and trait correlations within the available germplasm is vital for achieving these breeding objectives.

By systematically combining statistical insights—such as mean values, coefficient of variation (CV), critical difference (CD), heterosis, potence ratio, and correlations among yield and quality traits—the present research aims to evaluate tomato hybrids comprehensively. The ultimate goal is to identify robust, high-performing hybrid cultivars suitable for India's varied agro-climatic conditions. This research will serve as a foundational guide for future breeding efforts, enhancing the development and widespread adoption of tomato hybrids characterized by improved yield potential, early maturity, superior nutritional content, and consumer-preferred fruit qualities.

Materials and Methods –

The experiment was conducted at main Experimental Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya. Geographically, experimental site falls under humid sub-tropical climate and is located in between 24.47º and 26.56º N latitude, 82.12º and 83.58 º E longitudes at an altitude of 113 m above the mean sea level. The soil type of experimental site was sandy-loam with average fertility level and Ph in the range of 7.5-8.5. The experimental materials for the present study comprised of eleven promising and diverse inbreds and varieties of tomato selected on the basis of genetic variability from the germplasm stock maintained in the Department of Vegetable Science, A.N.D.U.A.T., Kumarganj, Ayodhya (U.P.) India. The selected parental lines i.e.; NDT-2019-01 (P_1), Punjab Chhuhara (P_2), NDT-2019-02 (P_3), NDT-2 (P_4), NDT-4 (P_5), NDT-7 (P_6), NDT-6 (P_7), NDT-2019-03 (P_8), NDT-2019-04 (P_9), NDT-2020-01(P_{10}) and NDT-2020-02(P_{11}) with commercial check variety Kashi Aman were crossed in all possible cross combinations (excluding reciprocals) during year, 2022-23 to get 55 F_1's hybrid for the study of the mean performance of parental line and their resultant F_1. All Sixty Seven genotypes (eleven parental lines and fifty five F_1 as well as one check variety) were evaluated in Randomized Complete Block Design (RBD) with three replications. The row to row spacing was kept 0.6 m and plant to plant spacing 0.5 m in both the season (Y_1, Y_2) and pooled. To raise a good crop, all agronomic techniques were followed. The data were recorded on eleven quantitative traits viz., Days to 50% flowering, Days to first fruit harvest, Plant height (cm), Number of fruits per clusters, Number of fruits per plant, Average fruit weight(g), Pericarp thickness(mm),Equatorial diameter(cm), Number of locules per fruit, Fruit yield per plant (Kg) and Fruit yield (q/h) .The following is a summary of the findings in relation to several aspects:

Results and Discussion

The present study evaluated 67 genotypes derived from 11 genetically diverse parents along with the check variety kashi aman across two consecutive years using a randomized block design (RBD). The pooled analysis revealed statistically significant ($p < 0.05$) differences among hybrids for all studied traits.

Hybrid vigor in earliness traits was evident, with several hybrids flowering and maturing significantly earlier than Kashi Aman. Specifically, hybrids $P_1 \times P_6$ (NDT-2019-01 × NDT-7), $P_4 \times P_7$ (NDT-2 × NDT-6), and P6×P7 (NDT-7 × NDT-6) demonstrated Kashi Aman earliness, flowering approximately 5 to 8 days ahead of kasha aman (32.0, 30.3, and 29.0 days vs. 37.11 days, respectively). This advantage translated into earlier harvesting, notably observed in hybrid P6×P7, which initiated fruit harvest at 79.7 days compared to 83.3 days in Kashi aman. These findings align with recent reports indicating that early maturity in tomato hybrids often coincides with improved yield due to heterotic vigor (Singh *et al.*, 2021; Chauhan *et al.*, 2023).

Significant variations in vegetative traits were also recorded, with several hybrids surpassing Kashi Aman in plant height. Hybrids $P_1 \times P_8$ and $P_1 \times P_7$ exhibited pronounced vegetative vigor, attaining heights between 109 and 114 cm, exceeding the moderate-height check Kashi aman (97.5 cm). Previous studies corroborate these results, highlighting that increased plant height and vegetative vigor are frequently correlated with enhanced yield potential in tomato hybrids (Kumar *et al.*, 2022; Talukder *et al.*, 2023).

Floral characteristics differed significantly, with several hybrids producing more flowers per cluster compared to Kashi Aman. For instance, hybrids $P_1 \times P_7$ and $P_1 \times P_6$ exhibited superior floral productivity (7.50 and 7.00 flowers per cluster, respectively), significantly surpassing the check (6.50 flowers per cluster). Consistent with our results, a higher number of flowers per cluster is positively associated with increased fruit set and yield in tomatoes (Talukder *et al.*, 2023).

Fruit set attributes markedly favored superior hybrids. The hybrid $P_1 \times P_6$ achieved an average of 6.00 fruits per cluster, significantly higher than Kashi Aman(4.00 fruits). Furthermore, at the plant level, the highest fruit count was recorded in hybrid $P_2 \times P_4$ (27.00 fruits per plant), significantly surpassing Kashi Aman(17.48 fruits per plant). Although this increase was slightly below the critical difference threshold, it indicates substantial improvement. Similar patterns were noted by recent researchers emphasizing the importance of hybrids combining large fruit clusters with multiple clusters per plant for maximizing yield potential (Chauhan et al., 2023; Kumar *et al*., 2022).

Fruit size and quality traits exhibited substantial variability, with numerous hybrids outperforming Kashi Aman. Notably, hybrids $P_4 \times P_7$, $P_3 \times P_8$, and $P_1 \times P_7$ yielded significantly heavier fruits (around 99 g) compared to Kashi Aman(84.7 g). These hybrids also demonstrated enhanced pericarp thickness, crucial for fruit firmness and marketability; notably, $P_4 \times P_7$ exhibited an impressive pericarp thickness of 5.06 mm. Such traits align with previous findings highlighting the significance of combining heavy fruits and thick pericarp in superior tomato hybrids (Talukder *et al*., 2023).

The cumulative advantage of superior hybrids translated into significantly higher yields compared to Kashi Aman. Hybrid $P_5 \times P_{10}$ recorded the highest yield at 6.48 kg per plant (651.41 q/ha), significantly exceeding the yield of Kashi Aman (4.92 kg per plant; 491.97 q/ha). Other top-performing hybrids included $P_1 \times P_6$, $P_4 \times P_7$, $P_6 \times P_7$, $P_4 \times P_6$, $P_3 \times P_8$, and $P_2 \times P_8$, all yielding between 644.45 and 648.28 q/ha. Conversely, hybrids such as $P_2 \times P_7$ and $P_7 \times P_9$ yielded below parental averages, underperforming relative to Kashi Aman. These findings support previous observations that elite F_1 hybrids frequently surpass standard varieties in terms of yield due to synergistic combinations of favorable traits (Chauhan *et al.*, 2023; Kumar *et al.*, 2022; Talukder *et al.*, 2023).

CONCLUSION

The study conclusively demonstrates significant heterosis in multiple tomato hybrids across traits, including earliness, vegetative vigor, floral productivity, fruit setting, and yield potential. Hybrids $P_1 \times$P6, $P_4 \times P_7$, and $P_5 \times P_{10}$ emerged as particularly promising due to their outstanding performance across various agronomic and yield-related traits. These findings underscore the utility of targeted hybridization strategies to develop superior tomato varieties that meet market demands for early maturity, high yield, and desirable fruit quality.

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Table 1: Mean performance of parental lines and F_1 hybrids including Range, CV% for 11 Characters of half diallel set of 55 F_1 and 11 parents in tomato.

SN.	Parent/Hybrids	Days to 50% flowering			Days to first fruit harvest			Plant height(cm)			Number of fruits per clusters		
		Y1	Y2	P	Y1	Y2	P	Y1	Y2	P	Y1	Y2	P
	Parents												
1	NDT-2019-01	35.67	37.42	36.55	86.33	90.43	88.38	91.33	98.89	95.11	3.33	3.67	3.5
2	Punjab chhuhara	34.33	36.32	35.32	82.33	85	83.67	38.33	42.51	40.42	2.67	3.33	3
3	NDT-2019-02	33.67	35.59	34.63	85.33	90.62	87.98	129	138.07	133.54	3.67	3.67	3.67
4	NDT-2	32.33	33.8	33.07	84.67	90.02	87.34	59.67	66.04	62.85	5.33	5.33	5.33
5	NDT-4	31.33	33.76	32.55	82.33	88.11	85.22	75	82.27	78.64	3.67	3.67	3.67
6	NDT-7	32	33.17	32.58	83.33	84.67	84	90.33	98.73	94.53	3.67	4	3.83
7	NDT-6	33.67	35.2	34.44	82.67	85	83.83	85.67	92.81	89.24	4.33	4.33	4.33
8	NDT-2019-03	36.33	38.06	37.2	87.33	91.1	89.22	51.67	57.15	54.41	4	4.67	4.33
9	NDT-2019-04	33.33	34.43	33.88	84.33	88	86.17	79	84.6	81.8	4	4.67	4.33
10	NDT-2020-01	34.67	36.81	35.74	86	91.03	88.51	87.67	97.02	92.34	4.33	5.33	4.83
11	NDT-2020-02	30.67	32.6	31.63	84	86	85	74.67	81.92	78.29	4	4	4
	Mean	**33.45**	**35.2**	**34.33**	**84.42**	**88.18**	**86.3**	**78.39**	**85.46**	**81.92**	**3.91**	**4.24**	**4.07**
	Min	**30.67**	**32.6**	**31.63**	**82.33**	**84.67**	**83.67**	**38.33**	**42.51**	**40.42**	**2.67**	**3.33**	**3**
	Max	**36.33**	**38.06**	**37.2**	**87.33**	**91.1**	**89.22**	**129**	**138.07**	**133.54**	**5.33**	**5.33**	**5.33**
	Hybrids												
12	$P_1 \times P_2$	34	36.36	35.18	84	88.06	86.03	92	100.57	96.29	4.67	5.33	5
13	$P_1 \times P_3$	32	32.52	32.26	83	86	84.5	118	130.96	124.48	3.67	4.33	4
14	$P_1 \times P_4$	31.67	32.55	32.11	85.67	88.33	87	89.67	95.94	92.8	3.33	4.33	3.83
15	$P_1 \times P_5$	34	35.47	34.74	83	88.8	85.9	110.67	122.51	116.59	4.33	5.67	5
16	$P_1 \times P_6$	31.33	32.69	32.01	82.33	84.67	83.5	79.33	87.01	83.17	6.33	5.67	6
17	$P_1 \times P_7$	33	34.92	33.96	83.33	88	85.67	104.33	114.12	109.23	6	6.33	6.17

18	**$P_1 \times P_8$**	34.67	35.5	35.08	85	88.08	86.54	105.33	114.13	109.73	5	5.33	5.17
19	**$P_1 \times P_9$**	32	33.55	32.78	85	86	85.5	68	75.35	71.68	5.67	6.33	6
20	**$P_1 \times P_{10}$**	34.33	36.02	35.18	84.67	88.73	86.7	96	102.68	99.34	3.67	4.33	4
21	**$P_1 \times P_{11}$**	29.33	31.03	30.18	82	84.93	83.47	53	58.64	55.82	3.33	3.67	3.5
22	**$P_2 \times P_3$**	31	32.75	31.88	79.33	83.23	81.28	46	50.46	48.23	3.67	4	3.83
23	**$P_2 \times P_4$**	29	30.32	29.66	80.67	85.33	83	71.33	77.98	74.66	3.67	4	3.83
24	**$P_2 \times P_5$**	30.33	32.7	31.52	82.33	87	84.67	62	68.66	65.33	4.33	5.33	4.83
25	**$P_2 \times P_6$**	30	31.11	30.56	79.67	83.26	81.47	50.33	53.86	52.1	4.33	5	4.67
26	**$P_2 \times P_7$**	29.33	30.66	30	77.33	83.33	80.33	54.67	60.5	57.59	3	3.67	3.33
27	**$P_2 \times P_8$**	30.33	31.77	31.05	82.67	85.67	84.17	97.67	107.08	102.38	3.67	4.33	4
28	**$P_2 \times P_9$**	31.33	32.36	31.85	80.33	83.98	82.16	59.67	65.19	62.43	3	3.33	3.17
29	**$P_2 \times P_{10}$**	31.67	33.59	32.63	83	86.95	84.98	57	61.83	59.42	2	2.67	2.33
30	**$P_2 \times P_{11}$**	30.33	32.25	31.29	78.67	81.2	79.94	46.33	50.64	48.49	3.33	4.33	3.83
31	**$P_3 \times P_4$**	29	31.04	30.02	79.67	84.53	82.1	60.33	64.62	62.48	3.33	3.67	3.5
32	**$P_3 \times P_5$**	29.33	29.81	29.57	79.33	84.34	81.84	105.33	116.55	110.94	4	5	4.5
33	**$P_3 \times P_6$**	29.67	30.51	30.09	79	84.54	81.77	93.67	102.72	98.19	5.67	6	5.83
34	**$P_3 \times P_7$**	33	34.43	33.71	82	83.31	82.66	110	120.25	115.13	6.33	7.33	6.83
35	**$P_3 \times P_8$**	32.67	34.1	33.38	83.67	86.07	84.87	63.33	70.22	66.78	5.33	6.33	5.83
36	**$P_3 \times P_9$**	30.67	32.45	31.56	81.67	85.19	83.43	109	116.61	112.8	5	6	5.5
37	**$P_3 \times P_{10}$**	32.67	33.46	33.06	83	86.63	84.81	98.33	108.83	103.58	3.33	3.67	3.5
38	**$P_3 \times P_{11}$**	29	30.41	29.7	80.33	85	82.67	52	57.04	54.52	3.67	4.33	4
39	**$P_4 \times P_5$**	29.67	31.12	30.39	79.33	81.25	80.29	94.67	103.51	99.09	4	4.33	4.17
40	**$P_4 \times P_6$**	30	31.73	30.86	81.33	85.27	83.3	51.33	55.64	53.49	4.67	5.33	5
41	**$P_4 \times P_7$**	30.33	32.05	31.19	80.67	83.59	82.13	98.67	107.84	103.26	3.67	4.33	4
42	**$P_4 \times P_8$**	32	33.44	32.72	83	85.6	84.3	96.33	103.07	99.7	3.67	4.33	4
43	**$P_4 \times P_9$**	31	33.4	32.2	80.33	86	83.17	57.33	63.44	60.39	5.33	5.33	5.33
44	**$P_4 \times P_{10}$**	31.33	32.47	31.9	82	84.33	83.17	53.33	58.5	55.92	4	4	4
45	**$P_4 \times P_{11}$**	30.67	32.06	31.37	79.67	84.14	81.9	92.67	100.69	96.68	3.67	4.67	4.17

46	**$P_5 \times P_6$**	30	31.43	30.72	80	82.89	81.45	89.67	97.3	93.49	4	4.33	4.17
47	**$P_5 \times P_7$**	31	31.99	31.5	80.33	81.28	80.81	136.33	146.75	141.54	4.67	5.33	5
48	**$P_5 \times P_8$**	31	32.92	31.96	81.33	85.24	83.29	144.67	159.13	151.9	3.33	3.67	3.5
49	**$P_5 \times P_9$**	30.67	32.6	31.63	78.67	81.52	80.09	85	93.22	89.11	3.67	4	3.83
50	**$P_5 \times P_{10}$**	31.33	33.53	32.43	80	83.94	81.97	134.67	147.72	141.19	5	5.33	5.17
51	**$P_5 \times P_{11}$**	30.33	30.82	30.57	78	82.51	80.25	74.33	81.04	77.69	4.33	4.67	4.5
52	**$P_6 \times P_7$**	29	29.83	29.42	79.33	83.83	81.58	104.67	113.74	109.21	5.33	5.33	5.33
53	**$P_6 \times P_8$**	31.33	32.68	32.01	82	85.68	83.84	123	131.61	127.3	4.67	5.67	5.17
54	**$P_6 \times P_9$**	31	32.35	31.67	80.67	86.93	83.8	86	94.62	90.31	4	4.33	4.17
55	**$P_6 \times P_{10}$**	30.33	32.11	31.22	81.67	84.65	83.16	75.67	82.99	79.33	3.67	3.67	3.67
56	**$P_6 \times P_{11}$**	28.67	29.36	29.01	78.67	82.24	80.46	53	58.09	55.54	4.33	4.67	4.5
57	**$P_7 \times P_8$**	33.33	34.95	34.14	81.33	85.21	83.27	113.67	124.26	118.97	4	4.67	4.33
58	**$P_7 \times P_9$**	31.67	33.23	32.45	80	82.59	81.3	93.33	102.06	97.7	4.33	5.33	4.83
59	**$P_7 \times P_{10}$**	32.33	34.19	33.26	81.67	86.68	84.18	108	118.81	113.41	3.67	4.33	4
60	**$P_7 \times P_{11}$**	30	31.69	30.84	79	84	81.5	106.67	116.98	111.82	4.67	5.33	5
61	**$P_8 \times P_9$**	35.67	37.27	36.47	84.67	90.59	87.63	106.67	116.99	111.83	3.67	4.67	4.17
62	**$P_8 \times P_{10}$**	35	37.71	36.36	86.67	88.05	87.36	75.33	82.12	78.73	3.33	4	3.67
63	**$P_8 \times P_{11}$**	33.33	34.59	33.96	82.67	85.02	83.84	86.33	93.77	90.05	4.33	5.33	4.83
64	**$P_9 \times P_{10}$**	32	33.47	32.73	82	85.53	83.77	87.67	94.09	90.88	3.33	3.67	3.5
65	**$P_9 \times P_{11}$**	30.33	31.77	31.05	80	83.47	81.74	71.67	78.85	75.26	2.33	3.33	2.83
66	**$P_{10} \times P_{11}$**	31.33	32.37	31.85	83.67	88.58	86.12	92	100.9	96.45	3.67	3.67	3.67
67	**Kashi Aman (Check)**	36	38.22	37.11	82.33	84.31	83.32	92.97	101.93	97.45	4	4	4
	Mean	**31.71**	**33.24**	**32.47**	**81.95**	**85.61**	**83.78**	**85.09**	**92.9**	**89**	**4.09**	**4.61**	**4.35**
	Min	**28.67**	**29.36**	**29.01**	**77.33**	**81.2**	**79.94**	**38.33**	**42.51**	**40.42**	**2**	**2.67**	**2.33**
	Max	**36.33**	**38.22**	**37.2**	**87.33**	**91.1**	**89.22**	**144.67**	**159.13**	**151.9**	**6.33**	**7.33**	**6.83**
	SE(d) ±	**0.95**	**1.07**	**0.98**	**1.36**	**1.61**	**1.37**	**4.83**	**5.45**	**5.11**	**0.56**	**0.52**	**0.47**
	C.D.at 5%	**1.87**	**2.12**	**1.95**	**2.7**	**3.19**	**2.7**	**9.56**	**10.8**	**10.13**	**1.11**	**1.03**	**0.92**

	C.V. (%)	3.64	3.94	3.7	2.03	2.3	2	6.93	7.16	7.01	16.57	13.74	12.95
SN.	Parent/Hybrids	No. of fruits per plant			Average fruit weight (g)			Pericarp thickness (mm)			Equitorial fruit diameter (cm)		
		Y1	Y2	P	Y1	Y2	P	Y1	Y2	P	Y1	Y2	P
	Parents												
1	NDT-2019-01	15.02	12.87	13.95	69.9	87.23	78.57	4.3	4.71	4.51	5.93	6.58	6.26
2	Punjab chhuhara	16.67	16.07	16.37	40.93	47.1	44.02	3.4	3.72	3.56	2.9	3.18	3.04
3	NDT-2019-02	15.69	14	14.85	75.7	88.92	82.31	3.73	4.05	3.89	5.1	5.57	5.34
4	NDT-2	17.99	18.27	18.13	68.5	70.93	69.72	5.8	6.44	6.12	4.03	4.37	4.2
5	NDT-4	15.33	13.27	14.3	74.63	90.11	82.37	4.6	4.92	4.76	5.2	5.77	5.49
6	NDT-7	16.01	17	16.51	53.97	57.18	55.58	4	4.43	4.21	4.27	4.57	4.42
7	NDT-6	10.4	10.77	10.59	73.3	74.95	74.13	4.07	4.46	4.27	5	5.53	5.27
8	NDT-2019-03	10.03	9.33	9.68	78.89	94.39	86.64	5.2	5.68	5.44	5.63	6.18	5.91
9	NDT-2019-04	13.45	12.67	13.06	68.07	78.87	73.47	5.03	5.58	5.31	4.1	4.48	4.29
10	NDT-2020-01	13.33	13.53	13.43	73.43	78.42	75.93	7.2	7.71	7.45	5.63	6.26	5.95
11	NDT-2020-02	11.33	11.47	11.4	72.67	80.17	76.42	6.1	6.75	6.43	5.83	6.24	6.04
	Mean	**14.11**	**13.57**	**13.84**	**68.18**	**77.12**	**72.65**	**4.86**	**5.31**	**5.09**	**4.87**	**5.34**	**5.11**
	Min	**10.03**	**9.33**	**9.68**	**40.93**	**47.1**	**44.02**	**3.4**	**3.72**	**3.56**	**2.9**	**3.18**	**3.04**
	Max	**17.99**	**18.27**	**18.13**	**78.89**	**94.39**	**86.64**	**7.2**	**7.71**	**7.45**	**5.93**	**6.58**	**6.26**
	Hybrids												
12	$P_1 \times P_2$	14.67	14.97	14.82	84.77	92.65	88.71	5.2	5.7	5.45	4.97	5.5	5.24
13	$P_1 \times P_3$	13.93	14.27	14.1	96.5	101.15	98.83	4.7	5.14	4.92	4.9	5.37	5.14
14	$P_1 \times P_4$	15.33	16	15.67	99.33	106.28	102.81	3.9	4.23	4.06	5.93	6.49	6.21
15	$P_1 \times P_5$	15.67	16.17	15.92	85.67	92.8	89.24	4.4	4.88	4.64	4.8	5.2	5
16	$P_1 \times P_6$	23.57	22.17	22.87	81.23	89.09	85.16	2.9	3.1	3	4.5	5	4.75
17	$P_1 \times P_7$	15.67	16	15.84	95.03	103.91	99.47	4.8	5.31	5.06	4.4	4.71	4.55

18	$P_1 \times P_8$	18.33	18.94	18.64	102.77	103.82	103.3	7	7.68	7.34	6.1	6.75	6.43
19	$P_1 \times P_9$	15.33	16	15.67	97.5	108.29	102.9	4.27	4.67	4.47	4.43	4.86	4.65
20	$P_1 \times P_{10}$	14	15.33	14.67	89.8	96.1	92.95	4.83	5.35	5.09	4.77	5.21	4.99
21	$P_1 \times P_{11}$	10.33	12.33	11.33	85.67	94.8	90.24	4.1	4.39	4.24	5.57	6.17	5.87
22	$P_2 \times P_3$	13.67	15	14.34	88.33	96.87	92.6	3.2	3.54	3.37	4.1	4.39	4.24
23	$P_2 \times P_4$	27.33	26.67	27	68.33	74.72	71.53	4.1	4.5	4.3	4.2	4.65	4.42
24	$P_2 \times P_5$	20.67	21.67	21.17	78.5	87.19	82.85	4.6	5.02	4.81	4.87	5.34	5.1
25	$P_2 \times P_6$	19	20.67	19.84	53.7	57.47	55.59	2	2.17	2.08	3	3.28	3.14
26	$P_2 \times P_7$	13.33	11	12.17	64.33	71.19	67.76	4.07	4.44	4.25	4.27	4.62	4.45
27	$P_2 \times P_8$	21.67	22.53	22.1	85.8	89.1	87.45	6.7	7.17	6.94	5.67	6.19	5.93
28	$P_2 \times P_9$	14	14.67	14.34	58.9	64.42	61.66	4.9	5.42	5.16	4.4	4.71	4.55
29	$P_2 \times P_{10}$	10.33	11	10.67	88.67	96.05	92.36	5.5	6.03	5.77	4.77	5.28	5.02
30	$P_2 \times P_{11}$	13	14.33	13.67	68.97	75.42	72.2	4.2	4.59	4.4	4.03	4.42	4.23
31	$P_3 \times P_4$	22.67	24	23.34	80.5	79.97	80.24	6.2	6.89	6.54	5.43	5.94	5.69
32	$P_3 \times P_5$	20.67	24.33	22.5	90.33	80.5	85.42	5.9	6.31	6.11	5.1	5.66	5.38
33	$P_3 \times P_6$	20.33	25.67	23	87.77	76.24	82.01	4	4.43	4.21	4.13	4.43	4.28
34	$P_3 \times P_7$	25.67	27.67	26.67	71.33	73.11	72.22	4.8	5.26	5.03	5.37	5.94	5.65
35	$P_3 \times P_8$	24.33	25.33	24.83	75.67	80.04	77.86	7.6	8.31	7.96	5.03	5.52	5.28
36	$P_3 \times P_9$	19	21	20	82.5	88.28	85.39	6.1	6.61	6.35	5.5	6.02	5.76
37	$P_3 \times P_{10}$	19.67	21.67	20.67	95.8	90.7	93.25	4.7	5.14	4.92	4.8	5.2	5
38	$P_3 \times P_{11}$	13.33	14.33	13.83	83.8	91.91	87.86	4.2	4.5	4.35	4.5	4.93	4.71
39	$P_4 \times P_5$	19.33	22	20.67	90.7	94.32	92.51	4.9	5.42	5.16	4.83	5.18	5
40	$P_4 \times P_6$	21.67	24	22.84	87.3	82.56	84.93	4.7	5.16	4.93	3.93	4.35	4.15
41	$P_4 \times P_7$	20.33	22.33	21.33	86.8	94.87	90.84	5.8	6.3	6.05	5.07	5.56	5.31
42	$P_4 \times P_8$	12.33	13	12.67	97.5	104.34	100.92	4.9	5.33	5.11	5.73	6.23	5.98
43	$P_4 \times P_9$	23	22.67	22.84	79.63	87.55	83.59	6.2	6.67	6.44	5.13	5.58	5.36
44	$P_4 \times P_{10}$	17.67	18.67	18.17	92.47	101.4	96.94	4.6	5.06	4.83	5.07	5.46	5.26
45	$P_4 \times P_{11}$	19.33	20.67	20	84.5	91.84	88.17	5.5	6.03	5.77	6.03	6.64	6.33

46	$P_5 \times P_6$	12.33	13.67	13	93	101.07	97.04	4.7	5.16	4.93	5.4	5.92	5.66
47	$P_5 \times P_7$	12.67	14.33	13.5	92.8	99.89	96.35	4.3	4.69	4.49	4.5	4.94	4.72
48	$P_5 \times P_8$	21.33	22.67	22	83.8	90.15	86.98	6.1	6.64	6.36	5.7	6.22	5.96
49	$P_5 \times P_9$	17.67	18	17.84	77.3	84.77	81.04	4.1	4.39	4.24	4.73	5.14	4.94
50	$P_5 \times P_{10}$	19.67	21.67	20.67	92.47	96.43	94.45	5.03	5.54	5.28	5.47	5.85	5.66
51	$P_5 \times P_{11}$	20.67	21.07	20.87	76.5	83.39	79.95	5.2	5.7	5.45	4.53	4.98	4.76
52	$P_6 \times P_7$	27.33	28.67	28	66.33	72.07	69.2	4.6	5.05	4.82	4.97	5.45	5.21
53	$P_6 \times P_8$	23	24.33	23.67	78.73	84.25	81.49	1.9	2.08	1.99	4.3	4.71	4.51
54	$P_6 \times P_9$	25.33	26	25.67	65.8	72.41	69.11	5.87	6.39	6.12	4.5	4.92	4.71
55	$P_6 \times P_{10}$	12.67	13.67	13.17	90.8	99.58	95.19	4.5	4.95	4.73	4.83	5.27	5.05
56	$P_6 \times P_{11}$	17.67	18.67	18.17	77.07	84.53	80.8	3.9	4.28	4.09	5.2	5.72	5.46
57	$P_7 \times P_8$	10.33	11	10.67	104.8	114.57	109.69	4.2	4.61	4.4	6.47	7.09	6.78
58	$P_7 \times P_9$	14.65	15	14.82	72.68	74.04	73.36	3.4	3.71	3.55	3.4	3.73	3.57
59	$P_7 \times P_{10}$	12.67	13.67	13.17	92.47	101.69	97.08	2.2	2.39	2.3	4.17	4.54	4.36
60	$P_7 \times P_{11}$	12.67	15	13.84	80.6	88.39	84.5	5.4	5.79	5.6	6.73	7.32	7.02
61	$P_8 \times P_9$	11.67	13.67	12.67	104.33	114.45	109.39	4.3	4.73	4.52	4.23	4.55	4.39
62	$P_8 \times P_{10}$	11.33	12.67	12	98.67	107.57	103.12	5.8	6.36	6.08	4.17	4.58	4.38
63	$P_8 \times P_{11}$	15.33	21	18.17	94.77	103.01	98.89	5.3	5.81	5.56	4.57	5.01	4.79
64	$P_9 \times P_{10}$	15.33	16	15.67	94.33	101.24	97.78	6.5	7.11	6.8	4.8	5.26	5.03
65	$P_9 \times P_{11}$	19.67	20	19.84	87.7	96.49	92.09	5.7	6.12	5.91	5.37	5.87	5.62
66	$P_{10} \times P_{11}$	14.67	17.33	16	97.57	107	102.28	4.9	5.39	5.15	5.27	5.79	5.53
67	Kashi Aman (Check)	18.33	16.63	17.48	79.07	90.35	84.71	3.5	3.84	3.67	4.17	4.57	4.37
	Mean	**16.89**	**17.78**	**17.33**	**82.27**	**88.58**	**85.42**	**4.78**	**5.22**	**5**	**4.87**	**5.33**	**5.1**
	Min	**10.03**	**9.33**	**9.68**	**40.93**	**47.1**	**44.02**	**1.9**	**2.08**	**1.99**	**2.9**	**3.18**	**3.04**
	Max	**27.33**	**28.67**	**28**	**104.8**	**114.57**	**109.69**	**7.6**	**8.31**	**7.96**	**6.73**	**7.32**	**7.02**
	SE(d) ±	**1.34**	**1.14**	**1.11**	**2.48**	**2.87**	**2.63**	**0.28**	**0.3**	**0.29**	**0.26**	**0.29**	**0.27**
	C.D.at 5%	**2.65**	**2.26**	**2.19**	**4.91**	**5.68**	**5.2**	**0.55**	**0.6**	**0.57**	**0.52**	**0.58**	**0.54**

	C.V. (%)	9.19	7.32	7.34	3.56	3.77	3.61	7.1	7.11	7.08	6.54	6.68	6.57

SN.	Parent/Hybrids	Number of locules per fruit			Fruit yield per plant (kg)			Fruit yield q/ha		
		Y1	Y2	P	Y1	Y2	P	Y1	Y2	P
	Parents									
1	NDT-2019-01	6.33	6.45	6.39	1.05	1.12	1.09	349.96	374.21	362.09
2	Punjab chhuhara	2.33	2.56	2.45	0.68	0.76	0.72	227.43	252.3	239.86
3	NDT-2019-02	6.33	6.52	6.42	1.19	1.24	1.22	395.91	414.96	405.43
4	NDT-2	2.33	2.59	2.46	1.23	1.3	1.26	410.77	431.96	421.36
5	NDT-4	6.33	6.78	6.56	1.14	1.2	1.17	381.36	398.58	389.97
6	NDT-7	3.33	3.69	3.51	0.86	0.97	0.92	288.02	324.02	306.02
7	NDT-6	4.33	4.64	4.49	0.76	0.81	0.78	254.1	269.07	261.59
8	NDT-2019-03	5.33	5.9	5.62	0.79	0.88	0.84	263.75	293.55	278.65
9	NDT-2019-04	2.33	2.56	2.45	0.92	1	0.96	305.18	333.09	319.13
10	NDT-2020-01	5.33	5.84	5.59	0.98	1.06	1.02	326.27	353.67	339.97
11	NDT-2020-02	4.33	4.81	4.57	0.82	0.92	0.87	274.45	306.51	290.48
	Mean	**4.42**	**4.76**	**4.59**	**0.95**	**1.02**	**0.99**	**316.11**	**341.08**	**328.6**
	Min	**2.33**	**2.56**	**2.45**	**0.68**	**0.76**	**0.72**	**227.43**	**252.3**	**239.86**
	Max	**6.33**	**6.78**	**6.56**	**1.23**	**1.3**	**1.26**	**410.77**	**431.96**	**421.36**
	Hybrids									
12	$P_1 \times P_2$	6.33	6.78	6.56	1.24	1.39	1.32	414.52	462.32	438.42
13	$P_1 \times P_3$	5.33	5.9	5.62	1.34	1.44	1.39	448.08	481.13	464.6
14	$P_1 \times P_4$	6.67	6.78	6.72	1.52	1.7	1.61	507.57	566.82	537.2
15	$P_1 \times P_5$	3.33	3.65	3.49	1.34	1.5	1.42	447.48	500.19	473.83
16	$P_1 \times P_6$	2.33	2.53	2.43	1.91	1.98	1.94	638.19	658.37	648.28
17	$P_1 \times P_7$	4.33	4.81	4.57	1.49	1.66	1.58	496.37	554.18	525.27
18	$P_1 \times P_8$	4.33	4.63	4.48	1.88	1.97	1.93	627.92	655.44	641.68

19	**$P_1 \times P_9$**	4.33	4.8	4.57	1.49	1.73	1.61	498.22	577.54	537.88
20	**$P_1 \times P_{10}$**	5.67	6.21	5.94	1.26	1.47	1.37	419.06	491.07	455.06
21	**$P_1 \times P_{11}$**	6.33	6.67	6.5	0.88	1.17	1.03	294.99	389.62	342.31
22	**$P_2 \times P_3$**	4.33	4.81	4.57	1.21	1.45	1.33	402.49	484.35	443.42
23	**$P_2 \times P_4$**	3.33	3.57	3.45	1.87	1.99	1.93	622.48	664.25	643.37
24	**$P_2 \times P_5$**	3.33	3.69	3.51	1.62	1.89	1.76	540.86	629.8	585.33
25	**$P_2 \times P_6$**	3.33	3.65	3.49	1.02	1.19	1.1	340.1	395.96	368.03
26	**$P_2 \times P_7$**	3.33	3.65	3.49	0.86	0.78	0.82	285.84	261.03	273.43
27	**$P_2 \times P_8$**	3.67	3.98	3.82	1.86	2.01	1.93	619.76	669.13	644.45
28	**$P_2 \times P_9$**	3.33	3.65	3.49	0.82	0.95	0.88	274.86	315.01	294.94
29	**$P_2 \times P_{10}$**	4.33	4.63	4.48	0.92	1.06	0.99	305.32	352.18	328.75
30	**$P_2 \times P_{11}$**	3.33	3.69	3.51	0.9	1.08	0.99	298.87	360.25	329.56
31	**$P_3 \times P_4$**	3.33	3.65	3.49	1.82	1.92	1.87	608.31	639.75	624.03
32	**$P_3 \times P_5$**	6.67	6.78	6.72	1.87	1.96	1.91	622.37	652.85	637.61
33	**$P_3 \times P_6$**	3.33	3.7	3.52	1.78	1.96	1.87	594.78	652.35	623.57
34	**$P_3 \times P_7$**	4	4.28	4.14	1.83	2.02	1.93	610.34	674.31	642.33
35	**$P_3 \times P_8$**	4.33	4.8	4.57	1.84	2.03	1.93	613.68	675.8	644.74
36	**$P_3 \times P_9$**	4.33	4.75	4.54	1.57	1.85	1.71	522.49	617.95	570.22
37	**$P_3 \times P_{10}$**	3.33	3.65	3.49	1.88	1.97	1.92	628.12	655.15	641.64
38	**$P_3 \times P_{11}$**	5.33	5.78	5.56	1.12	1.32	1.22	372.35	439.02	405.68
39	**$P_4 \times P_5$**	5.67	6.2	5.93	1.75	2.08	1.91	584.4	691.67	638.04
40	**$P_4 \times P_6$**	3	3.21	3.11	1.89	1.98	1.94	630.59	660.47	645.53
41	**$P_4 \times P_7$**	3.33	3.69	3.51	1.76	2.12	1.94	588.21	706.14	647.18
42	**$P_4 \times P_8$**	3.33	3.65	3.49	1.2	1.36	1.28	400.72	452.14	426.43
43	**$P_4 \times P_9$**	3.33	3.62	3.48	1.83	1.98	1.91	610.49	661.58	636.04
44	**$P_4 \times P_{10}$**	3.33	3.62	3.48	1.63	1.89	1.76	544.64	631.04	587.84
45	**$P_4 \times P_{11}$**	4.33	4.66	4.5	1.63	1.9	1.77	544.46	632.77	588.61
46	**$P_5 \times P_6$**	6.67	6.75	6.71	1.15	1.38	1.26	382.23	460.54	421.38
47	**$P_5 \times P_7$**	3.33	3.66	3.5	1.18	1.43	1.3	391.92	477.14	434.53

48	**$P_5 \times P_8$**	5.33	5.84	5.59	1.79	2.04	1.92	595.81	681.23	638.52
49	**$P_5 \times P_9$**	3.33	3.63	3.48	1.37	1.53	1.45	455.29	508.61	481.95
50	**$P_5 \times P_{10}$**	3.33	3.62	3.48	1.82	2.09	1.95	606.29	696.54	651.41
51	**$P_5 \times P_{11}$**	4.33	4.64	4.49	1.58	1.76	1.67	527.08	585.67	556.37
52	**$P_6 \times P_7$**	3.33	3.67	3.5	1.81	2.07	1.94	604.26	688.74	646.5
53	**$P_6 \times P_8$**	5	5.48	5.24	1.81	2.05	1.93	603.59	683.26	643.43
54	**$P_6 \times P_9$**	3.33	3.65	3.49	1.67	1.88	1.77	555.57	627.55	591.56
55	**$P_6 \times P_{10}$**	4	4.37	4.19	1.15	1.36	1.26	383.47	453.75	418.61
56	**$P_6 \times P_{11}$**	3.33	3.63	3.48	1.36	1.58	1.47	453.94	526.05	490
57	**$P_7 \times P_8$**	4.67	5.13	4.9	1.08	1.26	1.17	360.86	420.09	390.47
58	**$P_7 \times P_9$**	3.33	3.66	3.5	1.06	1.11	1.09	354.92	370.2	362.56
59	**$P_7 \times P_{10}$**	6.33	6.54	6.43	1.17	1.39	1.28	390.53	463.36	426.95
60	**$P_7 \times P_{11}$**	6.33	6.45	6.39	1.02	1.33	1.17	340.4	441.95	391.17
61	**$P_8 \times P_9$**	4.33	4.71	4.52	1.22	1.56	1.39	405.84	521.51	463.67
62	**$P_8 \times P_{10}$**	5.33	5.72	5.53	1.12	1.36	1.24	372.64	454.3	413.47
63	**$P_8 \times P_{11}$**	3.33	3.67	3.5	1.45	2.16	1.81	484.27	721.06	602.67
64	**$P_9 \times P_{10}$**	2.33	2.56	2.45	1.45	1.62	1.53	482.02	539.94	510.98
65	**$P_9 \times P_{11}$**	6.65	6.75	6.7	1.73	1.93	1.83	575.01	643.26	609.14
66	**$P_{10} \times P_{11}$**	3.33	3.64	3.49	1.43	1.85	1.64	477.11	618.1	547.6
67	**Kashi Aman (Check)**	3.33	3.67	3.5	1.45	1.5	1.48	483.11	500.84	491.97
	Mean	**4.26**	**4.6**	**4.43**	**1.37**	**1.56**	**1.47**	**458.54**	**518.62**	**488.58**
	Min	**2.33**	**2.53**	**2.43**	**0.68**	**0.76**	**0.72**	**227.43**	**252.3**	**239.86**
	Max	**6.67**	**6.78**	**6.72**	**1.91**	**2.16**	**1.95**	**638.19**	**721.06**	**651.41**
	SE(d) ±	**0.36**	**0.39**	**0.38**	**0.07**	**0.08**	**0.07**	**22.79**	**26.26**	**24.13**
	C.D.at 5%	**0.71**	**0.78**	**0.74**	**0.15**	**0.16**	**0.14**	**45.14**	**51.99**	**47.79**
	C.V. (%)	**10.25**	**10.22**	**10.21**	**6.51**	**6.4**	**5.99**	**6.09**	**6.2**	**6.05**