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Growth, Yield and Quality Attributes of Determinate Tomato Genotypes in Parwanipur, Bara of Nepal

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ABSTRACT

With the aim of identifying suitable open pollinated determinate tomato genotypes, investigation was carried out at Directorate of Agricultural Research (DoAR), Parwanipur in two consecutive winter seasons of 2020/21 and 2021/22. Experiment was laid out in randomized complete block design (RCBD) with 16 treatments and replicated thrice. Crop geometry was maintained 75×60 cm and fertilizers and manure was applied at the rate of 200:150:120 kg N: P_2O_5:K_2O kg + 20 tons FYM per hectare. Analysis of results showed significant variation in yield and yield attributing characters among genotypes. The maximum plant height (75.67 cm) was recorded on genotypes AVTO 0301.The genotypes AVTO 1716 and AVTO 0301 showed significantly earlier to 50% flowering (45 days) while AVTO 1711 recorded shortest days to first harvest (81 days). The highest plant vigour (5 scales) showed by AVTO 1712, AVTO 0302 and Pusa Ruby check variety. The maximum fruit diameter (7.52 cm), length (6.54 cm) and fruit weight (49.9 g) recorded on genotype AVTO 1711. The highest number of fruits/ plant (56.7) and marketable yield (58.08 t ha^{-1}) was recorded in AVTO 1610 and AVTO 1711 respectively. The genotype AVTO 1712 showed the highest firmness (1.92 kg cm^{-2}) and Vitamin C (59.36 mg/ 100 g). The maximum pericarp thickness of fruits (7.43 mm) obtained on AVTO 1610. The genotype Pusa Ruby showed the maximum total soluble solid (5.6 Obrix) and Titratable acid 0.75 %. Similarly, the highest colorimetric value of a* (12.62) was recorded on Pusa Ruby and the highest value of b* (19.37) was found on AVTO 1713 while the highest value of L* (30.56) was observed on AVTO 171. Considering the overall performance, genotypes AVTO 1711, AVTO 1702 and AVTO 1712 were performed better in terms of the highest yield and other horticultural traits.

Keywords: Tomato, open-pollinated, determinate-genotypes, yield, quality

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INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most important vegetable crops grown in the tropics and subtropics in the world. It is the second most important vegetable crop after potato in the world with the production of 186.12 million tons of fresh fruit in 4.92 million hectares of land and achieving average yield 37.84 tons per hectare. China is the highest tomato producing country 67.5 million tons with average yield (59.86 t ha^{-1}) followed by India 20.69 Million tons and 24.55 t ha^{-1} production and with average yield respectively and Belgium is the highest average yielding (466.88 t ha^{-1}) country followed by Netherland (423.08 t ha^{-1}) (FAOSTAT 2022). Whereas in Nepal, tomato is ranked the third most commercially grown vegetable after cauliflower and cabbage which cultivated in total 22,911 hectares of land and produces annually 4,22,703 tons with an average productivity 18.45 ton per hectare (MoALD 2023). Which is far below as compared to others countries and even neighboring countries and world average. However, tomato is successfully cultivated in mid- and high-hills during the summer and rainy season (April-November) and in Terai, it is confined to the winter season. In other seasons, tomato cultivation in Terai region is limited due to high summer temperatures,

frequent heavy rains and humid weather which causes poor flower development, low fruit set and higher incidence of bacterial wilt (Chapagain et al 2020). As result, the productivity of tomato in central terai i.e. Madesh Province, is significantly lower (14.96 t ha^{-1}) than the national average (18.45 t ha^{-1}). Among the different factors for reasoning of low production and productivity of tomato in terai region is lack of suitable high yielding cultivars especially open-pollinated determinate types of genotypes with multiple traits likewise good quality potential, proper management practices, resistance to biotic and abiotic stresses and post-harvest self-life etc.

Most of the varieties recommended for hills of Nepal which may not be suitable for cultivation in terai due to differences in climatic conditions and other cultural requirements like staking. Shrestha and Sah (2014) also reported the absence of high-yielding tomato cultivars is a major cause of low tomato productivity. The recommended determinate varieties of tomato viz. Pusa Ruby, Monoprecos, Roma, BL-410 and NCL-1 are very old and outdated which have not maintained properly way due to degradation and degeneration of their original characters resulting the poor yielding.

The hybrid tomato cultivars recommended by government agencies were mainly for the mid hills of Nepal which may not be suitable for terai regions. Other hybrids recommended by private seed companies are very costly and their seeds were not available at the required time and place. These hybrids are not durable for a long time and every year new hybrids developed by seed companies are brought to the market which is confusing the farmers in the selection of suitable hybrids. Moreover, farmers have not the capacity to maintain their hybrid seeds along with the performance of hybrids varies seasonally in different agro-ecological regions (Shrestha, 2022) and are very sensitive to recommended management practices which may not be suitable in specific periods for terai conditions due to various factors. Most of the recommended hybrids are indeterminate and require substantial quantities of staking materials for getting the optimum yield which is difficult to manage in terai conditions due to the unavailability of staking materials.

Considering the above facts, the collection of local and exotic open pollinated determinate tomato germplasm, their characterization and continuous evaluation is needed. Collection and evaluation of germplasm provide sufficient varietal options for the farmers (Chapagain et al 2014). Before recommendation of any variety suitable for the region, it is utmost necessary to evaluate the cultivars for quality and yield in the specific region. Therefore, present study was conducted with an objective to identify suitable open pollinated determinate tomato genotypes having high yield and good quality potential for plains area of central Terai region of Nepal.

MATERIALS AND METHODS

Experiments were conducted at the Research Farm of the Directorate of Agricultural Research (DoAR) Horticulture Research Unit, Parwanipur in two consecutive winter seasons of 2020/21 and 2021/22. It is located at 27°.07'°N latitude and 84°.91' °E longitude with an elevation of 115 meter above mean sea level. The soil type of the experimental plot was black and sandy loam in texture, slightly acidic and medium in organic matter (DoAR 2019). Altogether 15 open-pollinated determinate types of tomato germplasms were collected from the World Vegetable Center and Pusa Ruby from the National Horticulture Research Centre, Khumaltar, Nepal. Experiments were laid out in Randomized Complete Block Design (RCBD) with 16 treatments including Pusa Ruby as a check and replicated thrice. Crop geometry was maintained with the 75×60 cm row-to-row and plant to plant distance and individual plot size was kept 6.3 m^2 having 14 plants i.e. 2 rows and 7 plants in each row in each plot. About 28 days old seedlings were transplanted in the open field in first week of November. Fertilizers and manures were applied at the rate of 200:150:120 kg N: P_2O_5:K_2O kg + 20 tons Farm Yard Manure (FYM) per hectare. All FYM, P_2O_5:K_2O and half of N were applied before one week of transplanting of seedlings. The remaining half dose of nitrogen was equally top-dressed at 30 and 60 days after transplanting. Required cultural operation like weeding, irrigation, normal staking and spraying of insecticide and fungicides for controlling different insects and fungal diseases were carried out as per needed. The plant extract, Vircon H was sprayed at the rate of 2 ml/ litre water as a protective spray against viruses.

Observations were recorded on yield and yield attributing parameters. Plant vigour was recorded at first harvesting using a 1 to 5 rating scale method described by Gotame et al (2019, 2021). Plants of each cultivar were visually observed during their growth period for vegetative parameters; plant uniformity, plant vigor, plant height and ground coverage. Likewise, fruit parameters; fruit characteristics, maturity and fruit yield in number and weight were recorded. The fruits were harvested when ripened or changed in color.

All the collected data were processed by using MS Excel 2016 and analyzed by using Genstat 18th Edition, Genstat Procedure Library Release PL26.2 64-bit Release and mean separation was done by Duncan Multiple Range Test (DMRT) at 0.05 least significant difference (LSD) level.

RESULTS

The mean data concerning to diameter and length of fruit, number of fruits per plant, average fruit weight and marketable yield revealed highly significant differences among genotypes. The maximum dimeter of fruits (7.76 cm) recorded on genotype AVTO 0301 followed by AVTO 1711 (7.52 cm) and they are statistically at par with genotypes AVTO 1719, AVTO 1702, AVTO 1716, AVTO 1717 and AVTO 1712 with AVTO 0301. Similarly, the maximum fruit length (6.54 cm) was observed in the genotype AVTO 1711 followed by AVTO 1702, AVTO 1288, AVTO 1712 and AVTO 1306 recorded their length 6.62, 6.46, 6.35 and 6.26 cm respectively and these were at par with AVTO 1711. The minimum diameter and length of fruits (4.22 and 4.01cm) were observed on AVTO 1314 followed by Pusa Ruby (5.11 and 4.35 cm) respectively. Fruit diameter and fruit length jointly contribute to fruit size which ultimately related to fruit yield.

Table 1. Mean performance of open pollinated determinate types of tomato genotypes on vegetative parameters at DoAR, Parwanipur, Bara in 2020/21 and 2021/22.

S. N.	Genotypes	Plant height (cm)	Day to 50% flowering	Days to first harvest	Days to last harvest	Plant vigour (1-5 scales)	TYLCV (1-5 scales)
1.	AVTO 1713	61.87^{fg}	52^{efg}	93^{cd}	112^{abc}	4.3^{bc}	2.2
2.	AVTO 1610	73.59^{ab}	47^{abcd}	90^{bc}	111^{bcd}	4.3^{bc}	2.0
3.	AVTO 1712	70.78^{abcd}	52^{defg}	84^{a}	107^{de}	5.0^{a}	1.7
4.	AVTO1306	66.94^{bcdef}	47^{abcd}	90^{bc}	111^{bcd}	4.5^{abc}	2.0
5.	AVTO 1711	72.21^{abcd}	48^{abcde}	81^{a}	106^{e}	4.5^{abc}	1.8
6.	AVTO 1424	58.72^{g}	50^{bcdefg}	92^{bcd}	110^{bcd}	4.3^{bc}	2.2
7.	AVTO 1715	63.17^{efg}	47^{abc}	88^{b}	109^{cde}	4.5^{abc}	2.5
8.	AVTO 1716	65.63^{cdefg}	45^{a}	89^{b}	111^{abc}	4.2^{c}	2.2
9.	AVTO 1717	69.58^{abcde}	49^{abcdef}	90^{bc}	111^{abc}	4.5^{abc}	1.8
10.	AVTO 1719	70.71^{abcd}	48^{abcde}	88^{b}	110^{bcd}	4.5^{abc}	2.5
11.	AVTO 0301	75.67^{a}	45^{ab}	88^{b}	108^{cde}	5.0^{a}	2.3
12.	AVTO 1314	72.92^{abc}	52^{efg}	90^{bc}	110^{bcd}	4.8^{ab}	2.0
13.	AVTO1288	71.85^{abcd}	53^{fg}	92^{bcd}	112^{abc}	4.8^{ab}	1.8
14.	AVTO 1315	64.67^{defg}	50^{cdefg}	89^{b}	111^{abc}	4.1^{c}	1.8
15.	AVTO 1702	74.15^{ab}	49^{bcdefg}	89^{b}	113^{ab}	4.5^{abc}	1.8
16.	Pusa Ruby	61.23^{fg}	54^{g}	95^{d}	115^{a}	5.0^{a}	2.3
Mean		68.36	49	89	110	4.6	2.06
P value		<0.001	<0.001	<0.001	<0.001	0.012	0.17
LSD(≤0.05)		6.61	4	3	3	0.55	-
CV %		8.4	6.9	3.2	2.5	10.4	25.6

LSD: Least Significant Difference, CV: Coefficient of Variation, Means followed by a different letter are significantly different at P< 0.05 according to an LSD test.

The existence of variability among the genotypes for fruit size factors (fruit length and diameter) may provide an opportunity to select a genotype with desirable fruit size. Variability in fruit diameter of tomato genotypes is due to the different shapes and sizes of different genotypes of tomato; similar findings were reported by Asati et al (2008) in tomato.

The number of fruits and fruit weight plays a significant role in the final yield. A perusal of data on the number of fruits per plant revealed that the highest number of fruits (56.7) were shown in genotype AVTO 1610 followed by AVTO 1713 (53.9). Genotypes AVTO 1713, AVTO 1315, AVTO 1288, AVTO 1711, AVTO 0301, AVTO 1717, AVTO 1702 and AVTO 1712 were observed significantly at par with AVTO 1610. While the lowest number (35.8) was produced by genotype AVTO 1715 followed by AVTO 1424 (35.9). In the case of average fruit weight, genotypes AVTO 1711 showed the highest fruit weight (49.9 g) followed by AVT 1306 (48.1 g) and AVTO 1717 (47.5 g) and these were significantly at par with each other. Whereas the lowest fruit weight (20.1 g) was recorded on Pusa Ruby. These results are in close conformity with the findings of Gotame et al 2021a who reported variation among the cultivars of tomato for the number of fruits per plant with the highest number of fruits per plant in HRDTOM 011 (64 per plant) followed by HRDTOM084 (53 per plant).

As far as marketable yield ton per hectare, the response of the genotypes under investigation differed significantly amongst themselves. It is obvious from the data that all the tested genotypes gave significantly higher yields as compared to cv. Pusa Ruby which ranged from 18.27 in Check Pusa Ruby to genotypes AVTO 1711 58.8 tha^{-1}. The genotype AVTO 1711 gave the highest yield (58.08 t ha^{-1}) followed by AVTO 1717 (54.09

t ha^{-1}) and genotypes AVTO 1717, AVTO 1288, AVTO 1702 and AVTO 1712 and AVTO 1306 were observed significantly at par with AVTO 1711 while the lowest yield (18.27 t ha^{-1}) was recorded in genotype Pusa Ruby followed by AVTO 1424 (27.09 t ha^{-1}). A similar, result is reported by Rawal et al (2017), who evaluated open-pollinated tomato genotypes in the mid-western Terai region. Our results are also in agreement with the results of Gotame et al (2021a) and Bhurtyal et al (2007).

Table 2. Mean performance of open pollinated determinate tomato genotypes on yield attributing and yield traits at DoAR, Parwanipur, Bara in 2020/21 and 2021/22.

S.N.	Genotypes	Fruit diameter (cm)	Fruit length (cm)	No. of fruit per plant	Av. fruit wt. (g)	Marketable Yield (t ha^{-1})
1.	AVTO 1713	6.94^{bcde}	5.23^{f}	53.9^{ab}	36.1^{fg}	43.28^{cd}
2.	AVTO1610	6.18^{g}	5.79^{bcdef}	56.7^{a}	37.9^{ef}	47.82^{bc}
3.	AVTO 1712	7.15^{abcde}	6.18^{abcd}	48.4^{abcde}	47.5^{bc}	50.96^{b}
4.	AVTO1306	6.88^{cdef}	6.13^{abcd}	46.7^{bcde}	48.1^{ab}	49.94^{bc}
5.	AVTO 1711	7.52^{ab}	6.54^{a}	52.2^{abc}	49.9^{a}	58.08^{a}
6.	AVTO1424	6.75^{defg}	5.61^{def}	35.9^{f}	34.1^{h}	27.09^{f}
7.	AVTO 1715	6.67^{efg}	5.98^{abcde}	35.8^{f}	46.7^{bc}	37.16^{de}
8.	AVTO 1716	7.32^{abcd}	5.85^{bcde}	42.3^{def}	42.5^{d}	40.23^{de}
9.	AVTO 1717	7.21^{abcde}	5.79^{bcdef}	51.1^{abcd}	47.6^{bc}	54.09^{ab}
10.	AVTO 1719	7.49^{abc}	5.66^{cdef}	46.3^{bcde}	42.5^{d}	43.72^{cd}
11.	AVTO0301	7.76^{a}	5.43^{ef}	51.2^{abcd}	34.1^{gi}	38.76^{de}
12.	AVTO1314	4.22^{i}	4.01^{g}	43.9^{cdef}	34.1^{gi}	33.57^{e}
13.	AVTO1288	6.75^{defg}	6.23^{abc}	53.0^{abc}	45.6^{c}	53.76^{ab}
14.	AVTO 1315	6.31^{fg}	5.58^{def}	53.8^{ab}	39.4^{e}	47.24^{bc}
15.	AVTO 1702	7.44^{abc}	6.39^{ab}	50.8^{abcd}	46.7^{bc}	52.56^{ab}
16.	Pusa Ruby	5.11^{h}	4.35^{g}	41.2^{ef}	20.1^{j}	18.27^{g}
Mean		6.77	5.67	47.7	40.8	43.52
P value		<0.001	<0.001	<0.000	<0.001	<0.001
LSD (≤0.05)		0.54	0.52	7.76	1.01	6.17
CV %		7.0	8.0	14.1	4.3	12.3

LSD: Least Significant Difference, CV: Coefficient of Variation, Means followed by a different letter are significantly different at P< 0.05 according to an LSD test.

The mean data regarding the quality parameter is presented in Table 3. The firmness of fruits was observed highly significant difference among the evaluated genotypes. Genotype AVTO 1712 showed the highest firmness (1.92) followed by AVTO 1610 (1.73), AVTO 1288 (1.72) and AVTO 1713 (1.70 kg/cm^2) respectively whereas, the lowest firmness (0.82 kg/cm^2) found on Pusa Ruby. Similarly, the pericarp thickness of fruits varied significantly from 3.96 to 7.43 mm in genotype AVTO 1314 and AVTO 1610 respectively. The genotype AVTO 1711 recorded the highest thickness (7.14 mm) followed by AVTO 1610 (7.0 mm). Genotypes AVTO 0301, AVTO 1306 and AVTO 1402 were found statistically with them. The lowest pericarp thickness (4.43 mm) was recorded on genotypes AVTO 1717 followed by Pusa Ruby (4.60 mm). The results are in close agreement with Kharat et al. 2022 who reported the variation in pericarp thickness in different tested genotypes. As far as on total soluble solid (TSS) revealed highly significant differences among genotypes. The maximum TSS (5.6 ^{o}B) was observed in genotype Pusa Ruby whereas the lowest (3.48 ^{o}B) was exhibited by AVTO 0301. It was at par with AVTO 1715 (3.52 ^{o}B) followed by AVTO 1713 and 1719 (3.82 ^{o}B). Meena et al (2015), Kumara et al (2017), Nadia et al (2017), Vijeth et al (2018) and Kharat et al (2022) also reported similar variability among the tomato genotypes for TSS.

In the case of titratable acid (TA) parameter resulted highly significant differences among genotypes. The maximum TA (0.75 % citrate) was recorded in Pusa Ruby followed by AVTO 1315 (0.63 % citrate) and the lowest was in AVTO 1712 (0.29 % citrate) followed by AVTO 1713 (0.30 %). Likewise, mean data of Vitamin C (mg/100g) revealed a highly significant effect among genotypes. The highest Vitamin C content (59.01 mg/100g) was observed on genotypes AVTO 1712 followed by AVTO 1713 (54.26) and it was at par with AVTO 171 (52.75), AVTO and 1306 (52.48 mg/100g) respectively while the lowest (39.45 mg/100g) observed on AVTO 1424 followed by AVTO 1315 (43.34 mg/100g). The results are in line with the results observed by Meena et al (2015), Kumara et al (2017) and Nadia et al (2018).

Table 3. Mean performance of open pollinated determinate tomato genotypes on quality parameters at DoAR, Parwanipur, Bara in 2020/21 and 2021/22

S. N.	Genotypes	Fruit firmness (kg/cm^2)	Pericarp thickness (mm)	TSS (ºBrix)	TA (% citrate)	Vitamin C (mg/100g)
1.	AVTO 1713	1.56^{bcd}	5.69^{bcde}	3.82^{ef}	0.31^{fg}	54.26^{ab}
2.	AVTO1610	1.74^{ab}	7.00^{ab}	4.47^{bcd}	0.36^{defg}	46.39^{bdefg}
3.	AVTO 1712	1.84^{a}	5.34^{cde}	4.03^{de}	0.29^{g}	59.01^{a}
4.	AVTO1306	1.55^{bcd}	6.24^{abc}	4.50^{bc}	0.30^{fg}	52.48^{abcde}
5.	AVTO 1711	1.69^{abc}	7.14^{a}	4.17^{cde}	0.31^{fg}	52.75^{abcd}
6.	AVTO1424	1.37^{de}	5.85^{bcd}	4.37^{cd}	0.48^{cde}	39.45^{g}
7.	AVTO 1715	1.33^{de}	5.08^{cde}	3.52^{f}	0.34^{fg}	44.26^{efg}
8.	AVTO 1716	1.45^{cde}	5.89^{bcd}	4.03^{de}	0.42^{defg}	45.28^{defg}
9.	AVTO 1717	1.28^{e}	4.43^{e}	3.53^{f}	0.35^{efg}	49.45^{bcdef}
10.	AVTO 1719	1.33^{de}	5.15^{cde}	3.82^{ef}	0.44^{def}	46.03^{defg}
11.	AVTO0301	1.37^{de}	6.31^{abc}	3.48^{f}	0.37^{defg}	47.78^{bcdef}
12.	AVTO1314	1.68^{abc}	4.96^{cde}	4.28^{cd}	0.49^{cd}	54.25^{abc}
13.	AVTO1288	1.58^{bcd}	5.88^{bcd}	4.80^{b}	0.60^{bc}	46.52^{bcdefg}
14.	AVTO 1315	1.45^{cde}	5.69^{bcd}	4.17^{cde}	0.61^{bc}	43.34^{fg}
15.	AVTO 1702	1.46^{cde}	6.05^{abc}	4.48^{bc}	0.63^{b}	51.42^{bcde}
16.	Pusa Ruby	0.85^{f}	4.60^{de}	5.60^{a}	0.75^{a}	49.49^{bcdef}
Mean		1.47	5.70	4.19	0.44	48.88
P value		<0.001	<0.001	<0.001	<0.001	<0.001
LSD(≤0.05)		0.22	1.16	0.39	0.12	6.71
CV %		12.7	17.7	8.0	23.4	11.9

LSD: Least Significant Difference, CV: Coefficient of Variation, Means followed by a different letter are significantly different at P< 0.05 according to an LSD test.

The data on various colorimetric development values viz., L* (white/black), a*(red/green) and b*(yellow/blue) clearly revealed the highly significant differences among genotypes. The values of L* ranged from 21.48 to 30.56. Whereas the maximum value (30.56) was recorded in AVTO 1717 followed by AVTO 1713 (30.08) and they are at par with genotypes AVTO 1719, AVTO 0301, AVTO 1716, AVTO 1315, AVTO 1715, AVTO 1424, AVTO 1702 AVTO 1712, AVTO 1306 and AVTO 1288 showed significantly at par with AVTO 1717. While the minimum observation of values of L* was noticed under AVTO 1711 (2148).

Likewise, the colorimetric value of a* showed the highest in Pusa Ruby (12.62) and it was at par with AVTO 1315, AVTO 1314, AVTO 1717, AVTO 1712, AVTO 1713, AVTO 1288 and AVTO 1702. The lowest value of a* (5.61) was found at AVTO 1610 followed by AVTO 1716 (6.05). In Genotypes AVTO 1713 recorded the higher colorimetric value of b* (19.37) followed by AVTO 1712 (18.75). The lowest value was noticed on AVTO 1702 (14.66) followed by AVTO 1288 (14.69). The variation of different colorimetric values (L*, a* and b*) was recorded by Mehraj et al (2014), Ghasemi et al (2015), Meena et al (2015), Nalla and Rana (2021) in different tomato genotypes

Table 4. Mean performance of open pollinated determinate tomato genotypes on colorimetric values at DoAR, Parwanipur, Bara in 2020/21 and 2021/22

S. N.	Genotypes	Colorimetric Value		
		L*	a*	b*
1.	AVTO 1713	30.08^{ab}	9.79^{abc}	19.37^{a}
2.	AVTO1610	21.32^{d}	5.61^{e}	17.41^{abc}
3.	AVTO 1712	23.7^{cd}	10.12^{abc}	18.75^{ab}
4.	AVTO1306	24.2^{bcd}	7.95^{cde}	17.43^{abc}
5.	AVTO 1711	21.48^{d}	7.55^{cde}	15.41^{cd}
6.	AVTO1424	25.77^{abcd}	8.68^{cd}	16.42^{bcd}
7.	AVTO 1715	26.23^{abcd}	6.26^{de}	16.51^{bcd}
8.	AVTO 1716	27.74^{abc}	6.05^{de}	16.48^{bcd}
9.	AVTO 1717	30.56^{a}	10.16^{abc}	16.39^{bcd}
10.	AVTO 1719	29.93^{ab}	7.73^{cde}	16.23^{cd}
11.	AVTO0301	29.19^{abc}	8.99^{bcd}	17.71^{abc}
12.	AVTO1314	23.56^{cd}	10.37^{abc}	17.32^{abc}
13.	AVTO1288	24.83^{abcd}	9.95^{abc}	14.69^{d}

S. N.	Genotypes	Colorimetric Value		
		L*	a*	b*
14.	AVTO 1315	26.81^{abcd}	12.02^{ab}	15.47^{cd}
15.	AVTO 1702	25.74^{abcd}	9.80	14.66^{d}
16.	Pusa Ruby	23.66^{cd}	12.62	15.4^{cd}
Mean		25.93	8.98	16.60
P value		0.004	<0.001	<0.001
LSD (≤0.05)		5.14	2.62	2.08
CV %		17.2	25.3	11.7

LSD: Least Significant Difference, CV: Coefficient of Variation, Means followed by a different letter are significantly different at P< 0.05 according to an LSD test.

CONCLUSION

The study of this experiment showed that genotypes AVTO 1711, AVTO 1702 and AVTO 1712 had performed better based on earliness, yield and other horticultural and quality parameters. These genotypes attained similar plant height, days to fifty percent flowering, plant vigor, fruit diameter, number of fruit per plant and colorimetric value Further one to two years verification trial in farmers' fields is needed before the recommendation of varieties for growing on a commercial scale.

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AUTHORS' CONTRIBUTION

J.N. Chaudhary designed, involved in field laid out, observation data collection of the experiment, data analyzed, and prepared a draft of the manuscript, A. Srivastava guided overall research and finalized manuscript, I.P Gautam assisted in final data tabulation, interpretation and literature review and M.D. Sharma edited thoroughly and gave final shape of paper.

CONFLICT OF INTEREST

The authors have declared that there is no conflict of interest regarding the publication of this manuscript.

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