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Evaluation of Tomato Varieties for Resistance against Tomato Leaf Curl Virus in Raipur, Chhattisgarh

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Abstract

A sum of twenty three varieties with one susceptible check variety *viz*. Punjab Chhuhara was evaluated against *Tomato leaf curl virus* during two consecutive *rabi* seasons (2015-16 and 2016-17) under natural conditions at Horticulture Instruction cum Research Farm, College of Agriculture, Indira Gandhi KrishiVishwavidyalaya, Raipur to find out resistant varieties with desirable parameters for the farmers of study area. Out of twenty three commercial varieties the performance of seventeen varieties was consistent in both the evaluation years. Of them ten varieties *viz*. Bharani, Bhagyawan, Abhilash, Karan, Kareena, Karishma, VNR-3357, Lakshmi, Saksham and NS 962 showed resistant reaction, four varieties *viz*. MHTM 256, Anvitha, Nun 7610 and Kundan were moderately resistant and one (Red Ruby) was moderately susceptible against ToLCD. The maximum (471.22 q) total yield (ha^{-1}) was recorded in Arka Rakshak followed by Bharani (419.49 q), Abhilash (412.43 q), Bhagyawan (386.11 q) and Priya-6636 (327.35 q).

Key words : *Disease, leaf curl, susceptible, tomato, virus.*

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most important and extensively grown vegetables (1) of both tropics and subtropics of the world (2). Worldwide, the tomato ranks second in importance after the potato (3) while it ranks third in priority after potato and onion in India (4).*Tomato leaf curl virus* transmitted by sweet potato whitefly (*Bemisia tabaci* Gennadius) has emerged as devastating pathogens during the last two decades particularly in tropics and sub-tropics causing huge economic losses (5). The loss accounted due to this disease has been reported to be as high as 90 percent depending upon season and crop growth stage (6). It has become a major production constraint among others in tomato production in Chhattisgarh also (7). There is very limited number of resistant varieties with combination of high yield and other desirable characteristics including consumer preference (8). Therefore an investigation was carried out to evaluate some tomato varieties to identify resistant varieties along with desirable parameters for the farmers of study area.

Materials and Methods

Total twenty three popular commercial varieties with one susceptible check variety *viz*. Punjab Chhuhara was evaluated against tomato leaf curl disease during two consecutive *rabi* seasons (2015-16 and 2016-17) under natural conditions at Horticulture Instruction cum Research Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur to find out resistant varieties with desirable parameters for the farmers of study area.Seedlings of each variety of tomato were raised in nursery beds. Seeds of each variety of tomato were sown in separate rows on 7th October 2015 and 7th October 2016 in *rabi* 2015-16 and 2016-17 respectively. Twenty two days old seedlings were transplanted into main field with maintaining 60 cm row to row and 50 cm plant to plant spacing in randomized block design (RBD) and three replications were maintained for each variety. No chemicals or pesticides were applied during the course of experiment.

The observations on percent disease incidence and percent disease index (PDI) of disease were taken for each variety from 15 to 90 days after transplanting at 15-day intervals. The percent disease incidence was calculated by following formula suggested by Nene, 1972 (9). The rating of leaf curl disease was recorded for each plant of every variety by using rating scale of 0-7 as suggested by (10). However, percent disease index (PDI) was calculated for each variety by implying formulae suggested by (11). Thereafter on the basis of reactions different varieties were classified into different categories *viz*. Highly resistant (HR), Resistant (R), Moderately resistant (MR), Moderately susceptible (MS) and Susceptible (S).

$$\text{Percent disease incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants observed}} \times 100$$

$$\text{PDI} = \frac{\text{Sum of numerical disease ratings}}{\text{Total number of plants observed} \times \text{Maximum disease ratings}} \times 100$$

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ToLCV Disease Rating Scale

Grade / Rating	Symptoms	PDI	Reaction category
0	No visible disease symptom	0	HR
1	Top leaves curled only	1.0-15.9	R
3	Top leaves curled and slight stunting of plant or All leaves curled without stunting	16.0-25.9	MR
5	All leaves curled and slight stunting of plant	26.0-36.9	MS
7	Severe curling of leaves, stunting of plant and proliferation of auxiliary branches	37.0 and above	S

Overall performances : The overall performances of all the varieties were analyzed on the basis of following parameters :

Days to first fruiting : Days to first fruiting was calculated by counting the days taken for first fruiting after transplanting.

Average fruit weight (g) : The weight of each fruit was calculated by weighing the fruits of five randomly selected plants and mean was calculated

Total yield per hectare (q) : Total yield per ha was calculated by adding per ha marketable and unmarketable yield

Equatorial diameter (mm) : Equatorial diameter/ Fruit girth of five randomly selected fruits from each replication were measured with the help of Vernier scale (Fisher Scientific) and average was calculated.

Polar diameter (mm) : Polar diameter/ Fruit height of five randomly selected fruits were measured from top to bottom pole of each fruit with the help of Vernier scale (Fisher Scientific) and average was calculated for each replication.

Pericarp thickness (mm) : The pericarp thickness of five randomly selected fruits from each replication was measured with the help of Vernier scale (Fisher Scientific) and average was calculated.

Total soluble solid/TSS (Brix %) : The TSS of five randomly selected fruits from each replication was measured with the help of hand refractometer (0-32% Brix) and average was calculated

Results and Discussion

Reaction and level of resistance of popular commercial varieties of tomato against ToLCD **:** Among the twenty three varieties evaluated during 2015-16, eleven varieties *viz*. Bharani, Bhagyawan, Abhilash, Karan, Kareena, Priya-6636, Karishma, VNR-3357, Lakshmi, Saksham and NS 962 were regarded as resistant and fall under the grade 1. Of them eight varieties *viz*. MHTM 256, Arundhati 809, Anvitha, Kohinoor, VNR-3348, Nun 7610, Kundan and ArkaRakshak were categorized as moderately resistant with rating 3. However one variety i.e. Red Ruby was kept in moderately susceptible category with rating 5. Three varieties viz. S-22, Pusa Ruby and Punjab Chhuhara were classified under the susceptible reaction with rating 7 (Table-1).

Out of twenty three varieties evaluated during 2016-17 thirteen varieties viz. Bharani, Arundhati 809, Bhagyawan, Abhilash, Kohinoor, Karan, Kareena, Karishma, VNR-3348, VNR-3357, Lakshmi, Saksham and NS 962 were resistant against ToLCD and fall under the grade 1. Five varieties viz. MHTM 256, Anvitha, Priya-6636, Nun 7610 and Kundan were regarded as moderately resistant with rating 3. Three varieties *viz*. S-22, Red Ruby and ArkaRakshak were categorized as moderately susceptible and assigned with rating 5. Two varieties *viz*. Pusa Ruby and Punjab Chhuhara were shown as susceptible with rating 7 (Table-1).

The result of evaluation for both years (2015-16 and 2016-17) displayed that the performance of seventeen varieties were constant. Of them ten varieties viz. Bharani, Bhagyawan, Abhilash, Karan, Kareena, Karishma, VNR-3357, Lakshmi, Saksham and NS 962 were found resistant against ToLCD with rating 1. Four varieties *viz*. MHTM 256, Anvitha, Nun 7610 and Kundan were moderately resistant and rated 3. Only one variety *i.e*. Red Ruby was denoted as moderately susceptible with rating 5. Two varieties *viz*. Pusa Ruby and Punjab Chhuhara were put in reaction category susceptible and fall under rating 7 (Table-1).

The results are in agreement with the findings of (9) who found that among the twenty nine tomato genotypes including 15 hybrids, 13 varieties screened against ToLCD, one wild accession, EC251672 was immune without any symptoms, ten genotypes comprising of 9 hybrids *viz*. Akash-918, NS-539, NS-515, Siri-9005, STH-803, STH-807, To-1827, US-1196, US-2175 and one cv. Vybhav were resistant against ToLCD. (12) reported that among thirty two tomato genotypes screened for its resistance/ susceptible reaction against tomato leaf curl disease, one wild accession, H-88-78-1 was immune without producing any symptoms of leaf curl disease, three genotypes *viz*. HissarLalima, TLBRH-6 and NS-515 were resistant and eight *viz*. HissarAnmol, KishiVishesh, KashiAmrit, KashiSharad, KS-17, KS-118, Avinash-2 and US-1008 were moderately resistant to ToLCV. (13) screened twelve tomato genotypes, two resistant checks (56-14-7 and 58-11-1-1), two susceptible checks (Punjab Upma and Punjab Chhuhara) and eight

Table-1 : Classification of popular commercial varieties in different reaction categories.

Year	Reaction category	No. of variety	Name of variety
Varieties with constant reaction in both the years	Resistant	10	Bharani, Bhagyawan, Abhilash, Karan, Kareena, Karishma, VNR- 3357, Lakshmi, Saksham, NS 962
	Moderately resistant	4	MHTM 256, Anvitha, Nun 7610, Kundan
	Moderately susceptible	1	Red Ruby
	Susceptible	2	Pusa Ruby, Punjab Chhuhara
2015-16	Resistant	11	Bharani, Bhagyawan, Abhilash, Karan, Kareena, Priya-6636, Karishma, VNR- 3357, Lakshmi, Saksham, NS 962
	Moderately resistant	8	MHTM 256, Arundhati 809, Anvitha, Kohinoor, VNR- 3348, Nun 7610, Kundan, ArkaRakshak
	Moderately susceptible	1	Red Ruby
	Susceptible	3	S-22, Pusa Ruby, Punjab Chhuhara
2016-17	Resistant	13	Bharani, Arundhati 809, Bhagyawan, Abhilash, Kohinoor, Karan, Kareena, Karishma, VNR- 3348, VNR- 3357, Lakshmi, Saksham, NS 962
	Moderately resistant	5	MHTM 256, Anvitha, Priya- 6636, Nun 7610, Kundan
	Moderately susceptible	3	S-22, Red Ruby, ArkaRakshak
	Susceptible	2	Pusa Ruby, Punjab Chhuhara

Table-2 : Overall performance of popular commercial varieties in 2015-16.

Variety	Disease incidence (%)	PDI	Reaction	Average fruit weight (g)	Total yield (q ha^{-1})	Equat-orial diameter of fruit (mm)	Polar diameter of fruit (mm)	Thickness of pericarp (mm)	TSS (% Brix)	First fruiting (DAT)
MHTM 256	28.44	18.95	MR	60.26	259.63	62.29	43.68	5.70	3.92	33.67
S-22	68.80	48.78	S	42.93	176.93	51.38	39.50	4.58	4.23	34.67
Bharani	23.17	15.84	R	52.94	401.94	53.40	42.68	5.36	4.29	34.33
Arundhati 809	24.39	16.73	MR	49.61	285.56	56.55	45.33	5.35	4.33	34.67
Bhagyawan	19.60	13.33	R	44.71	382.41	54.22	42.94	5.61	4.15	35.00
Abhilash	10.34	6.73	R	61.92	425.92	58.88	47.42	6.12	3.97	38.67
Anvitha	33.32	22.37	MR	75.30	281.11	59.70	44.58	5.03	4.25	34.67
Red Ruby	46.77	31.98	MS	63.89	260.93	56.95	45.07	5.28	4.60	37.00
Kohinoor	23.66	16.23	MR	50.94	191.85	54.81	50.05	5.45	3.85	35.67
Karan	13.19	9.07	R	66.42	310.56	51.75	56.16	6.04	4.56	35.00
Kareena	19.70	13.39	R	54.56	228.33	60.21	43.09	5.81	3.75	36.33
Priya-6636	22.99	15.77	R	55.90	351.85	53.89	42.03	5.31	4.07	33.00
Karishma	16.72	11.26	R	49.14	202.96	56.69	45.54	5.51	3.64	33.67
VNR-3348	24.25	16.63	MR	66.03	211.85	53.70	44.76	4.82	3.99	37.00
Nun 7610	33.14	21.99	MR	62.51	224.07	55.52	47.99	5.74	3.47	38.67
VNR- 3357	18.41	11.95	R	71.37	260.19	55.99	47.57	5.33	3.84	38.00
Kundan	25.31	16.99	MR	46.03	253.33	48.27	53.65	5.48	4.93	40.33
Lakshmi	15.49	11.06	R	67.46	161.48	52.10	41.63	5.15	4.09	35.67
Saksham	23.45	15.69	R	48.86	301.11	52.79	40.47	4.91	3.87	35.00
NS 962	22.33	15.29	R	54.02	83.52	50.04	41.09	5.26	4.11	32.33
ArkaRakshak	36.24	25.05	MR	73.96	472.82	49.32	52.69	4.80	3.92	35.67
Pusa Ruby	90.60	68.47	S	46.57	89.63	37.48	32.51	3.23	4.17	36.33
Punjab Chhuhara	92.02	70.77	S	34.15	41.26	36.42	53.07	4.89	4.27	39.33
Sem±				1.997	9.133	2.03	1.61	0.23	0.10	0.81
CD (p=0.05)				5.691*	26.030*	5.779*	4.582*	0.648*	0.291*	2.302*
CV				6.121	6.209	6.627	6.158	7.504	4.313	3.902

DAT : Days after transplanting.

advanced lines (11-22, 2-20-2, 6-23, 4-4-1-1, 7-4-5, 8-3-2, 8-5-2-1 and 1-2-3), for disease incidence of tomato leaf curl viral disease (ToLCVD). All eight advanced lines showed zero per cent infection and were found to be resistant to ToLCV and Punjab Upma and Punjab Chhuhara were susceptible.

Overall performance of popular commercial varieties :

It was clearly visible from Table-2 that in rabi 2015-16 Karan gave best overall rank followed by Abhilash, VNR-3357, Bhagyawan and Bharani. Though these five varieties showed commendable overall rank with resistant reaction but ArkaRakshak recorded maximum per ha total

Table-3 : Overall performance of popular commercial varieties in 2016-17.

Variety	Disease incidence (%)	PDI	Reaction	Average fruit weight (g)	Total yield (q ha^{-1})	Equatorial diameter of fruit (mm)	Polar diameter of fruit (mm)	Thickness of pericarp (mm)	TSS (% Brix)	First fruiting (DAT)
MHTM 256	32.35	21.64	MR	62.54	243.48	60.23	44.07	5.52	3.80	27.33
S-22	46.40	31.17	MS	40.94	204.81	53.33	42.35	4.41	4.45	28.67
Bharani	16.84	11.65	R	55.61	437.03	57.67	46.21	5.57	4.15	28.33
Arundhati 809	13.68	9.77	R	49.63	308.34	61.25	45.28	5.24	4.27	28.67
Bhagyawan	15.16	9.06	R	44.69	389.82	60.09	43.29	6.11	4.33	30.00
Abhilash	12.87	8.8	R	58.63	398.93	57.87	47.38	6.29	4.10	32.67
Anvitha	28.09	17.84	MR	76.38	275.00	63.49	47.15	4.87	4.16	28.67
Red Ruby	53.70	35.48	MS	63.52	251.19	55.82	46.13	5.73	4.74	31.33
Kohinoor	15.24	9.44	R	60.74	185.18	61.60	55.34	5.18	3.64	30.00
Karan	14.58	10.05	R	65.66	294.11	53.45	57.02	5.84	4.31	30.00
Kareena	16.73	10.12	R	53.32	241.30	63.02	41.47	6.15	3.81	31.00
Priya-6636	25.42	16.65	MR	53.99	302.85	55.41	45.04	5.24	3.93	27.33
Karishma	12.70	9.07	R	47.18	191.30	59.39	45.17	5.62	3.84	27.67
VNR-3348	16.44	10.98	R	64.96	215.93	56.50	46.21	4.60	4.12	31.33
Nun 7610	26.38	18.07	MR	56.92	218.89	56.35	48.20	5.58	3.62	31.33
VNR-3357	20.39	13.15	R	70.78	203.70	56.03	47.31	5.10	3.68	30.67
Kundan	26.75	17.19	MR	50.88	283.22	50.14	52.90	5.69	5.02	35.00
Lakshmi	23.19	14.47	R	61.47	168.89	50.85	42.32	5.38	4.25	30.00
Saksham	19.11	12.92	R	58.16	305.81	53.09	42.46	4.47	3.78	29.67
NS 962	14.94	9.1	R	61.78	122.15	54.38	43.95	5.09	3.92	25.00
Arka Rakshak	46.99	30.97	MS	72.70	469.63	47.48	50.51	4.63	4.04	30.33
Pusa Ruby	86.89	65.81	S	44.35	88.37	43.33	34.12	3.52	4.25	32.67
Punjab Chhuhara	84.33	68.81	S	33.22	56.44	38.36	53.15	4.94	4.29	39.67
Sem±				2.083	9.464	1.649	1.378	0.225	0.133	1.384
CD (p=0.05)				5.936*	26.975*	4.700*	3.926*	0.641*	0.379*	3.944*
CV				6.461	6.438	5.193	5.143	7.419	5.612	7.906

DAT: Days after transplanting

yield (472.82 q) and exhibited moderately resistant reaction followed by Abhilash (425.92 q), Bharani (401.94 q), Bhagyawan (382.41 q) and Priya-6636 (351.85 q). Moreover the performance of each variety was different for different parameter such as the heaviest fruit was obtained from Anvitha with average fruit weight of 75.30 g followed by ArkaRakshak (73.96 g), VNR-3357 (71.37 g), Lakshmi (67.46 g) and Karan (66.42 g). However largest round fruits were recorded in MHTM 256 with equatorial diameter of 62.29 mm followed by Kareena (60.21 mm), Anvitha (59.70 mm), Abhilash (58.88 mm) and Red Ruby (56.95 mm). Karan was recorded for the longest fruit with polar diameter of 56.16 mm followed by Kundan (53.65 mm), Punjab Chhohara (53.07), ArkaRakshak (52.69 mm) and Kohinoor (50.05 mm). However Abhilash had the maximum (6.12 mm) pericarp thickness followed by Karan (6.04 mm), Kareena (5.81 mm), Nun 7610 (5.74 mm) and MHTM 256 (5.70 mm). In case of TSS the maximum total soluble solids content (4.93 °Brix) was found in Kundan followed by Red Ruby (4.60 °Brix), Karan (4.56 °Brix), Arundhati 809 (4.33 °Brix) and Bharani (4.29 °Brix). Whereas the minimum (32.33 days) days to first fruiting were observed in NS 962 followed by Priya-6636 (33.00 days), MHTM 256 and Karishma (33.67 days) and Bharani (34.33 days).

It was revealed from the experimental data presented in Table-3 that in 2016-17 Karan performed outstanding followed by Abhilash, Bhagyawan, Arundhati 809 and Bharani. Though these varieties were superfine in overall performance with resistant reaction but maximum (469.63 q) per ha total yield was recorded in ArkaRakshak that showed moderately susceptible reaction. This was followed by Bharani (437.03 q), Abhilash (398.93 q), Bhagyawan (389.82 q) and Arundhati 809 (308.34 q). Moreover the performance of each variety was different for different parameter such as the heaviest fruit was obtained from Anvitha with average fruit weight of 76.38 g followed by ArkaRakshak (72.70 g), VNR-3357 (70.78 g), Karan (65.66 g) and VNR-3348 (64.96 g). While largest round fruits were recorded in Anvitha with equatorial diameter of 63.49 mm followed by Kareena (63.02 mm), Kohinoor (61.60 mm), Arundhati 809 (61.25 mm) and MHTM 256 (60.23 mm). Karan was recorded for the longest fruit with polar diameter of 57.02 mm followed by Kohinoor (55.34 mm), Punjab Chhuhara (53.15 mm), Kundan (52.90 mm) and ArkaRakshak (50.51 mm). However Abhilash had the maximum (6.29 mm) pericarp thickness followed by Kareena (6.15 mm), Bhagyawan (6.11 mm), Karan (5.84 mm) and Red Ruby (5.73 mm). In case of TSS the maximum total soluble

Table-4 : Overall performance of popular commercial varieties in both the years (2015-16 and 2016-17).

Variety	Disease incidence (%)	PDI	Reaction	Average fruit weight (g)	Total yield (q ha^{-1})	Equatorial diameter of fruit (mm)	Polar diameter of fruit (mm)	Thickness of pericarp (mm)	TSS (% Brix)	First fruiting (DAT)
MHTM 256	30.40	20.30	MR	61.40	251.56	61.26	43.87	5.61	3.86	30.50
S-22	57.60	39.98	S	41.94	190.87	52.35	40.93	4.50	4.34	31.67
Bharani	20.01	13.75	R	54.27	419.49	55.54	44.44	5.47	4.22	31.33
Arundhati 809	19.04	13.25	R	49.62	296.95	58.90	45.30	5.29	4.30	31.67
Bhagyawan	17.38	11.20	R	44.70	386.11	57.16	43.12	5.86	4.24	32.50
Abhilash	11.61	7.77	R	60.28	412.43	58.38	47.40	6.21	4.04	35.67
Anvitha	30.71	20.11	MR	75.84	278.06	61.60	45.86	4.95	4.21	31.67
Red Ruby	50.24	33.73	MS	63.70	256.06	56.39	45.60	5.50	4.67	34.17
Kohinoor	19.45	12.84	R	55.84	188.52	58.20	52.70	5.32	3.75	32.83
Karan	13.89	9.56	R	66.04	302.33	52.60	56.59	5.94	4.44	32.50
Kareena	18.22	11.76	R	53.94	234.82	61.62	42.28	5.98	3.78	33.67
Priya-6636	24.21	16.21	MR	54.95	327.35	54.65	43.54	5.28	4.00	30.17
Karishma	14.71	10.17	R	48.16	197.13	58.04	45.36	5.57	3.74	30.67
VNR-3348	20.35	13.81	R	65.50	213.89	55.10	45.48	4.71	4.06	34.17
Nun 7610	29.76	20.03	MR	59.72	221.48	55.94	48.09	5.66	3.55	35.00
VNR-3357	19.40	12.55	R	71.07	231.95	56.01	47.44	5.22	3.76	34.33
Kundan	26.03	17.09	MR	48.45	268.28	49.21	53.28	5.59	4.98	37.67
Lakshmi	19.34	12.77	R	64.47	165.18	51.47	41.98	5.26	4.17	32.83
Saksham	21.28	14.31	R	53.51	303.46	52.94	41.47	4.69	3.82	32.33
NS 962	18.64	12.20	R	57.90	102.83	52.21	42.52	5.18	4.01	28.67
Arka Rakshak	41.62	28.01	MS	73.33	471.22	48.40	51.60	4.71	3.98	33.00
Pusa Ruby	88.75	67.14	S	45.46	89.00	40.41	33.32	3.38	4.21	34.50
Punjab Chhuhara	88.18	69.79	S	33.68	48.85	37.39	53.11	4.91	4.28	39.50
Sem±				1.238	6.372	1.414	1.053	0.159	0.084	0.778
CD (p=0.05)				3.529*	18.160*	4.029*	3.000*	0.454*	0.240*	2.218*
CV				3.783	4.333	4.535	3.981	5.256	3.552	4.073

DAT : Days after transplanting.

solids content (5.02 °Brix) was found in Kundan followed by Red Ruby (4.74 °Brix), S-22 (4.45 °Brix) Bhagyawan (4.33 °Brix), and Karan (4.31 °Brix). While the least (25.00 days) number of days required for first fruiting were recorded in NS 962 followed by MHTM 256 and Priya-6636 (27.33 days), Karishma (27.67 days) and Bharani (28.33 days).

It was revealed from the average data of both the years (2015-16 and 201617) that the overall performance of Karan was best which was followed by Abhilash, Bhagyawan, Arundhati 809 and Bharani (Table-4). Though these varieties were superior in overall performance with resistant reaction but maximum (471.22 q) per ha total yield was recorded in Arka Rakshak that showed moderately susceptible reaction. This was followed by Bharani (419.49 q), Abhilash (412.43 q), Bhagyawan (386.11 q) and Priya-6636 (327.35 q). Moreover the performance of each variety was different for different parameter such as the heaviest fruit was obtained from Anvitha with average fruit weight of 75.84 g followed by Arka Rakshak (73.33 g), VNR-3357 (71.07 g), Karan (66.04 g) and VNR-3348 (65.50 g). While largest round fruits were recorded in Kareena with equatorial diameter of 61.62 mm followed by Anvitha (61.60 mm), MHTM 256 (61.26 mm), Arundhati 809 (58.90 mm) and Abhilash (58.38 mm). Karan was recorded for the longest fruit with polar diameter of 56.59 mm followed by Kundan (53.28 mm), Punjab Chhuhara (53.11 mm), Kohinoor (52.70 mm) and Arka Rakshak (51.60 mm). However Abhilash had the maximum (6.21 mm) pericarp thickness followed by Kareena (5.98 mm), Karan (5.94 mm), Bhagyawan (5.86 mm) and Nun 7610 (5.66 mm). In case of TSS the maximum total soluble solids content (4.98 °Brix) was found in Kundan followed by Red Ruby (4.67 °Brix), Karan (4.44 °Brix), S-22 (4.34 °Brix) and Arundhati 809 (4.30 °Brix). Whereas the least (28.67 days) number of days required for first fruiting were noted in NS 962 followed by Priya-6636 (30.17 days), MHTM 256 (30.50 days), Karishma (30.67 days) and Bharani (31.33 days).

The average fruit weight of Anvitha, Arka Rakshak, VNR-3357, Karan and VNR-3348 was higher than the other commercial varieties. Our findings were supported with the findings of (14) found that tomato accession B23 recorded the highest average fruit weight. Earlier worker like (15) reported that resistant genotype Anastasia yielded highest number of fruits $plant^{-1}$ with maximum average fruit weight.In contrast to our results (7) achieved highest fruit yield from H-24. The yield performance of Arka Rakshak, Bharani, Abhilash, Bhagyawan and Priya-6636 were scrumptious than other commercial varieties and least in Punjab Chhuhara, Pusa Ruby and NS 962.The fruits of Kareena, Anvitha, MHTM 256, Arundhati 809 and Abhilash were large with higher equatorial diameter and all were round shaped while both

the susceptible varieties Punjab Chhuhara and Pusa Ruby were smallest (15). In commercial varieties group the polar diameter of Kundan, Punjab Chhohara, Kohinoor and Arka Rakshak were higher than the others and with the exception of Punjab Chhohara these four were oval in shaped however round shaped fruits (Pusa Ruby and S-22) had minimum polar diameter (16). Thus it was revealed from the results that the equatorial diameter indicates the globosity of fruits and generally round shaped fruits had wider equatorial diameter whereas polar diameter represents the length/ height of fruits and generally oval/ pear shaped fruits had higher polar diameter (17). (18) reported that entries/ hybrids with high polar diameter and having pear shape are desired for processing purpose.Thickness of pericarp influences the shelf life of fruits and bears an important quality attributes for processing purpose (17). Among the commercial varieties Abhilash, Kareena, Karan, Bhagyawan and Nun 7610 produced fruits with thicker pericarp than other however Pusa ruby produced fruits with very thin pericarp.High total soluble solids (TSS) are the main quality component for nutrition and processing purposes (17). The performance of Kundan, Red Ruby, Karan, S-22 and Arundhati 809 were commendable for TSS content in fruits than other entries however Nun 7610 and Karishma presented poor performance. (18) reported negative but non significant correlation between tomato leaf curl incidence and TSS.

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