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Performance of Tomato (Solanum Lycopersicum L.) Genotypes for Yield and Quality Traits Under Jammu Subtropical Condition

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Abstract **– The present investigation was carried out at Vegetable Experimental Farm, Division of Vegetable Science & Floriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Chatha during spring - summer 2012-13 and 2013-14 to evaluate the performance genotypes for yield, quality, and reaction against biotic stress. The highest number of fruits per plant were recorded in Pusa Ruby (30.82) and maximum marketable fruit yield per plot was recorded in hybrid Tokita (5.07 kg/plot). With respect to quality traits, maximum pericarp thickness (6.86mm) was observed in genotype Anand. Arka Vikas recorded highest fruit pH (4.49); beta-carotene (7.06mg/100g) and total soluble solids (5.02^{0}B). Genotype Aditya gave highest lycopene (5.22mg/100g) content and highest ascorbic acid content was recorded in Arka Meghali (27.96mg/100g). Genotype DVRT-2 showed minimum incidence of fruit borer (15.60 %). From the present studies, it can be inferred that the genotypes Tokita, US-3383 and Pusa Ruby were high yielding and good for fresh marketing. Genotypes Arka Vikas, Aditya and Arka Meghali were found suitable for processing. However, potential of these genotypes is needed to be further tested under the sub-tropical conditions of Jammu.**

Keywords **– Tomato, Performance, Genotypes, Yield, Quality and Biotic Stress.**

I. Introduction

Tomato (*Solanum lycopersicum* L.) is an important warm season, self-pollinated vegetable crop grown both for fresh and food processing market (Nwosu *et al*., 2014). It is second popular widely grown and consumed vegetable in the world, next to potato (Anonymous, 2005) and has great demand in the international market (Solieman *et al*., 2013). Tomatoes are an excellent source of minerals, vitamins (Akinfasoy *et al*., 2011) and antioxidants viz., lycopene and beta-carotene which prevent cancer and other heart diseases (Kaur *et al*., 2013). The quality of tomato genotypes plays an important role in deciding the suitability of the genotype for processing purpose, fresh market or table purpose. The antioxidant content of tomato mostly depends on genetic and environmental factors (Martinez *et al*. 2002).In India, tomato is cultivated over an area of 905 (000 ha) with an annual production of 19104 (000 MT) (Anonymous, 2014a). In Jammu and Kashmir region tomato is cultivated over an area of 3.58 (000 ha) with an average production of 88.09 (000 MT) (Anonymous, 2014b) which is far behind to the national states.

In order to increase the tomato production under Jammu subtropical condition, it is essential to identify capable genotypes giving year round production with higher yield and resistant to pests. There are a few high yield and disease and insect resistant varieties but they do not perform well throughout the year because of their photo-sensitiveness and less adaptability. The present investigation was undertaken to identify suitable genotypes capable of giving higher fruit yield and quality performance under Jammu subtropical regions.

II. Materials and Methods

The experimental material for the present studies comprised of 25 tomato genotypes (12 hybrids and 13 open pollinated) collected from different sources (Table 1) and these were tested for two years during spring summer season of 2012-2013 and 2013-2014 at the experimental farm of Division of Vegetable Science and Floriculture, SKUAST-Jammu which is situated at 32^o 40'N latitude and 74^o 58' E longitude and has an elevation of 332 m above mean sea level. The place experiences hot dry summer, hot and humid rainy season and cold winter months, the maximum temperature goes up to 45^o C during summers (May to June) and minimum temperature falls to 1^o C during winters. The individual experiment was conducted in Randomized block design with three replications. The uniform, healthy seedlings were planted on ridges maintaining inter and intra row spacing of 60 and 45 cm respectively. All the package of practices were followed to raise a healthy crop. Observations were recorded on five randomly selected plants of each genotype and replication for days to 50% flowering, days to first marketable fruit picking, total number of fruits per plant, average fruit weight (g), marketable yield per plot, total yield per plot (Kg), plant height (cm), number of seeds fruit^{-1}, Incidence of fruit borer (%) and Intensity of early blight (%), number of locules fruit^{-1}, Pericarp thickness (mm), Total soluble solids (^{0}B), Lycopene (mg/100g), Beta carotene (mg/100g), Ascorbic acid (mg/100g) and pH.

A drop of tomato juice from each reference was put on the prism of hand refract meter and reading on per cent scale was noted for total soluble solids estimation. Beta carotene content (mg/100g) was estimated through the procedure given by (Sadasivam and Manickam, 1992); Lycopene content (mg/100g) and Ascorbic acid content (mg/100g) by Rangana (1976). The mean data for all observations were pooled and statistically analyzed following standard procedure as suggested by the Panse and Sukhatme (1978).

III. Result and Discussion

Analysis of variance revealed highly significant differences among genotypes for all the traits under study. The genotype took minimum days to 50 percent flowering (28.23) and over all grand mean for the trait was found to be 30.22. Lehar (28.84) and US-3383 (28.84) were statistically at par with Sonali, whereas Arka Vikas, Arka Abha and Swarna Naveen which took 30.81, 30.73 & 30.70 days respectively for 50% flowering were statistically at par with grand mean. Similar findings were obtained by Raju *et al*. (2014); Kumar *et al*. (2012) and Das *et al*. (2011). Minimum days to first marketable fruit picking were taken by genotype US-3383 i., 69.24 days which was statistically at par with Sonali (69.51) and Lehar (69.97). Genotypes viz., Swarna Naveen, Kubergeeta and Anand took more days (71.78, 71.73 & 70.71) which was statistically at par with grand mean (71.21). The genotype Marglobe was late in maturity (73.11) followed by Solan Lalima (73.09) and DVRT-2 (72.98). The early or late maturity is attributed as genotypic character and somewhat influenced by the environmental factors of any particular growing area. The highest number of fruits per plant were recorded by the genotypes Pusa Ruby (30.83) followed by Lehar (29.95) and US-3383 (29.30). While the lowest number of fruits per plant was recorded for DVRT-2 (18.86) and Arka Meghali (19.57). This showed that plants bearing less fruits has bigger size of fruits. These results resemble with those of Gautam *et al*. (2013); Cheema *et al*. (2013); singh *et al*. (2012); Kumar *et al*. (2012) and Dar *et al*. (2011). Average fruit weight (g) was highest in Rupali (81.34 g) followed by Heem Sohna (72.78 g), Naveen (70.87 g) and minimum was recorded in Angoorlata (30.39 g) which might be due to small fruit size. Whereas genotype Aditya (63.95) was statistically at par with grand mean (57.44). Similar findings was obtained by Raju *et al*. (2014)

Fruit yield is the most important complex trait in tomato. It is influenced by genetic and environmental effects, such as numerous abiotic and biotic stresses (Kaskavalic, 2007) and growing location (Yoltas *et al*., 2003). Marketable yield per plot (kg) was recorded highest in genotype Tokita (5.08 kg/plot) followed by US-3383 (4.44 kg) and Pusa Ruby (4.26 kg). The lowest was recorded in Marglobe (2.02 kg) and Arka Meghali (2.09 kg). Similar results were obtained by Dufera *et al*. (2013). The highest yield might be due to more number of pickings because of indeterminate nature and higher number of fruits per plant which has direct impact on yield. Genotype Tokita recorded highest total yield / plot (6.87 kg) as compared to grand mean (4.44 kg) which was followed by Aditya (6.02 kg), US-3383 (5.77), Pusa Ruby (5.72 kg) and lowest was noticed in Naveen (2.83 kg).

Difference in plant height among genotypes is by virtue of their indeterminate and determinate growth habit. The tallness, shortness and other morphological differences are varietal characteristics, which are controlled and expressed by certain genes. Genotype Heem Sohna had the tallest plant height (162.18 cm) followed by DVRT-2 (138.34 cm) and Anand (136.87 cm). Whereas Sonali (107.67 cm) was statistically at par with grand mean (99.31 cm). The shortest plant height was secorded in Swarna Lalima (64.72 cm). These results coincide with the findings of Raju *et al*. (2014) and Singh *et al*. (2012). Number of seeds / fruit was recorded minimum in genotype Swarna Naveen (52.60) followed by Kubergeeta (62.46), Heem Sohna (93.88) and maximum number of seeds/fruit was recorded in Arka Abha (187.62) recorded which is at par with Rupali (187.06). Genotype Swarna Lalima (133.57) and Arka Vikas (133.07) which was statistically at par with grand mean (120.01). Similar reports are reported by Kumar *et al*. (2012).

The percent incidence of fruit borer was minimum in the genotype DVRT-2 (15.60 %) followed by Naveen (16.33 %) and Swarna Naveen (16.49 %). The maximum fruit borer damage was noticed in Leh Local (26.00 %). While genotype Aditya (22.78) was found statistically at par with grand mean (20.30 %). Similar findings are obtained by Ngullie and Biswas (2014); Singh *et al.* (2013) and Sajjad *et al*. (2011). Selvanarayanan and Narayanasamy, 2006 reported that resistant may be due to high ortho dihydroxy phenols and trichome density in the foliage of genotypes. On comparing the mean performance for intensity of early blight genotypes, Aditya had the least damage (17.81 %) followed by Solan Lalima (17.85 %) and DVRT-2 (20.28 %). Maximum incidence of early blight was noticed in Kubergeeta (48.88 %) and Lehar (48.58 %). The results are in conformity with Rani *et al.* (2015); Kumar *et al*. (2013)

Locule number is an important phenotypic trait of tomatoes because it affects the shape and size of the fruit. Most tomato genotypes have two to eight locules filled with seeds and gelatinous material. The greater the number of locules, the larger is the fruit size which indicates direct correlation between these two traits. The genotype Arka Vikas recorded maximum number of locules per fruit (4.42) followed by Arka Abha (4.24), Marglobe (4.23) and minimum was observed in Aditya (2.29). The genotypes Arka Saurabh (3.45) and DVRT-2 (3.66) was statistically at par with grand mean (3.16). These results are in accordance with the findings of Raju *et al*. (2014) and Kumar *et al*. (2012). Genotype Anand possessed maximum pericarp thickness (6.87 mm) followed by Kubergeeta (6.75mm), NS-2535 (6.73 mm). Genotype Arka Meghali possessed minimum pericarp thickness (3.85 mm). While Lehar (6.09 mm) was found statistically at par with grand mean (5.59 mm). Kumari and Sharma (2011) reported that genotypes with thicker pericarp are better to withstand long distance transportation and remain firm for a longer period, when compared to thinly fleshed tomatoes. Total soluble solids content of tomato fruits is essential for processing purpose. High total soluble solids are desirable to higher yield of processed products. Genotype Arka Vikas recorded the highest total soluble solid (5.03 ^{0}B) and lowest was recorded by Tokita (3.36 ^{0}B). Whereas, genotypes Naveen (4.39 ^{0}B) and Angoorlata (4.38 ^{0}B) was statistically at par with grand mean (4.14 ^{0}B) These findings are in support to the findings of Raju *et al*. (2014); Dufera (2013); Jyothi *et al*. (2012). Genotype Aditya recorded maximum lycopene (5.23 mg/100 g) followed by Naveen (4.56 mg/100 g) and minimum was noticed in Swarna Lalima (1.36 mg/100 g). Whereas Heem Sohna (3.64) and Angoorlata (3.60) was statistically at par with grand mean (2.95 mg/100 g). These

findings are in agreement with the results of Cheema *et al*. (2013); Dufera (2013); Panthee *et al*. (2012) and Jyothi *et al*. (2012). The genotypes with the highest contents of lycopene and highest antioxidant activity represents a valuable genotype not only for improving the status of dietary antioxidants in our diet but also for increasing nutritional value through germplasm enhancement programs (George *et al*., 2004). Genotype Arka Vikas had the highest beta-carotene (7.61 mg/100g) content followed by Solan Lalima (7.07 mg/100 g) and Maharishi showed the lowest beta-carotene content (1.60 mg/100g). Whereas Arka Saurabh (6.07 mg/100 g) was statistically at par with grand mean (4.70 mg/100 g).Similar results were earlier reported by Cheema *et al*. (2013) and Dar and Sharma (2011). Genotype Arka Meghali had maximum ascorbic acid (27.96 mg/100 g) followed by Swarna Lalima (27.18 mg/100 g), While the minimum was noticed in Sonali (10.97 mg/100 g). These results in accordance with the findings of Cheema *et al*. (2013); Reddy *et al*. (2013); Zahedi *et al*. (2012); Gosavi *et al.* (2010). Genotype Arka Vikas recorded maximum pH (4.49) followed by Lehar (4.48), Arka Meghali (4.45) and lowest pH was noticed in Pusa Ruby (4.07). Whereas, DVRT-2 (4.33) and Arka Saurabh (4.33) was statistically at par with grand mean (4.28).

From the present studies, it can be inferred that the genotypes Tokita, US-3383 and Pusa Ruby were high yielding and good for fresh marketing. Genotypes Arka Vikas, Aditya, Arka Meghali and Anand were found suitable for processing and long distance transportation. Hence, these genotypes can be recommended as better genotypes for commercial cultivation in Jammu subtropical conditions.

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Table 1. List of Source of Genotypes

S. No	Genotypes	Source
1	Anand	Noble seeds, Delhi
2	Aditya	Noble seeds, Delhi
3	Heem Sohna	Syngenta, Pune
4	Karan	Crystal seeds
5	Naveen	IAHS(India) Pvt.Ltd.
6	Rupali	IAHS(India) Pvt.Ltd.
7	Sonali	Century seeds
8	Maharishi	Century seeds
9	Lehar	Century seeds
10	Kubergeeta	Golden seeds
11	NS 2535	Nam Dhari Seeds, Karnataka
12	US3383	US Agriseeds, Hyderabad
13	Tokita	Tokita seed India
14	Pusa Ruby	Pahuja seeds
15	Solan Lalima	Nauni, Solan
16	Marglobe	SKUAST-Kashmir
17	Leh Local	DRDO ,Leh
18	Angoorlata	CSA, Kanpur
19	Arka Saurabh	IIHR, Bangalore
20	Arka Vikas	IIHR, Bangalore
21	Arka Abha	IIHR, Bangalore
22	Arka Meghali	IIHR, Bangalore
23	Swarna Lalima	IVRI, Varanasi
24	Swarna Navi	IVRI, Varanasi
25	DVRT-2	IVRI, Varanasi

Table 2. Mean performance of tomato genotypes for yield and yield contributing traits

Traits	Days to 50 percent flowering	Days to first marketab-le fruit picking	Total numb er of fruits plant^{-1}	Average fruit weight (g)	Marketab le yield plot^{-1} (kg)	Total yield plot^{-1} (kg)	Plant height (cm)	Number of seeds / fruit	Incidence of fruit borer (%)	Intensity of early blight (%)
Anand	29.22	70.71	21.13	61.78	2.93	3.75	136.87	97.85	18.49	29.26
Lehar	28.84	69.97	29.95	58.30	3.22	4.74	75.40	97.33	17.98	48.58
Heem Sohna	30.62	71.50	23.93	72.78	2.67	4.26	162.18	93.88	20.59	35.72
Karan	29.38	71.50	22.42	54.49	2.72	3.94	93.87	109.20	21.73	43.72
Tokita	29.33	70.26	28.34	60.79	5.08	6.87	89.95	110.49	17.94	32.10
Rupali	29.90	71.11	24.08	81.34	3.23	5.26	87.28	187.06	23.98	35.73
Sonali	28.23	69.51	28.51	48.04	3.88	5.27	107.67	122.27	21.80	42.98
Maharishi	29.74	70.30	24.65	57.34	3.51	4.96	102.25	100.61	23.98	41.24
Aditya	30.32	70.59	24.48	63.95	4.25	6.02	91.31	120.99	22.78	17.81
Kubergeeta	30.19	71.73	26.25	61.55	3.74	5.28	75.70	62.46	24.28	48.88
NS 2535	30.10	70.53	28.51	52.90	3.21	4.29	83.54	127.20	23.06	21.32
US 3383	28.84	69.24	29.30	56.74	4.44	5.77	95.60	128.65	22.00	35.56
DVRT-2	32.02	72.99	18.86	51.94	2.99	4.43	138.34	169.22	15.60	20.28
Solan Lalima	31.13	73.09	22.67	60.30	3.31	4.31	134.58	122.90	21.86	17.85
Arka Abha	30.73	72.01	24.48	66.14	3.10	4.53	91.37	187.62	21.34	38.27
Leh Local	32.12	72.54	20.49	58.30	2.64	4.34	92.32	103.71	26.00	42.46
Angoorlata	31.12	71.47	24.76	30.40	3.04	3.85	124.54	125.10	20.13	33.85
Arka Saurabh	30.24	71.47	23.76	61.04	2.51	3.60	68.43	115.03	17.76	40.31
Pusa Ruby	30.57	70.88	30.83	36.79	4.26	5.72	65.89	103.56	17.52	37.34
Marglobe	31.84	73.11	21.95	57.95	2.02	3.03	121.72	170.50	19.99	22.19
Arka Vikas	30.81	70.85	24.00	50.26	3.36	3.87	67.75	133.07	18.01	41.20
Swarna Lalima	29.52	70.15	23.59	58.75	2.13	3.31	64.72	133.57	18.32	39.88
Swarna Naveen	30.70	71.78	23.97	50.38	2.18	3.20	91.39	52.60	16.49	34.34
Arka Meghali	30.57	72.11	19.57	52.92	2.09	3.49	91.08	109.33	19.64	30.55
Naveen	29.64	70.85	21.00	70.87	2.13	2.83	128.89	115.94	16.33	20.24
Mean	**30.23**	**71.21**	**24.46**	**57.44**	**3.15**	**4.44**	**99.31**	**120.01**	**20.30**	**34.07**
C.V.	3.26	1.54	15.60	16.79	45.16	39.63	14.83	16.48	19.56	22.50
S.E.	0.23	0.26	0.90	2.27	0.33	0.41	3.47	4.66	0.94	1.81
C.D. 5%	0.65	0.72	2.50	6.32	0.93	1.15	9.65	12.96	2.60	5.02

Contd..

Table 3. Mean performance of 25 tomato genotypes for fruit and quality traits

Character	Number of locules fruit^{-1}	Pericarp thickness (mm)	Total soluble solids (^{0}B)	Lycopene (mg/100g)	Beta carotene (mg/100g)	Ascorbic acid (mg/100g)	pH
Anand	2.71	6.87	4.32	1.79	6.48	12.60	4.22
Lehar	2.64	6.09	4.03	3.02	4.14	20.41	4.48
Heem Sohna	2.52	6.57	3.95	3.64	5.44	17.71	4.19
Karan	2.86	6.35	3.53	2.45	4.47	15.44	4.21
Tokita	3.89	5.47	3.36	2.43	4.54	20.73	4.21
Rupali	3.27	6.21	4.09	2.31	3.31	16.85	4.35
Sonali	2.85	5.91	3.69	2.51	5.23	10.97	4.21
Maharishi	2.40	5.61	4.18	2.61	1.60	22.98	4.10
Aditya	2.29	6.59	3.92	5.23	6.41	18.20	4.12
Kubergeeta	2.98	6.75	3.85	3.13	1.75	15.37	4.43
NS 2535	2.46	6.73	4.19	2.98	5.14	17.09	4.42
US 3383	3.05	5.56	3.74	3.42	6.40	15.33	4.35
DVRT-2	3.66	4.92	4.54	2.65	1.77	22.73	4.33
Solan Lalima	2.57	6.40	4.43	3.65	7.07	20.31	4.10
Arka Abha	4.24	5.54	4.25	2.88	4.20	25.51	4.25
Leh Local	2.42	6.56	4.35	3.85	4.96	26.08	4.38
Angoorlata	2.42	4.62	4.38	3.60	3.46	25.03	4.29
Arka Saurabh	3.45	5.20	4.12	2.67	6.07	23.71	4.33
Pusa Ruby	3.42	4.13	4.70	3.03	2.57	19.04	4.07
Marglobe	4.23	4.20	4.04	2.73	6.31	20.12	4.42
Arka Vikas	4.42	4.98	5.03	2.51	7.61	22.82	4.49
Swarna Lalima	3.73	4.82	4.04	1.36	6.65	27.18	4.28
Swarna Naveen	3.88	4.79	4.15	2.21	5.11	23.64	4.10
Arka Meghali	3.25	3.85	4.20	2.46	4.34	27.96	4.45
Naveen	3.35	5.09	4.39	4.56	2.58	15.22	4.14
Mean	**3.16**	**5.59**	**4.14**	**2.95**	**4.70**	**20.12**	**4.28**
C.V.	16.73	13.75	12.40	34.40	44.57	11.10	1.99
S.E.	0.12	0.18	0.12	0.24	0.49	0.53	0.02
C.D. 5%	0.35	0.50	0.34	0.66	1.37	1.46	0.06

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