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Characterization of exotic germplasm of tomato (*Solanum lycopersicum* L.) and variability studies at mid hills of Himalaya

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Abstract

The present study comprised of fifteen exotic lines of tomato collected through NBPGR, New Delhi from Plant Gene Resources of Canada (PGRC) Saskatchewan, Canada. The result revealed a high degree of variability, heritability and genetic advance among the germplasm lines. Germplasm line EC664597 was the early maturing (first picking 65.33 days after transplanting) followed by EC664595 (69.0 days). Two genotypes that exhibited more than 100g fruit weight were EC664596 and EC664591. Six germplasm lines viz., EC664585, EC664592, EC664593, EC664596, EC664597 and EC664598 exhibited total soluble solids content more than 5.0. Three germplasm lines exhibited pericarp thickness more than 6.0mm were EC664586, EC664590 and EC664591. Based on this information variety development programme may be undertaken in tomato using appropriate germplasm for mid hills of India.

Keywords: Genotypic screening, descriptor, characterization, quantitative traits, fruit quality

Introduction

Tomato (*Solanum lycopericum* L.) is treated as protective food universally being rich in antioxidants, organic acids, vitamins and minerals. It is the second most consumed vegetable of the world after potato with a production of 123.6 million ton from 4.5 million ha area worldwide (FAO, 2008). Introduction of germplasm has been an important breeding methodology for genetic improvement in most of the crops including tomato, which include proper and systematic evaluation of genetic resources to understand and estimate the genetic variability, heritability and genetic advance. Exploring natural diversity as a source of novel alleles to improve the productivity, quality and nutritional value of crop is of prime importance in 21st century breeding program (Fernie *et al.,* 2006) and performance of germplasm under varying climatic conditions is required to be checked to ascertain their adaptability to environmental condition (Singh *et al*., 2015). Therefore, the present investigation was carried out to evaluate the newly introduced exotic germplasm of tomato for horticultural and quality traits especially pericarp thickness, TSS and dry matter content for their use in breeding programme.

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Materials and Methods

The present investigation was carried out at Defence Institute of Bio-Energy Research (DIBER) field station Pithoragarh, Uttarakhand, India located at 1730 m above mean sea level. The average annual rainfall of the area is 1200 mm. The experiment comprised of fifteen exotic lines of tomato collected through NBPGR, New Delhi from Plant Gene Resources of Canada (PGRC) Saskatchewan, Canada. Germplasm was evaluated under naturally ventilated glasshouse conditions. Seeds of the germplasm lines were sown in the nursery during fourth week of August and transplanted in the beds during last week of September. Transplanting was done with 60 cm × 45 cm plant spacing and all recommended cultural practices were followed uniformly to raise healthy crop. The experiment was laid out in a randomized block design (RBD) with three replications having twelve plants per plot and data were recorded on five randomly selected plants. The observations were recorded on qualitative and quantitative traits following the International Plant Genetic Resource Institute (IPGRI) descriptors for tomato. List of descriptors were leaf type (1=dwarf, 2=potato leaf type, 3=standard, 4=peruvianum, 5=pimpinellifoilium, 6=hirsutum), fruit shape (1=flattened, 2=slightly flattened, 3=rounded, 4=high rounded, 5=heart shaped, 6=long oblong, 7=pyriform, 8=ellipsoid, 9=other), pistil scar shape (1=dot, 2=stellate, 3=linear, 4=irregular), fruit blossom end shape (1=indented, 2=flat, 3=pointed), immature fruit colour (1=greenish white, 3=light green, 5=green, 7=dark green,

9=very dark green), mature fruit colour (1=green, 2=yellow, 3=orange, 4=pink, 5=red, 6=other), presence or absence of dark green strips on fruit (1=present, 0=absent), plant height (m), days to first picking, number of fruits per plant, average fruit weight (g), fruit pericarp thickness (mm) using digital calliper, total soluble solids (T.S.S. in ºbrix) using hand refractometer model Erma 422, Japan and dry matter content (%) by hot air oven drying. Statistical analysis was carried out as per standard statistical procedures. Coefficients of variation were calculated as per Comstock and Robinson (1952). Heritability in broad sense and expected genetic advance were calculated as per Allard (1960) and Johnson *et al.* (1955), respectively.

Results and Discussion

Characterization based on eight morphological descriptors revealed notable variation among the germplasm lines (Table 1). Germplasm line EC664599 was dwarf whereas EC664596 exhibited flattened fruit shape. All germplasm were light green to green at immature stage with red fruits at maturity. Analysis of variance also revealed significant variation for yield and yield attributing traits among the germplasm lines (Table 2). Parameters of genetic variability also revealed significant variation among the genotypes for various traits exhibiting high genotypic coefficient of variation and heritability in broad sense except plant height and fruit weight (Table 3). According to Falconer (1981) heritability is a convenient expression of the phenotypic value that serves as a guide to the degree of genetic determination of trait and breeding value.

The mean values for different quantitative traits are presented in Table 4. A close perusal revealed that plant height varied from 30.23 (EC664599) to 158.30 cm (EC664596). Germplasm line EC664597 was the early maturing (first picking 65.33 days after transplanting) just followed by EC664595 (69.0 days) significantly superior over EC644588 taking 86.33 days for first picking. Other germplasm lines which took 71-72 days to first picking were EC664585, EC664586, EC664590, EC664598, and EC664599. Average fruit weight which is an important criterion for breeding tomatoes for table purpose exhibited high degree of variability and it ranged from 25.0 to 130.0 g. Two genotypes (EC664598 and EC664589) were small fruited genotypes and exhibited

Table 1. Horticultural traits of tomato germplasm under study according to IPGRI, Rome, Tomato descriptors

Germplasm	Canadian gene bank No.	Growth habit	Leaf type	Fruit shape	Pistil scar shape	Blossom end shape	Immature fruit colour	Mature fruit colour	Presence/ absence of dark green strips
EC664585	CN612	Indet	Standard	Flattened	Dot	Flat	Light green	Red	Present
EC664586	CN1499	Det	Standard	Slightly flattened	Dot	Flat	Light green	Red	Absent
EC664587	CN1632	Det	Standard	Slightly flattened	Dot	Flat	Light green	Red	Absent
EC664588	CN7232	Det	Potato leaf	Heart shaped	Dot	Flat	Light green	Red	Absent
EC664589	CN93	Det	Potato leaf	Rounded	Dot	Flat	Light green	Red	Absent
EC664590	CN95	Det	Potato leaf	High rounded	Dot	Flat	Green	Red	Absent
EC664591	CN298	Det	Standard	Slightly flattened	Dot	Flat	Greenish white	Red	Absent
EC664592	CN300	Det	Potato Leaf	Flattened	Dot	Flat	Light green	Red	Absent
EC664593	CN309	Indet	Peruvia-num	Slightly flattened	Dot	Flat	Light green	Red	Absent
EC664594	CN1298	Det	Standard	Slightly flattened	Dot	Flat	Light green	Red	Absent
EC664595	CN1331	Det	Standard	Slightly flattened	Dot	Flat	Light green	Red	Absent
EC664596	CN1467	Indet	Peruvia-num	Flattened	Irregular	Indented	Green	Deep Red	Present
EC664597	CN6801	Det	Standard	Rounded	Dot	Flat	Light green	Red	Absent
EC664598	CN18763	Det	Standard	Rounded	Dot	Flat	Green	Red	Present
EC664599	CN 42875	Dwarf	Dwarf	Flattened	Dot	Flat	Greenish white	Red	Present

Det: determinate; Indet: indeterminate

Table 2. ANOVA for yield and yield attributing traits in tomato germplasm

Source	df	Mean Squares							
		Plant ht (cm)	Fruits/ plant	Days to 1st picking	Average fruit wt. (g)	Pericarp thickness (mm)	T.S.S. (ºbrix)	Dry matter content (%)	Fruit yield (kg/plant)
Rep	2	27.90	3.95	1.68	34.02	0.009	0.003	0.021	0.015
Treatment	15	2185.7**	366.59**	183.68**	2084.9**	2.603**	2.054**	0.499**	0.451**
Error	30	1.77	0.645	0.287	1.435	0.002	0.0003	0.002	0.001

Table 3. Genetic parameters for different traits in tomato germplasm

Character	Mean	GCV	PCV	Heritability (%)	Genetic advance
Plant height (cm)	78.64 ± 0.77	7.65	40.98	3.48	1.98
Number of fruits per plant	20.65 ± 0.46	136.7	153.5	79.23	48.32
Average fruit weight (g)	63.12 ± 0.69	15.87	45.28	12.29	7.64
Total soluble solids (%)	4.54 ± 0.009	137.2	151.5	82.04	47.87
Dry matter (%)	3.63 ± 0.023	135.8	152.9	78.81	47.97
Pericarp thickness (mm)	5.00 ± 0.030	139.9	157.8	78.56	44.11
Days to 1st picking	78.85 ± 0.31	137.3	154.1	79.43	48.41
Fruit yield (kg/plant)	1.401 ± 0.020	135.8	149.9	82.06	47.50

Table 4. Yield and yield attributing traits of tomato germplasm under study

Germplasm	Plant ht (cm)	Fruits/ plant	Days to 1st picking	Average fruit wt. (g)	Pericarp thickness (mm)	T.S.S. (ºbrix)	Dry matter content (%)	Fruit yield (kg/plant)
EC664585	98.80	15.27	72.00	63.00	4.26	5.19	3.67	1.25
EC664586	60.47	18.00	72.00	51.00	6.23	4.19	3.11	1.57
EC664587	67.23	11.40	86.00	64.00	5.00	3.52	3.89	1.28
EC664588	65.83	11.20	86.33	61.00	4.94	4.32	3.47	1.02
EC664589	58.33	12.00	85.67	30.03	4.38	4.53	3.97	0.87
EC664590	55.63	11.67	72.00	50.33	6.11	4.23	3.87	0.92
EC664591	85.67	30.27	84.33	110.00	6.07	4.12	3.68	2.18
EC664592	83.20	24.57	85.00	81.03	5.08	5.13	3.66	1.72
EC664593	90.63	27.67	85.33	49.03	5.98	5.22	3.56	1.51
EC664594	83.67	20.43	85.00	59.00	4.93	4.22	3.61	1.32
EC664595	80.13	21.67	69.00	70.13	5.30	4.23	3.08	1.63
EC664596	158.30	9.20	85.33	130.00	5.30	6.10	3.01	1.28
EC664597	76.80	32.40	65.33	54.03	3.81	5.23	3.57	1.67
EC664598	80.30	52.27	71.67	25.00	2.63	5.12	3.65	1.42
EC664599	30.23	16.40	71.33	64.03	5.07	2.53	3.59	0.82
CO-3	83.07	16.00	85.67	48.23	5.01	4.82	4.75	1.98
CD (P=0.05)	2.22	3.88	0.89	1.99	0.087	0.028	0.068	0.058

fruit weight in the range of 25-30 g. Two genotypes that exhibited more than 100g fruit weight were EC664596 and EC664591. Since EC664596 was irregular in shape, EC664591 showed its superiority for utilization in breeding tomatoes for table purpose.

Pericarp thickness is an important criterion for selecting lines for flesh firmness, textural quality and storage life. Batu (1998) and Lana *et al.* (2007) reported that pericarp thickness, skin toughness and some other factors in tomato affect fruit firmness. Three germplasm lines exhibited pericarp thickness more than 6.0 mm were EC664586 (6.23mm), EC664590 (6.11mm) and EC664591 (6.07mm) which can be further utilized for breeding tomatoes with good shelf life and long transit quality. Total soluble solids content also varied significantly and was the maximum in EC664596 (6.10). Other germplasm lines that exhibited total soluble solids content more than 5.0 were EC664585 (5.19), EC664592 (5.13), EC664593 (5.22), EC664597 (5.23) and EC664598 (5.12) showing their potential for use in breeding program for developing varieties/hybrids for processing industry as suggested by Berry and Uddin (1991) where 1% increase in TSS results in 20% increase in recovery of processed products. Dry matter content also varied significantly ranging from 3.01 (EC664596) to 4.75% (CO-3). The results are in accordance with findings of Bhatt *et al.* (2001), and Hedau *et al.* (2008) who reported wide variations in total soluble solids and dry matter content in tomato.

Fruit yield per plant also varied significantly and EC664591 exhibited the maximum yield (2.18 kg/plant) followed by EC664592 (1.72 kg/plant). A high degree of variability has also been reported by Dhaduk *et al.* (2004), Borgohain and Swargiary (2008), Hedau *et al.* (2008) and Kumari and Sharma (2013) in tomato. The results indicated the availability of good variability for desirable horticultural traits among the germplasm for their use in breeding program for development of new cultivars. Based on this information variety development programme may be undertaken in tomato using appropriate germplasm for mid hills of India.

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सारांश

टमाटर की 15 प्रभेदों का संकलन राष्ट्रीय पादप अनुवांशिक संसाधन ब्यूरों नई दिल्ली के माध्यम से प्लान्ट जीन रिसोर्स आफ कनाडा (पी.

जी.आर.सी.) संस्कर चेवान, कनाडा द्वारा प्राप्त कर अध्ययन किया गया। परिणाम से स्पष्ट हुआ कि उच्च स्तर की विविधता, अनुवांशिकता एवं अनुवांशिक अग्रिमता प्रभेदों में व्याप्त है। जननद्रव्य लाईन ईसी–664597 कम समय में पकने वाली (प्रथम तुड़ाई पौध रोपड़ के 65.33 दिन बाद) पाया गया और इसके बाद ईसी–664595 (69.0 दिन) का स्थान रहा। जिन्होंने 100 ग्राम से अधिक फल भार प्रदर्शित किए उनमें ईसी–664596 एवं ईसी–664591 प्रमुख हैं। कुल छः जननद्रब्य यानी ईसी–664585, ईसी–664592, ईसी–664593, ईसी–664596, ईसी–664597 एवं ईसी–664598 में 5.0 से ज्यादा कुल विलेय ठोस की मात्रा पायी गयी। तीन जननद्रव्य यानी ईसी–664586, ईसी–664590 एवं ईसी–664591 में फल भित्ती मोटाई 6.00 मि.मि. से अधिक पायी गयी। इन सूचनाओं के आधार पर टमाटर के प्रजाति विकास कार्यक्रम में उपयुक्त जननद्रव्य का उपयोग भारत के मध्य पहाड़ी क्षेत्रों में किया जा सकता है।

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