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Evaluation of Diverse Tomato Hybrids for Morphological and Qualitative Character under Protected Cultivation

Sarvan Kumar
Department of Agriculture,
Guru Teg Bahadur Khalsa College Sri Anandpur sahib Rupnagar (Punjab), India.

(Corresponding author: Sarvan Kumar)
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ABSTRACT: Ten tomato (*Solanum lycopersicum* L.) hybrids obtained from Budhlada and Patiala Market were evaluated for fourteen morphological and eight qualitative characters in polyhouse at department of agriculture, Guru Nanak College, Budhlada during Kharif 2021-22. The experiment was conducted in RBD with three replications. The Analysis of variance revealed significant difference among the hybrid for all the traits under study, which indicated the existence of ample genetic variability among the hybrids. Days to flowering and days to days to first fruiting were observed early in the Himshikher and NS 4266 hybrids. Highest fruit length and fruit diameter was observed by Abhinav and Himshikher, respectively. The maximum fruit yield per plant was exhibited in Himshikher hybrid, Polyana and Lakshmi under protected cultivation.

Keywords: Tomato, polyhouse, fruit yield, fruit colour, fruit shape, mean performance.

INTRODUCTION

The tomato (*Lycopersicum esculentum* L) belongs to the family solanacae is being widely cultivated under protected conditions to give privileged returns. The fruits are harvested as red for consumption at maturity. It has well-known place in human food. It is indigenous of South America, but is now grown international for its edible fruits with thousands of cultivars having been selected with changeable fruit types and for optimal growth in differing growth conditions. It is a trendy vegetable all over the world because of its high nutritive value and rich supply of vitamin A and C. It is eaten as salad and cooked as vegetable.

Tomato is the world's biggest vegetable crop after potato and onion. India position second in the area and production of tomato after China country. In India, Madhya Pradesh leads in production followed by Karnataka, Andhra Pradesh, Tamil Nadu and Gujarat. During 2018-19, India produced 20.51 million metric tonnes of tomato in an area of about 0.81 million hectares (NHB, 1st Advance estimates, 2018-19).

Protected cultivation is a distinctive and precise form of agriculture in which the microclimate surrounding the plant is controlled partially or completely, as per the requirement of the plant species grown during their growth period. The objective is to grow crops where otherwise they could not survive by modifying the natural environment to make longer the harvest period often with earlier maturity to increase yield, improve quality and stability of production and create commodities available at the same time as there is no outdoor production (Ojo and Umar 2013). Tomato is a lukewarm season crop and requires a relatively long growing season and reasonably high temperature (22-28°C). It ensures that the optimal fruit setting is at night temperature and the optimum range is 15-20°C. In Haryana and Punjab coldness planted crop is most successful one and gives a very high fruit yield, but distributed over a small time span of less than two month. During peak harvesting season there is glut in the market and the price crashes, while during rest part of the year it is in short supply and the price rises beyond the reach of common man. Recently, to overcome these environmental conditions and pesticide residue problem, protected cultivation of vegetables, particularly protected cultivation of tomato, brinjal, cucumber, capsicum, lettuce etc. has been suggested by Punjab Agricultural University, Ludhiana, CCS HAU Hisar and state government bodies.

Protected cultivation of tomato offers typical advantages of earliness, higher output and quality particularly pesticide residue free produce, as well higher returns to growers. Being an important vegetable crop research on every part of tomato cultivation to improve the yield becomes essential. Newly India has entered into the area of greenhouse vegetable cultivation. India being a vast country with various and intense agro-climatic conditions. The protected vegetable cultivation technology can be utilized for year round and off-season production of high value vegetables as well as production of virus free and quality seedlings, quality hybrid seed production. In the current scenario of continuous demand of vegetables and considerably decrease land holdings in the country. It is the best

alternative and drudgery less approach for using land and other resources more efficiently. In Punjab and Haryana, the push is now being given for protected cultivation using hybrids. Keeping these in view, the present experiment was undertaken to identify better-quality and promising tomato hybrids with respect to yield, disease resistance and quality of the produce under protected conditions in Guru Nanak College campus, Budhlada (Punjab).

MATERIALS AND METHODS

The study was conducted in poly house at experimental farm of Department of Agriculture, Guru Nanak College; Budhlada Mansa during 2021-22 to identify superior tomato hybrids under Protected cultivation. Geographically, Campus of Guru Nanak College Budhlada, which is situated at 29°56′N 75°34′E, or 29.93°N 75.57°E. Ten tomato hybrids seed were obtained from Budhlada and Patiala Market for study (Table 1). The seed of tomato hybrids used for experiment were laid out in RBD with three replications. The poly house was provided micro irrigation system with fogger unit to control temperature and humidity. Seedlings were raised in portrays filled with potting mixture. Seedlings transplanting was done at a spacing of 60 x 60 cm on raised beds after the 20 to 25 days after seed sowing. The observation were recorded for morphological and quality character with proper methodology as Days to flowering was recording at time of 50% plant in blooming condition, Days to first fruiting were days taken count for first picking/ harvesting from date of transplanting, number of clusters per plant were counted at flowering stage for all three replication and the average of them was recorded for further analysis. Number of flowers per cluster was counted at the flowering stage for all three replication and the average of them was recorded for further analysis. Number of fruits per cluster it was average of number of fruits on first second and third trusses/cluster. Total number of fruits per plant was counted at the fruiting stage for all three replication and the average of them was recorded for further analysis. Plant height (cm) of the tomato plant at the flowering stage was measured in centimeters from the base of the plant to the tip of the axial shoot in the tomato plant. Fruit length, fruit diameter in cm. was measured in term of fruit diameter and fruit length in randomly selected plants, with the help of Vernier Calipers at the time of first picking., number of locule per fruit determination of the number of locules was performed through a visual inspection of a cross section of the fruit and pericarp thickness After dissecting the equatorial plan of each fruit, pericarp thickness was measured per fruit with the help of vernier caliperse. Pericarp thickness (mm): After dissecting the equatorial plane of each fruit, pericarp thickness was measured at two places per fruit with the help of Vernier Calliper and averaged over five fruits., total soluble solids (brix) the total soluble solid (TSS) of the selected samples were determined with help of hand refractrometer (Model: ERMA INC. Tokyo, Japan). The refractrometer washed with distilled water each time after use and dried with blotting paper., average fruit weight (gm) was taken as determinant of fruit size a random sample of 1 kg marketable fruits from second harvest was taken and average fruit weight was calculated by dividing the weight of sample with the number of fruits in the sample and fruit yield per plant (kg) were recorded of 5 randomly selected plants was recorded from each replication than averaged and for eight qualitative (External attributes) traits such as fruit shape, immature fruit skin colour and mature fruit skin colour were categorized by using plant descriptor (IPGRI)., leaf /foliage coverage were recorded on visible basis, number of leaf density, stem pigmentation was observed on the visible basis of color of stem a tomato, this is subjective and can be partial by factors like lighting and sample size green or light green or pigmented etc., pulpiness of tomato is slab-sided fruit with hollow gaps between the outer wall and locules and a reduced number of seeds than categories of pulpi or juicy., plant habits have different growth habits, including determinate, indeterminate, and semi-determinate, Determinate also known as bush tomatoes, these plants have a final number of clusters and stop growing taller after developing three clusters. They are good for growing in pots or mini greenhouses, these plants have additional vegetative growth and nonstop flower and fruit formation is Indeterminate and Semi-determinate plants have an familiar vegetative-to-reproductive balance, which increases water-use efficiency and productivity and final fruit firmness of tomatoes has commonly been measured by flat-plate compression. The mean of the data taken randomly for each trait from five different plants from each treatment in all replications was used for statistical analysis.

RESULTS AND DISCUSSION

The analysis of variance showed mean sum of squares of all the hybrids was significant for all the fourteen morphological and quality characters. Thus, there is profuse possibility for selection of better hybrids. Similar finding were also reported by Akram *et al*. (2016); Kumar *et al*. (2017); Panchbhaiya *et al*. (2018); Naik *et al*. (2024).

Mean performance for all 14 morphological characters for all the 10 hybrids of are presented in (Table 2). Mean performance showed that the hybrid Himshikher (27.67 days) was earliest for days to flowering while local check (54.50 days) took maximum days to flowering. The hybrid US 3383 (28.43 days) was statistically at par with Himshikher as also reported by Sharma and Singh (2015). Hybrid Shaktiman (33.87 days), Abhinav (34.43 days), US 1083 (34.43 days) and NS 4266 (33.60days) were recorded as earliest in days to flowering as compared to local check. Three hybrids NS 585 (45.0 days), Lakshmi (44.23 days) and Polyana (42.43 days) were observed as late flowering. Early or late flowering may be due to inherent genetic potential and good growing conditions inside the polyhouse which may triggered the hormonal activity of the plant for creation of flower forming hormone.

The earliest days to first fruiting was observed for Himshikher (78.13 days) followed by local check (92.0 days) and US 1083 (78.40 days), US 3383 (83.17 days).

Contrarily, highest days to first fruiting were recorded in Lakshmi (86.37days) and Polyana (86.30 days). Similar results were obtained by Sinha *et al*. (2020). Days to early flowering and days to first fruiting was most important for getting earlier fruit and thus fetching higher price from the market.

Hybrids Himshikher (10.67) and NS 4266 (10.30) exhibited utmost number of clusters per plant whereas; least number of clusters per plant was observed in local check (6.00). Hybrids Polyana (9.30) and US 3383 (8.47) showed maximum number of clusters per plant as compared local check. The minimum number of clusters per plant was recorded in NS 585, Abhinav and Shaktiman as compared to Lakshmi and US 1083.

Maximum number of flowers per cluster and number of fruits per cluster were recorded in hybrids Himshikher and NS 4266 followed by local check. Whereas, hybrid Polyana and US 3383 observed maximum number of flower per cluster, number of fruit per cluster as compared to NS 585, US 1083 and other hybrids. The variation in these traits may be due to interaction between genetic factor and the environmental conditions like temperature, light, humidity and other climatic factors existing inside the polyhouse during the growing period of the crop. The total number of fruits per plant ranged from minimum 13.53 to maximum 44.33. Hybrid Himshikher had highest number of fruits per plant and NS 4266 hybrid was statistically at par with Himshikher. Contraily, the lower value of fruits per plant was observed in hybrid Abhinav and local check. The increase or decreased in size and weight of fruit influenced number of fruits per plant. Small sized fruit and early fruiting tended to produce larger number of fruits per plant as also reported by earlier researchers (Meena and Bahadur 2015; Prajapati *et al.*, 2015; Kumar and Singh 2016; Thapa *et al*., 2016; Lekshmi and Celine 2017).

Plant height ranged from 95.47 (Local check) to 202.53 cm (Himshikher) with a mean value of 118.81 cm. The higher plant height was exhibited by the hybrid Himshikher (202.53 cm), and Lakshmi (164.27cm), as compared to the general mean. The other hybrids were shorter as compared to the general mean. In polyhouse, plant received lower light intensity which may help in cell elongation and intermodal length which lead to increase plant height. It may also be due to vertically trained plant which helped in gaining height and having better aeration. The similar findings were recorded by Srinivasulu and Singh (2021); Waiba *et al.* (2021). Maximum (5.98) and minimum (3.40) fruit length was recorded in Abhinav and local check respectively with an overall mean value of (5.21 cm). The hybrids Himshikher (5.69), NS 4266(5.37), Polyana (5.30) and US 1083 (5.70), US 3383 (5.68) had long fruits whereas; the hybrids Lakshmi (4.71cm) and NS 585 (4.92 cm) were having short fruits. Sharma and Singh (2015) noticed similar deviation for equatorial diameter of fruit. Variation in fruit shape might be due to genetic makeup of the hybrids.

The highest fruit diameter was observed in Himshikher (5.70) followed by US 1083 (5.42) while Polyana (3.88) was having the lowest diameter of fruit. The hybrids NS 4266 (4.94), NS 585 (4.78) and US3383 (4.69) exhibited high value as compared the overall mean. The variation in mean value for fruit diameter was 3.88 to 5.70 cm as also reported by Dhyani *et al.* (2018); Srinivasulu and Singh (2021).

The mean performance of number of locules per fruit ranged from 2.17 to 3.80. The maximum number of locules was observed in hybrid US 3383(3.80) as compared Shaktiman (3.70) and Himshikher (3.23). Other hybrids exhibited lowest number of locules per fruit as compare local check except Polyana (2.93). Similar findings were reported by Dhyani *et al.* (2018). For seed production and table purpose higher number of locules per fruit is preferred whereas, for processing purpose lower number of locules per fruit is perfect.

Pericarp thickness is a very important parameter in tomato fruit, as thicker pericarp is desirable for longer shelf life and transportation. Hybrid Himshikher showed higher pericarp thickness (0.793) whereas lower pericarp thickness was recorded in US1083 (0.577). The four hybrids NS 4266 (0.770), Polyana (0.687), NS 585 (0.680) and Shaktiman (0.673) showed higher thickness as compared to overall general mean. Thick pericarp is also suitable for canning. Waiba *et al.* (2021) observed similar deviations in pericarp

Higher total soluble solids are desirable quality attribute for tomato in processing as well as for fresh consumption. Highest total soluble solid was found in Himshikher (5.080°B) and NS 4266 (4.563°B) as compared to other hybrids but showed high brix followed by local check. The differences in total soluble solids were due to variations in hybrids and environmental conditions that prevailed during the growing seasons. Significant variability among the tomato hybrids for this trait was also observed by many earlier researchers (Meena and Bahadur 2015; Mitul *et al*., 2016; Rai *et al*., 2016).

The highest average fruit weight (gm) was observed in Himshikher (95.40) followed by US 1083 (85.40) while Polyana (74.17), NS 585 and Lakshmi (77.73) had the lowest fruit weight as compared to overall general mean. The hybrids namely NS 4266 (82.43), Abhinav (83.07) and Shaktiman (82.37) also exhibited high fruit weight. Fruit weight is inversely related with number of fruit per plant although both of these traits are basic yield contributing characters. Deviation in average fruit weight might be due to interaction between genetic factor and environmental conditions existed during flowering, fruit set, fruit growth and development Sinha *et al.* (2020).

Fruit yield per plant ranged from 1.24 to 2.12 kg with an overall mean value of 1.61 kg. The significantly higher yield per plant was recorded in hybrid Himshikher (2.12 kg) and Polyana (1.96 kg) as compared to local check (1.37 kg). The hybrids namely NS 4266 (1.63 kg), US1083 (1.64 kg) and Shaktiman (1.63 kg) showed maximum yield per plant. Fruit yield depends upon various yield contributing characters such as number of fruits per plant, average fruit weight, number of flowers per cluster, number of fruits per cluster, plant height, number of nodes per plant etc. The environment inside the polyhouse favoured early flowering which resulted

in early fruit set and thereby increased fruit yield per plant (Dhyani *et al*., 2018; Sinha *et al.,* 2020; Venkadeswaran *et al*., 2020; Dar *et al.,* 2024).

Flat round shaped fruit was found in five hybrids (Table 3). Three hybrids showed oval round, round shaped fruit and two hybrids were heart shaped fruit. Three hybrids were found dark green, four hybrids as green and three as light green in skin colour. At maturity, fruit skin colour became red in seven hybrids and remaining became dark red. Five hybrids had moderate and four hybrids excellent coverage of leaf and foliage. All the hybrids showed green stem pigmentation. Five hybrids showed medium firmness and four hybrid were found as firm. All the hybrids were found juicy type except Polyana, US 1083 and Abhinav. Local check also showed pulpy nature fruit. Three hybrids were found indeterminate and five hybrids were determinate while two hybrids were semi-determinate. The diversity in fruit shape, fruit colour at maturity and presence of pigmentation on stem etc. among tomato hybrids was due to differences in their genetic behavior and environmental condition in the poly house.

Table 1: Details of hybrids use for experiment.

Sr. No.	Hybrids	Sources	Procured
1.	Himshikher	Syngenta seeds (I) Pvt Ltd	Patiala Punjab
2.	Abhinav	Syngenta seeds (I) Pvt Ltd	Patiala Punjab
3.	NS 4266	Namdhari seed Pvt Ltd	Patiala Punjab
4.	NS-585	Namdhari seed Pvt Ltd	Patiala Punjab
5.	US 1083	US Agri seed Pvt Ltd	Patiala Punjab
6.	US 3383	US Agri seed Pvt Ltd	Patiala Punjab
7.	Polyana	Fito seed limited	Budhlada Mansa Punjab
8.	Shaktiman	Shaktiman seed Pvt Ltd	Patiala Punjab
9.	Lakshmi	Nunhems seed Pvt Ltd	Patiala Punjab
10.	Local Check	Shakti Vardhak Hybrid seed Pvt Ltd	Budhlada Mansa Punjab

Table 2: Mean performance of all the 14 morphological characters for 10 hybrids in tomato.

Sr. No.	Hybrids	Days to flowering	Days to first fruiting	Number of clusters / plant	Number of flowers/ cluster	Number of fruits/ cluster	Number of fruits / plants	Plant height	Fruit length	Fruit diameter	Number of locules / fruit	Pericarp thickness	TSS (brix)	Average fruit weight	Fruit yield/ plant
1.	Himshikher	27.67	78.13	10.67	8.27	4.40	44.33	202.53	5.69	5.70	3.23	0.793	5.080	95.40	2.12
2.	NS 4266	33.60	81.27	10.30	7.17	3.60	35.80	106.40	5.37	4.94	2.70	0.770	4.563	82.43	1.63
3.	Polyana	42.43	86.30	9.30	6.40	3.47	30.97	107.47	5.30	3.88	2.93	0.687	3.543	74.17	1.96
4.	NS-585	45.00	81.27	8.07	6.03	2.83	21.23	99.53	4.92	4.78	2.47	0.680	3.153	71.87	1.45
5.	US 1083	34.43	78.40	8.33	6.50	2.77	24.00	99.07	5.70	5.42	3.80	0.577	3.107	85.40	1.64
6.	US 3383	28.43	83.17	8.47	6.90	3.43	25.30	103.97	5.68	4.69	2.83	0.590	3.100	77.60	1.27
7.	Abhinav	34.43	81.40	6.97	6.00	3.07	19.70	105.67	5.98	4.52	2.50	0.583	2.830	83.07	1.24
8.	Shaktiman	33.87	76.60	7.67	5.53	2.83	20.20	103.70	5.40	4.59	3.70	0.673	2.497	82.37	1.63
9.	Lakshmi	44.23	86.37	8.33	5.07	2.43	20.53	164.27	4.71	4.39	2.29	0.650	2.567	77.73	1.81
10.	Local	54.50	92.00	6.00	4.33	2.40	13.53	95.47	3.40	4.02	2.17	0.680	2.393	82.83	1.37
	Mean	37.86	82.49	8.41	6.22	3.12	25.56	118.81	5.21	4.69	2.86	0.670	3.28	81.29	1.61
	Min	27.67	76.60	6.00	4.33	2.40	13.53	95.47	3.40	3.88	2.17	0.580	2.39	71.87	1.24
	Max	54.50	92.00	10.67	8.27	4.40	44.33	202.53	5.98	5.70	3.80	0.79	5.08	95.40	2.12
	SE(d)	0.95	1.82	0.36	0.31	0.19	1.03	2.06	0.23	0.29	0.13	0.021	0.094	1.46	0.09
	C.D. at 5%	2.02	3.85	0.77	0.65	0.40	2.19	4.37	0.49	0.62	0.27	0.043	0.199	3.10	0.20
	C.V. %	3.08	2.70	5.28	6.00	7.34	4.95	2.13	5.47	7.61	5.42	3.760	3.513	2.20	7.06

Table 3: Performance of all eight qualitative Characters in 10 hybrids of tomato.

Hybrids	Fruit shape	Immature fruit skin colour	Mature fruit skin colour	Leaf/ Foliage cover	Stem pigmentation	Fruit firmness	Pulpiness	Plant habit
Himshikher	Flat round	Green	Red	Moderate	Green	Medium	Juicy	Indeterminate
NS 4266	Heart	Green	Red	Moderate	Green	Medium	Juicy	Determinate
Polyana	Flat round	Dark green	Dark red	Excellent	Green	Firm	pulpy	Indeterminate
NS-585	Flat round	Dark green	Red	Moderate	Green	Firm	Juicy	Determinate
US 1083	Flat round	Green	Red	Moderate	Green	Medium	Pulpy	Determinate
US 3383	Oval Round	Dark green	Red	Excellent	Green	Firm	Juicy	Semi-determinate
Abhinav	Heart	Light green	Dark Red	Excellent	Green	medium	Pulpy	Semi-determinate
Shaktiman	Oval	Light green	Dark red	Moderate	Green	Firm	Juicy	Determinate
Lakshmi	Flat Round	Green	Red	Excellent	Green	Medium	Juicy	Indeterminate
Local check	Oval	Light green	Red	Moderate	Green	Soft	Pulpy	Determinate

CONCLUSIONS

It can be concluded that wide range of genetic variability exist in present set of genetic material. Thus there is abundant scope for selection of promising hybrids. Among the hybrids/ hybrids namely Himshikher, Polyana and Lakshmi were identified higher yielder under protected cultivation.

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