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Effect of growing conditions on growth, seed yield and quality attributes in cherry tomato (*Solanum lycopersicum* var *cerasiferme*)

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ABSTRACT

A study was conducted at CPCT, IARI, New Delhi to investigate the effect of different growing conditions on plant growth, seed yield and quality traits in cherry tomato cv. Pusa Cherry Selection 1 grown under three different environmental conditions, viz. semi-climate controlled polyhouse (P1), naturally ventilated polyhouse (P2) and insect proof nethouse (P3). Among the structures P3 recorded significantly higher plant growth up to 60 days after transplanting (DAT) (217.68cm) as compared to P2 and P1. However, at 120 DAT the plant growth was higher in P1 (313.68 cm), followed by P2 (280.40 cm) and P3 (265.59 cm). The days to 50% flowering was earlier in P3 (24.74 days) than P2 and P1. Significantly higher number of flowers per truss (115.16), number of berries per truss (39.15) number of mature berries (25.85) were noted in P1 as compared to P2 and P3. The berry weight (5.12 g), number of seeds per berry (34.52), 100 seed weight (0.113 g) and seed yield per berry (0.075 g) were recorded significantly higher values in P1 in comparison to P2 & P3. The seed quality parameters, viz. germination (84.63%), vigour index-I (532.53) and vigour index - II (1.29) were higher, whereas lower values for electrical conductivity (0.007 µS/g/cm) was recorded in P1 than P2 & P3. The benefit cost ratio (BCR) is higher in P3 (1:2.70) followed by P1 (1:1.62) and lower in P2 (1:1.35).

Key words: BCR, Cherry tomato, EC, Germination%, Insect proof nethouse, Naturally ventilated polyhouse, Semi-climate controlled polyhouse, Seed yield per berry, Vigour indices

Cherry tomato (*Solanum lycopersicum* var *cerasiforme* L.) is gaining popularity as an integral component of salad in and around the globe. It has nutraceutical potential, contained vitamin A and C and minerals (K, P, Mg and Ca), photo-chemicals (lycopene, β-carotene, flavonoids) (Crisanto-Juarez *et al*. 2010). Lycopene has an antioxidant role, which minimizes the risk of cancer, prostate adenocarcinoma and cardiovascular diseases in humans (Takeoka *et al*. 2001). In addition, cherry tomato is used for the preparation of tomolive and tomatina, which are having more industrial value. The cultivation of cherry tomato is becoming popular particularly among upper segments of the society. Thus, to meet the growing demand of cherry tomato for the urban population and to overcome the recurring biotic and abiotic production constrains during rainy and post rainy season under open field conditions, protected cultivation is one of the most advisable means of production to address such constraints. Globally about 115 countries in greenhouse vegetable production with an area of nearly 623 302 ha while total estimated world greenhouse vegetable production area is 402 981 ha. In India, the area under protected cultivation is presently around 25000 ha while the greenhouse vegetable cultivation area is about 2000 ha (Sabir and Singh 2013).

The demand of the quality seed of cherry tomato is increasing for cultivation under protected structures but the cost of the seed and uncertainty in supply affecting the cherry tomato cultivation. The development of cherry tomato cultivar Pusa Cherry Selection 1 (release proposal was submitted to IARI, New Delhi) necessitated the generation of development of seed production technology to ensure the production and supply of quality seed at affordable prices. Thus, the present investigation was planned and carried out with the goal to find the suitable growing structure/condition, for cultivation of cherry tomato.

MATERIALS AND METHODS

The present field investigation was carried out at the Centre for Protected Cultivation Technology (CPCT), Indian Agricultural Research Institute (IARI), New Delhi which is located at $28^0 35$ N latitude and $77^0 12$ E longitude and at an altitude of 228.6 m above mean sea level. It has a semi-arid and subtropical climate characterized by extreme hot summer and cold winter. The soil of experimental site is sandy loam in texture with a pH of 8.0 and organic content of 0.25%. The seedlings of Pusa Cherry Selection 1 were raised inside the high-tech polyhouse in multi-

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celled plastic plug trays having a cell volume of 20 cubic centimeters by using soil less media consisting of cocopeat, vermiculite and perlite in the ratio of 3:1:1 (on a volume basis). The seedlings were transplanted at the two true-leaves stage during 10 September 2011-12 and 12 September 2012-13, to three different environments, viz. P1 (Semi-climate controlled polyhouse), P2 (Naturally ventilated polyhouse) and P3 (Insect proof nethouse) after hardening of seedlings under direct sunlight for two days. Fertigation was done through a drip system with integrated droppers for every 30 cm^3. The experimental plots were maintained by the identical management practice (stacking, irrigation and plant protection measures) under three environments.

The observations, viz. plant height (30, 60, 90, 120 DAT), days for 50% flowering, number of flowers per truss, initial berry set per cent, matured berry per cent, average berry weight, berry radial diameter, berry polar diameter, number of seeds per berry, 100 seed weight, seed yield per berry were recorded on ten randomly selected plants in each condition. The observations on germination (%), speed of germination, dry weight, vigour index - I & II and speed of germination (SOG) and electrical conductivity (EC) were estimated at the Division of Seed Science and Technology (DSST) as suggested by ISTA (2008), Abdul–Bakir (1973), Dadlani and Agarwal (1983) respectively. The experiment was established according to RBD and data of initial and the second year as well the pooled were subjected to statistical analysis using SAS 9.2 software for deriving meaningful conclusions.

RESULTS AND DISCUSSION

The results of a pooled analysis of plant growth, berry attributes, seed yield and quality characters obtained from the three growing condition attributes of cherry tomato presented and discussed here under. The growing conditions have significantly influenced on plant growth, berry weight, berry polar diameter, berry radial diameter, number of seed per berry, seed yield per plant, germination (%), vigour index-I & II and electrical conductivity.

Influence on plant growth

Significantly higher plant height was recorded in P1 (313.67 cm) at 120 DAT, followed by P2 and P3, whereas P3 recorded early higher plant growth (217.68 cm) up to 60 DAT in comparison with P2 and P1 (Table 1). The results are in agreement with Dayan *et al.* (1985), and reported that in the changing greenhouse environmental conditions, the photosynthetic rates are also varied thereby variable response in plant height was observed. The reduction in plant height after 60 DAT in P2 and P3 conditions could be due to low temperature and low light intensity prevailed during November to January might have resulted the reduction in the internodal length and thereby less plant height. However, in P1 temperature remained higher as compared to open condition during the same months that favoured better plant growth. Our findings are in accordance with Kimball (1986) who opined that low light intensity is the important limiting factor for photosynthesis and growth especially for winter grown greenhouse crops.

Influence on flowering, fruit setting and ripening of berries

The parameters, viz. 50% flowering, 50% berry set and 50% ripening have taken less number of days under P3 (24.74, 35.40 and 82.72 respectively) followed by P2 (24.83, 35.77, and 83.28 respectively) (Table 1). Contrary to P3 and P2, these attributes have taken more number of days for P1 and this could be due to vigourous plant growth might have delayed the flowering, fruit set and fruit ripening.

The number of flowers per truss (115.16), the number of berries per truss (39.15), berry set per cent (34.15), number of mature berry per truss (25.85) were recorded more in P1 condition followed by P2 (104.20, 30.15, 28.99% and 19.31 respectively) and P3 (109.67, 25.4, 23.38% and 18.49 respectively) (Table 1). The lower number of flowers in P3 may be due to the prevailing unfavourable conditions as compared to P1 and P2. These results were in tune with Stephenson (1981), who suggested that the rate of abortion of flowers or fruits represents the plant's assessment of its ability to support subsequent fruit development. If conditions are favourable, more fruit will be retained, and if unfavourable, less. Under low temperatures, protrusion of

Table 1 Effect of growing structures on plant height (cm), flowering and fruiting characters in cherry tomato cv. Pusa Cherry Selection 1

Parameter	Plant height (Pooled data)				Days to 50% flowering	Days to 50% berry set	Number of flowers per truss	Days to 50% berry maturity	Number of berry set per truss	Berry set (%)	Number of mature berry
	30 DAT (cm)	60 DAT (cm)	90 DAT (cm)	120 DAT (cm)	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
P1	145.15	202.73	234.42	313.68	25.76	36.52	115.16	84.11	39.15	34.15	25.85
P2	153.90	212.10	230.06	280.40	24.83	35.77	104.20	83.28	30.15	28.99	19.31
P3	156.73	217.68	224.90	265.59	24.74	35.40	109.68	82.72	25.40	23.38	18.49
SE(m)±	0.28	0.90	0.47	1.03	0.04	0.00	0.92	0.25	0.23	0.27	0.06
CV (%)	0.37	0.85	0.41	0.72	0.34	0.45	1.67	0.59	1.48	1.89	0.53
CD (P=0.05)	0.99	3.17	1.67	3.63	0.15	0.01	3.24	N.S	0.83	0.96	0.20

P1, Semi-climate controlled polyhouse; P2, naturally ventilated polyhouse; P3, insect proof nethouse

Table 2 Effect of growing structures on berry weight and seed yield characters in cherry tomato cv. Pusa Cherry Selection 1

Parameter	Mature berry weight (g) Pooled	Berry radial diameter (cm) Pooled	Berry polar diameter (cm) Pooled	Number of berry/plant Pooled	Number of seeds/berry Pooled	Seed yield/ berry (g) Pooled	Seed yield/ plant (g) Pooled	100 seed weight (g) Pooled
P1	5.12	2.45	2.32	155.10	34.52	0.075	7.11	0.113
P2	4.58	2.40	2.22	115.88	31.44	0.074	4.08	0.112
P3	4.23	2.01	1.89	110.93	29.91	0.072	3.38	0.102
SE(m)±	0.05	0.03	0.01	0.34	0.25	0.000	0.0000	0.000
CV (%)	1.97	2.50	1.13	3.17	1.56	0.512	0.5010	0.203
CD (P=0.05)	0.16	0.10	0.04	0.78	0.88	0.001	0.0008	0.000

P1, Semi-climate controlled Polyhouse; P2, naturally ventilated polyhouse; P3, insect proof nethouse

style and splitting of antheridial cone, followed by flower abscission, was more prominent under P3 condition which has resulted in less number of fruit set compared to P1 and P2. The significantly higher number of flowers per truss (115.16) in P1 as compared to P2 and P3 may be due to the better growth and development of the plants, which have allowed bearing more number of flowers per truss. The conversion ratio flowers to berries were significantly higher in P1, followed by P2. But it is interesting to note that the rate of conversion from number of flowers to berry set was higher in P2 as compared to P3. Although, the number of flowers per truss higher in P3 than P2. This could be attributed to more favourable conditions in P1 and P2 and blossom drop in P3. Beside the above the exertion of stigma under P3 has deprived the pollination thereby resulted in low berry set. The significantly higher number of mature berry (25.85) in P1 than P2 and P3 is because of the higher number of berry set and might be favoured by better climate and robust plant growth.

Influence on seed yield traits

Seed yield is a complex attribute and depend upon plant growth and flowering attributes but largely on the number of mature berry/per truss, seed yield/berry and seed yield/plant. Significantly the maximum number of mature berries/plant (155.10) was recorded in P1, whereas P2 and P3 have shown the decreasing trend. The significantly higher number of mature berry in P1 could be attributed to the higher number of berry set (37.45%) and favourable environmental condition. The seed yield/plant in P1 (7.11 g) was much higher than P2 and P3 (Table 2). The highest seed yield/plant in P1 could be attributed to a number of mature berries/plant, more number of seeds/berry, higher seed yield/berry and significantly higher 100 seed weight (0.113g). These results are in agreement with the reports of Patil *et al*. (1973) and Mangal *et al*. (1981) in tomato, who have recorded higher fruit and seed yield with an increase in the yield components.

Influence on seed quality traits

The primary goal of seed quality attributes is to ensure the highest emergence and plant stand under field condition for better yield. The significantly higher germination (84.63%) and speed of germination (1.58) was noted under P1 while reduction trend in germination per cent and speed of germination was noticed in P2 and P3 (Table 3). The higher germination and speed of germination in P1 could be due to the accumulation of more food reserves due to better growth of the plant and berry development attributes, which is evident from the high 100 seed weight (0.113 g) in P1. Similar trends were recorded for vigour index-I and II from the seed obtained from P1 condition (Table 3). Significantly higher vigour index-I and II could be attributed to higher germination (%), higher seedling dry weight. The results are in agreement with Kaur and Kanwar (2000) and Jolli (2004) in tomato.

The significantly lower electrical conductivity (0.007 µS/g/cm) indicated the better development of seed in P1 as

Table 3 Effect of growing structures on seed quality attributes in cherry tomato cv. Pusa Cherry Selection 1

Parameter	Germination (%) Pooled	Speed of germination (SOG) Pooled	Shoot length (cm) Pooled	Root length (cm) Pooled	Seedling dry weight (g) Pooled	Vigour index–I Pooled	Vigour index –II Pooled	EC (µS/g/cm) Pooled
P1	84.63	1.58	6.34	6.49	0.016	532.53	1.29	0.0070
P2	79.88	1.39	6.38	6.44	0.014	521.95	1.13	0.0080
P3	79.88	1.27	6.21	6.35	0.013	506.75	1.05	0.0080
SE(m)±	0.46	0.02	0.06	0.05	0.000	3.92	0.01	0.0000
CV (%)	1.14	2.72	1.78	1.49	1.198	1.51	1.06	3.6170
CD at (5%)	1.64	0.07	N.S.	N.S.	0.000	13.84	0.02	0.0010

P1, Semi-climate controlled polyhouse; P2, naturally ventilated polyhouse; P3, insect proof nethouse compared to P2 and P3. The lower electrical conductivity in P1 could be due to the sound development of seed organelles due to more availability of maturation time resulted low solute leakage.

The mean brix of fruits in each section of freshly harvested berries were significantly differed. Higher Brix were noted under P3 (8.31) followed by P2 (6.77) and P1 (5.29). The Brix values were increased as the colour changed from green to red, may be due to physiological transformation ascribed by David and Philip (2001).

CONCLUSION

Based upon the results obtained in this study it is concluded that the quality seed production of cherry tomato cv. Pusa Cherry Tomato 1 should be undertaken in semi-climate controlled polyhouse to get high seed yield & quality (7.11 g/plant & 8.532 kg/1000m^2 polyhouse). However, the benefit cost ratio (BCR) is higher in insect proof nethouse (1:2.70) followed by semi-climate controlled polyhouse (1:1.62).

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