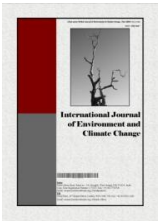

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Effect of Microclimate on Yield and Quality Attributes of Cherry Tomato (*Solanum lycopersicum* L. var*. cerasiforme*) under Open Field and Polyhouse Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Cherry tomatoes are usually cultivated under greenhouse which is out of the reach of the marginal farmers. Due to unavailability of microclimatic and biochemical data in cherry tomato, meagre yield is obtained at open field conditions. Since the microclimatic factors and growing environment have immense influence on yield and quality attributes of any crop, this experiment was aimed to study the correlation of microclimate with the yield and quality contributing traits of eighteen genetically diverse genotypes of cherry tomato at open field trained on trellis and under naturally ventilated polyhouse conditions. In the given study, under open conditions, mean canopy temperature in morning at 7 a.m. (15.3-19.4°C) showed highly significant positive correlation with total yield, whereas total yield possessed highly significant negative association with the mean mid-day (12 noon) canopy temperature and mean mid-day soil temperature above 25°C. In poly house condition, total yield reflected significant negative correlation with morning mean canopy temperature (24.6°C) and mid-day mean canopy temperature (25.8-26°C), whereas total yield was negatively correlated with morning and mid-day mean soil temperature when the temperature was

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above 20.7°C. Among biochemical parameters, lycopene and beta-carotene content increased with mean canopy temperature at 19.5°C and further decreased above 21.5°C, however TSS increased with increase in mean canopy temperature from 15 to 25°C and decreased beyond 30°C temperature.

Keywords: Quality; canopy temperature; trellis; Solanum lycopersicum L. var. cerasiforme.

1. INTRODUCTION

Cherry tomato (*Solanum lycopersicum* L. var. *cerasiforme*), is one of the profitable crop with small grape like fruits varying 1.5 to 3.5 cm in diameter. Cherry tomatoes are usually consumed raw and used for table purposes. The demand for cherry tomato is continuously enhancing in domestic as well as international market chiefly due to its good appearance, neutraceutical content and amazing taste [1]. They are excellent sources of vitamin A, C and K along with good sources of antioxidants and phyto-chemical compounds, including lycopene, β-carotene and flavonoids [2].

Genotypes behaviour of a crop is different in diverse conditions due to G x E interaction. Yield and qualitative attributes of a crop depends on various growing conditions, genetic makeup of genotypes and prevailing microclimate. Among various microclimatic factors, canopy and soil temperature, relative humidity and light intensity are the factors which mainly affect the crop yield and quality (Osei et al., 2018). Though, cherry tomatoes are generally cultivated under polyhouse conditions, but to increase the profitability of marginal farmers at open field, it has become imperative to develop high yielding and qualitative varieties that are suitable for growing in open field conditions. Keeping the above facts in view, the present investigation was conducted to study the correlation between micro environment with yield and quality attributes of cherry tomato cultivars under different growing conditions.

2. MATERIALS AND METHODS

The experiments were conducted in polyhouse and at open field on trellis at Bihar Agricultural University, Sabour located at 25°15'40" N and 80°2'42" E with an altitude of 46 meter above mean sea level in the vast Indo-Gangetic plains of eastern India. Eighteen diverse cherry tomato genotypes were evaluated in randomized block design, replicated thrice in autumn-winter season of 2018-19 in polyhouse covered with transparent UV stabilized polythene of 200 microns and open field trained on iron trellis (Table 1). Thirty days old plants were transplanted maintaining 50 x 50 cm^2 planting distance. All the recommended agro-techniques were practiced with recommended method and at correct crop stage both at field and in polyhouse conditions.

Table 1. Plant genotypes traits used in the study

S.N.	Genotype	Source	Morphological description
1	BRCT-33	BAU, Sabour	Oval, red fruits, indeterminate
2	BRCT- 21	BAU, Sabour	Round, red fruits, indeterminate
3	BRCT- 22	BAU, Sabour	Round, red fruits, indeterminate
4	BRCT- 23	BAU, Sabour	Oval, red fruits, indeterminate
5	BRCT- 24	BAU, Sabour	Round, red fruits, indeterminate
6	BRCT- 25	BAU, Sabour	Oval, red fruits, indeterminate
7	BRCT- 20	BAU, Sabour	Plum shape, red fruits, indeterminate
8	BRCT- 26	BAU, Sabour	Round, red fruits, indeterminate
9	BRCT-34	BAU, Sabour	Round, red fruits, indeterminate
10	BRCT-27	BAU, Sabour	Round, red fruits, indeterminate
11	BRCT-35	BAU, Sabour	Oval, red fruits, indeterminate
12	BRCT-28	BAU, Sabour	Round, red fruits, indeterminate
13	BRCT-36	BAU, Sabour	Oval, red fruits, indeterminate
14	BRCT-29	BAU, Sabour	Pyriform, red fruits, indeterminate
15	BRCT-30	BAU, Sabour	Round, red fruits, indeterminate
16	BRCT-31	BAU, Sabour	Round, red fruits, indeterminate
17	BRCT-37	BAU, Sabour	Round, red fruits, indeterminate
18	BRCT-32	BAU, Sabour	Pyriform, red fruits, determinate

Correlation between microclimate, yield and quality parameter was recorded under field and polyhouse condition. Three quality traits, i.e., lycopene, β–Carotene and total soluble solids were measured from composite sample prepared from ten fruits from each replication. Total sugar was estimated by Lane-Eynon method [3]. Lycopene and beta-carotene were estimated by the spectrophotometric procedure established by Davies, [4]. Statistical analyses were performed using SPSS version 16.2 software.

3. RESULTS AND DISCUSSION

The ANOVA for yield and quality traits of cherry tomato under both the condition showed that the total yield and biochemical parameters traits vary significantly at different timing of mean canopy and soil temperature. High variability in these traits depicted gene and environment interaction as per the research outcome reported by Oum [5] and Pandey et al. [6].

3.1 Correlation between Microclimate and Yield

The microclimate and growing environment were found to have profound influence on total yield of cherry tomato in both open field as well as under polyhouse conditions. Mean canopy and soil temperature had a significant influence on timing and crop maturity, thus impacting total yield [7]. The mean temperature inside polyhouse was 3-4°C higher than that of open field condition, which was in accordance with the findings of Ganesan [8] and Cheema et al. [9] in tomato. The rise in temperature in polyhouse was due to greenhouse effect. The mean relative humidity was higher in polyhouse by 5-6% which corroborated to previous findings of Nimje and Shyam [10]. The increase in mean relative humidity in polyhouse was due to 200 micron UV-stabilized polythene covering material [11,12].

The mean canopy temperature at morning (7 a.m.) in open field ranged from 12.5 to 19.4°C over eight observations taken at ten days interval, while the mid day mean canopy temperature (12 noon) ranged between 22.7 to 28.0°C. In polyhouse, the mean canopy temperature at morning (7 a.m.) was in the range of 14.1 to 24.6°C, while the mid-day mean canopy temperature (12 noon) ranged from 25.6 to 30.4°C. In open field conditions, when the morning mean temperature was between 15.3 to 19.4°C, it showed positive and highly significant effect on total yield, whereas there was highly significant negative association with total yield of cherry tomato when the mid-day mean canopy temperature reached 26.4°C,. Under polyhouse condition, general trend was observed with a negative correlation of mean canopy temperature and total yield, though significant negative correlation was observed when the morning mean canopy temperature was above 24.5°C and noon mean canopy temperature was in the range of 27.6 to 30.4°C. This may be due to the fact that the optimum temperature for tomato growth is 20-24°C [13]. At higher mean canopy temperature, the plant may be under stress condition ultimately affecting yield. Similar study was observed in tomato by Nemeskeri et al. [14].

The mean soil temperature at morning (7 AM) in open field has been in the range of 14.4 to 20.4°C, whereas at mid-day it ranged between 18.8 to 26.2°C. In polyhouse the values have ranged from 17.1 to 24.8°C at morning and 20.7 to 30.2°C at mid-day. In open field conditions, the mean soil temperature at morning (7 AM) had non-significant negative impact on yield when it was below 16.2°C and at mid-day (12 noon) highly significant but negative association was observed when mean temperature was 25.7°C. Under polyhouse, highly significant but negative association was observed when mean morning soil temperature was 24.8°C, where as mid-day mean soil temperature showed significant to highly significant negative effects when it was beyond 24.8°C. Baudoin et al. [15] reported that the optimum soil temperature for plant development phase was 13-14°C, for flowering stage 15-16°C and for fruit development and ripening it was 23-25°C. Therefore, higher soil temperature had a negative impact on crop yield (Fig. 1).

3.2 Correlation between Microclimate and Qualitative Traits

Among the qualitative traits, TSS, lycopene and beta-carotene were highly influenced by microclimatic factors. TSS increased with increasing canopy temperature till 29°C, beyond which there was reduction in its value (Fig. 2). Vijaylakshmi et al. [16] observed significant negative correlation between canopy temperature and TSS in pearl millet under water-deficit condition, whereas there was no significant correlation under optimum growing conditions. Genotypes with higher canopy temperature under mid day condition utilized lesser amounts of water [17]. Therefore the

moisture content of the fruits might be lesser in these genotypes leading to higher TSS. However, when this temperature became very high, then the plant was under stress, leading to lowered photosynthetic activity also resulting in lesser accumulation of sugars and hence the TSS decreased under such circumstances [18] (Table 2).

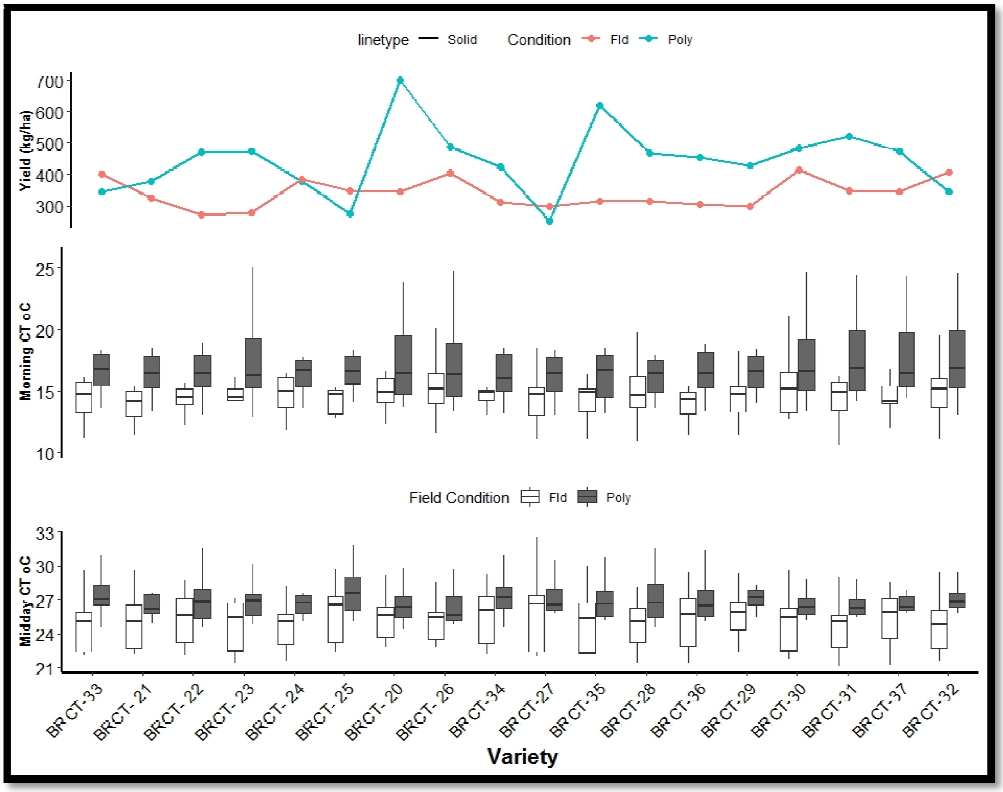

Fig. 1. Graphs showing variation in canopy temperature of different tomato varieties under different growing condition and its influence on total crop yield

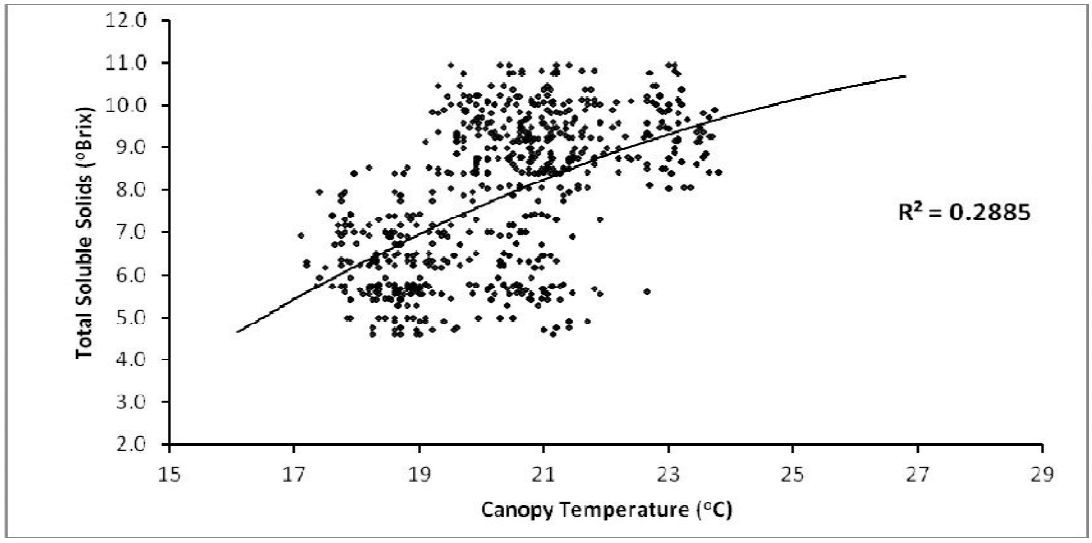

Fig. 2. Effect of mean canopy temperature on the total soluble solids (TSS)

Table 2. Variation in total crop yield with mean canopy temperature and mean soil temperature at morning and mid-day

	Field canopy temperature			Field soil temperature			Polyhouse canopy temperature			Polyhouse soil temperature		
	Mean temperature	**SD**	**Corr. with yield**	**Mean temperature**	**SD**	**Corr. with yield**	**Mean temperature**	**SD**	**Corr. with Yield**	**Mean temperature**	**SD**	**Corr. with yield**
Morning (7AM) w1	12.5	0.58	0.046	16.2	0.48	-0.086	15.6	0.47	-0.43	17.1	0.25	0.187
Morning (7AM) w2	14.8	0.46	0.31	16.3	0.60	-0.055	17.2	0.25	-0.084	20.2	1.34	.503*
Morning (7AM) w3	15.2	0.53	-0.113	14.4	0.58	0.213	14.1	0.63	-0.048	17.2	0.45	-0.289
Morning (7AM) w4	13.8	0.46	-0.089	14.5	0.54	0.102	15.4	0.52	0.248	17.3	0.38	-0.223
Morning (7AM) w5	12.5	1.30	0.134	15.6	0.71	0.167	14.8	0.83	-0.304	17.7	0.45	0.226
Morning (7AM) w6	15.3	0.79	.732**	20.3	0.96	0.116	18.5	0.97	0.369	24.8	0.73	-.518*
Morning (7AM) w7	15.3	0.79	.734**	20.4	0.94	0.077	18.6	0.98	0.385	24.8	0.74	-.607**
Morning (7AM) w8	19.4	0.84	.767**	20.2	0.98	-0.033	24.6	0.63	-.570*	24.8	0.71	-.548*
Midday (12 PM) w1	28.0	1.66	0.026	21.9	1.02	0.283	27.1	1.00	-.530	22.8	0.75	0.26
Midday (12 PM) w2	23.1	1.10	-0.144	21.9	1.07	0.267	25.6	0.60	-0.28	24.0	0.69	-0.183
Midday (12 PM) w3	22.9	0.84	0.39	18.8	0.68	0.122	26.0	0.74	-0.169	20.7	0.69	-.476
Midday (12 PM) w4	22.7	0.64	-0.19	18.8	0.54	-0.396	26.1	0.71	-0.319	21.5	0.60	0.208
Midday (12 PM) w5	25.1	0.83	0.16	22.1	1.25	0.02	25.8	0.65	-.505	24.8	0.73	-.518*
Midday (12 PM) w6	26.4	0.78	-.697**	25.7	0.87	-.732**	27.6	0.66	-0.367*	30.2	1.04	-.566*
Midday (12 PM) w7	26.4	0.78	-.701**	26.2	1.11	-.679**	27.6	0.66	-0.388*	29.3	1.02	-.605**
Midday (12 PM) w8	26.4	0.79	-.685**	26.1	1.20	-.710**	30.4	0.84	-0.454*	29.2	1.23	-.548*

*Correaltion - Pearson Correlation coefficient, *. Correlation is significant at the 0.05 level (2-tailed), **. Correlation is significant at the 0.01 level (2-tailed), SD - Standard Deviation*
Note: Here w represents the weeks of observation which can be convert into days after sowing (DAS)

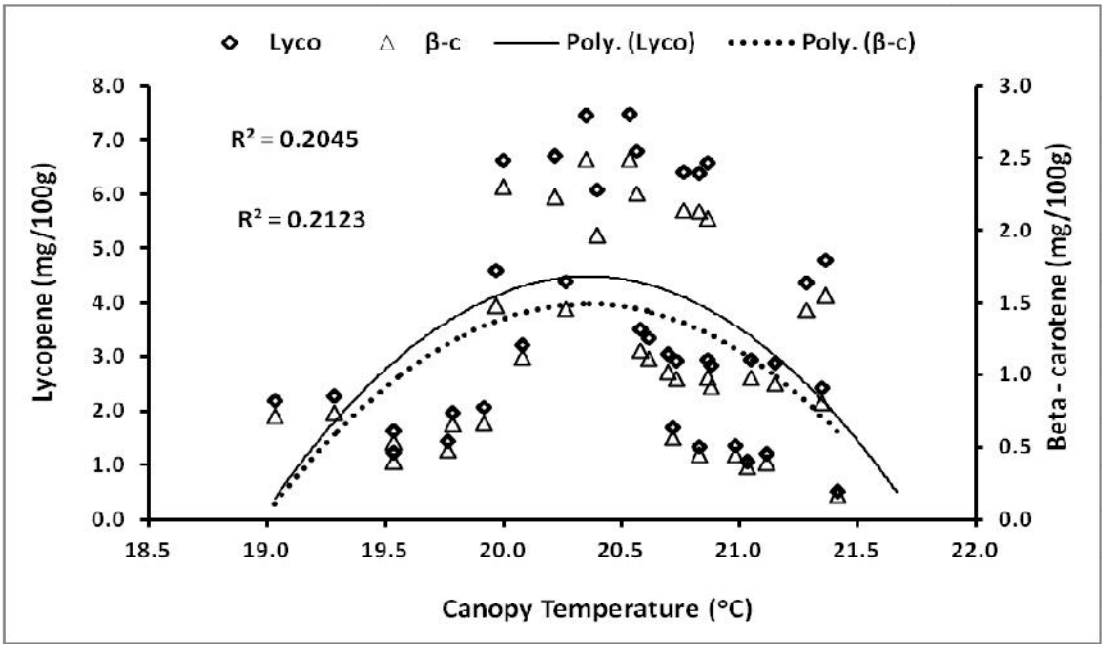

Fig. 3. Effect of mean canopy temperature on lycopene and beta-carotene content

The lycopene and beta carotene content of fruit increased with canopy temperature from 19.5°C and attained maximum value at 20.5°C, which further decreased beyond 21.0°C. This might be due to enhanced lycopene and carotene synthesis at optimum temperature and decreased or no lycopene synthesis at higher temperature (Fig. 3). This might be due to the reason that higher temperature beyond optimum level and direct sunlight may deteriorate the colour formation in fruits drastically. The results are in line with the findings reported by Brandt et al. [19] and John et al. [20] in cherry tomato.

4. CONCLUSION

Different timing of mean canopy and soil temperature had a significant effect on total yield and biochemical parameters traits. From the present investigation, it was observed that yield decreased with increase in canopy temperature above 26 ^{o}C in field and 24.5°C in polyhouse conditions. There was a negative impact of soil temperature on yield when it went below 24.5°C under both open field and polyhouse conditions whereas for quality parameters of TSS showed increasing trend with increase in canopy temperature till 29°C beyond which it decreased. The lycopene and ß-carotene content increased with increase in canopy temperature till 20.5°C and thereafter it also decreased with increasing canopy temperature.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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