ISSN-1923-7766 (Online)
Int. J. Expt. Agric. 2(1):8-11(January 2011)

EFFECT OF TEMPERATURE ON PHOTOSYNTHESIS, YIELD ATTRIBUTES AND YIELD OF TOMATO GENOTYPES

M.T. ISLAM

Crop Physiology Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh.

Corresponding author & address: Dr. Md. Tariqul Islam, Email: islamtariqul05@yahoo.com
Accepted for publication on 15 December 2010

ABSTRACT

Islam MT (2011) Effect of temperature on photosynthesis, yield attributes and yield of tomato genotypes. *Int. J. Expt. Agric.* 2(1), 8-11.

The experiment was conducted at the Bangladesh Institute of Nuclear Agriculture, Mymensingh during the period from November 2009 to March 2010 to assess the effects of temperature (32°C) on photosynthesis, yield attributes and yield of five tomato genotypes *viz*., Binatomato-6, Binatomato-5, CLN-2413, D_6 12 and D_6 18. Three temperature treatments *viz*., Ambient, 32°C at pre-flowering stage and 32°C at flowering stage were imposed and continued for 7 days in controlled plant growth chamber. Photosynthetic rate, number of fruits, individual fruit weight and fruit yield/plant significantly decreased with the temperature (32°C) at pre-flowering and flowering stages. Effects of temperature were more pronounced at flowering stage compared to pre-flowering stage. The tomato genotype CLN-2413 showed the best yield performance under the temperature stress.

Key words: *high temperature, photosynthesis, pre-flowering and flowering stages, tomato yield*

INTRODUCTION

Temperature has a significant influence on many aspects of growth and development in tomato (*Lycopersicon esculentum* Mill.). The optimum temperature for tomato production is 21°C to 25°C with an average monthly minimum temperature >18°C and a monthly maximum temperature of 27°C (Haque *et al*. 1999; Araki *et al*. 2000). Fruit set is optimal between 18°C and 20°C (De Koning 1994). Temperature below 16°C can cause flower abscission and temperature above 30°C can cause cracked fruit and blotchy ripening. Temperature significantly affects the partitioning of assimilates between the vegetative and generative parts. At higher temperatures, trusses appear faster (Adams *et al*. 2001) and therefore, initially, there are more fruits on a plant at a higher temperature. These will grow at the expense of vegetative growth, but may also cause a delay in the growth of newly set fruit and might even lead to flower or fruit abortion (De Koning 1989), as developing and flowering trusses are weaker sinks than fruiting trusses (Ho and Hewitt, 1986). A discrepancy exists between the long-term and short-term effects of temperature on fruit growth rate. Short-term temperature effects could be different from long-term temperature effects, as a high initial fruit load might lead to a limited assimilate supply for developing trusses (Ploeg and Heuvelink, 2005). In Bangladesh, tomato is widely grown in winter season. High temperatures in summer is a limiting factor to fruit set due to impaired complex physiological processes in the pistil which results in floral or fruit abscission (Picken 1984). Therefore, it is very essential to find out suitable genotypes that are tolerant to high temperature. In this regard, the scientists of different research institutes in Bangladesh are successful in developing tomato genotypes those are suitable for summer season. However, information regarding tolerance to high temperature stress of those tomato genotypes at vegetative and reproductive stages is scanty. Keeping with this in view five advance tomato genotypes were evaluated under high temperature at pre-flowering and flowering stages.

MATERIALS AND METHODS

A pot experiment was conducted with five tomato genotypes to see their temperature tolerance. Binatomato-6, Binatomato-5, CLN-2413, D_6 12 and D_6 18 were used in this study. The experiment consists of two factors *viz.*, three temperature treatments *viz.*, Ambient, 32°C at pre-flowering stage and 32°C at flowering stage and five tomato genotypes. The experiment was laid out in a Randomized Complete Block design with three replications. Thirty-day old seedlings were transplanted in plastic pots on 5 November 2009. Each pot contained 8 kg of soils (Silty loam, organic matter 1.05%, total nitrogen 0.07%, available phosphorus 14.3 ppm, exchangeable potassium 0.25 meq.per 100g soil, available sulphur 13.2 and soil pH 6.67). Urea, TSP, MP and cowdung were applied at the rate of 666 mg, 532 mg, 612 mg and 26 g/pot at correspondent dose of 250 kg, 200 kg, 230 kg and 10 ton/ha, respectively. Temperature treatments were imposed at pre-flowering and flowering stages of tomato genotypes and continued for 7 days in controlled plant growth chamber (32°C, 80% RH, 300 ppm CO_2). Data on photosynthetic parameters, yield attributes and yield were recorded. The collected data were analyzed statistically using the computer package program, MSTAT-C and the mean differences were adjudged by Duncan's New Multiple Range Test.

RESULTS AND DISCUSSION

Result showed that photosynthetic rate decreased with high temperature (32°C) at both pre-flowering and flowering stages (Table 1). But leaf conductance and transpiration rate decreased with the temperature treatment only at flowering stage. Binatomao-6 and D_6 18 had higher photosynthetic rate compared to other genotypes. All genotypes showed the highest photosynthetic rate at ambient temperature (Table 1).

Number of fruits/plant, individual fruit weight and fruit yield/plant significantly decreased at 32^{o}C temperature at pre-flowering and flowering stages (Table 2). Temperature effects were more pronounced at flowering stage compared to pre-flowering stage. The highest number of fruits/plant, individual fruit weight and fruit yield/plant were produced by CLN-2413 under the temperature stress (Table 2).

The experimental results showed that photosynthetic rates of all tomato genotypes decreased significantly with high temperature (32^{o}C) at pre-flowering and flowering stages. The decline in photosynthetic rate caused by high temperature has something to do with stomatal factors and it also has something to do with non-stomatal factors. The synthesis of chlorophyll content is blocked because of high temperature. Content of lutein and carotenoids are decreased, and the ratio between various pigments is also changed which has a direct effect on the absorption of light energy.

Tomato grows under high temperature produced lower fruit yield (Ho 1996; Adams *et al*. 2001). Lower fruit yield under high temperature is mainly due to limiting carbohydrate supply. The optimum fruit growth and development occur when night temperature is between 15 and 20^{0}C and the day temperature at about 25^{0}C (Kalloo 1985). Ambient temperature in winter of Bangladesh generally remains optimum for tomato production. So, better yield was obtained from ambient temperature.

CONCLUSION

Lower fruit yield of tomato genotypes under high temperature is mainly due to limiting carbohydrate supply. Effects of high temperature were more pronounced at flowering stage compared to pre-flowering stage. The tomato genotype CLN-2413 showed the best yield performance under the temperature stress.

REFERENCES

Adams SR, Cockshull KE, Cave CRJ (2001) Effect of temperature on the growth and development of tomato fruits. Annals Bot. 88, 869-877.

Araki T, Kitano M, Equchi H (2000) Dynamics of fruit growth and photoassimilation translocation in tomato plant under controlled environment. Acta Hort. 534, 85-92.

DE Koning ANM (1989) The effect of temperature on fruit growth and fruit load of tomato. Acta Hort. 248, 29-337.

DE Koning ANM (1994) Development and dry matter distribution in glasshouse tomato: a quantitative approach. Ph.D. Thesis. Wageningen Agricultural University, Wageningen, The Netherlands. p 240.

Haque MA, Hossain AKMA, Ahmed KU (1999) A comperative study on the performance of different varieties of tomato. II. Varietal response of different seasons and temperature in respect of yield and yield components. Bangladesh Hort. 26, 39-45.

Ho LC (1996) The mechanism of assimilate partitioning and carbohydrate compartmentalization in fruit in relation to the quality and yield of tomato. *J. Exp. Bot.* 47, 1239-1243.

HO LC, Hewitt JD (1986) Fruit development. In: *The Tomato Crop. A Scientific Basis for Improvement.* (Atherton, J.G. and Rudich, J. Eds.). Chapman & Hall, London, UK. 201–239.

Kalloo D (1985) Tomato. Allied Publishers Private Ltd. 13/14 Asaf Ali Road, New Delhi-110002. p 172-202.

Picken AJE (1984) A review of pollination and fruit set in tomato. *J. Hort. Res.* 31(8), 1778-1784.

Ploeg AVD, Heuvelink E (2005) Influence of sub-tropical temperature on tomato growth and yield: a review. *J. Hort. Sci. Biotech.* 80, 652-659.

Table 1. Effect of temperature on photosynthetic parameters of tomato genotypes

Treatment	Pn	Cond	Tr
Temperature			
Ambient (T0)	17.1a	0.36a	2.99a
32^{o}C at pre-flowering stage (T1)	12.4b	0.35a	3.08a
32^{o}C at flowering stage (T2)	11.0c	0.24b	1.47b
Genotypes			
Binatomato-6 (V1)	14.3a	0.33b	2.59b
Binatomato-5 (V2)	13.1b	0.24d	1.96c
CLN-2413 (V3)	12.6b	0.36ab	3.00a
D_6 12 (V4)	12.7b	0.38a	2.53b
D_6 18 (V5)	14.7a	0.29c	2.48b
Interaction			
T0V1	17.8a	0.44b	3.52b
T0V2	17.1a	0.27def	1.99f
T0V3	17.6a	0.33cd	3.92a
T0V4	15.4b	0.50a	2.85cd
T0V5	17.3a	0.28de	2.69d
T1V1	11.6ef	0.28de	2.73d
T1V2	11.8e	0.21g	2.27e
T1V3	12.2e	0.52a	3.88a
T1V4	12.3de	0.42b	3.49b
T1V5	13.8c	0.34c	3.01c
T2V1	13.6cd	0.28de	1.52g
T2V2	10.2g	0.23efg	1.62g
T2V3	7.9h	0.23efg	1.21h
T2V4	10.4fg	0.22fg	1.26h
T2V5	12.9cde	0.26efg	1.75fg

Values having common letter(s) in a column do not differ significantly at 5% level as per DMRT

Where, Pn= Photosynthetic rate ($\mu molCO_2m^{-2}s^{-1}$), Cond= Conductance ($molH_2Om^{-2}s^{-1}$), Tr= Transpiration rate ($mmolH_2Om^{-2}s^{-1}$)

Table 2. Effect of temperature on yield attributes and yield of tomato genotypes

Treatment	Fruits/plant (no.)	Individual fruit wt.(g)	Yield/ plant (g)
Temperature			
Ambient (T0)	26.9a	52.3a	1423a
32^{o}C at pre-flowering stage (T1)	19.6b	35.4b	694b
32^{o}C at flowering stage (T2)	17.4c	30.4c	532c
Genotypes			
Binatomato-6 (V1)	21.5	41.9b	935b
Binatomato-5 (V2)	21.0	34.7c	742d
CLN-2413 (V3)	21.4	48.5a	1153a
D12 (V4)	22.0	35.9c	806c
D18 (V5)	20.7	35.9c	781cd
Interaction			
T0V1	24.6b	63.3b	1561b
T0 V2	26.0b	38.7e	1007e
T0V3	31.0a	70.6a	2192a
T0V4	26.3b	42.1d	1110d
T0 V5	26.6b	46.8c	1248c
T1V1	20.0cd	37.0ef	740fg
T1 V2	22.3c	34.2fg	765fg
T1V3	18.6de	42.3d	790f
T1 V4	19.0de	26.7i	506h
T1V5	18.3de	36.7ef	673g
T2 V1	20.0cd	25.4i	506h
T2 V2	14.6f	31.1h	455h
T2V3	14.6f	32.6gh	478h
T2 V4	20.6cd	38.8e	803f
T2V5	17.3e	24.3i	421h

Values having common letter(s) in a column do not differ significantly at 5% level as per DMRT