SHORT COMMUNICATION

Evaluation of Tomato Genotypes for High Temperature Tolerance

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Twenty tomato genotypes were evaluated for heat tolerance by comparing six heat influenced traits under normal and elevated temperature regime. Stigma exersion, reduction in pollen fertility, increased flower drop, decreased fruit numbers, fruit weight and fruit yield were observed under high temperature in all the genotypes. However, the yield loss due to high temperature was comparatively lesser in genotypes LP-1, CLN2001A, BL1174, CLN2366A and CLN2413R.

Key Words: Tomato, High temperature tolerance, Stigma exersion, Pollen fertility

High temperature is a major production constraint of tomato in tropical and subtropical regions. Temperature regime higher than 32-33^{o}C/20-22^{o}C (day/night) or exposure of tomato plants for a period of four hours at 36-38^{o}C causes blossom drop in most of the cultivars (Hall, 1992). At high temperature the whole plant and the reproductive parts in particular are adversely affected resulting in poor fruit set (Kuo *et al.*, 1979, Peet *et al.*, 1997). Stigma exersion, poor pollen fertility/germination, poor pollen tube growth and carbohydrate stress are some of the manifestations of high temperature reducing fruit set in tomato (Lohar and Peet, 1998; Sato *et al*., 2004). Therefore, high temperature restricts the cultivation of tomatoes in the tropics and subtropics to the relatively cooler winter season only. To extend tomato cultivation into the off-season in these areas, heat tolerance in tomato varieties is the most important prerequisite.

The present investigation was aimed at evaluation of heat tolerance of 20 tomato genotypes, 17 of which were collected from AVRDC, Taiwan and three were from India. Some of them were advance breeding lines while others were established varieties from different countries (Table 1). To assess the heat tolerance of the genotypes, we compared several traits like stigma exersion (%), pollen fertility (%), flower drop (%), fruit weight (g), number of fruits/plant and fruit yield/plant (g) under favourable temperature and at elevated temperature during 2005-06 at Assam Agricultural University, Jorhat. For evaluation of the genotypes under normal temperature regime, the genotypes were grown under field condition during Nov.-Feb. (average day/night temperature was 26^{o}/18^{o}C). Evaluation under high temperature regime was done in a green house maintained at a temperature of 33±2^{o}C day/ 24±2^{o}C night during entire reproductive phase. In each temperature regime, the genotypes were grown in two replications and each of the genotypes were grown in two 5 rows. The data were analyzed as a randomized block design.

A stigma was considered exerted when it was out of the antheridial cone due to heat stress and was recorded on the flowers of first three clusters of 3 selected plants of each genotype and from each replication on the day of anthesis.

Pollen fertility was recorded in two flowers taken from each of the 3 plants from each genotype and replication. One anther from each flower was squashed in a drop of 2% acetocarmine solution on a slide. After placing the cover slips, the slides were allowed to stain for 2 minutes. Five fields were then observed under a compound microscope for each slide and percentage of fertile grains was calculated. Well filled and stained pollen grains were scored as fertile while shrunken, deformed, unstained and partially stained grains were considered sterile. Flower drop was recorded in first three clusters of 3 selected plants of each genotype from each replication.

Analysis of variance revealed significant variation among the 20 cultivars for the six characters. The mean values of the characters under normal and high temperature regime are presented in Table1. Exersion of stigma from the anthridial cone under high temperature hampers the pollination process in tomato. It was observed that under high temperature all the genotypes exhibited stigma exersion which ranged from 4.25-94.42%. LP-1, Saladette, CLN2001A and CLN2413R exhibited relatively low stigma exersion. Similarly, pollen fertility was high under normal temperature but it was adversely affected under high temperature. LP-1, CLN2001A,

Table 1. Mean performance of 20 tomato genotypes under normal (26^0 C day/18^0 C night) and high temperature (33^0 C day/24^{0}C night)

Genotypes	EC No	Origin	Flowers with exerted stigma (%)		Pollen fertility (%)		Flower drop (%)		No. of fruits/ plant		Fruit wt (g)		Yield/ plant (g)		Yield reduction over normal temperature (%)
			NT	HT	NT	HT	NT	HT	NT	HT	NT	HT	NT	HT	
PI120277	-	Turkey	00.00	40.50	88.26	48.75	5.25	57.32	22.75	11.27	56.34	54.00	1735.33	856.50	50.64
PI205009	-	USA	00.00	66.45	87.00	20.65	2.00	86.50	27.50	10.45	47.22	43.21	1875.50	435.37	76.78
H7996	-	Taiwan	00.00	55.00	90.54	52.33	4.00	58.33	15.25	7.23	75.33	69.75	1026.00	457.50	55.40
H7997	-	-do-	00.00	60.23	87.26	50.60	4.25	52.45	28.00	12.00	62.45	54.78	1321.00	573.45	56.58
BL1174	-	-do-	00.00	37.25	92.35	66.03	3.83	29.50	47.25	35.59	30.25	29.59	1400.33	1095.00	21.80
BL1176	-	-do-	00.00	45.35	83.20	58.00	2.33	65.23	27.79	10.29	55.71	47.84	1200.12	475.50	60.37
CLN2264F	-	-do-	00.00	50.50	89.33	60.00	3.00	66.75	32.12	11.33	35.42	32.85	1081.35	382.45	64.63
CLN2264G	-	-do-	00.00	38.67	93.00	57.67	1.05	55.62	38.20	12.36	62.93	59.00	1826.00	822.50	54.95
CLN2413R	-	-do-	00.00	25.52	89.00	68.75	3.24	49.05	25.36	11.00	39.95	37.50	886.20	570.67	35.60
CLN2366A	-	-do-	00.00	33.25	82.25	50.83	2.75	27.70	26.82	19.00	43.76	42.30	1205.09	880.00	26.97
CLN1621L	-	-do-	00.00	30.00	80.00	53.44	1.23	36.95	24.25	14.25	40.44	38.67	876.33	507.35	42.10
CLN2001A	-	-do-	00.00	21.01	90.75	71.42	3.05	23.77	54.75	45.27	24.22	24.00	1235.45	992.00	19.70
Saurav	-	India	00.00	94.42	86.33	32.87	2.89	77.10	34.18	13.25	68.67	62.09	2210.45	453.52	79.49
Arka Aloak	-	India	00.00	71.75	85.73	20.00	4.75	91.33	29.00	3.56	94.33	86.00	2354.20	150.75	93.59
Saladette	EC501581	Netherlands	00.00	17.00	82.50	68.79	2.00	48.50	20.00	10.00	48.63	45.22	962.50	465.67	51.61
Severnian	EC501579	USSR	00.00	40.75	70.20	36.00	5.45	59.66	22.00	7.50	57.23	50.15	1200.33	375.25	68.73
Walter	EC501584	USA	00.00	55.25	91.00	50.25	2.15	48.33	20.20	9.00	70.75	68.00	1206.67	576.45	52.22
Avalance	EC501583	Netherlands	00.00	57.33	95.00	30.50	2.65	80.00	21.33	3.25	61.00	58.00	1098.18	247.58	77.45
LO6035 (*L. Cheesmanii*)	EC501584	Taiwan	00.00	67.28	87.75	45.50	3.00	88.69	35.36	5.26	10.25	10.00	800.66	202.25	74.22
LP-1 (*L. pimpinellifolium*)	-	India	00.00	4.25	95.66	75.23	1.75	10.33	130.45	101.23	7.00	6.85	780.25	661.00	15.28
Mean± S. Em			00.00	45.24± 2.45	87.35± 5.22	50.88± 3.10	3.03± 0.16	55.65± 3.30	34.13± 9.22	17.65± 1.86	49.59± 2.89	45.99± 2.35	1314.09± 40.35	554.04± 24.75	- -
C.D (p=0.01)			-	9.34	7.33	5.26	1.12	4.65	4.86	2.85	13.05	3.34	80.12	26.33	-

*NT= Normal Temperature, HT= High Temperature

Saladette, CLN2413R and BL1174 however recorded relatively higher pollen fertility even under high temperature. The highest flower drop under normal temperature was only 5.45% (Severnian) while, under high temperature, flower drop scaled up to 91.33% (Arka Aloak). Genotypes LP-1, CLN 2001A, CLN2366A and BL1174 exhibited comparatively low flower drops even under high temperature. No remarkable change was observed for fruit weight under both the temperature regimes. However, a uniform trend was recorded that invariably in all the genotypes fruit weight was observed to be higher under normal temperature to those harvested from plants raised under high temperature condition. This clearly depicts the adverse effect of high temperature on fruit weight. Similar observation was also reported by Levy *et al*. (1978). Yield under normal temperature ranged from 780.25 g (LP-1) to 2354.20 g (Arka Aloak) while under high temperature, it ranged from 150.75 g (Arka Aloak) to 1095.00 g/plant (BL1174). It was evident that under high temperature conditions fruit set and yield were drastically reduced in several of the cultivars. The per cent reduction in yield under high temperature regime ranged from as high as 93.59% (Arka Aloak) to as low as 15.28% (LP-1). Considering the performance for all the characters, it appeared that LP-1 had the highest thermo tolerance among the genotypes followed by CLN2001A, BL1174, CLN2366A and CLN2413R as their yield reduction under high temperature was comparatively less, whereas, Arka Aloak was the most heat sensitive cultivar among the test entries.

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