International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 262-266
© 2019 IJCS
Received: 12-01-2019
Accepted: 15-02-2019

Prakash G
College of Horticulture,
UHS Campus GKVK Post,
Bengaluru, Karnataka, India

Muksh L Chavan
College of Horticulture,
UHS Campus GKVK Post,
Bengaluru, Karnataka, India

Ramachandra RK
College of Horticulture,
UHS Campus GKVK Post,
Bengaluru, Karnataka, India

Maheshkumar B Doddamani
College of Horticulture,
UHS Campus GKVK Post,
Bengaluru, Karnataka, India

Correspondence
Prakash G
College of Horticulture,
UHS Campus GKVK Post,
Bengaluru, Karnataka, India

Screening of tomato genotypes for growth, biophysical and biochemical and yield parameters under controlled deficit irrigations in northern dry zone of Karnataka

Prakash G, Muksh L Chavan, Ramachandra RK and Maheshkumar B Doddamani

Abstract
The effect of irrigation schedules on biophysical, biochemical and yield of tomato genotypes were evaluated in the field experiment at KRC College of Horticulture, Arabhavi, Karnataka. The experiment was laid out in a factorial randomized block design with thirteen genotypes and two replications. Water stress was imposed two weeks after the transplanting to all the genotypes in two stress conditions viz. the IW/CPE ratio of 0.40, 1.20 and farmers practice as control. Furrow irrigation was given when the pan evaporation reading reached 41.66 mm (1.20 IW/CPE ratio) and 125 mm (0.40 IW/CPE ratio) using V notch. The genotypes which perform better under 0.4 IW/CPE ratio, PUSA 120 had which maximum total chlorophyll content with better yield of 1.48 kg/ plant, EC 638519 had maximum proline which recorded yield of 1.47 kg/plant and genotype EC 608362 maximum photosynthetic rate and it recorded maximum of yield per plant of 1.65 kg/ plant. With all these growth, biochemical, biophysical and with yield record we can categories PUS 120, EC 638519 and EC 608362 as drought tolerant genotypes.

Keywords: Tomato, water stress, deficit irrigation, Physiological traits, yield, IW/CPE ratio

Introduction
Tomato (*Solanum lycopersicon* L.) which belongs to solanaceae which is one of the most popular and widely used vegetable in the world. Tomato are the chief source of lycopene, ascorbic acid and β carotein. Tomato has rich in medicinal values too. Drought stress is a very important limiting factor at the initial phase of plant growth and establishment. Drought affects both elongation and expansion growth. Water deficit in the early stages of tomato showed a greater effect on reduction in plant height. There are several physiological, genetical and biochemical traits contributing to the drought tolerance nature of agricultural/horticultural crops. Plants which tolerate moderate stress at low tissue water potential may do so by virtue of several dehydration tolerance mechanisms like maintenance of membrane integrity, osmotic adjustment and chloroplast integrity. Tomato genotypes have not been screened for drought tolerance for their cultivation. Hence, the present investigation was carried out to screen the tomato genotypes for various growth, biophysical, biochemical parameters viz leaf area, LAI, leaf temperature (°C), photosynthesis (mmol $CO_2/m^2/s$), stomatal conductance (mmol/m^2/s), transpiration rate (mmol $H_2O/m_2/s$), total chlorophyll, proline and yield/plant by adopting simple field technique of two levels of irrigation water to cumulative pan evaporation ratio (IW/CPE ratio) along with control.

Materials and Methods
The experiment was conducted at the Biotechnology and Crop Improvement unit of Kittur Rani Channamma College of Horticulture, Arabhavi, is situated in northern dry zone of Karnataka at 16°15’ north latitude, 75°45’ east longitude and at an altitude of 612.03 meters above mean sea level. The experiments were laid out in a factorial randomized block design with thirteen genotypes which were collected from different places like NBPGR and IIHR, Bangalore these genotypes were replicated twice with the spacing of 60cm x 60cm by following all the recommended production practices. Water stress was imposed after two weeks after transplanting to all the genotypes in both the IW/CPE ratio of 0.40, 1.20 and

farmers practice as control. Furrow irrigation was given when the pan evaporation reading reached 41.66 mm (1.20 IW/CPE ratio) and 125 mm (0.40 IW/CPE ratio) using V notch. The list of 13 tomato genotypes are 1) Arka Meghali, 2) EC 608362, 3) EC 610652, 4) EC 634394, 5) EC 638519, 6)EC 610661, 7) EC 631962, 8) EC 686550, 9) Kashi Anupam, 10) EC 686543, 11) EC 608269, 12) EC 686553, 13) PUSA 120. Observation on various growth, biophysical, biochemical parameters viz leaf area, LAI, leaf temperature (°C), photosynthesis (mmol $CO_2/m^2/s$), stomatal conductance (mmol $/m^2/s$), transpiration rate (mmol H2O/m2/s), were taken using the steady state poromters(LC pro$^+$ portable photosynthetic system, ADC Bioscientific Ltd. England. Total Chlorophyll content of leaf tissue was estimated as suggested by Hiscox and Israelstom (1979) [7]. Proline content of the sample was calculated by using the formula given by Bates *et al.* (1973) [2] and was expressed in ($\mu g.g^{-1}$of fresh weight). The total weight of fruits harvested from five tagged plants of all six picking was added and average yield per plant was worked out and expressed in kilogram per plant. Later the yield per hectare was calculated and expressed as tons per hector.

Results and discussion

Leaf area and leaf area index (LAI) are most important variable and it can be widely changed by agronomical manipulation. Leaf area and LAI was found to be significant for genotypes as well as for irrigation schedules (Table 1). When the plants subjected to deficit water condition there was decrease in the leaf area. Leaf area was found significantly maximum at control when compared to deficit 0.4 IW/CPE ratio. The maximum leaf area was maintained by genotype EC 638519 followed by EC 634394 and EC 608362 while least was maintained by EC 686553. These genotypes also maintained optimum photosynthetic rate with lower transpiration rate. The present study was found to be on par with earlier workers, Upreti *et al*. (2000) opined that, water stress treatments lead to significant reduction in leaf area in all the cultivars of pea and the decline was greater with stress at flowering than at vegetative stage. Similarly, the possible reason for reduced vegetative growth of most of the tomato genotypes under stress might be due to decreased relative turgidity to below 90 per cent which caused dehydration of the protoplasm and associated with loss of turgor. Leaf area index (LAI) is the most important variable and it can be widely changed by manipulation. LAI indicated significant difference among the irrigation levels and genotypes at all the growth stages (Table 1). Significantly maximum LAI was noticed under control compared to 0.4 IW/CPE ratio. The selected genotypes indicated that, EC 638519 exhibited maximum LAI at 0.4 IW/CPE ratio followed by EC 634394 at 90 DAT whereas, minimum was recorded in the genotype EC 686553. Similarly Haloi and Baldev (1986) showed that good supply of moisture was the basis for the maximum LAI. Present investigation is in conformity with earlier findings of Chavan *et al.,* 2010 in tomato, Panda *et al*. (2004) in mustard.

Chlorophyll are photosynthetic pigments which absorbs light energy for synthesis of carbohydrates and are important factor for plant productivity. Total chlorophyll content indicated significant difference among irrigation schedules among the studied genotypes. (Table-1). The genotypics data on chlorophyll content indicated that, EC 608362 recorded maximum total chlorophyll content (1.82 mg/g of fresh weight) compared to other genotypes including the check Arka Meghali during 90 DAT. Whereas, minimum was noticed in the genotype EC 686553 during 90 DAT. Under the sever drought of 0.4 IW/CPE ratio PUSA 120 recorded maximum total chlorophyll of 1.35 mg/g of fresh weight and minimum was noticed in EC 686553. Present investigation is in conformity with Gladden *et al*. (2012) [6] who showed that water deficit earlier in the growth of tomato caused a significant reduction in leaf chlorophyll content. Abdellah *et al*. (2011) [1] recorded the highest reduction in the chlorophyll content in susceptible wheat cultivar under water stress of 30 per cent FC. Water stress reduced the total chlorophyll content significantly in different genotypes of moth bean and reduction was more pronounced in late flowering genotypes (Garg *et al*., 2004) [5].

The results on proline indicated significant differences in irrigation levels indicated significant differences among genotypes, irrigation levels and their interactions (Table 1). Among all the irrigation schedules, proline content shown to be increased to the extent of 63.50 per cent in 0.4 IW/CPE ration over control. Maximum proline content was noticed in the genotype EC 638519 followed by EC 610652 during 90 DAT. The present findings are accordance with the earlier findings of Shah *et al*. (2010) who showed that the moisture stress increased the proline content 2.75 and 3.60 times that of control by moderate and severe stress respectively in *Withania somnifera.* The highest average proline content found in the tomato cultivar Denar, displayed the most evident adaptation to stress conditions through osmotic adjustment (Jurekova *et al*., 2011) [9]. Patel *et al.* (2012) [11] showed that the proline content was increased significantly by drought stress in chickpea. Beena *et al*. (2012) [3] reported that, high proline content was recorded in tolerant inbred lines of rice than susceptible lines under water stress condition. Thus, from the above biochemical studies, it could be inferred that chlorophyll and proline content could be taken as one of the parameters while screening for drought tolerance.

Internal leaf temperature is one parameter which is associated with photosynthetic efficiency of plant among the different genotypes minimum leaf temperature was noticed in the genotype EC 686550 of 30.03 °C (Table 2) and the same genotypes maintained lowest temperature among all the genotypes under 0.4 IW/CPE ratio. The genotypes EC 631962 recorded maximum temperature of 36.83 °C among all the genotypes which also showed a marked increase in temperature at different irrigation levels.

Photosynthetic efficiency of the plant is one the most important parameter under given environmental condition is a function of various biophysical and biochemical processes involved during diffusion of CO_2 from the atmosphere into chloroplast and subsequent enzyme reactions. Among the different genotypes, maximum photosynthetic rate was noticed in Arka Megali of 18.50 mmole CO_2. m^{-2}. s^{-1} (Table 2) while, minimum was noticed in genotype EC 686543. Under the deficit irrigation of 0.4 IW/CPE ratio, the photosynthetic rate was reduced to 53.65 per cent over control. Under this condition also Arka Megali noticed the maximum photosynthetic rate which was on par with EC 608362, EC 610652 and EC 634394. These results are in conformity with findings of Sivakumar (2015), The photosynthetic rate in 100 per cent FC plants was significantly higher than 50 per cent FC plants and reduced at 90 DAT. Abdellah *et al*. (2011) [1] reported that, the highest reduction in the photosynthetic rate was observed in susceptible wheat cultivar by water stress of 30 per cent FC.

Transpiration is a unavoidable necessary evil process. There will more of transpiration takes place from the plant parts under favorable conditions. In present study there was significant reduction in transpiration rate was noticed from the control to 0.4 IW/CPE ratio, it was to the extent of 38.15 per cent (Table 2). Significantly minimum transpiration was noticed in genotypes EC 686550 (6.09 mmole H_2O. $m^{-2}.s^{-1}$) among all the genotypes while, genotype EC 610661 recorded maximum transpiration rate under 0.4 IW/CPE ratio. EC 608269 recorded lower of 3.60 mmole H_2O. $m^{-2}.s^{-1}$ and maximum was noticed in the genotypes EC 610661. Stomatal conductance was significant for genotypes, irrigation and their interaction (Table 2). Among the different irrigation levels, significantly lowest stomatal conductance was noticed in 0.4 IW/CPE. It was reduced to the extent of 41.77 per cnet in 0.4 IW/CPE over control. Among all the genotypes Akra Megali recorded significantly maximum stomatal conductance of 0.83 mmole H_2O. $m^{-2}.s^{-1}$ while, genotype EC 608269 recorded significantly lowest stomaal conductance. Among the interaction between genotypes and irrigation levels, significantly maximum was noticed in genotype EC 638519 (1.05 mmole H_2O. $m^{-2}.s^{-1}$) under control and minimum was noticed in genotype EC 686553 (0.2 mmole H_2O. $m^{-2}.s^{-1}$) under 0.4 IW/CPE ratio. A fundamental response to drought by plants is to conserve water through stomatal regulation. Stomata are pores found in the epidermis of the leaf that allow for an influx of CO_2 for photosynthesis and consequently water loss through transpiration. These pores are flanked by specialized cells, known as guard cells. Within these guard cells, the plant hormone abscisic acid (ABA) is one of the most important chemical signals that trigger a signaling cascade leading to stomatal closure under abiotic conditions such as drought. Guard cell control of transpiration and water loss is strongly associated with drought tolerance (Tuberosa, 2012) [13]. Reduced stomatal conductance and photosynthetic rate were observed under 50 per cent and 100 per cent water stress over control in tomato (Bhatt *et al*., 2002) [4]. Photosynthetic and transpiration rate were reduced, whereas leaf temperature and stomatal resistance were increased by water stress in all cultivars of tomato (Hnilickova and Duffek, 2004) [8]. Transpiration is important trait for assessment of drought tolerance, and is widely affected by environmental stress conditions. Higher transpiration rate were observed in control plants (100% FC) at all the stages compared to water deficit stress condition (50% FC) in tomato all the genotypes (Sivakumar, 2014) [12]. Mingchi *et al*. (2010) [10] reported that, the stomatal conductance, transpiration rate and photosynthetic rate were reduced under simulated drought stress in tomato.

Yield per pant and yield per hectare found to be significant for genotypes, irrigation and their interactions (Table 3). Among all the genotypes EC 631962 recorded maximum yield per pant and yield per hectare (1.65 kg/plant and 49.83 t/ha, respectively) which was followed by the Arka Megali and EC 608362 and minimum was in the genotype EC 608269. Same trend was noticed in the sever water deficit of 0.4 IW/CPE ratio.

Conclusion

Based on the all the above parameters the genotypes which perform better under 0.4 IW/CPE ratio, PUSA 120 had which maximum total chlorophyll content with better yield of 1.48 kg/plant, EC 638519 had maximum proline which recorded yield of 1.47 kg/plant and genotype EC 608362 maximum photosynthetic rate and it recroded maximum of yield per plant of 1.65 kg/plant. With all these growth, biochemical, biophysical and with yield record we can categories PUS 120, EC 638519 and EC 608362 as drought tolerant genotypes. Further these can be used for breeding programme.

Table 1: Influence of irrigation levels on leaf area (cm^2), LAI, Total Chlorophyll content (mg/g of fresh weight) and proline (µg/g of fresh leaf weight) of tomato genotypes at 90 DAT

S. No	Genotypes	Leaf area				LAI				Total Chlorophyll				Proline			
		IW/CPE ratio															
		Control	1.2	0.4	Mean	Control	1.2	0.4	Mean	Control	1.2	0.4	Mean	Control	1.2	0.4	Mean
1	Arka Meghali	2066.44	1796.37	1166.47	1676.43	0.77	0.67	0.43	0.62	2.25	1.65	1.26	1.72	220.25	319.11	380.84	306.73
2	EC 608362	2213.82	1669.00	1276.39	1719.74	0.82	0.62	0.47	0.64	2.42	1.70	1.33	1.82	241.64	351.84	423.47	338.98
3	EC 610652	1870.68	1236.74	1035.49	1380.97	0.69	0.46	0.38	0.51	2.43	1.54	0.91	1.63	300.71	378.90	474.31	384.64
4	EC 634394	2249.86	1675.17	1377.08	1767.37	0.83	0.62	0.51	0.65	2.17	1.60	1.31	1.69	184.35	303.60	370.24	286.06
5	EC 638519	2497.22	2086.22	1411.42	1998.29	0.93	0.77	0.52	0.74	2.21	2.03	0.92	1.72	230.90	350.54	498.59	360.01
6	EC 610661	1557.3	1354.16	998.86	1303.44	0.58	0.50	0.37	0.48	2.41	1.44	1.05	1.63	226.43	329.01	418.63	324.69
7	EC 631962	1694.61	1332.77	966.32	1331.24	0.63	0.49	0.36	0.49	2.60	1.64	1.30	1.84	192.20	302.91	341.95	279.02
8	EC 686550	1113.9	765.26	335.54	738.23	0.41	0.28	0.12	0.27	2.03	0.73	0.46	1.07	131.44	124.09	87.27	114.27
9	Kashi Anupam	2166.13	1392.28	1077.38	1545.27	0.80	0.52	0.40	0.57	2.28	1.70	1.22	1.73	164.48	239.09	325.08	242.88
10	EC 686543	989.14	710.243	332.55	677.31	0.37	0.26	0.12	0.25	1.85	0.94	0.49	1.09	115.31	123.35	95.20	111.29
11	EC 608269	1124.05	781.77	345.20	750.34	0.42	0.29	0.13	0.28	1.82	0.83	0.44	1.03	93.04	97.20	89.38	93.21
12	EC 686553	1029.62	669.60	285.99	661.73	0.38	0.25	0.11	0.25	1.59	0.99	0.38	0.99	118.67	95.11	87.74	100.51
13	PUSA 120	2147.64	1410.19	935.98	1497.94	0.80	0.52	0.35	0.55	1.93	1.53	1.35	1.61	168.00	261.72	310.85	246.85
Mean		1747.72	1298.44	888.05	1311.41	0.65	0.48	0.33	0.49	2.15	1.41	0.96	1.51	183.65	252.04	300.27	245.32
Range		2497.22	2086.22	1411.42	1998.29	0.92	0.77	0.52	0.74	2.60	2.03	1.35	1.84	300.71	378.90	498.59	384.64
		989.14	669.60	285.98	661.73	0.36	0.24	0.11	0.24	1.59	0.73	0.38	0.99	93.04	95.11	87.27	93.21
		S.Em ±		CD @ 5%		S.Em ±		CD @ 5%		S.Em±		CD at 5%		S.Em ±		CD @ 5%	
Genotypes (G)		84.01		236.63		0.03		0.09		0.07		0.20		4.63		13.05	
Irrigation (I)		40.36		113.67		0.01		0.04		0.03		0.10		2.23		6.27	
G X I		145.51		NS		0.05		NS		0.12		0.35		8.03		22.60	

DAT = Days after transplanting
NS = Non Significant
Control = Farmers practice

Table 2: Leaf temperature, Photosynthetic rate, Transpiration rate and Stomatal conductance of tomato genotypes as influenced by irrigation levels

S. No	Genotypes	Leaf temperature (°C)				Photosynthesis (mmol $CO_2/m^2/s$)				Transpiration rate (mmol $H_2O/m^2/s$)				Stomatal conductance (mmol $/m^2/s$)			
		IW/CPE ratio															
		Control	1.2	0.4	Mean	Control	1.2	0.4	Mean	Control	1.2	0.4	Mean	Control	1.2	0.4	Mean
1	Arka Meghali	34.12	36.22	39.11	36.48	22.92	18.91	13.68	18.50	8.62	7.07	5.73	7.14	1.03	0.79	0.66	0.83
2	EC 608362	32.77	35.97	38.89	35.88	18.18	16.78	12.81	15.92	8.30	6.42	6.23	6.98	0.89	0.74	0.63	0.75
3	EC 610652	32.51	34.71	38.19	35.14	19.20	16.57	12.71	16.16	9.42	7.27	7.30	8.00	0.72	0.71	0.61	0.68
4	EC 634394	32.74	35.40	38.05	35.40	20.07	16.66	12.43	16.39	7.26	8.45	7.46	7.72	0.65	0.64	0.57	0.62
5	EC 638519	30.54	37.04	37.26	34.94	21.60	17.21	11.56	16.79	11.84	9.28	8.04	9.72	1.05	0.75	0.62	0.81
6	EC 610661	33.09	34.13	37.95	35.06	22.18	19.11	10.12	17.13	11.70	9.29	8.36	9.78	0.96	0.73	0.65	0.78
7	EC 631962	35.52	37.23	37.75	36.83	21.64	16.77	7.99	15.47	9.51	7.61	6.41	7.84	0.76	0.64	0.49	0.63
8	EC 686550	32.51	29.89	27.67	30.03	19.06	12.81	5.29	12.39	9.28	5.33	3.67	6.09	0.69	0.27	0.29	0.42
9	Kashi Anupam	33.92	35.93	37.59	35.81	17.33	16.27	9.36	14.32	10.00	7.89	6.94	8.27	0.69	0.41	0.52	0.54
10	EC 686543	33.75	29.19	30.45	31.13	17.92	11.95	3.89	11.25	11.39	5.31	4.89	7.20	0.73	0.26	0.22	0.40
11	EC 608269	32.01	30.86	28.57	30.48	20.52	9.44	4.22	11.39	10.95	5.23	3.60	6.59	0.67	0.22	0.23	0.37
12	EC 686553	31.70	30.57	30.32	30.86	19.67	11.55	4.57	11.93	9.22	5.41	3.97	6.20	0.68	0.27	0.20	0.38
13	PUSA 120	33.08	36.50	37.81	35.80	17.69	15.68	10.98	14.78	9.21	6.85	5.79	7.28	0.71	0.50	0.34	0.52
Mean		32.94	34.13	35.35	34.14	19.85	15.36	9.20	14.80	9.75	7.03	6.03	7.60	0.79	0.53	0.46	0.59
Range		35.52	37.23	39.11	36.83	22.92	19.11	13.68	18.50	11.84	9.29	8.36	9.78	1.05	0.79	0.66	0.83
		30.54	29.19	27.67	30.03	17.33	9.44	3.89	11.25	7.26	5.23	3.60	6.09	0.65	0.22	0.20	0.37
		S.Em ±		CD @ 5%		S.Em ±		CD @ 5%		S.Em ±		CD @ 5%		S.Em ±		CD @ 5%	
Genotypes (G)		0.35		0.99		0.33		0.94		0.29		0.81		0.03		0.09	
Irrigation (I)		0.17		0.48		0.16		0.45		0.14		0.39		0.02		0.04	
G X I		0.61		1.72		0.58		1.63		0.50		1.41		0.05		0.15	

DAT = Days after transplanting
Control = Farmers practice

Table 3: Influenced by irrigation levels on yield of tomato genotypes

S. No	Genotypes	Yield/plant (Kg/plant)				Yield/ hectare (t/ha.)			
		IW/CPE ratio							
		Control	1.2	0.4	Mean	Control	1.2	0.4	Mean
1	Arka Meghali	1.89	1.65	1.33	1.62	58.83	49.95	38.14	48.97
2	EC 608362	1.77	1.50	1.28	1.52	54.48	44.33	36.21	45.01
3	EC 610652	1.65	1.44	1.22	1.44	49.98	42.19	34.19	42.12
4	EC 634394	1.79	1.52	1.33	1.55	55.10	45.25	38.33	46.22
5	EC 638519	1.67	1.46	1.27	1.47	50.83	42.94	36.03	43.27
6	EC 610661	1.59	1.31	1.21	1.37	47.61	37.55	33.76	39.64
7	EC 631962	1.95	1.62	1.37	1.65	61.29	48.73	39.48	49.83
8	EC 686550	1.79	1.24	0.95	1.33	55.25	34.72	24.07	38.01
9	Kashi Anupam	1.66	1.39	1.24	1.43	50.48	40.55	34.98	42.01
10	EC 686543	1.69	1.21	0.82	1.24	51.33	33.74	19.25	34.77
11	EC 608269	1.62	1.22	0.66	1.17	48.75	33.99	13.41	32.05
12	EC 686553	1.64	1.20	0.70	1.18	49.49	33.32	14.70	32.50
13	PUSA 120	1.77	1.39	1.27	1.48	54.36	40.36	35.85	43.52
Mean		1.73	1.40	1.13	1.42	52.91	40.59	30.65	41.38
Range		1.95	1.65	1.37	1.65	61.3	49.95	39.48	49.83
		1.59	1.20	0.66	1.17	47.61	33.32	13.41	32.05
		S.Em ±		CD @ 5%		S.Em ±		CD @ 5%	
Genotypes (G)		0.04		0.1		1.29		3.64	
Irrigation (I)		0.02		0.05		0.62		1.75	
G X I		0.06		0.17		2.24		6.30	

DAT = Days after transplanting
Control = Farmers practice

References

1. Abdellah A, Boutraa T, Alhejely A. The rates of photosynthesis, chlorophyll content, dark respiration, proline and abscicic acid (ABA) in wheat (*Triticum durum*) under water deficit conditions. Int. J. Agric. Biol. 2011; 13(2):215-221.
2. Bates LS, Walderen RP, Teare ID. Rapid determination of free proline in water stresses studies. Plant and Soil. 1973; 39:205-207.
3. Beena R, Thandapani V, Chandrababu R. Physio-morphological and biochemical characterization of selected recombinant inbred lines of rice for drought resistance. Indian J Plant Physiol. 2012; 17(2):189-193.

4. Bhatt RM, Rao NKS, Sadahiva AT. Rootstock as a source of drought tolerance in tomato (*Lycopersicon esculentum* Mill). Indian J Plant Physiol. 2002; 7(4):338-342.
5. Garg BK, Burman U, Kathuja S. Effect of water stress on moth bean (*Vigna aconitifolia* (Jacq) Marechal) genotypes. Indian J Plant Physiol. 2004; 9:29-35.
6. Gladden LA, Wang Y, Hsieh C, Tsou I. Using deficit irrigation approach for evaluating the effects of water restriction on field grown tomato (*Lycopersicon esculentum*). Afr. J Agric. Res. 2012; 7(14):2083-2095.
7. Hiscox JD, Israelstom GF. A method of extraction of chlorophyll content from leaf tissue without maceration. Canadian J Bot. 1979; 57:1332-1334.
8. Hnilickova H, Duffek J. The effect of water deficit and subsequent regeneration on selected physiological characteristics in tomatoes (L*ycopersicum esculentum* mill.). Scient. Agric. Bohem. 2004; 35(1):26-31.
9. Jurekova Z, Molnar KN, Paganov V. Physiological responses of six tomato (*Lycopersicon esculentum* Mill*.)* cultivars to water stress. J Hort. Forest. 2011; 3(10):294-300.
10. Mingchi L, Xiangli L, Jing H, Lihong G. Effect of simulated drought stress on plant growth, yield and fruit properties of tomato. Acta Hort. 2010; 856:193-202.
11. Patel PK, Hemantaranjan A, Sarma BK. Effect of salicylic acid on growth and metabolism of chickpea (*Cicer arietinum* L.) under early and late drought stress. Indian J Plant Physiol. 2012; 17(1):170-176.
12. Sivakumar R, Durga Devi D, Chandrasekar CN, Santhi R, Vijaya Kumar RM. Impact of drought on gas exchange and physiological parameters and yield in contrasting genotypes of tomato (Solanum lycopersicum). Indian J Plant Physiol. 2014; 19:1-7.
13. Tuberosa R. Phenotyping for drought tolerance of crops in the genomics era. Front. Physiol. 2012; 3:347.