International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(5): 259-263

Received: 26-06-2020
Accepted: 10-08-2020

MK Rathod
Ph. D. Scholar, Department of Agril-Botany Post Graduate Institute Mahatma Phule Krushi Vidyapith Rahuri Ahmednagar, Maharashtra, India

Dr. RW Bharud
Ex-Head, Department of Agril-Botany Post Graduate Institute Mahatma Phule Krushi Vidyapith Rahuri Ahmednagar, Maharashtra, India

Neeraj Nath Parihar
Ph. D. Scholar, Department of Agril-Botany (Seed Science and Technology) Post Graduate Institute Mahatma Phule Krushi Vidyapith Rahuri Ahmednagar, Maharashtra, India

Corresponding Author:
MK Rathod
Ph. D. Scholar, Department of Agril-Botany Post Graduate Institute Mahatma Phule Krushi Vidyapith Rahuri Ahmednagar, Maharashtra, India

Effect of temperature stress on seedling growth and development in soybean [*Glycine max* (L.) merrill] genotypes

MK Rathod, RW Bharud and Neeraj Nath Parihar

DOI: https://doi.org/10.22271/chemi.2020.v8.i5d.10305

Abstract
Temperature is an environmental factor that has a considerable influence on seedling growth and development. It plays a role in seed development, controlling seed yield, composition, and vigor. A laboratory experiment was conducted at Central Phytotron Facility during 2017-2018 in Completely Randomized Block Design (CRD) with two replications. Twenty genotypes were exposed to various temperature regimes *viz*; control (T1), day/night temperature regime 30 ^{0}C/25 ^{0}C (T2), 32 ^{0}C/27 ^{0}C (T3), 34 ^{0}C/29 ^{0}C (T4), and 36 ^{0}C/31 ^{0}C (T5) under phytotronic conditions for germination in growth chambers 1, 2, 3, 4, and 5 respectively. Ten seeds per replication were sown in Petri plates and were exposed to above temperature regimes upto 8 days and 10000 foot candle light and 1000 ppm CO_2 was provided. Among the genotypes KDS-904 (97.75%) recorded significantly maximum shoot length stress tolerance index percent followed by KDS-1032 (97.43%) while genotype KDS-344 (92.36%) recorded significantly minimum shoot length stress tolerance index percent on the eight day. Similarly among the different interactions day/night temperature regime 36/31 ^{0}C treatment on eighth day, genotype DS-288 recorded significantly maximum total seedling length (10.72 cm) followed by same genotype (10.47 cm) under day/night temperature regime 32/27 ^{0}C whereas genotype KDS-904 recorded significantly minimum seedling length (3.73 cm) under control treatment.

Keywords: Phytotron, soybean, temperature stress, temperature regime

Introduction
Soybeans [*Glycine max* (L.) Merrill] rank as one of the most important agricultural crops in the world. Temperature is an environmental factor that has a considerable influence on plant growth and development. It plays a role in seed development, controlling seed yield, composition, and vigor. Soybean is a major source of plant protein and oil. High temperature during soybean seed development has been reported to have a considerable effect on soybean yields, seed composition, and seed vigor (Dornbos, 1995 and Wilson, 2004) [4, 9]. Dornbos and Mullen (1991) [3] reported that water stress at optimum air or atmospheric temperatures (ATs) reduced seed number more than individual seed weight, but water stress at high ATs reduced individual seed weight more than seed number. Water or high AT stress caused fewer larger seed and more small seed to be produced. The germination percentage and vigour of the harvested seeds was reduced by water stress and high ATs, but by a smaller proportion than yield or seed number. Individual seed weight, germination, and seedling growth rate were strongly correlated when reduced by water and high AT stress. Severe stress during seed fill caused soybean plants to exceed their capacity to buffer seed number, shifting seed weight distributions towards a larger proportion of small seed, resulting in poor seed lot germination and vigour.

Drought and heat stress often decrease stem growth and plant height. When plants experience drought stress, stem diameter shrinks in response to changes in internal water status (Simonneau *et al*., 1993) [8]. Root growth decreases when heat stress occurs during reproductive development, mainly because of decreased carbon partitioning to roots (Batts *et al*., 1998) [1]. Thirty diverse genotypes of bread wheat were evaluated by Dhanda *et al.*, (2004) [2] and recorded seed vigour index, germination percentage, root length, shoot length, coleoptile length and osmotic membrane stability under laboratory conditions. They observed considerable variation for all the characters.

Comparison of mean performance under normal and osmotic stress conditions indicated that the seed vigour index was the most sensitive trait followed by shoot length, germination percentage and root length. All the characters except germination percentage, shoot length and coleoptile length showed considerable genetic variability. Heritability in the broad sense was also moderate to high for all the characters under both environments. Due to high heritability and genetic advance great benefit from selection can be expected for the osmotic membrane stability of leaf segments and root-to-shoot length ratio. Therefore considering all those factors the present investigation was carried out to understand the effect of temperature stress on seedling growth and development in soybean genotypes.

Material and methods

A laboratory experiment was conducted at Central Phytotron Facility, Post Graduate Institute, Department of Agricultural-Botany, during *kharif*, 2017 in Completely Randomized Block Design (CRD) with two replications. The pure seeds of 20 soybean genotypes were obtained from Agricultural Research Station, Kasbe-Digraj, District-Sangli Maharashtra. Twenty genotypes were exposed to various temperature regimes *viz*; control (T1), day/night temperature regime $30^0C/25^0C$ (T2), $32^0C/27^0C$ (T3), $34^0C/29^0C$ (T4), and $36^0C/31^0C$ (T5) under phytotronic conditions for germination in growth chambers 1, 2, 3, 4, and 5 respectively. Ten seeds per replication were sown in Petri plates and were exposed to above temperature regimes upto 8 days and 10000 foot candle light and 1000 ppm CO_2 was provided. Hoagland solution was used for germination test as a nutrient medium. The thermo-treatments were given separately in different growth chambers as mentioned above. The seed surface was sterilized with 10% sodium hypo chloride solution for five minutes and washed three times with distilled water. For germination test, ten seeds of every genotype were sown separately in Petri dish covering by Whatman filter paper. The 5 ml of Hoagland solution was added in each petridish. The experiment was carried out in Completely Randomized Design with two replications for each experimental unit. Number of seeds germinated was counted from 2nd day and data was recorded upto 8th days. Shoot length and root length of seedling was recorded at 8th days after start of the experiment.

Five normal seedlings were selected randomly from each genotype and replication on 8th day. The shoot length was measured form the tip of the primary leaf to the base of the hypocotyle with the help of a scale and mean shoot length was expressed in centimeter.

After 8th day shoot length stress tolerance index (SLSTI) (%) for each genotype was worked out by using the following formula (Sammar Raza *et al.*, 2012) [7].

$$\text{SLSTI (\%)} = \frac{\text{Shoot length of stressed seedling (cm)}}{\text{Shoot length of control seedling (cm)}} \times 100$$

The five normal seedlings used for shoot length measurement, were also used for the measurement of root length. The root length was measured from the tip of the primary root to base of hypocotyl with the help of a scale and mean root length was expressed in centimeters.

After 8th day root length stress tolerance index (RLSTI) (%) for each genotype was worked out by using the following formula (Sammar Raza *et al.*, 2012) [7].

$$\text{RLSTI (\%)} = \frac{\text{Root length of stressed seedling (cm)}}{\text{Root length of control seedling (cm)}} \times 100$$

The five normal seedlings were used for shoot and root length measurement, and also used for the measurement of total seedling length. The seedling length was measured from the tip of the primary leaf to base of hypocotyl with the help of a scale and mean total seedling length was expressed in centimeters.

After 8th day seedling length stress tolerance index (TSLTI) (%) for each genotype was worked out by using the following formula (Sammar Raza *et al.*, 2012) [7].

$$\text{TSLTI (\%)} = \frac{\text{Seedling length of stressed plant (cm)}}{\text{Seedling length of control plant (cm)}} \times 100$$

The analysis of CRD was performed to test the significance of differences between the treatments for all the characters as per the methodology suggested by Panse and Sukhatme (1989) [5].

Results and discussion

Temperature plays a major role in determining the seed germination, root length, shoot length; seedling length, total seedling length and seedling dry weight. The data regarding shoot length (cm) and shoot length stress tolerance index (%) influenced by genotypes, temperature stress treatment and their interaction effects on 8th day are presented in Table 1. The differences among genotypes, temperature stress treatment and their interaction effects were statistically significant for shoot length (cm) and shoot length stress tolerance index (%) at 8th day. However, interaction effects were statistically non significant.

Among the different temperature stress treatments, day/night temperature regime $32/27^0C$ treatment recorded significantly maximum shoot length (4.44 cm) followed by day/night temperature regime $30/25^0C$ treatment (4.29 cm) whereas day/night temperature regime $36/31^0C$ treatment recorded significantly minimum shoot length (3.39 cm). Similarly among the genotypes DS-228 (5.96 cm) recorded significantly maximum shoot length followed by KDS-726 (5.86 cm) while genotype KDS-904 (2.14 cm) recorded significantly minimum shoot length on eighth day.

Among the different temperature stress treatments, day/night temperature regime $32/27^0C$ treatment recorded significantly maximum shoot length stress tolerance index percent (107.53%) followed by day/night temperature regime $30/25^0C$ treatment (103.45%) whereas day/night temperature regime $36/31^0C$ treatment recorded significantly minimum shoot length stress tolerance index percent (80.86%). Similarly among the genotypes KDS-904 (97.75%) recorded significantly maximum shoot length stress tolerance index percent followed by KDS-1032 (97.43%) while genotype KDS-344 (92.36%) recorded significantly minimum shoot length stress tolerance index percent on the eight day.

These results are in conformity with the findings of Simonneau *et al.* (1993) [8] wherein they also observed that drought and heat stress often decrease stem growth and plant height. When plants experience drought stress, stem diameter shrinks in response to changes in internal water status.

The data regarding the root length (cm) and root length stress tolerance index (%) influenced by genotypes, temperature stress treatment and their interaction effects on 8th day are depicted in Table 2. The differences among the genotypes, temperature stress treatment and their interaction effects were statistically significant for root length (cm) and root length stress tolerance index (%) at 8^{th} day.

Among the different temperature stress treatments, day/night temperature regime $36/31^{0}$C treatment recorded significantly maximum root length (4.31 cm) followed by day/night temperature regime $34/29^{0}$C treatment (3.86 cm) whereas control treatment recorded significantly minimum root length (2.64 cm). Similarly among the genotypes DS-228 (4.35 cm) recorded significantly maximum root length followed by JS-335 (4.18 cm) while genotype KDS-980 (2.27 cm) recorded significantly minimum root length on the eight day.

However, among the different interaction effects day/night temperature regime $36/31^{0}$C treatment on eighth day genotype DS-288 recorded significantly maximum root length (5.59 cm) followed by JS-335 (5.07 cm) whereas genotype KDS-980 recorded significantly minimum root length (1.42 cm) under control treatment.

Nonetheless among the different temperature stress treatments, day/night temperature regime $36/31^{0}$C treatment recorded significantly maximum root length stress tolerance index percent (173.15%) followed by day/night temperature regime $34/29^{0}$C treatment (153.79%) whereas control treatment recorded significantly minimum root length stress tolerance index (102.45%). Similarly among the genotypes KDS-1059 (178.76%) recorded significantly maximum root length stress tolerance index followed by KDS-980 (174.90%) while genotype KDS-726 (110.76%) recorded significantly minimum root length stress tolerance index on eighth day.

Eventually among the all interaction effects, day/night temperature regime $36/31^{0}$C treatment on eighth day genotype DS-288 recorded significantly maximum root length stress tolerance index (321.26%) followed by same genotype (285.63%) under day/night temperature regime $34/29^{0}$C whereas genotype KDS-869 recorded significantly minimum root length stress tolerance index (97.06%) under day/night temperature regime $30/25^{0}$C treatment. Similar results were also recorded by Saensee *et al.* (2012) [6] and they reported that the dry matter stress index, plant height stress index, root length stress index and germination stress index were significantly decreased with increase in water stress levels in all sunflower genotypes. They recorded that the genotype S473, S471 and S475 and hybrid Pacific 77 were drought tolerant and could be selected and used for general planting and further genetic improvement programs, whereas inbred lines: 5A, 6A, 9A and 10A were drought sensitive.

The data regarding to the seedling length (cm) and seedling length stress tolerence index (%) influenced by genotypes, temperature stress treatment and their interaction effects on 8^{th} day are depicted in Table 3. The differences among the genotypes, temperature stress treatment and their interaction effects were statistically significant for the seedling length (cm) and seedling length stress tolerence index (%).

Among the different temperature stress treatments, day/night temperature regime $32/27^{0}$C treatment recorded significantly maximum seedling length (7.81 cm) followed by day/night temperature regime $36/31^{0}$C treatment (7.70 cm) whereas control treatment recorded significantly minimum seedling length (6.80 cm). Similarly among the genotypes DS-228 (10.30 cm) recorded significantly maximum seedling length followed by KDS-726 (9.99 cm) while genotype KDS-904 (4.46 cm) recorded significantly minimum seedling length on the eight day.

However, among the different interactions day/night temperature regime $36/31^{0}$C treatment on eighth day genotype DS-288 recorded significantly maximum total seedling length (10.72 cm) followed by same genotype (10.47 cm) under day/night temperature regime $32/27^{0}$C whereas genotype KDS-904 recorded significantly minimum seedling length (3.73 cm) under control treatment.

Among the different temperature stress treatments, day/night temperature regime $32/27^{0}$C treatment recorded significantly maximum seedling length stress tolerance index percent (117.13%) followed by day/night temperature regime $36/31^{0}$C treatment (116.25%) whereas control treatment recorded significantly minimum seedling length stress tolerance index percent (103%). Similarly among the genotypes KDS-980 (125.14) recorded significantly maximum seedling length stress tolerance index percent followed by KDS-904 (124.51%) while genotype KDS-726 (100.20%) recorded significantly minimum seedling length stress tolerance index percent on the eight day.

Moreover, among the interaction effects day/night temperature regime $36/31^{0}$C treatment on eighth day genotype DS-288 (156.72%) recorded significantly maximum seedling length stress tolerence index (%) followed by same genotype (153.07%) under day/night temperature regime $32/27^{0}$C whereas genotype KDS-726 (97.72%) recorded significantly minimum seedling length stress tolerence index (%) under day/night temperature regime $36/31^{0}$C treatment. Thirty diverse genotypes of bread wheat were evaluated by Dhanda *et al.*, (2004) [2] and recorded seed vigour index, germination percentage, root length, shoot length, coleoptile length and osmotic membrane stability under laboratory conditions. They observed considerable variation for all the characters.

Table 1: Shoot length (cm) and shoot length stress tolerance index percent (SLSTI %) influenced by genotypes, diurnal temperature regimes and their interactions at 8th day

Genotypes	Shoot length (cm) on 8^{th} day					Mean (G)	Shoot l Shoot length stress tolerance index (%)				Mean (G)
	T_1	T_2	T_3	T_4	T_5		T_2	T_3	T_4	T_5	
KDS-1069	3.27	3.40	3.55	2.94	2.67	3.16	104.15	108.72	90.21	81.54	96.15
KDS-1024	3.19	3.35	3.47	2.82	2.54	3.07	105.20	108.70	88.24	79.60	95.43
KDS-1042	3.55	3.74	3.90	3.14	2.60	3.38	105.40	109.87	88.50	73.03	94.20
KDS-730	3.39	3.54	3.67	3.08	2.72	3.28	104.55	108.33	90.99	80.18	96.01
KDS-1032	5.09	5.25	5.45	4.77	4.37	4.99	103.07	107.10	93.73	85.81	97.43
KDS-1045	3.49	3.61	3.78	3.15	2.80	3.37	103.43	108.37	90.50	80.21	95.63
KDS-1095	3.36	3.53	3.72	3.04	2.74	3.27	105.30	111.27	90.86	81.67	97.27
KDS-1063	4.93	5.22	5.38	4.59	4.36	4.89	106.26	109.44	93.39	88.61	99.42
KDS-1059-A	3.61	3.71	3.87	3.21	2.98	3.47	102.92	107.25	89.04	82.67	95.47
KDS-992	5.06	5.19	5.33	4.70	4.03	4.86	102.56	105.40	92.79	79.54	95.07
KDS-980	2.44	2.61	2.78	2.18	1.80	2.36	107.16	114.31	89.53	73.70	96.17
KDS-921	3.61	3.73	3.85	3.17	2.79	3.43	103.22	106.65	87.83	77.27	93.74
KDS-904	2.18	2.27	2.48	2.07	1.69	2.14	104.30	114.27	94.95	77.48	97.75

KDS-344	5.32	6.19	6.28	5.43	4.86	5.78	116.35	118.04	102.06	91.35	92.36
KDS-726	6.17	6.27	6.42	5.47	4.97	5.86	101.68	104.00	88.65	80.47	93.70
KDS-753	5.03	5.07	5.18	4.53	4.31	4.82	100.75	103.07	90.04	85.62	94.87
JS-335	4.98	5.04	5.18	4.49	4.33	4.80	101.36	104.20	90.23	87.05	95.71
JS-9305	4.37	4.45	4.60	3.99	3.89	4.26	101.75	105.27	91.18	89.02	96.80
KDS-869	3.05	3.19	3.35	2.74	2.25	2.92	104.82	110.01	89.96	73.94	94.68
DS-228	5.10	6.39	6.50	5.42	5.14	5.96	125.29	127.45	106.27	100.78	92.38
Mean (T)	4.12	4.29	4.44	3.74	3.39	4.00	103.45	107.53	90.21	80.86	95.51
	Genotypes (G)		Treatments (T)		G X T		Genotypes (G)		Treatments (T)		G X T
SE(±)	0.05		0.02		0.10		1.96		0.88		3.99
CD @ 1%	0.19		0.09		NS		NS		3.28		NS

Note: Treatment (T), NS: Non-significant

T1: Control

T2: Day/Night temperature regime $30^0C/25^0C$

T3: Day/Night temperature regime $32^0C/27^0C$

T4: Day/Night temperature regime $34^0C/29^0C$

T5: Day/Night temperature regime $36^0C/31^0C$

Table 2: Root length (cm) and root length stress tolerance index percent (RLSTI %) influenced by genotypes, diurnal temperature regimes and their interactions at 8th day

Genotypes	**Root length (cm) on 8th day**					**Mean (G)**	**Root length stress tolerance index (%)**				**Mean (G)**
	T_1	**T_2**	**T_3**	**T_4**	**T_5**		**T_2**	**T_3**	**T_4**	**T_5**	
KDS-1069	1.70	1.80	2.73	3.43	4.21	2.77	105.89	160.39	201.21	247.55	178.76
KDS-1024	2.32	2.27	3.13	3.60	3.88	3.04	97.72	135.19	155.69	167.85	139.11
KDS-1042	1.74	1.82	2.89	3.55	3.74	2.75	104.08	167.00	204.79	215.60	172.87
KDS-730	2.21	2.32	3.36	3.80	4.18	3.17	104.57	151.81	171.80	189.10	154.32
KDS-1032	3.26	3.25	3.78	4.02	4.27	3.71	99.75	116.17	123.38	131.00	117.58
KDS-1045	2.54	2.60	3.16	3.55	3.91	3.15	102.42	124.53	139.73	153.78	130.12
KDS-1095	2.38	2.45	3.47	3.85	4.11	3.25	103.16	146.08	162.04	173.03	146.08
KDS-1063	3.30	3.40	3.75	4.16	4.45	3.81	102.98	113.60	125.94	134.90	119.36
KDS-1059-A	1.89	1.95	2.61	3.32	3.87	2.73	103.23	138.20	175.77	204.93	155.53
KDS-992	3.30	3.38	3.79	4.23	4.61	3.86	102.61	114.95	128.38	140.10	121.51
KDS-980	1.42	1.55	2.16	2.87	3.35	2.27	108.96	152.29	202.70	235.65	174.90
KDS-921	2.45	2.55	3.26	3.73	4.13	3.22	104.17	132.96	152.23	168.50	139.46
KDS-904	1.56	1.72	2.18	2.76	3.42	2.33	110.92	140.98	177.40	219.54	162.21
KDS-344	2.02	3.57	3.79	4.21	4.70	3.95	176.73	187.62	203.96	232.67	116.12
KDS-726	3.80	3.73	3.99	4.28	4.85	4.13	98.18	104.94	112.42	127.52	110.76
KDS-753	3.43	3.38	3.89	4.22	4.70	3.92	98.83	113.57	123.25	137.54	118.29
JS-335	3.39	3.45	4.32	4.66	5.07	4.18	101.66	127.13	137.18	149.43	128.85
JS-9305	2.39	2.48	3.71	3.89	4.66	3.42	103.92	155.04	162.55	194.76	154.07
KDS-869	2.49	2.42	3.60	4.08	4.61	3.44	97.06	144.45	163.47	185.35	147.58
DS-228	1.74	3.55	3.97	4.97	5.59	4.35	204.02	228.16	285.63	321.26	123.36
Mean (T)	2.64	2.68	3.37	3.86	4.31	3.37	102.45	132.79	153.79	173.15	140.54
	Genotypes (G)		Treatments (T)		G X T		Genotypes (G)	Treatments (T)			G X T
SE(±)	0.04		0.02		0.10		3.31	1.48			6.63
CD @ 1%	0.18		0.09		0.40		12.50	5.53			24.77

Note : Treatment (T), NS: Non-significant

T1: Control

T2: Day/Night temperature regime $30^0C/25^0C$

T3: Day/Night temperature regime $32^0C/27^0C$

T4: Day/Night temperature regime $34^0C/29^0C$

T5: Day/Night temperature regime $36^0C/31^0C$

Table 3: Total seedling length (cm) and total seedling length stress tolerance index percent (TSLSTI %) influenced by genotypes, diurnal temperature regimes and their interactions at 8th day

Genotypes	**Total seedling length (cm) on 8th day**					**Mean (G)**	**Total seedling length stress tolerance index (%)**				**Mean (G)**
	T_1	**T_2**	**T_3**	**T_4**	**T_5**		**T_2**	**T_3**	**T_4**	**T_5**	
KDS-1069	4.97	5.20	6.28	6.37	6.87	5.94	104.60	126.28	128.14	138.24	124.31
KDS-1024	5.51	5.62	6.60	6.42	6.42	6.11	101.90	119.68	116.42	116.33	113.58
KDS-1042	5.29	5.56	6.79	6.69	6.34	6.13	105.10	128.44	126.72	119.68	119.98
KDS-730	5.60	5.85	7.03	6.88	6.90	6.45	104.56	125.51	122.81	123.15	119.01
KDS-1032	8.35	8.50	9.23	8.79	8.64	8.70	101.75	110.53	105.20	103.47	105.24
KDS-1045	6.03	6.21	6.94	6.70	6.71	6.52	103.00	115.18	111.23	111.20	110.16
KDS-1095	5.73	5.98	7.18	6.89	6.85	6.52	104.40	125.71	120.35	119.63	117.52
KDS-1063	8.23	8.62	9.13	8.75	8.81	8.71	104.93	111.12	106.43	107.25	107.43
KDS-1059-A	5.49	5.66	6.48	6.53	6.85	6.20	103.04	117.89	118.86	124.70	116.12
KDS-992	8.36	8.57	9.12	8.93	8.63	8.72	102.60	109.15	106.83	103.36	105.49
KDS-980	3.85	4.16	4.94	5.05	5.14	4.63	107.84	128.28	131.08	133.37	125.14
KDS-921	6.06	6.28	7.11	6.90	6.92	6.65	103.55	117.25	113.86	114.11	112.19
KDS-904	3.73	3.99	4.66	4.82	5.11	4.46	106.86	125.27	129.22	136.70	124.51
KDS-344	7.34	9.76	10.07	9.64	9.56	9.73	132.97	137.19	131.33	130.24	100.97
KDS-726	9.97	10.01	10.41	9.75	9.82	9.99	100.33	104.35	97.72	98.42	100.20

KDS-753	8.46	8.45	9.07	8.75	9.00	8.74	99.96	107.31	103.45	106.59	104.33
JS-335	8.37	8.49	9.50	9.15	9.40	8.98	101.48	113.49	109.27	112.35	109.15
JS-9305	6.76	6.93	8.31	7.87	8.55	7.68	102.51	122.86	116.42	126.41	117.05
KDS-869	5.54	5.61	6.95	6.82	6.86	6.35	101.33	125.49	123.04	124.04	118.47
DS-228	6.84	9.94	10.47	10.39	10.72	10.30	145.32	153.07	151.90	156.72	103.72
Mean (T)	6.80	6.97	7.81	7.60	7.70	7.38	103.00	117.13	114.53	116.25	112.73
	Genotypes (G)		**Treatments (T)**		**G X T**		**Genotypes (G)**		**Treatments (T)**		**G X T**
SE(±)	0.07		0.03		0.15		1.78		0.79		3.57
CD @ 1%	0.26		0.13		0.58		6.73		2.98		13.33

Note: Treatment (T), T1: Control, T2: Day/Night temperature regime $30^0C/25^0C$, T3: Day/Night temperature regime $32^0C/27^0C$, T4: Day/Night temperature regime $34^0C/29^0C$, T5: Day/Night temperature regime $36^0C/31^0C$, NS: Non-significant

References

1. Batts GR, Ellis RH, Morison JIL, Nkemka PN, Gregory PJ, Hadley P. Yield and partitioning of crops of contrasting cultivars of winter wheat in response to CO2 and temperature in field studies using temperature gradient tunnels. J Agric. Sci. 1998; 130:17-27.
2. Dhanda SS, Sethi GS, Behl RK. Indices of drought tolerance in wheat genotypes at early stages of plant growth. J Agron. Crop Sci. 2004; 190:6-12.
3. Dornbos DL, Mullen RE. Influence of stress during soybean seed fill on seed weight, germination, and seedling growth rate. J Plant Sci. 1991; 71:373-383.
4. Dornbos DL. Production environment and seed quality. In A.S. Basra (ed.) Seed quality: Basic mechanisms and agricultural implications. Food Products Press, New York, 1995, 119-149.
5. Panse VG, Sukhatme PV. Statistical methods for Agril.Workers, ICAR, New Delhi, 1989.
6. Saensee K, Machikowa T, Muangsan N. Comparative performance of sunflower synthetic varieties under drought stress. Int. J Agric. Biol. 2012; 14:929-934.
7. Sammar Raza MA, Saleem MF, Khan IH, Jamil M, Ijaz M, Khan MA. Evaluating the drought stress tolerance efficiency of wheat (*Triticum aestivum* L.) cultivars. Russian J Agri. and Socio-Econ. Sci. 2012; 12(12):41-47.
8. Simonneau T, Habib R, Goutouly JP, Buguet JG. Diurnal changes in stem diameter depend upon variation in water content: Direct evidence from peach trees. J Exp. Bot. 1993; 44:615-621.
9. Wilson RF. Seed composition. In H.R. Boerma and J.E. Specht (ed.) Soybeans: Improvement, production, and uses. 3rd ed. ASA, CSSA, SSSA, Madison, WI, 2004, 521-677.