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MK Rathod
Department of Agricultural-Botany, Post Graduate Institute, Mahatma Phule Krishi Vidyapith, Rahuri-Ahmednagar, Maharashtra, India

RW Bharud
Department of Agricultural-Botany, Post Graduate Institute, Mahatma Phule Krishi Vidyapith, Rahuri-Ahmednagar, Maharashtra, India

SS Kakde
Department of Agricultural-Botany, College of Agricultural, Jalna, VNMKV, Parbhani, Maharashtra, India

Corresponding Author:
MK Rathod
Department of Agricultural-Botany, Post Graduate Institute, Mahatma Phule Krishi Vidyapith, Rahuri-Ahmednagar, Maharashtra, India

Effect of temperature stress on soybean [*Glycine max* (L.) Merrill] genotypes morphology

MK Rathod, RW Bharud and SS Kakde

Abstract
Temperature is an environmental factor that has a considerable influence on crop morphology. It significantly affects the plant height, number of branches and leaves. A pot 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 in growth chambers 1, 2, 3, 4, and 5 respectively. Five seeds per replication were sown in pots and were exposed to above temperature regimes and 10000 foot candle light and 1000 ppm CO_2 was provided. Plant height is important and visible measure of plant growth. Among the genotypes DS-228 (30.89 cm) recorded significantly maximum plant height followed by JS-9305 (29.90 cm) while genotype KDS-980 (20.63 cm) recorded significantly minimum plant height at 30 DAE. Similarly at 60 DAE among the different temperature stress treatments, day/night temperature regime 32/27 ^{0}C treatment recorded significantly maximum number of leaves plant-1 (47.77) followed by day/night temperature regime 30/25 ^{0}C treatment (47.12) whereas day/night temperature regime 36/31 ^{0}C treatment recorded significantly minimum number of leaves plant-1 (46.27).

Keywords: Morphology, 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. Temperature and photoperiod predominantly affect morphological and physiological growth and development of soybean plant among other environmental variables. While the phenological response to temperature can primarily determine soybean variety selection for cultivation in a given geographical location during early growth stages with little interaction of photoperiod, however, photoperiod modifies the response to temperature with changing geographical locations and therefore serves as a basis for classifying the cultivars by maturity group (Heatherly *et al.*, 2004) [5]. 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) [7].
Batwal *et al.* (2004) [2] also reported that as the sowing was delayed there was reduction in plant height. The reason for increased plant height in early sowing may be the enhanced vegetative development of crop due to the favorable weather condition, particularly favorable rainfall and hence soil moisture regime throughout the growing period that facilitated better shoot growth. Board and Settimmi (1986) [4] studied effect of photoperiod prior to flowering and after flowering on branch development in determinant soybean at South Eastern United States of America and found that number of branches has positive correlation with seed yield. Arora (1981) [1] reported that in soybean number of leaves per plant were reduced with delay in sowing. Therefore considering all those factors the present investigation was carried out to understand the effect of temperature stress on crop morphology.

Material and Methods
A pot 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 ^{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. Five seeds per replication were sown in Pots and were exposed to above temperature regimes and 10000 foot candle light and 1000 ppm CO_2 was provided.

Hoagland solution was used 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. The experiment was carried out in Completely Randomized Design with two replications for each experimental unit. Four to five seedlings were grown in pots having growth media of clay, cocopit and vermiculite or perlite. (2:1:1).

To record growth observations three plants were randomly selected from each pot, in all the replications. Plant height of three randomly selected observation plants from each plot was recorded in cm by measuring from the base of plant near the ground up to apex of the main stem at 30, 60, 90 DAS. The number of primary branches and leaves were recorded at 30, 60, 90 DAS.

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) [6].

Results and Discussion

Plant height is important and visible measure of plant growth. Plant height is a function of internodal elongation and leaf emergence. Since leaves are born on stem, leaf area development and biomass production shows a close relationship with plant height. The data regarding mean plant height (cm) influenced by genotypes, temperature stress treatment and their interaction effects were statistically significant at 30, 60 and 90 DAS are presented in Table 1.

At 30 DAE among the different temperature stress treatments, day/night temperature regime 32/27 ^{0}C treatment recorded significantly maximum plant height (25.93 cm) followed by day/night temperature regime 30/25 ^{0}C treatment (25.49 cm) whereas day/night temperature regime 36/31 ^{0}C treatment recorded significantly minimum plant height (23.56 cm). Similarly among the genotypes DS-228 (30.89 cm) recorded significantly maximum plant height followed by JS-9305 (29.90 cm) while genotype KDS-980 (20.63 cm) recorded significantly minimum plant height.

Similarly, among the interaction effects genotype DS-228 (31.13 cm) recorded significantly maximum plant height under day/night temperature regime 32/27 ^{0}C while genotype KDS-980 (18.74 cm) recorded significantly minimum plant height under day/night temperature regime 36/31 ^{0}C.

At 60 DAE among the different temperature stress treatments, day/night temperature regime 32/27 ^{0}C treatment recorded significantly maximum plant height (47.83 cm) followed by day/night temperature regime 30/25 ^{0}C treatment (47.67 cm) whereas day/night temperature regime 36/31 ^{0}C treatment recorded significantly minimum plant height (46.24 cm). Similarly among the genotypes KDS-753 (57.71 cm) recorded significantly maximum plant height followed by KDS-726 (54.98 cm) while genotype KDS-1095 (40.92 cm) recorded significantly minimum plant height.

Similarly, among the interaction effects genotype KDS-753 (58.98 cm) recorded significantly maximum plant height at 60 DAE under control condition followed by same genotype under day/night temperature regime 36/31 ^{0}C while genotype KDS-1095 (39.66 cm) recorded significantly minimum plant height under day/night temperature regime 36/31 ^{0}C.

At 90 DAE among the different temperature stress treatments, day/night temperature regime 30/25 ^{0}C treatment recorded significantly maximum plant height (55.91 cm) followed by control treatment (55.77 cm) whereas day/night temperature regime 36/31 ^{0}C treatment recorded significantly minimum plant height (53 cm). Similarly among the genotypes KDS-753 (66.41 cm) recorded significantly maximum plant height followed by JS-335 (62.57 cm) while genotype KDS- 1045 (46.70 cm) recorded significantly minimum plant height.

Nonetheless among the interaction effect genotype KDS-753 (68.80 cm) recorded significantly maximum plant height at 90 DAE under day/night temperature regime 30/25 ^{0}C while genotype KDS-1045 (44.95 cm) recorded significantly minimum plant height under day/night temperature regime 36/31 ^{0}C. Studies in the past have determined genotypic variability in phenological responses to temperatures for the traits such as germination, plant height, node number, net photosynthesis, leaf area, and fruit number per plant by either varying the planting date in the field or utilizing controlled-environment facilities (Tacarindua *et al.*, 2013) [8].

The differences among the genotypes, treatments and interaction effects were statistically significant in respect of number of branches per plant at 30, 60 and 90 DAS and depicted in Table 2.

At 30 DAE among the different temperature stress treatments, day/night temperature regime 32/27 ^{0}C treatment recorded significantly maximum number of branches plant-1 (1.62) followed by day/night temperature regime 30/25 ^{0}C treatment (1.60) whereas control treatment recorded significantly minimum number of branches plant-1 (1.48). Similarly among the genotypes DS-228 (2.53) recorded significantly maximum number of branches plant-1 followed by KDS-726 (2.20) while genotype KDS-904 (1.13) recorded significantly minimum number of branches plant-1. Similarly among the interaction effects day/night temperature regime 30/250C genotype DS-288 (2.67) recorded significantly maximum number of branches per plant whereas genotype KDS-980 (1.33) recorded significantly minimum number of branches per plant under day/night temperature regime 36/31 ^{0}C at 60 DAE.

At 60 DAE among the different temperature stress treatments, day/night temperature regime 32/27 ^{0}C treatment recorded significantly maximum number of branches plant-1 (2.85) followed by day/night temperature regime 30/25 ^{0}C treatment (2.60) whereas day/night temperature regime 36/31 ^{0}C recorded significantly minimum number of branches plant-1 (2.29). Similarly among the genotypes DS-228 (3.75) recorded significantly maximum number of branches plant-1 followed by KDS-344 (3.26) while genotype KDS-980 (1.42) recorded significantly minimum number of branches plant-1.

At 90 DAE among the different temperature stress treatments, day/night temperature regime 32/27 ^{0}C treatment recorded significantly maximum number of branches plant^{-1} (4.67) followed by day/night temperature regime 30/25 ^{0}C treatment (4.39) whereas day/night temperature regime 36/31 ^{0}C recorded significantly minimum number of branches plant^{-1} (3.98). Similarly among the genotypes DS-228 (6.40) recorded significantly maximum number of branches plant^{-1} followed by KDS-344 (6) while genotype KDS-980 (3.33) recorded significantly minimum number of branches plant^{-1}. The decreasing trend of number of branches was observed as temperature treatment increased. Board and Settimmi (1986) [4] also studied the effect of photoperiod prior to flowering and after flowering on branch development in determinant soybean at South Eastern United States of America and they also found the similar results that number of branches has positive correlation with seed yield.

The differences in respect of leaves number per plant among the genotypes, treatments and interaction effects were statistically significant at 30, 60 and 90 DAS and depicted in Table 3.

At 30 DAE among the different temperature stress treatments, day/night temperature regime 32/27 ^{0}C treatment recorded significantly maximum number of leaves plant-1 (16.80) followed by day/night temperature regime 36/31 ^{0}C treatment (16.70) whereas control treatment recorded significantly minimum number of leaves plant-1 (16.33). Similarly among the genotypes DS-228 (20.33) recorded significantly maximum number of leaves plant-1 followed by KDS-726 (19.63) while genotype KDS-980 (13.63) recorded significantly minimum number of leaves plant-1.

At 60 DAE among the different temperature stress treatments, day/night temperature regime 32/27 ^{0}C treatment recorded significantly maximum number of leaves plant-1 (47.77) followed by day/night temperature regime 30/25 ^{0}C treatment (47.12) whereas day/night temperature regime 36/31 ^{0}C treatment recorded significantly minimum number of leaves plant-1 (46.27). Similarly among the genotypes DS-228 (51.14) recorded significantly maximum number of leaves plant-1 followed by KDS-344 (50.53) while genotype KDS-904 (44.13) recorded significantly minimum number of leaves plant-1. Whereas among the interaction effects under day/night temperature regime 34/29 ^{0}C genotype DS-288 (20.67) recorded significantly maximum number of leaves per plant whereas genotype KDS-904 (43.50) recorded significantly minimum number of leaves per plant under day/night temperature regime 36/31 ^{0}C at 60 DAE.

At 90 DAE among the different temperature stress treatments, day/night temperature regime 32/27 ^{0}C treatment recorded significantly maximum number of leaves plant-1 (19.78) followed by day/night temperature regime 30/25 ^{0}C treatment (19.18) whereas day/night temperature regime 36/31 ^{0}C treatment recorded significantly minimum number of leaves plant-1 (15.44). Similarly among the genotypes KDS-1045 (26.30) recorded significantly maximum number of leaves plant-1 followed by KDS-1024 (26.07) while genotype KDS-344 (12.30) recorded significantly minimum number of leaves plant-1.

Moreover among the interaction effects genotype KDS-753 recorded significantly maximum number of leaves plant-1 under day/night temperature regime 32/27 ^{0}C at 90 DAE. The stress at vegetative phase has been reported to decline photosynthesis, leaf area and biomass and once the stress is over, plant can recover to a certain extent. However, stress at reproductive stage is known to influence reproductive processes such as abortion of flowers, reproductive efficiency, development of seeds and young pods. Also, stress at reproductive phase has often no chance of recovery and hence, results in severe loss of soybean productivity (Bhatia and Jumrani, 2016).

Table 1: Plant height (cm) influenced by genotypes, diurnal temperature regimes and their interactions at 30 60 and 90 days after emergence (DAE)

Genotypes	30 DAE					Mean (G)	60 DAE					Mean (G)	90 DAE					Mean (G)
	T_1	T_2	T_3	T_4	T_5		T_1	T_2	T_3	T_4	T_5		T_1	T_2	T_3	T_4	T_5	
KDS-1069	22.94	23.18	23.95	22.19	21.04	22.66	44.06	45.07	45.78	42.24	41.10	43.65	51.60	51.95	51.10	50.60	48.85	50.82
KDS-1024	24.37	25.00	25.50	23.90	21.87	24.13	49.18	49.73	50.03	48.07	47.61	48.92	56.30	56.80	55.85	55.00	53.95	55.58
KDS-1042	22.84	23.05	23.33	22.05	20.77	22.41	51.75	52.87	51.80	51.04	49.65	51.42	58.25	59.35	56.60	54.30	52.20	56.14
KDS-730	25.05	25.17	25.55	24.25	21.82	24.37	44.19	44.71	45.07	42.23	41.25	43.49	53.25	52.15	52.10	50.90	50.00	51.68
KDS-1032	26.15	26.65	27.12	25.16	22.88	25.59	52.37	51.80	52.37	51.21	50.07	51.56	53.20	54.20	52.70	52.10	51.15	52.67
KDS-1045	22.89	23.51	23.80	21.87	20.77	22.57	41.81	42.80	42.52	40.87	40.54	41.71	46.85	47.70	48.05	45.95	44.95	46.70
KDS-1095	24.04	24.34	24.77	23.54	22.60	23.86	41.33	41.62	41.80	40.21	39.66	40.92	57.00	58.35	55.70	54.70	52.90	55.73
KDS-1063	26.04	26.45	27.07	25.09	22.81	25.49	47.33	45.95	46.88	46.83	45.33	46.46	50.95	50.25	51.90	50.80	49.80	50.74
KDS-1059-A	22.29	22.90	23.18	21.41	20.61	22.08	43.79	43.15	43.08	43.30	41.98	43.06	56.35	57.55	54.70	52.20	50.10	54.18
KDS-992	23.83	24.42	25.27	23.08	21.78	23.68	52.32	51.83	52.47	50.61	49.75	51.40	53.75	52.90	53.20	52.65	52.40	52.98
KDS-980	20.96	21.58	21.95	19.91	18.74	20.63	45.00	44.63	44.75	44.28	42.54	44.24	51.85	50.95	51.60	51.15	49.95	51.10
KDS-921	23.66	24.05	24.52	23.11	22.01	23.47	44.74	45.29	45.78	44.20	43.09	44.62	54.10	52.85	54.80	53.05	52.70	53.50
KDS-904	22.13	22.44	22.82	21.83	19.98	21.84	43.10	44.02	44.50	41.81	41.32	42.95	53.90	54.50	53.10	52.10	50.85	52.89
KDS-344	27.39	27.50	27.88	27.16	27.27	27.44	51.19	50.66	51.45	51.57	52.19	51.41	57.90	57.05	56.80	56.15	55.05	56.59
KDS-726	27.14	27.57	28.07	27.29	27.36	27.49	54.55	55.08	55.43	54.82	55.03	54.98	62.10	61.10	63.10	62.10	61.05	61.89
KDS-753	27.04	27.68	27.95	27.51	27.56	27.55	57.56	58.98	55.70	58.01	58.29	57.71	68.20	68.80	67.00	65.00	63.05	66.41
JS-335	26.99	27.31	27.87	27.27	27.49	27.39	40.84	41.21	40.60	41.03	41.14	40.96	63.95	63.20	63.45	62.05	60.20	62.57
JS-9305	29.64	29.94	30.33	29.73	29.84	29.90	42.83	43.31	43.58	42.89	42.93	43.11	51.00	52.20	50.40	50.20	49.00	50.56
KDS-869	25.55	26.02	26.48	25.03	23.21	25.26	51.75	52.22	53.07	50.70	49.87	51.52	56.35	57.35	55.80	55.25	54.60	55.87
DS-228	30.68	30.98	31.13	30.79	30.86	30.89	51.02	50.46	49.92	51.30	51.59	50.86	58.50	59.00	58.85	58.20	57.25	58.36
Mean (T)	25.08	25.49	25.93	24.61	23.56	24.93	47.53	47.67	47.83	46.86	46.24	47.23	55.77	55.91	55.34	54.22	53.00	54.85
	Genotypes (G)		Treatments (T)		G x T		Genotypes (G)		Treatments (T)		G x T		Genotypes (G)		Treatments (T)		G x T	
SE(±)	1.23		0.22		2.62		0.67		0.39		1.36		0.94		0.50		1.85	
CD @ 1%	4.72		085		7.59		2.20		1.53		5.19		3.49		1.95		6.43	

Note: DAE : Days after emergence, Treatment (T) T1 : Control, T2 : Day/Night temperature regime 30 ^{0}C/25 ^{0}C, T3 : Day/Night temperature regime 32 ^{0}C/27 ^{0}C,
T4 : Day/Night temperature regime 34 ^{0}C/29 ^{0}C, T5 : Day/Night temperature regime 36 ^{0}C/31 ^{0}C,

Table 2: Number of primary braches per plant influenced by genotypes, diurnal temperature regimes and their interactions at 30 60 and 90 DAE

Genotypes	30 DAE					Mean (G)	60 DAE					Mean (G)	90 DAE					Mean (G)
	T_1	T_2	T_3	T_4	T_5		T_1	T_2	T_3	T_4	T_5		T_1	T_2	T_3	T_4	T_5	
KDS-1069	1.50	1.67	1.67	1.33	1.50	1.53	2.50	2.67	2.83	2.33	2.17	2.25	4.17	4.33	4.67	4.00	3.83	4.20
KDS-1024	1.33	1.50	1.67	1.17	1.33	1.40	2.17	2.50	2.83	2.17	2.00	2.09	4.17	4.33	4.67	4.00	3.83	4.20
KDS-1042	1.50	1.50	1.67	1.50	1.50	1.53	2.33	2.50	2.67	2.00	1.83	1.92	4.00	4.33	4.50	4.00	3.83	4.13
KDS-730	1.50	1.67	1.50	1.33	1.50	1.50	2.33	2.50	2.67	2.33	2.17	2.25	4.00	4.33	4.67	3.83	3.67	4.10
KDS-1032	1.33	1.50	1.33	1.50	1.33	1.40	2.67	3.00	3.17	2.67	2.50	2.59	3.67	4.00	4.67	3.50	3.33	3.83
KDS-1045	1.33	1.50	1.67	1.17	1.33	1.40	2.33	2.50	2.83	2.17	2.00	2.09	4.00	4.33	4.50	3.83	3.83	4.10
KDS-1095	1.33	1.50	1.50	1.33	1.50	1.43	2.33	2.67	2.83	2.33	2.17	2.25	3.67	3.83	4.17	3.50	3.33	3.70
KDS-1063	1.33	1.17	1.50	1.50	1.33	1.37	2.50	2.67	2.83	2.50	2.33	2.42	4.00	4.17	4.50	4.00	3.83	4.10
KDS-1059-A	1.33	1.50	1.67	1.17	1.33	1.40	2.33	2.67	3.00	2.17	2.17	2.17	3.67	4.00	4.33	3.50	3.33	3.77
KDS-992	1.33	1.50	1.67	1.33	1.33	1.43	2.33	2.50	2.67	2.33	2.17	2.25	3.83	4.17	4.50	3.67	3.50	3.93
KDS-980	1.17	1.33	1.17	1.17	1.17	1.20	1.67	1.83	2.00	1.50	1.33	1.42	3.33	3.50	3.67	3.17	3.00	3.33
KDS-921	1.33	1.50	1.33	1.17	1.33	1.33	2.17	2.33	2.50	2.00	1.83	1.92	4.00	4.17	4.33	3.83	3.67	4.00
KDS-904	1.17	1.33	1.00	1.00	1.17	1.13	1.83	2.00	2.17	1.67	1.67	1.67	3.50	3.83	4.00	3.33	3.33	3.60
KDS-344	1.50	2.17	2.33	2.17	2.50	2.13	3.50	3.34	3.84	3.34	3.17	3.26	6.00	6.00	6.50	5.83	5.67	6.00
KDS-726	2.33	2.33	2.00	2.17	2.17	2.20	3.33	2.67	3.67	3.33	3.17	3.25	4.67	4.83	5.00	5.00	5.17	4.93
KDS-753	1.33	1.50	1.33	1.50	1.33	1.40	2.17	2.17	2.33	2.17	2.00	2.09	3.50	3.67	3.83	3.33	3.17	3.50
JS-335	1.67	1.83	2.00	1.67	1.83	1.80	2.67	2.83	3.00	2.83	2.67	2.75	4.67	5.00	5.17	5.00	4.83	4.93
JS-9305	1.50	1.50	1.67	1.50	1.50	1.53	2.50	2.67	2.83	2.67	2.67	2.67	4.67	4.83	5.17	4.83	4.83	4.87
KDS-869	1.33	1.17	1.33	1.33	1.33	1.30	2.00	2.17	2.33	2.00	1.83	1.92	3.50	3.67	3.83	3.33	3.17	3.50
DS-228	2.50	2.67	2.50	2.50	2.50	2.53	3.67	3.83	4.00	3.83	3.67	3.75	6.17	6.50	6.67	6.33	6.33	6.40
Mean (T)	1.48	1.60	1.62	1.49	1.54	1.55	2.47	2.60	2.85	2.42	2.29	2.36	4.16	4.39	4.67	4.10	3.98	4.26
	Genotypes (G)		Treatments (T)		G x T		Genotypes (G)		Treatments (T)		G x T		Genotypes (G)		Treatments (T)		G x T	
SE(±)	0.40		0.18		0.54		0.21		0.12		0.34		0.27		0.20		0.42	
CD @ 1%	1.52		0.69		2.86		0.76		0.47		1.20		0.92		0.79		1.28	

Note: DAE : Days after emergence, Treatment (T) T1 : Control, T2 : Day/Night temperature regime 30 ^{0}C/25 ^{0}C, T3 : Day/Night temperature regime 32 ^{0}C/27 ^{0}C,
T4 : Day/Night temperature regime 34 ^{0}C/29 ^{0}C, T5 : Day/Night temperature regime 36 ^{0}C/31 ^{0}C,

Table 3: Number of leaves per plant influenced by genotypes, diurnal temperature regimes and their interactions at 30 60 and 90 days after emergence (DAE)

Genotypes	30 DAE					Mean (G)	60 DAE					Mean (G)	90 DAE					Mean (G)
	T_1	T_2	T_3	T_4	T_5		T_1	T_2	T_3	T_4	T_5		T_1	T_2	T_3	T_4	T_5	
KDS-1069	18.33	18.33	19.00	18.50	19.00	18.63	47.33	47.50	47.83	46.67	46.33	47.13	21.67	22.83	23.67	20.00	18.00	21.23
KDS-1024	18.00	18.17	18.83	18.50	18.50	18.40	46.33	46.67	48.00	46.17	45.83	46.60	26.00	27.67	28.50	25.00	23.17	26.07
KDS-1042	16.00	16.17	16.67	16.17	16.50	16.30	46.50	46.67	47.83	46.17	45.67	46.57	17.00	17.83	18.67	16.00	14.83	16.87
KDS-730	17.50	18.00	17.83	17.67	18.00	17.80	46.00	46.17	47.50	45.33	45.00	46.00	16.83	17.67	18.33	16.00	14.00	16.57
KDS-1032	15.50	15.83	16.00	15.67	15.50	15.70	45.83	46.00	46.50	45.50	45.17	45.80	21.00	22.17	22.83	19.67	18.17	20.77
KDS-1045	14.33	14.83	15.00	14.83	14.83	14.76	46.50	46.67	47.67	46.17	45.33	46.47	26.67	27.67	28.17	25.83	23.17	26.30
KDS-1095	15.50	15.83	15.67	15.67	15.50	15.63	46.00	46.17	46.50	45.67	45.17	45.90	17.83	18.83	18.33	17.00	15.83	17.56
KDS-1063	15.33	15.67	16.00	15.67	15.67	15.67	46.33	46.67	47.17	45.84	45.50	46.30	17.67	18.50	19.00	16.83	15.67	17.53
KDS-1059-A	14.17	14.67	14.83	14.50	14.67	14.57	46.00	46.17	46.67	45.67	45.33	45.97	17.00	18.00	18.50	16.00	14.83	16.87
KDS-992	15.00	15.17	15.50	15.67	15.67	15.40	46.00	46.17	47.00	45.33	45.00	45.90	18.17	19.17	20.00	16.83	14.83	17.80
KDS-980	13.50	13.50	13.83	13.67	13.67	13.63	44.83	45.17	45.50	45.00	44.50	45.00	19.00	19.83	20.17	17.83	15.00	18.37
KDS-921	14.00	14.33	14.17	14.50	14.33	14.27	46.00	46.00	46.83	45.50	45.17	45.90	17.00	17.83	18.17	15.67	14.67	16.67
KDS-904	13.83	13.83	14.00	14.00	14.17	13.97	44.17	44.33	44.83	43.84	43.50	44.13	17.17	17.83	18.50	16.00	14.83	16.87
KDS-344	19.67	20.17	20.17	20.33	20.50	20.17	50.17	51.33	51.33	49.83	50.00	50.53	13.00	13.17	13.50	12.00	9.83	12.30
KDS-726	19.50	20.00	19.83	19.50	19.33	19.63	49.83	50.17	50.83	49.34	49.34	49.90	15.50	16.00	16.83	15.00	13.00	15.27
KDS-753	15.17	15.67	15.50	15.67	15.33	15.47	45.83	46.00	46.17	45.50	45.17	45.73	19.17	19.83	20.50	18.00	17.84	19.07
JS-335	18.83	19.17	19.00	19.00	19.33	19.07	47.83	48.00	48.67	48.00	48.17	48.13	16.67	17.00	17.67	14.83	11.83	15.60
JS-9305	16.50	17.50	17.17	17.00	17.00	17.03	49.00	49.17	49.33	49.17	49.17	49.17	16.00	16.83	17.50	14.67	12.83	15.57
KDS-869	16.00	16.00	16.50	16.17	16.17	16.17	46.00	46.33	47.00	45.83	45.17	46.07	17.50	17.67	18.50	16.83	14.83	17.07
DS-228	19.83	20.33	20.50	20.67	20.33	20.33	50.67	51.00	52.17	50.84	51.00	51.14	16.00	17.17	18.33	14.83	11.67	15.60
Mean (T)	16.33	16.66	16.80	16.67	16.70	16.63	46.86	47.12	47.77	46.57	46.27	46.92	18.33	19.18	19.78	17.24	15.44	17.99
	Genotypes (G)		Treatments (T)		G x T		Genotypes (G)		Treatments (T)		G x T		Genotypes (G)		Treatments (T)		G x T	
SE(±)	0.52		0.24		1.06		0.41		0.22		0.75		0.59		0.33		1.06	
CD @ 1%	2.01		0.94		3.87		1.52		0.85		2.46		2.16		1.30		3.89	

Note: DAE: Days after emergence, Treatment (T) T1 : Control, T2 : Day/Night temperature regime 30 ^{0}C/25 ^{0}C, T3 : Day/Night temperature regime 32 ^{0}C/27 ^{0}C,
T4: Day/Night temperature regime 34 ^{0}C/29 ^{0}C, T5 : Day/Night temperature regime 36 ^{0}C/31 ^{0}C,

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