Determination of the High Temperature Stress Tolerances of Bread Wheat Genotypes

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Abstract: Thirty bread wheat genotypes were used as material during the 2014-2015 cropping season. The experimental layout was a randomized complete block design with 3 replications. The sowing rate was 500 seeds square meter. Sowing was done in plots of 6 rows (1.2 m × 5 m, spaced 20 cm apart) in Namık Kemal University, Faculty of Agriculture, Field Crops Department experimental area. Two sowing times were performed. First sowing was made in November suggested usual (standard) and second one was made in January as delayed sown in order to push growing stages of plants into periods in which heat stress is expected will be effected. Sowing times were allotted to main-plots while genotypes were allotted to sub-plots. When the bread wheat varieties and lines used in the experiment are evaluated in terms of tolerance to high temperature, it was shown that Dropia and Nota varieties and CIMMYT-HTN 2014/15-2, CIMMYT-HTN 2014/15-6, CIMMYT-HTN 2014/15-10 lines were better tolerance to high temperature. However, it was noticed that these genotypes were not included in the first groups in terms of grain yield. It is possible to utilize these genotypes as a genitor in cross-breeding programs for breeding studies for tolerance to high temperatures.

Key words: Heat tolerance, bread wheat, advanced lines, heat sensitive.

1. Introduction

Adaptation to environmental stresses arises in the result of interrelated events emerging at the anatomical, morphological, biochemical and molecular levels. The growth and development of the plants have a great importance for the temperature and hence the water. The high temperature in the growth environment causes the degradation of the naturalness of proteins, the loss of enzyme activity and the alteration of cell structure and function. Thus, vegetation development and growth are affected negatively in plants exposed to these conditions [1].

Determination of the effects of mechanisms which are effective for tolerance to high temperature in plants is of great importance. The increased temperature negatively affects the different phases of plant growth [2]. In addition to mechanisms that tolerate high temperatures in plants, there are important factors that limit the development of stress

tolerance in plants. These factors are complex events involving morphological, physiological and biochemical parameters among genotypes, and some shortcomings in increasing the efficiency of selection using all agronomic parameters [3] and the lack of effective methods for screening genotypes in breeding programs [4]. Because of the genotypic differences between and within species, plants respond differently to increasing temperatures [5]. These genotypic response differences are important for plant breeding in terms of environmental stresses [6].

In the developmental process of the wheat plant, it has been reported that the decrease in yield, which is caused by the high temperature stress, is related to the number of grain and grain weight per spike reduction [7-11].

Sowing time is particularly important for wheat produced in areas that do not have irrigation. Late sown crops are exposed to high temperatures during developments of growth [12], high temperatures during the seeding and grain filling stages accelerate maturing, and cause significant reductions in grain

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size and weight [13]. At higher temperatures than optimal, grain yields have been reported to decline and quality degradation has been reported in cereals [12, 14-16]. All over the world, researchers have concentrated their efforts on the identification and development of high temperature tolerant genotypes [16-25].

In this research, it was aimed to determine the effect of high temperature stress on bread wheat in Trakya Region, selection criteria that can be used in high temperature tolerance wheat breeding studies and tolerant wheat genotypes.

2. Materials and Methods

The research was carried out in Namık Kemal University, Faculty of Agriculture, Field Crops Department Application and Research Area during 2014-2015 growing season. In the study, the experiments were set up at two sowing times in order to create heat stress. These are Standard and late sowing. First sowing was made in November suggested usual (standard) and second one was made in January as delayed sown in order to push growing stages of plants into periods in which heat stress is expected will be effected.

The total temperatures between heading and maturing were 915.4 °C for the standard sowing and 1,084.8 °C for late sowing. The total temperature difference of heading and maturing stages between the standard and late sown was 169.4 °C.

2.1 Material

A total of 30 bread wheat (*Triticum aestivum* L.) genotypes including 15 bread wheat varieties with different phenological characteristics (early, middle early, late) (Nota, Kate A1, Basribey, Gelibolu, Esperia, Saraybosna, Syrena, Flamura 85, Krasunia, Dropia, Tina, Golia, Tekirdag, Pehlivan, Yubileynaya 100) and 15 high-temperature tolerant wheat lines (CIMMYT-HTN 2014/15-1, CIMMYT-HTN 2014/15-2, CIMMYT-HTN 2014/15-3,

CIMMYT-HTN 2014/15-4, CIMMYT-HTN 2014/15-5, CIMMYT-HTN 2014/15-6, CIMMYT-HTN 2014/15-7, CIMMYT-HTN 2014/15-8, CIMMYT-HTN 2014/15-9, CIMMYT-HTN 2014/15-10 and CIMMYT-HTN 2013/14-4464, CIMMYT-HTN 2013/14-4488, CIMMYT-HTN 2013/14-4489, CIMMYT-HTN 2013/14-4490, CIMMYT-HTN 2013/14-4492) from CIMMYT (International Corn and Wheat Improvement Center—Mexico) were used as plant material. Among these genotypes, Basribey variety is defined as tolerant to high temperature.

2.2 Methods

The experiments were carried out as split plot design based on randomized complete block design with three replications and sown on 09 November 2014 and 09 January 2015. Sowing times were allotted to main-plots while genotypes were allotted to sub-plots. The sowing rate was 500 seeds per square meter. Sowing was done by hand in plots of 6 rows (1.2 m × 5 m, spaced 20 cm apart) in Namık Kemal University, Faculty of Agriculture, and Field Crops Department experimental area.

The 250 kg ha^{-1} of 20.20.0 compound fertilizer (50 kg ha^{-1} of pure nitrogen and 50 kg ha^{-1} pure phosphorus) at sowing time, Urea fertilizer (46% N) at tillering stage and ammonium nitrate fertilizer (33%) at stem elongation stage were applied in experimental area. Moreover, based on the development status of weeds, chemical control was performed between the periods of tillering and stem elongation. The trial plots were harvested in July 2015 by HEGE 160 plot harvester.

Some characters such as number, width and length of stoma, glaucousness, heading date, thousand kernel weight, test weight and grain yield were investigated in the context of high temperature tolerance mechanisms in bread wheat varieties and lines in which the high temperature stress is effected on the plants in the late sowing condition.

The data obtained from the study were analyzed by

variance analysis according to the method recommended by Ref. [26] using MSTAT-C computer package program. The statistical significance of differences between mean values of genotypes for the traits examined was determined by Duncan-test.

3. Results and Discussion

The results of variance analysis and significance test on the obtained data of the characters examined in the scope of high temperature tolerance mechanisms in the bread wheat cultivars and lines in late sowing conditions which affect high temperature stress on plants are given in Tables 1-3.

The grain yield and quality characteristics of plants are highly influenced by the abiotic and biotic stress factors that occur in the environment where they grow. Many researchers in the world have focused on the identification and development of high temperature tolerant genotypes [20-22, 25, 27].

Tolerance to abiotic stress factors such as drought, temperature, salinity are closely related to stoma movement in plants. Stomata characters such as number of stomata and their width and length in the unit area of plant leaves affect the photosynthesis capacity of plants significantly, and cause in significant changes in grain yield. Plants can be protected to a certain degree from high temperature stress with the waxy layer they form on the plant surface. Stomata are important portals for gas and water exchange in plants and have a strong influence on characteristics associated with photosynthesis and transpiration. As stomata control temperature and water use efficiency, they are vital to the existence of the plant. Stomata vary in size and density among different species and among cultivated varieties within species [28].

In this study, the stoma characteristics and glaucousness average values and significance groups determined in the bread wheat varieties and lines exposed to high temperature stress by late sowing are given in Table 1. The number of stomata, stomata

length and width of wheat genotypes examined ranged from 4.667-10.667, 1.967-3.067 mμ (millimicron) and 0.667-1.30 μm, respectively. And glaucousness values of them ranged from 1.0 to 9.0. Of the genotypes, the most number of stomata was obtained for Golia with 10.667, and followed by CIMMYT-HTN 2013/14-4464 and Gelibolu genotypes with 10.33. Krasunia, Flamura 85, Gelibolu, CIMMYT-HTN 2014/15-9 and CIMMYT-HTN 2014/15-10 were the other higher number of stomata genotypes with 10.00 units.

Under both drought stress and normal irrigation, and on the 10th and 20th day after anthesis, there were significant correlations between stomata density and stoma length and stomata width, but the correlations of between density and length of stomata changed with water condition or growth stage [29]. On the other hand, Nota were a genotype with the least number of stoma (4.667 units). This genotype was followed by CIMMYT-HTN 2014/15-3, CIMMYT-HTN 2014/15-2 and Dropia with 6.33 units. In addition to the number of stomata, stomata's length and width are closely affecting water losses in plants. The highest stomata length value in the genotypes of the bread wheat was measured for Nota with 3.067 mμ and for CIMMYT-HTN 2014/15-10 with 3.033 mμ. The lowest values were found for CIMMYT-HTN 2013/14-4488 genotype with 1.967 mμ followed by Saraybosna with 2.033 mμ and Flamura 85 and Golia with 2.067 mμ. Genotypes with the most stomata width were Sarayabosna, CIMMYT-HTN 2013/14-4488 and CIMMYT-HTN 2014/15-1 with 1.33 mμ. In comparison, the lowest stomata width was measured in CIMMYT-HTN 2014/15-10 and Dropia genotypes.

When the obtained data are examined, it is seen that the number of stomata, width and length of wheat genotypes changed according to each other. Note cultivar, which has at least the number of stomata, was found in the first important and statistical group in terms

Table 1 Stomata properties and glaucousness averages and significance groups for bread wheat genotypes.

Genotypes	Number of stomata (unit)	Length of stomata (μm)	Width of stomata (μm)	Glaucousness
Golia	10.667 a	2.067 fgh	1.000 abc	3.000 e
CIMMYT-HTN 2013/14-4464	10.333 ab	2.367 b-h	1.200 a	7.000 bc
Gelibolu	10.333 ab	2.100 e-h	1.233 a	6.333 c
Krasunia	10.000 abc	2.400 b-h	1.033 abc	7.667 b
Flamura 85	10.000 abc	2.067 fgh	1.200 a	3.000 e
CIMMYT-HTN 2014/15-9	10.000 abc	2.433 b-h	1.033 abc	7.000 bc
CIMMYT-HTN 2014/15-10	10.000 abc	3.033 a	0.667 c	5.000 d
Saraybosna	9.667 a-d	2.033 gh	1.333 a	3.000 e
Tekirdağ	9.333 a-d	2.800 abc	1.300 a	1.000 f
Syrena	9.333 a-d	2.633 a-e	0.900 abc	4.333 d
CIMMYT-HTN2013/14-4488	9.333 a-d	1.967 h	1.333 a	7.667 b
Tina	9.333 a-d	2.267 c-h	1.233 a	9.000 a
CIMMYT-HTN 2014/15-6	9.333 a-d	2.467 b-h	1.200 a	7.000 bc
Pehlivan	9.000 a-e	2.233 d-h	1.333 abc	9.000 a
CIMMYT-HTN 2014/15-4	9.000 a-e	2.333 b-h	0.867 abc	1.000 f
Yubileynaya 100	9.000 a-e	2.467 b-h	1.300 a	5.000 d
CIMMYT-HTN 2014/15-8	8.667 a-e	2.533 a-g	1.000 abc	7.000 bc
CIMMYT-HTN 2013/14-4490	8.333 a-e	2.467 b-h	1.167 ab	9.000 a
Kate A1	8.333 a-e	2.433 b-h	1.100 abc	9.000 a
CIMMYT-HTN 2014/15-5	8.333 a-e	2.833 ab	0.967 abc	3.000 e
CIMMYT-HTN 2014/15-7	8.333 a-e	2.300 b-h	1.200 a	1.000 f
Basribey	8.000 a-e	2.633 a-e	0.933 abc	7.000 bc
Esperia	7.667 b-e	2.200 d-h	1.100 abc	5.000 d
CIMMYT-HTN 2013/14-4492	7.333 c-f	2.667 a-d	1.200 a	9.000 a
CIMMYT-HTN 2013/14-4489	7.333 c-f	2.600 a-f	1.167 ab	9.000 a
CIMMYT-HTN 2014/15-1	7.333 c-f	2.267 c-h	1.333 a	9.000 a
Dropia	7.00 def	2.800 abc	0.733 bc	7.000 bc
CIMMYT-HTN 2014/15-2	7.00 def	2.800 abc	1.000 abc	7.000 bc
CIMMYT-HTN 2014/15-3	6.333 ef	2.433 b-h	1.000 abc	1.000 f
Nota	4.667 f	3.067 a	1.300 a	5.000 d

of stoma width and length. On the other hand, it is seen that the genotypes showing the highest number of stomata are not in the front row in terms of stoma width and height. When the results of number, width and length of stoma are evaluated together with grain yield, it is seen that wheat genotypes having lower values for stoma characteristics are less affected by stress conditions and consequently give better grain yields under high temperature stress conditions (Table 3). Ref. [30] found that differences in leaf stomata width in high temperature resistant and sensitive wheat varieties. Also anatomy was affected adversely under higher temperature in all ten genotypes leaf but

with more affected in susceptible as compared to tolerance genotypes.

Plants consume more water and decrease net photosynthesis ratio by increasing respiratory losses in arid and high temperature conditions. These reductions are lower in genotypes that are less affected by reducing respiratory losses from high temperature conditions. The stoma properties of plants and the cuticle layer on the plant surface have a considerable effect on respiratory losses through transpiration. One of the important factors in protecting plants from high temperatures is the presence of the cuticle layer on the plant surface. When the wheat genotypes are

examined, a high level of glaucous layer was determined in the genotypes of Tina, Pehlivan, Kate A1, CIMMYT-HTN 2013/14-4490, CIMMYT-HTN 2013/14-4492, CIMMYT-HTN 2013/14-4489 and CIMMYT-HTN 2014/15-1, no glaucous layer was observed in CIMMYT-HTN 2014/15-4, CIMMYT-HTN 2014/15-3, CIMMYT-HTN 2014/15-7 and Tekirdağ genotypes. On the other hand, Golia, Saraybosna, CIMMYT-HTN 2014/15-7 genotypes have a low level of glaucousness.

Results of the heading time and the thousand kernel weight obtained from standard and late sowing for

wheat genotypes are given in Table 2.

The heading time of 30 wheat genotypes varied from 164.33 to 172.33 days for standard sowing and from 119.0 to 126.33 days for late sowing. This shows that plants that have been sown late reached the period of physiological maturity in 30-40 days shorter than those sown on standard date. CIMMYT-HTN 2014/15-7 showed the longest heading time for standard sowing with 172.33 days, followed by Syrena and CIMMYT-HTN 2014/15-9 for 171.33 days. The shortest heading time was 164.33 days for Golia, followed by 164.67 days for CIMMYT-HTN2013/14-4488

Table 2 Mean values and significances of heading time and thousand kernel weight for bread wheat genotypes.

Genotypes	Heading time (days)			Thousand kernel weight (g)		
	Standard sowing	Late sowing	Mean	Standard sowing	Late sowing	Mean
Golia	164.33 ı	119.00 t	141.67 kl	26.33 rst	24.33 g-n	25.33 n
CIMMYT-HTN 2013/14-4464	164.67 hi	118.00 tu	141.33 l	43.67 a	39.33 b-e	41.50 a
Gelibolu	167.67 ef	123.67 l-o	145.67 efg	34.33 g-n	34.67 f-m	34.50 gh
Krasunia	170.33 bc	124.00 lmn	147.17 bcd	34.67 f-m	36.33 c-k	35.50 d-h
Flamura 85	170.33 bc	123.33 m-p	146.83 cd	36.33 c-k	35.67 c-l	36.00 c-g
CIMMYT-HTN 2014/15-9	171.33 ab	126.33 k	148.83 a	38.00 c-h	37.33 c-j	37.67 c-f
CIMMYT-HTN 2014/15-10	168.00 ef	123.00 m-q	145.50 e-h	26.33 rst	28.67 p-t	27.50 mn
Saraybosna	171.33 ab	124.33 lm	147.33 abc	25.67 t	27.67 q-t	26.67 n
Tekirdağ	168.67 de	122.33 o-s	145.50 e-h	38.00 c-h	38.33 c-h	38.17 b-e
Syrena	171.33 ab	125.00 l	148.17 ab	36.33 c-k	39.00 b-f	37.67 c-f
CIMMYT-HTN2013/14-4488	164.67 hi	118.00 tu	141.33 l	38.33 c-h	38.33 c-h	38.33 a-d
Tina	170.33 bc	123.67 l-o	147.00 cd	35.33 d-l	35.00 c-m	35.17 e-h
CIMMYT-HTN 2014/15-6	168.67 de	122.67 lmn	145.67 efg	37.67 d-i	40.00 abc	38.83 abc
Pehlivan	168.67 de	124.33 lm	146.50 de	39.33 b-e	42.67 ab	41.00 ab
CIMMYT-HTN 2014/15-4	167.33 ef	123.33 m-p	145.33 fgh	39.67 bcd	34.00 h-o	36.83 c-g
Yubileynaya 100	165.67 gh	122.33 o-s	144.00 ı	34.67 f-m	34.33 g-n	34.50 gh
CIMMYT-HTN 2014/15-8	166.00 gh	119.00 t	142.50 k	37.00 c-k	38.67 d-g	37.83 c-e
CIMMYT-HTN 2013/14-4490	165.00 hi	116.67 v	140.83 lm	38.67 b-g	38.00 c-h	38.33 a-d
Kate A1	167.33 ef	121.67 qrs	144.50 hi	32.67 k-p	33.00 j-o	32.83 hil
CIMMYT-HTN 2014/15-5	168.33 de	121.33 n-r	144.83 ghi	36.00 c-k	36.33 c-k	36.17 c-g
CIMMYT-HTN 2014/15-7	172.33 a	124.00 l	148.17 ab	31.00 m-q	28.67 p-t	29.83 lm
Basribey	165.00 hi	118.00 tu	141.50 kl	31.00 m-q	30.33 nr	30.67 l
Esperia	168.00 def	123.00 n-q	145.50 e-h	30.00 o-s	31.67 l-q	30.83 il
CIMMYT-HTN 2013/14-4492	165.00 hi	118.33 t	141.67 kl	38.00 c-h	39.00 b-f	38.50 a-d
CIMMYT-HTN 2013/14-4489	165.33 hi	117.00 uv	141.17 l	37.67 c-i	38.00 c-h	37.83 c-e
CIMMYT-HTN 2014/15-1	170.00 bc	124.33 lm	147.17 bcd	34.33 g-n	33.33 i-o	33.83 ghi
Dropia	168.00 def	122.00 prs	145.00 ghi	37.67 c-i	37.67 c-i	37.67 c-f
CIMMYT-HTN 2014/15-2	167.67 ef	121.33 n-r	144.50 hi	35.33 d-l	34.00 h-o	34.67 fgh
CIMMYT-HTN 2014/15-3	166.67 fg	122.33 o-s	144.50 hi	26.33 st	34.33 g-n	30.33 lm
Nota	169.33 cd	123.00 m-q	146.17 def	32.67 k-p	35.33 d-l	34.00 gh
Mean	167.86 b	121.80 a		34.77	35.13	

and CIMMYT-HTN 2013/14-4464 genotypes. The CIMMYT bread wheat breeding program focused on developing early-maturing and heat tolerant wheat lines. Early maturity to escape high temperature stress has been suggested that is an excellent crop adaptation approach in regions suffering from terminal and continual high temperature stress [31, 32]. In late sowing, the longest heading time was obtained for CIMMYT-HTN 2014/15-9 genotype with 126.33 days, and followed by Syrena cultivar with 125.0 days. The shortest heading time was determined for CIMMYT-HTN 2013/14-4490 with 116.67 days, and followed by CIMMYT-HTN 2013/14-4489 with 117.00 days. When grain yields of genotypes are examined in terms of heading time, it is seen that genotypes generally have a shorter heading time in late sowing than that of standard sowing, resulting in a decrease in yields. Higher temperatures at post-anthesis stage in wheat increase the rate but reduce the duration of seed filling [13, 22, 33]. When bread wheat genotypes were examined for thousand kernel weights, which are one of the important yield and quality characteristics, it ranged from 25.67 to 43.67 g for standard sowing and ranged from 24.33 to 41.00 for late sowing. As can be seen from the obtained data, the intervals of change are close to each other due to late planting and early seeding for thousand kernel weight. The results show that the heading time is significantly affected by high temperature, while the thousand kernel weight is relatively low.

Results of the test weight and the grain yield obtained from standard and late sowing for wheat genotypes are given in Table 3.

When the test weight and the grain yield value of examined for the 30 bread wheat genotypes obtained in the experiment, significant variations were obtained according to the sowing time. The test weight ranged from 72.00 to 82.33 kg/hL in the standard sowing, and ranged from 77.33 to 82.00 kg/hL in the late sowing. The test weight in the late sowing was higher than that

of standard sowing for some varieties. CIMMYT-HTN 2013/15-44 genotype gave the highest test weight of 82.33 kg/hL, and followed by CIMMYT-HTN 2014/15-5 and CIMMYT-HTN 2014/15-4 genotypes in standard sowing. In the late sowing, the highest test weight was obtained for CIMMYT-HTN 2014/15-5 with 82.00 kg/hL, which was followed by CIMMYT-HTN 2013/14-4490, CIMMYT-HTN 2013/14-4464, CIMMYT-HTN 2014/15-6, Basribey, Syrena and Krasunia genotypes. As can be seen from the results obtained, high temperature-resistant genotypes from CIMMYT, Basribey cultivar known for its high temperature resistance in our country and Syrena and Krasunia cultivars originated from Ukrainian grown in the Thrace region gave the most appropriate mean for test weight (Table 3). The lowest values for test weight were obtained in CIMMYT-HTN 2014/15-6 genotype with 72.00 kg/hL for standard sowing, followed by CIMMYT-HTN 2014/15-2, Saraybosna and Golia genotypes. In late sowing, the lowest test values (77.33 kg/hL) were obtained in the Gelibolu cultivar, followed by CIMMYT-HTN 2014/15-3 and Flamura 85 with 77.67 kg/hL. These results show that the effect of high temperature on the test weights of bread wheat genotypes is quite different. It has been reported that grain yields and quality decline at higher than optimal temperatures [14, 34].

When the yields of the wheat genotypes used in the study were examined, average yield was between 459.25 and 686.67 kg/da in standard sowing, while those in late sowing varied between 388.00 to 614.00 kg/da. Refs. [15, 16] have shown decreasing effects on grain yield of high temperature. The highest grain yields in standard sowing were 686.67 kg/da and 685.33 kg/da with CIMMYT-HTN 2013/14-4492 and CIMMYT-HTN 2013/14-4489, respectively. These genotypes followed CIMMYT-HTN 2014/15-5 with 676.00 kg/da and Nota with 673.00 kg/da. The highest grain yield (614.00 kg/da) in late sowing was obtained from CIMMYT-HTN 2014/15-4 genotype, which was

Table 3 Mean values and significances of test weight and grain yield for bread wheat genotypes.

Genotypes	Test weight (kg/hL)			Grain yield (kg/da)		
	Standard sowing	Late sowing	Mean	Standard sowing	Late sowing	Mean
Golia	74.67 j-m	77.33 e-j	76.00 lm	478.00 p-v	514.00 j-t	496.00 ghı
CIMMYT-HTN 2013/14-4464	82.33 a	81.33 a-d	81.33 a	561.67 e-p	594.67 b-j	578.17 a-f
Gelibolu	77.33 e-j	77.33 e-j	77.33 e-m	583.33 d-m	474.33 q-v	528.83 fgh
Krasunia	76.67 f-k	81.33 a-d	79.00 b-ı	565.00 e-n	556.33 f-q	560.67 c-f
Flamura 85	78.33 c-ı	76.67 f-k	77.50 e-m	609.00 a-ı	494.33 n-u	551.67 c-f
CIMMYT-HTN 2014/15-9	79.00 a-h	79.00 a-h	79.00 b-ı	571.67 e-n	564.00 e-o	567.84 b-f
CIMMYT-HTN 2014/15-10	72.00 m	79.33 a-g	75.67 m	459.25 t-w	428.50 uvw	443.85 ij
Saraybosna	74.67 j-m	79.33 a-g	77.00 g-m	500.33 m-u	471.67 q-v	486.00 hij
Tekirdağ	77.00 e-j	77.67 e-j	77.33 e-m	487.00 n-u	479.00 o-v	483.00 hij
Syrena	78.00 d-j	81.33 a-d	79.67 a-e	504.00 k-u	555.00 f-r	529.50 fgh
CIMMYT-HTN2013/14-4488	78.67 b-h	80.00 a-f	79.33 a-g	663.00 a-d	505.67 k-u	584.34 a-f
Tina	73.67 klm	78.67 b-h	76.17 klm	609.33 a-ı	471.33 r-v	540.17 efg
CIMMYT-HTN 2014/15-6	72.00 m	81.33 a-d	76.67 ı-m	546.00 g-s	536.00 h-t	541.00 efg
Pehlivan	79.00 a-h	80.33 a-e	79.67 a-e	553.67 f-r	564.00 e-o	558.84 c-f
CIMMYT-HTN 2014/15-4	80.00 a-f	78.00 d-j	79.00 b-ı	627.00 a-g	614.00 a-h	620.50 ab
Yubileynaya 100	75.67 h-l	78.00 d-j	76.33 h-m	639.00 a-f	538.00 e-n	588.50 a-e
CIMMYT-HTN 2014/15-8	79.00 a-h	78.00 d-j	78.50 c-k	563.33 e-o	388.00 w	475.67 hij
CIMMYT-HTN 2013/14-4490	79.00 a-h	81.67 abc	80.33 abc	663.00 a-d	505.67 k-u	584.34 a-f
Kate A1	78.33 c-ı	80.00 a-f	79.17 b-h	594.00 b-j	553.33 f-v	573.67 b-f
CIMMYT-HTN 2014/15-5	80.00 a-f	82.00 ab	81.00 ab	673.00 abc	594.67 b-j	633.84 a
CIMMYT-HTN 2014/15-7	77.33 e-j	78.33 c-ı	77.83 d-m	467.00 s-v	403.33 vw	435.17 j
Basribey	77.67 e-j	81.33 a-d	79.50 a-f	646.00 a-e	599.00 b-j	622.50 ab
Esperia	75.00 ı-m	79.33 a-g	77.17 f-m	529.00 h-t	566.00 e-n	547.50 d-g
CIMMYT-HTN 2013/14-4492	77.33 e-j	79.33 a-g	78.33 c-l	686.67 a	526.33 ı-t	606.50 abc
CIMMYT-HTN 2013/14-4489	76.67 f-k	78.67 b-h	77.67 d-m	685.33 a	519.33 j-t	602.33 a-d
CIMMYT-HTN 2014/15-1	79.33 a-g	78.33 c-ı	78.83 b-ı	637.00 a-f	606.00 a-ı	621.50 ab
Dropia	78.67 b-h	81.33 a-d	80.00 a-d	465.33 s-v	502.33 l-u	483.83 hij
CIMMYT-HTN 2014/15-2	73.33 lm	78.67 b-h	76.00 lm	593.33 b-j	586.67 d-k	589.84 a-e
CIMMYT-HTN 2014/15-3	78.67 b-h	77.67 e-j	78.17 c-l	515.33 j-t	589.33 c-k	552.33 c-f
Nota	76.33 g-l	80.00 a-f	78.17 c-l	676.00 ab	562.33 e-p	619.17 ab
Mean	77.19 b	79.39 a		576.49	531.63	

not included in the highest yield genotype order in standard seeding. This genotype was followed by CIMMYT-HTN 2014/15-1 with 606.00 kg/da, CIMMYT-HTN 2014/15-5 and CIMMYT-HTN 2013/14-4464.

When grain yield means obtained from sowing times are evaluated, it is shown that genotypes are affected differently from high temperature stress and it is seen that the yields of temperature-resistant genotypes are high in late sowing. Refs. [7-11] have suggested that yield reduction in wheat due to high temperature stress is associated with a decrease in the

spike number and weight.

The lowest mean in terms of grain yield was obtained from CIMMYT-HTN 2014/15-10 genotype with 459.25 kg/da for standard sowing, followed by Dropia cultivar. In late sowing, CIMMYT-HTN 2014/15-8 genotype gave the lowest yield (388.00 kg/da), followed by CIMMYT-HTN 2014/15-7 genotype with 403.33 kg/da and CIMMYT-HTN 2014/15-10 genotype with 428.50 kg/da.

4. Conclusions

The results indicate that grain yields of genotypes

are significantly affected by high temperature in late sowing. When the bread wheat genotypes are evaluated in terms of tolerance to high temperature, it was shown that Dropia and Nota varieties and CIMMYT-HTN 2014/15-2, CIMMYT-HTN 2014/15-6, CIMMYT-HTN 2014/15-10 lines were better tolerance to high temperature. Besides, these genotypes are not included in the first group due to grain yield for high temperature resistance breeding studies can be recommended as a genitor.

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