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The Study of the Sum of Active Temperatures Affecting Autumn Bread (*Triticum aestivum* L.) Wheat Under Dry Rainfed Conditions

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ABSTRACT

The sum of active temperatures affecting 21 autumn bread wheat genotypes with contrasting morphophysiological properties during the flowering and grain filling phases after earing has been studied under dry rainfed conditions in 2013-2014, during vegetation periods characterized by different hydrometeorological parameters. The functioning period of flag leaves in Murov 2, Gyrmyzy gul-1 and Zirva 85 genotypes appeared to be longest and they had higher sums of active temperatures (SAT) compared with other varieties during both years. Qyzyl bugda, Layagatli-80 and 12 IWWYT № 6 varieties had quite high higher sums of active temperatures values in 2013, but they showed lower results under unfavorable climatic conditions in 2014. There were a positive correlation between SAT and productivity at $r=0.55^{**}$, and a negative correlation between earing dates and higher sums of active temperatures at $r=-0.41^{**}$ during both years.

Keywords: *Triticum aestivum* L., morphophysiological properties, productivity, dry rainfed conditions.

Introduction

Wheat is the most important food plant for humanity, one of the strategic foods in the world. After the so called "Green Period" the world wheat productivity and production increased by 50% and 38% , respectively. This increase occurred at the expense of developing short varieties and increasing number of productive stems (Aliyev, 2000; Aliyev, 2002a). Whereas, the total biological mass remained almost unchanged. However, productivity increase due to genetic progresses does not seem to meet the rising demands. Currently, substantial achievements have been made in the wheat selection by using morphophysiological parameters. Considering other morphophysiological parameters and different selection approaches is important for the further success (Aliyev *et al*., 2002b; Aliyev, 2012). Most wheat in our country is produced in the regions with dry rainfed conditions, including Daghlig Shirvan's foothill areas. Little and unevenly distributed annual precipitation is characteristic for this district. Generally, drought begins at the periods close to the beginning of flowering and continues intensively till the end of the grain filling phase.

Currently, some visible morphological parameters (height, leaf and ear sizes, etc.) of plants as well as fast-growing is used as the selection signs and taking into account productivity, researches have been carried out for developing drought tolerance varieties. However, in developing drought tolerant wheat genotypes, along with the morphological parameters, there is a great need in physiological tests which are repeatable and easily performable.

The main purpose of the research was to study the sum of active temperatures affecting plants for characterizing their functioning during the flowering and grain filling phases.

Materials and Methods

The research was carried out in dry rainfed areas of the Daghlig Shirvan district of the Republic of Azerbaijan, during the 2012-2013 and 2013-2014 vegetation years. The planting area is located at 780 m above sea level. The light-brown type soil of the district is carbonated. The amount of humus in the planting layer with pH 8.6 is 1.25-2.17%, digestible nitrogen in 1kg of soil is 42.7 mg, phosphorus 23.4 mg and K_2O in 100 g of soil is 17.5 mg. Multiyear average atmospheric precipitation in the district is 350-400 mm and unevenly distributed during the vegetation period of the autumn wheat. Average annual temperature is 10.2°C. Sometimes temperature in winter is -15-20°C, in summer temperature rises to 30-35°C and relative humidity declines to 25%.

Thirteen autumn bread wheat genotypes with contrasting morphophysiological properties and eight lines chosen from the International Selection Centers for the rainfed districts were used as the study objects. Wheat varieties of tall stature (115-130 cm) - Bezostaya-1, Gizil bugda, Sheki-1, Sonmez were planted under rainfed conditions. Medium-height (110-115 cm) varieties Gobustan and Leyagetli-80 were developed for the rainfed districts. But, they show also good results under irrigated conditions. Short-stature wheat varieties - Aran, Vostorg, Murov-2, Tale-38, Fatima, Girmizi gul-1, Zirve-85 demand more water and are highly productive under watered conditions.

To determine the sum of active temperatures influencing on the plant after the earing phase, chlorophyll amount was measured in flag leaves on different dates using SPAD meter. According to the obtained data the theoretical zero-point for chlorophyll was estimated using the square regression method, where the SPAD value was dependent variable (y) and the sum of active temperatures, measured from the beginning of the earing phase, was independent variable (x). The sum of active temperatures corresponding to this point was used for the assessment of the flag leaf functioning. Moreover, using SPAD values and the same method the day corresponding to the zero-point for chlorophyll was established, which was then used for the assessment of the flag leaf functioning in various genotypes (Çekiç, 2007). The results were analyzed using the JMP 5.0.1 statistical program.

Results and Discussion

Weather conditions during the research are presented in Table 1. As seen from the table during the vegetation period the average annual temperature was higher than multiyear average temperature in both years.

The amount of precipitation was slightly lower during the 2012-2013 vegetation year compared with the multiyear average values. However, it was sufficient for the plant development in spring months and the grain filling period (264.5 mm). During the 2013-2014 vegetation year, 156.7 mm and 91.5 mm less amount of precipitation was observed compared with the multiyear average values found for the plant development in spring months and the grain filling period, respectively. Such changes in weather conditions had an effect on developmental stages of genotypes and finally on the plant productivity. The SPAD values of bread wheat flag leaves are presented in Table2.

As seen in the table the chlorophyll amount decreased to the end of the vegetation, but a higher rate of this decrease was observed in 2013-2014, due to the less precipitaion and higher temperature. The highest chlorophyll amount was observed in the Gyrmyzy gul 1, Bezostaya 1 and Tale 38 genotypes and the lowest in the Gyzyl bugda, Fatima varieties and 12 IWWYT № 6, 12 IWWYT № 17, 4th FEFWSN № 50 lines.

Based on the SPAD values the theoretical zero-point for chlorophyll was estimated using the square regression method and beginning from the earing date, the sum of active temperatures of the corresponding day was found according to the the daily weather data. The chlorophyll amount decline in flag leaves of the genotypes has been presented in Figure 1. As seen in the figure in flag leaves of Murov 2 and Gyrmyzy gul 1 the chlorophyll amount fell to zero after a longer period of time. Zero-point for the chlorophyll amount was achieved faster in flag leaves of the Gyzyl bugda and 12 IWWYT № 6 genotypes. It should be noted that other genotypes, which are not presented in the figure, occupy an intermediate position.

Sum of the active temperatures affecting all the studied genotypes till the end of the earing period was estimated and the results along with the earing date and productivity were presented in Table 3. As seen in the Table average SAT values were 547 and 477°C in 2013 and 2014, respectively. This 70°C decline in the SAT value may be the result of the less precipitation and fast yellowing of the plants observed in 2014. The different responses of the studied genotypes should be also noted. During both years SAT values of the Murov 2, Gyrmyzy gul 1, Zirva 85 genotypes were found to be 663, 577 and 607°C, respectively, which are the highest results among the studied genotypes. Unlike to others, Murov 2 and Zirva 8 are fast-growing genotypes.

High SAT values for the Gyrmyzy gul 1 genotype are attributed to the late yellowing of its leaves in spite of the late earing. So, according to Table 4 the

Murov 2 and Zirva 85 genotypes are fast-growing and the functioning period of their flag leaves are the longest during both years. In spite of the late earing of Gyrmyzy gul 1, the flag leaf was yellowed late and its functioning period was long and thereby this genotype also had high SAT values.

Rather high values of SAT for the Gyzyl bugda, Layagatli 80 and 12 IWWYT № 6 varieties observed during favorable 2013, decreased significantly in unfavorable 2014. This can occur due to the earlier yellowing of their leaves in spite of the earlier earing period compared with other genotypes. So, the table shows that the functioning period of flag leaves of these genotypes during the unfavorable year decreased by 14.3, 14.7 and 16.7 days, respectively.

The dependence between SAT influencing on plants and earing dates and also between SAT and productivity was studied for both years. As seen in figure 2, there is a negative correlation between earing dates and SAT, at r= -0.41.

Thus, the research carried out showed a positive relationship between SAT affecting plants after the earing period and productivity. The obtained results are recommended for the use in the selection of the autumn bread wheat.

Table 1. Amount of precipitation and temperature during the 2012-2013 and 2013-2014 vegetation years

Months	2012-2013		2013-2014		Multiyear average	
	Precip. (mm)	Average temp. °C	Precip. (mm)	Average temp. °C	Precip. (mm)	Average temp. °C
September	23.1	18.0	52.0	19.5	31.0	17.1
October	24.1	14.9	23.2	11.2	45.0	11.2
November	21.6	7.8	11.7	7.2	36.0	6.0
December	28.7	2.2	18.3	-0.7	30.0	1.7
January	27.5	1.0	20.1	0.03	26.0	-0.2
February	48.2	3.2	12.5	-0.23	35.0	0.1
March	28.9	6.2	37.4	4.9	42.0	3.1
April	40.2	9.7	19.8	10.7	47.0	9.2
May	75.2	15.7	23.2	19.5	47.0	14.9
June	20.2	20.9	4.1	21.1	40.0	19.5
Total:	337.7		222.3		379.0	
Average:		9.96		9.32		8.3

Table 2. SPAD values during the 2012-2013 and 2013-2014 vegetation years

N	Varieties	2013						2014						
		08.06	11.06	16.06	18.06	20.06	24.06	19.05	27.05	02.06	06.06	09.06	12.06	16.06
1	Bezostaya 1	51.5	50.9	33.8	22.8	2.5	-	51.4	50.6	45.4	25.6	17.9	-	-
2	Gyzyl bugda	45.8	36.9	6.8	2.0	-	-	49.0	47.8	40.8	14.1	-	-	-
3	Sheki 1	48.2	50.8	32.3	20.2	4.2	-	52.2	50.9	46.5	40.5	35.5	22.5	10.0
4	Sonmez	49.2	51.0	19.3	8.4	-	-	51.0	50.7	46.5	23.2	16.3	10.0	-
5	Aran	49.2	52.4	45.4	27.2	20.3	8.0	49.7	49.6	45.8	40.6	28.1	14.1	6.0
6	Vostorg	50.1	52.8	31.6	8.4	-	-	51.8	52.8	45.6	33.1	20.7	8.5	-
7	Murov 2	49.8	48.6	41.3	31.1	21.1	10.2	48.0	47.4	45.7	40.5	30.9	19.1	10.0
8	Gobustan	47.8	42.5	5.4	-	-	-	49.8	50.6	38.7	19.0	-	-	-
9	Tale 38	50.9	51.0	16.3	3.5	-	-	53.6	45.7	47.1	35.2	12.5	-	-
10	Fatima	46.0	51.1	20.2	4.5	-	-	42.0	51.8	43.3	25.3	10.2	-	-
11	Gyrmyzygul 1	52.6	49.8	42.5	30.1	15.6	5.7	49.0	47.5	48.5	46.5	35.0	22.4	12.0
12	Zirva 85	49.1	45.7	32.5	20.4	6.5	-	49.2	50.6	45.1	35.2	15.6	8.0	-
13	Layagatli 80	48.7	51.8	19.9	4.5	-	-	48.3	50.6	48.2	16.8	-	-	-
14	Ferrigineum 2/19	51.0	48.1	20.3	7.5	-	-	50.3	50.4	46.2	20.2	-	-	-
15	11 IWWYUT № 20	47.6	50.2	24.5	13.2	3.5	-	47.7	48.6	45.2	23.2	-	-	-
16	12 IWWYUT № 6	42.9	30.2	3.5	-	-	-	52.0	49.2	44.0	10.6	-	-	-
17	12 IWWYUT № 8	47.7	49.0	20.5	6.5	-	-	50.1	52.9	46.8	30.9	18.7	-	-
18	12 IIWWYUT № 9	47.7	51.4	13.1	4.3	-	-	47.6	45.6	44.5	21.1	-	-	-
19	12 IWWYUT № 17	44.1	37.3	4.1	-	-	-	46.8	45.7	43.2	18.5	-	-	-
20	7 WONSA № 477	50.1	47.5	25.9	16.3	4.1	-	47.2	48.2	45.8	38.3	27.2	10.5	-
21	4th FEFWSN № 50	40.3	50.0	6.1	2.0	-	-	52.0	46.7	43.9	14.6	-	-	-

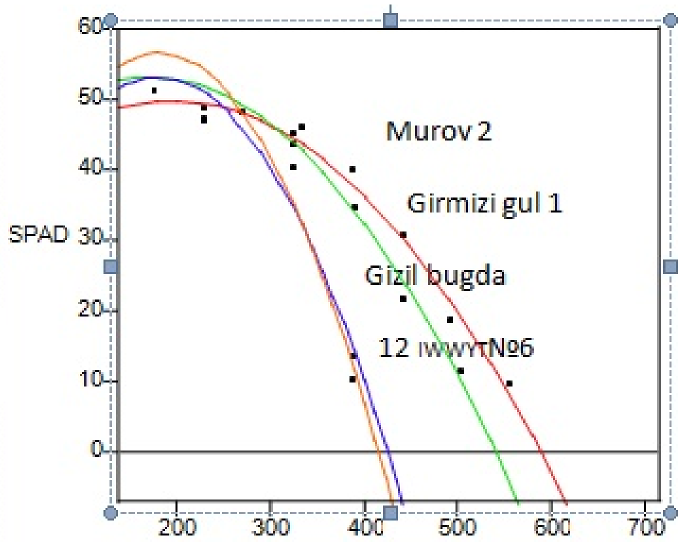
Table 3. Earing dates (days from May the 1st), productivity and SAT values for the studied genotypes

№	Genotypes	Earing date		SAT, °C		Productivity, g/m²	
		2013	2014	2013	2014	2013	2014
1	Bezostaya 1	15.7	16.0	507	445	562	421
2	Gyzyl bugda	8.3	13.3	548	428	596	450
3	Shaki 1	16.7	17.0	552	527	572	428
4	Sonmez	9.0	13.0	551	515	678	488
5	Aran	18.0	17.3	550	497	630	440
6	Vostorg	15.0	15.3	511	481	608	409
7	Murov 2	8.3	13.0	663	592	624	378
8	Gobustan	7.0	11.7	529	476	812	501
9	Tale 38	14.0	15.7	494	435	811	449
10	Fatima	11.3	14.0	526	454	723	358
11	Gyrmyzy gul 1	15.0	16.0	577	542	752	468
12	Zirva 85	7.3	12.0	607	531	705	442
13	Layagatli 80	8.0	13.7	551	432	794	560
14	Ferrigenium 2/19	8.3	11.7	560	462	782	437
15	11 IWWYT № 20	10.3	13.0	569	460	717	432
16	12 IWWYT № 6	6.3	12.7	538	418	768	503
17	12 IWWYT № 8	11.0	14.0	531	479	728	475
18	12 IWWYT № 9	13.3	13.7	505	442	642	445
19	12 IWWYT № 17	8.3	14.0	518	430	689	407
20	7 WON-SA №477	12.0	14.0	558	517	723	476
21	4th FEFWSN №50	7.3	13.3	551	450	680	424
	Average	11.0	14.0	547	477	695	447
	and %	9.4	5.14			5.4	8.4
	Minimal important difference (MID)	1.7	1.2			62	62

Table 4. Functioning periods (in days) of flag leaves after earing

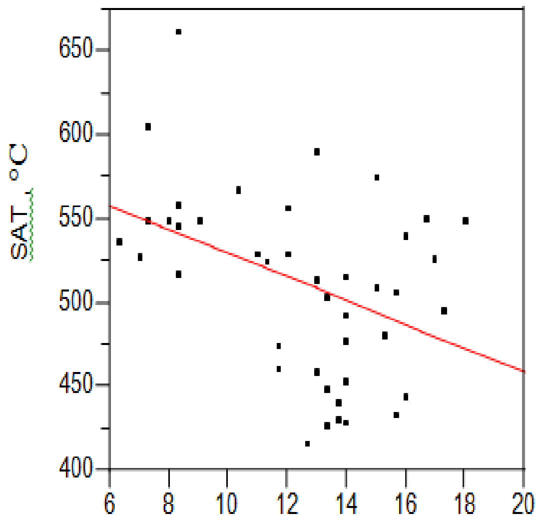
N	Variety name	2013	2014	Difference
1	Bezostaya 1	35.4	27.4	8.0
2	Gyzyl bugda	41.0	26.7	14.3
3	Shaki 1	35.4	32.7	2.7
4	Sonmez	40.7	31.5	9.2
5	Aran	38.0	31.0	7.0
6	Vostorg	34.8	29.6	5.2
7	Murov 2	48.6	36.2	12.4
8	Gobustan	40.4	29.5	10.9
9	Tale 38	35.2	27.0	8.2
10	Fatima	38.2	28.0	10.2
11	Gyrmyzy gul 1	40.7	33.5	7.2
12	Zirva 85	44.8	32.3	12.5
13	Layagatli 80	41.7	27.0	14.7
14	FERRIGINEUM2/19	41.5	28.8	12.7
15	11 IWWYT№ 20	41.2	28.7	12.5
16	12 IWWYT№ 6	42.7	26.0	16.7
17	12 IWWYT№ 8	38.5	29.5	9.0
18	12 IWWYT№ 9	36.1	27.9	8.2
19	12 IWWYT№ 17	39.4	26.9	12.5
20	7 WON-SA№ 477	39.5	31.6	7.9
21	4th FEFWSN № 50	41.7	28.0	13.7

Figure 1. A decrease in chlorophyll content of flag leaves of the genotypes in 2014



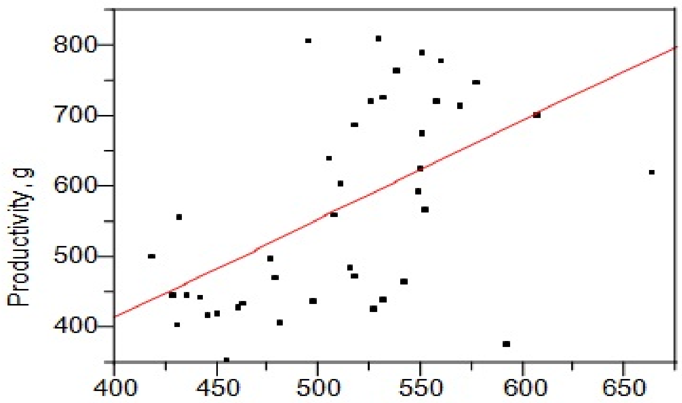
SAT °C

Figure 2. Relationship between earing dates and SAT values



Earing date

Figure 3. Relationship between SAT and productivity



SAT °C

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