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Morpho-physiological Study of Wheat Genotypes With Contrasting Growth Periods, Cultivated Under Various Climatic and Soil Conditions

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The effect of drought on the surface area of various assimilating organs of durum and bread wheat genotypes with contrasting growth periods, cultivated under various climatic and soil conditions has been studied. To establish the accuracy of the obtained data, statistical analysis of some productivity indices was performed.

Keywords: *Drought, wheat genotypes, assimilating parts, plant metabolism, early maturing wheat genotypes*

INTRODUCTION

Recent global climatic changes have caused destructions in the ecological balance, and development in stress factors such as drought and salinity, which can lead to serious issues in satisfying the population demands for food.

It is known that biotic (pathogen, competition with other organisms etc.) and abiotic (drought, salinity, radiation, high and low temperature etc.) stresses cause drastic changes in physiological activity of plants, attenuate biosynthesis in cells, disturb normal vital functions and eventually can completely destroy the plant (Arora et al., 2002; Peet et al., 1977; Wang et al., 2003).

From this point of view, one of the main issues facing breeders is the creation of new, highly productive and stress-tolerant varieties using plant genotypes grown under unfavorable climatic conditions, tolerant to various stresses, including drought and salt-tolerant plant genotypes (Anjum et al., 2011; Blum, 1986; Witcombe et al., 2008).

To enhance plant tolerance to stress factors, physiological studies should be preferred for the revelation of mechanisms of tolerance and determination of physiological and genetic changes occurred in plants under stress (Moghaddam et al., 2012). Physiological investigations can facilitate the establishment of the stress tolerance associated genes in wheat genotypes. It should be noted that the establishment of genes tolerant to stress factors as well as the use of them in the hybridization process as donors is one of the most important issues facing modern plant breeding (Anjum et al., 2011; Tamrazov, 2016). The role of assimilating organs (leaf, stem, spike) is crucial in the proceeding photosynthesis and the formation of the product. Therefore, we measured assimilating surface area during vegetation and analyzed the obtained data.

MATERIALS AND METHODS

Durum and bread wheat genotypes with contrasting maturation periods were chosen as the study objects. Measurements were conducted with 4 samples of each group. However, the article presents data only on the early maturing durum and bread wheat genotypes. Although the study was performed in 3 regions and throughout 3 groups, only the results of the study in 1 group have been discussed.

The experiments were carried out on wheat genotypes with contrasting maturation periods (early, medium and late) at the Absheron, Jalilabad and Gobustan Experimental Stations of the Research Institute of Crop Husbandry during 2017-2018 year vegetation years. Regular phenological observations were performed on early maturing varieties. Assimilating surface area was measured using an automatic device AAS-400. Correlation was established between spike structural elements, characterizing productivity and statistical indicies were calculated using Excel and SPSS-19 statistical package programs.

As the studied varieties have various maturation periods, they divided into 3 groups: early, medium and late maturing varieties.

RESULTS AND DISCUSSION

The aim of the work was to determine drought effects on assimilating surface areas and productivity elements of bread and durum wheat genotypes differing in their maturation periods and grown under various climatic and soil conditions with following comparison of other physiological indices.

Maturing duration is known to be the most important factor in the plant growth. Because of differences in climatic and soil conditions in the regions of our country, the study of this factor is needed. In this point of view, early and late maturing varieties should be preferred. In general, early maturing wheat genotypes are more characteristic of regions, where spring-summer drought onsets early. On the other hand, the main part of the genotypes are medium maturing that should be considered in the wheat cultivation in most regions.

Genotypes tolerant to soil and air water deficiency and able to provide high production are considered to be drought tolerant.

The results of the study (assimilating surface area) performed in Absheron are presented in Fig. 1. As seen in the figure assimilating surface area of various organs were comparatively studied in 2 durum (Garagylchyg 2 and Alinja 84) and 2 bread wheat (Alinja 84 and Gobustan) varieties, under normal water supply and drought conditions. The assimilating surface area in leaves of Garagylchyg-2 was measured since the 3rd decade of March. The maximum value was obtained in the middle of vegetation and then began to decline until the end of vegetation, which is attributed to the increase in the surface of other assimilating organs - stem and spike as a result of leaf senescence. The maximum values in the leaves are usually observed during the earing-flowering phase. The assimilating surface area in the Garagylchyg 2 leaf was 66.8 and 51.8 thous. m^2/ha, in watered and drought-exposed variants, respectively. The variants differ by 22.4%.

On the other hand, the maximum values in leaves of the bread wheat genotype- Gobustan were observed in the 1st decade of May, during the earing-flowering phase. Thus, in the watered and drought-exposed genotypes these values were found to be 64.2 and 61.2 thous. m^2/ha, respectively, with 4.6% difference between variants. In the Garagilchyg-2 variety the assimilating surface area of stem reached maximum values in the second decade of May and in watered and drought-exposed genotypes, was equal to 66.8 and 56.7 thous. m^2/ha, respectively, with 15.1% difference between the variants.

The similar situation was detected in the bread wheat genotype Gobustan. The stem assimilation surface area reached maximum values in the 1st and 2nd decades of May and in watered and drought-exposed genotypes, was equal to 69.7 and 61.2 thous. m^2/ha, respectively, with 12% difference between the variants.

Dynamics of the increase in the spike surface of the Garagylchyg-2 variety was as follows: during the maturation phase – at the end of May and at the beginning of June-31.2 and 20.9 thous.m^2/ha, in the watered and drought-exposed plants, respectively, with 33% difference between variants. Such a sharp variation is attributed to the intensification of drought to the end of vegetation.

In the Gobustan variety this index was equal to 28.6, and 23.4 thous. m^2/ha, in watered and drought-exposed variants, respectively, and the difference between the variants was 18%.

The dynamics of the changes in productivity indices were determined in 2 genotypes of each group (durum and bread genotypes). However, one genotype of each group was analyzed.

The same indices were also determined in the wheat varieties cultivated in the Jalilabad region of Azerbaijan.

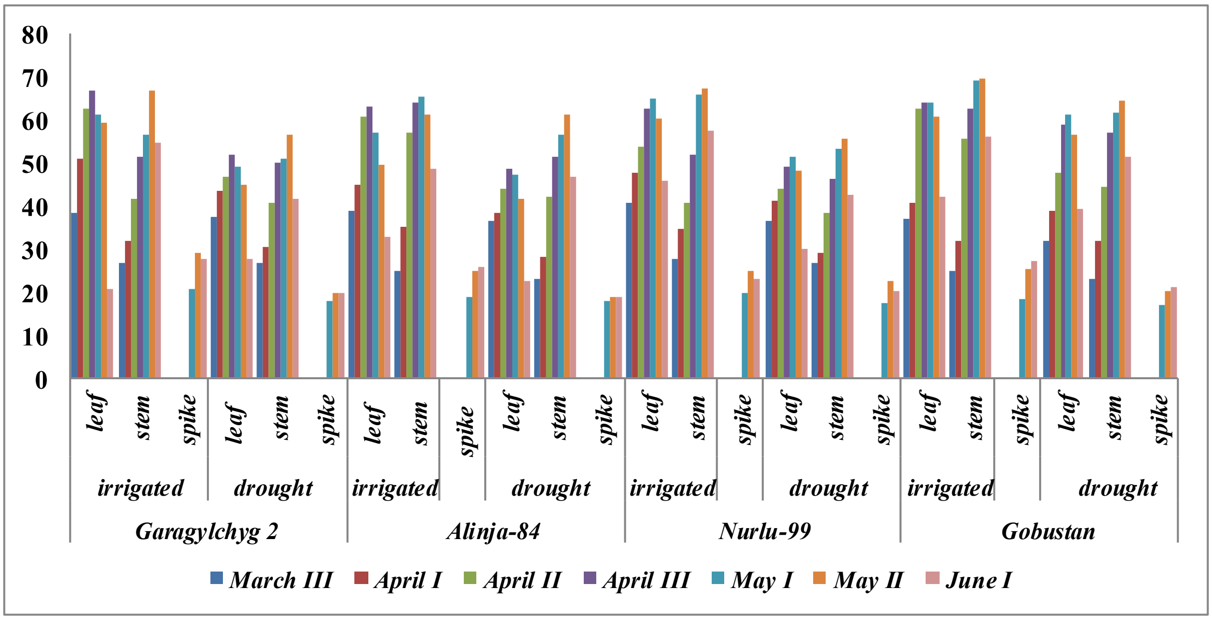

Fig. 1. The dynamics of the assimilating surface area of early maturing wheat genotypes-thous. m^2/ha (Absheron).

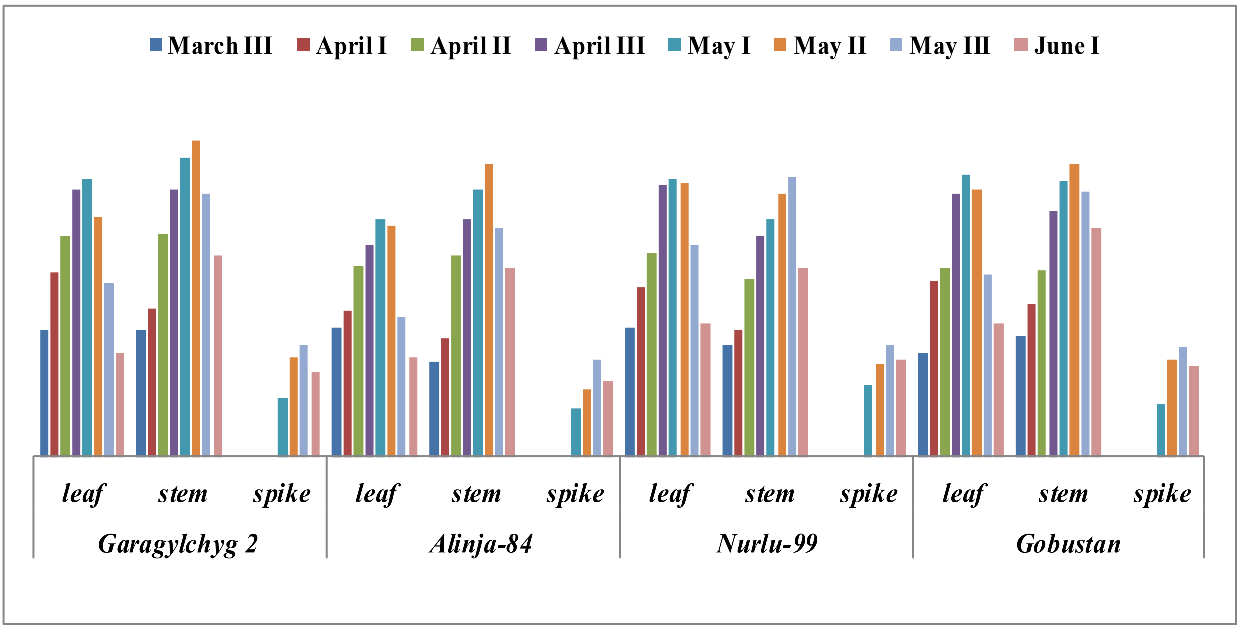

Fig. 2. The dynamics of the assimilating surface area of early maturing wheat genotypes-thous. m²/ha (Jalilabad).

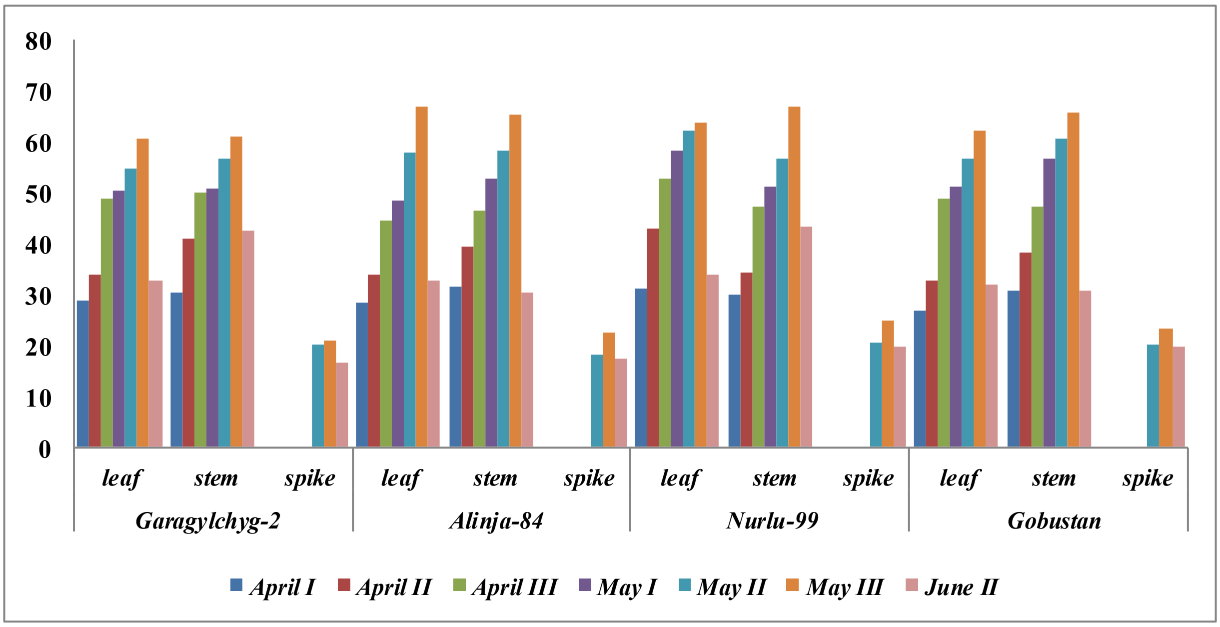

Fig. 3. The dynamics of the assimilating surface area of early maturing wheat genotypes-thousand m²/ha (Gobustan).

As seen in the figure 2, the studied wheat genotypes did not change. However, contrary to Absheron, Jalilabab is a rainfed region and the measurements were conducted only with the drought-exposed plants. In the Garagylchyg 2 variety the maximum assimilating surface area of leaf - 61.3 thous.m²/ha - was observed during the 1st decade of May. The maximum value of this index for stem- 69.7 thous. m²/ha- was observed in the 2nd decade of May and for spike the maximum value detected in the 3rd decade of May was equal to 24.9 thous. m²/ha.

Similar to Garaglchyg 2, in the Gobustan variety maximal values for the assimilating surface area in leaf (62.2 thous. m²/ha), stem (64.4 thous.m²/ha) and spike (24.4 thous. m²/ha) were found in the 1st, 2nd and 3rd decades of May, respectively.

Thus, drought conditions characteristic of the Jalilabad region of Azerbaijan, earlier onset of drought and its intensity lead to the acceleration of the vegetation process (Tamrazov, 2016).

The next investigations were carried out in the Gobustan region, which climatic conditions are very different from those of Absheron and Jalilabad. Early onset of winter and late spring-summer drought affect the duration of vegetation. The results of the study are presented in Fig. 3.

Contrary to the first 2 regions, in Gobustan the measurements began in April. In the durum wheat variety Garagylchyg-2 the maximal value for the assimilating surface area in leaf was determined

(60.5 thous.m^2/ha) in the third decade of May - during the earing-flowering phase. However, in both stem (68.5 thous.m^2/ha) and spike (22.8 thous. m^2/ha) this index reached the maximum in June.

In the Gobustan variety the maximal values for the assimilating surface area in leaf (62.2 thous.m^2/ha) and stem (65.6 thous.m^2/ha) were detected in the third decade of May, in the same phase. However, in spike this index was maximum (27.9 thous. m^2/ha) in the 1st decade of June.

According to the obtained results, for the all assimilating organs of the early maturing genotypes the earing phase is considered to be the most favorable. Thus, the most active metabolism occurs during the mentioned growth phase of the plant (Peet et al., 1977; Witcombe et al, 2008).

The performed analysis showed that physiological processes proceeding in the plant changed due to the environmental factors. According to the obtained data drought-tolerant genotypes are more productive. Because, all physiological processes proceed to the end in these plants.

To determine productivity indices, sheaves were taken from 1m^2 area in 3 replicates prior to harvesting and 10 characteristic spikes were taken from each sample for the structural analysis.

From the development stage, there is a relative decline in the leaves and an increase in the body and spike.

Grain yield of the same varieties were determined in various regions. As seen in the table 1 in the durum wheat genotype-Garagylchyg 2 grown in Absheron the highest productivity index was found to be 617 g/m^2 and 457 g/m^2 in watered and drought-exposed plants, respectively, with 25.9% difference between the variants. In other durum wheat variety Alinja 84 this index was equal to 473 and 380 g/m^2 in watered and drought-exposed plants, respectively, and the difference between these values was 19.6%. The same parameter was determined in the bread wheat varieties Alinja 84 and Gobustan. The productivity index was found to be 518 and 493, respectively, for watered and drought-exposed plants of the Alinja 84 variety. However, for the Gobustan variety 423 and 405 were found, respectively, for watered and drought-exposed plants. The difference between varieties was as follows: 4.8% in Alinja 84 and 4.3% in Gobustan.

Considering the general dynamics, it can be concluded that productivity index and difference between variants were higher in Garagylchyg-2 compared with Alinja 84. The difference between variants in bread wheat varieties was almost the same, though productivity index was higher in Alinja 84.

Comparison of the productivity of durum and bread wheat genotypes showed that under Absheron conditions the durum wheat variety Garagylchyg 2 and the bread wheat variety Alinja 84 were more productive. In general, among early maturing wheat genotypes these genotypes were more efficient for the Absheron peninsula.

Maximal indices were also found for the durum wheat variety Garagylchyg 2 and the bread wheat variety Alinja 84 as a result of the analysis of productivity of wheat varieties cultivated in the Jalilabad region. Thus, similar results were obtained almost for all the studied genotypes. Regarding to the tolerance, Garagylchyg 2 and Alinja 84 were more tolerant as well.

The results of the experiments performed in Gobustan were completely different. Because, contrary to previous regions, early maturing genotypes are not considered as characteristic for the Gobustan region. Generally, bread wheat varieties were more productive compared with durum wheat varieties. Thus, maximum productivity for Gobustan and Garagylchyg 2 was found to be 550 g/m^2 and 400 g/m^2, respectively.

It should be noted that the evaluation of the studied early maturing wheat genotypes was conducted based on their tolerance to diseases, height, productivity and architectonics.

To examine the accuracy of the obtained data, some indices were analyzed statistically. First of all, according to the structural analysis, the correlation between structural elements was established and regression model was constructed.

As seen in the table there is a positive correlation between result trait and factor trait. So when factor trait (x) increases, result trait (y) also increases.

The results of the spike structural analysis are shown in table 2.

Table 1. Productivity indices of wheat genotypes.

Genotypes	Absheron Experimental Base Station		Jalilabad Regional Experimental Station	Gobustan Regional Experimental Station
	Irrigated, g/m^2	Drought, g/m^2		
Garagylchyg 2	617	457	515	400
Alinja 84	473	380	485	340
Alinja 84	518	493	585	450
Gobustan	423	405	455	550

Table 2. Characteristics of productivity and its structural elements in the studied wheat genotypes (Absheron-2017).

Wheat genotypes	Variant	Spike weight, g	Width of spike, cm	Length of spike, cm	Number of spikelets, number	Number of grains per spike	Weight of grain per spike, g
Garagylchyg 2	I	4.74	1.16	9.88	22.2	50	2.07
	II	3.3	1.14	7.25	19	48	1.02
Alinja 84	I	3.99	1.4	9.5	21	45.7	1.85
	II	2.91	1.16	8.4	17.8	40.2	1.02
Alinja 84	I	2.59	1.26	9.64	16.2	38.6	1.8
	II	2.5	1.44	9.46	16.2	37.2	1.05
Gobustan	I	2.73	1.22	11.7	17.8	42.5	2
	II	2.69	1.3	10.6	17.4	40.2	1.6

Table 3. Correlation analysis of the spike elements.

	Spike weight (y)	Width of spike (x_1)	Length of spike (x_2)	Number of spikelets (x_3)	Number of grains per spike (x_4)	Weight of grain per spike (x_5)
Spike weight (y)	1					
Width of spike (x_1)	-0.244	1				
Length of spike, (x_2)	-0.130	0.275	1			
Number of spikelets (x_3)	0.979	-0.256	-0.094	1		
Number of grains per spike (x_4)	0.877	-0.485	-0.231	0.910	1	
Weight of grain per spike (x_5)	0.435	0.002	0.725	0.434	0.321	1

As can be seen from the table, the spike elements of the studied wheat genotypes are analyzed and the results are presented in two variants. Given the difference in options, it is possible to note that in all the indicators of the spike there is a decrease in drought versus other variant. According to the research, the difference between the varieties of some wheat genotypes in comparison to other genotypes is characterized by drought resistance.

In the next table, there is a correlation between the indicators that accurately characterize the spike.

First of all correlation between the spike weight and other indices was analyzed. As can be seen in table 3, there is a closer connection between the number of spikelets and the number of grains per spike in the spike elements.

The correlation is weak, if the relation between these indices is expressed with a value less than 0.3, and a negative value shows that these indices do not depend on each other or even a negative correlation exists. On the other hand, if the values ranged from 0.5 to 0.7, the correlation is strong and above 0.9 corresponds to the formation of the functional correlation.

The smallest average index was observed in the spike width, the largest in the number of grains. This is attributed to the fact that average values were calculated on the basis of the spike width, which is the smallest index.

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Müxtəlif Torpaq İqlim Şəraitində Becərilən və Yetişmə Müddətinə Görə Fərqlənən Buğda Genotiplərinin Morfofizioloji Tədqiqi

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Azərbaycan Respublikası KTN Əkinçilik Elmi Tədqiqat İnstitutunun
Bitki fiziologiyası və biotexnologiya şöbəsi

Məqalədə, əsasən müxtəlif torpaq-iqlim şəraitində becərilən yetişmə müddətlərinə görə fərqlənən bərk və yumşaq buğda genotiplərində müxtəlif assimiləedici orqanların assimliyasiya səthi sahəsinə quraqlığın təsiri müəyyənləşdirilmişdir. Ölçmələr zamanı əldə olunan nəticələrin dəqiqliyini yoxlamaq üçün bir sıra məhsuldarlıq göstəriciləri arasında statistık tədqiqatlar aparılmışdır.

Açar sözlər: *Quraqlıq, buğda genotipləri, assimiləedici orqanlar, bitki metabolizmi, tez yetişən buğda genotipləri*

Морфо-физиологические Исследования Генотипов Пшеницы с Различным Периодом Созревания, Выращенных в Различных Почвенно-Климатических Условиях

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Отдел физиологии растений и биотехнологии Научно-исследовательского института земледелия МСХ Азербайджанской Республики

Изучено влияние засухи на площадь поверхности различных ассимилирующих органов генотипов твердой и мягкой пшеницы с различным периодом созревания, выращенных в различных почвенно-климатических условиях. Для установления точности данных, был проведен статистический анализ некоторых показателей производительности.

Ключевые слова: *Засуха, генотипы пшеницы, ассимилирующие части, метаболизм растений, рано созревающие генотипы пшеницы*