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EVALUATION OF WINTER WHEAT GENOTYPES UNDER RAINFED FARMING CONDITIONS

*©**Jahangirov A.**, Ph.D., Gobustan Zonal Experimental Station, Gobustan, Azerbaijan*
*©**Mammadova S.**, Ph.D., Azerbaijan Sciences Research Institute of Agriculture, Baku, Azerbaijan*
*©**Allahverdiyev T.**, Ph.D., Azerbaijan Sciences Research Institute of Agriculture, Baku, Azerbaijan*
*©**Huseynova I.**, Academician Azerbaijan NAN, Dr. habil., Scientific and Research Institute of Molecular Biology of the National Academy of Sciences of Azerbaijan, Baku, Azerbaijan, zahid.mustafayev67@mail.ru*

ОЦЕНКА ГЕНОТИПОВ ОЗИМОЙ ПШЕНИЦЫ В УСЛОВИЯХ БОГАРНОГО ЗЕМЛЕДЕЛИЯ

*©**Джахангиров А. А.**, канд. с.-х. наук, Гобустанская зональная опытная станция, п. Гобустан, Азербайджан*
*©**Мамедова С. М.**, канд. биол. наук, Азербайджанский научно-исследовательский институт земледелия, г. Баку, Азербайджан*
*©**Аллахвердиев Т. И.**, канд. с.-х. наук, Азербайджанский научно-исследовательский институт земледелия, г. Баку, Азербайджан*
*©**Гусейнова И. М.**, акад. НАН Азербайджана, д-р биол. наук, Институт молекулярной биологии и биотехнологии НАН Азербайджана, г. Баку, Азербайджан*

Abstract. Drought has a serious effect on the plant height, the heading date and the grain yield of winter wheat genotypes in Mountainous Shirvan. Genotypes of Sonmez 01, Sheki 1, Bezostaya 1 and Gyzilbughda were noted as the tallest (120.1, 118.9, 114.9 and 111.8 cm), Gyrmizigul 1, Guneshli, Tale 38, Aran, Zirva 85 and Azamatli 95 as the short (83.6, 92.8, 95.8, 92.9, 94.0 and 98.0 cm), respectively, which indicates the adaptability of tall varieties for rainfed conditions. Gobustan, Zirva 85, Ruzi 84 and Gunashli genotypes were noted as the early heading, and Bezostaya 1, Sheki 1, Aran, Tale 38, Gyrmizigul 1 and Baba 75 as the late heading, which is associated with their genotypic characteristics. The yield was changed depending on the genotypic characteristics and annual total precipitation during the growing season. The highest yield was recorded in Gobustan and 7WON-SA no. 465 genotypes, while the lowest yield was in Azeri, Bezostaya 1 and Murov 2 during the research. Adaptation to adverse conditions and high yielding of Gyrmizigul 1 genotype shows the possibility of cultivation under adverse conditions. By adaptability to drought high yield of genotypes can be obtained responding to high soil fertility and favorable climatic conditions. Cultivation of these genotypes in rainfed regions such as Mountainous Shirvan is recommended.

Аннотация. Засуха оказывает серьезное влияние на высоту растений, сроки колошения и урожайность зерна генотипов озимой пшеницы в Горном Ширване. Генотипы Сонмез 01, Шеки 1, Безостая 1 и Гызылбугда отмечены как самые высокие (120,1, 118,9, 114,9 и 111,8 см), Гырмызигул 1, Гюнешли, Тале 38, Аран, Зирва 85 и Азаматлы 95 как низкорослые (83,6, 92,8, 95,8, 92,9, 94,0 и 98,0 см) соответственно, что свидетельствует о приспособленности высокорослых сортов к богарным условиям. В качестве ранней товарной позиции отмечены генотипы Гобустан, Зирва 85, Рузи 84 и Гюнешли, а в качестве поздней товарной позиции Безостая 1, Шеки 1, Аран, Тале 38, Гырмизигул 1 и Баба 75, что связано с их генотипическими особенностями. Урожайность изменяли в зависимости от генотипических признаков и годовой суммы осадков за вегетационный период. Наивысшая урожайность отмечена у генотипов Гобустан и 7WON-SA №465, а наименьшая у Азери, Безостая 1 и Муров 2 в ходе исследований. Адаптация к неблагоприятным условиям и высокая урожайность генотипа Гырмизигул 1 свидетельствует о возможности выращивания в неблагоприятных условиях. Благодаря адаптивности к засухе можно получить высокие урожаи генотипов, отвечающих высокому плодородию почвы и благоприятным климатическим условиям. Рекомендуется выращивание этих генотипов в богарных районах, таких как Горный Ширван.

Keywords: winter wheat, rainfed farming, plant height, heading, crop yield.

Ключевые слова: озимая пшеница, богарное земледелие, высота растений, появление соцветий, урожайность.

Wheat as a widely adapted crop is grown from temperate, irrigated to dry and high-rain-fall areas and from warm, humid to dry, cold environments. Increasing wheat production is a priority task facing agricultural and biological sciences and producers in most of countries in the world.

Increasing the wheat yield can be achieved only by creating diseases and pests-resistant varieties, as well as tolerant to extreme environmental factors and adaptingto the ecological conditions of each region varieties [1].

Yield is an important indicator for evaluating the ecological plasticity and stability of the variety which indicates the level of intensity of technological cultivation. Plasticity is an adaptive response of genotypes to changes in the growing environment. Evaluation of the adaptability of variety to environmental conditions by its ecological plasticity and yield stability is effective [5].

Drought resistance is usually quantified by grain yield under drought. Wheat grain yield under drought, however, depends on yield potential as well as the phenology of the genotype [3].

Changes in climatic conditions during the growing season of winter wheat in the Mountainous Shirvan region seriously effect crop production and leads to an increase or decrease in yield. Selection of adaptive, relatively plastic varieties for the region can provide a significant increase in yield in favorable years, as well as stable production under adverse conditions.

Materials and methods

The research was conducted on 16 winter wheat genotypes in 2010-2018 years in rainfed conditions of the Mountainous Shirvan region, in the Gobustan Regional Experimental Station (RES) of the Research Institute of Crop Husbandry with the average amount of precipitation — 406.0 mm [6]. The investigated genotypes were planted in three replicates in the randomly placed blocks with the area of each experimental unit 32.0 m^2, the sowing rate 450 germinating seeds per 1 m^2. The hydrothermal coefficient (HTC) was calculated for the autumn and spring periods of plant growth and the total growing period using the method of G. T. Selyaninov to assess the degree of moisture supply of the growing year.

During the growing period the data from the Gobustan hydrometeorological station was used. Phenological observations were carried out according to Kuperman during the growth period [10].

In the complete maturity stage, the experimental areas were harvested with a mini-experimental combine FotonGushen, and the yield was determined by weighing. The analysis of the results was carried out by using JMP 5.0.1 and Genstat statistical software.

Results and discussions

The course of the climatic conditions of the growing year has a serious impact on the morphophysiological parameters and the yield of winter wheat. Therefore, following the course of climatic conditions of the year is significant in the discussion of development and crop yield [4].

The long-term average of precipitation and temperature during growing years are shown in Table 1. Except 2011-2012 growing year average annual temperature was above normal in other growing years. The amount of annual precipitation varied at 218.3-451.8 mm and was above the long-term average in 2010-2011 and 2016-2017 growing years, near to long-term average in 2011-2012, 2012-2013, 2015-2016, 2017-2018, and below the long-term average in 2013-2014 and 2014-2015 growing years.

Table 1

AVERAGE PRECIPITATION AND TEMPERATURE IN THE 2010-2018 GROWING YEARS

Months	*Growing seasons*	
	Precipitation, mm	*Temperature, °C*
September	31.0	17.13
October	45.0	11.2
November	36.0	6.0
December	30.0	2.03
January	26.0	−0.23
February	35.0	0.13
March	42.0	3.06
April	47.0	9.2
May	47.0	14.93
June	40.0	19.46
July	14.0	22.63
August	13.0	21.96
Average	406.0	10.6

The hydrothermal coefficient (HTC) value, calculated for different stages of the growing year and the growing season as a whole, more accurately characterizes the moisture supply of the year [7]. The Selyaninov's hydrothermal coefficient (HTC) calculated for autumn (October-November) and spring (April-June) periods of winter wheat growth, as well as for the growing season are given in Table 2.

Table 2

THE VALUE OF THE HYDROTHERMAL COEFFICIENT AT DIFFERENT STAGES OF WINTER WHEAT GROWING

Years	*October-November*	*April-May-June*	*Full vegetation period*
2010-2011	0.8	1.4	1.2
2011-2012	3.5	0.5	0.4
2012-2013	0.8	1.1	1.0
2013-2014	0.8	0.3	0.4
2014-2015	1.7	0.3	0.5
2015-2016	3.8	0.7	1.2
2016-2017	2.9	1.7	1.9
2017-2018	2.0	0.8	1.1

As indicated in the table 2, the calculated value of HTC for the full vegetation of winter wheat in 2010-2011, 2012-2013, 2015-2016, 2016-2017 and 2017-2018 was ‘low’ (1.2, 1.0, 1.2, 1,9 and 1.1), and in 2011-2012, 2013-2014 and 2014-2015 growing seasons ‘moderately low’, so the value of HTC was 0,4, 0,4 and 0.5, respectively.

It showed that the annual humidity supply was at a ‘dry’ level. Thus, based on the values of these indicators at different stages of the growing season and throughout the growing season, the climatic conditions of 2010-2011, 2012-2013, 2016-2017 and 2017-2018 growing years were favorable, in the 2014-2015 and 2015-2016 were moderate, and in the 2011-2012 and 2013-2014 growing seasons were adverse for the development of winter wheat.

Plant height and heading date of studied genotypes

The height of winter wheat plants grown under rainfed conditions is one of the morphological indicators that strongly depend on the climatic conditions of the year. The soil moisture and air temperature play an important role in the development of plant height during the stem elongation stage under rainfed conditions [8].

According to the results of years of research, Sonmez 01, Sheki 1, Bezostaya 1 and Gyzil bughda varieties were marked as the tallest genotypes (average value of eight years — 120.1, 118.9, 114.9 and 111.8 cm). The Gyrmyzy gul 1, Gunashli, Tale 38, Aran, Zirva 85 and Azamatli 95 were marked as short-stature genotypes (83.6, 92.8, 95.8, 92.9, 94.0 and 98.0 cm). These results were expected since the specified varieties are mainly intended for irrigation conditions. The rest of the studied genotypes had intermediate height [9].

The role of the heading date under water stress conditions is important in yield formation. Frequent droughts under the rainfed conditions of the Mountainous Shirvan region, cause soil water deficit, and as a result, plants are exposed to drought stress. This feature was evaluated to determine the differences in the heading date of the wheat genotypes differing in morphophysiological features.

According to the average eight-year data, Gobustan, Zirva 85, Ruzi 84, and Gunashli belong to the early heading group with 12-13 days (heading is indicated as a day from May 1). Gyzil bughda, Sonmez 01, Azeri, Murov 2, 7thWON-SA no. 465 and Azamatli 95 — to the medium heading group with 14-15 days, and rest of the genotypes belong to late heading with 17-20 days. The difference between the heading dates of the genotypes was related to their genotypic characteristics.

The yield of studied genotypes

The study of the yield of new varieties and yield stability, plasticity and variety adaptability under rainfed conditions of the Mountainous Shirvan of great importance [3]. So, the yield of 16 varieties of winter wheat was studied in 2010-2018 (eight years) growing seasons, and the average yield parameters for the research years also was provided. The highest value of average yield was observed in the 2013, 2017 and 2018growing seasons (69.8, 67.4 and 66.9 c/ha), respectively. High hydrothermal coefficient (1.0, 1.9 and 1.1 respectively) was observed in the years of the study.

The normal development of plants occurred by reason of favorable conditions for winter wheat, and the harvest quantity was in accordance with their genetic yield potential. The lowest value of the average yield was recorded in 2012, however the annual amount of precipitation was 362.8 mm in the 2011-2012 growing seasons, which should have ensured a sufficient harvest of winter wheat.

The study of hydrometeorological factors of the 2011-2012 growing seasons showed that the climatic conditions were adverse during the fall period of 2011. So, the quite adequate precipitation observed during October 2011, and the normal air temperature affected seedling emergence

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positively. In November, despite sufficient rainfall, the air temperature decreased significantly. Thus, the average air temperature in the first and second decade of November was 4.2 and 1.1 °C, respectively, the lowest decrease in average temperature was observed (2 °C) in the third decade. Decrease in the minimum air temperature (−8 °C in the first decade, −3.9 °C in the second and -10.4 °C in the third decade) was not typical for the region and had a negative impact on the development of plants. Below zero temperatures in December, January and February of the 2011-2012 growing seasons caused the death of some plants by frost.

As a result, the above factors caused a serious decrease in the number of plants per unite area. Therefore, in the 2011-2012 growing seasons, the low number of plants in a unite area seriously affected the yield, as a result the yield this year was significantly lower than in other years (average yield 27.2 hwt/ha). This indicates that the yield of wheat also strongly depends on the autumn period of growing season. In 2013-2014 and 2014-2015, the yield was observed to be 47.3 and 53.0 c/ha, respectively.

In our opinion, the low HTC in these years (respectively 0.4 and 0.5) caused a decrease in yield compared to other years. The average yield for all genotypes was 49.8 c/ha in 2016 (lower than in 2015). In spite of the high value of HTC 2016 (1.2), the yield was low. In 2016, the yield of Bezostaya 1, Gyzil bughda, Sheki 1, Sonmez 01, Aran, Azeri and Murov 2 was significantly low than in 2015 due to the stripe rust damage.

The statistical analyzes conducted to determine the resistance indicators included 15 varieties. According to the table, differences at the confidence level of 0.01 of yield between the studied genotypes during the growing seasons were observed. The results of the calculated average yield of the studied varieties in 8 years are given in Table 3.

High yield values were observed in Gobustan (A-group) and 7thWON-SA no. 465 (B-group) genotypes, medium yield in Bezostaya 1, while Azeri and Murov 2 are the lowest (all three are H-group), and other genotypes showed average results. AMMI (Additive main effects of ANOVA along with the multiplicative interaction effects of Principal Components Analysis) analysis was carried out in the Genstat program to study the stability parameters of the yield of the studied genotypes and to get information about their adaptability, and the linear dependence of the yield of the genotypes on the environmental factor was established.

The following linear regression equations were established for each variety in the form of y= a + bx based on these dependencies:

7th WON-SA no. 465	yield (c/ha) = 1,56+1,12 *EI
Aran	yield (c/ha) = 2,72+0,92 *EI
Azeri	yield (c/ha) = −0,90+0,90 *EI
Bezostaya 1	yield (c/ha) =1,72+0,84 *EI
Azamatli 95	yield (c/ha) = −7,73+1,13 *EI
Gunashli	yield (ce/ha) = 3,64+1,00*EI
Murov 2	yield (c/ha) = −6,44+1,01*EI
Gyrmyzy gul 1	yield (c/ha) = 4,82+1,01*EI
Gyzil bughda	yield (c/ha) = −1,22+0,10*EI
Gobustan	yield (c/ha) = 0,64+1,19*EI
Ruzi 84	yield (c/ha) = 3,75+0,87*EI
Sonmez 01	yield (c/ha) = 7,80+0,84*EI
Sheki 1	yield (c/ha) = −1,04+0,95*EI
Tale 38	yield (c/ha) = −4,95+1,18*EI
Zirve 85	yield (c/ha) = −4,37+1,04*EI

Table 3

YIELD OF STUDIED GENOTYPES BY GROWING SEASONS

Genotypes	Yield, c/ha								
	2011	2012	2013	2014	2015	2016	2017	2018	Average
7thWON-SA №465	76,2 b	30,4 abc	79,8 ab	55 a	57,8 b	60,3 ab	74,6 ab	73,1 b	63,4 B
Aran	63,4 e	27,7 bcde	62,8 f	45,9 de	53,2 de	45,3 fg	69,6 cde	60,8 efg	53,6 EF
Azeri	47 h	25,5 de	66,8 de	44,2 efg	48,8 f	37,1 i	59,6 h	60,4 fg	48,7 H
Bezostaya 1	41,1i	25,6 de	62,1f	44,6 defg	49,1 f	39,6 hi	61,3 h	63,1 def	48,3 H
Azamatli 95	48,2 h	20,1 f	67,3 de	43,7 efg	57,6 bc	54,2 c	68,3 def	75,7 b	54,4 E
Gunashli	69,7 cd	30,5 abc	74 c	51,1 abc	55,2 bcd	53,4 c	67,9 defg	69,6 c	58,9 D
Murov 2	56,6 g	24,5 e	70 d	41,3 g	43 g	38,3 hi	59,6 h	59,2 g	49,1 H
Gyrmizi gul 1	73,8 bc	31,5 ab	76,7 bc	53,9 ab	56,8 bcd	53,5 c	67,5 defg	69,6 c	60,4 C
Gyzil bughda	65,5 de	27,5 cde	63,3 f	45 defg	49,6 ef	44 g	70,4 cd	64,6 d	53,7 EF
Gobustan	82,5 a	31,7 a	81,8 a	54,6 a	63,4 a	62,1 a	75 a	80,4 a	66,4 A
Ruzi 84	50,6 h	26,2 de	70,1 d	45,4 def	48,5 f	51,7 cd	60,5 h	59,4 g	51,6 G
Sonmez 01	57,7 fg	28,8 abcd	62,7f	50,2 bc	55,7 bcd	47,4 ef	66,8 efg	64,3 d	54,2 EF
Sheki 1	58,3 fg	27,4 cde	64,2 ef	41,8 fg	49,7 ef	40,5 h	65,5 fg	62,5 def	51,2 G
Tale 38	70,2 c	26,3 de	76,8 bc	48,3 cd	54 cd	58,5 b	71,7 bc	73,5 b	59,9 CD
Zirva 85	61,9 ef	23,8 ef	68,9 d	44,4 defg	47,4 f	49,2 de	65 g	63,4 de	53 F
Average	61,5 C	27,2 G	69,8 A	47,3 F	52,7 D	49 E	66,9 B	66,6B	55,1
LD (0.01) variety	4,4	4	3,5	4	3,8	3	3	2,8	1,2
LD (0.01) year					1,2				
%	4,2	8,7	3	5	4,3	3,7	2,7	2,5	3,9

The Environmental index represents the average yield of all genotypes of the growing season. Bezostaya 1, Ruzi 84 and Sonmez 01 are the genotypes with the least plasticity and high adaptability. The yield of these genotypes is permanent in adverse climatic conditions compared to eco plastic i. e. intensive type. Since such genotypes can provide greater value at lower costs, it is expedient to cultivate them in extensive conditions. 7th WON-SA no. 465 and Gobustan show both adaptabilities to adverse conditions and high plasticity, which indicates their specific adaptation. Thus, these genotypes respond to high agricultural backgrounds and favorable climatic conditions and increase yield, but also show compatibility with unfavorable conditions.

Therefore, the cultivation of these varieties in rainfed regions such as Mountainous Shirvan, and in high agricultural backgrounds creates conditions for obtaining high yields.

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