*Journal of Life Sciences & Biomedicine, vol. 5(78), No 2, p. 61-70 (2023)*

# Evaluation of wheat genotypes according to morphophysiological and economic value characteristics under drought conditions

**Javanshir Talai[1*], Tofig Allahverdiyev[1,2], Sevda Abdulbagiyeva[1], Irada Ibrahimova[1], Atif Zamanov[1]**

*[1]Research Institute of Crop Husbandry, Ministry of Agriculture of the Republic of Azerbaijan, Sovkhoz 2, AZ1098, Baku, Azerbaijan*
*[2]Institute of Molecular Biology & Biotechnologies, Ministry of Science and Education of the Republic of Azerbaijan, 11 Izzat Nabiyev Str., AZ1073, Baku, Azerbaijan*

***For correspondence:** talai.akinchi63@gmail.com*

Received: October 11, 2023; Received in revised form: November 14, 2023; Accepted: December 04, 2023

**The main goal of the research was a comparative assessment of zoned genotypes of durum and bread wheat, under drought conditions, according to morphophysiological and economically valuable traits, grain quality indicators, determining the correlation between them and their use in breeding. It has been established that plants, due to increased temperature and accelerated transpiration in the afternoon, are more susceptible to the effects of drought. From this point of view, the values of daily water deficit according to the experimental variants varied in a wide range at the heading phase - the formation of wheat grains. In contrast to the daytime water deficit, all varieties, regardless of water availability, restored the missing water in the plant by reducing transpiration at night. This pattern was confirmed by the results obtained from the residual water deficit of flag leaves. The values of water-holding capacity, which is an indicator of plant resistance to drought, in flag leaves of wheat genotypes, were high mainly under drought conditions, regardless of the biological characteristics of the varieties. Based on many years of research, it has been established that the area of flag leaves in plants reaches its maximum size in the heading-flowering phase. In the studied genotypes, the area of flag leaves varied within the range of 15.8-40.7 cm$^2$ under irrigation, 12.5-36.0 cm$^2$ under drought, the difference between the variants ranged from 10.0% to 43.8%. The specific surface density of flag leaves in wheat varieties, as an important photosynthetic trait, varied over a wide range among the studied varieties. In wheat genotypes with high values, the specific surface density of leaves in both variants led to high grain yield per unit area. This led to high grain yield per unit area in both options. In general, the size of the grain yield due to drought in the studied varieties decreased by 16.5-38.2%. The bread wheat genotypes Gyrmyzy gul 1, Jumhuriyet 100 and Khazri with high architectonics, grain yield (732-746 g/m$^2$ and 477-538 g/m$^2$), were distinguished in both variants by their short stature, better restoration of lost water at night, and optimal area sizes flag leaf (15.8-25.9 cm$^2$ and 12.5-23.3 cm$^2$) and high values of the specific surface density of flag leaves (0.408-0.777 g/dm$^2$ and 0.509-0.596 g/dm$^2$), low values of length from flag leaf of the spike (11.5-15.9 cm and 7.7-12.6 cm), the optimal length of the last internode (15.3-19.0 cm and 15.4-18.5 cm), with small distances from the last node to the spike (28.2-33.4 cm and 23.6-29.8 cm), high protein yields (85.6-91.8 g/m$^2$ and 62.8-69.4 g/m$^2$) per unit area. Correlations between morphophysiological and economically valuable traits of wheat differed under drought conditions. Similar positive and negative correlations between the studied traits under drought conditions were also obtained in the irrigated variant. However, in contrast to the water-supplied variant of plants, under drought conditions, positive and negative correlations were obtained between the WHC of the flag leaf with TWC (r=0.680), LLIN with LLNS (r=0.642*), YI with GY (r=0.667*), amount of protein in grain with TWC (r=0.873**), protein yield per unit area and GY(r= 0.967**), MI (r=0.609*), yield index and LLNS (r=-0.629).**

https://doi.org/10.59849/2710-4915.2023.2.61
Available online 31 December 2023

***Keywords:*** *Drought, wheat, genotype, water regime, morphophysiological characteristics, yield, yield index, quality, correlation dependencies*

## INTRODUCTION

Today, water shortage is considered one of the main pressing problems facing agriculture. The critical situation in meeting the irrigation water needs of the population and agriculture has worsened, primarily due to climate change. The land and water resources that support agricultural production and food security for the world's population are under threat. Agriculture currently uses 11% of the world's land and 70% of freshwater resources for agricultural production (FAO, 2012 ).In this regard, the annual volume of total surface water resources, which has become one of the decisive factors for the sustainable development of the agricultural sector of Azerbaijan, is 30-31 cubic km. In dry years, this reserve decreases to 20.3 cubic km. Two-thirds of our water supplies are generated outside the country. Therefore, Azerbaijan did not remain aloof from these risks. All this requires the study of the morphophysiological, biochemical and agronomic principles of creating drought-resistant plant varieties for arid regions, as well as the use of technologies that save water resources in agriculture.

In 2019-2023, the total area under wheat, considered strategic for the country, fluctuated between 572.4-672.2 thousand hectares. Over the past five years, the total volume of wheat production in Azerbaijan amounted to 1736.1-2171.5 thousand tons, the average yield was 3.17-3.29 tons/ha. This allows us to cover up to 60% of our wheat needs in the country. Since up to 40% of wheat crops fall in the rain-fed regions of the country. Drought, which often occurs during the reproductive phase of wheat growing season in rain-fed areas, causes a decline in overall wheat production. To obtain a high yield in the rainfed regions of the country, it is necessary to use highly reproductive, certified seeds of drought-resistant wheat genotypes, soil and moisture protection technologies. Effective breeding is based on a comprehensive study of morphophysiological and economically valuable traits and the creation of new wheat genotypes on this basis. Therefore, genotypes containing the results of a multidisciplinary comprehensive assessment are considered competitive (Maimistov, 2000; Talai, 2010). Currently, numerous studies conducted using the comparative method under irrigation and drought conditions have established the presence of correlations between morphophysiological and economically valuable traits when studying the photosynthetic activity of wheat (Aliev et al., 1988; Jahangirov, 2023; Jahangirov et al., 2022). In this regard, drought stress is considered one of the main factors limiting wheat production in the world. One of the main reasons for the decrease in winter wheat yield is an increase in air temperature and lack of moisture in the soil, as a result of which the normal course of physiological and biochemical processes in plants is disrupted. Studying the water regime, morphophysiological and economically valuable characteristics of wheat genotypes under drought conditions will allow us to draw conclusions about their resistance to drought (Tamrazov, 2021). When determining a wheat breeding strategy under drought conditions, many researchers considered it advisable to evaluate germplasm both in near-optimal and under stress conditions (to protect drought-resistant alleles) (Bauder, 2001; Balota et al., 2007).

Drought stress affects many morphological and physiological parameters of winter wheat. To increase the efficiency of the selection of drought-resistant varieties, it is necessary to select indicators that can accurately show the drought resistance of the variety. Many researchers, when assessing wheat for drought resistance, considered it important to study plant height, structural elements of the crop, the amount of water in the leaf, photosynthetic traits, photosynthesis intensity, $CO_2$ concentration in the intercellular region, peroxidase activity and the amount of abscisic acid (Xiaoyuan et al., 2023; Bardees et al., 2020). The study of water regime indicators, including the water-holding capacity of leaves of winter wheat genotypes during drought, is of great practical importance. Genotypes of common wheat resistant to water stress were distinguished by high values of the water-holding capacity of leaf tissues during the heading-flowering phase (Nekrasov et al., 2020). The water-holding capacity of leaves is positively related to the drought resistance of the variety under field conditions and economically valuable traits, which is especially noticeable in dry years. The maximum values of grain weight in the main ear, lateral stems and the plant as a whole were formed in those varieties that have a slight loss of moisture during wilting (Sanina, 1996 ). On days of high temperatures (May, June), a sharp increase in the intensity of transpiration leads to an imbalance in the water balance in the wheat plant and, as a consequence, to a lack of water. One of the signs of this is a sharp increase in water shortage in the second half of the day, which is accompanied by a decrease in the rate of $CO_2$ assimilation during photosynthesis. Of course, all this does not go unnoticed by the plant and is manifested by disruption and retardation of growth and reproductive processes, all of which ultimately lead to a decrease in plant productivity (Ergashev et al., 2010).

The main goal of the study was to compare varieties of durum and bread wheat, zoned under drought conditions, according to morphophysiological and economically valuable characteristics, grain quality indicators, to determine the relationships between them and their use in breeding. Based on the purpose of the research, the tasks ahead include studying the effect of drought on water regime indicators, morphophysiological characteristics, yield, harvest index, amount of protein in grain and protein yield per unit area of wheat varieties.

## MATERIALS AND METHODS

Field experiments to achieve this goal were carried out in the fall of 2020-2022. at optimal sowing dates (between the third ten days of October and the first ten days of November) and the norm (200 kg/ha) at the Absheron experimental base of the Research Institute of Agriculture. Field experiments were carried out in 4 replicates on an area of 25 sq. m. The site where the experimental field is located on Absheron is located in circles N 40º31. 957ʿ latitude and E 49º52. 525ʿ longitude, at an altitude of 6 m above sea level. The climate of Absheron is predominantly moderate, hot and dry, with favorable conditions. This is a windy and low-precipitation (200-400 mm) region of the republic, the average annual air temperature is 13.9ºC. The common gray-brown type of soil in Absheron has alkaline properties, carbonate, the amount of total humus in the arable layer is low and amounts to 1.27-1.32%. As the object of study, 3 genotypes of durum and 9 bread wheat were used, zoned and belonging to the selection of the Scientific Research Institute of Crop Husbandry. In the studied wheat genotypes, the angle of deviation of flag leaves from the stem ranged from 10-80º, and in the bread wheat varieties Tale 38, Girmyzy gul 1 and Jumhuriyet 100 with high architectonics and vertically oriented leaves, it ranged from 10-20º. The tetra- and hexaploid wheat genotypes were studied in irrigated (control) and arid (experimental) variants and optimal fertilizer rates ($N_{90}$, $P_{90}$, $K_{60}$). In the control variant, the plants were watered 3-4 times depending on the year of vegetation. In field experiments, the dynamics of moisture distribution in soil layers of 0-20, 20-40 and 40-60 cm (Lysogorov et al.,1985), the development phases of winter wheat and the stages of organogenesis were determined using the thermostat-weight method, were determined using the Fix and Zadox scales (Large,1954 ). The water regime of flag leaves, including total water capacity (TWC), daily water deficit (DWD) and residual water deficit (RWD), water holding capacity (WHC) based on the guidelines of the All-Russian Institute of Plant Genetic Resources named after N.I.Vavilov (Borodina,1987 ), the areas of flag leaves were determined using an automatic leaf area meter "AAS-400", manufactured in Japan, and the specific surface density of the leaf (SSLD) was calculated as the ratio of the biomass of leaf samples to its area. Productivity was calculated based on the weight of grain in sheaves taken from 1 sq. m. The amount of total nitrogen was determined by the modified Keldahl micromethod using a Kjeltec TM8200 instrument manufactured by FOSS (Pleshkov, 1976). To calculate the amount of protein, the coefficient Nx 5.70 was used. The amount of raw gluten corresponds to state standards (Sozinov, 1977), the yield index was calculated as the ratio of grain to plant biological mass. Correlation dependencies between morphophysiological and economically valuable traits were determined using the statistical program SPSS 16. 0.

## RESULTS AND DISCUSSION

During the years of research, the dynamics of moisture distribution in different soil layers were studied, starting from the 1st ten days of March to June. In wheat, this period covers from the end of the spring tillering phase to the phase of waxy ripeness of the grain. Depending on meteorological and growing conditions, the distribution of moisture in soil layers during the growing season varied depending on a number of factors, including the water supply of crops. Optimal soil moisture for most crops, including wheat, should be 65-85% of the minimum field soil moisture capacity. In this regard, the experimental plot in the control version was watered to maintain soil moisture at a given level during the growing season. During the tillering phase, the plants' need for water is minimal; starting from the tubing phase, it begins to increase due to the intensive formation of above-ground biomass. No significant differences were observed between the treatments at the end of the tillering phase and at the beginning of booting. Therefore, starting from the end of the tubing phase, the difference between the variants in soil moisture begins to increase due to a gradual increase in air temperature and irrigation of the experimental plot in the control variant. In general, the average soil moisture during the growing season in the control variant ranged from 78.7-57.8%, and in the experimental variant – 59.7-31.8% based on the lowest field moisture capacity. As you can see, the plants cultivated in the experimental version, especially in the reproductive period of the growing season, are in unfavorable conditions. The role of water regimes in the drought resistance of biological systems is irreplaceable. Since the physiological processes occurring in plants largely depend on the amount and state of water in cells and tissues. All this, in turn, determines the direction and intensity of these processes. In this regard, when determining the response of wheat genotypes to different water regimes, it is of great importance to study the indicators of different tiers of leaves, other vegetative and generative organs in different phases of vegetation development. Therefore, studying the indicators of the water regime of plants under drought conditions allows us to formulate ideas about the drought resistance of wheat varieties (Clarke et al.,1982; Rustamov et al., 2012 ).

During the years of research, some indicators of the water regime, including total water capacity, daily water deficit, residual water deficit and water-holding capacity in the flag leaf tissues of durum and bread wheat genotypes, were comparatively studied depending on water availability during the heading-formation period of grain.

High values of total water capacity in leaf tissues of wheat genotypes under drought conditions had a positive effect on the course of physiological processes in plants. In the studied genotypes of durum and bread wheat during the period of heading-grain formation, the TWC values in flag leaves in the control variant ranged from 66.8-72.5%, and under drought conditions 63.6-70.8%. At the reproductive stage of the growing season in the control variant, the maximum TWC values at noon were observed in the wheat genotypes Garagylchyg 2, Giymatli 2/17, Gyrmyzy bugda, Deyirman and varied between 71.3-72.5%. At noon, the difference between the options according to TWC data was 1.7-3.2%. Compared to the control variant under drought conditions, minimal decreases in the TWC value in flag leaves at noon were recorded in the wheat genotypes Gyrmyzy bugda, Barakatli 95, Khazri, Nurlu 99, Jumhuriyet 100, Saratovskaya 29, and the maximum values were recorded in the genotypes Deyirman, Giymatli 2/17, which amounted to 0.7-3.3% and 5.5-6.8%, respectively. The tall wheat genotype Gyrmyzy bugda differed in both variants in its maximum TWC values (Fig.).

Plants, as a result of rising temperatures and accelerated transpiration in the afternoon, are more susceptible to the effects of soil and atmospheric drought. From this point of view, the daily water deficit was determined in flag leaves during the period of heading and grain formation. DWD expresses the amount of water missing in plant tissues due to soil and atmospheric drought. During this growing season, the DWD values according to the experimental variants varied in a wide range and amounted to 17.4-24.9% and 19.3-30.7%, respectively.

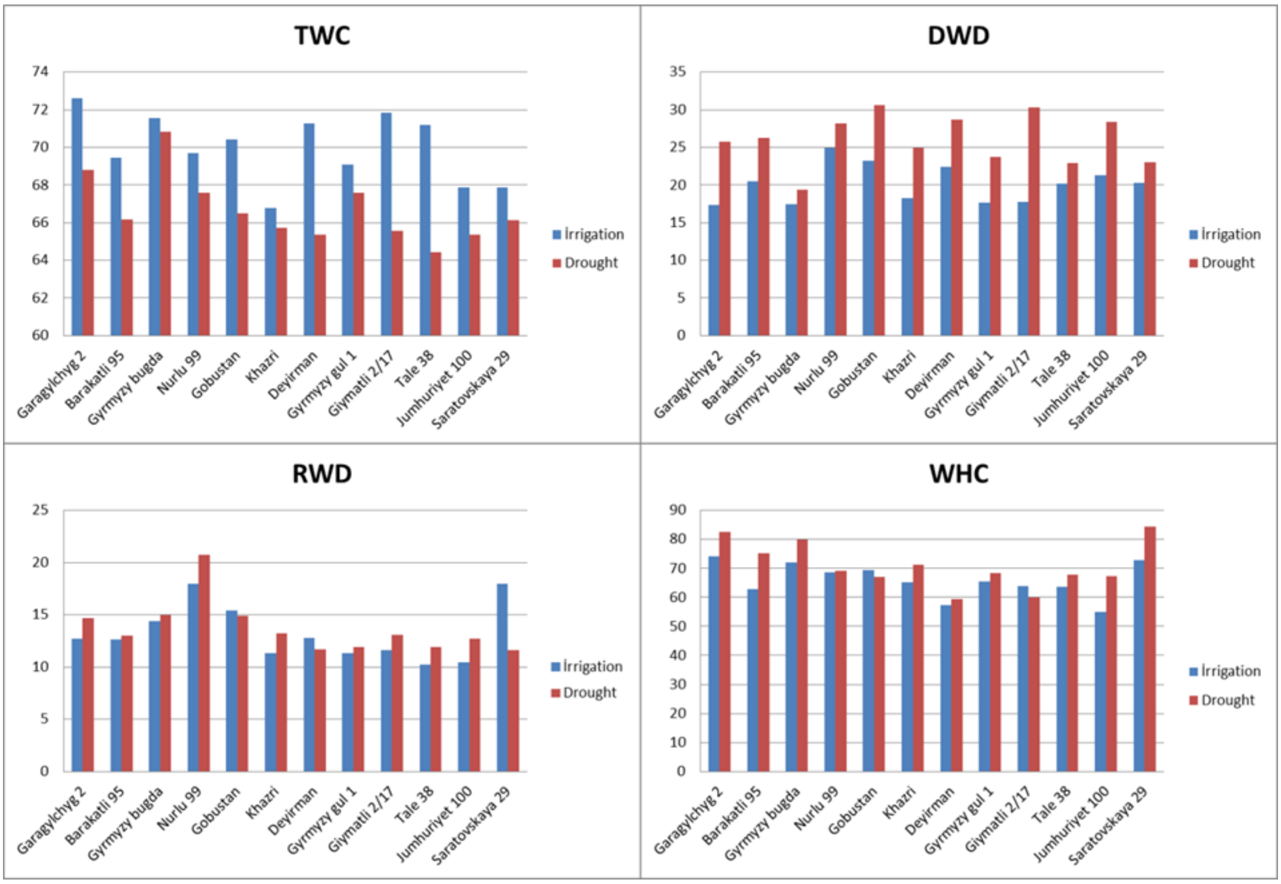


**Fig.** Some indicators of the water regime of flag leaves of durum and bread wheat varieties depending on water availability, % (Absheron, average indicators 2021-2023); ***Note:*** TWC - total water capacity, DWD - daily water deficit, RWD - residual water deficit, WHC - water holding capacity

In the experimental version, since the plants suffered from drought, this led to high values of DWD in flag leaves; this difference ranged from 0.6-16.6% depending on the biological characteristics of the genotypes studied. The highest rates of DWD during drought were observed in the genotypes Gobustan (30.7%), Giymatli 2/17 (30.3%), Deyirman (28.7%), Nurlu 99 (28.2%), and the lowest values in Gyrmyzy bugda (19.3%), Tale 38 (22.9%), Saratovskaya 29 (23.0%), Gyrmyzy gul 1 (23.7%) (Figure).

All genotypes, in contrast to DWD, restored the missing water in the plant by reducing transpiration at night. This pattern was confirmed by the results obtained from the residual water deficit of flag leaves. Therefore, RWD is considered the most reliable and objective indicator of drought resistance. The water supply is set early in the morning, before sunrise, so at this time transpiration is reduced to a minimum and reflects the lack of water that plants cannot recover in the evening. Indicators of RWD in leaves of the studied wheat genotypes were 10.2-17.9% in the irrigated variant and 11.6-20.8% under drought conditions. Plants grown under irrigated conditions were relatively better at restoring the missing water at night. This is due to the regulation of soil moisture according to the lowest field moisture capacity and the strong development of the root system in the control variant. Under drought conditions, the common wheat genotypes Saratovskaya 29, Deyirman, Gyrmyzy gul 1, Tale38, Jumhuriyet 100, Khazri worked effectively, better restoring the missing water at night, and the water content values fluctuated between 11.6-13.3% (Figure).

**Table 1.** Morphophysiological characteristics of durum and bread wheat genotypes depending on water availability (Absheron, average for 2021-2023)

| Genotype name | Variant of experience | Flag leaf area, $cm^2$ | Specific surface density of the flag leaf, $g/dm^2$ | Length from the flag leaf of the spike, cm | Length of the last internode, cm | Length from the last node to the spike, cm |
|---|---|---|---|---|---|---|
| **Durum wheats** | | | | | | |
| Garagylchyg 2 | irrigation | 25.0 | 0.534 | 20.1 | 14.5 | 42.0 |
| | drought | 15.5 | 0.430 | 13.7 | 15.7 | 31.9 |
| Barakatli 95 | irrigation | 23.6 | 0.524 | 15.2 | 15.6 | 36.2 |
| | drought | 17.7 | 0.517 | 11.1 | 12.8 | 30.2 |
| Gyrmyzy bugda | irrigation | 33.3 | 0.388 | 33.1 | 25.5 | 60.7 |
| | drought | 27.1 | 0.388 | 17.5 | 21.7 | 44.7 |
| **Bread wheats** | | | | | | |
| Nurlu 99 | irrigation | 23.8 | 0.449 | 20.5 | 14.8 | 30.5 |
| | drought | 18.4 | 0.528 | 18.4 | 16.0 | 35.5 |
| Gobustan | irrigation | 25.5 | 0.421 | 20.2 | 19.7 | 42.1 |
| | drought | 21.6 | 0.536 | 18.6 | 16.4 | 40.7 |
| Khazri | irrigation | 25.9 | 0.508 | 15.9 | 19.0 | 33.4 |
| | drought | 23.3 | 0.509 | 12.6 | 18.5 | 29.8 |
| Deyirman | irrigation | 34.0 | 0.594 | 16.0 | 16.2 | 32.3 |
| | drought | 19.1 | 0.316 | 12.6 | 14.8 | 31.8 |
| Gyrmyzy gul 1 | irrigation | 15.8 | 0.777 | 13.6 | 15.3 | 31.1 |
| | drought | 12.5 | 0.596 | 7.70 | 15.4 | 23.6 |
| Giymatli 2/17 | irrigation | 40.7 | 0.388 | 16.0 | 17.5 | 35.9 |
| | drought | 36.0 | 0.269 | 8.00 | 14.8 | 26.2 |
| Tale 38 | irrigation | 35.4 | 0.464 | 24.1 | 16.3 | 46.8 |
| | drought | 30.4 | 0.448 | 19.5 | 16.7 | 39.6 |
| Jumhuriyet 100 | irrigation | 20.6 | 0.675 | 11.5 | 19.0 | 28.2 |
| | drought | 16.4 | 0.566 | 10.5 | 17.6 | 28.2 |
| Saratovskaya 29 | irrigation | 19.7 | 0.491 | 28.8 | 23.2 | 51.1 |
| | drought | 15.2 | 0.623 | 24.5 | 19.8 | 45.7 |

The water-holding capacity of leaves, being an indicator of plant resistance to drought, was high in the non-irrigated version, regardless of the biological characteristics of the genotypes. Because the WHC indicators of flag leaves in the control variant changed in the range of 54.9-74.2%, and in the experimental variant 59.4-84.4%. This difference was 4.5-10.2% compared to the control variant. Under drought conditions, the highest WHC values were observed in the genotypes Garagylchyg 2, Saratovskaya 29, Gyrmyzy bugda, Barakatli 95, and Khazri, the minimum values were noted in the genotypes Deyirman, Giymatli 2/17, which varied between 71.2-84.8 and 59.4-60.0% respectively. The remaining genotypes were in an intermediate position according to these indicators. However, minimal differences between the variants in terms of WHC values were observed in the genotypes Nurlu 99, Gobustan, Deyirman, and Gyrmyzy gul 1 (Figure).

The morphophysiological characteristics that determine the productivity of the studied wheat genotypes were once again confirmed in the studies conducted. Table 1 for the studied genotypes shows the maximum values of the flag leaf area (FLA), the specific surface density (SSD), length from the flag leaf of the spike (LFLS) and the length of the last internode (LLIN), the length from the last node to the spike (LLNS). In this aspect, a comparative study of the activity of photosynthesis under conditions of irrigation and drought, combining several important features, provided certain information about the role of leaves as an assimilation organ in the formation of the crop and its potential.

Based on many years of research, it has been established that the area of flag leaves in plants reaches its maximum size in ontogenesis during the heading-flowering period. In the studied genotypes, the area of flag leaves ranged from 15.8-40.7 $cm^2$ under irrigation and 12.5-36.0 $cm^2$ under drought, the difference between the variants varied within 10.0-43.8%. In both variants, the wheat genotypes of the extensive type Gyrmyzy bugda (37.8 and 30.8 cm$^2$), Giymatli 2/17 (40.7 and 36.0 cm$^2$) distinguished themselves with the maximum sizes of flag leaves, with the minimum values Gyrmyzy gul 1 (15.8 and 12.5 cm$^2$), Jumhuriyet 100 (20.6 and 16.4 cm$^2$), Saratovskaya 29 (19.7 and 15.2 cm$^2$). The remaining varieties were in an intermediate position according to this indicator. The bread wheat genotypes Gyrmyzy gul 1, Jumhuriyet 100, Khazri, which have high architectonics and optimal leaf area sizes, were also distinguished by high grain yields. Similar results were obtained for wheat genotypes based on the specific surface density of flag leaves (SSD). These indicators for the experimental variants were 0.388-0.777 g/dm$^2$ and 0.269-0.623 g/dm$^2$. Under irrigated conditions, wheat varieties were characterized by predominantly high SSDL values. The difference between the variants in terms of LPL was 1.34-46.8 %. In the Gyrmyzy bugda variety, the size of the SSDL was the same in both variants. The smallest difference between the options was observed in Barakatli 95 and Tale 38 wheat, and the largest difference was noted in the Deyirman and Ghiymatli 2/17 wheat genotypes and ranged from 1.34-3.45% and 30.7-46.8%, respectively. In both variants, the maximum SSDL values were distinguished by the intensive type wheat Gyrmyzy gul 1 (0.777 and 0.596 g/dm$^2$), Jumhuriyet 100 (0.675 and 0.566 g/dm$^2$), the minimum genotypes of the extensive type Gyrmyzy bugda (0.388 g/dm$^2$) and Giymatli 2/17 (0.388 and 0.269 g/dm$^2$). High values of SSDL made it possible to more effectively use assimilation processes involved in leaf growth to form the assimilation surface area of wheat varieties (Table 1).

The length of the donor-acceptor path plays an important role in the transport of assimilates. Here, the size, length from the flag leaf of the spike (LFLS), is of great importance. There is an opinion that when it is short, rapid movement of assimilates from the leaves to the ear is ensured. At this time, the consumption of organic substances for respiration decreases, which leads to an increase in the accumulation of substances in the grain (4). However, in different genotypes, a positive correlation between the LFLS and the size of the yield is not always observed. In the studied genotypes, the LFLS ranged from 11.5-33.1 cm under watering and 7.7-24.5 cm under drought. The genotypes Gyrmyzy gul 1 (13.6 and 7.7 cm), Jumhuriyet 100 (11.5 and 10.5 cm) were distinguished by small values of spikelets in both studied variants; the maximum sizes were noted in wheat varieties of the extensive type, tall Gyrmyzy bugda (33.1 and 27.5 cm), Saratovskaya 29 (28.8 and 24.5 cm) (Table 1).

During the years of the research, plant height (PH), length of the last internode (LLIN) and length from the last node to the ear (LLNS), which are considered one of the main morphobiological characteristics of wheat varieties, have been comparatively studied. Many researchers note a high correlation between plant height and the length of the last internode and drought resistance, especially during the heading phase. Thus, the latter is very sensitive to unfavorable environmental conditions, especially drought. In the genotypes participating in the study, plant height during irrigation was 80.7-130.6 cm, LLIN - 15.4-25.5 cm, LLNS – 28.2-60.7 cm, and during drought, respectively, fluctuated within 76.5-121.3 cm, 14.5-21.7 cm and 28.2-45.7 cm. The short-stemmed group included the genotypes of wheat Gyrmyzy gul 1 (80.7 and 76.5 cm), Deyirman (83.3 and 74.2 cm), the tall group included the extensive type of wheat Gyrmyzy bugda (130.6 and 121.3 cm) and Saratovskaya 29 (120.6 and 108.7 cm). Similar results for the indicated genotypes were obtained when measuring LLIN and LLNS. The results obtained allowed us to conclude that there is a positive correlation between plant height and LLIN and LLNS. The depression of plant height under drought conditions, depending on the biological characteristics of the variety, was 1.8-13.5%, according to LLIN 0.65-17.9%, LLNS 1.5-27.0% (Table 2).

The grain yield (GY) of different wheat genotypes varies depending on the biological characteristics of the variety, soil and climatic conditions, meteorological factors of the growing season and water availability. Average long-term grain yields obtained at the Absheron experimental base, under irrigation conditions, amounted to 418-746 g/m$^2$, under drought conditions 319-538 g/m$^2$.

**Table 2.** Economically valuable characteristics of durum and bread wheat genotypes depending on water availability (Absheron, on average for 2021-2023)

| Genotype name | Variant of experience | Plant height, cm | Grain yield, g/m$^2$ | Yield index | 1000 grain weight, g | Protein content in grain, % | Protein yield, g/m$^2$ |
|---|---|---|---|---|---|---|---|
| **Durum wheats** | | | | | | | |
| Garagylchyg 2 | irrigation | 88.5 | 463 | 0.36 | 44.4 | 12.9 | 59.7 |
| | drought | 80.5 | 319 | 0.31 | 39.9 | 14.9 | 47.5 |
| Barakatli 95 | irrigation | 92.3 | 524 | 0.34 | 49.4 | 12.3 | 64.5 |
| | drought | 87.7 | 324 | 0.28 | 43.8 | 13.0 | 42.1 |
| Gyrmyzy bugda | irrigation | 130.6 | 439 | 0.19 | 47.1 | 12.7 | 55.8 |
| | drought | 121.3 | 366 | 0.21 | 41.9 | 14.7 | 53.8 |
| **Bread wheats** | | | | | | | |
| Nurlu 99 | irrigation | 89.1 | 486 | 0.34 | 39.3 | 12.8 | 62.2 |
| | drought | 77.1 | 375 | 0.34 | 33.2 | 13.9 | 52.1 |
| Gobustan | irrigation | 94.0 | 610 | 0.39 | 44.1 | 12.2 | 74.4 |
| | drought | 92.3 | 423 | 0.33 | 34.1 | 14.0 | 59.2 |
| Khazri | irrigation | 86.5 | 740 | 0.42 | 46.9 | 11.9 | 88.1 |
| | drought | 78.5 | 483 | 0.32 | 41.9 | 13.0 | 62.8 |
| Deyirman | irrigation | 83.3 | 595 | 0.36 | 53.2 | 12.3 | 73.2 |
| | drought | 74.2 | 449 | 0.35 | 46.4 | 12.9 | 57.9 |
| Gyrmyzy gul 1 | irrigation | 80.7 | 746 | 0.43 | 39.0 | 12.3 | 91.8 |
| | drought | 76.5 | 538 | 0.40 | 35.4 | 12.9 | 69.4 |
| Giymatli 2/17 | irrigation | 86.6 | 443 | 0.34 | 49.7 | 12.3 | 54.5 |
| | drought | 82.6 | 359 | 0.30 | 44.5 | 13.3 | 47.7 |
| Tale 38 | irrigation | 95.9 | 603 | 0.35 | 43.9 | 12.1 | 72.9 |
| | drought | 89.6 | 473 | 0.31 | 39.1 | 13.2 | 62.4 |
| Jumhuriyet 100 | irrigation | 88.6 | 732 | 0.42 | 43.7 | 11.7 | 85.6 |
| | drought | 83.5 | 477 | 0.35 | 38.4 | 13.5 | 64.4 |
| Saratovskaya 29 | irrigation | 120.6 | 418 | 0.28 | 34.2 | 13.1 | 54.8 |
| | drought | 108.7 | 349 | 0.28 | 31.6 | 13.5 | 47.1 |

The grain yield of the common wheat genotypes Gyrmyzy gul 1, Khazri, Jumhuriyet 100, characterized by high architectonics, vertical orientation of leaves and optimal FLA sizes, lower values of RWD and high values of SSD of flag leaves, the short base of LFLS in both variants was high. The yield of these varieties ranged from 603 to 746 g/m$^2$ under irrigated conditions and 477-538 g/m$^2$ under drought conditions. In both options, the minimum yield values were obtained for the extensive wheat genotypes Gyrmyzy bugda, Garagylchyg 2, Saratovskaya 29 and Giymatli 2/17. For these genotypes, the average yield values for the options were 29.9 and 21.4% less than for other genotypes, respectively. This contrast in productivity indicators is also reflected in the yield index (YI) of wheat genotypes. Similar results were obtained on high-yielding varieties. The yield index, which expresses the ratio of grain yield and the amount of total biomass, under irrigation conditions was 0.19-0.43 and under drought – 0.21-0.40 for the studied genotypes. In both variants, the genotypes of bread wheat Girmyzy gul 1, Jumhuriyet 100 with high productivity also differed in terms of the yield index. In these genotypes, 42-43% of the organic mass collected during irrigation is used to form the crop, and 35-40% during drought. In both options, the lowest yield index values were obtained for the tall wheat genotypes Gyrmyzy bugda and Saratovskaya 29. Here, the share of the grain yield in the total biological harvest was 19-28 and 21-28%, respectively. Thus, the growth of dry biomass in genotypes of this type occurs mainly due to vegetative organs (Table 2).

The studied wheat genotypes also differed in 1000 grain weight (TGW) depending on growing conditions. The weight of 1000 grains, considered the main indicator of grain filling and size, was expressed in contrasting values in the genotypes studied. Thus, the weight of 1000 grains fluctuated between 34.2-53.2 g during irrigation and 31.6-46.4 g during drought. Under the influence of drought, the weight of 1000 grains decreased to 12.1%. According to this indicator, the minimum differences between the variants were obtained in the Saratovskaya 29 (7.6%), Gyrmyzy Gul 1 (9.2%) genotypes, the maximum differences in the Gobustan genotype (22.7%) (Table 2).

Determining the biochemical parameters of grain is of great importance when characterizing the quality indicators of wheat genotypes depending on water availability. From this point of view, the studied genotypes differed sharply in protein content in grain(PCG) and protein yield(PY) per unit area under different growing conditions. The maximum values of the amount of protein in grain were obtained in the dry variant. Under irrigation, these figures were 11.7-13.1%, in dry conditions – 12.9-14.9%. Genotypes of durum wheat Gyrmyzy bugda, Garagylchyg 2, Gobustan, Nurlu 99, Jumhuriyet 100, Saratovskaya 29 bread wheat under drought conditions were distinguished by the highest levels (13.5-14.9%) of protein content in grain. The studied genotypes also differed in protein yield per unit area depending on cultivation conditions. The protein yield per unit area for irrigated wheat genotypes was 54.5-91.8 g/m$^2$, and during drought – 42.1-69.4 g/m$^2$. The highest yields of protein per unit area in both variants were distinguished by the high-yielding varieties Gyrmyzy gul 1, Jumhuriyet 100, Khazri, Tale 38, Gobustan. These indicators for the options were 72.9-91.8 g/m$^2$ and 59.2-69.4 g/m$^2$ (Table 2).

During the years of research, depending on the water supply, the correlations between the morphophysiological and economically valuable characteristics of wheat genotypes were comparatively studied.

Under irrigation conditions, highly significant positive correlations were recorded between plant height and the WHC of the flag leaf (r=0.694*), WHC and RWD (r=0.694*), FLA and TWC (r=0.641*), LFLS and WHC of the leaf (r=0.723**), PH (r=0. 904**), LLNS and WHC of the flag leaf (r=0.654*), plant height (r=0. 898**) and LFLS (r=0.933**), GY and SSD of the flag leaf (r=0.595*), SBAU and PH (r=0.861), LFLS(r=0.666*), LLNS (r=0.705*), TGW and FLA (r=0.668) *), amount of protein in grain and WHC ( r=0.735**), WHC(r=0.832**) and LFLS (r=0.640*). However, under these conditions, highly significant negative correlations were also recorded between the SSD of the flag leaf with the FLA (r=-0.753**), YI and PH (r=-0.875**), LFLS (r=-0.864**), LLNS (r=-0.824**), TGW and WHC of the flag leaf (r=-0.622*), protein content in grain and GY (r=-0.804**), YI (r=-0.630*), LLIN and YI (r=-0.621*).

Correlations between morphophysiological and economically valuable traits of wheat differed under drought conditions. Similar positive and negative correlations between the studied traits under drought conditions were also obtained in the irrigated variant. However, in contrast to the water-supplied variant of plants, under drought conditions, positive and negative correlations were obtained between the WHC of the flag leaf with TWC (r=0.680), LLIN with LLNS (r=0.642*), YI with GY (r=0.667*), amount of protein in grain with TWC (r=0.873**), protein yield per unit area and GY(r=0.967**), MITGW (r=0.609*), yield index and LLNS (r=-0.629).

## CONCLUSIONS

Thus, the size of the grain yield due to drought in the studied genotypes decreased by 16. 5-38. 2%. The bread wheat genotypes Gyrmyzy gul 1, Jumhuriyet 100 and Khazri with high architectonics, grain yield (732-746 g/m$^2$ and 477-538 g/m$^2$), were distinguished in both variants by their short stature, better restoration of lost water at night, and optimal area sizes flag leaf (15.8-25.9 cm$^2$ and 12.5-23.3 cm$^2$) and high values of specific surface density of flag leaves (0.408-0.777 g/dm$^2$ and 0.509-0.596 g/dm$^2$), low values of length from flag leaf of the spike (11.5-15.9 cm and 7.7-12.6 cm), the optimal length of the last internode (15.3-19.0 cm and 15.4-18.5 cm), with small distances from the last node to the spike (28.2-33.4 cm and 23.6-29.8 cm). cm), high protein yields (85.6-91.8 g/m$^2$ and 62.8-69.4 g/m$^2$) per unit area.

## REFERENCES

**Aliev J.A., Kazibekova E.G.** (1988) The importance of photosynthetic traits in yield and their use in the selection of ideal wheat. In the collection Photosynthesis and the production process (edited by A.A. Nichiporovich). M.: p. 237-243 (in Russian)

**Balota M., Payne W.A., Evett S. R., Peters T.R.**

(2008) Morphological and physiological traits associated with canopy temperature depression in three closely related wheat lines; doi: 10.2135/cropsci 2007. 06. 0317

**Bardees M., Heshmat A., Mustafa E.** (2020) Effect of drought on yield of ten wheat cultivars linked with their flag leaf water status, fatty acid profile and shoot vigor at heading. *Physiol. Mol. Biol. Plants*, **26(6):** 1111-1117; doi: 10.1007/s12298-020-00807-0.

**Bauder J.** (2001) Irrigating with limited water supplies. Montana State Univ. Comm. Ser. Montana Hall. Bozeman, MT., V. 59717.

**Borodina R.A.** (1987) Comprehensive physiological assessment of drought and heat resistance of wheat in the conditions of Uzbekistan. Ed. by N.N. Kozhushko. *Method. Directions*. Leningrad, 24 p. (in Russian).

**Clarke J.M., McCaid T.N.** (1982) Excised - leaf water retention capability as an indicator of drought resistance of triticum genotypes. *Canad. J. Plant Science,* **62(3):** 571-578.

**Ergashev A.E., Abdullaev A.A., Karimov Kh.H., Ibrokhimov K., Rakhimov M.** (2010) The influence of soil drought on water exchange in wheat leaves. *Reports of the Academy of Sciences of the Republic of Tajikistan*, **53(1):** 64-69 (in Russian).

**Jahangirov A.A.** (2023) Morphophysiological basis of selection of winter bread wheat (*Triticum aestivum* L.) in the conditions of Mountain Shirvan. *Abstract dissertation doc. biol. sciences*, Baku, 49 p. (in Azerbaijani).

**JahangirovA.A., Allahverdiyev T.I., Huseynova I. M. et al.** (2022) Some morphological and physiological traits of bread wheat genotypes grown under irrigated, rainfed and drought conditions. *Cereal Research Communitions,* **08:** 905-911; doi: 10.1007/s42976-022-00248-3.

**Large E.** (1954) Growth stages in cereals: Illustration of the Feeke's. *Pl. Path.*, **3:** 128-129.

**Lysogorov S.D., Ushkarenko V.A.** (1985) Workshop on irrigated agriculture. M.: Agropomizdat, 128 p. (in Russian).

**Maimistov V.V.** (2000) Physiological foundations of wheat selection. *Dissertation doc. biol. science*s, 314 p. ( in Russian).

**Managing systems at risk** (2012) FAO, 310 p.

**Nekrasov E.I., Ionova E.V.** (2020) Water-holding capacity of winter bred wheat varieties under different growing conditions. FGBNU “Agrarian Scientific Center “Donskoy”, Russia, Rostov region, Zernograd, **3(23):** 122-130 (in Russian).

**Pleshkov B.P.** (1976) Workshop on biochemistry of agricultural crops. M.: Kolos, 256 p. (in Russian).

**Rustamov Kh. N. , Talai J. M.** (2012**)** On methods for studying the indicators of the water regime of wheat genotypes. *Collection of scientific works of the Azerbaijan Research Institute of Crop Husbandry*, **XIII:** 109-117 (in Azerbaijani).

**Sanina N.V.** (1996) Using the water-holding capacity of leaves in assessing spring wheat varieties for drought resistance in the forest-steppe conditions of the middle Volga region. *abstr. of the dissertation for the scientific degree of candidate of agricultural sciences,* Kinel, 18 p. (in Russian).

**Sozinov A.A.** (1977) Methodological recommendations for assessing grain quality. Moscow, 172 p. (in Russian).

**Talai J.M.** (2010) Biological and economic peculiarities of newly developed wheat varieties. *Proceedings of the Azerbaijan National Academy of Sciences (biological sciences), special issu*e, **5(5-6):** 216-223.

**Tamrazov T. G.** (2021) The influence of drought on the morphophysiological parameters and productivity indicators of the studied local wheat genotypes. *Agricultural Sciences* , **7(10):** 45-56 (in Russian).

**Xiaoyuan B., Xiaoyang H., Weiwei D. et al.** (2023) Screening and evaluation of drought resistance traits of winter wheat in the North China Plain. *Frontiers in Plant Science*, **10:** 3389; doi: 10.3389/fpls.2023.1194759.

**ORCIDS**

Javanshir Talai: https://orcid.org/0009-0002-6848-3646
Tofig Allahverdiyev: https://orcid.org/0000-0002-6039-7068
Sevda Abdulbagiyeva: https://orcid.org/0009-0004-8710-4976
Irada Ibrahimova: https://orcid.org/0009-0005-3569-3112
Atif Zamanov: https://orcid.org/0009-0004-8299-2038