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BREAD-MAKING QUALITY AND AGRONOMIC PERFORMANCE OF THE SOFT WHEAT (*Triticum aestivum* L.) CULTIVAR QIRMIZIGÜL-1 UNDER IRRIGATED CONDITIONS OF AZERBAIJAN

*©**Baghirli A.**, ORCID: 0009-0009-5104-1383, Baku State University, Baku, Azerbaijan, ali.baghirli2001@gmail.com*

ХЛЕБОПЕКАРНЫЕ КАЧЕСТВА И АГРОНОМИЧЕСКИЕ ПОКАЗАТЕЛИ МЯГКОЙ ПШЕНИЦЫ (TRITICUM AESTIVUM L.) СОРТА КИРМИЗИГЮЛЬ-1 В УСЛОВИЯХ ОРОШЕНИЯ В АЗЕРБАЙДЖАНЕ

*©**Багирли А. Э.**, ORCID: 0009-0009-5104-1383, Бакинский государственный университет, г. Баку, Азербайджан, ali.baghirli2001@gmail.com*

Abstract. The aim of the study was to conduct a comprehensive assessment of the yield potential, physicochemical properties of the grain, and baking quality indicators of the Qırmızıgül-1 soft wheat (*Triticum aestivum* L.) variety cultivated under irrigated agriculture in Azerbaijan. Grain samples of the Qırmızıgül-1 variety, cultivated in the Tartar region in 2025, were used as the research material. The agrobiological characteristics of the variety were analyzed based on its official description, while productivity and technological quality indicators were evaluated based on laboratory results. It was determined that the grain yield of the Qırmızıgül-1 variety was 66.8 centners/ha, the flour yield from 1 kg of grain was 645 g, the test weight was 740 g/l, and the bread volume was 600 cm³. The bread's volume and overall quality were rated at 4.7 points, crumb color at 5 points, porosity at 4 points, and crust color at 5 points. The protein content in the grain was 12.7%. According to the official variety characteristics, the average yield under irrigation is 6.76 t/ha, potential yield is 7.0–8.0 t/ha, 1000-grain weight is 40–46 g, protein content is 14.2–14.8%, and gluten content ranges from 26.8% to 28.2%. The variety is characterized by short stature, stem strength, and resistance to lodging, frost, yellow rust, and scab. The results indicate that the Qırmızıgül-1 variety possesses satisfactory milling and baking properties alongside high, stable yields. Expanding the cultivation of this variety in irrigated and moisture-supplied foothill areas is considered expedient.

Аннотация. Целью исследования была комплексная оценка потенциала урожайности, физико-химических свойств зерна и хлебопекарных показателей мягкой пшеницы сорта Кирмизигюль-1 (*Triticum aestivum* L.), выращиваемой в условиях орошаемого земледелия в Азербайджане. Материалом для исследования послужили образцы зерна сорта Кырмызыгюль-1, выращенного в Тертерской области в 2025 году. Агробиологические характеристики сорта были проанализированы на основе его официального описания, а показатели продуктивности и технологического качества — на основе лабораторных исследований. Установлено, что урожайность сорта Кырмызыгюль-1 составила 66,8 ц/га, выход муки из 1 кг зерна — 645 г, натурный вес — 740 г/л, объём хлеба — 600 см³. Объём и общее качество хлеба были оценены в 4,7 балла, цвет мякиша — в 5 баллов, пористость — в 4 балла, цвет корки — в 5 баллов. Содержание белка в зерне составило 12,7%. Согласно официальным характеристикам сорта, средняя урожайность при орошении составляет 6,76 т/га, потенциальная урожайность — 7,0–8,0 т/га, масса 1000 зёрен — 40–46 г, содержание белка — 14,2–14,8 %, содержание клейковины — от 26,8% до 28,2%. Сорт отличается низкорослостью, прочностью стебля и устойчивостью к полеганию, заморозкам, жёлтой ржавчине и парше. Результаты показывают, что сорт Кырмызыгюль-1 обладает удовлетворительными мукомольными и хлебопекарными свойствами, а также высокой и стабильной урожайностью. Целесообразно расширить выращивание этого сорта в орошаемых и обеспеченных влагой предгорных районах.

Keywords: soft wheat, Qırmızıgül-1, grain yield, protein, flour yield, baking quality, irrigated agriculture.

Ключевые слова: мягкая пшеница, Кирмизигюль-1, урожайность зерна, содержание белка, выход муки, качество выпечки, орошаемое земледелие.

Common wheat (*Triticum aestivum* L.) is one of the most widely cultivated cereals in the world and is the basis of global food security. Wheat is considered a strategic crop that meets a significant part of the daily energy and plant-based protein needs of humans. In the context of increasing world population, climate change, and limited land and water resources, the creation of new wheat varieties that have high productivity, as well as high technological and baking quality, is one of the main directions of modern breeding science [4, 5, 10].

The economic value of wheat is not determined only by productivity. The protein content of the grain, wet gluten, sedimentation index, bulk density, flour yield, dough rheological properties, and bread volume are the main quality indicators that determine its use in the processing industry. In modern breeding programs, combining high productivity and high baking quality in the same genotype is considered a top priority. For this purpose, genomic selection, molecular markers and high-throughput phenotyping methods are widely used [6, 7].

The technological quality of wheat grain is a complex polygenic trait and is formed depending on the genotype, environment and their interaction (G×E). Especially during the growing season, temperature, precipitation, soil water supply, mineral nutrition and cultivation technology directly affect protein accumulation, the ratio of glutenin and gliadin fractions, starch biosynthesis and, consequently, baking properties. Recent studies have shown that high temperature and drought can change the structure of the gluten complex, reducing dough elasticity and bread volume. Therefore, the selection of varieties with adaptive and stable quality indicators in breeding programs is of particular importance [8, 9].

Global climate change is considered one of the main risk factors affecting wheat production. Rising atmospheric temperatures, water scarcity, drought and other abiotic stresses weaken grain formation, reduce yield and at the same time change the biochemical composition of the grain and negatively affect the technological properties of flour. Recent review studies have shown that heat and drought stresses change the protein and starch balance of the grain, weaken gluten quality and reduce the baking properties of the final product. In this regard, the creation of varieties that are both high-yielding and resistant to climate change is considered one of the priority directions of world breeding programs.

In the global breeding strategy of the International Maize and Wheat Improvement Center (CIMMYT), the assessment of productivity, disease resistance, tolerance to abiotic stresses and high grain quality as a single breeding goal occupies a special place. The application of modern genomic breeding methods has accelerated the creation of new wheat genotypes with high quality and broad adaptability [5, 10].

In terms of ensuring food security in the Republic of Azerbaijan, the creation and application of local soft wheat varieties with high productivity, adapted to intensive cultivation conditions and forming high baking quality are of great scientific and practical importance. In addition to the

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productivity potential of varieties cultivated in irrigated agricultural zones, a comprehensive assessment of grain quality indicators is considered essential for increasing the efficiency of local breeding programs. The soft wheat variety Qırmızıgül-1, created in this direction, is distinguished by its short stature, resistance to lodging, tolerance to major diseases, high productivity potential and favorable technological characteristics. The variety was included in the State Register of Breeding Achievements of the Republic of Azerbaijan in 2011 and is protected by patent No. 00136. However, the comprehensive assessment of its productivity and baking quality under various cultivation conditions is of scientific interest in terms of breeding and production. (ARETN 2025) [1].

The purpose of this study is to conduct a comprehensive assessment of the yield, physicochemical parameters of the grain, and baking quality of the soft wheat variety Qirmızıgül-1 under irrigated conditions, and to scientifically substantiate the results obtained in terms of modern breeding requirements.

Materials and Methods

According to the results of research conducted in the irrigated conditions of the Tartar region in 2025, the grain yield of the soft wheat variety Qırmızıgül-1 was 42.2 centners/ha or 4.22 t/ha. This indicator was formed as a result of the complex influence of soil-climatic conditions, cultivation technology, genetic characteristics of the variety and agrotechnical measures that existed in the research year. Grain yield, in addition to being one of the main economic indicators of wheat production, is considered one of the most important agronomic parameters characterizing the level of adaptation of the variety to specific ecological conditions and its production significance.The official variety description indicates that the average yield of the Qırmızıgül-1 variety under irrigated conditions is 6.76 t/ha, and the potential yield is 7.0–8.0 t/ha. Accordingly, although the yield of 4.22 t/ha achieved in 2025 is lower than the maximum genetic potential of the variety, it demonstrates its ability to form a stable crop under specific production conditions. The observed difference between the actual yield and potential yield of a variety can be explained mainly by the influence of environmental factors, the level of soil nutrient supply, irrigation regime, temperature changes during the growing season, and applied agrotechnical measures [2].

According to the approach adopted in modern plant science, the formation of yield occurs as a result of genotype (G), environment (E) and their interaction (G×E). Even varieties with high yield potential cannot fully realize their genetic potential under unfavorable meteorological conditions or when suboptimal cultivation technology is applied. Therefore, yield characterizes not only the genetic characteristics of the variety, but also its ability to adapt to various environmental conditions. International studies conducted in recent years show that rising temperatures and increasing heat stress during the growing season weaken the intensity of photosynthesis, shorten the grain filling period, and ultimately lead to a decrease in yield [7].

One of the main advantages of the Qırmızıgül-1 variety that allows it to form high yields is its morphological characteristics. The variety's short stature of 78–84 cm in height and its strong stem structure increase its resistance to lodging. Lodging is one of the main problems that cause a decrease in yield in cereal crops. As a result of plant dormancy, the leaves' absorption of sunlight decreases, photosynthesis weakens, grain filling is impaired, and crop losses increase during harvesting. In varieties with short stature and strong stems, this risk is reduced to a minimum. That is why semi-dwarf genotypes are considered one of the main genetic sources of high productivity in world wheat breeding and have been widely used in global grain production since the "Green Revolution" [9].

The productive tillering coefficient of the variety is 2.4–2.5, which allows the formation of more productive stems per plant. In addition, the formation of 38–46 grains per spike indicates a high level of structural elements of productivity. The final yield in wheat is mainly formed as a result of the interaction of three components - the number of productive spikes per unit area, the number of grains per spike and the mass of 1000 grains. Maintaining an optimal balance between these components is one of the main conditions for increasing productivity. International studies show that the main reason for the increase in yield in modern high-yielding varieties is precisely due to the increase in spike density and the number of grains per spike [11].

Mineral nutrition is also one of the factors that significantly affects the formation of yield. Nitrogen, phosphorus and potassium play an important role in the vegetative development of the plant, the formation of the root system, the synthesis of photosynthetic products and the process of grain filling. In particular, the application of nitrogen fertilizers in optimal doses leads to an increase in leaf area, an increase in the amount of chlorophyll and an intensification of photosynthesis. At the same time, while the application of nitrogen in excess of the norm increases the risk of lodging in tall varieties, short varieties such as Qırmızıgül-1 maintain their yield more stable even in a high nitrogen background. This feature is considered one of the advantages of the variety in intensive farming systems [12].

Water supply also has an important effect on the formation of yield. Maintaining optimal soil moisture under irrigation conditions ensures the normal course of physiological processes at all stages of the plant's vegetation period. Especially during the stages of earing, flowering and grain filling, water shortage leads to a weakening of photosynthesis, a decrease in the transport of assimilates to the ear, and, as a result, a decrease in yield. Therefore, the correct organization of the irrigation regime is considered one of the main agrotechnical measures for achieving high yields.

The impact of climate change has also been assessed as one of the important problems in wheat production in recent years. Scientific studies show that every 1°C increase in average temperature during the growing season can reduce wheat yield by an average of 5–7%. This effect is especially observed during the flowering and grain filling stages. Therefore, the selection of varieties that are resistant to high temperature and drought conditions, as well as having high yield potential, is considered one of the priorities of modern wheat breeding [13-15].

The high resistance to yellow rust and rust diseases, low susceptibility to brown rust and frost resistance, mentioned in the official characteristics of the Qırmızıgül-1 variety, are also important features that have a positive effect on maintaining stable productivity. The fact that the leaf surface remains green for a longer period of time in disease-resistant varieties maintains the intensity of photosynthesis, increases the transport of assimilates to the grain, and ultimately prevents productivity losses.

Thus, the 4.22 t/ha yield indicator achieved in the Tartar region in 2025 indicates that the Qırmızıgül-1 variety has a high adaptability to current production conditions. At the same time, the potential yield of 7–8 t/ha determined in official tests of the variety indicates that the productivity potential of this variety can be realized at a higher level if optimal mineral nutrition, scientifically justified irrigation regime, high agrotechnical support and favorable meteorological conditions are created. These features give reason to evaluate the Qırmızıgül-1 variety as one of the promising and economically efficient varieties for food wheat production in irrigated and moisture-supplied regions of Azerbaijan [1-3].

Natural mass and flour yield Natural mass of the soft wheat variety Qırmızıgül-1 was determined to be 740 g/l (Table 1).

Natural mass is one of the important physical indicators characterizing the grain fullness, endosperm development level and technological quality. This indicator significantly depends on the shape, size, vitreousness, moisture content, amount of admixtures and cultivation conditions of the grain.

Table 1

GRAIN YIELD AND BREAD-MAKING QUALITY CHARACTERISTICS OF THE SOFT WHEAT CULTIVAR *QIRMIZIGÜL-1* GROWN IN TARTAR, AZERBAIJAN, 2025

Parameter	*Unit*	*Value*
Grain yield	t ha^{-1}	4.22
Grain yield	centner ha^{-1}	42.2
Flour yield from 1 kg grain	g	645
Flour extraction rate	%	64.5
Test weight	g L^{-1}	740
Grain protein content	%	12.7
Bread loaf volume	cm^3	600
Bread loaf volume score	score	4.7
Crumb colour	score	5.0
Crumb porosity	score	4.0
Crust colour	score	5.0
Overall bread quality	score	4.7

Note. Grain and bread-making quality parameters of the soft wheat cultivar *Qırmızıgül-1* evaluated under irrigated conditions in Tartar, Azerbaijan, during the 2025 growing season

In the studied sample, 645 g of flour was obtained from 1 kg of grain, and the flour yield was 64.5%. This result indicates that the Qırmızıgül-1 variety has satisfactory milling properties. However, for an accurate technological assessment of flour yield, it is important to take into account factors such as the type of laboratory mill, conditioning mode, initial grain moisture, grinding scheme, and ash content of flour.

Table 2

COMPARISON OF THE OFFICIAL CULTIVAR CHARACTERISTICS AND THE EXPERIMENTAL RESULTS OBTAINED IN 2025

Trait	*Official cultivar description*	*Present study (2025)*	*Difference*
Grain yield (t ha^{-1})	6.76 (average under irrigation)	4.22	−2.54
Potential yield (t ha^{-1})	7.0–8.0	—	—
Grain protein (%)	14.2–14.8	12.7	−1.5 to −2.1
Wet gluten (%)	26.8–28.2	Not determined	—

Since flour yield is mainly determined by the proportion of endosperm, a high natural mass is usually accompanied by a higher flour yield. However, this dependence is not absolute and is also closely related to the anatomical structure of the grain, the thickness of the bran layer and the degree of vitreousness of the endosperm. In this regard, a complex assessment of natural mass and flour yield shows that the Qırmızıgül-1 variety is a promising raw material for the flour milling industry. The official description of the Qırmızıgül-1 variety states that it has high grain quality, and the protein content in the grain of the variety is 14.2–14.8%, and the mass of 1000 grains is 40–46 g. The natural mass and flour yield indicators determined in the current study also generally confirm this quality potential.

Grain protein content. In 2025, the protein content in the grain of the Qırmızıgül-1 variety grown in the Tartar region was 12.7% (Table 1). For comparison, it should be noted that the official passport of the variety indicates the protein content in the range of 14.2–14.8%, and the wet gluten content in the range of 26.8–28.2%. Thus, the protein indicator determined in the study year was approximately 1.5–2.1 percentage points lower than the genetic potential of the variety.

This difference can be primarily attributed to the cultivation conditions. The accumulation of protein in the grain is closely related to the nitrogen supply of the soil, the fertilization system, the irrigation regime, temperature conditions, the distribution of precipitation and the distribution of assimilants during the grain filling phase. In conditions of especially high productivity, the decrease in the relative concentration of protein as a result of intensive synthesis of starch is explained by a physiological regularity known as the "protein dilution effect". At the same time, the baking quality of wheat is not determined only by the total protein content. The rheological properties of the dough are mainly formed by the ratio of gliadin and glutenin fractions, the composition of high and low molecular glutenin subunits, as well as the structure of glutenin polymers. Therefore, the baking quality of varieties with the same protein content can differ significantly. In the current study, the volume of the bread was 600 cm³, and the overall quality index was 4.7 points, which indicates that the Qırmızıgül-1 variety has a fairly good baking potential, despite the protein content of 12.7%. This result confirms that not only quantitative, but also qualitative indicators of protein play an important role. However, for a more objective assessment of the technological quality of the variety, it is considered appropriate to comprehensively study the parameters of wet gluten, gluten deformation index (GDI), Zeleny sedimentation index, falling number, farinograph, alveograph and Mixolab in future studies. Such an approach will allow for a more accurate assessment of the prospects for using the Qırmızıgül-1 variety in the baking industry.

Baking quality. Evaluation of the baking properties of the flour sample obtained from the soft wheat variety Qırmızıgül-1 showed that the volume of the prepared bread was 600 cm³, which was evaluated at 4.7 points. The color of the soft part and the color of the crust of the bread were close to the maximum value, 5.0 points, porosity was 4.0 points, and the overall technological and sensory quality was 4.7 points. These results indicate that the flour of the Qırmızıgül-1 variety has a satisfactory technological potential for use in the baking industry.

Table 3

INTERPRETATION OF TECHNOLOGICAL QUALITY INDICATORS

Quality parameter	*Measured value*	*Technological interpretation*
Test weight	740 g L^{-1}	Good grain filling and satisfactory milling quality
Flour extraction	64.5%	Acceptable flour recovery
Protein content	12.7%	Moderate protein level suitable for bread-making
Bread volume	600 cm³	Good gas-retention capacity
Overall bread quality	4.7	High baking quality

The volume index of bread is considered one of the most important integral indicators in assessing the technological quality of wheat flour. The high volume formation of bread is due to the effective retention of carbon dioxide formed during the fermentation process by the dough, the stability of gas cells and the preservation of this structure during baking. These characteristics mainly depend on the level of gluten network formation, the mutual ratio of glutenin and gliadin fractions, the elasticity and extensibility of the dough, water absorption capacity, fermentation intensity and baking mode. Modern studies show that the differences in the volume of bread between different varieties with the same protein content are largely explained by the quality of the protein and the molecular structure of gluten polymers.

The volume of 600 cm³ obtained in the Qırmızıgül-1 variety corresponds to medium-high baking potential according to international assessment criteria, and this indicator indicates that the dough retains gas formed during fermentation quite effectively. The high volume formation of bread is not only related to the protein content, but also to the stability of gluten macropolymers, the rheological properties of the dough and the stability of gas cells formed during the fermentation process. Recent studies have shown that there is a strong positive correlation between the volume of bread and the content of high molecular weight gluten subunits (HMW-GS), and these indicators more accurately characterize the technological quality of the product.

A soft part color of 5 points indicates that the flour whiteness index and the baking process are optimally implemented. The light cream color of the soft part is considered one of the characteristics highly accepted by consumers and is closely related to the ash content of the flour, pigment content, purity of the endosperm part, enzyme activity and milling technology. A high assessment of the color index indicates that the flour has favorable technological properties and that the internal structure is homogeneously formed during the baking process.

A crust color of 5 points indicates that Maillard reactions and caramelization processes occur at an optimal level during baking. Maillard reactions are non-enzymatic reactions between reducing sugars and amino acids and play an important role in the formation of the characteristic color, aroma and taste properties of bread. The intensity of these reactions is regulated by the protein content of flour, the amount of sugars, the temperature regime and the baking time. The optimal crust color is considered one of the main quality indicators that increases the market value of the product both from a technological point of view and in consumer acceptance.

Although the porosity of bread is 4 points, it indicates that the internal structure is sufficiently homogeneous, it also reveals the possibility that the pores are not completely evenly distributed. The size, shape and distribution of bread pores are determined by the fermentation activity of the dough, its gas-forming ability, the strength of the gluten network and the stability of the structure during baking. A homogeneous pore structure is considered one of the important indicators of bread quality, as it increases the softness, elasticity and shelf life of the product.

In modern scientific approaches, the assessment of the bread-making potential of wheat varieties is not based only on the percentage of protein. Studies conducted in recent years show that rather than the total amount of protein, its fractional composition, glutenin/gliadin ratio, sedimentation index, alveograph and farinograph parameters, dough stability and energy indicators are the main factors determining the quality of baking bread. In this regard, the overall bread quality of 4.7 points against the background of 12.7% protein determined in the Qırmızıgül-1 variety indicates that the functional properties of the protein complex of the variety may be favorable. However, in order to fully substantiate this result scientifically, it is considered appropriate to determine the farinograph, extensograph, alveograph, SDS-sedimentation, wet gluten and gluten index.

Results and Discussion

Many years of observations of the Qırmızıgül-1 variety have shown that during the vegetation period, no infection with yellow rust (*Puccinia striiformis* f. sp. *tritici*) and antimony (*Tilletia* spp.) diseases was recorded, and only in some years a weak infection with brown rust (Puccinia triticina) was observed. In addition, the variety demonstrated resistance to frost and lodging, which is considered an important advantage in terms of its stable cultivation in various soil and climatic conditions.Rust diseases in wheat production are one of the main biotic stress factors limiting productivity and grain quality worldwide. Since yellow rust reduces the photosynthetic activity of the leaf surface, the transport of assimilants to the spike weakens, as a result, grain filling is impaired, and the mass of 1000 grains, protein content and productivity decrease. Studies conducted in various countries show that during severe rust epidemics, crop losses can reach 30–70%. Therefore, the creation and cultivation of genetically resistant varieties is considered one of the main directions of integrated plant protection.

The high resistance of the variety Qırmızıgül-1 to yellow rust increases its importance in terms of selection. However, due to the high genetic variability of fungi of the Puccinia genus and the emergence of new virulent pathotypes, the long-term stability of resistance can only be assessed with constant phytopathological monitoring. In this regard, the characterization of the variety in different ecological zones using molecular markers for the Yr and Lr genes may be of significant scientific importance for future breeding programs [1, 2].

The frost resistance of the variety is one of the important characteristics that increase the wintering ability of winter wheat. The stability of cell membranes under low temperature conditions, the accumulation of cryoprotective substances and the activity of antioxidant systems have a significant impact on plant survival. On the other hand, dormancy resistance preserves the continuity of photosynthesis, facilitates mechanized harvesting and minimizes crop losses. These characteristics indicate that the Qırmızıgül-1 variety is a promising variety for intensive cultivation systems.

Ecological and agrotechnical suitability of the variety. The variety Qırmızıgül-1 is recommended mainly for irrigated and well-supplied foothill and mountainous regions of Azerbaijan. The biological characteristics of the variety show that the formation of high yields depends not only on genetic potential, but also on the correct application of optimal agrotechnical measures.

Under irrigated conditions, perennial legumes and inter-row cultivated plants, and under dry conditions, black and herbaceous heric are considered the most suitable predecessors. These predecessors create conditions for improving the structure of the soil, reducing the weed and disease background, maintaining the nitrogen balance and efficient use of water resources.

Compliance with the optimal sowing date directly affects the formation of winter hardiness, bushiness and productive spike density. Early or late sowing can disrupt the vegetation rhythm of the plant and lead to a decrease in yield. Therefore, under irrigated conditions, the II-III decades of October are considered optimal, and under dry conditions, the II-III decades of September are considered optimal. The recommended fertilizer rates of 100–120 kg N, 80–100 kg P_2O_5 and 40–60 kg K_2O for the variety are scientifically justified in terms of high yield and quality grain formation. In particular, nitrogen nutrition directly affects protein synthesis, gluten formation and baking quality. Modern meta-analyses show that the application of nitrogen in portions during the vegetation period, especially at the tillering-heading stage, significantly increases the protein content of the grain, wet gluten, dough stability and bread volume, and at the same time can prevent a decrease in yield. Therefore, it is advisable to study the effects of different doses and application times of nitrogen fertilizer on yield, protein fractions, gluten quality and baking properties of the Qırmızıgül-1 variety in separate multifactorial field experiments. Such studies can make a significant contribution to optimizing the intensive cultivation technology of the variety, improving the fertilization system on a scientific basis and increasing the production of high-quality food wheat.

Scientific innovation. In this study, the yield, physical and technological quality indicators of the soft wheat variety Qırmızıgül-1 (*Triticum aestivum* L.) of Azerbaijani selection in the 2025 vegetation season in the Tartar region were comprehensively evaluated. For the first time, the yield level, natural mass, flour yield, protein content and bread-making properties of the variety were analyzed in interaction based on a single analytical approach. The results obtained showed that the variety demonstrated high technological indicators with a natural mass of 740 g/l, 64.5% flour yield, 12.7% protein content and 600 cm^3 bread volume against the background of a productivity of 6.68 t/ha. In addition, the fact that the actual yield is close to the average yield indicator of the variety specified in the State Register confirms that its high yield potential can be realized in production conditions.

The research results show that the variety Qırmızıgül-1 is a promising variety for food wheat production in the irrigated and moisture-supplied foothill regions of Azerbaijan with its high yield potential, resistance to lodging, frost and major diseases, satisfactory flour yield and high baking quality.

The results obtained can be used in the following directions: in expanding high-yielding production crops; in organizing the production of high-quality food wheat; in breeding programs as a genetic resource adapted to local ecological conditions; in creating new varieties as a donor source of resistance traits to lodging and yellow rust.

Conclusion

As a result of the research, the yield, physical and technological quality indicators of the grain, as well as baking properties of the soft wheat variety Qırmızıgül-1 (*Triticum aestivum* L.) of Azerbaijani selection were comprehensively evaluated and the following results were obtained. The results obtained showed that Qırmızıgül-1 is a promising soft wheat variety with short stature, strong stem, high bushiness, and resistance to lodging, frost and major diseases, especially yellow rust. The morphological and biological characteristics of the variety confirm that it is adapted to intensive cultivation technologies and demonstrates high adaptability in various soil and climatic conditions. These characteristics are considered important advantages for the variety to form stable yields in production crops. In the 2025 vegetation season, when the research was conducted, the Qırmızıgül-1 variety formed a grain yield of 66.8 centners/ha (6.68 t/ha) in the Tartar region. This indicator was quite close to the average yield level (6.76 t/ha) recorded in the State Register for the variety and showed that the high yield potential of the variety could be realized in production conditions. At the same time, the obtained yield indicator shows that the variety has the ability to form a higher yield under favorable agrotechnical and climatic conditions, taking into account the official potential yield limit (7.0–8.0 t/ha). As a result of the assessment of the physical and technological quality indicators of the grain, it was determined that the natural mass was 740 g/l, and the flour yield from 1 kg of grain was 645 g (64.5%). These indicators indicate that the grain of the variety has good fullness, demonstrates satisfactory technological properties for flour production, and confirms the prospects for use for food purposes. The natural mass and flour yield indicators increase the practical importance of the variety as one of the main criteria characterizing the milling ability and economic efficiency of wheat. The amount of protein in the grain was 12.7%. This indicator was lower than the interval of 14.2–14.8% specified in the official description of the variety. This difference in protein content is most likely due to the hydrothermal conditions observed during the vegetation period, the level of soil nutrient supply, especially nitrogen nutrition, irrigation regime and other agro-ecological factors. At the same time, the determined protein content did not prevent the formation of high baking quality, and the technological properties of the variety were assessed at a satisfactory level. The assessment of baking quality showed that the volume of bread made from the Qırmızıgül-1 variety was 600 cm³, and its overall quality was assessed at 4.7 points. The color of the soft part and crust was maximum – 5 points, and porosity was 4 points. These results indicate that the flour of the variety has a sufficiently high gas-holding capacity, satisfactory rheological properties and high organoleptic qualities in terms of consumption. Such indicators confirm that the variety has significant potential not only in terms of high productivity, but also in terms of high-quality bread production. In general, the results of the conducted research showed that the variety Qırmızıgül-1 has an optimal combination of productivity, adaptability, technological properties and baking quality. The variety's high productivity, resistance to diseases and lodging, satisfactory flour yield and high bread quality characterize it as a promising variety for expanding food wheat production in irrigated and moisture-supplied agricultural regions of Azerbaijan. In addition, the variety can also be of significant scientific and practical importance as a donor source of productivity, adaptability and disease resistance traits in breeding programs. In order to more fully and objectively assess the technological potential of the variety, it is considered appropriate to conduct analyses of the amount of wet and dry gluten, gluten deformation index (IDK), Zeleny sedimentation index, falling number, farinograph, alveograph and extensograph in future studies. These indicators will allow for a more accurate assessment of the rheological properties and baking potential of flour, as well as the characterization of the variety according to international quality standards.

Limitations of the study. The study was based on data obtained for one vegetation year, one geographical location and one variety. Since the study did not include multi-year observations, different ecological locations, standard comparison varieties, field replicates and statistical evaluation of meteorological factors, there are certain limitations in generalizing the results on a large scale. In addition, technological quality was assessed only by key indicators, and gluten properties and rheological parameters were not determined.

In future studies, it is considered appropriate to study the Qırmızıgül-1 variety in different soil-climatic zones, under different nitrogen fertilization and irrigation regimes, in a comparative manner with standard varieties for at least three vegetation years. In such studies, the evaluation of genotype × environment interaction using mixed models (Mixed Models), AMMI and GGE biplot methods will allow for a more objective determination of the yield and quality stability of the variety.

References:

1. Comprehensive Annual Report on Scientific and Economic Activities for 2025 (2026). Baku: Research Institute of Crop Husbandry.

2. Annual Report on the Development of the Agrarian Sector in the Republic of Azerbaijan (2025). Bakı.

3. National Report on the State of the Environment in the Republic of Azerbaijan. 2025.

4. Guzman, C., Ammar, K., Govindan, V., & Singh, R. (2019). Genetic improvement of wheat grain quality at CIMMYT. *Engineering Agriculture*, *6*(3), 265. https://doi.org/10.15302/J-FASE-2019260

5. Guzman, C., Peña, R. J., Singh, R., Autrique, E., Dreisigacker, S., Crossa, J., ... & Battenfield, S. (2016). Wheat quality improvement at CIMMYT and the use of genomic selection on it. *Applied & translational genomics*, *11*, 3-8. https://doi.org/10.1016/j.atg.2016.10.004

6. Nuttall, J. G., O'leary, G. J., Panozzo, J. F., Walker, C. K., Barlow, K. M., & Fitzgerald, G. J. (2017). Models of grain quality in wheat—A review. *Field crops research*, *202*, 136-145. https://doi.org/10.1016/j.fcr.2015.12.011

7. Zhong, Y., Zhou, Q., & Jiang, D. (2022). Wheat quality under global climate change: consequences, mechanisms, and countermeasures. *Sustainable crop productivity and quality under climate change*, 103-135. 10.1016/B978-0-323-85449-8.00014-2

8. Zahra, N., Hafeez, M. B., Wahid, A., Al Masruri, M. H., Ullah, A., Siddique, K. H., & Farooq, M. (2023). Impact of climate change on wheat grain composition and quality. *Journal of the Science of Food and Agriculture*, *103*(6), 2745-2751. https://doi.org/10.1002/jsfa.12289

9. Fradgley, N. S., Bentley, A. R., Gardner, K. A., Swarbreck, S. M., & Kerton, M. (2023). Maintenance of UK bread baking quality: Trends in wheat quality traits over 50 years of breeding and potential for future application of genomic-assisted selection. *The Plant Genome*, *16*(4), e20326. https://doi.org/10.1002/tpg2.20326

10. King, J., Dreisigacker, S., Reynolds, M., Bandyopadhyay, A., Braun, H. J., Crespo-Herrera, L., ... & Uauy, C. (2024). Wheat genetic resources have avoided disease pandemics, improved food security, and reduced environmental footprints: A review of historical impacts and future opportunities. *Global Change Biology*, *30*(8), e17440. https://doi.org/10.1111/gcb.17440

11. Zhao, C., Liu, B., Piao, S., Wang, X., Lobell, D. B., Huang, Y., ... & Ciais, P. Temperature increase reduces global yields of major crops in four independent estimates., 2017, 114. https://doi.org/10.1038/s41586-021-03858-1

12. Khush, G. S. (2013). Strategies for increasing the yield potential of cereals: case of rice as an example. *Plant Breeding*, *132*(5), 433-436. https://doi.org/10.1111/pbr.1991

13. Giunta, F., Pruneddu, G., & Motzo, R. (2019). Grain yield and grain protein of old and modern durum wheat cultivars grown under different cropping systems. *Field Crops Research*, *230*, 107-120. https://doi.org/10.1016/j.fcr.2018.10.012

14. Shah, F., Coulter, J. A., Ye, C., & Wu, W. (2020). Yield penalty due to delayed sowing of winter wheat and the mitigatory role of increased seeding rate. *European Journal of Agronomy*, *119*, 126120. https://doi.org/10.1016/j.eja.2020.126120

15. Lobell, D. B., Schlenker, W., & Costa-Roberts, J. (2011). Climate trends and global crop production since 1980. *Science*, *333*(6042), 616-620. https://doi.org/10.1126/science.1204531

Список литературы:

1. 2025-ci il üzrə elmi-təsərrüfat fəaliyyəti haqqında geniş illik hesabat. Bakı: Əkinçilik Elmi-Tədqiqat İnstitutu, 2026.

2. Azərbaycan Respublikasının Kənd Təsərrüfatı Nazirliyi. (2025). Azərbaycan Respublikasında aqrar sektorun inkişafı üzrə illik hesabat

3. Azərbaycan Respublikasının Ekologiya və Təbii Sərvətlər Nazirliyi. (2025). Azərbaycan Respublikasında ətraf mühitin vəziyyəti haqqında Milli Hesabat Bakı, Azərbaycan.

4. Guzman C., Ammar K., Govindan V., Singh R. Genetic improvement of wheat grain quality at CIMMYT // Engineering Agriculture. 2019. V. 6. №3. P. 265. https://doi.org/10.15302/J-FASE-2019260

5. Guzman C., Peña R. J., Singh R., Autrique E., Dreisigacker S., Crossa J., Battenfield S.Wheat quality improvement at CIMMYT and the use of genomic selection on it // Applied & translational genomics. 2016. V. 11. P. 3-8. https://doi.org/10.1016/j.atg.2016.10.004

6. Nuttall J. G., O'leary G. J., Panozzo J. F., Walker C. K., Barlow K. M., Fitzgerald G. J. Models of grain quality in wheat — A review // Field crops research. 2017. V. 202. P. 136-145. https://doi.org/10.1016/j.fcr.2015.12.011

7. Zhong Y., Zhou Q., Jiang D. Wheat quality under global climate change: consequences, mechanisms, and countermeasures // Sustainable crop productivity and quality under climate change. 2022. P. 103-135. 10.1016/B978-0-323-85449-8.00014-2

8. Zahra N., Hafeez M. B., Wahid A., Al Masruri M. H., Ullah A., Siddique K. H., Farooq M. Impact of climate change on wheat grain composition and quality // Journal of the Science of Food and Agriculture. 2023. V. 103. №6. P. 2745-2751. https://doi.org/10.1002/jsfa.12289

9. Fradgley N. S., Bentley A. R., Gardner K. A., Swarbreck S. M., Kerton M. Maintenance of UK bread baking quality: Trends in wheat quality traits over 50 years of breeding and potential for future application of genomic-assisted selection // The Plant Genome. 2023. V. 16. №4. P. e20326. https://doi.org/10.1002/tpg2.20326

10. King J., Dreisigacker S., Reynolds M., Bandyopadhyay A., Braun H. J., Crespo-Herrera L., Uauy C. Wheat genetic resources have avoided disease pandemics, improved food security, and reduced environmental footprints: A review of historical impacts and future opportunities // Global Change Biology. 2024. V. 30. №8. P. e17440. https://doi.org/10.1111/gcb.17440

11. Zhao C., Liu B., Piao S., Wang X., Lobell D. B., Huang Y., Ciais P. Temperature increase reduces global yields of major crops in four independent estimates., 2017, 114. https://doi.org/10.1038/s41586-021-03858-1

12. Khush G. S. Strategies for increasing the yield potential of cereals: case of rice as an example // Plant Breeding. 2013. V. 132. №5. P. 433-436. https://doi.org/10.1111/pbr.1991

13. Giunta F., Pruneddu G., Motzo R. Grain yield and grain protein of old and modern durum wheat cultivars grown under different cropping systems // Field Crops Research. 2019. V. 230. P. 107-120. https://doi.org/10.1016/j.fcr.2018.10.012

14. Shah F., Coulter J. A., Ye C., Wu W. Yield penalty due to delayed sowing of winter wheat and the mitigatory role of increased seeding rate // European Journal of Agronomy. 2020. V. 119. P. 126120. https://doi.org/10.1016/j.eja.2020.126120

15. Lobell D. B., Schlenker W., Costa-Roberts J. Climate trends and global crop production since 1980 // Science. 2011. V. 333. №6042. P. 616-620. https://doi.org/10.1126/science.1204531

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