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Productivity and quality indicators of bread wheat variety samples depending on irrigation

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The research was conducted in the Absheron area of the Republic of Azerbaijan, to identify the relationship between the grain yield and certain parameters of its technological quality-mass fraction and quality of raw gluten in grains and content of protein of winter bread wheat variety and samples. In the vegetation seasons of 2020 and 2021 year fourteen wheat varieties of different geographical origin were studied. Despite the contrast between the years of research in weather conditions, most of the studied variety samples were characterized by high grain quality. On average, over the years, the yield capacity of varieties varied from 333.0 g/m2 (Giymatli 2/17) to 704.0 g/m2 (Gyrmyzy gul 1). The highest protein and gluten content on average over two years of research was noted in the Nurlu-99 variety (confidence limit 13.9±0.3% and 30.5±0.37%), 31.6%, gluten quality (GQ) - 93.1 d.r. The correlation between yield and protein and gluten content in grain was r=-0.30 and r=-0.39 in 2020, r=-0.638*and r=-0.19 in 2021, respectively. In both years of research, statistically strong significant relations between protein and gluten content in grain were noted (r=0.35 in 2020, r=0.47 in 2021). A moderately conjugate relationship between the mass fraction of gluten and its quality was revealed in 2020 (r=0.51) and a positive weak relationship (r=0.28) was revealed in 2021. The conducted studies showed the possibility of obtaining high-quality grains of winter bread wheat in the conditions of Absheron. The results obtained allow us to recommend the use of these varieties as initial material in the breeding process for the creation of frost-resistant, productive, and good grain quality varieties of bread wheat.

Keywords: *Bread wheat, variety, yield, protein, gluten, gluten quality.*

INTRODUCTION

The climate of the Republic of Azerbaijan is temperate continental, not provided with enough moisture. Risky agricultural regions are associated with special climatic conditions expressed by the diversity of weather conditions in one or another district and region. This creates certain difficulties in the cultivation of winter bread wheat.

Wheat is of supreme importance among cereals mainly because of its grains, which comprise protein with exclusive physical and chemical attributes (Garg et al., 2021).

The growth period is one of the main problems in breeding. A complete growing season consists of the sum of two main intermediate periods: germination-earing and earing-ripening. Compared to the second main period - earing-ripening, the duration of the first period depends more on the biological characteristics of the variety than on the weather environment (Dilmurodovich, 2023).

It is necessary to take into account the relationship between quantitative and qualitative indicators. For example, it is known that the relationship between the mass of 1000 grains and the amount of protein is compensatory, therefore, both characteristics should be controlled in selection work for yield and product quality (Dilmurodovich et al., 2021; Dilmurodovich and Usmanovna, et al., 2021; Egamberdievna et.al., 2021).

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The amount of protein in wheat grain mainly depends on the climatic conditions of the growing year and also increases from west to east and from north to south (Egushova & Kondretenko**,** 2012). According to some investigations, the conditions of the year of cultivation have a significantly higher influence on the formation of the mass fraction of protein and gluten in grain (Sukhorukov et al., 2010; Fadeev et al., 2018).

The influence of various factors on the quality of gluten in wheat grain has been studied by many scientists Livia (Hajasa et al., 2018; Lie et al., 2018).

One of the most effective ways used to improve the quality of grain is the use of mineral fertilizers. Mineral fertilizers continuously increase the productivity of the soil, facilitate the use of moisture by the plant and ensure an increase in grain yield.

To improve grain quality with the application of mineral fertilizers, it is essential to take into account the regularity of protein formation in grain and its unchangeable characteristics. The meaning of grain quality should be approached from two main aspects- nutritional value and technological properties, important for the baking industry (Tomaz et al., 2021).

The nutritional value of wheat mainly depends on the chemical composition of the grain, which consists of proteins and amino acids. The main product made from wheat grain is bread. Well-baked bread acts as a unique catalyst, improves the digestion process, and accelerates the assimilation of other products by the body (Sozinov and Jemela, 1983).

Wheat is the source of approximately half of the food calories consumed worldwide and is rich in proteins (gluten), minerals (Cu, Mg, Zn, P, and Fe), vitamins (B-group and E), riboflavin, niacin, thiamine, and dietary fiber (Khalid et al., 2023). Wheat production and quality could be enhanced through the development of new and improved varieties that are able to produce a superior yield and perform better under various agro-climatic stresses and conditions (Hassan and Gul, 2006).

It has been proven in scientific studies that the duration of the plant growth period is determined by the natural variability of the variety and depends on the growing conditions (Dilmurodovich, 2023)

The high amount of gluten in bread wheat varieties mainly depends on the ecological conditions of the year, and the quality of gluten depends on the genotype as well as the year and cultivation conditions. The observed regularity did not manifest itself in the collection of protein.

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It is very important to clarify the influence of factors that have a high role in the formation of grain quality. Thus, the study of complex factors in field conditions and the application of these indicators by demonstrating them in farms will create an opportunity to obtain high-yield and high-quality grain products and create an abundance of grain in our Republic.

The purpose of the study was to identify winter bread wheat varieties that have the ability to form high-quality crops in the conditions of Azerbaijan. To achieve the goal, the amount of protein and gluten in grain and the quality of gluten, as well as the relationship of these indicators with productivity, were studied.

MATERIALS AND METHODS

In order to achieve the goal set in the research, in accordance with the methodology, 14 different bread wheat varieties and prospective samples selected from the wheat nurseries introduced from the International Centers as CIMMYT and ICARDA and obtained through hybridization in 2 variants (I-optimally irrigated and II-non-irrigated) were planted in field conditions at the Absheron Subsidiary Experimental Farms of the Research Institute of Crop Husbandry and technological quality indicators, grain yield were studied.

The amount of nitrogen in the grain was determined by the modified Keldal micromethod with the use of the KeltekTM FOSS device. The coefficient (Nx 5.7) was used to convert the value of nitrogen into protein (Pleshkov, 1976).

The vitreousness of the grain is determined by using the diafanoscope-DSZ-3 device, the amount of gluten by the method of weighing the dough obtained by separating the starch from the flour by hand washing, the quality of gluten (deformation index of gluten - GDI) was determined by using the

IDK-3M device and the sedimentation index was determined by recording the volume of swelling and sedimentation of high molecular weight protein particles in 2.0% glacial acetic acid (Guidelines for assessing the quality of grains and oilseeds, 1986).

The efficient use of water should be promoted by evaluating the grain yield based on the number of irrigations applied in the crop cycle so that under these conditions yields can be maintained) as well as industrial quality (Martínez et al. 2020).

RESULTS AND DISCUSSION

Grain yield and other structural elements of the investigated wheat varieties differ sharply from each other. This is due to the fact that in a well-developed wheat plant under optimum irrigation, the flow of carbohydrates to the grains is faster than that of protein substances, while in the non-irrigated variant, the flow of carbohydrates from the stem and leaves to the grain is weakened and the flow of protein substances is accelerated.

For this reason, the number and mass of grains in one spike and the weight of 1000 kernels increase and the amount of protein decreases in the optimal irrigation option. In the non-irrigated version, the number and mass of grains in one spike and the weight of 1000 kernels decrease and the amount of protein increases. These results also coincide with the procedures of other scientific studies (Huseynov et al., 2005; Strelnikov, 1971; Fadeeva et al., 2018).

Also, it was determined by some researchers that the amount of nitrogen fertilizers in cultivated soils is not enough for the formation of high protein substances in the grain of high-yielding wheat varieties (Huseynov, 2009; Konovalov, 1981).

The evaluation of the productivity in the studies conducted by us shows that the average maximum productivity in two years for the varieties was 704.0 g/m^2 in the optimal irrigation option, and 600 g/m^2 in the non-irrigated option. This level of productivity is quite high for the conditions of Azerbaijan in unfavorable years. Along with the productivity of the varieties, the technological quality indicators of the grain were also studied. The main quality indicators characterizing food grains are the amount of protein and gluten, as well as the quality of gluten.

According to State Standards requirements, the mass share of gluten in 1st class wheat grain should be (at least) 32%, the mass share of protein 14.5%, and 28% and 13.5% in 2nd class wheat grain, respectively. The conducted studies show that the average amount of protein in the grain of the vast majority of studied varieties was high (13.0-13.9%). The highest result (13.9±0.3% within the confidence) was recorded in the Nurlu 99 variety and was significantly different from other varieties. The maximum mass share of gluten in this variety was 31.6%, GDI -93.1 d.r. on average over the years (30.5±0.37% within the confidence) (Tables 1 and 2).

Table 1. Correlation coefficient between yield and grain quality indicators in bread wheat varieties and prospective samples in irrigation option (Absheron 2020-2021 average)

	Grain mass, g/m^2	**1000 grain weight, g**	**Grain moisture, %**	**Test weight, g/l**	**Protein content, %**	**Protein yield per hectare, kg/ha**	**Vitrousness, %**	**Gluten content, %**	**GDI, d.r.**	**Dry gluten content, g**
Grain mass, g/m^2	14									
1000 grain weight, g	-0.294									
Grain moisture, %	0.232	-0.295								
Test weight, g/l	0.376	-0.263	0.117							
Protein content, %	-0.638*	-0.129	-0.534*	-0.189						
Protein yield per hectare, kg/ha	0.976**	-0.367	0.119	0.371	-0.459					
Vitrouseness,%	0.428	-0.070	0.390	0.312	-0.428	0.394				
Gluten content,%	-0.193	0.125	-0.316	-0.723**	0.471	-0.092	-0.385			
GDI, d.r.	-0.069	0.436	-0.053	-0.344	-0.136	-0.110	-0.084	0.279		
Dry gluten content, g	-0.302	0.232	-0.527	-0.539*	0.564*	-0.188	-0.300	0.811**	0.061	
Sedimentation, ml	0.272	-0.312	0.300	0.134	-0.076	0.286	0.275	0.127	0.011	0.195

*. Correlation is significant at the 0.05 level. Optimum irrigation option. **. Correlation is significant at the 0.01 level.

Table 2. Correlation coefficient between yield and quality indicators of bread wheat varieties and prospective samples in non-irrigated option (Absheron 2020-2021 average)

	Grain mass, g/m²	**1000 grain weight, g**	**Grain moisture, %**	**Test weight, g/l**	**Protein content, %**	**Protein yield per hectare, kg/ha**	**Vitrousness, %**	**Gluten content, %, %**	**GDI, d.r.**	**Dry gluten content, g**
Grain mass, g/m²	1									
1000 grain weight, g	0.020	1								
Grain moisture, %	0.404	-0.651*	1							
Test weight, g/l	0.532	-0.457	0.341	1						
Protein content, %	-0.438	-0.212	0.008	-0.402	1					
Protein yield per hectare, kg/ha	0.980**	-0.017	0.425	0.499	-0.257	1				
Vitrouseness,%	0.443	-0.455	0.419	0.461	-0.155	0.447	1			
Gluten content,%	-0.157	0.179	-0.068	-0.415	0.403	-0.074	-0.047	1		
GDI, d.r.	-0.363	0.626*	-0.566*	-0.659*	0.069	-0.370	-0.318	0.317	1	
Dry gluten content, g	-0.218	0.230	-0.217	-0.362	0.412	-0.132	0.002	0.956**	0.324	1
Sedimentation, ml	0.382	-0.137	0.308	-0.072	0.491	0.506	0.011	0.204	-0.412	0.098

*. Corellation is significant at the 0.05 level. Optimum irrigation option. **. Corellation is significant at the 0.01 level.

A weak negative correlation between yield and grain protein content r=-0.30 and a significant negative correlation r=-0.39 between yield and gluten is observed in the varieties studied in 2020. It was also found that there is a relationship between the quality of protein and gluten and the mass fraction. In 2021, a weak negative correlation r=-0.19 was observed between yield and grain protein content, and a weak positive correlation r = 0.19 was observed between yield and gluten.

Based on the conducted research, it can be concluded that the weather conditions in the growing season of 2020 were not favorable for the collection of protein and gluten in winter wheat grain, and for this reason, the amount of protein and gluten in the grain of some varieties studied in 2020 was lower than in 2021.

When examining the relationship between the amount of protein and gluten in grain, it was found that there is a high positive correlation relationship (r=0.35 in 2020, r=0.47 in 2021) in both years. The correlation between wheat grain gluten and GDI was r=0.51, (moderate, significant value) in 2020 and weakly negative r=- 0.28 in 2021.

The above indicates that the agro-climatic conditions of our Republic are favorable for the breeding of high-yielding varieties and the production of high-quality grain. Such varieties include Gyrmyzy gul-1, Gobustan, Azamatli 95, Nurlu 99, and 12ndFAWWON N97, 4thFEFWSN N50 variety samples, and they have the potential to give 6.02 t/ha high-quality grain yield even in unfavorable weather conditions of the year.

CONCLUSION

The maximum amount of protein and gluten in the grain of the studied varieties was recorded in the 2020 research year. By results of the carried out correlation analysis the relationship between quality indicators and productivity of the winter wheat varieties was determined. It was also found that there is a relationship between protein content, gluten content, and gluten quality.

Thus, the high average value of protein was recorded in Nurlu 99 (13.9%), Gobustan (13.4%), Khazri (13.4%), Saratovskaya 29 (13.4%) varieties. - According to the mass share of gluten and the quality of gluten, the following varieties are Gobustan (38.0% and 90.3 d.r.), Khazri (34.8% and 112.0 d.r.), Giymatli 2/17 (32.8% and 99.6 d.r.), Dayirman (32.0% and 108.3 d.r.) was selected.

Gobustan, Azamatli 95, Gyrmyzy gul-1 and Nurlu 99 have the potential to give enough 3.1 t/ha of high-quality grain even in unfavorable weather conditions of the year. It is recommended to use the selected varieties and samples (Gobustan, Azamatli 95 and Nurlu 99, Gyrmyzy gul-1, 12ndFAWWONN97, 4thFEFWSN N50) in purposeful breeding works to improve the quality of winter wheat grain.

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