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Evaluating Genetic Variability and Biometric Indicators in Bread Wheat Varieties: Implications for Modern Selection Methods

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Major grain-producing countries such as Canada, the United States of America, Mexico, Brazil, Australia, China, India, Turkey, and Russia, in the direction of selection for the creation of new varieties of wheat resistant to abiotic factors, are paying great attention to creating new wheat varieties by developing new genotypes by identifying donors with high-quality and positive indicators of valuable economic traits and introducing them into modern selection methods.

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Progress has been made in this direction worldwide. Today, many varieties of wheat with valuable economic traits and high grain quality have been created and introduced to large areas. In this study, 23 genotypes were selected from 45 genotypes of bread wheat varieties and lines. The nursery's growth period lasted between 233-238 days, and the lines appeared more mature than the local check varieties. Compared to the local check varieties, among the plant's biometric indicators, 15 lines showed positive results in terms of plant height, 10 lines in peduncle length, 5 lines in spike length, 1 line in spike number, and 1 line in resistance to lodging. The statistical analysis of grain yield and grain quality using the Dospekhov method showed that the experimental error rates for various indices as follows: 0.888% for yield, 3.018% for weight of 1000 grains, 0.627% for Test weight, 2.028% for protein content, 1.519% for gluten content, 2.001% for IDK, and 4.01% for grain glassiness. It was noted that the experiment was conducted correctly in terms of repetitions and showed a positive result. 10 genotypes with yield of genotypes 72.6-96.7 c/ha, weight of 1000 grains 37.9-43.2 g, test weight 803-835 g/l, protein content 16.2-19.3%, gluten content 28.5-30.4% were selected. Accordingly, it was observed that the amount of iron was 1.0-1.8 mg. It was observed that the sample was 1.3 mg in the Gozgon variety and 1.4 mg in the Antonina variety. KR20-27-FAWIR-67, KR20-BWF5IR-2625, KR20-27-FAWIR-138 lines 1.6 mg relative to the local check variety. Lines KR20-BWF5IR-2460, KR20-27-FAWIR-39, KR20-BWF5IR-246 1.7 mg. It was observed that the KR20-27-FAWIR-154 line showed a high result of 1.8 mg.

Keywords: Bread wheat; varieties and genotypes; 1000 grain weight; protein content indicator; iron content in the grain.

1. INTRODUCTION

Wheat is considered one of the most important grain crops in world agriculture, occupying 17% of the total agricultural land, and about 750 million tons of grain is produced annually. Globally, a total of 240.8 million hectares are planted with wheat, and it is predicted that the demand for wheat grain will increase even more in the coming years [1].

Triticum aestivum L. is a biennial crop grown in spring and fall, and it is a spike-producing crop with a flat leaves and small flowers. Wheat stem is a common straw with five to seven joints and nodes, three to four leaves, the length of the leaf is 20-37 cm, and the width is 1-2 cm [2,3].

According to Sh. Dilmurodov [4], effective use of newly created intensive type varieties is one of the main factors in increasing bread wheat grain yield, which is competitive, suitable for regional soil and climate conditions.

During the period of shooting of wheat, productive stalks, spikes inside the stalks and grains in the spike are formed. The duration of the shooting phase in wheat is 25–30 days. During this period, the plant accumulates 50–60% of the dry matter that it accumulates during the entire vegetation period [5,6].

Highly significant General Combining Ability and Specific Combining Ability variances showed the predominance of additive, epistatic and dominant genes in controlling this character. In the process of hybridization, the application of the original biped gene is important, and for its appearance in the generation, it is necessary to choose a positive line of General Combining Ability. In this way, it will be possible to pre-estimate the characteristics of the future. A positive and negative heterozygosity for the parent was found for the studied trait, which increased the genetic diversity of the parents [7].

During the selection process, 24 genotypes were selected for use in selection and crossbreeding, and in order to study 30 varieties and genotypes in comparison with 6 regionized and promising varieties, agro-ecological varietal testing nurseries were established [2,8,9].

Winter wheat is divided into classes according to the height as follows: dwarf (lower from 60 cm), semi-dwarf (60-85 cm), lower height (85-105 cm), medium height (105-120 cm) and tall (higher than 120 cm) [10].

D.T. Juraev [1] stated that the height of the stalk of winter bread wheat changes depending on the weather conditions and is grouped as: dwarf-stemmed (50-75 cm), short-stemmed (76-90 cm), medium-stemmed (91- 110 cm), and long-stemmed (higher than 110 cm).

The grain yield can be reduced by 30-50% due to the lodging of the wheat plants, and the photosynthetic activity of the wheat leaves is reduced as a result of lodging, it becomes difficult to harvest the grain with machines [10, 11].

According to Khazratkulova S [12], the length of the spike and the number of spikelets in the spike are mainly related to the characteristics of the variety, which is determined by some differences. Productive tillering, the number of grains per spike and the weight of 1000 grains are of great importance in the high productivity, although they interact with the external environment.

The growing importance of wheat in the population requires increasing its gross yield and quality. In solving the problem, it is important to adapt new varieties of wheat to different soil-climate zones and agrometeorological conditions. The dependence of the variety and weather conditions on the accumulation of protein and crude gluten was studied in early-ripening and medium-ripening bread wheat varieties grown in the gray soils of Kemerovo region. As a result, it was determined that the protein content in early-ripening varieties was from 8.6 to 13.8%, and in the medium-ripening was from 9.0 to 14.0%. As the scientists emphasized, the effect of the genotype is not always the same, it changes a lot depending on the weather [13,14].

The relationship between the height of the stalk and the lodging does not always appear. Mostly lodging is caused depending on biological property of the variety and, mainly, on the anatomorphological structure. Below nodes of the varieties susceptable to lodging are longer, the plant is tall, the stalk and nodule is small or thin, while the resistant varieties to lodging are short in height and below nodes are short as well [15].

The formation of grains, a high weight of 1000 grains is a decisive factor for obtaining abundant and stable grain yield. Lack of moisture in the soil, high temperature, infestation by fungal diseases lead to a decrease in the weight of 1000 grains [16].

Under the influence of drought, the decrease in the yield was caused by stunted growth point of the plant, and a decrease of the assimilation process on the surface of the plant leaves. Dry weather has a negative effect on grain glassiness, grain quality, and different nitrogen combinations in the grain [17,18].

As A. Amanov [19] stated, the amount and quality of gluten is a defining indicator for assessing the technological and nutritional quality of wheat grain and is determined by the IDK (index of gluten deformation) tool. If IDK indicator is 0-15, then the gluten is very unsatisfactory belonging to group III, if IDK is 20-40 then gluten is satisfactory in the group II, when IDK is 45-75 the gluten is good belonging to group I, when 80-100 it is satisfactory, belonging to group II, and if IDK is 105-120 then gluten is unsatisfactory, belnging to group III [1].

D. Juraev, O. Amanov in their scientific research, stated that the grain weight in the spike is considered one of the important indicators for the high yield, and the grain weight in the spike of the varieties and samples changes over the years depending on the weather conditions [1].

Corresponding miRNAs were also identified for these 28 transcripts. The findings will help in better understanding of molecular basis of Fe/Zn transport and accumulation in grain and subsequent utilization in breeding to improve Fe/Zn content in wheat grain [20].

2. MATERIALS AND METHODS

Field experiments were conducted in the experimental plot of the Karshi district branch of the Southern Agricultural Research Institute. Experiments in field conditions were carried out in the field experiment area of "Genetics and selection of grain crops" department. To conduct field experiments, the central experimental area of the Southern Research Institute of Agriculture, located in the Karshi district, was selected (38°48'39.0"N 65°34'57.1"E).

In the field experiment, 45 wheat genotypes were placed in 3 plots, the crop area was 10 m^2. GenStat's Alpha Lattice design was used using a randomized method of placing genotypes in the experimental field. Two of the genotypes selected for testing are local check varieties, the Gozgon variety was created in local conditions, and the Antonina variety was acclimatized from Russia. The rest of the genotypes were derived from the international IWWIP program and developed locally.

Experiments in laboratory conditions were carried out in the "Laboratory of Plant Biochemistry and Evaluation of Quality Indicators" and "Laboratory of Organo-Mineral Fertilizers and Agrochemical Gross Analysis" of the institute.

Table 1. Origin of winter bread wheat genotypes (Karshi 2021-2022)

Entry	Name of Genotypes	Origin Country	PEDIGREE
1	Ғозғон (ст)	Uzbekistan	
2	Антонина (ст)	Russia	
3	KR20-BWF5IR-45	Uzbekistan	Hisorak/Elomon
4	KR20-BWF5IR-74	Uzbekistan	Xisorak/Bunyodkor
5	KR20-BWF5IR-94	Uzbekistan	Xisorak/Kranodar-99
6	KR20-BWF5IR-144	Uzbekistan	Starshina/Bunyodkor
7	KR20-BWF5IR-182	Uzbekistan	Yaksart/Gozgon
8	KR20-BWF5IR-235	Uzbekistan	Bunyodkor/Kroshka
9	KR20-BWF5IR-246	Uzbekistan	Bunyodkor/Yasovul
10	KR20-BWF5IR-254	Uzbekistan	Bunyodkor/Yasovul
11	KR20-BWF5IR-1959	Uzbekistan	Bologna//H.Beshir/Krasnodar-99
12	KR20-BWF5IR-2083	Uzbekistan	Bologna X Turkiston/Yaksart
13	KR20-BWF5IR-2095	Uzbekistan	Antonovka//Elomon/Xisorak
14	KR20-BWF5IR-2113	Uzbekistan	Elomon X Selyanka/Xisorak
15	KR20-BWF5IR-2117	Uzbekistan	Elomon //Selyanka/Xisorak
16	KR20-BWF5IR-2121	Uzbekistan	Elomon X Selyanka/Xisorak
17	KR20-BWF5IR-2202	Uzbekistan	Sharara//Elomon/Bezostaya-1
18	KR20-BWF5IR-2343	Uzbekistan	KR11-010//Elomon/Sharara
19	KR20-BWF5IR-2455	Uzbekistan	Hisorak//Krasnodar-99/Bezostaya-1
20	KR20-BWF5IR-2459	Uzbekistan	Hisorak//Krasnodar-99/Bezostaya-1
21	KR20-BWF5IR-2460	Uzbekistan	Hisorak//Krasnodar-99/Bezostaya-1
22	KR20-BWF5IR-2625	Uzbekistan	059E//JAGGER/PECOS/3/KR11-9018/Bezostaya-1
23	KR20-BWF5IR-2900	Uzbekistan	Hisorak//Gozgon/Gozgon
24	KR20-BWF5IR-2949	Uzbekistan	Gondvana/3/Yaksart//Pobeda/118/2004
25	KR20-BWF5IR-3212	Uzbekistan	E-8/E-218
26	KR20-BWF5IR-3233	Uzbekistan	E-29/E-218
27	KR20-BWF5IR-3235	Uzbekistan	E-29/E-218
28	KR20-BWF5IR-3285	Uzbekistan	E-31/E-24
29	KR20-BWF5IR-3301	Uzbekistan	E-42/E-35
30	KR20-BWF5IR-3380	Uzbekistan	E-87/E-15
31	KR20-BWF5IR-3529	Uzbekistan	Samo/Hisorak
32	KR20-27-FAWIR-27	Turkey-IWWIP-CIMMYT	2180*K/2163//?/3/W1062A*HVA114/W3410 6/HP 1731
33	KR20-27-FAWIR-33	Turkey-IWWIP-CIMMYT	POSTROCK/4/AGRI/NAC//KAUZ/3/1D13.1/MLT
34	KR20-27-FAWIR-39	Turkey-IWWIP-CIMMYT	MERCATO//92.001E7.32.5/SLVS
35	KR20-27-FAWIR-46	Turkey-IWWIP-CIMMYT	DORADE-5/3/SHI#4414/CROWS"//GKSAGVARI/CA8055
36	KR20-27-FAWIR-66	Turkey-IWWIP-CIMMYT	GAHAR//DUMBRAVITA/SPELTA2/3/BILLING(N566/OK94P597)
37	KR20-27-FAWIR-67	Turkey-IWWIP-CIMMYT	GAHAR//DUMBRAVITA/SPELTA2/3/BILLING(N566/OK94P597)
38	KR20-27-FAWIR-73	Turkey-IWWIP-CIMMYT	MV-KOLOMPOS/4/MAHON DEMIAS/3/HIM/CNDR//CA8055
39	KR20-27-FAWIR-76	Turkey-IWWIP-CIMMYT	53/3/ABL/1113//K92/4/JAG/5/KS89180B/6/PBW343*2/KUKUNA*2//YANAC
40	KR20-27-FAWIR-84	Turkey-IWWIP-CIMMYT	ARESO/ROELFS F2007
41	KR20-27-FAWIR-127	Turkey-IWWIP-CIMMYT	KS020638~5/GALLAGHER
42	KR20-27-FAWIR-138	Turkey-IWWIP-CIMMYT	WHETSTONE
43	KR20-27-FAWIR-142	Turkey-IWWIP-CIMMYT	KS13DH002722
44	KR20-27-FAWIR-154	Turkey-IWWIP-CIMMYT	KS14DH0013-19
45	KR20-27-FAWIR-157	Turkey-IWWIP-CIMMYT	KS100196K-2

Isolation of gliadin proteins and their electrophoretic study. Electrophoretic analysis of gliadin from storage proteins in wheat was carried out on polyacrylamide gel (PAAG) in an acidic medium by the method of V.A. Bushuk and R.R. Zilman [21]. The electrophoretic spectrum of varieties with high iron content was used as a standard. The electrophoretic formulas of gliadin proteins were divided into four (α, β, γ and ω) fractions according to method of V.G. Konarev [22].

The experimental layout was done based on Complete block design and Alpha lattice design of GenStat 13 breadware. Phenological observations, calculations and analyzes were carried out according to the method of the All-Union Plant Science Institute (1984) [23].

The technological quality indicators of the grain of winter bread wheat crops grown in the experimental field were determined according to the methodological manuals "Guidegenotypes for assessing grain quality", "Methods of biochemical research of plants" [24,25,17].

Statistical analyzes was done based on the method of B.A. Dospekhov (1985) [26].

3. RESULTS AND DISCUSSION

The research was carried out in Ya. Omonov farm in Karshi district and the soil under the experiment was light gray soil. It constituted 19.2% of the total land area of Kashkadarya region. The irrigated area is 24.6%.

The control variety trial nursery has 45 varieties and genotypes, they planted in $10m^2$ area in 2 replications. It was observed that the germination of varieties and samples lasted until October 11-13. Standard variety Gozgon and Antonina variety germinated on October 12. The other 8 samples were observed to germinate on October 11. During the tillering period, the plant stops growing, and as a result of the cooling of the temperature, side stalks grow from the main stalk. It was observed that the tillering phase lasted from November 8 to November 19. Standard varieties Gozgon and Antonina manifested tillering on November 15. Compared to standard varieties, KR20-27-FAWIR-73 genotype tillered on November 8, and was found as earlier tillering vareity (Table 2). During the shooting phase, the plant growth point continues to grow in bread wheat varieties and samples. In this process, the spike is formed. The shooting phase of varieties and samples lasted from January 8 to February 16. It was noted that the spike formation period lasted from April 2-10.

Table 2. The duration of the growing season of bread wheat varieties and genotypes belonging to different ecological-geographical regions (Karshi 2021-2022)

№	Name of Genotypes	Germination date	Tillering date	Shooting date	Heading date	Days to heading	Days to maturity	Vegetation period
1	Gozgon (check)	12.10.21	15.11.21	07.02.22	10.04.22	180	03.06.22	234
2	KR20-27-FAWIR-67	12.10.21	15.11.21	08.01.22	02.04.22	172	03.06.22	234
3	Antonina (check)	12.10.21	15.11.21	14.02.22	07.04.22	178	02.06.22	233
4	KR20-BWF5IR-3301	11.10.21	18.11.21	16.02.22	04.04.22	175	03.06.22	235
5	KR20-27-FAWIR-73	12.10.21	08.11.21	10.02.22	05.04.22	175	03.06.22	234
6	KR20-BWF5IR-2083	12.10.21	19.11.21	02.02.22	05.04.22	176	03.06.22	235
7	KR20-BWF5IR-2460	11.10.21	16.11.21	02.02.22	04.04.22	176	05.06.22	237
8	KR20-BWF5IR-3380	12.10.21	15.11.21	09.02.22	02.04.22	172	05.06.22	236
9	KR20-BWF5IR-2095	11.10.21	18.11.21	14.02.22	05.04.22	176	01.06.22	233
10	KR20-BWF5IR-2625	11.10.21	18.11.21	16.02.22	06.04.22	177	04.06.22	236
11	KR20-BWF5IR-3529	13.10.21	16.11.21	16.02.22	05.04.22	174	02.06.22	233
12	KR20-27-FAWIR-84	12.10.21	19.11.21	13.01.22	05.04.22	175	07.06.22	238
13	KR20-BWF5IR-94	12.10.21	19.11.21	08.01.22	07.04.22	177	06.06.22	237
14	KR20-BWF5IR-2113	11.10.21	16.11.21	07.02.22	05.04.22	176	03.06.22	236
15	KR20-27-FAWIR-27	11.10.21	18.11.21	01.02.22	05.04.22	176	04.06.22	236
16	KR20-BWF5IR-144	11.10.21	16.11.21	15.02.22	03.04.22	174	04.06.22	236
17	KR20-27-FAWIR-138	12.10.21	19.11.21	12.01.22	03.04.22	173	04.06.22	235
18	KR20-27-FAWIR-39	11.10.21	17.11.21	14.02.22	03.04.22	174	01.06.22	233
19	KR20-27-FAWIR-142	12.10.21	17.11.21	11.01.22	02.04.22	172	02.06.22	233
20	KR20-27-FAWIR-46	12.10.21	16.11.21	01.02.22	03.04.22	174	01.06.22	233
21	KR20-27-FAWIR-154	12.10.21	17.11.21	12.01.22	08.04.22	178	03.06.22	234
22	KR20-BWF5IR-246	13.10.21	19.11.21	07.02.22	03.04.22	173	03.06.22	234
23	KR20-BWF5IR-3235	12.10.21	15.11.21	10.02.22	03.04.22	173	02.06.22	233
	Minimum	11.10.21	08.11.21	08.01.22	02.04.22	172	01.06.22	233
	Mean	11.10.21	16.11.21	01.02.22	04.04.22	175	03.06.22	234
	Maximum	13.10.21	19.11.21	16.02.22	10.04.22	180	07.06.22	238

Source: [Compiled by the authors]

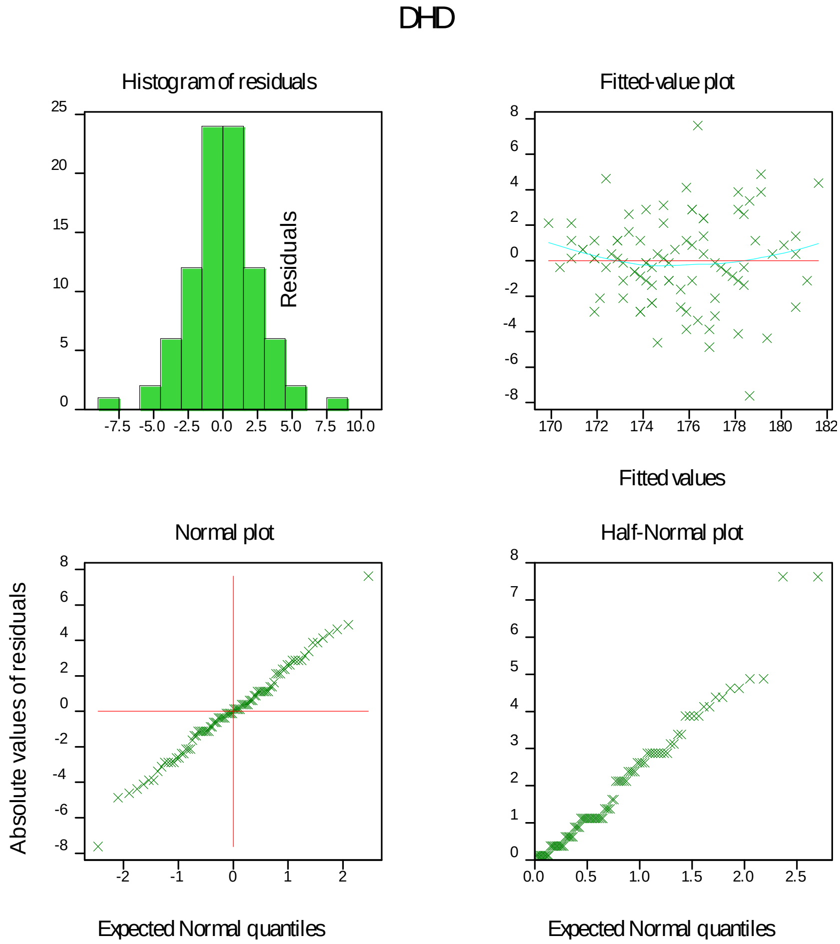

Fig. 1. Differentiation of germination-heading period between replications and genotypes

** DHD – Days to Heading Date.*
Source: [Compiled by the authors]

The day from germination to spike formatio lasted 172-180 days. It was noted that the standard variety Gozgon formed spikes in 180 days, Antonina variety in 178 days. Compared to the standard variety KR20-27-FAWIR-67, KR20-BWF5IR-3380 genotypes formed spikes in 172 days. Full ripening lasted until June 1-7. It was observed that the days from germination to maturity of the varieties and samples lasted for 233-238 days. It was found that the genotypes ripened 2-3 days earlier in comparison to the standard variety.

It was observed that the plant height index of bread wheat varieties and genotypes ranged from 91.5 to 123.0 cm. The indicator of plant height in standard Gozgon variety was 104.0 cm and in Antonina variety 98.5 cm. It was noted that the KR20-BWF5IR-2460 genotype was 120.0 cm, and the KR20-27-FAWIR-46 genotype was 123.0 cm higher than the standard variety. The length of the peduncle was 35.0-51.0 cm in varieties and genotypes, and compared to standard Gozgon variety, 5 genotypes and compared to standard Antonina variety, 10 genotypes showed higher results. Spike length serves as part of the crop element in the plant. It was found that the length of the spike in varieties and genotypes was 10.5-13.0 cm. It was observed that the number of spikelets ranged from 19-23 pieces, in the standard Gozgon variety, this index was 21 spikelets, and in the Antonina variety 22 spikelets. Compared to the standard variety, KR20-BWF5IR-3529 genotype showed a higher index of 23 spikelets with a difference of 1-2 pieces (Table 4). When the resistance to lodging in bread wheat varieties and genotypes was evaluated as a percentage, it was observed that it was up to 3-40% in the varieties and genotypes.

Table 3. Analysis of variance for various traits in winter wheat genotypes evaluated in 2022

Source of variation	df	Mean square			
		Days to heading	Days to maturity	Plant hieght	Grain yield
Replication	1	113,34	0,278	1448,01	1,188
Genotype	44	12,7	4,577	99,03*	6,12**
Error	44	12,78	3,164	58,94	6,961
Total	89	138,82	8,019	1506,95	8,149
CV (%)		2	0,8		0,4

ns Noon significant
*Significant at P=0,05
**Significant at P=0,01

Source: [Compiled by the authors]

Table 4. Biometric indicators of bread wheat varieties and genotypes belonging to different ecological and geographical regions (against 2021-2022)

№	Name of Genotypes	Plant height, cm	Peduncle length, cm	Spike length, cm	Number of spikelets of per spike	Lodging resistance,%
1	Gozgon (check)	104.0	41.5	12.0	21	10
2	KR20-27-FAWIR-67	108.5	37.5	11.0	22	5
3	Antonina (check)	98.5	35.0	10.5	22	25
4	KR20-BWF5IR-3301	108.0	45.5	12.0	22	18
5	KR20-27-FAWIR-73	108.5	38.0	11.0	20	25
6	KR20-BWF5IR-2083	115.0	40.0	10.5	20	13
7	KR20-BWF5IR-2460	120.0	51.0	13.0	21	15
8	KR20-BWF5IR-3380	114.5	37.5	10.5	22	25
9	KR20-BWF5IR-2095	110.5	42.5	11.5	20	25
10	KR20-BWF5IR-2625	96.5	38.0	10.5	20	3
11	KR20-BWF5IR-3529	103.0	40.0	12.5	23	8
12	KR20-27-FAWIR-84	111.5	37.0	10.5	19	5
13	KR20-BWF5IR-94	108.5	41.5	11.0	21	5
14	KR20-BWF5IR-2113	112.5	43.5	12.5	21	20
15	KR20-27-FAWIR-27	101.5	41.0	11.0	20	3
16	KR20-BWF5IR-144	106.0	40.5	12.0	21	8
17	KR20-27-FAWIR-138	96.5	42.0	10.5	20	10
18	KR20-27-FAWIR-39	112.0	43.0	11.5	21	10
19	KR20-27-FAWIR-142	91.5	35.0	11.0	21	15
20	KR20-27-FAWIR-46	123.0	42.0	10.5	21	15
21	KR20-27-FAWIR-154	110.0	38.5	11.0	21	40
22	KR20-BWF5IR-246	100.0	36.5	11.5	22	15
23	KR20-BWF5IR-3235	106.5	41.5	10.5	21	15
	Minimum	91.5	35.0	10.5	19	3
	Mean	107.2	40.4	11.2	21	14
	Maximum	123.0	51.0	13.0	23	40

Source: [Compiled by the authors]

The standard Gozgon variety has 10% lodging resistance, and Antonina variety has 25%. It was observed that the KR20-27-FAWIR-154 genotype has 40 percent resistance, higher than the standard varieties.

Under the influence of drought, a decrease in productivity was caused by stopping of growth points, reduction of assimilation processes on the plant leaf surface. Dry weather had a negative effect on grain glassiness, grain quality, and various nitrogenous compounds in grain. When determining the yield index in varieties and genotypes, it showed 59.7-96.7 c/ha. The standard Gozgon variety showed 80.5 c/ha, and Antonina variety 76.9 c/ha. Compared to the standard varieties, it was observed that the KR20-27-FAWIR-67 genotype showed a high rate of 90.9 c/ha, and the KR20-BWF5IR-2113 genotype showed a high rate of 96.7 c/ha. When the results of the statistical analysis by the Dospekhov method on the productivity indicator were carried out, it was observed that the experiment error was small, 0.888% and showed a positive result (Table 5).

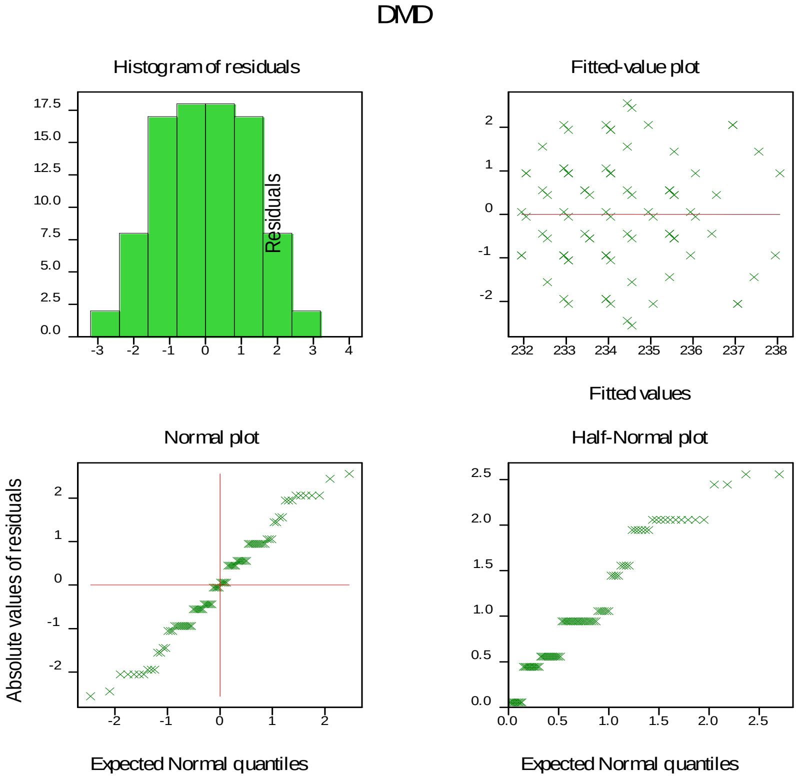

Fig. 2. Differentiation of germination-maturing period between replications and genotypes

** DMD – Days to Maturity Date*

Source: [Compiled by the authors]

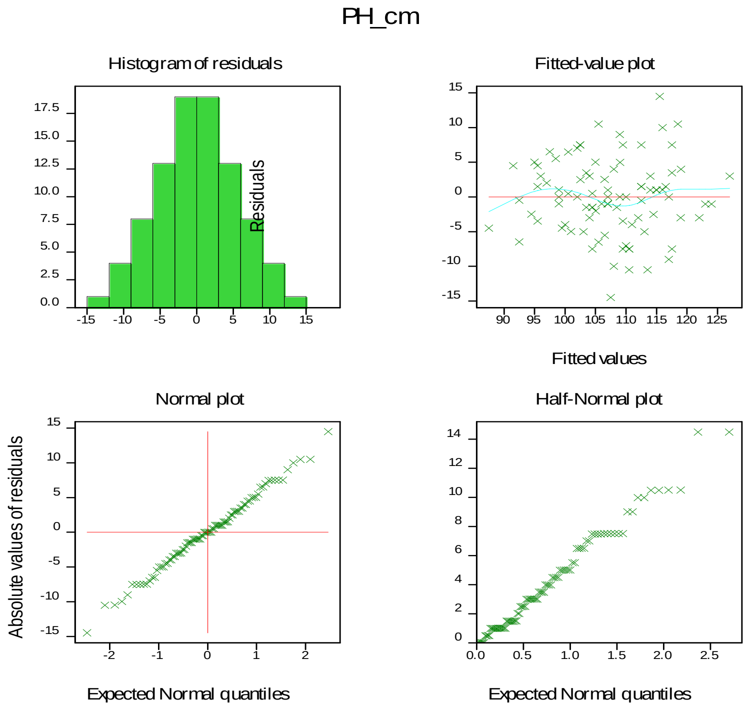

Fig. 3. Differentiation of plant height between replications and genotypes

** PH – Plant Height*

Source: [Compiled by the authors]

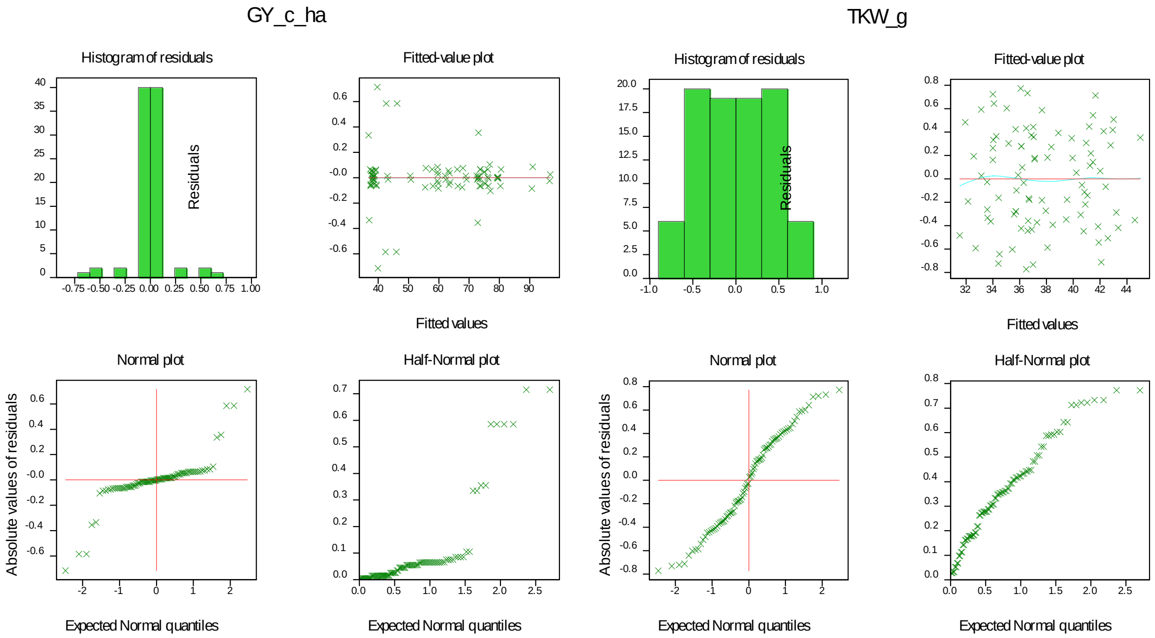

Fig.4 Differentiation of grain yield and TKW between replications and genotypes

** GY_c_ha– Grain Yield of Center/ha*

TKW – 1000 Kernel Weight

Source: [Compiled by the authors]

Table 5. Analysis of variance for various traits in winter wheat genotypes evaluated in 2022

Source of variation	df	Mean square			
		1000 kernel weight	Test weight	Protein	Gluten
Replication	1	3,873	23,511	0,093	0,004
Genotype	44	22,64**	1665,6**	2,648**	5,554**
Error	44	0,331	6,329	0,03	0,047
Total	89	4,204	29,84	0,123	0,051
CV (%)		1,5	0,3	1	
**Significant at P=0,01					

Source: [Compiled by the authors]

A high weight of 1000 grain in grain formation is a decisive sign of abundant and stable harvest. Lack of moisture in the soil, high temperature, infestation with fungal diseases lead to a decrease in the weight of 1000 grains. It was found that the weight of 1000 grains was 33.8-43.2 g in varieties and genotypes. Compared to the standard Gozgon variety, 14 genotypes, and compared to the Antonina variety, 3 genotypes showed higher results.

Test weight is the mass of grain per liter. Test weight is determined according to GOST 3040-55. It was observed that Test weight was up to 755.0-835.0 g/l in varieties and genotypes. KR20-BWF5IR-2083 genotype had 835.0 gr/l Test weight, KR20-27-FAWIR-84 genotype had 821.0 gr/l, KR20-BWF5IR-2113 genotype had 828.5 gr/l, KR20-27-FAWIR-39 genotype had was 834.0 g/l Test weight, and all showed good results compared to standard varieties. The experimental error was 0.627 % and it is proved that it showed a positive result.

According to the data, as the wheat fields move from north to south, from west to east, the amount of protein in the grain increases. The amount of protein depends on the amount of nitrogen content and moisture in the soil. For this reason, the amount of protein in grain depends on 30% heredity and 70% on agrotechnical measures. If the plant is supplied with enough nutrients, especially nitrogen, the protein will accumulate more in the grain. The reason for this is that protein is made up of amino acids, and amino acids have an amino group in their name, and the amino group holds nitrogen in its radical. Nitrogen increases protein, excess moisture causes it to decrease.

When determining the indicator of protein content in the grain of the high-yielding, high-grain quality of the studied varieties and genotypes of the control variety trial nursery on the range of project, it was 15.2-19.3%. Compared to the standard variety, 7 genotypes with higher protein content were selected among the genotypes.

The baking properties of wheat flour are mainly evaluated by the amount and quality of gluten. The amount and quality of gluten refers to the hydrated gel-rubbery mass, which consists mainly of water-insoluble protein when wheat dough is washed in water. It was noted that the gluten content of bread wheat varieties and genotypes was 25.8-31.2%. This index was 28.1% in standard variety Gozgon, and 31.2% in Antonina variety. It was found that 12 genotypes showed a higher index compared to the standard Gozgon variety. While the standard Antonina variety showed a higher index compared to the genotypes. It was observed that the experiment error was 1.519% in varieties and genotypes and showed a positive result. One of the necessary indicators characterizing the technological properties of the grain depends on the amount of gluten in the wheat grain and mainly on the IDK index of the gluten in the bread making process. The gluten quality of bread wheat varieties and genotypes the IDK unit indicator according to the state standard is: 1st class (excellent) up to 45-75; 2nd class (good) up to 80-100; 3rd class (unsatisfied) up to 105-120.

Table 6. Grain quality indicators of bread wheat varieties and genotypes belonging to different ecological and geographical regions (Karshi 2021-2022)

No	Name of Genotypes	Grain yield, c/ha	1000 kerenl weight, g	Test weight, g/l	Protein content, %	Gluten content, %	IDK	Vitreousity,%
1	Gozgon (check)	80.5	33.8	783.5	17.3	28.1	98.0	73.0
2	KR20-27-FAWIR-67	90.9	36.0	783.0	19.3	26.6	105.3	61.0
3	Antonina (check)	76.9	41.7	818.5	17.7	31.2	96.0	76.3
4	KR20-BWF5IR-3301	76.2	36.7	783.0	15.6	26.4	95.4	53.8
5	KR20-27-FAWIR-73	59.7	41.0	801.5	17.3	30.1	110.7	86.3
6	KR20-BWF5IR-2083	73.0	36.8	803.0	18.4	29.2	104.8	80.5
7	KR20-BWF5IR-2460	73.7	40.8	835.0	18.5	28.7	106.0	80.8
8	KR20-BWF5IR-3380	76.3	35.4	765.5	16.3	27.4	103.5	62.3
9	KR20-BWF5IR-2095	75.2	35.2	755.0	16.1	27.0	98.0	59.8
10	KR20-BWF5IR-2625	63.6	37.1	775.0	16.6	26.7	94.4	56.3
11	KR20-BWF5IR-3529	73.0	34.2	759.5	16.8	25.8	93.1	58.8
12	KR20-27-FAWIR-84	73.3	41.1	821.0	15.5	28.5	86.6	82.3
13	KR20-BWF5IR-94	66.2	43.0	811.5	15.5	29.2	92.1	84.8
14	KR20-BWF5IR-2113	96.7	43.2	828.5	15.4	30.9	104.8	72.8
15	KR20-27-FAWIR-27	62.2	39.7	809.0	16.2	28.6	95.9	70.3
16	KR20-BWF5IR-144	72.6	37.9	766.5	15.7	26.3	104.9	81.8
17	KR20-27-FAWIR-138	73.6	42.2	821.5	16.2	27.5	97.0	70.8
18	KR20-27-FAWIR-39	79.4	41.0	834.0	17.7	28.7	102.3	77.3
19	KR20-27-FAWIR-142	79.4	42.8	822.0	18.1	30.4	105.8	82.0
20	KR20-27-FAWIR-46	63.3	34.2	762.5	15.2	26.4	92.4	53.3
21	KR20-27-FAWIR-154	75.2	41.3	824.0	18.0	30.3	97.6	76.8
22	KR20-BWF5IR-246	69.0	42.1	820.5	18.6	29.7	98.0	85.3
23	KR20-BWF5IR-3235	67.8	36.8	822.5	18.4	28.7	118.8	86.8
	Minimum	59.7	33.8	755.0	15.2	25.8	86.6	53.3
	Mean	73.8	38.9	800.3	16.9	28.3	100.0	72.7
	Maximum	96.7	43.2	835.0	19.3	31.2	118.8	86.8
	LSD0,05	0.52	1.14	4.98	0.35	0.43	2	2.92
	LSD0,05%	0.888	3.018	0.627	2.028	1.519	2.001	4.01
	CV%	0.4	1.5	0.3	1	0.8	1	2

Source: [Compiled by the authors]

It was found that the IDK index of bread wheat varieties and genotypes in the control variety trial nursery ranged from 86.6 to 118.8. Standard varieties Gozgon and Antonina were accepted to the 2nd class (good) with 96.0 to 98.0 indicators. 11 genotypes were classified as 2nd class (good), 5 genotypes as 3rd class (unsatisfactory). The glassiness or hardness of the grain is one of the characteristics of the wheat variety. Nevertheless, these signs can change according to the growing conditions of the wheat plant. The glassiness quality of the grain decreases in conditions of excess moisture and lack of nitrogen.

The glassiness of grain is determined according to GOST 10987-76. According to our research, the glassiness of bread wheat varieties and genotypes was determined and showed was 73.0-76.3 indicators in the standard varieties Gozgon and Antonina. It was observed that 9 genotypes with 80.5-86.8 indicators showed higher results compared to standard varieties. The experimental error in grain glassiness according to the Dospekhov method was 4.01% and showed a positive result.

The iron content of the grain of bread wheat varieties and genotypes belonging to different ecological and geographical regions was determined under laboratory conditions. Accordingly, it was observed that the amount of iron was 1.0-1.8 mg. It was observed that the sample was 1.3 mg in the Gozgon variety and 1.4 mg in the Antonina variety. KR20-27-FAWIR-67, KR20-BWF5IR-2625, KR20-27-FAWIR-138 lines 1.6 mg relative to the local check variety. Lines KR20-BWF5IR-2460, KR20-27-FAWIR-39, KR20-BWF5IR-246 1.7 mg. It was observed that the KR20-27-FAWIR-154 line showed a high result of 1.8 mg (Table 8).

It was determined that the iron content of flour was 0.9-1.5 mg in varieties and genotypes. The sample was 1.1 mg in the Gozgon variety and 1.0 mg in the Antonina variety. It was observed that the local check showed a higher result than the variety KR20-27-FAWIR-67, KR20-BWF5IR-2460, KR20-BWF5IR-2625, genotypes of 1.5 mg.

Currently, due to the widespread use of new methods and, first of all, molecular genetics, significant progress has been made in understanding these mechanisms. It should be noted that a number of aspects of plant resistance to various metals and their absorption and adaptation by plants are still not sufficiently studied and require additional research. In recent times, the level of use of reserve proteins with a high degree of polymorphism as a marker of useful agricultural traits of cereal crops is increasing.

As a result of the determination of proteins in wheat plants using the electrophoresis method, it was found that gliadin and glutetin are storage proteins with a complex structure, composed of many structural components. It is noted that these proteins can represent the unique genetic system of wheat in a relatively detailed state. Therefore, the study of these structural components can serve as markers of wheat grain quality and specific genes.

Table 7. Correlation of characteristics of genotypes

Correlations	DHD	DMD	GY_c_ha	Gluten_%	IDK	PH_cm	PL_cm	Protein_%	SL_cm	TKW_g	TST_g_l
DMD	0,12	-									
GY_c_ha	-0,13	0,08	-								
Gluten_%	0,08	-0,04	-0,01	-							
IDK	-0,01	-0,10	0,03	-0,09	-						
PH_cm	0,12	0,01	0,03	0,04	-0,02	-					
PL_cm	-0,04	0,00	0,18	-0,01	0,12	0,48					
Protein_%	0,01	-0,23	-0,04	0,38	0,24	0,08	0,06	-			
SL_cm	0,05	-0,03	0,09	0,06	-0,04	0,00	0,17	0,09	-		
TKW_g	-0,07	0,15	0,30	0,44	-0,05	0,04	0,17	0,09	-0,12	-	
TST_g_l	-0,04	-0,07	0,20	0,44	0,09	0,12	0,17	0,30	-0,07	0,66	-
Vitreousity_%	0,05	0,09	0,03	0,62	0,12	0,04	-0,05	0,41	0,01	0,33	0,50

Source: [Compiled by the authors]

Table 8. Iron content of grain and flour genotypes (Karshi 2021-2022)

Plots	Entry	Name of varieties	Fe content in grain, mg/100 g	Fe content in flour, mg/100 g
1	1	Gozgon (check)	1,3	1,1
2	37	KR20-27-FAWIR-67	1,6	1,5
3	2	Antonina (check)	1,4	1,0
4	29	KR20-BWF5IR-3301	1,3	1,1
5	38	KR20-27-FAWIR-73	1,2	1
6	12	KR20-BWF5IR-2083	1,2	1
7	21	KR20-BWF5IR-2460	1,7	1,5
8	30	KR20-BWF5IR-3380	1,4	1,3
9	13	KR20-BWF5IR-2095	1,5	1,3
10	22	KR20-BWF5IR-2625	1,6	1,5
11	31	KR20-BWF5IR-3529	1,4	1,2
12	40	KR20-27-FAWIR-84	1,5	1,2
13	5	KR20-BWF5IR-94	1,4	1,3
14	14	KR20-BWF5IR-2113	1,5	1,4
15	32	KR20-27-FAWIR-27	1,2	1,1
16	6	KR20-BWF5IR-144	1	0,87
17	42	KR20-27-FAWIR-138	1,6	1,3
18	34	KR20-27-FAWIR-39	1,7	1,4
19	43	KR20-27-FAWIR-142	1,6	1,2
20	35	KR20-27-FAWIR-46	1,5	1,2
21	44	KR20-27-FAWIR-154	1,8	1,5
22	9	KR20-BWF5IR-246	1,7	1,5
23	27	KR20-BWF5IR-3235	1,5	1,3

In the studies, depending on the low or high iron content of grain and flour, reserve proteins in grain were analyzed according to the movement of proteins in polyacrylamide gel towards the poles and the bonds they left behind. For the analysis, one hundred grains of the varieties were threshed separately. After becoming flour form, each of them was mixed with 200 μl of 70% ethyl alcohol in a separate test tube and extracted for 30-40 minutes in a thermostat at a temperature of 40ºC.

According to the results of the analysis, it was known that there was 1.4 mg of Fe in the grain of Yaksart variety, and 1.1 mg of Fe in the flour of this variety, and its α-, β-, γ- and ω- bonds can be compared with other varieties. It is known that the grain of Bunyodkor variety under number 4 contains 1.6 mg Fe, and the flour of this variety contains 1.2 mg Fe. Although the amount of iron in Bunyodkor grain is somewhat higher, the amount of iron in the flour is 1.2 mg, and the iron in the grain is lost through the husk (bran). The grain of Bezostaya-100 variety studied in PAAG gel contains 1.6 mg Fe, its flour 1.2 mg. The variety Davr under number contains 121.4 mg Fe in the grain, 1.2 mg in flour. The variety Chillaki under number 14, contains 1.6 mg of iron, these varieties contain more iron than other varieties, and their β-zone protein bonds are similar (Fig. 6).

It is known that the electrophoretic spectra of gliadin proteins soluble in 70% ethanol spirit of wheat grain in 3.5% PAAG gel are genetically determined, these spectra are specific for each variety and do not change regardless of the conditions under which wheat varieties are grown. In several subsequent electrophoretic analyses, there is information that some varieties consist of certain biotypes according to their electrophretic spectra, and based on this information, the varieties with high Fe content were selected and analyzed.

In polyploid cereal species, prolamins have been found to be controlled by several independent (unlinked) gene clusters, and analysis of a small number of grains (around 100 grains) from a single cultivar population allows you to think with confidence about the degree of genetic homogeneity within the cultivar population. Nevertheless, genetic heterogeneity at prolamin gene loci was reported to be up to 17% in prolamin protein selection studies of wheat and oat varieties. In order to use several valuable economic traits of the studied wheat varieties for the purpose of selection and breeding and to study their genetic nature, their genotypes were identified.

The electrophoretic spectrum of gliadin proteins is divided into 4 zones, including those designated by α-, β-, γ- and ω-zones. It is noted that there are a number of bonds in each zone, on the basis of which intra- and inter-variety differences are determined.

Fig. 7 shows the 20 varieties in the exhibition nursery of the studied varieties. According to the results of the analysis, Alekseyvich variety is listed in number 1 with bands. This variety contains 1 mg of iron in the grain and flour, which indicates that the main part of iron is located in the endosperm. It was found that the analyzed grains of the variety Gurt under number 14 and Omad variety under number 15 contain 1.6 and 1.8 mg of iron, respectively, and their electrophoretic spectra on PAAG gel were genetically determined, and these spectra were specific for each variety.

When analyzing the 20 varieties whose electrophoretic spectra are presented in Fig. 5, it was found that Matonat variety under number 1 contains 1.4 mg of iron and 1.1 mg of iron in its flour, and their electrophoretic spectra on PAAG gel are genetically different. According to the results of the analysis, it was found that there is 1.6 and 1.5 mg of iron in Yuksalish variety grain and its flour respectively, and electrophoretic spectra in PAAG gel are genetically determined (Fig. 7).

In our experiments, the number of bands in the electrophoretic spectrum of gliadin proteins in the variety samples of ancient local bread wheat varieties in Uzbekistan were analyzed by dividing them into minor, moderately active or major groups. According to the results obtained when the electrophoretic spectra of the varieties with high iron content in grain and flour were analyzed by morphological characteristics and separated as individual variety samples, compared to the electrophoretic spectrum of the control, ancient local variety samples were divided into homogeneous or heterogeneous varieties according to the electrophoretic content of gliadin proteins.

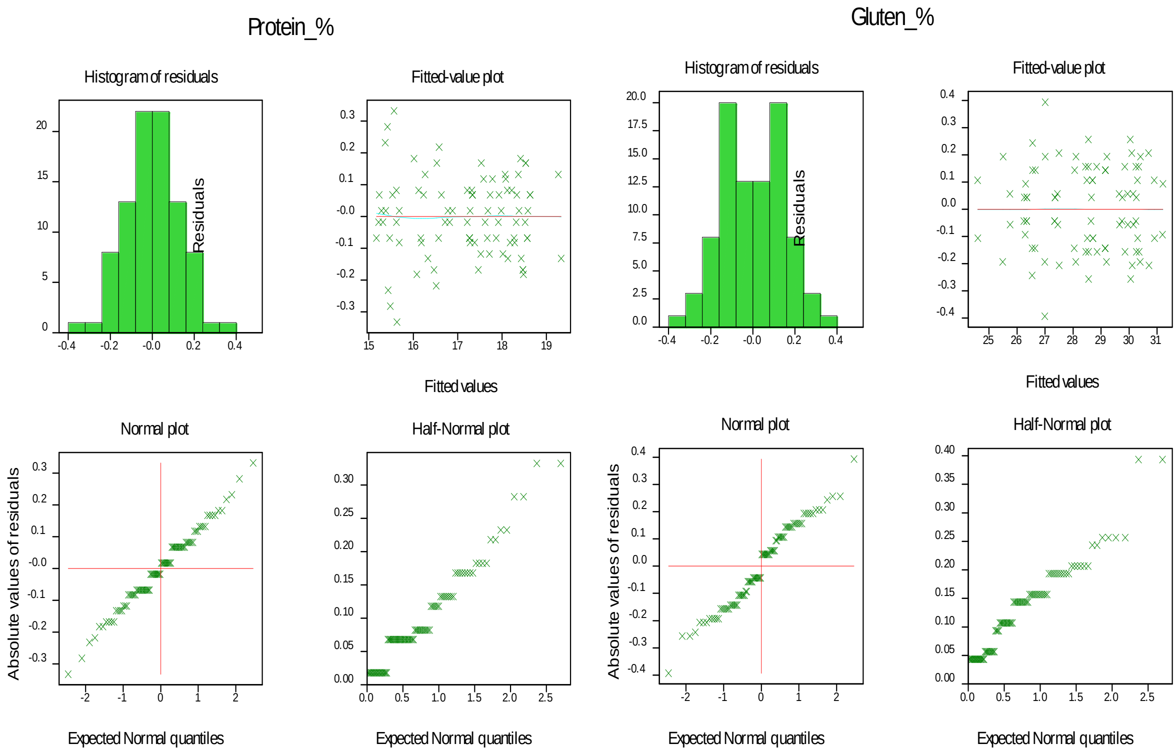

Fig. 5. Differentiation of grain yield and TKW between replications and genotypes
Source: [Compiled by the authors]

Fig. 6. Varieties in the exhibition nursery. 1. Yaksart, 2. Gozgon, 3. Antonina, 4. Bunyodkor, 5. Shams, 6. Krasnodarskaya-99, 7. Hisorak, 8. Turkistan, 9. Bezostaya-100, 10. Brigada, 11. .Navbahor, 12.Davr, 13.Grom, 14.Chillaki, 15.Mars, 16.Dostlik, 17.Kroshka, 18.Polovchanka, 19.Starshina, 20.Tanya

Source: [Compiled by the authors]

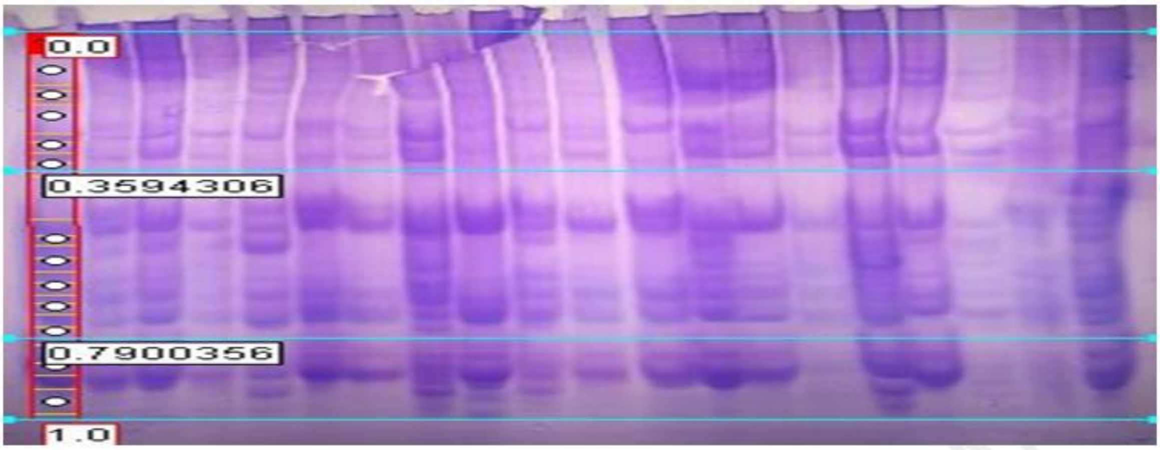

Fig. 7. Varieties in the nursery of demonstrative varieties. 1. Alekseyvich, 2. Nodr, 3. Asr, 4. Babur, 5. Qadr, 6. Yog'du, 7. Pervitsa, 8. Drujba, 9. Velena, 10. Zvezda, 11. Uzb. Mus.-25, 12. Aziz, 13. Durdona, 14. Gurt, 15. Omad, 16. Yuka, 17. Andijan-2, 18. Ishanch, 19. Andijan-4, 20. Aleksiy-2

Source: [Compiled by the authors]

In bread wheat (Triticum aestivum), gliadin proteins have been found to be controlled by several independent (unlinked) clusters, and analysis of 100 grains from a single cultivar population provides a reliable estimate of the degree of genetic homogeneity or heterogeneity within that cultivar population.

In addition to several valuable economic traits of the studied wheat varieties, it is necessary to identify their genotype in order to use them as varieties with high iron content and for breeding purposes, and to study their genetic nature (Fig. 8).

Therefore, it is important to analyze the electrophoretic content of gliadin proteins in samples of ancient local bread wheat varieties.

The flour obtained from threshing grain and grain sample was burned and the amount of Fe in the resulting ash was determined using an Atomic Adsorption Spectrometer AAS 200.

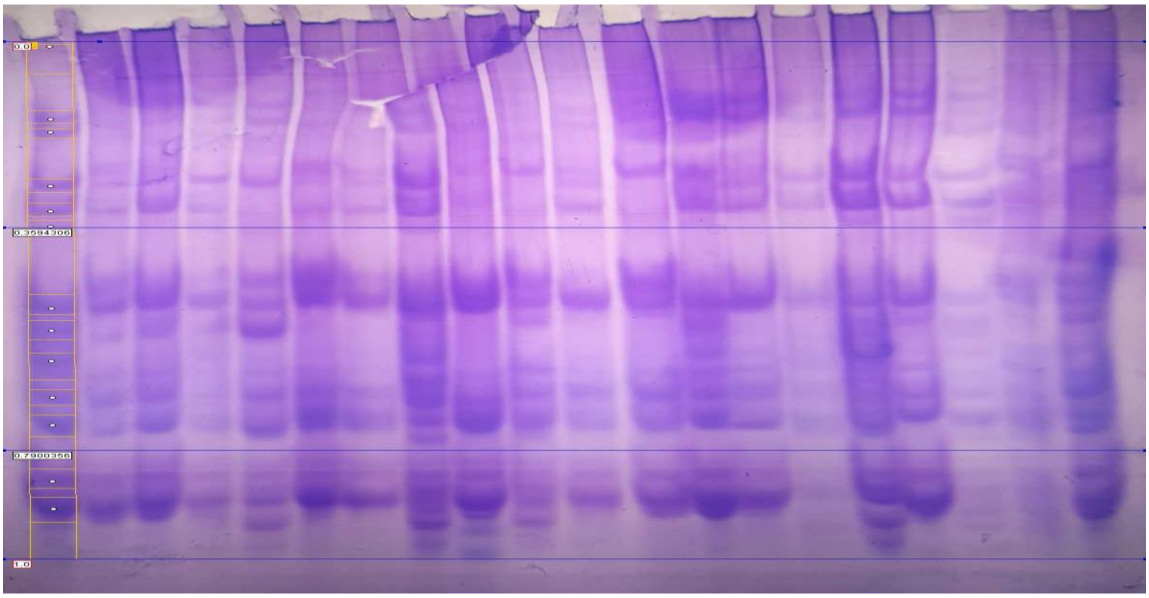

Fig. 8. Varieties in the nursery of demonstrative varieties. 1. Matonat, 2. Vekha, 3. Yangi hayot, 4. Sardar, 5. Shijoat, 6. Ziyokor, 7. Rokhat, 8. Turon, 9. Yuksalish, 10. Sarbon, 11. Shukrona, 12. Kesh-2016, 13. Dovan, 14. Istikbol, 15. Navroz, 16. Flight, 17. J. Gavhari, 18. Gallakor, 19. Ravon, 20. Aksaroy

Source: [Compiled by the authors]

The 20 varieties in the nursery of locally created bread wheat genotypes, and according to the results of the analysis, the presence of iron was detected and their electrophoretic spectra on the PAAG gel were genetically determined, and it was found that these spectra are specific for each genotype.

4. CONCLUSION

In this study, 23 genotypes were selected from 45 genotypes of bread wheat varieties and lines. The nursery's growth period lasted between 233-238 days, and the lines appeared more mature than the local check varieties. Compared to the local check varieties, among the plant's biometric indicators, 15 lines showed positive results in terms of plant height, 10 lines in peduncle length, 5 lines in spike length, 1 line in spike number, and 1 line in resistance to lodging. The statistical analysis of grain yield and grain quality using the Dospekhov method showed that the experimental error rates for various indices as follows: 0.888% for yield, 3.018% for weight of 1000 grains, 0.627% for Test weight, 2.028% for protein content, 1.519% for gluten content, 2.001% for IDK, and 4.01% for grain glassiness. It was noted that the experiment was conducted correctly in terms of repetitions and showed a positive result. 10 genotypes with yield of genotypes 7.26-9.67 t/ha, weight of 1000 grains 37.9-43.2 g, grain nature 803-835 g/l, protein content 16.2-19.3%, gluten content 28.5-30.4% were selected. Accordingly, it was observed that the amount of iron was 1.0-1.8 mg. It was observed that the sample was 1.3 mg in the Gozgon variety and 1.4 mg in the Antonina variety. KR20-27-FAWIR-67, KR20-BWF5IR-2625, KR20-27-FAWIR-138 lines 1.6 mg relative to the local check variety. Lines KR20-BWF5IR-2460, KR20-27-FAWIR-39, KR20-BWF5IR-246 1.7 mg. It was observed that the KR20-27-FAWIR-154 line showed a high result of 1.8 mg. Varieties and lines with high grain yield and grain quality indicators were selected, and the amount of iron contained in grain and flour was determined under laboratory conditions as follows: the grain of Bezostaya-100 in PAAG gel contains 1.6 mg iron, its flour contains 1.2 mg, Davr variety grain has 1.4 mg of iron, flour 1.2 mg, and the variety Chillaki grain contained 1.6 mg iron. These varieties had more iron than other varieties, and it was found that their protein bands in the β- zone were similar. The grain of Gurt and Omad varieties under analysis contained 1.6 and 1.8 mg of iron, respectively, and their electrophoretic spectra on the PAAG gel were genetically determined. These spectra were specific to each variety. The variety Yuksalish's grain contained 1.6 mg iron, while its flour had 1.5 mg. Additionally, their electrophoretic spectra on PAAG gel showed genetically differences. It is recommended that these varieties be used in selection and breeding work as a variety with a high iron content.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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