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ESTIMATION OF GRAIN QUALITY OF INSPECIES HYBRIDS OF SPRING SOFT WHEAT AT EARLY STAGES OF BREEDING

Abstract: *Currently, the search for a way to improve the technological quality of wheat grain is considered the most important task of genetics and breeding of this important food crop. In the conditions of the Pastdargom district of the Samarkand region (h = 644 m above sea level, 39039! N and 66040! E) in 2017-2020, the grain quality of spring soft wheat hybrids (Khupar x Kayraktosh, Bardosh x Ok marvarid) of the first and second generations obtained in the topcross scheme of crosses was evaluated. The Kroshka variety was used as a standard. Analyzing the data obtained, it can be noted that in the first generation of hybrids (F1) there is a fairly high frequency of heterosis based on the protein content in grain and gluten in flour. It is shown that in the studied hybrid combinations, heterosis in protein and gluten content was determined not by the belonging of the parent forms to certain ecological and geographical zones, but was determined by their genotypic features. It was revealed that in the splitting generations of spring wheat hybrids, combinations with positive dominance and intermediate inheritance of protein and gluten content and its quality, as well as sedimentation, are most important. The highest heritability index was found in the sign of "sedimentation". This trait, to a lesser extent than other signs, is subjected to genotype-environment interaction, which is one of the most reliable marker signs in wheat breeding for an increase in protein content, gluten and flour strength.*

Key words: *Wheat,Selection, Gluten, Protein, Sedimentation, Intraspecific hybrids.*

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Introduction

Soft wheat (*Triticum aestivum L.* 2n=6, x=42 AAVBDD genome) is one of the main agricultural crops providing billions of people with food. To meet the growing demand for wheat grain in the world, an annual increase in its production is necessary. In this regard, its share in the total grain production is gradually increasing, but the structure of production in terms of quality composition is deteriorating, the production of strong and valuable wheat necessary for the production of high-quality wheat flour has decreased (Baboev et al., 2006, Jabbarov, 2019). The growth in the production of high-quality wheat grain can be achieved by creating new adaptive and environmentally plastic varieties that give stable yields of good quality. Therefore, the strategy of soft breeding at the present stage is aimed at increasing productivity and adaptive potential with stable indicators of product quality in conditions of negative environmental factors (Fomenko et al., 2015, Berkutova et al., 2006). A sign of grain quality is one of the main properties of commercial varieties

(Netsvetaev et al., 2020, Kazartseva et al., 2010). At the same time, at the early stages of breeding, special attention is paid to the study of such signs as sedimentation index, gluten content and quality (Ignatieva et al., 2017, Kravchenko et al., 2016). At the present level of breeding and genetic research, intraspecific hybrids from simple crosses of contrasting parental forms are mainly used to assess the quality of wheat grain. Therefore, this principle of matching pairs for crosses allows you to get clear information about splitting. A number of authors have noted that grain quality is an integral feature and depends on the genotype of the variety (Bukreev, 2014, Sandukhadze, 2005), soil fertility and meteorological conditions of cultivation (Grabovets, 2007, Antonov, 2017, Umaeva and Lisunova, 2017), as well as the influence of pests (Davidyants and Eroshenko, 2017). To obtain extensive information on the influence of genotype and environmental factors on the phenotypic manifestation of a grain quality trait, the evaluation of hybrids on this trait at the early stages of breeding is of particular importance. Such information contributes to a better understanding of the genetic basis of variability and its effective use for practical breeding. However, many issues related to predicting the effectiveness of genotype selection based on the quality of wheat grain have not been sufficiently studied. Therefore, the evaluation of the grain quality of intraspecific hybrids of spring soft wheat at the early stages of breeding is very relevant.

The purpose of this study was to assess the grain quality in intraspecific hybrids of spring soft wheat and to isolate genotypes of high protein and gluten content for practical breeding of this crop.

1. Materials and methods

The research was carried out in 2017-2020 on the experimental plot of the farm "Bek-Dil-Beh-Shokhsuvoriy" of the Pastdargom district of the Samarkand region (h = 644 m above sea level, $39^{0}39^{!}$ N and $66^{0}40^{!}$ E). The plant was grown under irrigation and without irrigation (without watering). In experiments without watering, nitrogen-phosphorus fertilizers-N120 P90 were introduced before sowing spring wheat. In the irrigated area, alfalfa was the predecessor, fertilizers (N60 P40) were applied for the main tillage. The object of research was hybrid combinations of the first and second generations obtained in the topcross scheme of crosses. Local ancient varieties with different levels of grain and flour quality were involved in the crossing: Khupar, Bardosh, Ok marvarid, Dashnabadi, Safedak, Kayraktash, Vatan. Sowing was carried out manually. F_1-F_2 hybrids and their parent forms were grown with rendomization on a plot of $1m^2$ (row spacing 15 cm, row length 1 m, distance between plots 30 cm). The Crumb variety zoned in the zone was used as a standard. The evaluation of hybrids by grain quality was carried out in accordance with the methods of the national standards of the Russian Federation according to the following indicators: the mass fraction of protein in grain (GOST 10846, 1991), the quantity and quality of gluten (GOST R 54478, 2011), the physical properties of the test on the farinograph (GOST R 51404, 1999), and the methodology of the state variety testing (Methodology, 2017). The results obtained were processed by methods of biological statistics. The inheritance index (H) of grain quality traits in hybrids was determined by the method of F.Peter and K. Freit. The heritability of the studied grain quality characteristics in the "broad sense of the word" was determined by the formula (H^2) calculated by the formula of Mahmud and Kramer (Mahmud and Kramer, 1951). The agro-climatic conditions during the years of the experiments allowed the most complete and reliable assessment of the source material, which contributed to the achievement of the goal.

2. Results and discussion

The agro-climatic conditions over the years of the study allowed the most complete and reliable assessment of the genetic material, which contributed to the achievement of this goal.The results of the analysis of inheritance of grain quality traits of spring wheat hybrids are presented in Table 1.

Table 1. Frequency of types of inheritance of grain quality traits in spring wheat hybrids (God ra, average for 2018-2020)

Type of inheritance	Generation	A sign of grain quality			
		Proteincontentingrain	Glutencontentinflour	GlutenQuality	Sedimentation
Heterosis	F_1	25.4	24.3	5.8	10.9
	F_2	10.9	11.7	5.4	9.1
Positivedominance	F_1	21.5	22.6	24.7	25.3
	F_2	23.8	22.2	22.6	24.5
Intermediateinheritance	F_1	20.2	21.6	34.2	36.1
	F_2	28.1	30.3	35.6	34.5
Negative Dominance	F_1	16.6	15.3	14.1	15.4
	F_2	15.3	16.4	14.6	14.9

Depression	F_1	21.3	18.6	15.4	18.2
	F_2	22.4	20.2	16.2	19.8

From the data in the table it can be seen that in the F_1 generation there is a fairly high frequency of heterosis based on the protein content in grain and gluten in flour. In various hybrid combinations, a high frequency of heterosis is observed, both when crossing varieties of the same ecotype, and when crossing genotypes belonging to different ecotypes. For example, a heterosis effect was detected in hybrid combinations of Khupar x Dashnabadi, Khupar x Safedak, Kayraktash x Watan, whose parent forms belong to the high-altitude ecotype. Approximately the same type of inheritance in terms of protein and gluten content was observed in F_1 hybrids from crossing varieties belonging to alpine and steppe ecotypes. Such hybrid combinations include Khupar x Bardosh, Khupar x Ok marvarid.

The analysis of the obtained manifestations of heterosis based on the signs of protein and gluten content was determined not by the presence of swarming forms until environmental data indicate that within the studied hybrid combinations of types, but was determined by the genotypic features of the parent components. It should be noted that in the splitting hybrid populations (F_2), the frequency of heterosis manifestations on the basis of protein and gluten content decreased sharply.

As a result of our research, it has been reliably established that a significant number of hybrid combinations have the characteristics of protein content in grain and content in flour inherited by the type of positive dominance. At the same time, the manifestation of the studied signs in hybrids evaded in the direction of the best parents. In the second generation of hybrids (F_2), the number of combinations with positive dominance of protein content in grain and was insignificant, and the frequency of the same type of inheritance of gluten content in flour remained at the same level. These data indicate that in the studied hybrids, an increase in the homozygosity of genotypes in the splitting populations (F_2) caused significant changes in the protein content in the grain, which did not cause significant changes in the gluten content in flour. At the same time, in F_1 hybrids, an intermediate type of inheritance according to the characteristics of protein content in grain and gluten in flour was manifested in a significant number of hybrids. It should be particularly noted that in F_1, in terms of protein and gluten content, 21.6% of hybrid combinations on the first trait and 21.6% on the second showed intermediate inheritance (Table 1). Intermediate type inheritance was also characteristic for crosses of varieties differing in the levels of manifestation of the analyzed traits. In addition, hybrids created with the participation of non-differing parental forms can be attributed to the group of combinations with intermediate inheritance of signs of protein content in grain and gluten in flour. Obviously, in such cases, the hybrids and their parent forms had the same manifestation of signs. Judging by the data given, it can be assumed that in the process of splitting hybrids, the number of combinations with intermediate inheritance both the protein content in grain and gluten in flour increased sharply. This is due to the fact that hybrid combinations in F_1 showed heterosis.

It was found experimentally that in different hybrid combinations, the frequency of negative type of dominance and depression according to the signs of protein content in grain and gluten in flour is quite significant. Obviously, hybrid combinations with a negative and depressive type of inheritance of these traits are of no practical value in wheat breeding.

Based on the study of the type of inheritance of grain quality traits in hybrid combinations of spring soft wheat, manifestations of heterosis in gluten quality are quite rare.

Analysis of the data obtained showed that heterosis in terms of gluten quality is a rare phenomenon. In our studies, heterosis by this indicator was manifested in 5.8% of the studied F_1 hybrids, and the frequency of its manifestation in F_2 hybrids was much lower. Perhaps, in the second generation of hybrids, the effect of heterosis was created due to the cleavage of transgressive forms with a positive effect. At the same time, it was revealed that in different hybrid combinations, the frequency of negative type of dominance and depression according to the signs of protein content in grain and gluten in flour is quite significant. Obviously, hybrid combinations with a negative and depressive type of inheritance of grain quality traits are of no practical value in wheat breeding.

The results of the study showed that in the studied material, the number of hybrids with heterosis in terms of sedimentation was also insignificant. The manifestation of the heterosis effect in F_1 hybrids was noted only in 10.9% of the studied combinations, and with an increase in the homozygosity of plants as a result of their splitting decreased.

In the studied set of hybrid combinations of spring soft wheat, in terms of gluten quality and sedimentation, combinations with positive dominance and intermediate inheritance of these traits occupied a specific weight. From the data presented in Table 1, it can be seen that the frequencies of positive dominance in both studied signs were about 22.6-24.5%, while in different hybrid generations they had almost the same values. It should be noted that in the studied hybrids, intermediate type inheritance was manifested with great frequency. For example, on the basis of gluten quality, it was manifested in 34-36% of hybrid combinations, and in sedimentation - in 33-35%.

Consequently, the process of splitting second-generation hybrids and an increase in the level of homozygosity of plants in their population did not significantly affect the frequency of inheritance types.

In general, the results of the analysis of the inheritance of grain quality traits show that in intraspecific hybrids (F_1–F_2) of spring soft wheat, negative dominance and depression were manifested with the same frequency. It should be noted, however, that negative dominance and depression manifested with approximately the same and rather high frequency. Depressed hybrid populations have no prospects for use in practical breeding, although among the studied hybrid combinations with a negative type of dominance there were also breeding numbers with fairly high values of gluten quality and sedimentation, which makes it advisable to use them as a source material for selection.

In modern genetic and breeding research on wheat, the clarification of such features as protein content and sedimentation, on which the entire qualitative assessment of early hybrid generations is essentially based, is of particular relevance.

The results of the study showed that in spring wheat hybrids, the heritability in the broad sense of the word (H^2) for the studied grain quality characteristics varies depending on the combination of crossing (Table 2).

A high genotypic conditionality has been established for the signs of "gluten quality" and "sedimentation". At the same time, a low level of heritability was found on the basis of gluten content (H^2 = 0.40 under irrigation conditions and 0.45- without watering), which is advisable to use in breeding programs of spring wheat.

Among the studied hybrids, a large contribution of genotypes to the overall variability is characterized by combinations of crosses of varieties of "strong" (Khupar x Kayraktash) and "valuable" (Bardosh x Ok marvarid) wheat, which caused a decrease in heritability. However, it should be noted that the signs "protein content" and "gluten content" had lower heritability than other indicators of grain quality. However, in this case, the genetic origin of the hybrids was of significant importance. As follows from the data in Table 2, the hybrid combination Bardosh x Ok marvarid had a higher heritability index than that of Khupar x Kayraktash. In order to clarify the influence of plant growing conditions on grain quality indicators and the subsequent selection of perspect genotypes for further breeding work, we studied the effectiveness of the selection of spring soft wheat hybrids by sedimentation in different growing conditions.

Table 2 Heritability of grain quality indicators by spring soft wheat hybrids in F_1- F_2 (average for 2018-2020)

Combination crossings	Signs	F_2 (H^2)		The correlation coefficient between F_1- F_2	
		watering	withoutwatering	watering	withoutwatering
"strong x strong" Khupar x Kayraktash	Proteincontent	0.46	0.60	0.37	0.49
	Glutencontent	0.40	0.45	0.36	0.52
	Quality Gluten	0.54	0.65	0.54	0.67
	Sedimentation	0.72	0.86	0.73	0.75
"valuable x valuable" Bardosh x Ok marvarid	Proteincontent	0.47	0.67	0.42	0.59
	Glutencontent	0.41	0.47	0.47	0.65
	Quality Gluten	0.55	0.68	0.61	0.76
	Sedimentation	0.71	0.84	0.81	0.89

Studies have established that the growing conditions of plants had a unidirectional effect on the heritability of grain quality traits. It was revealed that good water availability during the growing season of plants led to a decrease in the heritability of the studied traits. At the same time, such a decrease concerned traits with both higher and relatively low heritability. So, for example, in an irrigated area under favorable conditions for the formation of high productivity, and against this background, the phenotypic variation increased due to environmental factors. Consequently, under irrigation conditions, in comparison with the variant without irrigation (without watering), the component of modification variability of grain quality characteristics increased. At the same time, it is clearly noted that the rank of heritability indicators is preserved both under irrigation and without watering conditions, that is, higher heritability is characteristic of hybrids of the first and third groups.

The results of a comprehensive assessment of spring soft wheat hybrids by grain quality indicators showed that in different growing conditions causes a change in the levels of absolute indicators and indicators of variability of individual traits. The results of such studies primarily testify to the interaction of genotype x environment. The simplest and most accessible way to evaluate genotype-environment interactions is to determine the correlation coefficients between the same-name traits

of varieties and hybrids in different growing conditions.

The data presented in Table 2 indicate that the studied hybrids in F_2 have the highest relationship between sedimentation and gluten quality. At the same time, the ranks of the correlation coefficients on the background of irrigation and without watering are preserved, but their values on the without watering variant are higher than on irrigation. It should be noted, however, that no low correlation coefficients were obtained on the hybrid material studied by us, especially coefficients with a negative value. This is due to the low phenotypic variability of the studied hybrids according to the analyzed grain quality characteristics.

To better understand the processes of variability of grain quality characteristics and determine the effectiveness of selections, it is advisable to choose a hybrid population with a wide shaping process as a starting material. In our set of hybrids, such requirements were met by the hybrid combination of Khupar x Bardosh (strong x valuable).

At the breeding nursery (F_2), the sedimentation rate of 65 families was analyzed in the irrigated and rainfed areas, which were divided into three groups. The numbers with the highest indicators are assigned to the first group, with the average - to the second and with the lowest to the third group. The breeding numbers with the highest grain quality indicators are assigned to the first group, with the average to the second group and with the lowest to the third group.

The offspring of each group of breeding numbers were tested on irrigation and bogprny plots, the gluten content, sedimentation index and flour strength were analyzed (Table 3).

Table 3. The effectiveness of the selection of spring soft wheat hybrids by sedimentation in different growing conditions (average for 2018-2020)

Conditions Selection	Group of selected lines F_2	Manifestations of signs in offspring in selections (F_2)					
		gluten content,%		Sedimentation, ml		the power of flour, e.a.	
		watering	withoutwatering	watering	withoutwatering	watering	withoutwatering
withoutwatering	I	32.4	5.8	71.2	10.4	328	49.4
	II	29.2	5.1	65.1	9.6	278	43.6
	III	20.4	4.2	55.3	9.0	164	45.2
Watering	I	30.3	5.6	66.8	13.1	319	46.8
	II	27.3	4.8	61.2	11.8	239	41.2
	III	19.8	4.1	51.3	11.4	137	37.4
Average by indicators		26.6	4.9	61.8	10.9	244	37.3
$HCP_{0,5}$		2.49	0.11	4.20	0.15	97.1	3.80

It is known that for practical breeding at the early stages it is important to identify and use an effective marker trait that has a close relationship with other traits. In our study, an analysis of the relationship of grain quality characteristics with various characteristics of crop structure elements was carried out and it was found that the sedimentation index and the mass of 1000 grains change independently (v=0.14-0.24). There is a slight correlation in the variability of sedimentation and protein content in the grain, that in various hybrid combinations the correlation coefficient is in the range of 0.26-0.349. At the same time, the variability of gluten content and sedimentation is most interrelated (v=0.46-0.62). The observed relationship between these indicators is explained by the fact that the amount of precipitation is a reflection not only of the quality, but also of the amount of gluten. Given the high degree of swelling of flour in acetic acid, it can be assumed that the selection of this indicator will increase both the protein content and the quality of gluten in spring wheat grain.

Table 3 presents data on the effectiveness of the selection of spring wheat hybrids based on sedimentation in different growing conditions.From the data in Table 3, it can be seen that high-quality lines selected for sedimentation at the bogar site without watering reproduced high indicators of both conjugate sedimentation-gluten content and flour strength. This is evidenced by the testing of the lines not only on the bogar, but also on irrigated areas, although the quality of grain, especially the strength of flour, was higher on the bogar variant.

3. Conclusions

As a result of the conducted studies, it was revealed that in the studied spring wheat hybrids, the protein content, gluten and sedimentation index have different types of inheritance, that in splitting generations, the main share is occupied by combinations with positive dominance and intermediate inheritance. The sedimentation index in spring soft wheat hybrids is a fairly reliable marker for an increase in flour and gluten content. The selection

of genotypes with high sedimentation values causes a significant improvement in the effective signs of the quality of spring soft wheat grain, which are manifested in irrigation and without watering conditions.

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