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AUTUMN SOFT WHEAT VARIETIES AND BREEDING LINES: GRAIN TECHNOLOGICAL QUALITY INDICATORS

Mirzabdullayev G. N.
Doctoral Student of the Research Institute of Grain and Leguminous Crops

Xolmurodova G. R.
Doctor of Agricultural Sciences (DSc), Professor, Department of Genetics,
Breeding and Seed Production of Agricultural Crops, Tashkent State Agrarian University

ABSTRACT

The article presents the technological quality indicators of autumn soft wheat varieties and breeding lines. It is noted that the AC-2010-D45 and AC-2010-D21 lines of autumn soft wheat demonstrated high protein and gluten content, while the AC-2013-D33, AC-2014-D7, and AC-2013-D9 lines showed positive results in terms of IDK value, grain nature, and transparency. The study emphasizes that these breeding lines are promising for use in genetic and breeding research aimed at improving grain quality traits.

Keywords: Autumn soft wheat, grain technological quality, protein, gluten, grain nature, transparency, IDK.

KUZGI YUMSHOQ BUG‘DOY NAVLARI VA SELEKSION TIZMALARINING DON TEXNOLOGIK SIFAT KO‘RSATKICHLARI

Mirzabdullayev G‘. N.
Don va dukkakli ekinlar ilmiy tadqiqot institute tayanch doktoranti

Xolmurodova G. R.
Toshkent davlat agrar universiteti
“Qishloq xo‘jaligi ekinlari genetikasi,
Seleksiyasi va urug‘chiligi” kafedrasi q.x.f.d. (DSc), professor

Annotatsiya:

Maqolada kuzgi yumshoq bug‘doy navlari va seleksion tizmalarining don texnologik sifat ko‘rsatkichlari keltirib o‘tilgan. Kuzgi yumshoq bug‘doyning AC-2010-D45 va AC-2010-D21 tizmalarida oqsil va kleykovina miqdori yuqoriligi, AC-2013-D33, AC-2014-D7 va AC-2013-D9 tizmalari IDK birligi bo‘yicha, don naturasi va shaffofligi bo‘yicha barcha yaratilgan tizmalari ijobiy natijalar ko‘rsatganligi yoritilgan va ulardan belgini yaxshilashda genetik-seleksion tadqiqotlarda foydalanish maqsadga muvofiq ekanligi ta’kidlangan.

Kalit so‘zlar: kuzgi yumshoq bug‘doy, don texnologik sifati, oqsil, kleykovina, don naturası, shaffoflik, IDK.

INTRODUCTION

Autumn soft wheat (Triticum aestivum L.) is one of the most important crops in ensuring global food security and bread-making quality. Under the conditions of Uzbekistan, wheat yield and grain technological quality are the main indicators of the breeding process. Grain technological quality is determined by the following parameters: protein and gluten content, grain nature, transparency, and IDK. At the same time, resistance to high temperatures, diseases, and other stress factors is also taken into account in the breeding process. Previous studies [2; pp. 145–152, 1; pp. 532–543] have shown that technological quality indicators of grain are significantly influenced by the differences between breeding varieties. Moreover, high gluten and protein content increase the baking suitability of wheat varieties, which is a priority quality indicator in breeding programs. However, the existing literature reveals that a systematic annual comparison of the technological grain quality of three-year autumn soft wheat varieties and lines has not been sufficiently studied.

The purpose of our research is to create breeding materials of autumn soft wheat that are adapted to soil and climatic conditions, high-yielding, with high gluten content and flour quality indicators, and resistant to high temperature and certain diseases.

During our studies, the technological quality indicators of autumn soft wheat varieties and breeding lines were determined for the years 2022–2024 and compared with the standard varieties Chillaki and Sharof-100. The following tasks were carried out: determination of grain composition using laboratory methods (protein, gluten), evaluation of grain nature, transparency, and IDK indicators, analysis of annual data to identify low and high values, and recommendations for the use of selected breeding lines in breeding processes.

MATERIALS AND METHODS

The research was carried out during 2022–2024 at the central experimental site of the Research Institute of Grain and Leguminous Crops located in Andijan region. As the research objects, the breeding lines AS-2012-D14, AS-2014-D15, AS-2013-D33, AS-2014-D3, AS-2014-D7, AS-2010-D45, AS-2010-D21, AS-2012-D28, AS-2013-D9, and AS-2013-D23 were studied, along with Chillaki and Sharof-100 as standard varieties.

In the studies, phenological observations of the main growth phases (germination, emergence, tillering, stem elongation, heading, milk, dough, and full ripening), as well as resistance to wintering, lodging, and diseases, were carried out under field conditions using the methodological guidelines of the International Classifier (SEV Triticum type) developed by the All-Russian Institute of Plant Industry (VIR). The technological quality indicators of grain (gluten, protein content, IDK) were determined using the “INFRASKAN-3150” device. The degree of rust infection in wheat varieties and lines was assessed according to the methodology developed by the International SEV classifier for the genus Triticum, while resistance to other fungal diseases was evaluated in percentage (%) based on the scale developed by the International Center for Agricultural Research in the Dry Areas (ICARDA). The obtained experimental data were statistically processed using the modern SPSS-17 software, with statistical analyses conducted following the method of B.A. Dospekhov, as well as with the help of STATISTICA, R, and Excel programs.

RESEARCH RESULTS

According to the experimental results, significant differences were observed in the technological grain quality indicators of autumn soft wheat varieties and breeding lines.

Protein content in autumn soft wheat (Triticum aestivum L.) is one of the main nutritional and technological indicators of grain. It largely depends on climate, soil conditions, agricultural practices, varietal characteristics, and fertilization systems. Protein content determines the nutritional value of grain and directly influences the quality of flour, bread, pasta, and other products made from it. Typically, autumn soft wheat accumulates about 10–15% protein. Depending on the variety and growing conditions, this indicator is classified as follows: low – 8–10%, medium – 11–12%, high – 13–15%, very high – 16% and above. From a practical point of view, the higher the protein content, the more gluten is formed, which results in bread with greater elasticity and strength. If the protein content is below 10%, flour quality is considered poor and mainly used for feed. At 12–14%, it is regarded as suitable for bread-making. At 14% and above, the grain is considered valuable raw material for producing high-grade flour, pasta, and specialized products. Climatic effects are also significant: in dry climates and with high mineral fertilization (especially nitrogen), protein content increases, while in humid conditions with high yields, protein content tends to decrease. In conclusion, protein content in autumn soft wheat is the key indicator determining both grain quality and the nutritional value of derived products.

The analysis of the 2022 data showed that the AS-2013-D9 line recorded an average protein content of 12.9%, while all other lines and varieties demonstrated higher protein levels. The AS-2014-D7 line showed clear superiority over other lines and standard varieties (14.7%). High protein content was also recorded in AC-2010-D45 (14.3%), AC-2010-D21 (14.5%), AC-2012-D28 (14.5%), and AC-2012-D14 (14.2%). In the standard varieties Chillaki and Sharof-100, the respective values were 14.2% and 14% (see table).

Another key technological indicator in soft wheat is gluten content. In cereal crops, gluten content refers to the total amount of a special elastic substance — gluten — formed when the proteins of wheat grain (mainly gliadin and glutenin) combine under the influence of water. Key points: gluten is a stretchy and elastic mass that primarily occurs in wheat grains. After milling grain into flour and adding water to make dough, the proteins absorb water and form the gluten structure. Its content is one of the main indicators used to assess grain quality. The higher and better the gluten, the stronger, more elastic, and more cohesive the products such as bread and pasta will be. Standard ranges are as follows: low-quality grains: 18–22%, medium-quality: 23–28%, high-quality: 28% and above.

Thus, gluten content in cereals is one of the most important technological indicators reflecting flour quality and baking value.

In this trait, the indicators ranged from 25.1% (AS-2013-D9) to 31.2% (AS-2010-D45). In the AC-2014-D7 line, gluten content reached 30.1%, which was recorded as a positive result. In the standard variety Chillaki, gluten content was also 30.1%, while in Sharof-100, it was 28.3%.

In soft wheat, grain nature refers to the weight of 1 liter of grain in grams, that is, the “density depending on the quality and structure of the grain.” Grain nature reflects the size, vitreousness, fullness, and absence of internal cavities in the kernels.

Table

Grain technological quality indicators of varieties and lines in the competitive variety test, 2022-2024.

№	Nav va tizmalar	Oqsil miqdori, %	Kleykovina miqdori, %	Don naturasi, gr.l	Shafofligi, %	IDK, birlik	Gruppasi	Oqsil miqdori, %	Kleykovina miqdori, %	Don naturasi, gr.l	Shafofligi, %	IDK, birlik	Gruppasi	Oqsil miqdori, %	Kleykovina miqdori, %	Don naturasi, gr.l	Shafofligi, %	IDK, birlik	Gruppasi
		2022 y.						2023 y.						2024 y.					
1	Chillaki St	14,2	30,1	815,2	65,3	70	I	14,0	29,7	810,5	59,2	75	I	14,0	30 ,2	815,0	60,2	75	I
2	Sharof-100St	14,0	28,3	801,7	57,9	70	I	14,0	29,0	781,5	57,9	75	I	14,0	28,7	787,3	58,9	75	I
3	AC-2010-D45	14,3	31,2	819,7	57,5	75	I	14,4	30,7	809,5	57,5	95	II	14,1	30,2	756,3	59,7	85	II
4	AC-2010-D21	14,5	30,5	793,7	60,8	80	I	14,1	30,3	793,7	60,8	80	II	14,7	30,5	725,7	48,5	105	III
5	AC-2012-D28	14,5	29,3	811,5	63,7	95	I	14,3	29,3	811,5	63,7	95	II	14,7	29,7	800,7	63,7	80	II
6	AC-2012-D14	14,2	28,8	745,7	59,7	85	I	14,0	28,8	745,7	59,7	85	II	14,5	28,9	767,7	63,5	95	II
7	AC-2013-D33	13,5	27,7	823,7	63,7	80	I	13,5	27,7	805,7	63,4	80	II	14,2	28,6	743,5	67,1	75	I
8	AC-2013-D9	12,9	25,1	711,2	49,5	105	II	13,0	25,1	721,2	49,5	105	III	14,0	29,7	790,7	60,8	75	I
9	AC-2013-D23	14,5	29,7	767,8	63,7	80	I	14,3	29,7	757,8	63,5	80	II	13,9	28,7	805,3	57,5	95	II
10	AC-2014-D7	14,7	30,1	793,5	68,2	75	I	14,6	28,5	793,5	67,1	75	I	14,5	29,3	810,5	63,7	75	II
11	AC-2014-D3	13,5	28,1	737,7	63,5	95	I	13,6	28,1	737,7	63,5	95	II	13,6	25,1	711,2	49,2	105	III
12	AC-2014-D15	13,2	25,5	712,7	47,8	115	III	13,8	25,5	712,7	48,5	105	III	14,2	29,2	717,8	63,7	91	II

It is determined using a special graduated cylinder (1-liter container): the container is filled with grain, and the measured weight is recorded in grams. For soft wheat, the standard grain nature is usually around 730–770 g/L. If the grain is well-filled, vitreous, and dense, the nature will be high (750–780 g/L). If the grain is small, porous, or unripe, the nature will be low (less than 700 g/L). This indicator is important because the higher the grain nature, the higher the flour yield. It is one of the main quality indicators in trade and export and plays a key role in variety evaluation—grain with high nature is considered valuable for baking. Thus, in soft wheat, grain nature is an indicator of density and quality, measured as the weight of 1 liter of grain (in grams).

Grain nature ranged from 711.2 g/L (AS-2013-D9) to 823.7 g/L (AC-2013-D33), with AC-2010-D45 (819.7 g/L) and AC-2012-D28 (811.5 g/L) also showing high results. The standard varieties Chillaki and Sharof-100 recorded 815.2 g/L and 801.7 g/L, respectively.

The “degree of transparency” in cereal crops is an indicator that evaluates the light-transmitting property of the endosperm (flour part) in grain or seeds. Transparency reflects the quality of grain and the technological value of flour produced from it. If the endosperm of the grain is transparent (glassy), starch and proteins are densely structured, typically resulting in high-quality flour. If the endosperm appears opaque and white, it indicates the presence of air cavities, weak starch structure, and low or poorly developed protein content, producing flour of low baking value. High transparency means harder grain, better starch and protein density, and stronger gluten, while low transparency indicates weaker flour quality. Transparency is assessed visually or with special instruments based on light transmission. In grain reception, the quality of wheat (hard or soft) is also evaluated through transparency. In

summary, transparency is an important indicator of the internal structure of the endosperm and the technological value of flour derived from it.

In autumn soft wheat varieties and lines, transparency ranged from 47.8% (AC-2014-D15) to 68.2% (AC-2014-D7). Lines with transparency above 60% included AC-2010-D21 (60.8%), AC-2012-D28 (63.7%), AC-2013-D33 (63.7%), AC-2013-D23 (63.7%), and AC-2014-D3 (63.5%). In the standard varieties, the values were 65.3% for Chillaki and 57.9% for Sharof-100.

The IDK (unit), short for "Index Doppel-Keller" in German, is used in cereals to evaluate grain quality and the technological properties of flour. The IDK unit characterizes the colloidal-biochemical properties of flour proteins and measures gluten deformation. It is usually measured with special devices (IDK-1, IDK-2, IDK-3). What does the IDK unit mean? It is a numerical indicator of gluten elasticity and strength. The lower the value, the stronger and more elastic the gluten; the higher the value, the weaker the gluten. Standard values for wheat are: 45–75 IDK – strong flour, suitable for high-quality bread; 75–95 IDK – good flour, suitable for baking; 95–110 IDK – average quality, recommended for blending; 110 IDK and above – weak flour, suitable mainly for cookies, crackers, and pastries. Thus, the IDK unit is an indicator used to assess gluten strength in wheat flour quality.

In AC-2010-D45 and AC-2014-D7 lines, IDK equaled 75, indicating strong flour characteristics. The standard varieties Chillaki and Sharof-100 also showed an IDK value of 70, confirming their suitability for high-grade bread production (Group I). Only AC-2014-D15 showed an IDK of 115, corresponding to weak flour, mainly suitable for cookies and pastries. AC-2013-D9 recorded an IDK of 105, classified as medium flour (Group II), while AC-2014-D15 (115) fell into the weak flour category (Group III).

According to the 2023 data, the protein content in the AC-2013-D9 line was 13.0%, considered average, while in other lines it ranged from 13.5% to 14.6%, exceeding or equaling the standard varieties. The highest protein content was observed in AC-2014-D7 (14.6%), AC-2010-D45 (14.4%), AC-2012-D28 (14.3%), and AC-2013-D23 (14.3%).

The gluten analysis showed that AC-2013-D9 and AC-2014-D15 had moderate gluten contents of 25.1% and 28.1%, respectively, while all other lines were classified as high-quality grains, with gluten ranging from 28.5% (AC-2014-D7) to 30.7% (AC-2010-D45).

Grain nature in 2023 ranged from 712.7 g/L (AC-2014-D15) to 809.5 g/L (AC-2010-D45), confirming acceptable levels across all lines. The standard varieties showed 781.5 g/L (Sharof-100) and 810.5 g/L (Chillaki).

Transparency indicators ranged from 48.5% (AC-2014-D15) to 67.1% (AC-2014-D7), within acceptable limits. Notably, lines exceeding 60% included AC-2010-D21 (60.8%), AC-2012-D28 (63.7%), AC-2013-D33 (63.4%), AC-2013-D23 (63.5%), and AC-2014-D3 (63.6%).

It should be emphasized that based on IDK parameters, autumn soft wheat lines can be classified into technological groups. These results can serve as a basis for selecting varieties and using them for technological purposes in breeding programs. For example, AC-2014-D7 had an IDK value of 75, equal to the standard varieties (Chillaki, Sharof-100), confirming strong flour properties. Other lines showed values from 80 (AC-2013-D9) up to 105 (AC-2013-D9, AC-2014-D15), corresponding to good flour.

According to the 2024 results, significant differences were again observed in the technological grain quality indicators of autumn soft wheat varieties and breeding lines. Protein content

ranged between 13.6% and 14.7%, with the highest levels in AC-2010-D21 (14.7%) and AC-2012-D28 (14.7%).

Gluten analysis showed the highest value in AC-2010-D21 (29.7%), while the lowest was recorded in AC-2013-D9 (25.1%) and AC-2014-D15 (25.5%). The standard varieties Chillaki and Sharof-100 had gluten contents of 29.2% and 28.7%, respectively. The AC-2010-D21 line demonstrated superior technological quality, confirming its recommendation for state variety testing and showing stable results in both grain composition and technological indicators.

The selected breeding lines and varieties outperformed the standards in terms of technological and baking quality indicators. Based on grain nature, transparency, protein and gluten content, and IDK parameters, the lines were classified into technological groups. These results provide a foundation for variety selection and technological applications in breeding work.

Grain nature showed the highest value in AC-2012-D28 (810.5 g/L). Similarly, Chillaki (815.0 g/L), AC-2010-D45 (805.3 g/L), and AC-2013-D33 (800.7 g/L) also recorded high values.

Transparency ranged from 48.5% (AC-2014-D15) to 67.1% (AC-2014-D7), remaining within acceptable limits. In standard varieties, Chillaki showed 60.2% and Sharof-100 reached 58.9%. In AC-2013-D33, AC-2014-D7, and AC-2013-D9, the IDK value was 75, equal to the standard varieties, confirming their classification as strong flour types. Other lines were categorized as good flour.

CONCLUSIONS

In autumn soft wheat, the AC-2010-D45 and AC-2010-D21 lines demonstrated high protein and gluten content, while AC-2013-D33, AC-2014-D7, and AC-2013-D9 showed positive results in terms of IDK, grain nature, and transparency. It is recommended that these lines be used in genetic and breeding research to improve grain quality traits.

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