

## ANNOTATION

**for the dissertation of Gulmira Baigenzhevna Akhmedova on the topic: "Creation of barley's source material with high yield and grain quality for the cereal industry" for the degree of Doctor of Philosophy (PhD) in the educational program 8D08171 - "Agronomy"**

**Relevance of the research topic.** The reduction of water resources in the Syr Darya river significantly impacts agricultural production in the Kyzylorda region (Oblast). This is because the region is situated in extremely unfavorable geographical conditions for growing agricultural crops, and drought and soil salinity are the main limiting factors for cultivation. Furthermore, the region's location in the lower reaches of the Syr Darya River dictates its dependence on the volume of water flowing from upstream sources. The increasing annual deficit of water resources, along with the salinization of local soils and the depletion of the humus layer, necessitates replacing rice, the widely cultivated crop in the Kyzylorda region, with other, less water-consuming crops. In this context, one of the strategic objectives of the Concept for Water Resources Management of the Republic of Kazakhstan for 2020-2030 (No. 577, dated May 30, 2013), aimed at transitioning to a "green economy," is the gradual reduction of low-profit and water-intensive agricultural crops and their replacement with less water-intensive vegetable, grain, and oilseed crops. At a meeting of the operational headquarters on anti-crisis measures, held at the government level to ensure the country's food security, the development of a program for breeding drought-resistant domestic varieties in the short term was named as a priority task to eliminate import dependence.

Rice is the main agricultural crop in the Kyzylorda region, annually accounting for over 45% of the region's total agricultural area. Rice is an economically, environmentally, and socially significant crop for the region and plays a vital role as a land reclamation crop. However, since rice is a highly water-intensive crop, water shortages in the region hinder the development of rice cultivation. In this case, domestic drought-tolerant barley varieties could be introduced into the crop rotation. Barley is highly adaptable to any environmental conditions, is resistant to drought and soil salinity, has a high yield, and is used as animal feed, and is a leading grain crop worldwide.

Agricultural crop yields have declined significantly recently, primarily due to the new environmental situation, directly related to water shortages, which significantly impact the climate of the Kyzylorda region. The increasing water shortage, along with soil salinity and humus depletion, are reducing the yield of the region's main grain crops, rice. Due to water shortages, a reduction in rice acreage is planned, followed by substitution with low-water-consuming crops. Long-term research has shown that cultivating barley in a rice-rice crop rotation allows for the efficient use of the region's bioclimatic potential.

By exploiting the natural moisture in the soil after rice cultivation, barley can produce high yields without a single irrigation. Furthermore, due to its short growing season, it matures before the onset of dry periods. This creates conditions for the

efficient use of agricultural machinery, reducing the intensity of work and allowing these fields to be reused for other crops.

The Concept for the Development of the Agro-Industrial Complex of the Republic of Kazakhstan for 2021-2030 places significant emphasis on the breeding and seed production of agricultural crops. Therefore, in order to develop new cereal barley varieties for the Aral Sea region of Kazakhstan, a comprehensive assessment and development of source material for its inclusion in practical breeding is essential.

### **Research objective.**

The objective of this dissertation is to develop valuable source material and a new cereal variety based on a comprehensive evaluation of barley varieties of various origins.

### **Research tasks:**

1. Create valuable source material for practical breeding through screening, comparative analysis, and hybridization of global spring barley collection accessions in field and laboratory conditions;
2. Determine the key criteria for selecting hull-less barley resistant to adverse weather conditions, using laboratory and direct field evaluation methods;
3. Identify donors of high-yielding and stress-resistant varieties through genetic selection analysis;
4. Conduct biochemical analysis of the grain of the selected genotypes;
5. Develop the model of the hull-less barley variety and create a new variety;
6. Determine the economic efficiency of the new hull-less barley variety.

### **Scientific novelty.**

The comprehensive study of the key economic performance indicators of barley varieties of various origins was conducted in the ecologically unfavorable conditions of Kazakhstan's Aral Sea region. The identified genotypes were used in hybridization programs to create high-yielding cereal source material resistant to abiotic factors.

As a result of the study, the isolated variety accessions were recommended for inclusion in the breeding process as donors of economically valuable traits.

For the first time, a model of a hulless barley variety adapted to ecologically unfavorable regions was developed, and Qonys is new variety was created. Applications for "Economic Utility" and "Patent for Breeding Achievement" have been submitted to the Republican State Institution "State Commission for Variety Testing of Agricultural Crops" and the Republican State Enterprise "National Institute of Intellectual Property."

### **Theoretical and practical significance of the research.**

In the saline soils of the Aral Sea region of Kazakhstan, 50 genotypes were isolated from the global barley collection, each with a complex set of economically valuable traits. These genotypes produce the highest yields, mature before the onset of summer drought, and have a slightly longer tillering and booting period. Using these selected genotypes in hybridization programs, the source material for cereal barley was created.

The genetic and statistical analysis conducted recommended using the number of grains per spike as a marker for selecting productive hulled barley varieties, while

the thousand-grain weight was used for selecting hulled varieties. Determining the heritability coefficient revealed that plant height, spike length, and the number of grains per spike were the most readily available traits for selection in the first generations of hybrid populations. As a result of the study, donors of economically valuable traits for widespread use in synthetic breeding were identified: DeirAlla106/Strain205//Rhn-03/3/B512, ICNBF8-611/Aths, Rhn-03/3/B512, ICNBF8-611/Aths, HIGO/LINO, Atahualpa/4/Avt/Attiki//Aths/3/Giza121/Pue, Atahualpa/4/Harrington/3/WI2291/Roho//WI2269, DeirAlla106/Strain205//Rhn-03/3/BF891M-582, Atahualpa/4/Avt/Attiki//Aths/3/Gizade121/Pue.

The selected variety samples were introduced into the breeding process as source material at the hybridization center of the LLP «Kazakh Research Institute of Agriculture and Plant Growing» and transferred to the laboratory of grain crop genetic resources of the LLP «A.I. Barayev Scientific and Production Center for Grain Farming» for medium-term storage and replenishment of the gene pool.

Taking into account the peculiarities of the soil, climatic and agro-ecological conditions of the Aral Sea region, based on selection and genetic indicators and analysis of the morphobiological characteristics of zoned varieties, a model of naked barley variety was developed and the new variety Qonyr was created.

#### **Main provisions submitted for defense:**

- Creation of valuable source material through a comprehensive evaluation of barley varieties of various origins and their integration into the breeding process;
- Use of selection and genetic indicators of productivity, variability, and correlations to select new adaptive forms of hull-less barley for the conditions of the Aral Sea region of Kazakhstan;
- Development of a model of a hull-less barley variety adapted to an ecologically unfavorable region and submission of the developed variety for variety testing to the Republican State Institution "State Commission for Variety Testing of Agricultural Crops" of the Ministry of Agriculture of the Republic of Kazakhstan.

#### **Approval results of the work.**

The results of this dissertation were presented and discussed at the international scientific conference "Grain Industry: Status and Development Prospects" (Almaty, February 28, 2020), organized in honor of the 70th anniversary of Academician of the Academy of Sciences of the Republic of Kazakhstan A.I. Izmayev; and the XII International Scientific and Practical Conference "International Scientific Journal "Global Science and Innovation 2021: Central Asia" (Astana, February 5, 2021).

The main results of this dissertation were published in 13 scientific papers, including 7 in journals recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan, 2 in collections of international scientific and practical conferences, 4 in foreign journals, including 3 in journals included in the Russian Science Citation Index (RSCI) database and 1 in a publication included in the Scopus database (International Journal of Agronomy, percentile 59, Q2).

#### **Connection of the dissertation with state programs.**

This dissertation was completed as part of the following research projects:

1. Program-targeted financing of the Ministry of Agriculture of the Republic of Kazakhstan for 2021-2023 within the framework of project BR10765056 "Creation of high-yielding varieties and hybrids of grain crops based on achievements in biotechnology-genetics-physiology-biochemistry of plants to obtain stable yields in various soil and climatic zones of Kazakhstan" (Agreement No. 111-2);

2. Targeted program financing of the Ministry of Agriculture of the Republic of Kazakhstan for 2024-2026 within the framework of project BR24892821 "Breeding and primary seed production of grain crops to increase productivity, quality, and stress resistance potential in various soil and climatic zones of Kazakhstan" (Agreement No. 32-1-2PKF-1)

#### **Implementation of research results.**

The selected variety samples were incorporated into the breeding process as source material at the hybridization center of the Kazakh Research Institute of Agriculture and Plant Growing in Almaty Region and transferred to the grain crop genetic resources laboratory of the A.I. Barayev Scientific and Production Center for medium-term storage and gene pool expansion.

The developed new hulless barley variety Qonys has been submitted for variety testing to the State Commission for Variety Testing of Agricultural Crops of the Ministry of Agriculture of the Republic of Kazakhstan.

#### **Volume and structure of the dissertation.**

The total volume of the dissertation is 146 pages. It includes an introduction, 6 chapters, conclusion, recommendations for breeding practice and production, list of references, and appendices. The text of the work is illustrated with 34 tables, 13 figures, and 5 appendices. The list of references includes 240 scientific works by domestic and foreign scientists.