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**ABSTRACT**

of the dissertation for the degree of Doctor of Philosophy

**STUDY OF THE LOCAL AND INTRODUCED AUTUMN  
BREAD WHEAT HYBRIDS UNDER IRRIGATED  
CONDITIONS AND THE DEVELOPMENT OF THE  
STARTING MATERIAL FOR BREEDING**

Specialty: 3103.04 – Breeding and seed production

Field of science: Agrarian sciences

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The work was performed at the "Plant Breeding" department of the Tartar Regional Experimental Station, Agrarian Science and Innovation Center, Research Institute of Crop Husbandry.

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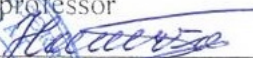
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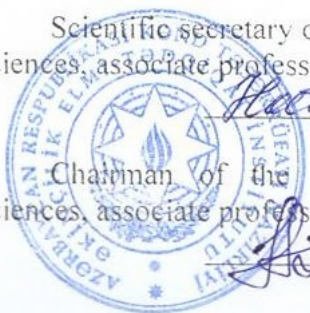
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**Relevance and degree of completion of the topic.** Special attention is paid to the development of the agricultural sector for ensuring food security and meeting the demand for food products. In our country, attention and care are paid to the dynamic development of all areas of the agricultural sector, including the development of grain growing. Since grain growing is a key strategic area in ensuring food security of the population, grain production in the country is expanding every year by giving priority to intensive technologies and measures are being taken, such as application of new cultivation technologies, development of high-yielding cereal varieties, assistance to grain farmers, the supply of newly created productive varieties to farmers and other landowners, etc. In the near future, it is planned to fully meet the demand for food cereals through our own production. To achieve this goal, more productive varieties must be created, cultivated and cultivation measures improved. For this purpose, new, quality, high-yielding wheat varieties, which are resistant to diseases and lodging, have been developed at the Research Institute of Crop Husbandry. Besides, a large number of hybrid lines have been created and tested in different regions, by the plant breeders of the institute every year. Given the strategic importance of creating high-quality varieties along with productivity at a time of agro-reforms in our country and the increase in the price of high-quality grain on the world market, the relevance of the research is undeniable.

**The purpose and tasks of the research.** The main goal of the research was breeding evaluation of introduced and newly developed hybrids by intraspecific hybridization and creation of a starting material tolerant to biotic and abiotic stress factors, having rich genetic diversity, high transgressive traits, and technological qualities for the selection of bread wheat.

To achieve the solution of the issues envisaged in the research work, the following main tasks have been set:

1. The study and breeding evaluation of introduced bread wheat hybrids based on the vegetation period, productivity, resistance to diseases, pests, and quality indices;

2. Selection of promising bread wheat lines with optimal morphophysiological parameters, distinguished by productivity and quality indices at different stages of breeding of hybrid lines;
3. Inclusion of selected lines in the breeding program and their use in the creation of new varieties;
4. Creation of new, bread wheat hybrids by intraspecific hybridization using local and introduced specimens;
5. Study of the patterns of inheritance of quantitative traits in the first (F<sub>1</sub>) generation bread wheat hybrids;
6. Study of transgressive variability (frequency and level of transgression) based on quantitative traits of the second-generation (F<sub>2</sub>) bread wheat hybrids;
7. Determination of the correlation between quantitative traits of the first (F<sub>1</sub>) and second (F<sub>2</sub>) generation hybrids;
8. Identification of valuable sources for selection according to individual traits.

**Research methods.** "Field research and observations on plants (phenological), the study of the resistance to lodging, grain shedding, frost, drought, structural elements of the product" were carried out considering the existing "methodological guidelines in this area"<sup>1</sup>. True heterosis and heredity were determined in the first generation hybrids according to individual characteristics (vegetation periods, plant height, productivity elements, etc.), and the level of transgression was determined in the second generation. Correlational relationships between quantitative indices were determined and "mathematical-statistical calculations"<sup>2</sup> were carried out.

1. Musayev, A.J. Methodology of field experiments on the research work in the field of selection of cereal crops / A.J.Musayev, H.S.Huseynov, Z.A.Mammadov; -Baku: Muallim, -2008. –p.88 (in Azerbaijani).

2. S-PLUS 2000 Professional User's Manual/MathSoft.Seattle,-1999.-p.570.

In F<sub>1</sub>-hybrids, "dominance"<sup>1</sup> and "heterosis rate"<sup>2</sup>, and in F<sub>2</sub>-hybrids, "transgression rate and transgression frequency"<sup>3</sup> were calculated. Also, based on the "International scale of rust disease report on leaves"<sup>4</sup>, the analysis of grain quality was carried out in the

"Grain Quality" laboratory of the Research Institute of Crop Husbandry on the basis of "Methodological guidelines for assessing the quality of grain"<sup>5</sup>.

Local specimens distinguished by complex traits and indices, Azeri, Murov, Murov-2, Aran, Zirva-85, Yegana as well as introduced bread wheat specimens, Bezostaya-1, Sonmez, Doka, Vassa, Tanya, Nota, Trap, Yubiliein100/Tilek /1, etc. were used for hybridization.

**Main points presented to the defense of the dissertation:**

The dissertation consists of the results of the scientific-theoretical points on the following scientific research.

-Comprehensive assessment of the second-generation (F<sub>2</sub>) bread wheat hybrids introduced by the breeding program from International Centers (CIMMYT-ICARDA, Turkey) under the irrigated conditions of the plain Garabagh region based on the agrobiological features and characteristics;

-Selection of perspective lines having optimal morphophysiological parameters and disease resistance, high productivity, and quality indicators;

1. Beil, G.M., Atkins, R.E. Inheritance of Quantitative Characters in Grain Sorgh // Lower State Journal of Science, -1965. v.39, No3, -pp.321-324.

2. Omarov, D.S. To the method of accounting and assessment of plant heterosis // -Moscow: Agriculture. Biology, -1975. V.10, No. 1, -pp.123-128 (in Russian).

3. Voskresenskaya, G.S., Shpota, V.I. Transgression of hybrids and a method for quantifying this phenomenon // -Moscow: Reports of the All-Union Academy of Agricultural Sciences named after V.I. Lenin, -1967. No.7, -pp.18-20 (in Russian).

4. Instruction for the Management and Reporting the Results for the FAWWON // Prepared and distributed by National Wheat Improvement Program of Turkey, CIMMYT-ICARDA, Oregon State University, -1998. -pp.1-7.

5. Grain Quality Handbook / Edited by PhD in agricultural sciences G.P. Zhemela –Kiev: Urozhay, -1977. –p.53 (in Russian).

-Inheritance and variability of quantitative traits in newly created intraspecific bread wheat hybrids based on local and introduced specimens;

-Determination of correlational relationships between genetic parameters of hereditary traits, level of phenotypic dominance (high

dominance, dominance, intermediate heredity, depression and true heterosis, frequency, and level of transgression), and quantitative and qualitative traits.

**Scientific novelty of the research.** For the first time, the second (F<sub>2</sub>) generation bread wheat hybrids introduced within the breeding program of International Centers (CIMMYT-ICARDA, Turkey) under the irrigated conditions of the Plain Garabagh region were comprehensively evaluated for agrobiological traits and characteristics. Perspective lines distinguished by high productivity and quality indices, optimal morphophysiological parameters, and disease resistance were selected and included in the breeding program. Based on the local and introduced specimens, hereditary transmission and variability of quantitative traits in newly created intraspecific bread wheat hybrids were studied according to the level of phenotypic dominance (dominance, heterosis) depending on the hybridization components, and genetic parameters (transgression frequency and level) for revealing traits were identified.

**Theoretical and practical significance of the research.** More than 100 disease-resistant, high-yielding, and high-quality hybrid lines having complex traits and characteristics were selected and included in the breeding program.

As a result of the selection carried out within the framework of the wheat program, together with the breeders of the Research Institute of Crop Husbandry, new Parvin, Metin, Altun-2, Saba-2, Billur, Tunj, Onur, Oghuz, Diabar bread wheat varieties were developed and submitted to “Agency for Agrarian Services” for regionalization. “Parvin” (patent No 00207), “Metin” (patent No 00247), and “Altun-2” (patent No 00272) bread wheat varieties were regionalized and included in the “State Register” and registered in 2017, 2019, and 2020, respectively.

**Approbation and application of the work.** The results of the research were presented annually at the final annual report meetings of the Research Institute of Crop Husbandry (2011-2015); at the International Scientific Conference, "Selection and Genetics of Agricultural Crops, Traditions and Prospects" organized by Ministry

of Agriculture of Ukraine, The National Academy of Agrarian Sciences Of Ukraine (October 17-19, 2012, Odessa); The II meeting on "Azerbaijan-Turkey Scientific Research Cooperation on Beekeeping Development" and the II International Conference of the Council of Young Scientists of the Agrarian Science Center organized by the Agrarian Science Center of the Ministry of Agriculture of the Republic of Azerbaijan and Research Institute of Silkworm Breeding (June 9-11, 2015, Baku); Conference of Young Scientists and Students, "Innovations in Biology and Agriculture to Solve Global Challenges", (Dedicated to the 90th Anniversary of Academician Jalal A.Aliyev), organized by the Research Institute of Crop Husbandry and the Institute of Molecular Biology and Biotechnologies (October 31, 2018, Baku); International Scientific-Practical Conference on "Ecological and genetic aspects in the selection of field crops under changing climatic conditions" dedicated to the 90th anniversary of Professor N.M. Chekalin, organized by the Ukrainian State Academy of Agricultural Sciences, Poltava State Academy of Agriculture (April 18-19, 2019, Poltava); International Scientific-Practical Conference on "Prospects of new and introduced foreign varieties of cereals and legumes, as well as modern resource-saving technologies for cultivation in the Republic of Uzbekistan" organized by the Ministry of Agriculture of the Republic of Uzbekistan, Research Institute of Grain and Legume (May 21-22, 2019, Andizhon); At the International Scientific Conference "Wheat in European countries and Georgia as one of the origins of wheat" organized by the Georgian Academy of Agricultural Sciences (October 2-04, 2019, Tbilisi) and the completed dissertation was discussed in detail at the Scientific Council of the Research Institute of Crop Husbandry.

**Name of the organization where the dissertation was performed:** The dissertation was performed at the "Plant Breeding" department of the Tartar Regional Experimental Station, Agrarian Science, and Innovation Center, Research Institute of Crop Husbandry.

**Total volume of the dissertation in characters with an**

**indication of the separate volumes of the structural units.** The main part of the work includes an introduction, four chapters, conclusions, recommendations for breeders and producers, a list of 185 references, and appendices. The dissertation contains 46 figures, 48 tables, and 43 appendices. In the main structure, the title part and the table of contents consist of 3 pages with 4462 characters, introduction-11 pages with 22319 characters, the first chapter-21 pages with 42405 characters, the second chapter-21 pages with 34987 characters, the third chapter-48 pages with 57703 characters, the fourth chapter-63 pages with 71967 characters, conclusions-2 pages with 3860 characters, recommendations for breeders and producers 1 page with 1841 characters, the list of references 19 pages with 31474 characters. The total volume of the dissertation is 287 pages, the general part of the text (excluding pictures, tables, appendices, and list of references) consists of 118 pages of computer typing or 235082 characters.

## **CONTENT OF THE WORK**

**The introduction** presents the actuality of the topic and the general description of the dissertation.

**Chapter 1** provides an extensive literature review under the headings "History, current status and main directions of wheat breeding in Azerbaijan", "Importance of starting material in wheat selection", "Key quality indices" and "Disease resistance". Performed research, scientific achievements in the world and in the country to date, other issues related to the topic of the dissertation have been studied based on the numerous literature sources, the analysis of literary data has been carried out.

**Chapter 2** presents extensive information on "Brief characteristics of soil and climatic conditions of the study area", "Main agrochemical parameters and agrometeorological conditions of the experimental years", "Research agrotechniques", "Research material", "Research methodology" and "Brief description of specimens used in hybridization".

The experiments were carried out on gray-brown soils irrigated



since ancient times. The experimental field had a weak alkaline property, so the pH varied between 8.14 and 8.42 depending on the depth. The amount of total humus in the plowed layer was 1.69-1.77%, and in the lower layers decreased naturally. The total nitrogen content in the plowing layer (0-25 cm) varied in the range of 0.135-0.144% depending on the years of the research. In the lower layers (25-50 and 50-70 cm) it was 1.05-1.16% and 0.85-0.96%, respectively. Depending on the years of the research, the amount of easily hydrolyzed nitrogen in the plowed layer of the experimental field was 48-58 mg per 1 kg of soil on average, the amount of mobile phosphorus was 12.5-14.3 mg, and exchangeable potassium was 225.0-252.0 mg.

During all the years of the research, there was black steam as a predecessor in experiments. The research material consisted of 27 second-generation ( $F_2$ ) bread wheat hybrids introduced from International Centers (CIMMYT, ICARDA), as well as local and introduced selection varieties and hybrid combinations created by intraspecific hybridization (hybridization was carried out in 2012-2013 (P-20; F0-62) and 2013-2014 (P-18; F0-39) research years in the earing phase according to the developed plan) based on the limited pollination method (Tvel method).

### **Chapter 3. Breeding evaluation of introduced autumn bread wheat hybrids**

**3.1. The study of the productivity elements of introduced autumn bread wheat hybrids.** The productivity elements in various generations of introduced bread wheat hybrids of different origins have been studied for several years.

In the 2009-2010 research years, the third-generation ( $F_3$ ) hybrids were selected from the second-generation ( $F_2$ ) combinations that distinguished by complex traits from the standard Aran variety. In 2010-2011, the visual assessment was performed based on disease resistance, architectonics, etc., and stabilized lines were selected.

In the 2011-2012 research years, plant height and productive tillering were studied in the selected stable lines of the fourth-generation (F<sub>4</sub>) hybrids of introduced autumn bread wheat.

“In the 2012-2013 research years, the study performed in Nursery I for breeding and control showed that yield and productivity elements of the introduced F<sub>5</sub> generation stable hybrid lines were higher compared to the standard. Thus, the stalk was higher in 94.0% of them, the number of grains per stalk in 62.0%, the mass of grains in 68.0%, the mass of 1000 grains in 54.0%, productivity in 92.3%. In F<sub>5</sub> hybrids, which differ in complex characteristics, the plant was 1.0-20.5 cm shorter compared to the standard. The stalk length, the number of grains per stalk, 1000 grain mass, and productivity were higher by 0.4-6.5 cm, 0.8-34.7, 0.01-1.54 g, 0-9.0 g, and 6.0-29.9 cwt/ha, respectively. The highest productivity (89.8 cwt/ha) was observed in the T154/Kristadora/1 hybrid line.

45.9% of the introduced sixth-generation (F<sub>6</sub>) hybrid lines studied in 2013-2014 were shorter than the standard (Aran). Compared to the standard, the spike length was superior in 9.2%, the number of grains per spike in 40.5%, the mass of grains per spike in 54.0%, the 1000 grain mass in 70.3%, and productivity in 66.7% of the studied lines.

The study of F<sub>7</sub> stable lines based on structural elements showed that 56.25% of the lines were shorter compared to the standard. The productive tillering was superior in 87.5%, the spike length in 81.25%, the number of spikelets in 56.25%, the number of grains per spike in 100%, the mass of grains per spike in 93.75%, and 1000-grain mass in 87.5%”<sup>1</sup>.

The lines - Son./4/Bab./Lr42//Bab.\*2/3/Tuk./1-1; Peh./4/Bab./Lr42//Bab.\*2/3/Kur. /4-3; Bez.1/4/Bab./Lr42//Bab.\*2/3/Bram./1-1; Star./Son. /2; T154/Krist. /1; Son./Pehl. /1; Star./Son. /3 etc. were distinguished by complex properties.

**3.2. The study of the vegetation period in the selected hybrid lines:** The vegetation period of the studied bread wheat F<sub>5</sub>-hybrid lines introduced in 2012-2013 varied between 180-205 days

and the lines were divided into 3 groups according to the vegetation period.

Of the 127 fifth-generation (F<sub>5</sub>) hybrids studied, 46 (36.22%) were early maturing (180-189 days), 73 (57.48%) were medium maturing (190-197 days), and 8 were (6.30%) late maturing (198-205 days). Compared to the standard Aran variety, 92.13% of the lines (117) had a short vegetation period and the difference compared to the standard was 14-17 days.

**The study of the quality indices in various generation hybrids of introduced bread wheat:** Quality indices of the introduced fifth-generation (F<sub>5</sub>) hybrid lines were studied in 2012-2013. The studied stable hybrid lines were compared to the local standard. Vitreousness was higher in 15.39% of the introduced hybrids, gluten content in 23.08%, deformation coefficient of gluten in 15.39%, sedimentation index in 92.31%, protein content in 30.77% compared to the local standard.

In 2014-2015, in the F<sub>7</sub>-lines studied in the competitive variety test (CVT), the vitreousness varied between 39.5-93.0% and was

1. Nazarov, B.B. The study of economic and biological indicators of promising hybrid lines of bread wheat // - Moscow: Scientific-theoretical and production journal "Agrarian Science", -2018. No. 7-8, -pp.47-49.

higher in Starshina/Sonmez/2 and Starshina/Sonmez/3 lines compared to the standard. These lines showed higher indices in the gluten content (28.8%; 33.6%), the deformation coefficient of gluten (83.4; 70.9 units), the sedimentation index (52.8 ml; 42.5 ml), and the protein content in the grain (14.5%; 12.7%). The lines - Gondwana/Demir/1, T154/Kristadora/2 were also distinguished by complex indices.

**The study of disease tolerance in various generation hybrids of introduced bread wheat:** During the years of the research, the introduced hybrids of different generations were infected to various degrees with septoriosi, powdery mildew, yellow and brown rust. However, loose smut and bunt diseases were not observed.

In the 2014-2015 research years, 74.47% (35) of the introduced F<sub>7</sub>-bread wheat hybrid samples were resistant (0-R) and moderately

resistant (MR) to yellow rust disease; 10.64% (5) were sensitive (S); 14.89% (7) were moderately sensitive (MS). Whereas, 4.25% (2) were resistant (0-R) and moderately resistant (MR); 29.79% (14) were sensitive (S); 65.96% (31) were moderately sensitive (MS) to brown rust.

**Statistical analysis of the correlational relationships between qualitative and quantitative traits of introduced various generation hybrids of bread wheat:** The results of the analysis of quantitative and qualitative traits in F<sub>5</sub> hybrid samples of bread wheat showed a positive correlation between the mass of 1000 grains and the plant height ( $r=0.578^*$ ), the coefficient of deformation of gluten, and the number of spikelets per spike ( $r=0.672^{**}$ ), the number of grains per spike and productivity ( $r=0.601^*$ ), sedimentation with gluten ( $r=0.541^*$ ) and protein ( $r=0.829^{**}$ ) at a level of 0.5-0.1% reliability.

Similar results were found in the correlation analyses of 13 quantitative and qualitative traits in the sixth-generation (F<sub>6</sub>) hybrid samples.

#### **Chapter 4. Creation and application of the starting material for bread wheat breeding by intraspecific hybridization**

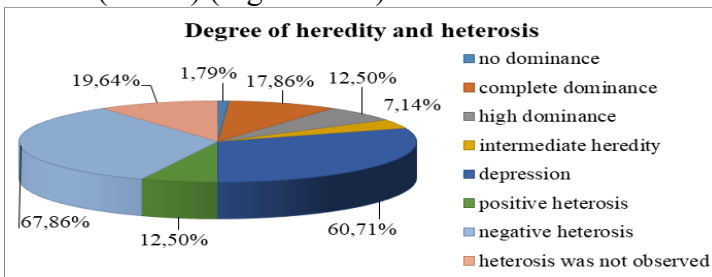
**4.1. Obtaining hybrid generations:** The main goal of our research was to create a genetically enriched, high-quality starting material for bread wheat breeding. "For this purpose, mainly local bread wheat varieties, Azeri, Murov, Murov-2, Shafag, Shafag-2, Parvin, Taraggi, Aran, Mahmud 80, Zirve 85, Yegana, TT 09214/3 lut., TT 09214/3-1 lut., Z 2009/1-1 (Aran x Umanka), Z 2009/2-1 (Murov x Aran), introduced bread wheat varieties of Russian origin Bezost.-1, Doka, Vassa, Tanya, Nota, Trap; the variety Sonmez of Turkish origin, the hybrid line Yubilieinaya100 x Tilek/1, and other samples were used as parental forms within intraspecific hybridization programs. Hybridization was performed according to the developed plan for 2012-2013 (P-20; F<sub>0</sub>-62) and 2013-2014 (P-18; F<sub>0</sub>-39), at the Tartar Regional Experimental Station of the Research Institute of Crop Husbandry under irrigated conditions, using the limited pollination method (the Tvel method). For

hybridization, in the 2012-2013 research years, 2988 flowers were castrated on 280 spikes, and in the 2013-2014 research years 2000 flowers were castrated on 204 spikes. In the 2012-2013 research years, 1159 hybrid grains were obtained from 280 castrated spikes and in the 2013-2014 research years, 986 hybrid grains (F<sub>0</sub>) were obtained from 204 castrated spikes. In the combinations obtained as a result of intraspecific hybridization, the grain yield of the spike was between 10.4-72.9%”<sup>1</sup>.

**4.2. The study of the vegetation period in various intraspecific generation hybrids of bread wheat:** “In the 2013-2014 research years, 60.71% (34) of 56 F<sub>1</sub> lines were dominated by fast maturity (hp=-1;-9) and at the level h<sub>true</sub>=-0.58;-3.55, matured 1-6 days earlier than the parental forms by forming true heterosis, 30.36% (17) of them matured 1-4 days later than the parental forms

1. Nazarov, B.B. The study of quantitative and qualitative traits in bread wheat hybrids // - Baku: Proceedings of the Research Institute of Crop Husbandry, -2018.V.29, -pp.169-173 (in Azerbaijani).

with complete and high (hp=+1;+7) phenotypic dominance. Intermediate heredity (hp=-0.33;+0.33) was observed in 4 combinations (7.14%) (Figure 4.2.1)”<sup>1</sup>.



**Figure 4.2.1: Vegetation period in intraspecific F<sub>1</sub> hybrids**

The shortest vegetation period was detected in the combinations: TT01404 Shafag x Sonmez (206 days), TT01422 Parvin x Murov-2 (204 days), TT01426 Par. x Alman (205 days), TT01427 Vas. x Mur.-2 (204 days), TT01432 Yub.100/Til./1 x Zirva 85 (205).

**4.3. Phenotypic detection of quantitative traits in the intraspecific first generation (F<sub>1</sub>) bread wheat hybrids:** “In the 2013-2014 years, high dominance in plant height was observed in

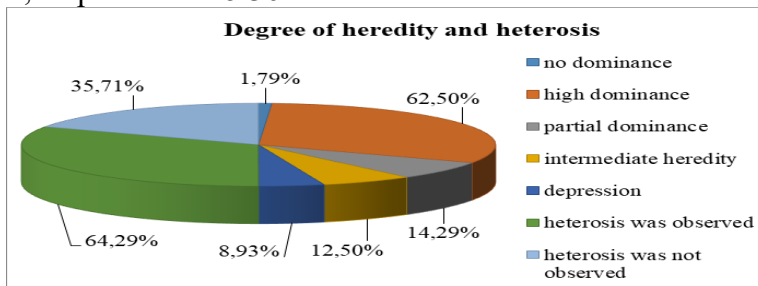
51.79% of 56 F<sub>1</sub> hybrids; Partial dominance in 12.5%; Intermediate heredity in 19.64%; Depression in 16.07%. High dominance in the stalk length was detected in 62.5% of the combinations; Partial dominance in 14.29%; Intermediate heredity in 12.5%; Depression in 8.93% (Figure 4.3.1). High dominance in the number of grains per stalk in 62.5% of the F<sub>1</sub> lines; Partial dominance in 10.71%; Intermediate heredity in 16.07%; Depression in 8.93%-da; heterosis in 62.5% (Figure 4.3.2)<sup>2</sup>.

“High dominance was observed in the mass of grains per stalk in 76.79% of the F<sub>1</sub>-combinations; Partial dominance in 5.36%;

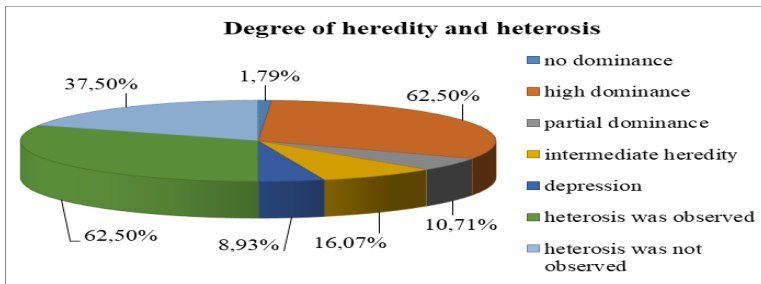
1. Nazarov, B.B. The study of the vegetation period in the intraspecific first generation (F<sub>1</sub>) bread wheat hybrids // - Baku: Proceedings of the Research Institute of Crop Husbandry, -2015, V.26, pp.123-128 (in Azerbaijani).

2. Nazarov, B.B. The study of the hereditary transmission of quantitative traits in the intraspecific first generation (F<sub>1</sub>) bread wheat hybrids // - Baku: Proceedings of the Research Institute of Crop Husbandry, -2015. V.26, -pp.112-122 (in Azerbaijani).

Intermediate heredity in 7.14%; Depression in 10.71%. The mass of grains per stalk varied between 1.33 and 3.19 g in the parental forms. Whereas, in the F<sub>1</sub> hybrids, this parameter was in the range of 1.68-4.56 g, depending on the combination. High dominance was detected in 1000 grain mass in 73.21% of the first generation (F<sub>1</sub>) hybrid combinations; Partial dominance in 8.93%; Intermediate heredity in 12.5%; Depression in 5.36%<sup>1</sup>.



**Figure 4.3.1: Hereditary transmission of spike length in F<sub>1</sub> hybrids**

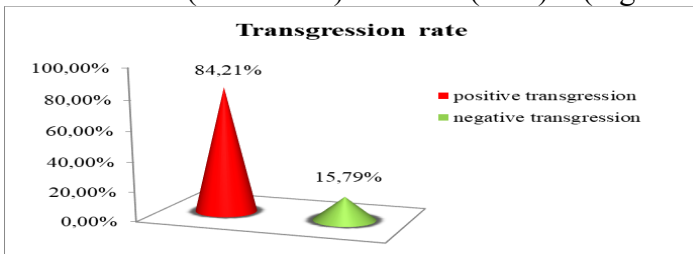


**Figure 4.3.2: Hereditary transmission of the number of grains per spike in F<sub>1</sub> hybrids**

**4.4. The study of transgressive variability in the second generation (F<sub>2</sub>) bread wheat hybrids:** “In the 2014-2015 research years, positive transgression in plant height was observed in 50.0% of thirty-eight F<sub>2</sub>-generation hybrid combinations (19); Negative transgression in 50.0% (19). Positive transgression in the stalk length in 84.21% of the combinations; Negative transgression in 15.79%.

1. Nazarov, B.B. The study of the hereditary transmission of quantitative traits in the intraspecific first generation (F<sub>1</sub>) bread wheat hybrids // - Baku: Proceedings of the Research Institute of Crop Husbandry, -2015. V.26, -pp.112-122 (in Azerbaijani).

The highest transgression level was detected in the lines: TT01318 Murov x Doka (Tgs=+21.95%), TT01316 Mur. x Bez.-1 (Tgs=+16.26%), TT01343 TT09214/3-1 lut. x Tanya (Tgs=+11.92%). Transgression frequency ranged between 10.0 and 100.0 depending on the combinations. The following combinations were distinguished by high indices: TT01316 Mur. x Bez.-1 (100%), TT01352 Z2009 /2-1 (Mur. x Ar.) x Bez.-1 (90%)”<sup>1</sup> (Figure 4.4.1).



**Figure 4.4.1: Transgressive variability according to the length of the F<sub>2</sub> generation spike**

“Positive transgression in the number of grains per spike was

detected in 52.63% (20) of the F<sub>2</sub> combination hybrids; Negative transgression in 47.37% (18). The combinations TT01334 Son. x Par. (Tgs=+32.83%), TT01343 TT09214/3-1 lut. x Tan. (Tgs=+24.77%), TT01317 Mur. x Tan. (Tgs=+20.70%) were distinguished by high transgression levels. Transgression frequency varied between 20.0% and 90.0 % depending on the combinations. The combinations TT01317 Mur. x Tan. (90%), TT01343 TT09214/3-1 lut. x Tan. (90%), TT01345 TT09214/3-1 lut. x Trap (90%), etc. were distinguished by the highest indices”<sup>1</sup>.

Positive transgression was detected in the mass of grains per stalk in 71.5% (27) of the F<sub>2</sub> lines; Negative transgression in 28.95% (11) of the combinations. The combinations TT01316 Murov x Bez.-1 (Tgs=+49.80%), TT01317 Murov x Tanya (Tgs=+32.71%) were distinguished by the highest transgression level. Transgression frequency in the mass of grains per stalk varied between 30 % and 100 %.

1. Nazarov, B.B. Studying the transgressive variability of quantitative characteristics in the second generation hybrids of winter bread wheat // -Baku: “Nature and Science” International scientific journal, -2020. №01/02, -pp.43-46.

The lines, TT01316 Mur. x Bez.-1 (100%), TT01317 Mur. x Tan. (90%), TT01353 Z2009/2-1 (Mur. x Aran) x Son. (90%) were distinguished by the high indices.

According to the results of the study, the negative level of transgression in plant height was detected in 2/1 of the F<sub>2</sub> hybrids studied and the positive level was found in 2/1 hybrids. Positive transgression was observed in the stalk length, the number of grains per stalk, the mass of grains per stalk in most lines.

**4.5. Evaluation of hybrid generations for diseases and selection of resistant samples:** The infection level in F<sub>2</sub> and F<sub>3</sub> generation lines of autumn bread wheat under irrigated conditions was studied in the Tartar Regional Experimental Station of Research Institute of Crop Husbandry. According to the results of the observations, loose smut and bunt diseases were not found in the field, the studied materials were infected with septoria, powdery mildew, yellow and brown rust to varying degrees. Based on the results, disease-resistant combinations were selected.



“In the 2015-2016 research years, 12.5% of the F<sub>2</sub>-generation bread wheat hybrids (32) studied were resistant to yellow rust (0-R); 56.25% were moderately resistant (MR); 9.37% were sensitive (S); 21.88% were moderately sensitive (MS). Whereas, 12.5% of them were resistant to brown rust (0-R); 18.75% were sensitive (S); 68.75% were moderately sensitive (MS).

In the 2015-2016 research years, 25.93% (81) of the studied F<sub>3</sub> generation bread wheat hybrid lines were moderately resistant to yellow rust disease (MR); 28.39% were sensitive (S), and 45.68% were moderately sensitive (MS). Whereas, 23.46% of these hybrids were resistant to brown rust disease (0-R); 39.51% were sensitive (S); 37.03% were moderately sensitive (MS) (Table 4.5.1)”<sup>1</sup>.

F<sub>2</sub> hybrids - TT01404 Shaf. x Son., TT01407 Alman x Mur.-2, TT01410 Shaf.-2 x Alman; F<sub>3</sub> hybrids TT01301/1 Mur.-2 x Bez.-1,

1. Nazarov, B.B. Assessment of the disease resistance of hybrid progenies and selection of the resistant species // -Nizhnevartovsk, Russia: “Bulletin of Science and Practice” scientific journal, -July 2019. Volume 5, Issue 7, -pp.122-127.

TT01302/2 Mur.-2 x Doka, TT01321/1 Tar. x Par. etc. were distinguished by resistance to yellow rust. F<sub>2</sub> hybrids - TT01417 Son. x Shaf.-2, TT01424 Par. x Az., TT01434 Yub.100/Til./1 x Mur.-2 and F<sub>3</sub> hybrids - TT01302/2 Mur.-2 x Doka, TT01304/1 Mur.-2 x Tanya, TT01305/1 Mur.-2 x Shaf.-2, etc. were distinguished by resistance to brown rust disease.

**Table 4.5.1**  
**The level of infection with yellow and brown rust diseases of different generations of bread wheat hybrid lines in the 2015-2016 research years**

Research years	Hybrid generations	The number	Yellow rust, %				Brown rust, %			
			R	MR	S	MS	R	MR	S	MS
2015-2016	F <sub>2</sub>	32	12.5	56.25	9.37	21.88	12.5	-	18.75	68.75
2015-2016	F <sub>3</sub>	81	-	25.93	28.39	45.68	23.46	-	39.51	37.03
<b>Note.</b> R-resistant, MR-moderately resistant, S-sensitive,										

**4.6. Quantitative and qualitative indicators of promising F<sub>3</sub> generation hybrids differing in complex indicators:** In the 2015-2016 research years, the length of F<sub>3</sub>-hybrid lines (81) studied ranged from 79.7 cm to 131.8 cm.

“Compared to the standard variety Aran, 95.1% (77) of the studied lines were shorter. Vitreousness was higher in 40.4% (19), gluten content in 59.6% (28); deformation coefficient of gluten in 48.9% (23); sedimentation in 34.0% (16). The highest vitreousness was observed in 94.0% of the lines (TT01315/2 Az. x Son), gluten content in 33.2% (TT01339/2 TT09214/3 lut. x Vas.). The smallest value of the deformation coefficient of gluten (82.4 units) was detected in the hybrid, TT01353/2 Z2009/2-1 (Mur. x Ar.) x Son. The highest sedimentation (64.5 ml) was found in 2 hybrid samples (TT01352/1 Z2009/2-1 (Mur. x Ar.) x Bez.-1; TT01356/2 Z2009/2-1 (Mur. x Ar.) x Par.). The samples TT01311/2 Shaf.-2 x Mur.-2; TT01316/2 Mur. x Bez.-1; TT01318/1 Mur. x Doka; TT01326/1 Doka x Shaf.-2; TT01328/1 Doka x Az.; TT01339/1 TT09214/3 lut. x Vas.; TT01350/1 Z2009/1-1 (Ar. x Um.) x Vas.; TT01352/1 Z2009/2-1 (Mur. x Ar.) x Bez.-1, etc. showed higher complex parameters compared to the standard variety, Aran”<sup>1</sup>.

**4.7. Statistical analysis of the correlational relationships in bread wheat hybrids:** “To determine statistical parameters, 56 hybrid lines of F<sub>1</sub> bread wheat along with parental forms were studied in the 2013-2014 research years. Seven quantitative traits were analyzed, statistical values, i.e. correlational relationships were studied based on these important economic indicators. The study of the structural elements in F<sub>1</sub> hybrids showed that the highest correlational relationship occurred between the plant height and the mass of 1000 grains ( $r=0.575^{**}$ ), the spike length, and the number of spikelets ( $r=0.543^{**}$ ), the spike length and the number of grains per spike ( $r=0.487^{**}$ ), the spike length and the mass of grains ( $r=0.602^{**}$ ), the number of spikelets and the number of grains per spike ( $r=0.619^{**}$ ), the number of spikelets and the mass of grains ( $r=0.528^{**}$ ), the number of grains per spike and the mass of the

grains ( $r=0.771^{**}$ ) and between the mass of the grains per spike and the mass of 1000 grains ( $r=0.461^{**}$ )”<sup>2</sup>.

“Similar results for correlational relationships were observed in 2014-2015 and 2015-2016 research years with thirty-two ( $n=32$ )  $F_1$  and  $F_2$  generation bread wheat hybrid combinations”<sup>3</sup>.

1. Nazarov, B.B. The study of quantitative and qualitative traits in bread wheat hybrids//Baku: Proceedings of the Research Institute of Crop Husbandry,-2018. V.29,-pp. 169-173 (in Azerbaijani).

2. Nazarov, B.B. The study of correlational relationships between quantitative and qualitative traits in various generation ( $F_1$  and  $F_6$ ) bread wheat hybrids//Materials of the II meeting on "Azerbaijan-Turkey Scientific Research Cooperation on Beekeeping Development" and the II International Conference of the Council of Young Scientists of the Agrarian Science Center, -Baku: Muallim, - June 09-11, -2015, -pp.78-83 (in Azerbaijani).

3. Nazarov, B.B. Statistical regularities between productivity components // International Scientific Conference, “Wheat in European countries and Georgia as one of the origins of wheat”,-Tbilisi, Georgia:[n.p.],-02-04.10.2019,-pp.251-254.

## **Conclusions**

1. The study of intraspecific variability in  $F_1$  and  $F_2$  generation hybrids of bread wheat showed that the determination of genotypic and phenotypic parameters of hybrids in lower generations allows the assessment of their genetic potential in the early stages of selection, by providing detailed information about hybridization components and combinations.

2. It was found that combinations with high phenotypic dominance in  $F_1$  generation hybrids often showed higher frequency and level of positive transgression in the  $F_2$  generation. This allows for the early selection of promising recombinants.

3. Depending on the components involved in hybridization, intraspecific  $F_1$  generation bread wheat hybrids show hereditary variability at different levels from high dominance to depression. Plant height, stalk length, the number and mass of grains per spike, 1000 grain mass were mainly characterized by high and complete (51.8-12.0%; 76.2-1.7%, respectively) dominance.

4. The highest dominance for productivity elements was observed in the following combinations: TT01325 Doka x Tan.

(hp=+149.0), TT01339 TT09214/3 lut. x Vas. (hp=+24.03), TT01338 TT09214/3 lut. x Bez.-1 (hp=+22.43) – for the number of grains per spike; TT01332 Son. x Trap (hp=+64.0), TT01330 Son. x Mur.-2 (hp=+56.5), TT01331 Son. x Tan. (hp=+54.0) - for the mass of grains per spike; TT01351 Z2009/1-1 (Ar. x Um.) x Par. (hp=+43.0), TT01327 Doka x Par. (hp=+36.0), TT01353 Z2009/2-1 (Mur. x Ar.) x Son. (hp=+21.0), TT01355 Z2009/2-1 (Mur. x Ar.) x Vas. (hp=+21.0) - for the 1000 grain mass.

5. In combinations having transgressive traits, the highest transgression rate and frequency were observed for spike length (84.21-100%) and grain mass (71.5-100%).

6. F<sub>2</sub>-generation bread wheat hybrids introduced from the International Centers were tested for agrobiological characteristics. Combinations (Yub.100/Til., Star./Son., Kros./Yub.100, Peh./4/Bab./Lr42//Bab.\*2/3/Kur., T154/Krist., Kat./Kros. etc.) carrying positive traits with properties that allow getting a wide range of forms were identified.

7. As a result of breeding evaluation and directional selection of the introduced bread wheat hybrids, about 30 stable lines (Star./Son. /2; Zag./4/Bab./Lr42//Bab.\*2/3/Kur. /1; Katial/Kros. /3; T154/Krist./1; Peh./4/Bab./Lr42//Bab.\*2/3/Kur./1-1; Peh./4/Bab./Lr42//Bab.\*2/3/Kur. /2-1; Peh./4/Bab./Lr42//Bab.\*2/3/Kur. /3-1; Son./4/Bab./Lr42//Bab.\*2/3/Tuk. /2-1; Son./4/Bab./Lr42//Bab.\*2/3/Tuk. /2-2; Kros./Yub.100 /1-2; Gon./Kny. /1-1, etc.) with complex positive traits (productivity 70.0-83.0 cwt/ha, plant height 80.0-100.0 cm, vitreousness 50.0-70.0 %, gluten content 36.0-42.0 %, gluten deformation coefficient 84.2-89.0 units, grain protein content 13.0-14.0 %, sedimentation index 47.0-54.0 ml) were selected and included in the tests at the final stage of the breeding process.

8. Perspective lines with a short vegetation period (T154/Kris./2, Star./Son./2, Peh./4/Bab./Lr42//Bab.\*2/3/Kur./4-2, Peh./4/Bab./Lr42//Bab.\*2/3/Kur./4-1, Kros./Yub.100/1-2), characterized by high productivity, quality indicators, and resistance to various leaf diseases, are being prepared for submission to the Agency for Agrarian Services.

9. During the years of the research, nine bread wheat varieties (Parvin, Metin, Altun 2, Saba 2, Billur, Tunc, Onur, Oguz, Diabar), which I co-authored, were submitted to the Agency for Agrarian Services.

10. “Parvin” (patent No 00207), “Metin” (patent No 00247) and “Altun-2” (patent No 00272) varieties of bread wheat, which I co-authored, were regionalized and included in the “Agency for State Register” in 2017, 2019 and 2020, respectively.

### **Recommendations for breeders and producers**

1. Local bread wheat varieties - Azeri, Aran, Murov-2, Gobustan, Gyrgyzgul-1, Fatima have been recommended for use in hybridization in the bread wheat breeding process.

2. It is recommended to use the newly created high-yielding promising lines based on the introduced hybrids in the bread wheat breeding Star./Son./2, T154/Kris./1, Peh./4/Bab./Lr42//Bab.\*2/3/Kur./3-2, Kros./Yub.100 /1-2 were distinguished by the complex economic-valuable features; Star./Son./2, T154/Kris./1, Katial/Kros./3; Sön./4/Bab./Lr42//Bab.\*2/3/Tuk./3 - by the short height; Pah./4/Bab./Lr42//Bab.\*2/3/Kur./4-1, Bez.1/4/Bab./Lr42//Bab.\*2/3/Bram./1-1 – by the 1000 grain mass; (204-213 gün) Son./4/Vee/Pjn//2\*Tui/3/Skautz\*2/Srma/2-2-1, Sön./4/Vee/Pjn//2\*Tui/3/Skautz\*2/Srma/2-2-2, Gond./Demir/1, Sön./Pah./1 - by the optimal vegetation period; Star./Sön./3, Son./Peh./1, T154/Kris./2, Gond./Demir/1 - by the content of high-quality protein (13.5-14.5%, being 12.0% in the standard Aran variety) and gluten (33.6-37.8%).

3. Promising lines created through intra-specific hybridization have been also recommended for bread wheat breeding due to high grain yield (71.3-87.7). These lines are TT01356 Z2009/2-1 (Mur. x Ar.) x Par., TT01321 Tar. x Par., TT01339 TT09214/3 lut. x Vas., TT01336 Alman x Son., TT01310 Shaf.-2 x Vas.

4. Patented in 2017, 2019, and 2020, “Parvin” (patent No 00207), “Metin” (patent No 00247), and “Altun-2” (patent No 00272) autumn bread wheat varieties have been registered in the “State Register of Protected Achievements Permitted and Protected

for Use in the Production of Agricultural Products in the Territory of the Republic of Azerbaijan”, as well as bread wheat varieties, Saba-2 (2015), Billur (2016), Tunj (2017), Onur (2018), Oghuz (2019), Diabar (2019) created during the research years and submitted to the “Agency for Agrarian Services” for regionalization have been recommended for cultivation in irrigated lowlands and mountainous and foothill regions of the Republic provided with moisture.

### **List of published scientific works on the topic of the dissertation**

1. Nazarov, B.B., Hajiyeva, S.K. Comparative study of introduced hybrids of F<sub>2</sub>-F<sub>4</sub> generation bread winter wheat under irrigated conditions of lowland Karabakh // Abstracts. The international scientific conference “Breeding and Genetics of Agricultural Crops: Traditions and Prospects”, -Ukraine, Odessa:[n.p.],-17-19 October,-2012,-pp.72-74

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3. Nazarov, B.B. The study of structural elements and quality indices in hybrid lines of introduced bread wheat // -Baku: Proceedings of the Research Institute of Crop Husbandry, -2014.V.25, -pp.284-289 (in Azerbaijani)

4. Nazarov, B.B. The role of intraspecific hybridization in the development of high - yielding wheat varieties // Materials of the II meeting on "Azerbaijan-Turkey Scientific Research Cooperation on Beekeeping Development" and the II International Conference of the Council of Young Scientists of the Agrarian Science Center-Baku: Muallim, -09-11 June, -2015, -pp. 74-77 (in Azerbaijani)

5. Nazarov, B.B. The study of correlational relationships between quantitative and qualitative traits in various generation (F<sub>1</sub> and F<sub>6</sub>) bread wheat hybrids // Materials of the II meeting on "Azerbaijan-Turkey Scientific Research Cooperation on Beekeeping Development" and the II International Conference of the Council of Young Scientists of the Agrarian Science Center-Baku: Muallim, -09-11 June, -2015, -pp.78-83 (in Azerbaijani)

6. Nazarov, B.B. The study of the hereditary transmission of quantitative traits in the intraspecific first generation ( $F_1$ ) bread wheat hybrids // - Baku: Proceedings of the Research Institute of Crop Husbandry, -2015. V.26, -pp.112-122 (in Azerbaijani)

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13. Nazarov, B.B. Phenotypic identification of quantitative traits in hybrids of the first generation ( $F_1$ ) bread wheat // International Scientific-Practical Conference on "Prospects of new and introduced foreign varieties of cereals and legumes, as well as modern resource-saving technologies for cultivation in the Republic of Uzbekistan" -Andizhon: MChZh, -May 21-22, -2019, -pp.76-86 (in Russian)

14. Nazarov, B.B. Assessment of the disease resistance of hybrid progenies and selection of the resistant species // -Russia, Nizhnevartovsk:

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15. Nazarov, B.B. Statistical regularities between productivity components // International Scientific Conference “Wheat in European countries and Georgia as one of the origins of wheat”, -Tbilisi, Georgia: Poligraf, -02-04 October, -2019, -pp.251-254

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