THE HIGHLIGHTING OF SOME WHEAT GENOTYPES AS A SOURCE OF GERMOPLASM FOR THE IMPROVEMENT OF THE MAIN ELEMENTS OF PRODUCTIVITY

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Abstract. The aim of this study was to highlight wheat genotypes with a high number of grains/spike, with a good weight of grains/spike and with a thousand kernel weight > 50 g, which can be used in wheat breeding programs. In 2022, at ARDS Turda, from 45 winter wheat genotypes (a small part from the collection that contains 1181 wheat genotypes), variant 23 was identified as a source of germplasm for improving productivity elements. It had an average of 78.4 grains/spike, a good weight of grains/spike (> 4.5g) and a high value of the thousand kernel weight (58.81g), close to that of the Arieşan variety, which is consecrated for this character. Five wheat genotypes with more than 80 grains/spike and eight genotypes with thousand kernel weight greater than 55 grams were also identified.

Keywords: wheat, source of germplasm, collection, breeding program.

INTRODUCTION

The diversity of life on earth involves four levels of approach: ecosystem diversity, species diversity, genetic diversity and ethno cultural diversity. This concept (biodiversity or biological diversity) was defined for the first time in the context of the adoption of a new international environmental instrument, at the UNCED Earth Summit in 1992 in Rio de Janeiro.

To ensure biodiversity in agricultural ecosystems, it is necessary to achieve genetic progress. This is possible only by creating genetic variability, and for this the available plant genetic resources must be maintained and exploited. In this context, Cristea (1985) mentioned the fact that "gene sources must not only be collected and maintained, they must be studied in order to be able to use them with maximum efficiency".

In a real sense, the fate of the human species depends on our ability to understand and use plant genetic resources (Savatti et al., 1993).

Breeders realized long ago that it is necessary to maintain and create genetic diversity within agricultural ecosystems. That is why, at the beginning of the 20th century, but especially after the end of the First World War, seed collections of agricultural plants were established in many countries.

After the Second World War, with the intensification of agriculture, genetic erosion made its mark more and more through the rapid loss of local populations, of primitive and selected varieties, as well as of newly improved material, producing an obvious narrowing of resources plant genetics. Therefore, firm measures were taken in this regard to stop or at least slow down this phenomenon by creating research institutions/stations, "gene banks" and botanical gardens (Murariu and Cristea, 2019).

The germplasm that needs to be preserved as a source of variability is classified according to two criteria as follows:

→ Depending on the origin of the variability:

- basic germplasm or with measured variability;
- germplasm newly created or with artificial variability.

→Depending on the origin:

- from the spontaneous flora;
- from cultivated forms.

The basic germplasm includes 3 types of germplasm:

- *forms from the spontaneous flora related to the species being improved* - used in improvement due to some properties such as high ecological plasticity and rusticity; their direction of use consists mainly in the transfer of these properties to already improved valuable varieties;

- *varieties and local populations* - distinguished by special properties of resistance to unfavorable climatic factors or to some phytopathogenic agents; sometimes through artificial selection works, it was possible to reach new approved varieties from these forms, but most frequently they are used as the first category;

- *improved varieties* - represent the most valuable source of germplasm because they already have imprinted superior properties regarding productivity, quality, resistance to diseases and pests, etc. They can only be improved through selection works, and in order to create a new cultivar it is necessary to use other methods such as hybridization, mutagenesis, etc.

The newly created germplasm includes:

- *hybrid populations in the process of segregation* - represent the most valuable source of initial material for autogamous species because, for the creation of new varieties, we are interested in plants from the segregating generations $F_2...F_n$, when new characters and properties, different from those of parents (transgressive forms may appear);

- *mutant and polyploid forms* (aneuploids in wheat) can be used to create new varieties, but most frequently they are used to transfer the new character to an already improved variety.

For the successful development of the breeding process, it starts from the detection within the plant genetic resources, of an initial improvement material that includes a constellation of valuable genes, from which it is possible to select through appropriate breeding methods, the biological material carrying the germplasm clearly superior in quality and productivity to the parental forms from which it started (Potlog and Velican, 1974).

Currently, at ARDS Turda, the main sources of germplasm are: the collection (with a number of 1181 autumn wheat genotypes and 100 spring wheat genotypes) and the hybrid populations in the process of segregation. The collection includes varieties and local populations and improved varieties.

As the end of a breeding program to be crowned with success, it directly depends on the sources of variability at its disposal: gene recombination, induction of mutations, gene transfer by recombinant DNA technique, somaclonal variation, application of *in vitro* cell and tissues culture techniques (Savatti et al., 2004). Within

ARDS Turda, recombination of genes through the hybridization method, which starts with the choice of parental forms and the planning of crosses, is the most used for obtaining genetic variability.

MATERIALS AND METHODS

In the autumn of 2021, the collection of winter wheat was sown in the straw grain breeding field belonging to ARDS Turda (46°35' N; 23°47'E; 345 m above Adriatic Sea), which is established on a typical clay Chernozem soil, typical for the forest steppe encountered over half of the Transylvanian Plain (Mureşan et al., 2020). This collection includes a number of 1181 genotypes. Each genotype was sown in 4 rows of one linear meter each, the distance between the rows being 25 cm.

Under the conditions of the 2021-2022 agricultural year (with 3 critical periods of drought – Figure 1), 45 winter wheat genotypes were phenotypically chosen from the autumn collection. In their selection, the following factors were taken into account: the appearance of the spike (the main selection unit), the height of the plants, the thickness, the presence/absence of pathogens and the tendency to shake and fall. From the selected genotypes, 7 are autochthonous, and 38 are of foreign origin.

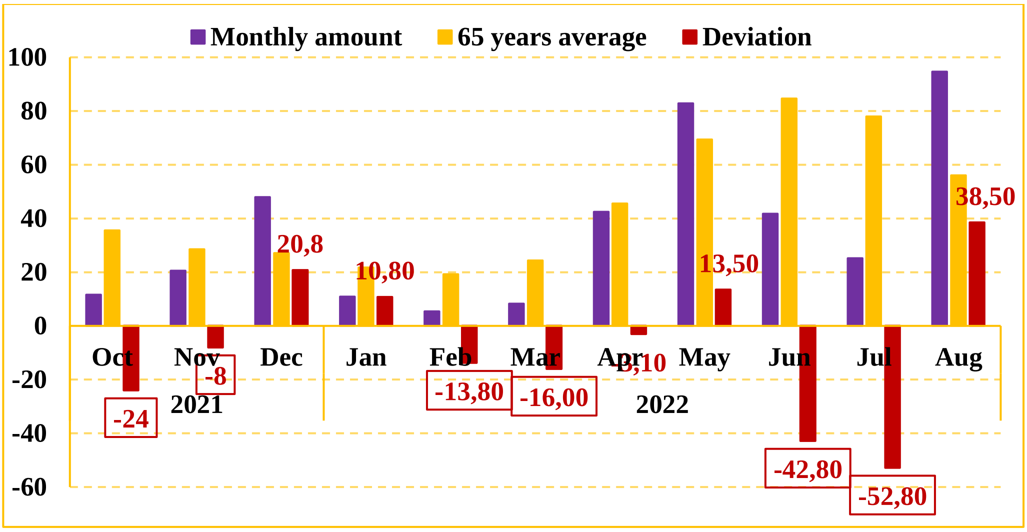


Figure 1. Rainfall (mm) – of the 2021-2022 agricultural year

Under laboratory conditions, the main productivity elements were determined for each chosen genotype: the number and weight of grains/spike and the thousand kernel weight. To determine the productivity elements, 30 plants from each selected winter wheat genotype were analyzed. The purpose of these determinations was to identify useful genotypes for the winter wheat breeding program, especially for the improvement of the main elements of productivity.

The statistical analysis was carried out in the Excel program using the Pearson correlation coefficient (https://www.statisticssolutions.com/table-of-critical-values-pearson-correlation/).

RESULTS AND DISCUSSIONS

The relationships that are established between the main analyzed productivity elements are presented graphically in Figures 2, 3 and 4, the critical values for the Pearson coefficient being α 5% = 0.288, α 1% = 0.372, α 0.1% = 0.465. The autochthonous genotypes are marked on the 3 graphs with orange dots.

The relationship between the number and weight of grains / spike

The number of spikelets/spike and therefore the number of grains/spike are a fundamental element in the production, and their weight is determined by the factors that affect the volume of the grains. Figure 2 illustrates a pronounced association between number and weight of grains/spike. The high value of the correlation coefficients (r = +0.759***) and determination (R^2 = 0.5757) statistically support this statement. Of interest for the breeding program are the genotypes located in quadrant IV (large number of grains/spike, considerable weight of grains/spike). Among the Romanian genotypes, only one fits here with an average number of 71.9 grains/spike and with an average weight of 3.77g.

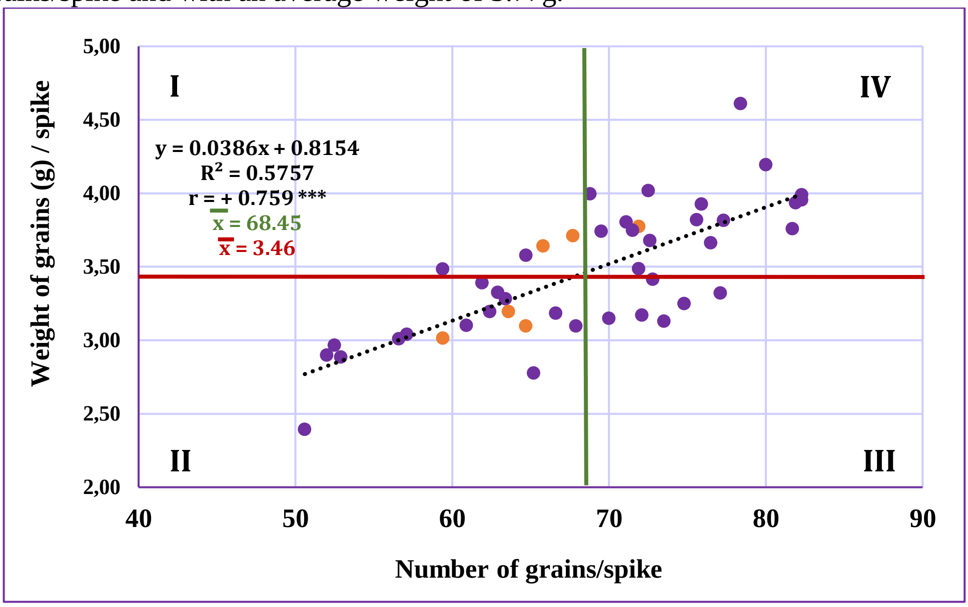


Figure 2. The relationship between the number and weight of grains / spike (g)

The relationship between the number of grains/spike and TKW

Grain yield can be increased indirectly through selection for increased grain mass, a fact demonstrated by Knott and Talukdar (1971), but it has the consequence of reducing the number of grains/spike. So, between the number of grains/spike and the thousand kernel weight is a close relationship, but with a negative sign (Figure 3). This fact is underlined by the value of the correlation coefficient r = - 0.361°. From Figure 3, it can also be seen that the Romanian genotypes (6 out of 7) have a thousand kernel weight above the average, which means that the breeding direction was aimed at obtaining genotypes with large, beautiful grains, good for milling (percentage of bran low and increased flour yield). However, there is an autochthonous genotype located in quadrant IV with an average TKW value of 52.49 g and an average number of grains/spike of 71.9. The share of genotypes located in quadrant IV is relatively small (only 9 of the 45 studied genotypes), which proves once again that it is very difficult to obtain productive varieties that have improved two elements of productivity.

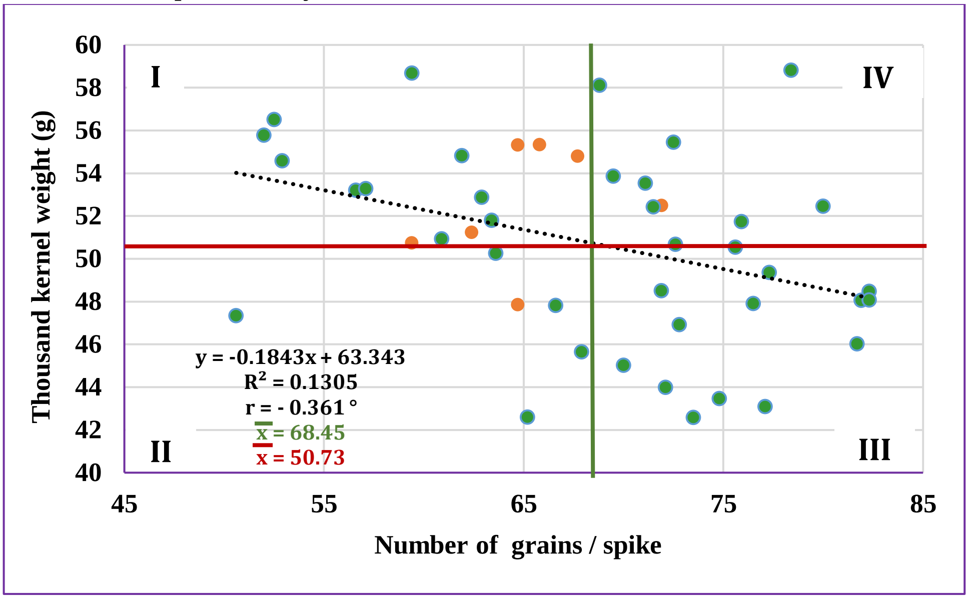


Figure 3. The relationship between the number of grains/spike and TKW (g)

The relationship between the weight of grains/spike and TKW

The relationship between the weight of grains/spike (g) and the thousand kernel weight (g) is significantly positive, a statement statistically ensured by the value of the correlation coefficient r = +0.329* (Figure 4). The upward trend of the slope of the regression line for this relationship shows that for a one-unit increase in grains/spike weight, the TKW can increase by up to approx. 3.3 g.

In quadrant IV of Figure 4, there are 4 autochthonous genotypes and 9 of foreign origin.

Identification of wheat genotypes as a source of germplasm for the improvement of the main productivity elements

The analyzed productivity elements are graphically presented for each genotype in Figure 5. One genotype of foreign origin (variant 23) was identified as a source of germplasm for all three studied productivity elements because it has a high number of grains/spike (78.4), a good weight of grains/spike (> 4.5g) and a high value of the thousand kernel weight (58.81g), close to that of the Arieşan variety, which is consecrated for this character.

A number of five genotypes were identified whith a hight number of grains/spike which exceeds 80, and four of these, were also distinguished by a good weight of the grains/spike (approx. 4g).

A number of 8 genotypes were identified as a source of germplasm for the improvement of the thousand kernel weight, two of them having autochthonous origin. Only those that exceeded the threshold of 55 grams were taken into account.

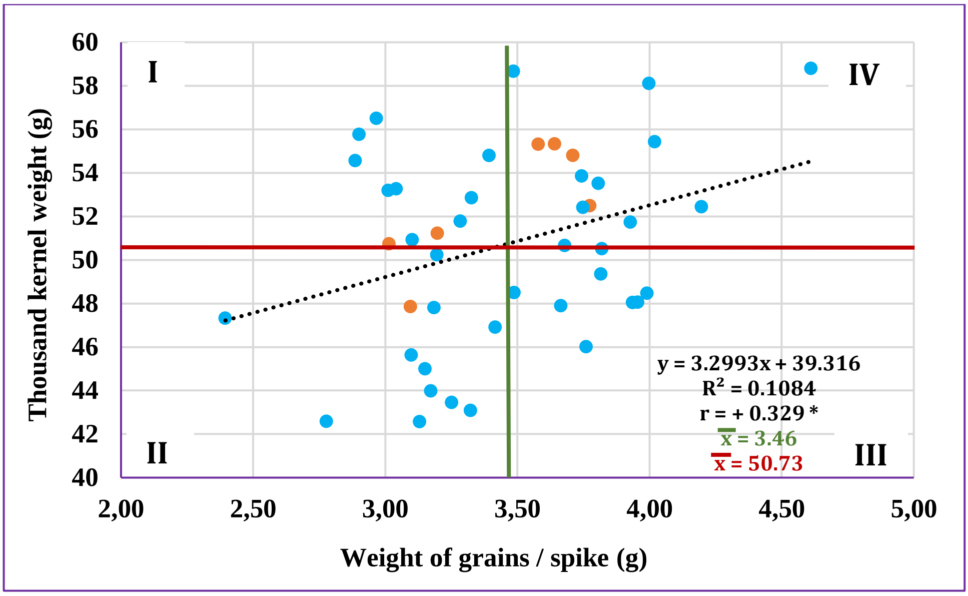
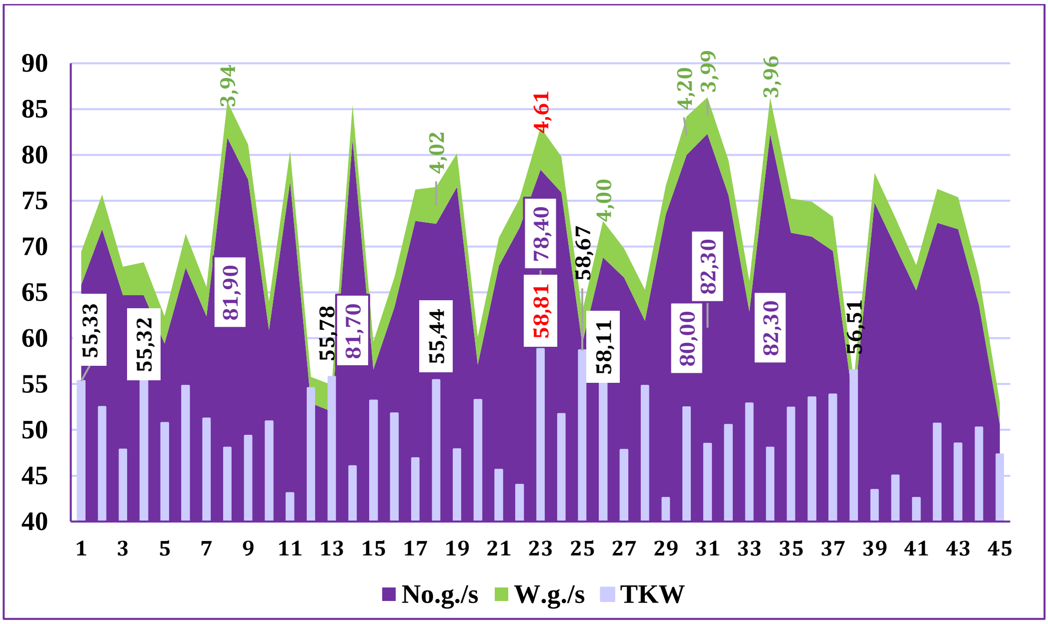


Figure 4. The relationship between the weight of grains/spike (g) and TKW (g)



No.g./s = number of grains/spike; W.g./s = weight of grains/spike; TKW = thousand kernel weight

Figure 5. Identification of wheat genotypes as a source of germplasm for the improvement of the main productivity elements

CONCLUSIONS

In wheat breeding programs, increasing yield capacity can be done in two ways: by optimizing fundamental physiological processes – photosynthesis, respiration and the use of assimilates for foraging, or by optimizing morphogenesis processes. In the second case, and the one most used at ARDS Turda, the only possibility to increase grain yield is the improvement of a single component, provided that the others remain unchanged. At present, the source of germplasm useful for improving productivity elements is quite limited in number. In order to avoid the narrowing of the genetic base and the appearance of genetic vulnerability, some measures / objectives are required, such as:

- maintaining biodiversity by conserving and enriching the collection of genetic resources and producing seed from the higher biological categories for representative varieties of the area;
- development and modernization of the winter wheat germplasm collection;
- regeneration, multiplication and characterization of unique local wheat varieties;
- creation of hybrid wheat populations in order to prevent genetic erosion;
- the implementation of biotechnological methods for increasing the genetic variability of breeding material and accelerating the genetic process regarding the level and stability of wheat harvests in the context of climate change and demographic growth;
- informing farmers about the adaptive capacity and the advantages of growing local wheat varieties, taking into account global climate changes;
- informing small producers that it is advisable to cultivate several different wheat varieties, this being a simple and affordable way to reduce harvest fluctuations;
- implementation of participatory breeding, where researchers work in partnership with farmers.

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