PhD THESIS

Variability of some quantitative traits for two-row spring barley in the conditions from A.R.D.S. Turda

(SUMMARY OF THE PhD THESIS)

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INTRODUCTION

Barley, considered one of the first domesticated species, is the main source for the production of malt since the beginning of brewing, in the years 3,400-3,000 BC. However, most of the barley production, about 70%, is used for animal feed. Given the importance of the species in both direct human and animal nutrition, breeding programs primarily aim to increase grain production along with improving their quality. The stability of cultivars production, as well as the creation of stress-resistant varieties produced by biotic and abiotic factors are also pursued by breeders. For two-row barley, the preferred variety for beer, the aim is especially to create forms with an optimal content of protein and starch, but also to improve the specific qualities for malting.

Wheat, rice, millet, corn or sorghum are other cereals used to make beer all over the world, but especially in western countries, the essential ingredient is barley which due to specific enzymes that break down starch quickly and easily into fermentable sugars, is considered the cereal more important for brazing. The layer of aleurone present in the seed coat is critical in the production of a quality beer, because it contains an essential reserve of enzymes that are released at the time of germination. They quickly begin to disintegrate the endosperm, the starch granules from an initial form unavailable to the seeds is turning into sugars, mainly maltose. Although the aleurone layer is present in other cereals, none has the ability of barley to break down the endosperm and turn starch into sugars. Moreover, usually in the case of beers produced with rice or wheat, a little barley is added to optimize malting.

The success of breeding programs for two-row barley is largely dependent on the variability of the biological material used, the doctoral thesis presents the evaluation of the variability in the germplasm collection of the two rows barley from ARDS Turda, in terms of the components of production, but also in terms of quality traits, so that the most suitable parental forms can be identified for beer barley breeding programs.

In the future, the prediction based on the genomic selection of a large number of cultivars will be one of the most suitable breeding methods for establishing genitors in the case of barley breeding programs. Molecular biology through CRISPR technology will also play an important role in beer production.

RESEARCH AIMS AND OBJECTIVES

The success of two-row barley breeding programs is largely dependent on the variability of the biological material used. In this sense, the aim was to evaluate the existing variability at the level of the collection of 25 varieties and two-row barley lines in the germplasm collection from SCDA Turda, in terms of the components of production, as well as in terms of quality. In order to achieve this goal, the following objectives have been established:

- the study of the phenotypic variability of the production elements: the length of the ear, the number of grains/ear, the weight of the grains/ear and the MMB;
- study of the phenotypic variability of some quality characteristics of the seeds: starch content, protein content and malt quality parameters (malt extract, diastatic strength and viscosity of the wort);
- analysis of the interrelationships between the component elements of the production and the quality characteristics, through the correlation;
- studying the stability of production elements and quality properties by using the analysis of the main components.

STRUCTURE OF THE THESIS

The paper entitled "VARIABILITY OF SOME QUANTITATIVE CHARACTERISTICS IN SPRING BARLEY UNDER THE CONDITIONS OF S.C.D.A. TURDA", contains 133 pages and is made according to the norms of elaboration and writing in force at university and national level. The doctoral thesis is structured in two parts consisting of 5 chapters and contains 36 tables, 25 figures and graphs and 143 bibliographic references. The first part of the doctoral thesis, that of the current state of knowledge, is structured in 2 chapters and comprises 28 pages. Chapters 1 and 2 summarize information on systematic classification, morphological description, origin, distribution area, ecological requirements, use of barley, importance in malting and important characteristics for obtaining beer.

The second part of the doctoral thesis is the part allocated to one's own research, being structured in 3 chapters and comprising 56 pages. Chapter 3 describes the material and method, the purpose and objectives of the research, the climatic conditions, the characterization of the area and the observations made at the 25 spring barley cultivation with 2 rows (barley). Chapter 4 contains results and discussions on the variability and stability of some quantitative characters and results regarding the malt quality parameters for the studied beer barley varieties. Chapter 5 presents the conclusions and recommendations made based on the results obtained. The thesis ends with the bibliography, the abstract in Romanian and English.

RESULTS AND DISCUSSIONS OF THE RESEARCH

In Chapter 4 are presented results and discussions on the variability and stability of some quantitative characters, respectively results on the parameters of malt quality in the studied barley varieties of beer.

Chapter 4 contains 4 sub-chapters, each of which is represented by a research issue conducted according to the proposed objectives. The first sub-chapter presents the experimental results performed at SCDA Turda where biometrizes were performed such

as mass of 1000 grains (MMB), ear length, number of grains / ear, grain mass of ear, crop production capacity and content of starch and protein.

These properties are influenced to a significant extent by climatic conditions.

If the averages of the three experimental years are analyzed, we can see the major involvement of the year factor in the accumulation and deposition of carbohydrates in the grain. The highest values of the grain mass / ear character were recorded in 2017, which was characterized by balanced rainfall during the vegetation period.

Climatic factors show a less eloquent influence on the length of the ear, but if we analyze the data presented, we can see that almost all genotypes had higher values of this property in 2018 compared to 2017 and 2019. Climatic conditions in 2017 favored the emergence the highest number of grains per ear, but the variability of the character was small, there were no statistically assured differences between the control and the cultivars studied. Unlike the other productivity elements studied in barley, it was found that MMB is not influenced by climatic conditions or genotype. Making a comparison between the three experimental years in terms of production, we found that 2019 was unfavorable to barley cultivation, the average production of the studied crops was below 3000 kg / ha. This fact is due to the drought in 2019, which affected the grain filling, an aspect also proved by the results obtained at MMB and the grain / ear mass for that year. The meanings of sample F for the genetic factor reflect the fact that there are no differences between the 25 genotypes regarding the influence of climatic conditions, which is why it cannot be used in the breeding process. Comparing the three experimental years in terms of quality, the protein content was significantly higher in 2018 compared to the other two experimental years.

The second sub-chapter presents the links between barley traits. By averaging the characters over the three experimental years, we found the existence of numerous statistically assured positive and negative correlations. Thus, the yield was positively correlated with the length of the ear, the number of grains / ear, the weight of the grains / ear, TKW and negatively with the content of starch; the content of starch was negatively correlated with the length of the ear, the weight of the grains / ear, the TKW and the protein content; the protein content was positively correlated with the length of the ear and negatively with the number of grains / ear and the weight of the grains / ear; TKW was correlated positively with the length of the ear and the weight of the grains / ear and negatively with the number of grains per ear; grain weight / ear was positively correlated with ear length and number of grains / ear and number of grains / ear with ear length.

Studying the linear regression in two rows barley in the three experimental years, we found that the seed yield showed a negative linear regression with the protein content. The barley genotypes studied at SCDA Turda can be divided into three groups: varieties / lines with low production and low protein content, varieties / lines with medium production and high protein content and varieties / lines with high production

and low protein content. It is important for breeders to identify the most valuable individuals in the third group, because obtaining new crops with a high production, with low protein grains is a main objective in barley breeding programs.

The third sub-chapter presents the principal component analyzes for two-row barley. Following the study of the 25 clutivars, for the seven characters of productivity and quality, in the three experimental years we obtained a dendrogram in which the two rows barley cultivars were grouped in four clusters. The genotypes were classified into two major groups: the first group containing cluster I, and the second group clusters II, III and IV. The genotypes in these two groups indicate that there it's a great variability between the component genotypes of large clusters, useful for performing recombination. The dendrogram indicates the smallest distance between clusters III and IV, and the largest between clusters I and IV.

And the last sub-chapter presents results on the quality parameters of malt Each malting barley variety malts differently (Paynter, 1996). The differences are manifested at the time of soaking, at the level of germination rate or temperatures required for germination. For this reason, each variety of beer barley must be subjected to the malting process in turn. All studied barley cultivars have a slightly lower protein content than the desired values for malting. the Jubilee variety with the highest starch content of 59.47% is noticed, followed by Romanița with a content of 59.26%. The lowest content of 53.67% was registered for the Aura variety. the six genotypes of beer barley studied for malting, only four meet this criterion, the varieties Aura and Daciana having slightly lower values of malt extract than the desired values, 79.5% and 79.8%, respectively. According to the desired values for malting barley, the viscosity must be less than 1.6 mPa * s. This criterion is met by all barley cultivars studied.

CONCLUSIONS

Climate change, such as early summer drought, late frosts or hailstorms, changes the goal of improving "high yield" to "stable yield". In this sense, it is recommended to use Xanadu, Armada, Sidney, Steward and Tatum parents in hybridizations.

The local cultivator Romanița can be considered a good parent for improving the length of the ear, because it registered the highest average value of this property in the experimental years. Along with this genotype, the To 2170/01 line is also noted.

Cultivations such as Turdeana, Daciana, Romanița, Aura, Xanadu, To 2027/10 and Capriana, which were superior to the control in all three years of vegetation, can be used as parents to improve the number of grains in the ear.

The starch content is one of the most important components of the barley quality for beer. With a high starch content, the cultivars of Odyssa, Chronicle and Sulilly were noticed, which could be used as parents to improve this character.

Protein, and in particular its low content, is an essential strategy in improving barley for braising. In this sense, the Thuringian cultivar stood out.

In the experimental conditions from ARDS Turda it was found that most of the correlations identified in two-row barley have an apparent character, being influenced by climatic conditions. At normal temperatures and rich rainfall, the yield was positively correlated, statistically assured, with the TKW and starch content and negatively with the length of the ear, the number of grains/ear and the protein content, and at high temperatures and drought the barley yield was negatively correlated, assured statistically only with the length of the ear.

Due to the different results, from year to year, the use of correlations in the selection for the improvement of barley yield does not lead to satisfactory results. Selection for a single production element cannot improve yield as it is necessary to simultaneously improve several production traits.

The quality traits presented statistically assured correlations, positive between the protein content and the length of the ear and negative between the starch content and the length of the ear, grain weight/ear, TKW and the protein content, respectively between the protein content and the number of grains/ear and grain weight/ear.

Under the conditions of ARDS Turda, we found that in the two-row barley varieties the seed yield showed a positive linear regression with the TKW and a negative one with the protein and starch content.

In terms of regression between yield and TKW, the studied barley genotypes can be divided into two groups: varieties / lines with low yield and TKW, respectively varieties / lines with high production and MMB. For breeders it is important to identify the most valuable individuals in the second group, because obtaining new crops with a high production, which have large grains is a main objective in barley breeding programs.

In terms of regression between yield and starch content, the studied barley cultivars can be divided into two groups: low-yielding varieties / lines rich in starch, respectively varieties / lines with higher yield poorer in starch. For breeders it is important to identify the most valuable individuals in the second group, which could contain genotypes that have a high production and a satisfactory percentage of starch.

In terms of regression between yield and protein content, the studied barley varieties can be divided into three groups: varieties / lines with low yield and low protein content, varieties / lines with medium yield and high protein content and varieties / lines with a high yield and low protein content. For breeders it is important to identify the most valuable individuals in the third group, because obtaining new crops with a high production, with low protein grains is a main objective in the programs.

The two-row barley cultivars studied at ARDS Turda were grouped in four clusters, which proves a great variability between the component genotypes of the clusters, useful for performing recombination. The dendrogram indicates the smallest distance between clusters III and IV, and the largest between clusters I and IV.

The cultivars from cluster I, Turdeana, To 2170/01, Aura, Xanadu, Daciana, Romanița, Capriana, Adina, To 2027/10 are characterized by a moderate production, an average starch and protein content, a low MMB and an average number of grains on ear.

In cluster II, the 13 cultivations: Thuringia, Marthe, Vienna, Sulilly, Tatum, Odyssey, Chronicle, Pasadena, Steward, Belgravia, Salome, Jubilee, To 2172/01 are characterized by a moderate production, an average starch and protein content, a moderate MMB and a large number of grains on ear.

Cluster III, comprises only the Concerto variety, characterized by a high production, a low starch and moderate protein content, a high MMB and a moderate number of grains on ear.

Cultivars of cluster IV, Sidney, Armada are characterized by a high production, a very high starch and low protein content, a moderate MMB and an average number of grains in the ear.

The identification of varieties with superior malting properties is essential for the successful establishment of suitable parents in breeding programs aimed at creating beer barley varieties with a high grain production potential, but at the same time with a higher malt quality.

The most important malt quality parameters, essential for brazing, are considered to be malt extract, diastatic strength and viscosity of the wort.

The best yield of malt extract was recorded for the Jubilee variety (80.4%), followed by Romanița and Turdeana (80.2%), then the To 2027/10 line (80.1%). It is also noted that the variety with the highest percentage of extract recorded the lowest protein content in the grains.

All studied barley beer cultivars have higher diastatic power values than the minimum desired value for beer production (200 WK). The To 2027/10 perspective line with the highest diastatic power, 350 WK, stands out.

According to the desired values for barley for malting, the viscosity must be less than 1.6 mPa * s, this criterion being met by all barley cultivars studied.

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