PhD THESIS

Research on the cultivation of spring barley in different farming systems

(SUMMARY OF THE PhD THESIS)

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INTRODUCTION

The latest statistical data show an increase in organic areas in recent years which is also due to the COVID-19 crisis, as a result of consumer awareness to pay more attention to food (WILLER et al., 2021), but also by subsidies granted to farmers through the new agricultural policies.

The European Commission proposed as an objective that by 2030, approximately 25% of the agricultural area will be ecologically certified (agriculture.ec.europa.eu). According to FIBL, organic agriculture in Romania represented 4.42% of the total cultivated area compared to 2021, while in 2020 it represented 3.45%.

Climate change and the frequency of extreme weather events in last years have led to awareness of the decision-making factors for the application of more friendly agricultural policies. Therefore, research in the ecological sector and especially in the current context of climate change and the efficient use of agricultural resources will be crucial.

Lower yields, which have higher selling prices, are a key problem of organic farming. For this reason, the comparative study between organic and conventional farming systems plays a central role in the debate on this topic. An important role in organic farming is the seeds material used at sowing. At the moment, a large part of the cultivated varieties are varieties that were created for cultivation in the conventional system and it is not known how they answer in ecological agricultural conditions.

In most newly sown crops, farmers used their own organically certified seed or buy conventional seeds. The organic seed available on the Romanian market is insufficient or even non-existent for many species. Derogation requests are currently being granted for the use of untreated conventional material that is approved by the certified body, but this situation is a sensitive one and the situation will become serious starting from December 31, 2036 (art. 53 of Reg. (EU) 848/2018).

Currently there are no recommendations for varieties of spring barley suitable for organic agriculture in Romania and especially in the area of Transylvania, so our research is a first step for farmers interested in the practice of this agriculture system.

The main objective of the present research is to identify the genotypes of spring barley currently cultivated at ARDS Turda and suitable for the ecological cultivation system in Transylvania area, to analyze the quantitative and qualitative characters of the studied genotypes, as well as to evaluate the sensitivity of the genotypes to diseases under the conditions of climate change. According to these aspects, it is necessary to carry out a comparative study between the conventional and ecological cultivation system in the pedoclimatic conditions of ARDS Turda.

STRUCTURE OF THE PhD THESIS

The PhD thesis comprises 134 pages and has of two parts. The first part includes the Scientific Literature Review dedicated to the bibliographic study which constitutes 26% of the thesis (35 pages), and the second part includes the Original Research which represents 74% of the thesis (99 pages).

The content of the PhD thesis includes 52 tables and 58 figures and graphs.

Part I of the doctoral thesis has two chapters:

Chapter 1. *Literature Review about General Aspects of Barley Crop*, this chapter is dedicated to the general presentation of barley, the crop importance, chemical composition, biological particularities, cultivation areas and distribution.

Chapter 2. *Literature Review about Spring Barley Cultivation Systems* includes information about climate change and the main farming cultivation systems, presenting the concept and technology of cultivation.

The second part of the doctoral thesis has six chapters:

Chapter 3. *The aim and objectives of research* expresses the aim of the PhD thesis, the general objective and the specific ones related to the research.

Chapter 4. *Soil and climate conditions in the experimental field* includes detailed information regarding location, pedoclimatic and agrochemical conditions, but also thermal and rainfal data during the vegetation period.

Chapter 5. *Material and method* contain information regarding biological material, inputs used, organization of experiments, working method, observations and determinations made, and statistical methods.

Chapter 6. *Results and discussion*s includes the largest part of the PhD thesis and presents the results regarding the research related to the behavior of the eight two-row spring barley genotypes in the three cultivation systems during the three experimental years and continuing with the data presented during the period of two years in rotation and monoculture.

Chapter 7. *Conclusions and recommendations*, includes the conclusions resulting from the research and related to the specific objectives. A series of recommendations are given to spring barley producers, but also to researchers based on the results.

Chapter 8. *Originality of thesis*, mentions the novelty of the PhD thesis and the contribution of the results obtained in the domain of research.

References list contains 169 sources, represented by books and articles, most of them of recent date, as well as information bulletins and web pages.

RESEARCH AIMS AND OBJECTIVES

Due to factors such as the Common Agricultural Policy (CAP), the European Green Deal and the subsidies granted to farmers, but not least consumer awareness of food quality and the increase in demand for organic products, we considered it necessary to carry out a comparative study between the conventional and ecological farming system in the Transylvania area.

The purpose of the experiment is to study the behavior of the analyzed genotypes in different culture systems, especially in the ecological system.

The general objective of the present doctoral study was to identify two-row spring barley genotypes suitable for ecological agriculture in Transylvania, in the context of climate change.

The specific objectives of the research that led to the achievement of the general objective were:

- Identification of spring barley genotypes suitable for ecological agriculture in the area of Transylvania;
- Evaluation of the influence of climatic conditions, cultivation system, crop rotation and genotypes on production and the main components of production, following: plant height, ear length, number of grains/ear, weight of grains/ear, TKW and test weight;
- Evaluation of the influence of climatic conditions, cropping system, rotation and genotypes on the quality indices, looking at: the content of protein, starch and beta-glucans.
- Evaluation of the susceptibility of spring barley genotypes to diseases;

MATERIAL AND METHOD

The experiments were located in the experimental field of the Agricultural Research and Development Station (Turda). A three-year cropping experiment (2021-2022-2023) and a stationary experiment during 2022-2023 were organized according to the randomized block method on a number of eight genotypes of spring barley.

The research included the following experimental factors:

Year - two graduations: 2021, 2022, 2023;

The culture system-three graduations: conventional, ecological and extensive;

Crop rotation-two graduations: wheat-spring barley rotation and monoculture;

Genotype-eight graduations: Turdeana, Aura, Daciana, Romanita, Sulilly, Tatum, Armada and Sunshine.

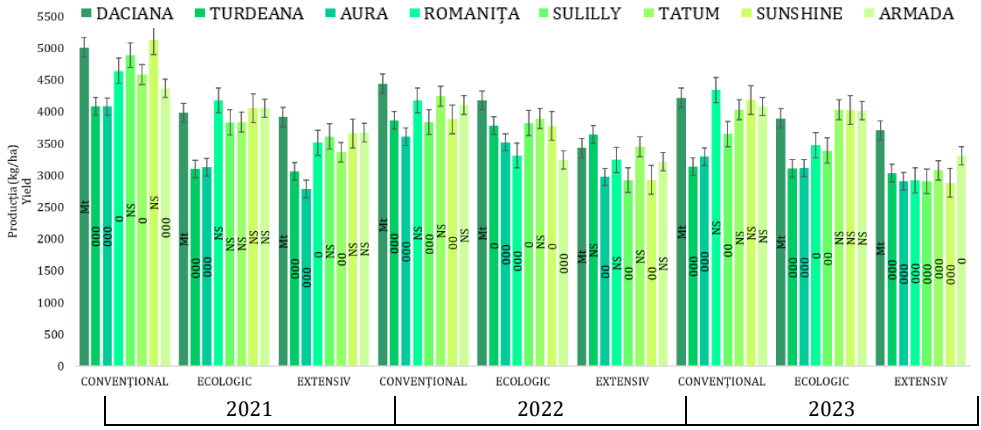
Each genotype was sown mechanized, the surface of a plot was 10 m^2. Plant height and disease attack were determined in the field, and biometrics determination and quality parameters were performed in the laboratory.

RESULTS AND DISCUSSIONS OF THE RESEARCH

Research results on polyfactorial experiment (3x3x8)

All three experimental factors (year, system and genotype) had a very significant impact on production formation, so the culture system show the greatest influence on production (39.20%), followed by the genotype factor (16.38%) and climatic conditions (8.46%).

The yield obtained in the conventional system for the eight analyzed varieties oscillated between 3661 kg/ha (Aura) and 4558 kg/ha (Daciana);(figure 1). In this system only at two varieties (Romaniţa and Sunshine) the yield were close to the control, the differences being negative but insignificant, while in the other varieties the differences were very significant (Turdeana, Aura, Sulilly and Armada) or distinctly significantly negative (Tatum). In the ecological system, the minimum production was 3254 kg/ha (Aura) and the maximum 4021 kg/ha (Daciana). Compared to Daciana variety, four varieties registered very significantly negative differences, such as Turdeana, Aura, Romanita and Sullily, respectively significantly negative for Armada cultivar and insignificant for the Tatum and Sunshine varieties. Similar results were reported by other authors, concluding that in the conventional system, higher yields are obtained by 20% (DE PONTI et al., 2012), respectively 34% (VERENA SEUFERT et al., 2012) than in the organic system. In the extensive system, most of the varieties registered very significant negative yield differences compared to the control, with the exception of the Armada variety where the differences were distinctly significantly negative.



DL (LSD) 5% = 337; DL (LSD) 1% = 446; DL (LSD) 0.1% = 574;

Fig. 1 The influence of G x A x S interaction on spring barley yield

Cultivation system and genotype had a highly significant influence on β-glucans content, while climatic conditions had a significant influence. Regarding the behavior of

the genotypes in the three culture systems regarding the content of β-glucans, we can see that the highest values were recorded in the system where no inputs were applied (4.54%), followed by the ecological system (4.31%) and conventional (4.30%), the differences between the last two systems being very small. The very close results of the β-glucans content of the organic and conventional system are confirmed with the results obtained by KHALEGHDOUST et al. (2024), who show that the content of β-glucans could be obtained in the organic system, as efficiently as in the conventional system, but adaptation strategies are needed considering the variation from one year to another. Researchers such as SINKOVIC et al. (2023); TAKAČ et al. (2022) also obtained a higher content of β-glucans in the organic system compared to the conventional.

In the conventional system, Turdeana, Tatum and Armada varieties stand out with the highest content of β-glucans, while Sulilly variety registers the lowest content (3.87%). In the ecological system, the content of β-glucans in the analyzed varieties was between 4.04-4.51%, the highest values being recorded at Aura, Romanita, Tatum and Sunshine varieties. In the extensive system, the highest content of β-glucans is noted at Turdeana variety (4.87%) and Tatum (4.74%), while Sulilly, Sunshine and Armada varieties record the lowest content of β-glucans compare to Daciana variety.

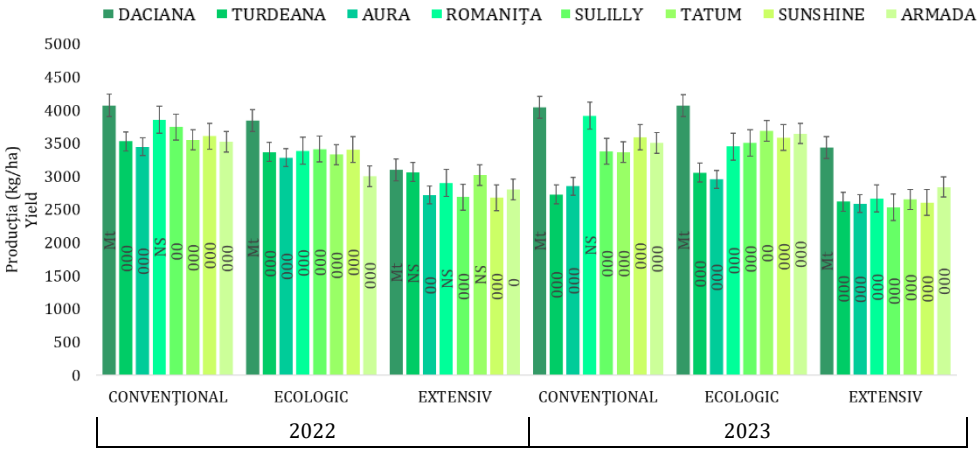
Research results on polyfactorial experiment (2x3x2x8)

Cultivation system, crop rotation and genotype contributed very significantly to the formation of production, while in this situation, the factor of climatic conditions did not show a significant influence. Similar results regarding the significant contribution of genotype, climatic conditions, as well as G x Y interaction on production were reported by IOANA DUNĂREANU et al. (2021). The most influence on yield is the rotation factor (28.33%), followed by the culture system (26.74%) and genotype (12.19%).

Knowing the negative effects of monoculture on yield, we note that yield was very significantly reduced (669 kg/ha) compared to the control where crop rotation was applied. Similar results were also obtained in the other studies carried out by WOŹNIAK et al., (2019), obtaining up to 23% lower yields in monoculture.

In the experimental year 2022, the varieties behaved differently in the culture systems (figure 2), so the closest yield to the control were recorded in the Romanita (conventional) variety and Turdeana, Romanita and Tatum (extensive). In the ecological system, all varieties registered very significant negative differences compared to the control. The yield of all barley varieties tested in the organic system was generally lower than in the conventional system, results also obtained by AINA KOKARE et al., (2014). The main factor that led to these results was most likely the lower level of fertilization in the version managed in the organic farming compared to the conventional one, but also the high weed pressure, as often happens in organic management (WOLFE and et al., 2008). On the other hand, in 2023 due to the location of the experiment in the same place (monoculture) and the accumulation of organic fertilizers, it can be observed that in the ecological system the productions were higher than in the conventional system.

In the second year, in the system where chemical products were applied, only one variety (Romaniţa) achieved yield close to the control, the rest of the varieties registering very significant negative differences in all three culture systems, with the exception of Tatum variety from the ecological system, where yield differences were distinctly significant.



DL (LSD) 5% = 233; DL (LSD) 1% = 308; DL (LSD) 0.1% = 396;

Fig. 2 The influence of G x A x S interaction on spring barley yield

The greatest influence on protein content is exerted by the culture system (112.02 ***), followed by genotype (24.39 ***), rotation (16.59 ***), while climatic conditions manifest a significant influence. In the conventional system, compared to the control, Turdeana and Aura varieties stand out with a very significant protein content. Compared to the conventional system, the protein content in the organic system was lower, results also reported by TEJIDO et al. (2011). The application of organic fertilizers led to an increase in protein content in four of the eight analyzed genotypes compared to the control. Turdeana, Aura, Romanita, Sunshine and Armada varieties were noted for their rich content in protein assimilates. In the extensive system, the highest protein values are noted at Turdeana, Aura and Armada varieties.

On the starch content, the greatest influence is exerted by the rotation factor (155.50***), followed by the genotype (6.72***), the climatic conditions (108.29**) and the culture system (5, 99*). Regarding the influence of the G x A x S interaction on the starch content, we note that in the 2022, in the conventional system, Tatum is the only variety that registers significant increases (60.52%) compared to the control. In the ecological system, the highest starch content is recorded at Daciana variety (59.88%), and the lowest at Aura variety (56.36%). In the extensive system, Romanita is the only variety that registers significant negative differences in starch content, the other varieties registering insignificant differences compared to the control.

CONCLUSIONS

In terms of yield, the most favorable year was 2021. Higher productions were obtained in the conventional system (4163 kg/ha), followed by the ecological system (3699 kg/ha) and extensive (3254 kg/ha). Compared to the Daciana variety, all the other varieties register a very significant negative production differences, with an amplitude between 251-819 kg/ha. In the variant with products allowed in E.A., close yield to the control are noted at Tatum and Sunshine varieties.

The highest values of β-glucans content were recorded in the system where no inputs were applied (4.54%), followed by the organic system (4.31%) and conventional (4.30%), the differences between the last two systems being very reduced. On average, the content of β-glucans recorded values between 3.87-4.87%.

According to the experience during the 2022-2023, the yield obtained in 2022 was higher, but the differences between the two analyzed years were not significant. Higher productions were obtained in the conventional system (3543 kg/ha), followed by the ecological system (3436 kg/ha) and extensive (2806 kg/ha). In monoculture the yield was very significantly reduced, obtaining yield with 18.6% lower than in the rotation (control). Daciana was the most productive variety, the other varieties registered very significant negative differences.

The most favorable climatic conditions for the assimilation of protein substances were in 2023. The varieties recorded the highest protein content in the conventional system (10.25%), in the ecological and extensive system the protein content was very significantly reduced by 7%, respectively 8.9%. In the monoculture there were distinctly significant increases compared to the control. Compared to the control, all analyzed varieties had a higher protein content, while the Tatum and Sunshine varieties had the lowest values.

Climatic conditions in the first experimental year were more favorable for the assimilation of starch content. A higher content was obtained in the system where organic fertilizers and products allowed in organic farming were applied (56.79%), followed by the extensive (56.06) and conventional (55.61%) systems. The starch content was different in the rotation and monoculture, achieving very significant increases compared to the control in the stationary experience. Daciana recorded the highest starch content, followed by the Sulilly and Tatum varieties, while the lowest content is recorded by Turdeana, Aura and Romanita varieties.

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