

RESEARCH ON THE BEHAVIOR OF SOME WINTER BARLEY VARIETIES AND LINES IN PEDOCLIMATE CONDITIONS AT A.R.D.S. SECUIENI, DURING THE PERIOD 2019-2022

Alexandra LEONTE*, Sabina PINTILIE, Diana POPA, Margareta Naie
Agricultural Research and Development Station Secuieni, Secuieni – Neamț, 617415, Romania
*Corresponding author: Andra29nt@yahoo.com

Abstract. The main purpose of this study was to establish the adaptability of 10 Romanian winter barley varieties and lines (creations of the National Agricultural Research Development Institute Fundulea) in the pedoclimatic conditions of Central of Moldova. On average, in the three years of testing, the yields obtained by the winter barley varieties and lines, varied from 5484 kg ha⁻¹ at the DH-432-6 line to 7587 kg ha⁻¹ at the F8-4-18 line. Compared to the yield recorded by the control variety, Dana (6221 kg ha⁻¹), the Cardinal variety – 6838 kg ha⁻¹ and the F8-4-18 line (7587 kg ha⁻¹) obtained higher yields, these being statistically ensured and interpreted as significant respectively very significant. The varieties of barley studied (Univers, Andreea, Artemis, Gabriela) produced higher yields than the control, but had no statistical interpretation.

Keywords: adaptability, barley, climatic conditions, lines, variety, yield.

INTRODUCTION

The yield of cereal varieties has increased considerably in many regions of the world, including Romania (Calderini and Slafer, 1998; Engler and Del Pozo, 2013; Del Pozo et al., 2014), a fact due both to the improvement of genetics and the adaptation of cultivation technology to these species, depending on the new climatic conditions and the new varieties created.

Barley variety and quality parameters are the key to success on the seed market and in the malt and beer industry (Križanova et al., 2010). Many characteristics are controlled by barley producers, but some are influenced by the climatic conditions during the growing season (www.bmbri.ca).

Yield is a complex character that depends on a large number of morphological, physiological and environmental traits (Alam et al., 2007) and also quality is determined by numerous genetic factors, and in certain years, environmental factors can reduce the quality of superior genotypes to that of fodder barley (Pržulj and Momcilovic, 2008; Pržulj et al., 2014). Achieving high yields of barley, stable and superior in terms of quality, requires the cultivation of valuable genotypes, with high production capacity, differentiated superior quality attributes, resistant to diseases and adapted to different environmental conditions (Voinea, 2016).

In order to increase the stability of yields from one year to another, the new varieties of cereals must have a superior behavior both in the conditions of dry years and in years with normal or excess precipitation, that is, they must combine a high yield potential and a resistance good to water stress (Blum, 1996, cited by Săulescu et al., 2006).

Cultivation conditions, variety and applied technology decisively influence the destination and technological quality of the final product (Vasilescu et al., 2014).

By introducing more and more valuable varieties of barley into culture, as well as by the permanent improvement of cultivation technologies, the conditions are created for the increase in the importance of barley culture in the following years (Pochișcanu and Buburuz, 2013).

Cereals provide over 50% of the total world crop production, their seeds being an important resource for human and animal feed, as well as for the industry. From these, winter barley is an appreciated crops by farmers due its ability to adapt to less favourable environmental conditions and also give high and economically efficient yields. The barley grain weights (GW) along with grain size are universally considered to be closely correlated with the level of technological quality indicators required by the malt and beer industry. Grain weight is first trait used to classify the barley seed quality (Vasilescu et al., 2020).

Drought and heat stress substantially impact plant growth even the productivity of barley culture. When subjected to drought or heat stress, plants exhibit reduction in growth resulting in yield losses (Mahalingam et al., 2022).

Barley has properties that can improve and maintain human health, but to upgrade the positive characteristics of grain, specific breeding programs are required. Consumption of chemically protected food is unpopular and, therefore, genetic sources of disease resistance to the most frequent diseases are essential. The aim of this contribution is to postulate genes for powdery mildew resistance in spring barley varieties bred for human consumption (Dreiseitl, 2022).

MATERIAL AND METHODS

The research was conducted during 2019-2022, in the experimental field from A.R.D.S. Secuieni, and aimed to establish the adaptability to pedoclimatic conditions in Central of Moldavia of a number of six barley

varieties (Dana, Cardinal, Univers, Andreea, Artemis, Gabriela) and four barley lines (F8-4-12, F8-4-18, DH-432-6, DH-432-1).

The crop was placed in the field according to the method of randomized blocks, in three replications, on a cambic faeozom (chernozem) soil, with medium texture, characterized as being well supplied with phosphorus (P_2O_5 -39 ppm) and mobile potassium (K_2O -161 ppm), moderately supplied with nitrogen, the soil nitrogen index being 2.1, weakly acidic, with pH values (in aqueous suspension) of 6.29 and poorly fertile, with a humus content of 2.3% (Leonte et al., 2021). The cultivation technology specific to the conditions in Central Moldavia was used in this case, and the data obtained was processed and interpreted statistically according to the method of variance analysis (CEAPOIU, 1968).

From a thermal point of view, compared to the multiannual average of the last 60 years, in the central area of Moldova, during the sowing-harvesting period for autumn barley, an increase in temperatures of 1.2 – 1.4 °C (2020 - 2022) can be observed, up to 2.1°C (2019-2020), a period that was framed as warm and warmer (Figure 1).

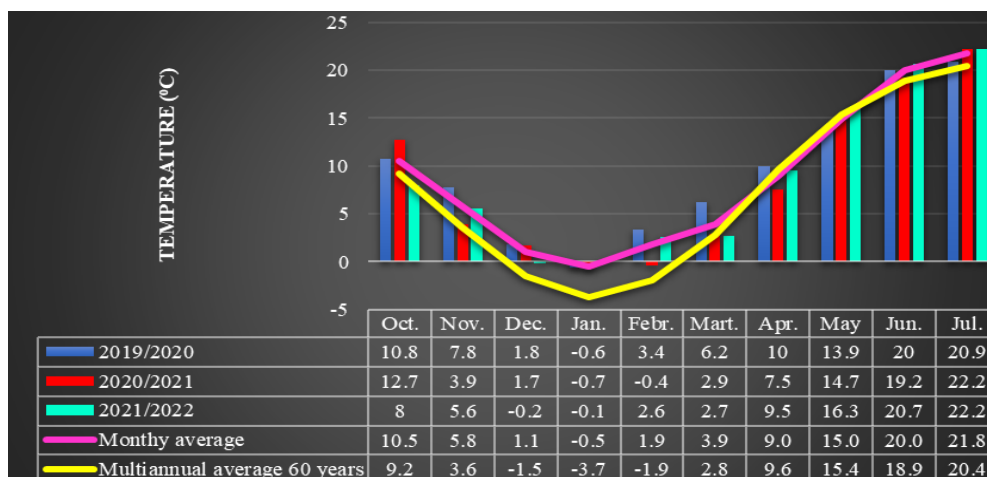


Figure 1. Average temperature (°C) during the barley vegetation period, A.R.D.S. Secuieni, 2019-2022

In terms of precipitation over the entire vegetation period of the barley crop, the deviations from the multiannual average were varied, of 115.8 mm in 2020-2021, 165.2 mm in 2019-2022, and the largest deficit was recorded in 2021- 2022, of 215 mm (Figure 2).

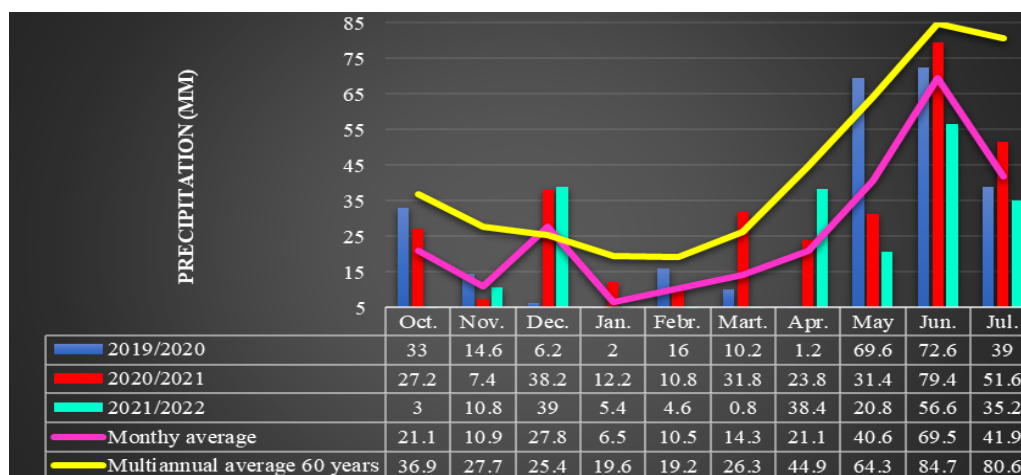


Figure 2. The monthly distribution of precipitation during the barley vegetation period, A.R.D.S. Secuieni, 2019-2022

RESULTS AND DISCUSSIONS

A series of observations were made on the varieties and lines of winter barley, in order to establish their behavior in the pedoclimatic conditions from A.R.D.S. Secuieni.

Regarding the height of the plants, during the three years of testing, it varied within quite large limits, from 44.5 cm in the F8-4-18 line (year 2019-2020) to 109 cm in the DH-432-6 line (year 2020-2021) (Figure 3). In the first year of testing, the height plants was between 44.5 cm at the line F8-4-18, and the maximum was registrated at the DH-432-6 line, of 64.2 cm. In the second year the height were between 90.1 cm (Gabriela) and 109 cm (DH-432-6). In the last

year of researches, the smallest height plant was at the DH-431-1 line (61.2 cm) and the highest height at the Dana variety (94.8 cm). The size of the plants in the barley crop was smaller in 2020 and 2022, due to the deficit of precipitation, but also the fact that they risen in the last decade of February.

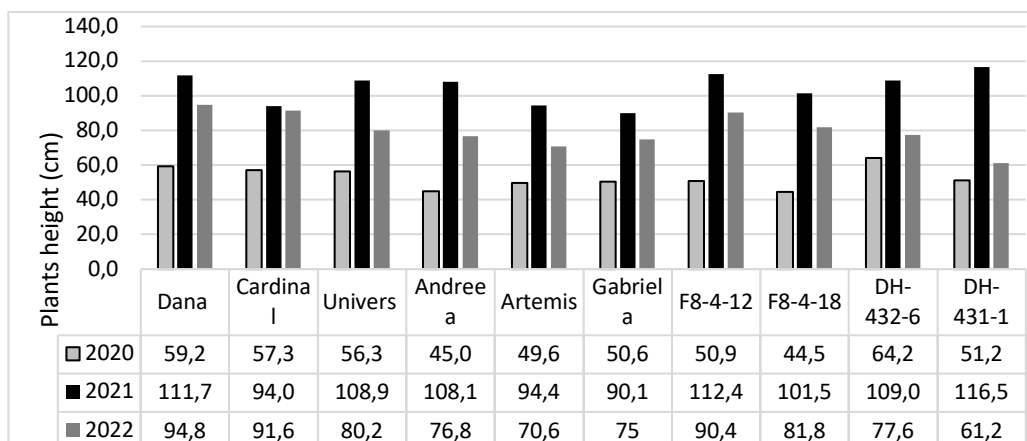


Figure 3. Plant height of winter barley varieties and lines, 2019-2022

Winter barley varieties and lines that were tested, differed from each other according to some agronomic characteristics (Table 1). On average, the highest number of ears of barley was obtained in the Artemis variety, 940 ears of barley / square meter with a number of 2.2 siblings / plant, and the Cardinal variety had the lowest density of ears of barley, 513 ears/ square meter. The highest number of grains in the ear was obtained in the Cardinal barley variety, with 40.6 grains/ear of barley, also registering a weight of 1.773 grains/ear of barley. Of the ten barley lines and lines studied, the DH-432-6 line obtained the fewest grains, 16.9 grains/ear of barley whose weight was 0.901.

Table 1. Some agronomic characteristics of experimental winter barley varieties and lines at A.R.D.S. Secuieni, average 2019 – 2022

Variety/line	Number of ears of barley/square meter	Numbers of siblings/plant	Number of grains/ear of barley	Grain weight/ear of barley (g.)
Dana	583	1.5	30.9	1.185
Cardinal	513	1.4	40.6	1.773
Univrs	586	1.6	28.4	1.296
Andreea	895	2.1	20.7	0.983
Artemis	940	2.2	17.7	1.476
Gabriela	882	2.1	20.9	0.941
F8-4-12	550	1.4	32.8	1.461
F8-4-18	564	1.4	35.9	1.559
DH-432-6	818	2.1	16.9	0.901
DH-431-1	612	1.7	17.5	0.956

The mass of one thousand grains in the winter barley varied within very wide limits, namely: from 41.6 g (F8-4-18), to 54.8 g (DH-432-6). The winter barley varieties had values between 43 g. obtained by the Dana variety, and the maximum was recorded by the Gabriela variety whose value was 47.9 g. (Figure 4).

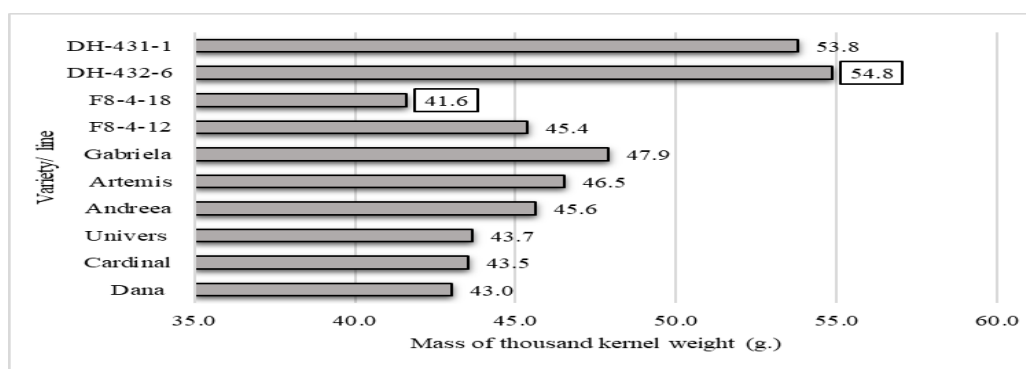


Figure 4. Thousand kernel weight (TKW) at winter barley varieties and lines

Regarding the hectoliter mass, it had values between 62.2 kg/hl obtained by the F8-4-12 line, and the maximum was obtained by the Gabriela variety, with a value of 70.7 kg/hl (Figure 5).

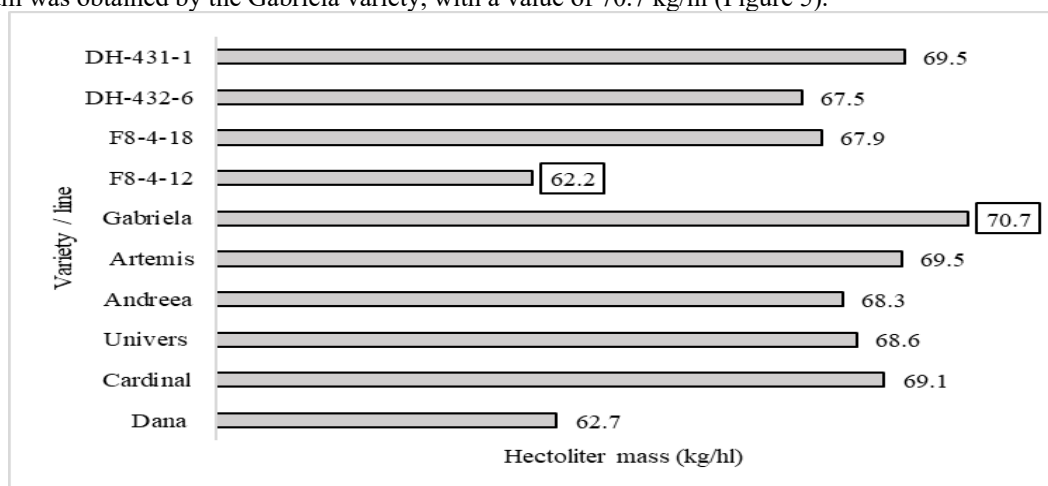


Figure 5. Weight per hectoliter at winter barley varieties and lines, average 2019-2022

In the first year of testing, the yields of the experimental winter barley varieties and lines were between 3656 kg ha⁻¹ and 5950 kg ha⁻¹. The highest winter barley yield, over 5000 kg ha⁻¹, were achieved by the Dana, Cardinal, Univers, Andreea, Artemis and Gabriela varieties, surpassing the control, the Dana variety, thus the yield increases being very significant, but also distinctly significant (Table 2).

The yield level obtained in the second agricultural year (2020-2021), had values between 5473 kg ha⁻¹ (at line DH-432-6) and 9720 kg ha⁻¹ (at line F8-4-18). The highest yields were obtained at the lines F8-4-18 (9720 kg ha⁻¹) and DH-431-1 (8253 kg ha⁻¹) registering very significant increases in yield compared to the control, the Dana variety (7107 kg ha⁻¹).

In the third year of testing, 2021 - 2022, yields ranged from 5943 kg ha⁻¹ in the DH-431-1 line to 8420 kg ha⁻¹ in the F8-4-18 line. Compared to the yield recorded by the control variety, Dana (7270 kg ha⁻¹), the F8-4-18 line (8420 kg ha⁻¹), obtained superior yield, a yield that was statistically ensured and interpreted as very significant. Compared to the Dana variety, there were also yield differences in two winter barley lines, DH-432-6 and DH-431-1, which were statistically ensured and interpreted as distinctly significant negative and highly significant negative.

On average, in the three years of testing, the winter barley yields of the studied varieties and lines varied from 5484 kg ha⁻¹ at the DH-432-6 line to 7587 kg ha⁻¹ at the F8-4-18 line. Compared to the yield recorded by the control variety (Dana – 6221 kg ha⁻¹), a variety (Cardinal – 6838 kg ha⁻¹) and a line (F8-4-18 – 7587 kg ha⁻¹) obtained higher yields, these being statistically ensured and interpreted as significant and very significant. The winter barley varieties studied had higher yields than the control, but had no statistical interpretation (Table 2).

Table 2. Yield of winter barley varieties and lines obtained at A.R.D.S. Secuieni in the years of experimentation

Variety / lines	Yield kg ha ⁻¹ 2019-2020	Yield kg ha ⁻¹ 2020-2021	Yield kg ha ⁻¹ 2021-2022	Average
Dana	4285 Mt.	7107 Mt.	7270 Mt.	6221 Mt.
Cardinal	5950 ***	6860	7700	6837 *
Univers	5391 ***	6397 °°	7733	6507
Andreea	5010 **	7237	7343	6530
Artemis	5350 ***	6407 °°	7467	6408
Gabriela	5247 ***	6847	6987	6360
F8-4-12	4329	5773 °°°	7587	5896
F8-4-18	4620	9720 ***	8420 ***	7587 ***
DH-432-6	4653	5473 °°°	6327 °°	5484 °°
DH-431-1	3656 °°	8253 ***	5943 °°°	5951
DL 5%	428 kg ha ⁻¹	478 kg ha ⁻¹	593 kg ha ⁻¹	500 kg ha ⁻¹
DL 1%	587 kg ha ⁻¹	656 kg ha ⁻¹	813 kg ha ⁻¹	685 kg ha ⁻¹
DL 0,1%	799 kg ha ⁻¹	893 kg ha ⁻¹	1107 kg ha ⁻¹	933 kg ha ⁻¹

The Cardinal and Gabriela winter barley varieties, as well as the DH-432-6 line, recorded the greatest stability in the pedoclimatic conditions of the area, realizing the smallest amplitude of yield variation (1750 kg ha⁻¹, 1740 kg ha⁻¹, respectively 1674 kg ha⁻¹). Amplitude bigger than 4000 kg ha⁻¹ was recorded in lines F8-4-

18 (5100 kg ha⁻¹) and DH-431-1 (4597 kg ha⁻¹), which shows that these lines have less stability at pedoclimatic conditions of the area (Table 3).

Table 3. Average, maximum, minimum productions and the amplitude of winter barley yield

Variety / lines	Obtained yield			Amplitudi kg ha ⁻¹
	Average	Maxim	Minimum	
Dana	5778	7270	4285	2985
Cardinal	6825	7700	5950	1750
Univers	6562	7733	5391	2342
Andreea	6177	7343	5010	2333
Artemis	6409	7467	5350	2117
Gabriela	6117	6987	5247	1740
F8-4-12	5958	7587	4329	3258
F8-4-18	7170	9720	4620	5100
DH-432-6	5490	6327	4653	1674
DH-431-1	5955	8253	3656	4597

The protein content of winter barley grains varied quite widely, from 11% in the Cardinal cultivar to 13.9% in the DH-431-1 line. The starch content varied very little, from 60% (DH – 431-1), and the maximum of 62.7% was obtained in the winter barley variety, Cardinal (Figure 6).

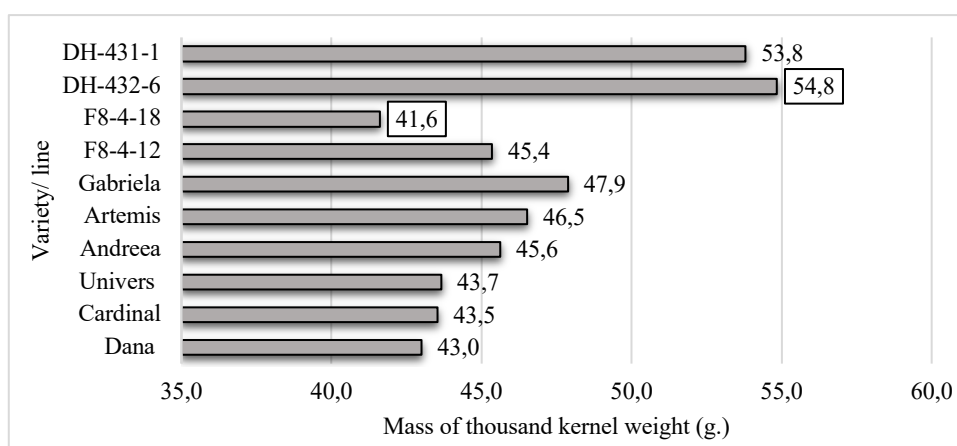


Figure 6. Quality indices at winter barle

CONCLUSIONS

During the three years of experimentation, the yields of the 10 varieties and lines of winter barley tested at the A.R.D.S. Secuieni, varied in quite large limits, from 5484 kg ha⁻¹ at the line DH-432-6 to 7587 kg ha⁻¹ at the line F8-4-18. Higher yields than control, Dana variety (6221 kg ha⁻¹), were recorded for five varieties of winter barley (Cardinal, Univers, Andreea, Artemis, Gabriela), as well as line (F8-4-18).

The highest stability among the studied varieties and lines was presented by the Cardinal and Gabriela varieties, realising the smallest amplitude of production variation (1750 kg ha⁻¹ and 1740 kg ha⁻¹ respectively), but the largest amplitude, of more than 4000 kg ha⁻¹ was recorded in lines F8-4-18 (5100 kg ha⁻¹) and DH-431-1 (4597 kg ha⁻¹), which shows that these lines have less stability in the pedoclimatic conditions of the central area of Moldova.

ACKNOWLEDGEMENT

This work was financed by a grant from the Ministry of Agriculture and Rural Development through the ADER 2019-2022 program, project no. 2.1.2 / 19.09.2019, ADER 2.1.2. " *The creation and promotion of new winter barley with six rows and winter barley with three rows genotypes characterized by superior adaptability to different environmental conditions, productivity and quality required by the food and animal husbandry industry* ".

REFERENCES

1. Alam M.Z., Haidar S.A., Paul, N.K. – Yield and yield components of barley (*Hordeum vulgare* L.) cultivars in relation to nitrogen fertilizer. 2007, Journal of Applied Sciences Research., 3(10), 1022-1026.

2. Blum A. – Crop responses to drought and the interpretation of adaptation. *Plant Growth Regulation*, 1996, 20, 135-148
3. Calderini D.F., Slafer G.A. – Changes in yield and yield stability in wheat during the 20th Century. *Field Crop. Res.*, 1998, 57, 335 - 347.
4. Ceapoiu N. – Statistical methods applied in agricultural and biological experiments. Agro-Forestry Publishing House, Bucharest, Romania, 1968.
5. Del Pozo A., Matus I., Serret M.D., Araus J.L.,– Agronomic and physiological traits associated with breeding advances of wheat under high - productive Mediterranean conditions. The case of Chile. *Env. Exp. Bot.*, 2014, 103, 180-189.
6. Dreiseitl A. – Powdery Mildew Resistance Genes in Barley Varieties Bred for Human Consumption, *Agronomy*, 2022, 12(10), 2245; <https://doi.org/10.3390/agronomy12102245>.
7. Engler A., Del Pozo A. – Assessing long and short run trends in cereal yields: the case of Chile between 1929-2009. *Cien. Inv. Agr.*, 2013, 40, 397-410.
8. Križanova K., Psota V., Sleziak L., Žofajova A., Gubiš J. – Spring Barley Breeding for Malting Quality. *Potravinarstvo*, 2010, 4(2), 39-44. ISSN 1337-0960.
9. Leonte A., Agapie A., Pintilie P.L., Druțu A.C., Amarghioalei G., Eșanu S. – Research regarding the influence of nitrogen and phosphorus fertilizers on winter wheat, in the pedoclimatic conditions in Central of Moldavia. *Journal Life Science and Sustainable Development Lovrin*, 2021, 2(2), ISSN 2734 – 5068, 52-57
10. Pochișcanu S.F., Buburuz A.A.– Comportarea unor soiuri de orz de toamnă în condițiile pedoclimatice din centrul Moldovei. *An. INCDA Fundulea*, 2013, Vol. LXXXI, 37-45
11. Pržulj N., Momcilovic V. – Cultivar x year interaction for winter malting barley quality traits. In: Kobiljski B. (Ed.) *Conventional and Molecular Breeding of Field and Vegetable Crops*, Institute of Field and Vegetable Crops, Novi Sad, Serbia, 2008, 24-27 November, 418-421.
12. Pržulj N., Momcilovic V., Simic J., Miroslavljevic M.– Effect of growing season and variety on quality of spring two rowed. *Barley Genetika*, 2014, Vol. 46, No. 1, 59-73.
13. Mahalingam R., Duhan N., Kaundal R., Smertenko A., Nazarov T., Bregitzer P. - Heat and drought induced transcriptomic changes in barley varieties with contrasting stress response phenotypes. *Front. Plant Sci.*, 08 December 2022 Sec. Plant Abiotic Stress, 2022, Volume 13, <https://doi.org/10.3389/fpls.2022.1066421>
14. Săulescu N.N., Ittu Gh., Mustăța P., Păunescu Gabriela, Stere Ioana, Nistor G., Rînciță I., Voinea I. – Comportarea unor soiuri de grâu de toamnă românești în condiții contrastante de aprovizionare cu apă. *Probleme de genetică teoretică și aplicată*, 2006, XXXVIII, 1-2, 21-29.
15. Vasilescu, L., Alionte E., Bude A. – Comportarea unor soiuri și linii de orz și orzoaică de toamnă la I.N.C.D.A. Fundulea în perioada 2008-2013 sub aspectul stabilității producției și calității. *An. INCDA Fundulea*, 2014, Vol. LXXXII, 69-82.
16. Vasilescu L., Petcu E., Sirbu A. – Winter barley grain weight stability under different management practices at NARDI Fundulea. *Romanian Agricultural Research*, 2020, No. 37, ISSN 2067-5720, 67 – 73.
17. Voinea L., – Comportarea unor soiuri de orz de toamnă la S.C.D.A. Mărculești în perioada 2013-2015. *An. INCDA Fundulea*, 2016, Vol. LXXXIV, 73-85.
18. www.bmbri.ca – Quality factors in malting barley. Brewing and Malting Barley Research Institute. Manitoba, Canada.