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THE BEHAVIOR OF SOME WINTER BARLEY VARIETIES IN THE CLIMATIC CONDITIONS OF THE CENTRAL MOLDAVIAN PLATEAU

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ABSTRACT. This paper presents the enviromental testing research results of seven romania varieties of winter barley, experienced on Agricultural Research and Development Station *(*ARDS) of Secuieni, Neamț county, Romania, during 2007 – 2010. By this was followed the zoning of the most adjusted and efficient genotypes, increasing their biodiversity so that to reduce the genetic and ecological vulnerability of the agroecosystems. In the last three years (2007 – 2010) was revealed the tendency of large fluctuations occurrence, both in terms of rainfall and temperature, from a normal crop year (2007 – 2008) in a dry year (2008 – 2009) and a rainy year (2009 2010). In the crop year 2009 – 2010, because of spring weather conditions that favored the installation of pathogen agents (*Erysiphe graminis* f.sp. hordei, *Pyrenophora graminea, Pyrenophora teres, Puccinia hordei)*, but especially of the rainfall fallen in the last decade of June, which negatively influenced the evolution of the barley crop and contributed to the quantity (by shaking the beans in the ear) and quality deteriorating of barley production, the winter barley yields were very small. On average over the three years of experimentation, the barley yields achieved ranged between 5232 kg/ha (Dana variety) and 6048 kg/ha (Sistem variety). Depending on the average production achieved during the three years of experimentation, top three ranked varieties are Sistem (6048 kg/ha), Andreea (5902 kg/ha) and Mădălin FD (5441 kg/ha). Regarding the resistance to abiotic and biotic stress factors, it has varied from year to year depending on variety. The romanian varieties were characterized by good resistance to lodging and brown rust.

Key words: Climatic conditions; Experience; Barley; Production; Ecological testing.

REZUMAT. Comportarea unor soiuri de orz de toamnă în condițiile climatice din Podişul Central Moldovenesc. Lucrarea de față prezintă rezultatele cercetărilor de testare ecologică a unui număr de şapte soiuri româneşti de orz de toamnă, experimentate la S.C.D.A. Secuieni-Neamț,

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în perioada 2007-2010. Prin aceasta s-a urmărit zonarea celor mai adaptate şi performante genotipuri, creşterea biodiversităţii lor, în aşa fel încât să se diminueze vulnerabilitatea genetică şi ecologică a agroecosistemelor. În ultimii trei ani (2007-2010), s-a evidenţiat tendinţa apariţiei fluctuaţiilor foarte mari ale precipitatiilor şi ale temperaturilor, de la un an agricol normal (2007-2008) la un an secetos (2008-2009) şi la unul ploios (2009-2010). În anul agricol 2009-2010, datorită condiţiilor climatice din primăvară, care au favorizat instalarea agenţilor patogeni (*Erysiphe graminis f.sp. hordei, Pyrenophora graminea, Pyrenophora teres, Puccinia hordei*), dar mai ales a precipitaţiilor căzute în ultima decadă a lunii iunie, care au influenţat negativ evoluţia culturilor de orz şi au contribuit la deprecierea cantitativă (prin scuturarea boabelor din spic) şi calitativă a producţiei de orz, producţiile realizate la orzul de toamnă au fost foarte mici. În medie pe cei trei ani de experimentare, producţiile de orz realizate au variat între 5232 kg/ha (soiul Dana) şi 6048 kg/ha (soiul Sistem). În funcţie de producţia medie realizată, pe primele trei locuri s-au situat soiurile Sistem (6048 kg/ha), Andreea (5902 kg/ha) şi Mădălin FD (5441 kg/ha). Rezistenţa la factorii de stres abiotic şi biotic a variat de la an la an şi în funcţie de soi. Soiurile româneşti s-au caracterizat prin rezistenţă bună la cădere şi rugina brună.

Cuvinte cheie : condiţii climatice; experienţă, orz, producţie, testare ecologică.

INTRODUCTION

Extremely large variation, both the total amount of rainfall from one year to another, and their distribution throughout the year, determine, in some years, important shortages of water during straw cereal vegetation, while in other years are recorded excess moisture. Lately the climate changes have emphasized this extreme variations, with serious consequences on the agricultural production (Săulescu *et al*., 2006).

To increase the stability of production from one year to another, the new cereals varieties must have a superior behavior both under drought years, and in years with normal or excess rainfall, ie it should combine a high production potential and a good resistance to water stress (Blum, 1996, quote by Săulescu *et al*., 2006). Strong interaction between genotype and enviroment requires that in the breeding process to create varieties with specific adaptability to both favorable and unfavorable climatic conditions (Tessemma *et al*., 1998). The production stability is given by the sum of the variety resistance to adverse environmental conditions (Săulescu, 1984) and the characters interaction with compensating effect (Timariu, 1975). Growing varieties with wide adaptability to the contrasting environmental conditions can reduce the risks in the production decline during the unfavorable years (Mustăţea *et al*., 2008).

The barley is adapted to different growing conditions due to its high environmental plasticity. The winter barley to humidity is not very demanding, but the critical phases are during the straw forming and grain filling. Compared with wheat, the barley has higher requirements to the soil, due to less developed root system

and the nutrient elements weaker leaching power.

The experiences located at the Agricultural Research and Development Station (ARDS) Secuieni, Neamț county, aimed at tracking the adaptability of the latest creations of winter barley to climatic conditions in the area of influence. By this was followed the zoning of the most suitable and efficient genotypes, increasing their biodiversity so as to reduce the genetic and environmental vulnerability of the ecosystems.

MATERIALS AND METHODS

At the ARDS Secuieni, Neamț county, during 2007 – 2010, there were conducted multiple and complexe environmental tests (competition test fields) in some winter barley varieties created at Fundulea, Călăraşi county, ARDS Suceava, ARDS Podu-Iloaiei, Iaşi county and ARDS Turda, Cluj county (Romania). Thus, it has been experienced seven romanian winter barley varieties in a competition comparative culture, placed in the field after the randomized block method, in three repetitions, without repeating the basic scheme, with the harvestable plot of 10 sqm.

The experiments were placed in the experimental field of Eco Testing Laboratory, on a typical cambic chernozem soil with 6,29 water pH; 2,3 humus content; 2,1 nitrogen index; P_2O_5 mobile - 39 ppm; K2O - 161 ppm. The fertilization was done with moderate doses of nitrogen and phosphorus, between 60 and 80 kg/ha a.s. The sowing was done in the optimal time for this area, except of 2009 – 2010 year crop, due to the excessive drought of the winter the land could not been prepare, and the sowing was done on 26 October.

The experimental period, 2007 – 2010, was characterized by years with less favorable weather conditions in the crop years 2007 – 2008 and 2009 – 2010 and very favorable in the 2008 – 2009 crop year . On average, the three years, the deviation to annual average in terms of temperature, was ranged from -0,3°C (January) and 2,1°C (March) *(Fig. 1).* Regarding the precipitations, throughout the barley growing season (from planting to physiological maturity), the deviation from the annual average ranged from -6.6 mm (November) and 25.1 mm (June) *(Fig. 2).* Analyzing the annual amount of rainfall compared to annual average shows that only the agricultural year 2007-2008 is characterized as a normal year (577.7 mm), the crop year 2008-2009 was dry (423.7 mm), and the crop year 2009-2010 was rainy (686.2 mm).

The observations and measurements consisted of notations on plant phenology. The lodging resistance was made in part for each repetition, in the form was past the average of the three notations. Grading the resistance to lodging was done in gray and technical maturity.

Lodging resistance was appreciated with notes as follows: note 1 – granted when the plants had a vertical position; note 3 – when the angle of plant inclination above the ground was more than 60°; note 5 – the plant bending angle above the ground is 30°-60°; note 7 - the plant bending angle above the ground is 30°; note 9 – the plants are completely fallen to the ground. The resistance to diseases was made in a single plot were the pathogen agent is most strongly manifested.

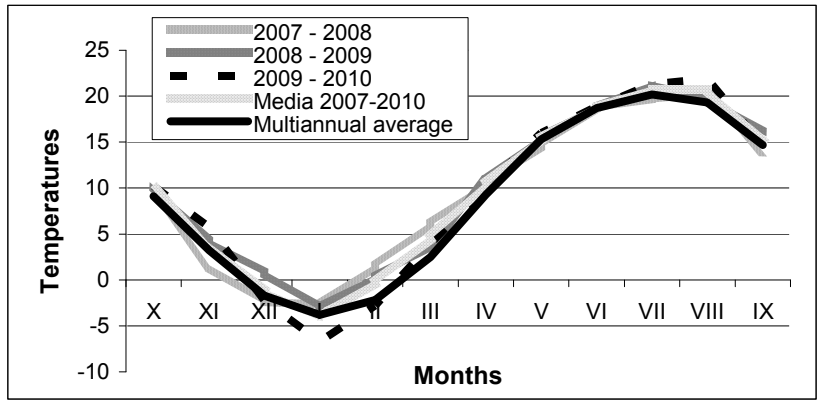

Figure 1 – The graphic of the temperatures recorded at ARDS Secuieni-Neamț

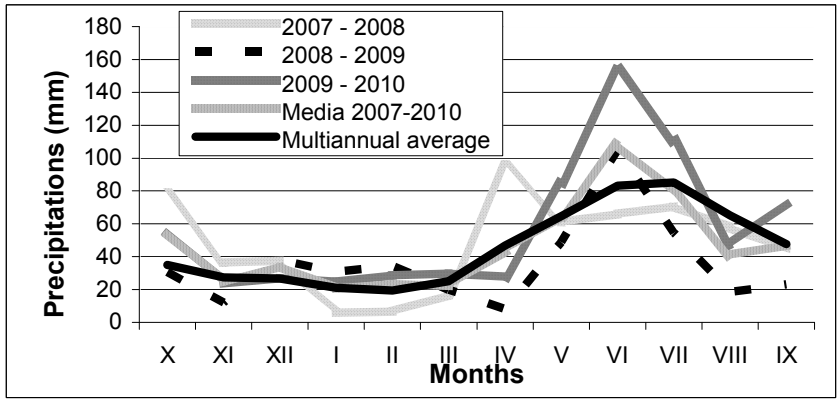

Figure 2 – The graphic of the precipitations recorded at ARDS Secuieni-Neamț

The methodology for making observations and calculating the intensity of the attack was so:

- the intensity calculation formula was: $I(\%) = \frac{\sum(ixf)}{n}$,

in which:

i – percentage of awarded mark;

f – number of plants (organs) marked with that note;

n – total number of attacked plants (organs) analyzed.

The attack intensity scoring scale

Contested area (%)	Note of attack intensity
0	0
1-3	1
4-10	2
11-25	3
26-50	4
51-75	5
76-100	6

RESULTS AND DISCUSSION

The production capacity of the tested genotypes varied widely, depending on the genotype and their reaction to climatic conditions. In the experimental conditions of the ARDS Secuieni, Neamț county, Romania, the density at sowing for winter barley was assured of 500 germinable seeds/sqm. During the vegetation, due to adverse climatic conditions, some of the barley plants have disappeared, so that at harvest there was a lower density.

Depending on the capacity of twinning of barley varieties, pre - plant, weed degree, disease frequency, yield per hectare showed different values for each variety and year separately. The elements of productivity which caused the achieving of this production were: density of ears/sm, the number of grains per ear and 1000 grain mass (MMB). The average density per square meter of the ears barley ranged from 525-752 *(Table 1).*

At barley, yields vary depending on climatic year, the highest production was in the crop year 2008-2009. The correlation between ears density and production is direct and significant. The average number of grains in the ear and 1000 grain mass are two other elements of winter barley production. Number of grains in the ear is determined by the number of ears and the number of fertile flowers in ear.

The number of ears is the contribution of heredity and is depending largely on environmental factors. The factors that contribute to increasing the number of ears, also contribute to increasing the number of grains in the ear. The large number of grains in the ear is a specific characteristic of varieties with high production capacity, and between each ear and the average yield per hectare is a positive correlation. In terms of the ARDS Secuieni, the average number of grains in the ear ranged from 23 to 29, depending on the size of ear *(Table 1).*

The bean meal is one of the basic components involved in the formation of the harvest. This component of production is dependent on the specific genotype, spare food and water in the soil, the health chain (Mc Dinald, 1992; Mc. Kay, 1996). The drought that occurs during grain filling is a key factor in reducing production by reducing the mass of 1000 seeds.

In terms of quality, in the conditions of the ARDS Secuieni, 1000 grain weight ranged from 42-46 g, so most of the varieties registered in 1000 grain weight values that are over the standard 42-g *(Table 1).*

The values of productivity (ear density/sqm, the number of grains per ear, MMB) largely depend on the morpho-physiological characteristics. Thus, in a culture in which the growth of all organs of the plant is slowed or stopped and the values of productivity elements are small or nonexistent.

Table 1 - Elements of productivity of barley varieties tested

Variety	2008			2009			2010			Average years		
	Nr.of grain/ear	Nr. ears/sqm	MMB	Nr.of grain/ear	Nr. ears/sqm	MMB	Nr.of grain/ear	Nr. ears/sqm	MMB	Nr.of grain/ear	Nr. ears/sqm	MMB
Dana	26	698	43	22	955	44	25	604	44	24	752	44
Amical	29	488	45	25	756	46	28	501	45	27	582	45
Mădălin	29	585	44	24	701	43	27	523	44	27	603	44
Sistem	32	500	41	28	675	42	28	503	43	29	559	42
Cardinal	29	547	43	26	598	42	27	508	41	27	551	42
Univers	30	453	41	26	651	43	29	470	42	28	525	42
Andreea	24	670	45	22	821	47	22	615	47	23	702	46

Table 2 - Production of winter barley varieties in the period 2008 - 2010

Variety	2008				2009				2010				2008-2010			
	kg/ha	%	Diff. (kg/ha)	Sign.	kg/ha	%	Diff. (kg/ha)	Sign.	kg/ha	%	Diff. (kg/ha)	Sign.	kg/ha	%	Diff. (kg/ha)	Sign.
Dana	4800	100	Mt	-	7450	100	Mt	-	4046	100	Mt	-	5432	100	Mt	-
Amical	5540	115	740	***	6441	86	-1009	000	4430	109	384	**	5470	101	38	
Mădălin	5000	104	200	***	8463	114	1013	***	4559	113	513	**	6007	111	575	***
Sistem	6320	132	1520	***	7756	104	306	***	5067	125	1021	***	6381	117	949	***
Cardinal	5446	113	646	***	6805	91	-645	000	4800	119	754	***	5684	105	252	**
Univers	4853	101	53		7438	100	12		4357	108	311	*	5549	102	117	*
Andreea	6233	130	1433	***	6324	85	-1126	000	5448	135	1402	***	6002	110	570	***
DL 5%	57 kg/ha				104 kg/ha				270 kg/ha				108 kg/ha			
DL 1%	80 kg/ha				146 kg/ha				379 kg/ha				164 kg/ha			
DL0,1%	112 kg/ha				206 kg/ha				535 kg/ha				264 kg/ha			

Analyzing the productions for the three years shows that the productions realised during the agricultural year 2008-2009 were the highest compared with the agricultural years 2007-2008 and 2009-2010. The productions that were made this year ranged from 6324 kg/ha at Andreea variety and 8463 kg/ha at Mădălin FD variety *(Table 2).*

In crop year 2007-2008, the yields achieved ranged from 4800 kg / ha (Dana variety) and 6320 kg / ha (variety Sistem). Compared with the reference variety, production increases ranged from 1-32%. The largest production increases were made to variants sown varieties: Sistem - 32% (1520 kg / ha), Andreea - 30% (1433 kg / ha), 15% Amical (740 kg / ha) and Cardinal - 13 % (646 kg / ha) *(Table 2).*

Compared with the reference variety, Dana, in the agricultural year 2008-2009, we obtained very significant production gains in two varieties: Mădălin FD - 14% (1013 kg / ha) Sistem - 4% (306 kg / ha). Three of the varieties, production differences were highly significant negative (Friendly - 1009 kg / ha, Cardinal FD - 645 kg / ha and Andreea - 1126 kg / ha) and the variety Univers, the difference in production was insignificant (12 kg / ha) *(Table 2).*

In crop year 2009-2010, spring weather conditions favored the installation of the pathogen agents (*Erysiphe graminis f.sp. hordei, Pyrenophora graminea, Pyrenophora teres, Puccinia hordei*) and the rainfall in the last decade of June, had negatively influenced the evolution of barley crops and contributed to the quantitative (by shaking the seeds in the ear) and qualitative depreciation of barley production.

Thus, the yields achieved in winter barley were very low, ranged from 4046 kg / ha (Dana variety) and 5448 kg / ha (Andreea variety). Compared with the reference variety, Dana, three options have made very significant increases of production, namely, varieties: Andreea - 35% (1402 kg / ha) Sistem - 25% (1021 kg/ha) and Cardinal FD - 19% (754 kg/ha). Significant differences were obtained separate production of varieties Mădălin FD- 13% (513 kg/ha) and Amical- 9% (384 kg/ha). The variety Univers - 8% (311 kg/ha), the difference in production was significant *(Table 2).*

Averaged over the three years of testing, the highest production was recorded at Sistem variety (6381 kg / ha), followed by Mădălin variety (6007) and Andreea variety (6002 kg / ha). The lower production was achieved by reference variety Dana (5432 kg / ha). Compared with the reference variety, very significant production differences were obtained for varieties Sistem - 17% (949 kg / ha), Mădălin - 11% (575 kg / ha) and Andreea - 10% (570 kg / ha). At the Cardinal variety were obtained significant production differences and at the Univers variety (117 kg/ha) the output gap was significant *(Table 2).*

Making a comparison between the order of clasification, according to

the average production achieved during the three years of testing, it appears that the first three places are occupied by the romanian barley varieties: Sistem (6381 kg/ha), Mădălin (6007 kg/ha) and Andreea (6002 kg/ha) *(Fig. 3)*.

The resistance to the abiotic and biotic stress factors varies from year to year and it depending on variety. On average over the three years, the winter barley varieties tested, showed good resistance to lodging, excepting the Univers variety which presented an average resistance *(Table 3, Fig. 4)*.

In terms of the resistance to the brown rust, all the seven varieties examined showed a good resistance to this pathogen agent (*Fig. 5*).

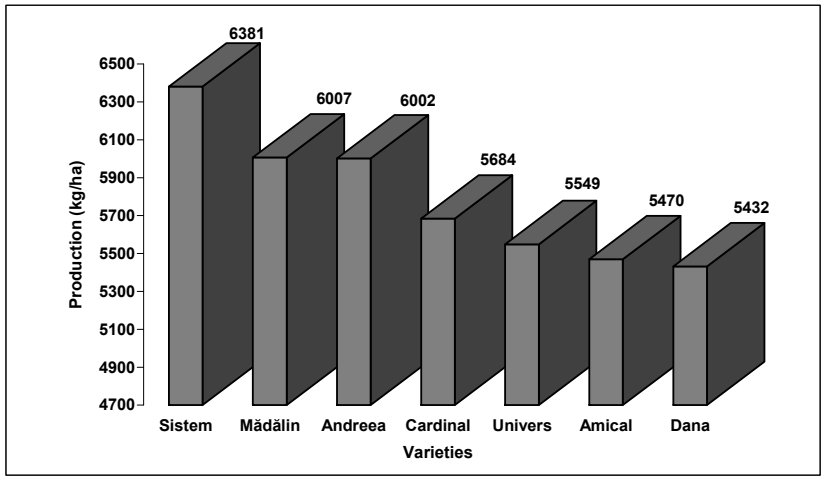

Figure 3 – Classification of varieties by production capacity

Table 3 - The resistance to the biotic and abiotic stress factors

No.	Variety	Lodging resistance			Average 2008-2010	Brown rust resistance			Average 2008 - 2010
		2008	2009	2010		2008	2009	2010	
1	Dana	3	1	1	2	1	1	3	2
2	Amical	1	1	3	2	1	1	3	2
3	Mădălin FD	7	1	1	3	3	1	1	2
4	Sistem	3	1	3	2	3	1	1	2
5	Cardinal FD	5	1	3	3	3	1	1	2
6	Univers	9	3	3	5	3	1	1	2
7	Andreea	5	1	3	3	3	1	1	2

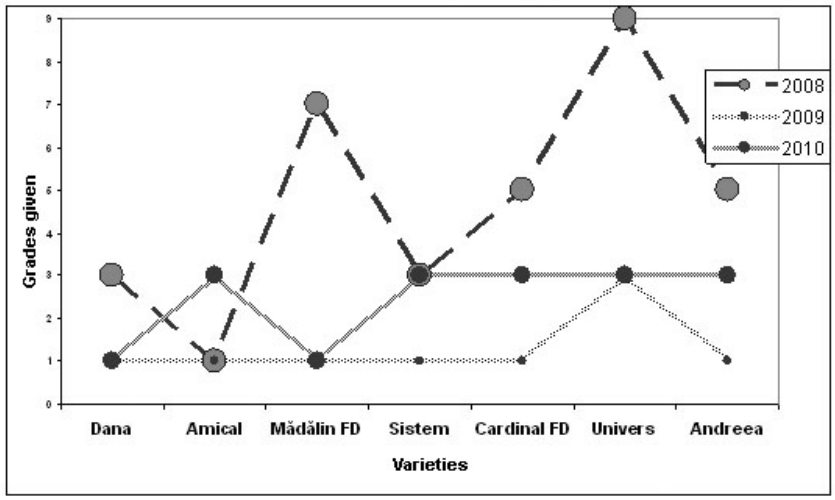

Figure 4 - Lodging resistance of barley varieties tested in ARDS Secuieni-Neamț

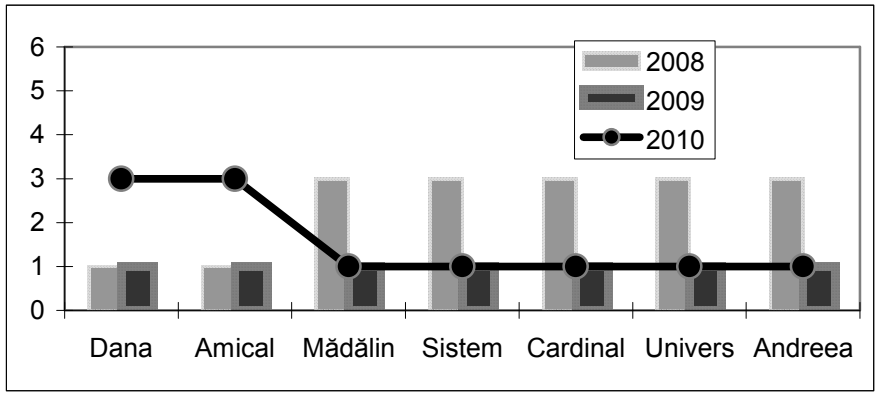

Figure 5 - Resistance to brown rust of barley varieties tested in ARDS Secuieni-Neamț

CONCLUSIONS

The average density per square meter of ears barley ranged from 525 – 752 samples/sqm.

The average number of grains in the ear ranged from 23 – 29 and the MMB was between 42 g and 46 g.

The average yeld of tested barley varieties ranged between 5432 kg/ha (Dana) and 6381 kg/ha (Sistem).

The highest yelds were obtained from the varieties Sistem, Mădălin and Andreea which are recommended to be grown in the central area of Moldavia.

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