THE BEHAVIOUR OF SOME SPRING BARLEY GENOTYPES *(HORDEUM VULGARE)* UNDER CONDITIONS OF IMPOSED DROUGHT

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Abstract. The climatic data of the last years presents a significant growth of temperatures even in the cultivation areas of two-rowed spring barley. These intervals of drought appear especially in the period of grain formation and filling, bearing a negative impact on production, both from the qualitative and quantitative points of view. Thus, in order to simulate the drought phenomenon, the method proposed by Blum (1983), cited by Elena Petcu and colab., (2014), was used. This method consists in treating the plants with desiccants (e.g. Sodium chlorate) in a 2% concentration, 14 days after the anthesis. Thus, the cultivars that manage to translocate a greater quantity of reserve carbohydrates from the vegetative organs towards the grains, present a better stability of grain weight under conditions of hydric stress.

Keywords: breeding, drought tolerance, *Hordeum vulgare*

INTRODUCTION

Barley is cultivated both in countries with advanced agriculture, the agricultural systems of which are highly productive, and in developing countries, where subsistence agriculture is practiced. Globally, the cultivation of barley is widely spread, its economic importance considerable in what alcohol production and animal fodder are concerned (Newton and colab., 2011). In comparison to wheat, barley displays better capacity to adapt to unfavourable environment conditions and exhibits far greater tolerance to environmental factors (Nevo and colab., 2012). Drought tolerance makes this species enjoy popularity in areas with reduced precipitation. In general, it is cultivated in the semi-arid regions of northern Africa, in the Middle and Near East, in South Asia, in the Russian Federation, East Asia, Europe, Australia and the Andean states (Tiwari, 2010).

Global warming, lessening of water resources for irrigations, demographic increase and intense desertification are just a few of the reasons that have led to new visions when breeding programmes are approached. The fairly brisk pace of multiannual temperatures' increase raises question marks over the new cultivars' adaptability to these changes.

Thus, in the breeding programme for two-row spring barley in Turda, a new strategy is required, too, its aim being to increase the new cultivars' resistance to drought. For the beginning, we proposed to ourselves the identification of some possible cultivars from the germplasm collection that would present a certain resistance to this factor of abiotic stress. A next stage would be the enrichment of the collection with new entries recognised as resistant to drought, which, after being tested in the agro-ecological conditions in Turda, will probably enter the hybridization programs. Another objective which is in trend with the new breeding methods would be the applications of biotechnologies through marker-assisted selection.

MATERIALS AND METHOD

All these problems will be approached step by step. Thus, a beginning phase would be the evaluation of the local germplasm from the point of view of its resistance to drought. A method proposed for the realisation of this stage is the use of the so-called methodology of inducing drought with the help of some chemical desiccants ($NaClO_3$), a method proposed by Blum (1983), used in our country by Elena Petcu (2014) for autumn barley. Similar studies were realised at SCDA Turda on a species related to barley, namely wheat (Cazacu Camelia, 2015). According to this protocol's method, the treatment with desiccant is applied in concentration of 2%, fourteen days after the anthesis. It is considered that after this phenophase, the process of grain formation and grain fill starts. In this paper we will present the behaviour of 35 genotypes from the germplasm collection, which were evaluated in the agro-ecological conditions in Turda in 2017. These were sown in rows 1 metre long, four rows allocated to each genotype, two treated and two untreated.

RESULTS AND DISCUSSIONS

The genotypes that constituted the object of this study were analysed through the prism of some components of production which we considered to be the most significantly affected by the effects of the drought which occurs in the phenophases after the heading. Thus, the variability parameters for grain mass/ear, grain number/ear and tkw were analysed.

If a comparison is made between the data presented in table 1, it can be observed that the most affected productive component of the ear is grain weight. The negative effects of drought in the formation of production and evidently in the formation of its components are reflected in the 0.23g/ear difference between the grain weight averages of treated and untreated plants. These significant differences seem to be blurred by the much more reduced differences between the maximum values of the two methods, only 0.14g. Another term of comparison which reflects the effect of drought is the difference between the minimum values: in the case of the untreated plants, the minimum value reaches the threshold of 1.28g/ear, while in the case of the treated variants it drops to 0.92 g/ear. Another important aspect that has to be taken into consideration is the modification of the relative value of the C.V. between the two culture conditions.

The intervention of a disturbing factor in the expression of genetic value obviously increases the interaction between the genotype and the environment, through increasing the fluctuations of phenotype expression. Comparing the coefficient of variation values of the grain weight corresponding to the two conditions, the significant growth of what can be remarked, as an effect of induced drought. All these come to demonstrate the genotypes' different reactions to the effects of drought. As it can be observed from the data presented in (Tab. 1), induced drought has a lesser effect on grain number/ear. Minor differentiations are registered by the CV values, 6% for treated plants and 7% for untreated variants. Grain number average is equal for both experimental factors (treated and untreated), namely 28.

As a consequence, we may affirm that the effects of drought which appears after anthesis do not sensibly affect grain number/ear. We mention that other biometric measurements regarding plant height and ear length were also conducted, but there were no differentiations registered between the two factors, in consequence, we considered that they do not need to be presented.

Table. 1.
String of variation analysis for grain weight and grain number corresponding to the two experimental factors (Turda 2017)

	Grain weight/ear			Grain number/ear		
	Untreated	Treated	Mean	Untreated	Treated	Mean
Count	35	35	35	35	35	35
Range	0.44	0.66	0.55	6.89	7.72	4.08
Mean	1.51	1.28	1.4	28	28	28
Minimum	1.28	0.92	1.1	24	24	24
Maximum	1.72	1.58	1.65	31	31	31
Sample variance	0.01	0.02	0.02	3.27	3.90	3.59
Coefficient of variation s (%)	8	12	10	6	7	7
Standard deviation	0.12	0.16	0.14	1.81	1.98	1.9
Standard Error	0.02	0.03	0.03	0.31	0.33	0.32

Thousand kernel weight (TKW) is a direct parameter for grain weight and an indirect one for grain size. The differences between the two averages quite faithfully reflect the genotypes' response to the interaction with the stress factor. A more pronounced difference between the minimal and maximal values can be observed on the level of the variants treated, a fact that can also be deduced from the superior values of the C.V., 11%. All these assertions come to underline the genotypes' varied response in the context of the behaviour under induced drought. Hence, choosing those variants which registered smaller losses of grain weight and size would be of much interest.

Table. 2.
String of variation analysis for the TKW corresponding to the two experimental factors (Turda 2017)

TKW			
	N	T	Mean
Count	35	35	35
Range	13.22	20.20	16.62
Mean	53.88	45.42	49.65
Minimum	46.66	36.44	41.55
Maximum	59.88	56.46	58.17
Sample variance	10.33	23.18	16.76
Coefficient of variation s(%)	6	11	9
Standard deviation	3.21	4.81	4.01
Standard Error	0.54	0.81	0.68

From the multitude of methods used for the assessment of production and its elements' stability, for this study we employed the one proposed by Francis and Kannenberg (1978), which is based on the value of the coefficient of variation (C.V.). In figure 1, the distribution of the genotypes according to grain weight/ear and the value of the coefficients of variation is presented. According to the method proposed by Francis and Kannenberg, the most stable genotypes are those in section I, their values under the C.V. average and above the grain weight/ear average. We notice that in the upper part of this section, only genotypes that were not treated with desiccant are positioned.

Still, the genotypes Bogdana (G9), Prima (G6), Scarlet (G18) and Victoriana (G15) can be highlighted, as even under conditions of induced drought, they have values under the C.V. average from both conditions, with grain weight/ear values close to the average from the normal conditions and above the average from the stress conditions. The stability of these cultivars is good under normal conditions, too (the C.V. value is inferior to the average) and grain weight/ear value is above the 1.51g average. An example of a typical reaction to stress conditions is represented by the Adina (G8) genotype, which, although under normal conditions has one of the most reduced C.V. values, under stress conditions it registers a significant fluctuation of values around the average, this being mirrored in the C.V., which reaches a relative value of 22%. Although this cultivar is placed at a considerable distance and in adjoining, not opposed, sections, it suggests that this has a high potential in the realisation of grain weight/ear, having, under stress conditions, the biggest values of this trait, above the average of the untreated variants.

The Adina, Bogdana and Prima genotypes are creations of S.C.D.A. Suceava. They are tall cultivars which are quite sensitive to lodging, but their growth rhythm is very intense and their robustness is a highlight. The lodging phenomenon appears only as a consequence of strong storms and nitrogen-rich agro-funds. Also, the Adina cultivar is a few days more precocious than the majority of the genotypes analysed, and the physiological maturity installs earlier in comparison with other variants the heading date of which was written down during the same period. All these suggest the intense biorhythm of this cultivar, an important prerequisite for the adaptation to the drought appearing in postanthesis.

The variants placed in section IV have a promising stability, but a reduced potential for the realisation of grain weight/ear. Section III incorporates the genotypes which register superior values of the C.V., above the averages of the experience from both the situations, having modest values of grain weight/ear. Reconsidering the stability of the new cultivars in the conditions of climatic change does not mean giving up on certain genotypes with superior productivity but with reduced stability. In this idea cand be remarked the varieties placed in section II, which have a superior potential of grain weight/ear, but have a considerable fluctuation of the values around the average. The coefficient of repeatability is an indirect parameter of heritability. The high annual repeatability of a string of measurements performed on a quantitative trait also suggests, with quite pronounced fidelity, the heredity of that trait. The very significant values of the correlation coefficient (r=0,61***) between the grain weight/ear from treated and untreated suggests the important implication of the genotype in the control of this important trait.

In section IV, the genotypes which realise the highest values of grain weight/ear from both situations are grouped. The forms placed in section I have narrower fluctuation of this trait in the two systems, as they are under the average of the grain weight/ear from untreated, but above the one from treated. The distribution of the cultivars in section II corresponds to those with grain weight under the average in both situations. The genotypes' distribution in section III belongs to the most instable genotypes, which under normal conditions have values above average, and in drought conditions register values under the average. Identifying genotypes such as the ones in section IV enable the breeder to choose the most valuable genitors, which react favourably under drought conditions, too. Thus, harvest losses or the loss of some of its components, such as grain weight/ear as a consequence of abiotic stress can be diminished as much as that is possible.

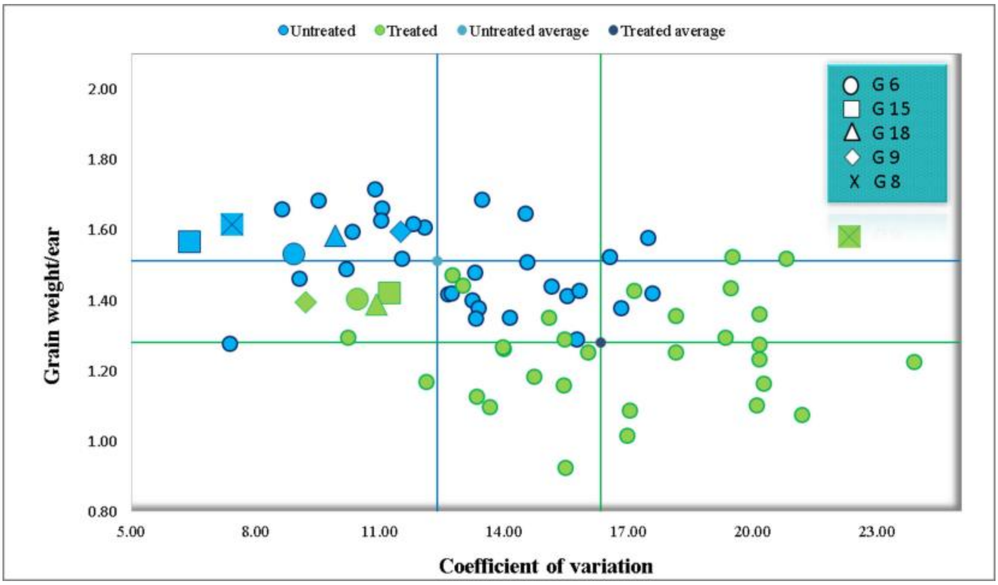

Figure 1. The stability of the genotypes analysed depending on the coefficient of variation and the grain weight/ear

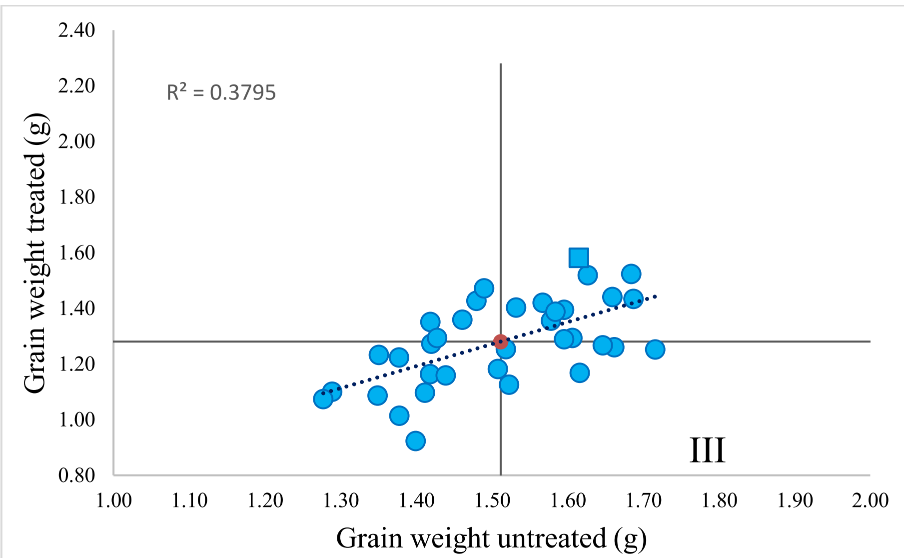

Figure 2. The coefficient of repeatability of grain weight/ear for treated and untreated

The effect of a stress factor is automatically found in the formation of production, influencing the physiological processes and, in the end, some constituents of production. These assertions are deducted from the significance of the F test for the treatment factor in the influence upon grain weight/ear. A major participation in the way this direct component of production manifests itself is that of the biological factor, which strengthens the previous assertions, namely that a source of variation for the grain weight/ear exists between the analysed genotypes. Sure enough, double interaction is very significant, too, in the way the reaction of the genotypes to the desiccant manifests.

Table 3.

The analysis of variation for the average grain weight of 35 two-row barley genotypes in a bifactorial experimental system (Turda 2017)

Source of variance	SPA	GL	s^2	Proba F
Treatements(T)	2,37	1	2,37	388,63***
Genotypes (G)	3,08	34	0,09	9,90***
T x G	0,84	34	0,03	2,70***
Error (T)	0,01	2	0,01	
Error (G)	1,24	136	0,01	
Total	7,54	207		

Table. 4.

The influence of the treatment factor upon the average grain weight of 35 genotypes of two-row barley studied

Variant	Grain weight	%	Difference	Significance
Untreated	1,51	100,0	0,00	Mt.
Treated	1,30	85,9	-0,21	00

DL (p 5%) 0,05
DL (p 1%) 0,11
DL (p 0.1%) 0,34

Table. 5.

The influence of genotype x treatement interaction for thr average grain weight at the studied genotypes

Cultivar	Grain weight	%	Difference	Significance
UNTREATED				
DACIANA	1,72	113,5	0,20	**
ROMANIȚA	1,69	111,8	0,18	*
FARMEC	1,29	85,3	-0,22	00
MARTHE	1,28	84,4	-0,24	00
CONCERTO	1,69	111,5	0,17	*
ARUPO	1,35	89,3	-0,16	0
STN 803	1,35	89,3	-0,16	0
TREATED				
CAPRIANA	1,02	78,2	-0,28	000
FARMEC	1,10	84,6	-0,20	0
ADINA	1,58	121,8	0,28	***
SIDNEY	0,92	71,0	-0,38	000
MARTHE	1,07	82,6	-0,23	00
BELGRAVIA	1,54	118,2	0,24	**
OUVERTURE	1,53	118,2	0,24	**
CONCERTO	1,46	112,1	0,16	*
ADELE	1,13	86,7	-0,17	0
KERVANA	1,52	116,9	0,22	**

DL (p 5%) 0,15
DL (p 1%) 0,20
DL (p 0.1%) 0,26

On a first analysis it could be affirmed that the weight losses between the two methods, even if they are not distinctively and significantly negative, do not seem to be very important. Perhaps the quite alert growth rhythm of two-row spring barley causes its metabolism to intensify under conditions of hydric stress, which enables loss reduction. (Tab 4).

In table 5, none of the genotypes we previously mentioned can be found, thus strenghtening the assertions with regard to the stability of those cultivars in what their grain weight/ear is concerned, even if they do not excel in this respect. These are probably extensive-type genotypes, but with a favourable reaction to the drought survened after the inspicat. An exception to these remarks is made by the Adina genotype, which in the conditions of the applying of the treatment, realises the biggests sporuri of this important productive component. Adina is quite a recent soi and it is characterised by medium productions in the conditions in Turda, above the other creations from Suceava, being an intensive soi.

What ensues is that all this reasearch to be extended and probably the germplas source from Turda to be improved with drought-tolerant forms.

CONCLUSIONS

An interesting aspect, that has to be neaparat remarked, is the high adaptability of autochthonous germplasm, in comparison with the straina one, to the effects of drought appearing in the grain formation and grain filling period. Thus, we recommend all farmers to cultivate only soiuri inscrise in th Official List of soiuri from Romania, because the apparision of some periods of droguth in these phenophases can affect seriously the production, if they cultivate soiuri which have not been tested in our country. The climatic differences between Romania and other countries that cultivate orzoaica from U.E. are important, thus, the soiuri obtained in our country it would be possible that they are better adapted to the pedoclimatic condicions.

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