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Sowing Season-Year Important Link in Maize Cultivation Technology

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Abstract

Every year, breeders create a small number of new varieties, which are cultivated, depending on the needs of each country and the existing environmental conditions. Plant genetic resources are represented by any type of reproductive or vegetative propagation of cultivated or newly created varieties, being used by farmers over time for their own needs and for animal feed. The use of an initial material with great variability, knowledge of the traits, the correct choice of parents, the use of the best breeding methods and carrying out a scientific selection, are primary factors in obtaining new, productive, and superior quality genotypes. A number of 185 genotypes were chosen from the spring barley germplasm collection of ARDS (Agricultural Research and Development Station) Turda, for the biometry. Part of the considerations underlying the choice of this material were the appreciation of some morphological and production traits, of the lines created at Turda and of the older varieties in relation to the new creations. The main agronomic traits of the production that were analyzed are represented by: TKW (thousand kernel weight) ear length, number of grains/ear and grains weight/ear. Experimental data processing was carried out with the ANOVA program.

Keywords: genetic resource, grains weight, number of grains, pring barley, TKW.

1. Introduction

Barley (*Hordeum vulgare* L.) is one of the oldest cereals in the world and is used in the malting and brewing industry, for animal feed and human consumption due to its many uses, for example as hulled grain for soup, bread, biscuits, muffins, pasta, breakfast cereals [8].

Germplasm can take different forms, either in the form of a single gene or a group of genes or it can exist in the form of seeds, shoots, or cuttings, taken from plants, trees, sections of leaf, root or stem. Everything is part of what we call germplasm.

Plant genetic resources helped establish agrosystems and provided material for modern scientific breeding. It is alarming that in the last 100 years there has been a drastic decrease in the variability used [4]. In general, a core collection can be defined as a set with a minimum number of entries (the limited genetic diversity of a cultivated plant species and its wild relatives) in a small number of repetitions [6]. Also, it is very difficult to maintain at the level of a single breeding program the existing variability of a species, it must use only that portion of the variability that is useful for that program.

The main goal of a germplasm collection is to use the useful part of this variability as effectively as possible, in order to obtain new varieties with high productivity and good stability of productions from one year to another [7]. In order to achieve this goal, it is necessary to periodically evaluate the existing genotypes in the collection from the point of view of the traits of interest. It is particularly necessary to analyze the new entries in order to make the best decisions regarding their ability to adapt to the new pedo-climatic conditions.

Globally, total collections of plant genetic resources amount up to 2.5 million accessions, of which over 1.2 million (48%) are cereals, 369,000 (14.7%) food legumes, 215,000 (86%) grasses fodder and legumes, 137,000 (5.5%) legumes, 174,000 (3%) root and tuber clones. Among cereals, wheat ranks first with 410,000 entries, followed by barley (280,000), rice (215,000) and maize (100,000) [4].

Every year, breeders create a small number of new varieties, which are cultivated, depending on the needs of each country and the existing environmental conditions. Plant genetic resources are represented by any type of reproductive or vegetative propagation of cultivated or newly created varieties, being used by farmers over time for their own needs and for animal feed [1].

Falconer (1967) states that the main problem that arises and needs to be discussed relates to adaptation to local conditions [5]. The existence of genotype-environment interactions may mean that the best genotype in one environment is not the best in another.

Crăciun and Mureșan (1966) recommend a period of at least three normal years for the research of the initial work improvement material. Based on this study, the researcher can characterize the genotypes that perform best under specific conditions as well as their relative value according to the objectives of the breeding program [3].

At the same time, negative traits for the area of interest of the breeding program can be highlighted in some valuable varieties.

The use of an initial material with great variability, knowledge of the traits, the correct choice of parents, the use of the best breeding methods and carrying out a scientific selection, are primary factors in obtaining new, productive, and superior quality genotypes.

Knowledge of correlated traits is important in selection work because it is important to know how improvement in one trait will produce simultaneous changes in other traits [5]. In this sense, we aimed to identify favorable correlations according to the objectives of the breeding program and to help us in the selection of possible valuable parents.

2. Material and Method

A number of 185 genotypes were chosen from the spring barley germplasm collection of ARDS (Agricultural Research and Development Station) Turda, for biometry. Part of the considerations underlying the choice of this material were the appreciation of some morphological and production traits, of the lines created at Turda and of the older varieties in relation to the new creations.

Sowing of the collection field was done by hand; each genotype being sown in five rows of 1 meter length. All these genotypes were phenotypically compared with a control represented by the Romanita genotype, ARDS Turda brand, placed from 20 to 20 variants.

In the two experimental years, 2016 and 2017, the sowing of the collection field took place on 22.03 and 18.03, respectively. The emergence was noted on 5.04 in 2016 and 29.03 in 2017. The rotation used was three years: maize-peas-spring barley, the fertilization was a moderate one taking into account the chemical properties of the soil and the recommendations regarding the fertilization of spring barley; thus, the same doses and types of mineral fertilizers were applied, in spring in a single round with 60 kg N a.i./ha.

The main agronomic traits of the production that were analyzed are represented by: TKW (thousand kernel weight) ear length, number of grains/ear and grains weight/ear. Experimental data processing was carried out with the ANOVA program.

The Transylvanian Plateau, in general and the research station area in particular, from the thermal point of view are very favorable or favorable areas for spring barley crop. Table 1 shows the evolution of temperatures during the spring barley vegetation period, but also in the winter months, which have an influence on the start date of sowing. In both experimental years, February and March were warm, registering important positive deviations from the multiannual average.

In June the process of forming and filling the grains begins, which can be negatively influenced by heat during this period. During this period, in both experimental years, there were positive deviations from the multiannual average. Consequently, it can be stated that from the point of view of temperatures considered as a single factor, the two years were favorable.

Table 1. Thermal regime of the experimental years 2016, 2017 (Turda meteorological station (longitude23° 47′′; latitude: 46°35′; altitude: 427m)

Month	Jan.	Feb.	Mar.	Apr.	May	June	July
Monthly average	-2.8	4.6	5.9	12.4	14.3	19.8	20.5
59 years average	-3.4	-0.8	4.5	9.9	15.0	17.8	19.7
Deviation	+0.6	+5.4	+1.4	+2.5	-0.7	+2.0	+0.8
Characterization	normal	Very hot	warm	hot	normal	hot	normal
2017							
Monthly average	-6.7	1.5	8.4	9.9	15.7	20.7	20.3
60 years average	-3.4	-0.9	4.7	9.9	15.0	17.9	19.7
Deviation	-3.3	+2.4	+3.7	0.0	+0.7	+2.8	+0.6
Characterization	cold	hot	hot	normal	normal	hot	normal

Primary data source: Turda meteorological station (longitude23� 47′′; latitude: 46°35′; altitude: 427m)

The data on the precipitation regime of the two experimental years (Table 2) indicate that compared to the multiannual average, in both experimental years, excess precipitation was recorded, except for June 2017 when the precipitation was deficient, the deficit being approximately 50 mm compared to the multiannual average.

Table 2. Precipitation regime of the experimental years 2016, 2017 (Turda meteorological station (longitude23° 47′′; latitude: 46°35′; altitude: 427m)

Month	Jan.	Feb.	Mar.	Apr.	May	June	July
Monthly amount	25.0	23.8	47.0	62.2	90.4	123.2	124.9
59 years average	20.8	18.4	19.3	44.4	67.1	83.4	72.9
Deviation	+4.2	+5.4	+27.7	+17.8	+23.3	+39.8	+52.0
Characterization	a little rainy	Rainy	excessively rainy	very rainy	very rainy	very rainy	excessivel y rainy
2017							
Monthly amount	2.6	19.2	46.1	65.2	65.4	30.6	110.2
60 years average	21.8	18.8	23.6	45.9	68.7	84.8	77.1
Deviation	-19.2	+0.4	+25.5	+19.3	-3.3	-54.2	+33.1
Characterization	excessively dry	normal	excessively rainy	very rainy	normal	excessively dry	very rainy

One of the rainiest years in the last 59 years was 2016, with positive deviations in all months from emergence to physiological maturity compared from the multiannual average.

Even if in 2016, excess precipitation was recorded, their distribution in the Turda area in relation to the critical water phenophases of the spring barley was quite deficient. Another important aspect, which must be mentioned, is the fact that these precipitations had a torrential nature, which led to the pooling of water. This phenomenon, even if it was quite limited in duration (1-3 days), intervening most of the time in the more advanced phases of vegetation, had a negative impact on yield and its component elements.

In 2017, during the entire vegetation period of spring barley, from emergence to physiological maturity, precipitation above the multiannual average was recorded, except for June. This coincides with the phenophase in which the process of grains formation of straw cereals is most affected by the lack of precipitation.

The more even distribution of these lower amounts of rainfall in June, combined with slightly higher temperatures in May and sufficient rainfall, made the plants much more tolerant of these negative effects.

3. Results and Discussions

The presentation in graphic form was also used for the purpose of identifying valuable parental genotypes in which the correlated traits exhibit useful values.

For the traits determined in both experimental years, the regressions are shown on the graph, in order to be able to make an easier comparison of the existing relationships between the traits in both different climatic years.

Relationship between TKW and grain weight/ear. According to the data presented in Fig. 1, it seems that there is a direct relationship between the thousand kernel weight and the grain weight/ear, the influence of the environment in the phenotypic expression of these two characteristics is evident, being reflected in the extremely low overlap of the groups of points from the two experimental years. Practically in the year 2016, the TKW values slightly exceed the threshold of 50 g, compared to the year 2017, when this value constitutes the lower limit of the TKW. The "R2" coefficients of determination values of 0.30 and 0.15 show that between 15 and 30% of the cases, the change in grain weight/ear is due to the change in TKW.

These values, together with those of the correlation coefficients, indicate the existence of a strong link between the two traits, so that the selection for a high TKW implicitly also leads to the improvement of the other production traits, namely grain weight/ear. Close values regarding the correlation of the two traits (0.303**) were also reported by Carpici and Celik (2012) [2].

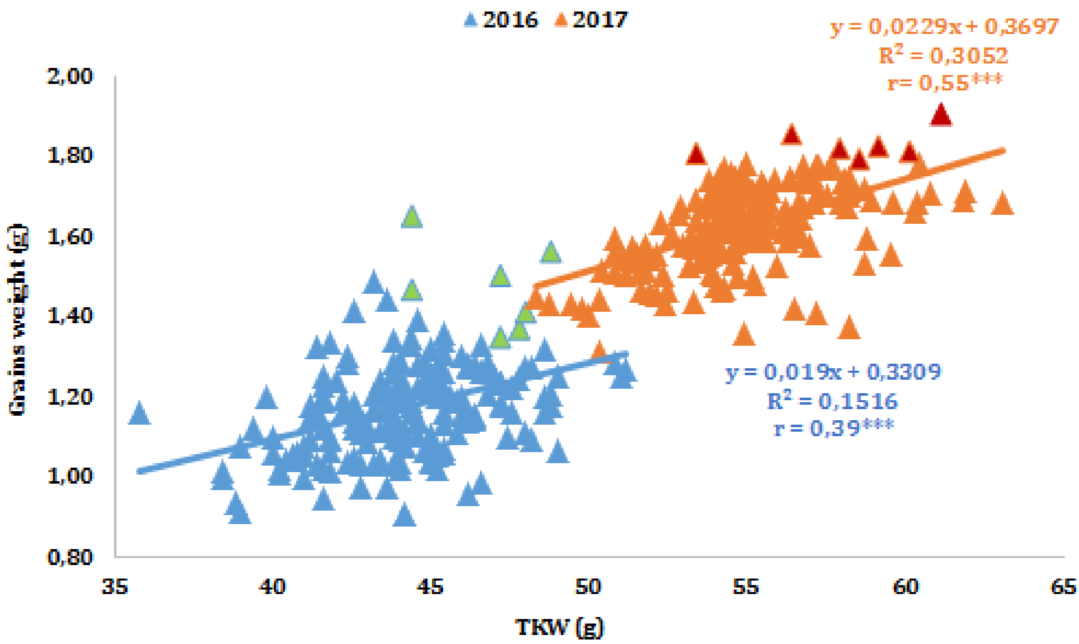

Figure 1. The positive correlation between TKW and grain weight/ear (2016, 2017)

Some valuable genotypes were identified, showing superior values for the two correlated traits (Table 3). There are a number of lines created at Turda with different genealogies (To2117 x Aura, To2034/91 x To2204/94 and To515/90 x Rapid) showing high values of the two traits in 2016. This is due to the superior adaptability of these lines, to variations in environmental conditions in the station area. For the year 2017, the best behavior regarding the association of the two traits can be observed in the case of the To 2220 line, originating from a complex hybridization. In second place is the Concerto cultivar of Limagrain provenance. The fourth place is occupied by the genotype Daciana, created in Turda. These lines will be processed through a hybridization system to improve other traits they present, expressed in a lower degree of favorability, probably constituting future varieties or valuable parents.

Table 3. Identification of valuable genotypes in terms of TKW and grain weight / ear

No. field	Genotype	TKW (g)	Grain weight / ear (g)
	2016		
128	To2034/91 x To2204/94	48,8	1,56
59	Ello	47,8	1,37
131	To2117 x Aura	47,3	1,50
15	Vienna	47,2	1,35
169	To515/90 x Rapid	44,4	1,65
28	Overture	44,4	1,47
142	To1646/79 xTo2346/81 x Marsh	43,2	1,17
	2017		
146	To 2220	61,14	1,90
28	Concerto	60,15	1,81
171	To3487/84 (M11 Ramona)	59,16	1,82
2	Daciana	58,55	1,79
96	Maresi x Turdeana	57,93	1,82
97	Nutans 1181/79 x Turdeana x Turdeana	56,41	1,85
163	Casino x STK 31	53,4	1,81

Relationship between ear length and grain weight/ear. The significance of the correlation coefficients between the two traits indicates the existence of a close association between the two agronomic components of production. The relatively large distance between the regression lines in the two years indicates the important influence of the environment, especially in achieving the grain weight/ear. In both experimental years, the regression lines record approximately the same upward trend, quite accentuated (Fig. 2).

The coefficients of determination in the two years have close values of 0.29 and 0.31, showing that in about 30% of the cases, the variation in grain weight/ear is due to the fluctuation of ear length. Also, the strong similarity between the determination coefficients values (R2) suggests that even at the genotypic level, this correlation is very close. The slope of the regression lines, being described by very close values of the regression coefficients in the two years (b=0.10 and 0.11 respectively), comes and reinforces the previous statements regarding the heritability of these correlations. An increase of 1 cm in the length of the ear can cause increases in the grain weight/ear of 0.1g. In 2012, Carpici and Celik also report significantly positive values of the correlation coefficient between the two traits (0.736**), a value quite close to those obtained in our study [2].

It is noteworthy that the line Casino x STK31, which in both experimental years presents high values of the two traits (Table 4). This indicates a good stability of these lines at the genetic level, regarding the two traits, which recommends it as a valuable parent for these traits' improvement.

The lines To2117 x Aura and To 2034/91 x To 2204/94 should also be highlighted, because in 2016 achieved higher values of the two correlated traits. These two lines also stood out in terms of TKW and grain weight/ear in the same year. Therefore, these two genotypes have a favorable reaction in terms of the three traits (ear length, TKW and grain weight/ear) in less favorable environmental conditions. Therefore, the two lines can be included in a hybridization program for the intensification of these traits and not only, or for the improvement of some other genotypes, in which the phenotypic expression of these traits is not expressively manifested in less favorable conditions. The Maresi x Turdeana, Nutans 1181/79 x Turdeana x Turdeana, To 2220 and Daciana genotypes are noticed again in 2017 and regarding these associations.

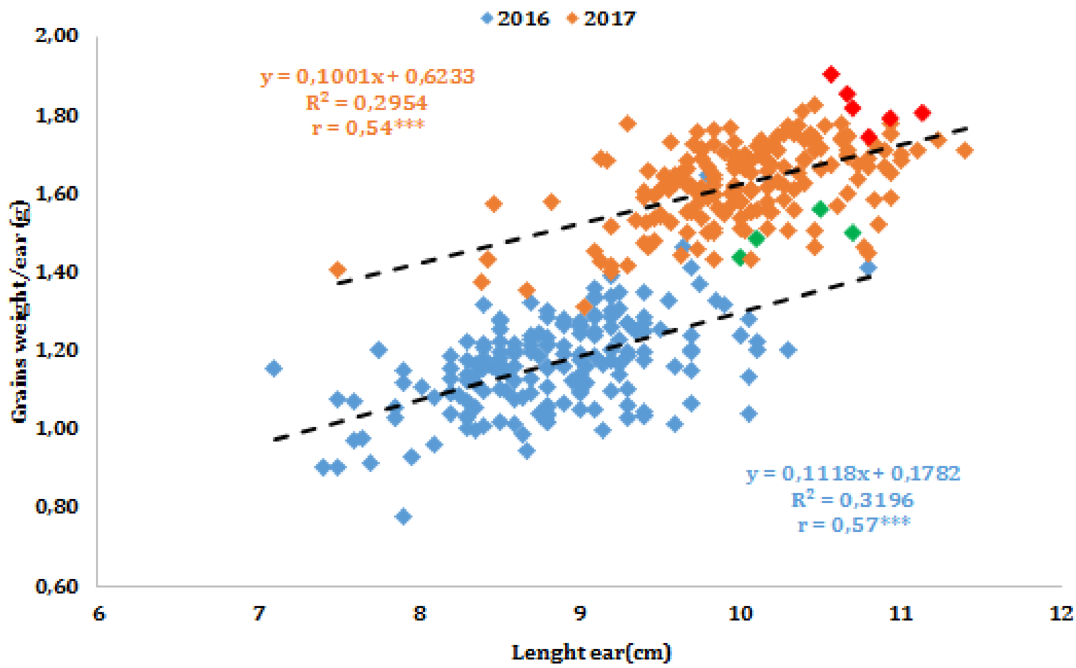

Figure 2. The positive correlation between ear length and grain weight/ear (2016, 2017)

Table 4. Identification of valuable genotypes in terms of length ear and grain weight / ear

No. Field	Genotype	Length ear (cm)	Grain weight / ear (g)
2016			
3	Capriana	10,77	1,46
131	To2117 x Aura	10,70	1,50
128	To 2034/91 x To 2204/94	10,50	1,56
166	Casino x STK 31	10,10	1,49
32	Salome	10,05	1,28
2017			
163	Casino x STK31	11,13	1,81
2	Daciana	10,93	1,79
54	SGS – 263	10,80	1,74
96	Maresi x Turdeana	10,70	1,82
97	Nutans 1181/79 x Turdeana x Turdeana	10,67	1,85
146	To 2220	10,57	1,90

The relationship between the number of grains/ear and grain weight/ear. The association between two other agronomic components of production, namely the number of grains/ear and the grain weight/ear is presented in Fig. 3. As in the previous situation, the almost perfect parallelism of the regression lines and the considerable distance between them, is mainly due to the variation of the grain weight/ear in the two years. The close clustering of points around the regression lines suggests that there is a fairly stable relationship between the two variables. In fact, the degree of association between the two traits is also reflected in the higher values of the correlation and determination coefficients. The pronounced stability of this regression, regarding the lower involvement of the environment in its manifestation, is also indicated by the almost identical values of the regression coefficients in the two years of b = 0.043 (2016) and 0.047 (2017).

Carpici and Celik (2012) also present positive values of the regression coefficient between the number of grains/ear and the weight of the grains, but insignificant (0.107) [2]. The superior performances of the two production elements are again identified in 2016 in the genotypes Casino x STK31, To 2034/91 x To 2204/94 and To2117 x Aura. These results allowed the formulation of a practical recommendation, regarding future breeding works and the use of these lines as valuable parents to improve the adaptability and stability of these important agronomic traits represented by TKW, grain weight/ear, ear length and number of grains/ear (Table5).

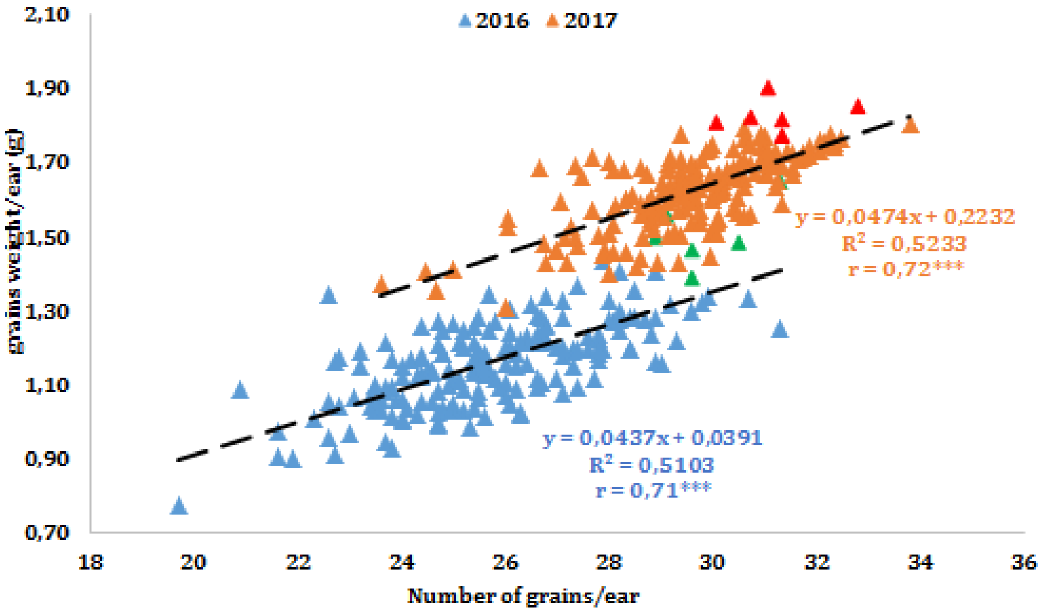

Figure 3. The positive correlation between the number of grains/ear and grain weight/ear

Table 5. Identification of valuable genotypes in terms of number of grains/ear and grain weight/ear

No. field	Genotype	No grains/ear	Grain weight / ear (g)
2016			
169	To 515/90 x Rapid	31	1,65
166	Casino x STK31	31	1,49
28	Overture	30	1,47
171	(Sornel x Odeski-10) x Trumpf x Temp	30	1,39
128	To 2034/91 x To 2204/94	29	1,56
131	To2117 x Aura	29	1,50
2017			
97	Nutans 1181/79 x Turdeana x Turdeana	33	1,85
146	To 2220	31	1,90
171	To 3487/84 x (M11 Ramona)	31	1,82
37	Magnif	31	1,77
2	Daciana	31	1,79
28	Concerto	30	1,81

A favorable behavior regarding the manifestation of the two productive components in 2017 can be observed in the case of some genotypes (table 5): To 2220 line is noted again with a number of 31 grains and a grain weight of 1.90g. In second place is also a line that was noted previously, namely Nutans 1181/79 x Turdeana x Turdeana. This line has the highest number of grains/ear, 33 and a weight of 1.85g. Also, the Daciana genotype should be highlighted again. Therefore, the To 2220 line is established as a valuable parent for improving the simultaneous expressiveness of the presented traits. In the same sense, the Nutans 1181/79 x Turdeana x Turdeana and Daciana genotypes can also be considered valuable parents.The behavior of the

Nutans 1181/79 x Turdeana x Turdeana genotype is due to the breeding value of the Turdeana genotype, which in combination with the Nutans 1181/79 line led to obtaining favorable transgressions for these traits.

4. Conclusions

Following this study, a series of recommendations regarding the choice of valuable parents for future hybridization programs, parents that can lead to obtaining favorable transgressions in new cultivars, emerged. Also, in the case of the traits analyzed, it can be observed that by making the selection for a certain trait, another trait can be simultaneously improved.

The lines To2117 x Aura and To 2034/91 x To 2204/94 can be included in a hybridization program for the intensification of TKW and grain weight/ear but also for the improvement of some genotypes, in which the phenotypic expression of these traits is not manifested as much expressive in less favorable conditions.

The line Casino x STK31, which in both experimental years presents high values of the grain weight/ear and ear length can also be included in a hybridization program. In future breeding works the lines Casino x STK31, To 2034/91 x To 2204/94 and To2117 x Aura will be used as valuable sources for the improvement of the genotypes adaptability and stability of the important agronomic traits represented by TKW, grain weight/ear, ear length and number of grains/ear.

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