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Analysis of two-row barley accessions by commercial traits for selection purposes

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Abstract

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The study was conducted during the period 2016-2018 in the experimental field at the Institute of Agriculture in Karnobat, Bulgaria. Eighteen breeding lines of winter two-row barley were studied. The accessions were assessed by basic economic traits. Correlation and multiple linear regression analyseses were applied to establish statistically proven relationships between the main structural elements of yield. As a result from the study and the accessions characteristic made by some economic traits was established a diversity of forms manifesting good combination of traits where line L 4384 was one of the best. Statistically proven correlations were established between spike length, number of grains per spike and grain weight per spike, between number of grains per spike and grain weight per spike, as well as between grain weight per spike and 1000-grain weight. The created regression equation showed that the grain weight per spike depends on the number of grains per spike and 1000-grain weight.

Keywords: two-row barley; economic traits; accession; principal component analysis; correlation analysis

Introduction

Creating high-yielding barley cultivars with good quality characteristics of grain, resistant to biotic and abiotic stress factors is a main objective of modern barley breeding (Gocheva et al., 2011; Valcheva & Vulchev, 2012; Valcheva et al., 2013; Valcheva & Valcheva, 2014; Dimova et al., 2014; Doneva et al., 2014; Dyulgerov & Dyulgerova, 2014). Research on the economic traits of barley accessions are subject of interest to many scientists who aim to discover suitable sources for their breeding programs (Savova et al., 2012; Dyulgerova, 2012; Dyulgerova et al., 2014; Mirosavljevic et al., 2015; Ozturk et al., 2014.). The accessions established as best are directly used in practice or in the breeding process.

The aim of this study is to analyze several economic traits of two-row barley accessions and to determine the possibilities for using them in the breeding program.

Materials and Methods

The study was conducted at the Institute of Agriculture in Karnobat, Bulgaria, in the period 2016-2018. Figures 1 and 2 show the mean monthly temperatures in ^{0}C and the amount of rainfall in mm by months during barley vegetation. The studied period covers three consecutive years, which were meteorologically different. Two of them (2015/2016 and 2017/2018) had greater rainfall during vegetation compared to the amount of rainfall for the multi-year period. The second year was characterized by significantly lower amount of rainfall and during vegetation the amount of rainfall for each month was lower than the monthly norm.

Tests were conducted on 18 lines of winter two-row barley, Bulgarian breeding. Every accession was annually sown on 1 m^2, in 3 replications. During vegetation the accessions were cultivated. 25 spikes in full maturity were

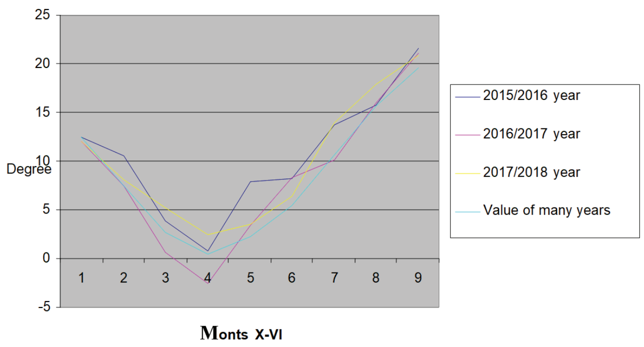

Fig. 1. Mean monthly air temperatures during the vegetation period in years 2016-2018

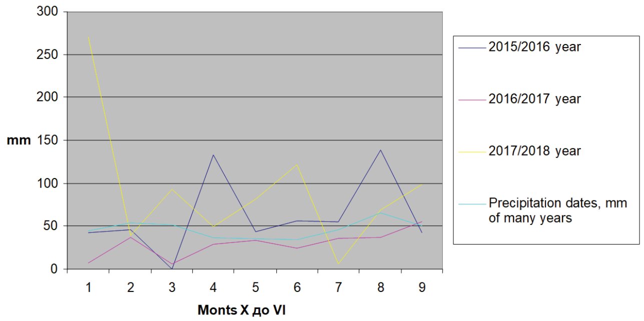

Fig. 2. Amount of rainfall by months for the vegetation period in years 2016-2018

picked from each accession in three replications. Biometry measurements were taken and each of the studied lines was assessed by traits: spike length, number of grains per spike, number of sterile spikelets, grain weight per spike and 1000-grain weight. The data were statistically processed with Fit analysis aided by JMP 5.0 software. The correlations between the tested indexes were assessed by means of correlation analysis. Multiple linear regressions was used to establish the dependency between grain weight per spike (GWP), spike length (SL), number of grains per spike (NGS), number of sterile spikelets (NSS) and 1000-grain weight (1000GW). The data were statistically processed with SPSS 19.0 software.

Results and Discussion

The results from the tested indexes for two-row barley accessions for the period 2016-2018 are presented in Table 1. The data showed that spike length for the tested accessions ranged from 9.2 cm for L 4398 to 12.7 cm for L 4384. For the tested period the average spike length was 10.5 cm. Average for the period 2016-2018, the number of grains per spike was 29.1, and it was highest for L 4384 (34 grains) and lowest for L 4406 and L 4394 – 26 grains. The variability of traits was weak (VC% = 8.17%). The number of sterile spikelets is an index strongly dependent on the year conditions (Dimova et al., 2007), and at the same time it was proven that it also varied according to its systematic affiliation (Vulchev et al., 2009). The number of sterile spikelets in this collection for the studied period was an average of 3.0, and L 4407 had 1.0 less sterile spikelets. The higher number of sterile spikelets (5.0 spikelets) was in L 4378 and L 4406. Total for the group, the variance of this trait was significant and the variation coefficient was 52.25%. Grain weight per spike was also of defining significance for the formation of barley productivity. Average for the period in the group the grain weight per spike ranged from 1.20 g to 1.90 g, with a mean value of 1.57 g. The greatest grain weight per spike was L 4384 (1.90 g). The lowest grain weight per spike was for L 4398, an average of 1.20 g. The 1000-grain weight varied weakly in the studied period (VC% = 9.23%). As a whole, the studied group of accessions was characterized by large grain (54.10 g). The greatest weight average for the period was for L 4407(58.67 g), and the lowest – for L 4398 (42.82 g) (Table 1).

Table 2 shows the information for established phenotype correlations between the studied traits. This study proved a strong positive correlation between spike length and number of grains per spike ($r=0.770^{**}$), as well as between spike length and grain weight per spike ($r=0.678^{**}$). In addition, strong proven correlation was established between number of grains per spike and grain weight per spike ($r=0.782^{**}$) and between grain weight per spike and 1000-grain weight ($r=0.778^{**}$). Similar results were reported by Dimova (2015), Doneva (2016), Gocheva et al. (2017).

In conducting the stepwise multiple regression analysis was assessed the provability and adequacy of the derived model. The results in Table 3 show that the model is statistically significant as the degree of significance expressed in the table is less than 0.05. The model is expressed as:

$$GWP = 45.879 + 0.369\ SL + 37.977\ NGS – 0.379NSS + + 61.5101000GW$$

Positive regression was established between grain weight per spike with number of grain per spike and 1000-grain weight. The obtained result is in line with the results from the correlation analysis.

Table 1. Mean values of the studied indexes for two-row barley accessions in the period 2016-2018

No	Accession	Spike length (cm)	Number of grains per spike	Number of sterile spikelets	Grain weight per spike (g)	1000-grain weight (g)
1.	L 4378	10.4 def	28.0 efg	5.0 a	1.50 de	53.44 cde
2.	L 4380	10.4 def	28.0 efg	3.0 bc	1.60 cd	57.11 abc
3.	L 4384	12.7 a	34.0 a	3.0 bc	1.90 a	55.82 a-e
4.	L 4386	10.3 def	32.0 abc	2.0 cd	1.80 ab	56.18 a-d
5.	L 4396	10.5 cde	31.0 bcd	3.0 bc	1.70 bc	54.82 a-e
6.	L 4399	11.7 b	33.0 ab	3.0 bc	1.90 a	58.07 ab
7.	L 4406	9.7 efg	26.0 g	5.0 a	1.40 e	53.79 b-e
8.	L 4407	10.3 def	29.0 def	1.0 d	1.70 bc	58.67 a
9.	L 4409	10.0 efg	28.0 efg	2.0 cd	1.60 cd	57.25 abc
10.	L 4410	10.4 def	28.0 efg	4.0 ab	1.62 cd	58.19 ab
11.	L 4411	10.0 efg	29.0 def	2.0 cd	1.50 de	51.77 de
12.	L 4393	11.3 bc	29.0 def	2.0 cd	1.70 bc	58.55 a
13.	L 4394	9.6 fg	26.0 g	3.0 bc	1.40 e	53.45 cde
14.	L 4397	10.2 def	27.0 fg	4.0 ab	1.40 e	51.72 e
15.	L 4303	10.9 bcd	29.0 def	2.0 cd	1.50 de	51.68 e
16.	L 4369	9.8 efg	28.0 efg	4.0 ab	1.50 de	53.77 b-e
17.	L 4395	11.5 b	30.0 cde	4.0 ab	1.40 e	46.68 f
18.	L 4398	9.2 g	28.0 efg	2.0 cd	1.20 f	42.82 f
Mean		10.5	29.10	3.0	1.57	54.10
LSD		0.86	2.10	1.38	0.17	4.43
VC %		9.27	8.17	52.25	11.88	9.23

Table 2. Phenotypic correlations between the studied traits in the period 2016-2018

Indexes	Spike length	Number of grains per spike	Number of sterile spikelets	Grain weight per spike	1000-grain weight
Spike length	1	0.770**	-0.012	0.678**	0.291
Number of grains per spike		1	-0.281	0.782**	0.218
Number of sterile spikelets			1	-0.270	-0.133
Grain weight per spike				1	0.778**
1000-grain weight					1

Table 3. Multiple regression analysis for grain weight per spike

Equation parameters	2016-2018 година
Multiple R	0.999***
Multiple R^2	0.999
Adjusted R^2	0.999
Standard error	0.007
F	2598.74
Sig.	0.000

, * Levels of reliability for $p < 0.05$ and $p < 0.01$

Conclusions

A multitude of forms was established by the studied traits. The accessions form a great number of sterile spikelets. Strong variance of trait was ascertained. Good combination of economic traits was demonstrated by line L 4384.

Statistically proven were correlation relations between the traits of spike length and number of grains per spike, spike length and grain weight per spike, number of grains per spike and grain weight per spike, as well as between grain weight per spike and 1000-grain weight.

Positive regression dependency was established which demonstrates that the number of grains per spike and 1000-grain weight is of significance for the formation of higher grain weight per spike?

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