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Study Of Several Traits Related To Productivity In Lines Of Winter Feed Barley (*var. Pallidum* and *var. Parallelum)*

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Abstract

The study was conducted in the period 2006-2008 in the experimental field of the Institute of Agriculture, Karnobat. The aim of this study was to assess the of yield related traits of 16 lines of winter feed barley (8 from var. pallidum and 8 from var. parallelum). According to variance analyses, spike length was less affected by the weather conditions and was determined mainly by the genotype. Plant height, number of fertile tillers per plant, grain number per a spike, sterile spikelet number per a spike, grain weight per a plant and 1000 grains weight were more affected by the weather conditions of a particular year. Hence, these traits could not be considered as suitable selection criteria for the development of high yielding feed barley genotypes. Differences were observed among the var. pallidum and var. parallelum regarding the traits studied.

Keywords: Barley, yield related traits, var. pallidum, var. parallelum

Introduction

Barley is one of the oldest grains cultivated by man. The first system of classification of the genus Hordeum was made by Carl Linnaeus in 1753. It covers a small part of the diversity of genus Hordeum but it is an important step in studying this crop.

Feed barley varieties are mainly multi-row. Multi-row barley combines cultural forms which have three normally developed fertile spikelets at each rachis node (Михова, 2012). They belong to subspecies Hordeum sativum ssp.vulgare L.polystichum, which is subdivided into two subgroups: Hexastichum L. and Tetrastichum. The first group includes the varieties: parallelym, pyramidatum and gracilium, and the second – pallidum, nigrum, ricotense, horsfordianum и trifurcatum (Takahash, 1955).

In the Bulgarian varietal catalogue the feed barley varieties are mainly from *var.pallidum* (Пехливанов и др., 1998), but in recent years have also been recognized and registered from *var. parallelum* (Шевцов, 2007).

Productivity is a main breeding trait and to increase it is a major task in any barley breeding program, which aims to create new varieties for industrial purposes (Митов, 1944; Шевелуха, 1989; Янкулов, 1996; Мерсинков, 2000 Михова, 2005; Johnson et al., 1959; Yau et al.,1994).

Productivity of feed barley depends on the genetic potential of the studied material and reflects the complex correlations between yield components and other traits related to it (Запрянов, 1990; Ганушева и кол., 2004; Ганушева, 2005; Михова, 2005; Димитрова-Донева и кол.,2012).

The aim of this study was to investigate productivity through its structural traits in feed barley of *var.pallidum* and *var. parallelum.*

Materials and Methods

This study was conducted in the period 2006-2008 at the Institute of Agriculture in Karnobat. 16 feed barley accessions were investigated – 8 from *var.pallidum* and 8 from *var. parallelum.* The investigated accessions were selected from the Institute's gene pool. The trial was set in four replications, with size of the plot - 10 m^2. 10 plants were collected for analysis from each line before harvesting. Biometrical measurements were taken by UPOV (2003). The following traits were analyzed: plant height (PH), total number of tillers (TT), number of productive tillers (NPT), spike length (SL), number of grains per spike (NGS), spikelet sterility (SS), grain weight per

spike (GWS), grain weight per plant (GWP), 1000-grain weight (W_{1000}).

The obtained data was processed by a two-factor analysis of variance. The impact of genotypes, environmental conditions and the genotype-environment interaction were assessed.

The experimental data was processed with software package SPSS 12.0.

Table 1. Analysis of variance of some yield related traits of winter feed barley lines

Traits	Source of variation					
	Genotype		Year		Interaction	
	MS	η^2	MS	η^2	MS	η^2
Plant height	4953. 42 ***	59,95	9560.329***	38,57	61.090***	1,48
Number of tillers per plant	20.933***	55,71	9.433***	8,37	6.750***	35,92
Number of fertile tillers per plant	5.389 ***	20,59	10.290 ****	13,1	8.679***	66,31
Spike length	6.922 ***	43,37	8.091***	16,9	3.170***	39,73
Grain number per a spike	363.565***	18,91	3333.348***	57,81	223.737***	23,28
Sterile spikelet number per a spike	988.530 ***	67,28	103.219***	2,34	223.180 ***	30,38
Grain weight per a spike	2.028 ***	14,13	14.814***	34,4	3.695***	51,47
Grain weight per a plant	56.870 ***	11,19	526.869***	34,57	137.795 ***	54,24
1000 grains weight	251.613 ***	16,1	1066.601***	22,75	477.985***	61,15

*** significant at 0.001 level

Table 2. Analysis of variance of some yield related traits of winter feed barley lines of *var. Pallidum*

Traits	Source of variation					
	Genotype		Year		Interaction	
	MS	η^2	MS	η^2	MS	η^2
Plant height	7973.571 ***	17,88	18315.514***	82,12	275.514	-
Number of tillers per plant	8.288	-	1.550	-	26.317 ***	100
Number of fertile tillers per plant	11.010 *	37,27	9.267**	62,73	2.352	-
Spike length	306.005***	88,22	20.434***	11,78	0.638	-
Grain number per a spike	3281.610* **	29,13	3478.431***	61,75	514.017***	9,12
Sterile spikelet number per a spike	402.193 * *	20,94	386.410 ***	40,23	372.943***	38,83
Grain weight per a spike	0.134	-	13.029***	76,17	4.076***	23,83
Grain weight per a plant	3.749	-	588.454***	88,36	77.491***	11,64
1000 grains weight	1634.828 ***	25,98	1707.698***	54,28	621.054 ***	19,74

Results and discussion

Plant height (PH) is a trait, which is indirectly related to the productivity of feed barley. The results of this study showed that the year conditions are decisive for the demonstration of this trait (Table 1). With the lines of *var. pallidum,* main part for the overall variability in the demonstration of this trait had the year impact (50.78%), whereas for the forms of *var. parallelum* it was the genotype which was decisive (59.95%) (Tables 2 and 3). Average for the period 2004 – 2006, the plant height for the studied group of lines ranged from 63.87 cm to 97.53 cm and had an average variability (Table 4). The representative of *var. pallidum* had greater plant height (86.55 cm average) compared to *var. parallelum* (78.11 cm average) (Table 4).

Table 3. Analysis of variance of some yield related traits of winter feed barley lines of var. *Parallelum*

Traits	Source of variation					
	Genotype		Year		Interaction	
	MS	η^2	MS	η^2	MS	η^2
Plant height	2579.016***	43,51	9030.700***	50,78	169.128***	5,71
Number of tillers per plant	46.921***	61,86	18.433***	8,1	11.394***	30,04
Number of fertile tillers per plant	16.675***	36	1.329ns	-	15.217***	64
Spike length	11.232***	63,78	12.980***	24,57	1.025*	11,65
Grain number per a spike	228.527***	23,08	659.100***	22,19	271.039***	54,74
Sterile spikelet number per a spike	1373.587***	69,22	656.133***	11,02	196.094***	19,76
Grain weight per a spike	1.707***	25,37	2.291***	11,37	2.127***	63,26
Grain weight per a plant	41.461***	13,35	139.077***	14,93	111.375***	71,72
1000 grains weight	506.160***	32,65	1262.151***	27,13	311.809***	40,22

Table 4. Average date for some yield related traits of winter feed barley lines of var. *Pallidum* and var. *Parallelum* (2004-2006)

Variety		Plant height /cm/	Number of tillers per plant	Number of fertile tillers per plant	Spike length /cm/	Grain number per a spike	Sterile spikelet number per a spike	Grain weight per a spike /g/	Grain weight per a plant /g/	1000 grains weight /g/
pall	min	70,7	5,43	4,5	6,88	46,8	9,3	1,72	5,28	34,45
	max	97,53	9,67	7,7	8,68	60,06	28,9	2,86	13,16	50,92
	X	86,55	7,02	5,69	7,56	55,11	14,92	2,4	8,61	43,49
	CV%	16,1	22	21	9,9	9,8	51,7	18,7	40,3	23,9
par	min	63,8	5,37	4,27	5	51,3	8,23	1,78	5,24	32,79
	max	96,9	8,1	6,47	6,68	69	25,06	3,28	14,52	50,03
	X	78,11	6,72	5,43	5,94	60,51	16,87	2,42	8,77	39,75
	CV%	20,2	14,9	16,4	10,8	13	39,8	26,8	44,5	17,21

The total number of tillers (TT) in the studied group of feed barley lines was determined by the genotype x environment interaction, which played main part in the overall trait variability (Table 1). The specific characteristics of the lines from the two varieties affected the total number of tillers, and the relative share of the genotype in the total variability of the *pallidum* accessions was 61.86%, while with the *parallelum* forms it was 55.71% (Tables 2 and 3). Table 4 shows that the trait variability was significant with *var. pallidum*, and average with the *parallelum* acessions.

The study found that the number of productive tillers (NPT) is a trait which is mainly demonstrated through its relation to genotype, but is much greater determined by the year conditions (Table 1). The results from the analysis of variance by varieties showed that the greatest impact was from the genotype x environment interaction (Tables 2 and 3). The mean values of the trait were similar in both varieties but the coefficients of variation showed significant variability for *var. pallidum* and average for *var. parallelum* (Table 4).

The trait of spike length (SL) in the studied group of feed barley accessions was comparatively conservative. Average for the period was established low impact of the year conditions, while the genotype played a decisive part and its relative share in the total variability was 88.22% (Table 1). In the literature there are reports that

spike length is slightly affected by the conditions but there are also cases where variability affected by the conditions exceeded the differences between varieties (Necas, 1963). In the study of lines of *var. parallelum* the demonstration of trait equally depended on the impact of genotype and genotype x year interaction in contrast to the behavior of the other accessions (Tables 2 and 3). The observed differences in the mean values of the index were subject to systematic affiliation, as the longer spikes were seen in the forms of *var. pallidum* (Table 4). The variability in the index was average for the two varieties.

Number of grains per spike (NGS) is a trait strongly influenced by the year conditions. In this study the relative share of the year conditions for the formation of this trait was 61.75% (Table 1). With the forms of *var. pallidum* decisive role played the genotype and year, with greatest effect from their interaction (Table 2).

In the selection materials for *var. parallelum* the main share of the total variability was taken by the year conditions (Table 3). The data in Table 3 shows that the mean values of the index were higher for *var. parallelum* and the number of grains in the lines was 5.4 more compared to the lines of the other variety. The coefficient of variation for *var. pallidum* shows that the variability of trait was insignificant and average for *var. parallelum* (Table 4).

Spikelet sterility (SS) is an index which is strongly influenced by the year conditions. The results in Table 1 confirm the high relative share of the year for the total variability of the index in the studied group. Spikelet sterility also depended on the systematic affiliation of the accessions and some research scientists found that in two-row barley it is far less compared to the multi-row forms (Вълчева и кол., 2009). The differences observed by varieties were the result of the genotype impact (Tables 2 and 3). Out of all studied traits related to productivity, spikelet sterility was one of the traits with greatest variability, which was well expressed in *var. pallidum* (Table 4).

The data from the analysis of variance for the studied group of feed barley shows that the grain weight per spike (GWS) was most influenced by the year conditions (Table 1). The trait was demonstrated in the two varieties according to the decisive genotype x environment interaction. The relative share of the total variability was respectively 63.26% for *var. pallidum* and 51.47% for *var. parallelum* (Tables 2 and 3). The values of the coefficients of variation were average for the lines of *var. pallidum* and high for *var. parallelum* (Table 4).

Along with the grain weight per spike, the grain weight per plant (GWP) also depended on the year conditions. The strength of the year factor in the study was 88.36% and had the greatest share in the total variability of the trait (Table 1). The results from the analysis of variance by varieties show that along with the year conditions for the *var. Parallelum* forms, there was also a great impact from the genotype x environment interaction, whereas for *var. pallidum* the interaction between the year conditions and the genotype was decisive (Tables 2 and 3). The values of the coefficients of variation were high, which demonstrated the great impact that the cultivation conditions had on the trait (Table 4).

Research has given evidence that 1000-grain weight (W_{1000}) is a genetically determined trait but also subject to the environmental conditions. At the same time Rasmusson et al. (1970), Hadjichristodolou (1990), Mihova et al. (2010) reported that 1000-grain weight of barley is among the traits least affected by the conditions and that two-row barley is characterized by a stable grain size compared to multi-row. The data in Table 1 confirms the role of the year to the demonstration of the trait. For the lines of *var. pallidum* 1000-grain weight was determined by the impact of genotype and genotype x year interaction. The trait in the accessions of *var. parallelum* mainly depended on the interaction between the genotype and environment of cultivation with a relative share in the total variability of 61.15 %. Over the studied years 1000-grain weight ranged from average to significant, with the higher range being found in the accessions of *var. pallidum* (Table 4).

Conclusion

This comparative study of traits related to the productivity of feed barley makes it apparent that spike length is least affected by the year conditions and mainly depends on the genotype. Plant height, number of productive tillers, number of grains per spike, spikelet sterility, grain weigh per spike and per plant and 1000-grain weight are traits which are demonstrated subject to the year conditions. Their strong dependence on the weather conditions impedes the selection and makes them an uncertain criterion in the search of highly-productive genotypes.

Differences have been found in the occurrence of the studied traits by varieties. Along with spike length for the representatives of var. Pallidum, genotype also played an important part in the demonstration of the traits total number of tillers, spikelet sterility, as well as plant height for the accessions of var. parallelum.

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