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Characteristics of Russian winter barley varieties in Southeast Bulgaria conditions

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Absract

The aim of this investigation was to study the characteristics of Russian winter barley varieties under the conditions of Southeast Bulgaria and to evaluate the possibility of their use in breeding work. For this purpose 10 feed barley varieties developed at the Krasnodar Lukyanenko Research Institute of Agriculture and Bulgarian national standard varieties Veslets and Izgrev were tested in complete block design with four replications. The study was conducted in the Institute of Agriculture - Karnobat, during the period 2010 - 2012. The traits spike length, spikelet number per spike, grain number per spike, grain weight per spike, 1000 grains weight, hectoliter weight, protein content, starch content and grain yield were studied. Significant differences between Bulgarian and Russian varieties for all studied traits, except starch content, were found. Varieties Platon and Mihailo showed a significantly higher grain yield than Veslets. Under the conditions of Southeast Bulgaria the highest yield was obtained in varieties Mihailo and Platon. The studied varieties were characterized with a high productivity combined with other valuable agronomic traits and they can be used in breeding programs for developing high-yielding winter feed barley varieties.

Key words: winter barley; grain yield; agronomic traits; breeding

INTRODUCTION

Modern barley breeding is largely directed towards development of genotypes characterized with increased yield potential, wide adaptation and tolerance of main biotical and abiotical stress factors in the region (Popova et al., 2009; Vulchev et al., 2009; Mihova, 2013). Barley grain is used primarily for feeding animals. The feed quality of barley is influenced both by physical grain quality indicators (grain weight and size, hull content, 1000-grain weight, volume weight and grain hardness) and by the chemical composition (starch, fiber, protein, fat, minerals and vitamins), that have to be considered in breeding of high-feed-value barley varieties (Bleidere and Gaile, 2012).

Genetic variation is the basis of barley breeding (Muñoz-Amatriaín et al., 2014). Variability in terms of genetic divergence for agronomic traits is the key component of breeding programes for broadening the gene pool of barley. In most barley programs, the sources of genetic diversity can be traced back to a small number of foundational varieties (Martin et al., 1991). Without new germplasm infusion, however, there is an increased risk of genetic vulnerability as a consequence of pathogen population evolution, loss of resistance genes (Condon et al., 2008), as well as the appearance of new abiotic stresses and yield constraints (Mikel and Kolb, 2008). Continued gains in yield and agronomic traits requires introgression of novel alleles in wild relatives, exotic germplasm and elite germplasm from other breeding programs.

The aim of this investigation was to study the characteristics of feed barley varieties developed at the Krasnodar Lukyanenko Research Institute under the conditions of Southeast Bulgaria and to evaluate the possibility of their use in breeding work.

MATERIAL AND METHODS

The study was conducted in the Institute of Agriculture – Karnobat, during the period 2010 – 2012. The experimental area is located in Southeast Bulgaria. The climate is transitional continental, with long and relatively cool spring, dry and hot summer, long and wet autumn, and little snow in winter, with large variations of temperature. The soil of experimental field is Pellic Vertisols, slightly acid (pH is 6,2).

Ten feed barley varieties developed at the Krasnodar Lukyanenko Research Institute of Agriculture - Secret, Dobrinya 3, Fedor, Zimur, Rubez, Samson, Kondrat, Mihailo, Platon, Romance and Bulgarian national check varieties - Veslets and Izgrev were tested.

The experiments were organized in a Complete Block Design with 4 replications on plots of 10 m^2. Standard agronomic and plant protection practices were used.

Data were collected for spike length (cm), spikelet number per spike, grain number per spike, grain weight per spike (g), 1000-grains weight (g), hectoliter weight (kg), protein content, starch content and grain yield per plot were recorded. The plot yield was converted to t/ha.

The significance of differences among means was compared by using Least Significant Difference (LSD) test at the 0,05 level using the computer software system of SPSS 16.00 for Windows 16.0 (SPSS Inc., 2007). Yield stability of studied varieties was evaluated according Francis and Kannenberg (1978). The cluster analysis was performed using the program Statistica (StatSoft Inc., 2004) that adopts Euclidian distance as a measure of dissimilarity and the Ward's method as the clustering algorithm (Ward, 1963). Before computing the data were standardized.

RESULTS AND DISCUSSION

Mean values of studied traits of winter feed barley varieties from the three-year period (2010-2012) are shown in Table 1. Spike length ranged from 5,75

Table 1. Mean values of studied traits of winter feed barley varietis (2010 - 2012)

Genotypes	Spike length, cm	Spikelet number per spike	Grain number per spike	Grain weight per spike	1000 grains weight, g	Hecto liter weight, kg/hl	Protein content, %	Starch content, %	Grain yield, kg/ha
Veslets	7,79	68,54	54,39	2,44	44,83	70,70	11,92	57,89	5210
Izgrev	6,91	61,63	45,25	1,82	40,29	68,70	12,32	58,63	5007
Secret	5,77	74,00	67,84	2,82	41,48	62,30	11,64	59,36	5297
Dobrinya 3	6,07	76,00	70,13	3,26	46,41	62,20	12,52	57,85	5527
Fedor	6,06	82,38	77,17	3,21	41,61	60,90	10,75	58,79	4817
Zimur	6,06	80,50	72,00	3,07	42,69	63,60	12,21	58,80	5007
Rubez	5,81	73,71	67,00	3,05	45,60	61,70	10,43	59,14	5440
Samson	7,69	70,75	61,42	2,98	48,42	59,80	12,02	59,42	5217
Kondrat	6,65	87,00	83,00	3,48	41,84	60,50	11,38	57,44	5333
Mihailo	6,00	74,88	65,33	3,16	48,37	63,50	12,32	56,43	5867
Platon	5,92	71,58	62,88	3,05	48,48	61,40	11,96	58,58	5817
Romance	5,75	71,16	62,72	2,78	44,38	60,35	10,05	61,30	5033
LSD 0.05	*0.42*	*4.90*	*4.09*	*0.44*	*3.22*	*2.23*	*0.49*	*ns*	*428*
Minimum	*5,75*	*61,63*	*45,25*	*1,82*	*40,29*	*59,8*	*10,05*	*56,43*	*4817*
Maximum	*7,79*	*87*	*83,00*	*3,48*	*48,48*	*70,70*	*12,52*	*61,30*	*5867*
CV%	*11,40*	*9,00*	*15,05*	*14,93*	*6,66*	*5,37*	*6,96*	*2,06*	*6,11*

cm for Romance to 7,79 cm for Veslets. All studied varieties, except Samson, had a significantly shorter spike compared to Veslets.

Spikelet number per spike varied from 61,63 for Izgrev to 87,00 for Kondrat. The varieties Secret, Dobrinya 3, Fedor, Zimur, Rubez, Kondrat, Mihailo had significantly higher number of spikelets per spike than Bulgarian check varieties.

The maximum grain number per spike had Kondrat (83,00) and minimum had Izgrev (45,25). All studied varieties had significantly higher number of grains per spike compared with Veslets and Izgrev.

Values from 1,82 g (Izgrev) to 3,48 g (Kondrat) for grain weight per spike were recorded. The varieties Dobrinya 3, Fedor, Zimur, Rubez, Samson, Kondrat, Mihailo and Platon showed a significantly higher weight of grains per spike than Veslets.

The 1000-grains weight ranged from 40,29 g for Izgrev to 48,48 g for Platon. Very high 1000-grains weight (above 42,0 g) was observed in Veslets, Dobrinya 3, Rubez, Samson, Mihailo, Platon and Romance.

The hectoliter weight was very high (above 64,0 kg) for Veslets and Izgrev, high (from 60,01 to 64,00 kg) for Secret, Dobrinya 3, Fedor, Zimur, Rubez, Kondrat, Mihailo, Platon and Romance and medium for Samson.

Protein content varied from 10,05% for Romance to 12,52% for Dobrinya 3. Low protein content (below 11,0%) was recorded in Fedor, Rubez and Romance, the rest of the varieties showed medium content of protein (from 11,0 to 13,5%).

Starch content ranged from 56,43% (Mihailo) to 61,30% (Romance). The differences between varieties for starch content were not significant.

The *average* grain yield for the *tree* experimental *years* varied from 4817 to 5867 kg/ha. Varieties Platon (5817 kg/ha) and Mihailo (5867 kg/ha) had a significantly higher grain yield, as compared to Veslets (5210 kg/ha).

The coefficient of variation was highest in grain number per spike (15,05%) and grain weight per spike (14,93%). Low variation among varieties was found in starch content (CV=2,06%).

Yield stability differences among varieties were investigated by plotting individual genotype mean yield (X axis) against the coefficient of variation (CV) percent for each genotype (Y axis) (Figure 1).

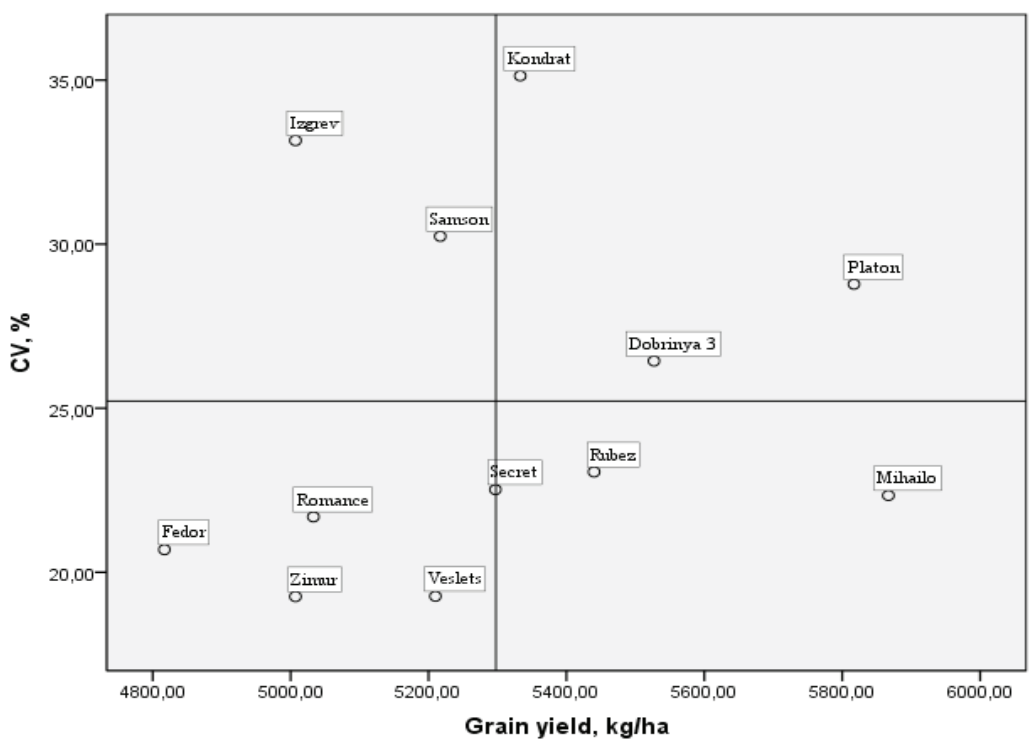

Figure 1. Mean grain yield (kg/ha) plotted against coefficient of variation (CV, %) for winter feed barley varieties for 3 years (2010 - 2012)

By drawing a vertical line through the varieties mean yield of 5298 kg/ha and a horizontal line through the CV percent grand mean, four quadrants were formed. Genotypes with CV mean and mean yield above grand mean were judged as high-yielding with low stability, while genotypes with low CV percent and mean yield below the grand mean were judged as low-yielding with high stability. Figure 1 shows that varieties Mihailo and Rubez had higher yield and lower CV than the average of all studied cultivars. Varieties Dobrinya 3 and Platon also had grain yield above averaged but showed lower stability. Standard variety Veslets along with Fedor, Zimur and Romance were located in the group with low yield and high stability. The variety Kondrat showed lowest yield stability in conditions of Southeast Bulgaria. The varieties Izgrev and Samson had a low yield and low stability. Mihova (2011) studied Russian winter barley varieties under the conditions of Northeast Bulgaria. She reported that highest yield was obtained from cultivar Romans while cultivars Dobrinya 3, Mihailo, Kondrat and Zimur had a favorable combination of productivity and stability.

The average of all studied traits of the three seasons was used to generate the dendrogram showing similarity among the varieties (Figure 2). Clustering separated the barley varieties into two main groups. The first group included all varieties originated from Russia. The varieties Mihailo, Platon and Dobrinya 3 were genetically most similar, they are linked in a subgroup and have the least distant unit. Those varieties had the highest grain yield and high 1000-grains weight. Within the first cluster, varieties Zimur and Secret were also very similar for studied traits. The second cluster included two Bulgarian varieties. The results revealed the existence of genetic differences among Russian and Bulgarian varieties.

CONCLUSIONS

Significant differences between feed barley varieties developed at the Krasnodar Lukyanenko Research Institute of Agriculture and Bulgarian national standard varieties Veslets and Izgrev for spike length, spikelet number per spike, grain number per spike, grain weight per spike, 1000-grains weight, hectoliter weight, protein content and grain yield were found.

Under the conditions of Southeast Bulgaria the highest yield was obtained from varieties Mihailo

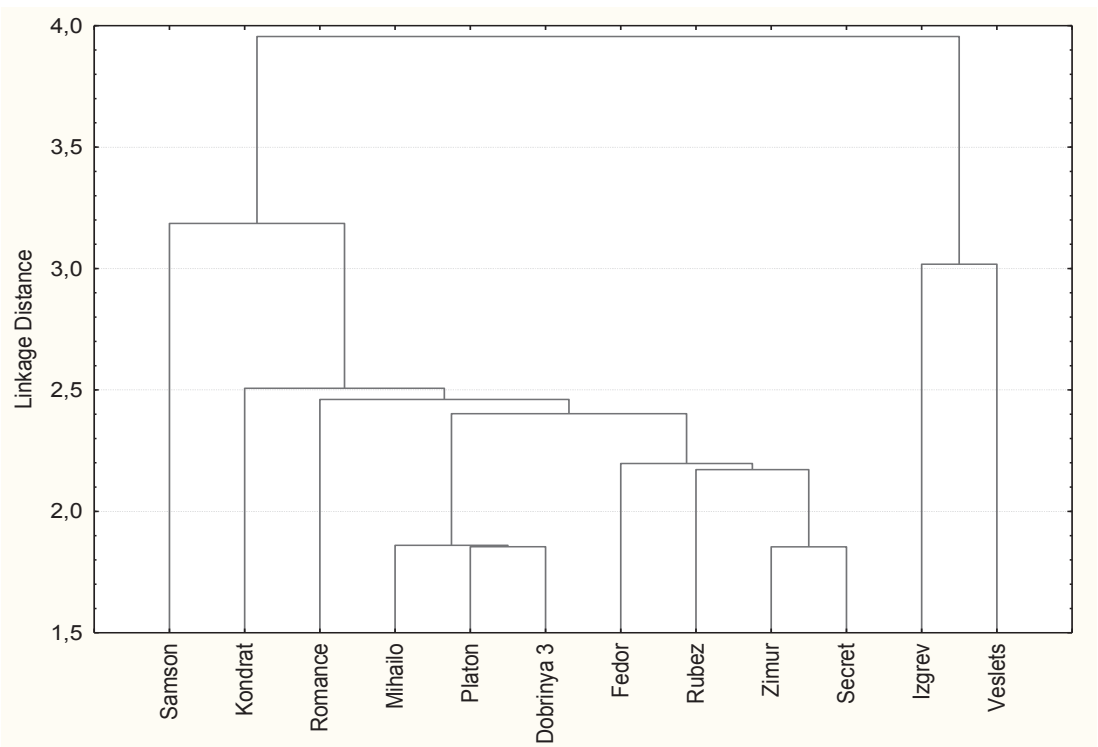

Figure 2. Dendrogram based on 9 traits of winter feed barley varieties

and Platon. High mean yield combined with yield stability over the three-year period of the study was founded in varieties Mihailo and Rubez.

The studied varieties were characterized with a high yield ability combined with other valuable agronomic traits and can be used in breeding program for developing high-yielding winter feed barley varieties.

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