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Study of relationship between yield and yield related components in spring barley varieties using multivariate analysis

Natalija Markova Ruzdik, Ljupco Mihajlov, Verica Ilieva, Biljana Kovacevik, Mite Ilievski, Nenad Petkovski
Faculty of Agriculture, University "Goce Delčev", Krste Misirkov bb, 2000 Štip, Macedonia

INTRODUCTION

After wheat, rice and maize, barley is the fourth most significant crop. Barley is used as a livestock feed, for malt and for preparing foods. In Republic of North Macedonia barley and wheat are the principal cereal crops. Successful growing of spring barley depends on many factors. The grain yield and quality traits of barley are determined by its genetic makeup and environment conditions during growth, harvest and storage. The yield formation can be defined as the interaction effect of soil and climatic conditions, genotype, fertilization and growing technology (Barczak and Majcherczak, 2008). Grain yield is made up of three main different yield components, the number of spikes, the number of grains per spike and the thousand kernel weight. The objective of this study was to study the relationship between yield and yield related components in spring barley varieties grown under agro-ecological conditions in the Republic of North Macedonia.

MATERIAL AND METHODS

PLANT MATERIAL

Five spring barley varieties (Makedo, Xanadu, Josefin Variety, Gladys Variety and Scarlet Variety) were used as an experimental material for this study. Only Makedo was domestic variety, and the other cultivar were introduced (Fig. 1). Macedo variety is registered as a Macedonian variety on the National variety list in the Republic of North Macedonia.

FIELD TRIAL

The field trial was carried out on the experimental field area in Probištip, Republic of North Macedonia, during 2013 and 2014 (Fig. 2). Two row barley cultivars were arranged in a randomized complete block design with three replications. The size of experimental plot for each variety and replication was 5 m².

Figure 1. Spring barley variety Makedo

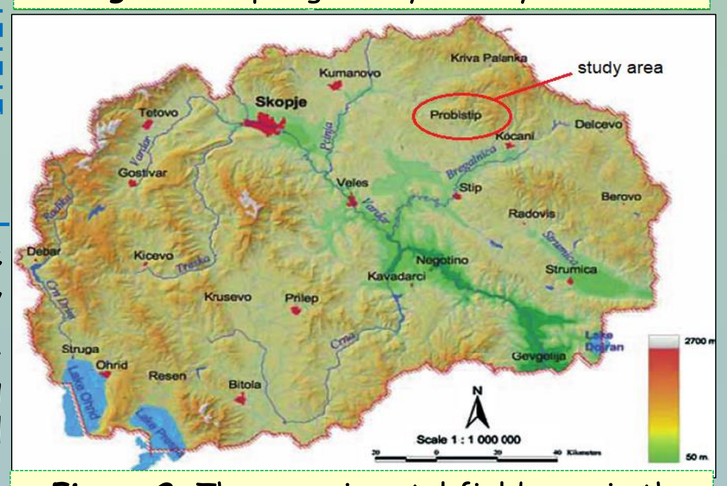

Figure 2. The experimental field area in the Republic of North Macedonia

DATA COLLECTON AND STATISTICAL ANAYSIS

According to descriptors for barley 30 plants were randomly were sampled from each plot to determine plant height (cm) and number of grains per spike. The number of spikes per m² was determinate by counting the plants from m² of each repetition. 1 000 grain weight has been determinate to measure 1 000 grains of each repetition and variety, while for hectoliter weight was used hectoliter measuring system. Grain yield was obtained from 5 m² and was calculated in kg/ha. Principal Component Analysis and linear correlation were applied to show the relationship between grain yield and yield components.

RESULTS AND DISCUSSION

Makedo variety showed the highest value for grain yield (6 844 kg/ha), followed by Xanadu (6 638 kg/ha). Also, Makedo has the highest values for number of spikes per m² and the number of grains per spike (Tab. 1). Principal Component Analysis was utilized to examine the variation and to estimate the relative contribution of tested traits for total variability. Two main components were extracted with Eigen value greater than one (Tab. 2). The first two principal components accounted for 82.46% of the entire variability. The first principal component (PC) explained 59.92% of the variance. Factor loading for number of spikes per m² (0.49), grain yield (0.48) and number of grains per spike (0.47) were the most important traits positively contributing to the first main component (Tab. 2). This comment relates to fact that spike number per m² had a high significant correlation with grain yield. On the other hand, the plant height showed negative correlated to PC1 (-0.51), which mean that higher plants should have lower grain yield. The second PC accounted 22.53% of the variation and 1 000 grain weight was the main highly positively trait of PC2. Linear correlation had been used to determine the interaction between grain yield and yield related components in barley (Markova Ruzdik et al., 2015). Grain yield was highly and significantly in positive correlations with number of spikes per m² (r=0.795) and number of grains per spike (r=0.632) (Tab. 3).

Table 1. *Average yield and yield components of tested barley varieties*

Variety	Number of spikes per m²	Plant height (cm)	Number of grains per spike	1 000 grain weight (g)	Hectoliter weight (kg/hl)	Grain yield (kg/ha)
Makedo	668	64.8	22	49.4	68.5	6844
Xanadu	617	64.4	20	43.5	66.0	6638
Gladys Variety	576	68.8	20	50.1	67.7	5841
Scarlet Variety	638	69.8	20	46.3	67.0	4949
Josefin Variety	517	76.3	20	45.8	64.7	5279

Table 2. Principal Component Analysis of all traits of barley varieties

Parameter	PC1	PC2
Eigen value	2.99	1.12
Percentage of variance (%)	59.92	22.53
Cumulative percentage (%)	59.92	82.46
Trait	Factor loading of tested traits	
Number of spikes per m²	0.49	-0.14
Plant height	-0.51	0.34
Number of grains per spike	0.47	0.35
1 000 grain weight	0.12	0.84
Hectoliter weight	0.15	0.25
Grain yield	0.48	-0.20

Table 3. Linear correlation coefficients between yield and yield components

	Plant height	Number of grains per spike	1 000 grain weight	Hectoliter weight	Grain yield
Number of spikes per m²	-0.823	-0.467	-0.075	-0.660	0.795**
Plant height		0.636	0.172	0.760	0.492
Number of grains per spike			0.490	0.649	0.632*
1 000 grain weight				0.748	0.101
Hectoliter weight					0.424

*Statistical significance of differences at P<0.05; **Statistical significance of differences at P<0.01

CONCLUSION

From all tested barley varieties, Makedo showed the highest values for grain yield, number of spikes per m² and number of grains per spike. This means that Makedo variety is suitable for cultivation and should be more present in barley production. Except Makedo variety, also Xanadu can be introduced in barley production or to be chosen as suitable variety for new parent in any future breeding process. From the other side, higher spikes per m² give the opportunity for higher grain yield.

REFERENCES

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