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INFLUENCE OF GENOTYPE ON YIELD AND QUALITY COMPONENTS OF DURUM WHEAT IN ORGANIC PRODUCTION

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ABSTRACT

This paper presents the results of field experiment conducted in Backa Topola in 2010-2011 year. The aim of research is to review variability of yield and quality components of five *durum* wheat genotypes in organic production. The lowest variability waspresented in test weight (CV=1.12%), while the highest variability wasobserved in grain weight per spike (CV=25.09%). Significant differences between genotypes has beenpresented in grain weight per spike, thousand grain weight and test weight. Highly significant and positive correlationswas found between all elements of spike. Thousand grain weight was in negative correlation with grain number per spike.

KEY WORDS

Durum wheat, organic production, yield components

1. INTRODUCTION

Production of alternative culture has a positive effect on agricultural biodiversity, adds to versatility nutrition and maintaining the health of the people and therefore plays an important role in organic agriculture.
Cereals are inevitable plant species in organic production. Numerous species, subspecies, forms, types and varieties of cereals make their growing possible in the whole world. As far as wheat is concerned, we have developed in Serbia several low-input cultivars of winter wheat (Kovačević and Lazić, 2012).

Many authors include durum wheat (*Triticumthurgidum* var. *durum*)in alternative group of cereals (Kovačevićet al., 2007).Durum wheat, which are intended exclusively for making pasta, spaghetti, macaroni,has incomparably less important value than *vulgare* wheat. However, because of its nutritional value, durum wheat is very important in organic farming (Malešević sar., 2008).Statistically significantly higher grain yield was given with species of *Triticum durum* in relation with yield given with *Triticumspelta* and *Triticumcompactum*(Kovačević and Lazić, 2012).

Organic wheat production has increased by 55% in the last decade and it is implemented in 24 countries of the world.Area under organic production of wheat in the 2012th amounted to 284 ha, or 5% of the total area under organic production in Serbia (Märzet al., 2012).

The production of high yield wheat cultivars is one of the main goals in wheat breeding. Indirect selection based on one or more grain yield components has been considered to be more effective than the direct selection for grain yield since grain yield has low heritability (Gorjanović and Kraljević-Balalić, 2006).

Today, wheat breeding is mainly focused on increasing the potential for grain yield, improving chemical and technological properties, good adaptability and earliness because of growing land and air dried in the grain filling period (Madić i sar., 2010).

The knowledge of genetic variability, the nature and the extent of association of various component characters with the yield are, therefore, important for genetic improvement of yield and other characters (Bilgin et al., 2011).

The knowledge of genetic correlation between grain yield and its components can improve the efficiency of breeding by identifying appropriate indices for selecting wheat varieties (Evans and Fischer, 1999). The study of correlations between traits that determine the yield can help in choosing the indirect yield components (Zečević et al., 2004; Hristov et al., 2011).

The main reason that makes breeding for the main yield components difficult is that they are in negative correlation with each other (Gorjanović and Kraljević-Balalić, 2006).

The goal of this paper is to estimate the variability, coeficient of variation and correlation between yield and quality component in order to try to make the breeding more efficient. Furthermore, the aim is to discuss the possibility of a successful production of durum wheat in organic farming.

2. MATERIALS AND METHODS

The experiment was conducted at the Economy of High Agrucultural School in Bačka Topola, during 2011-2012 vegetation period, using the randomized block design with three replications. Sowing was done in 23rd of October with a sowing density of 700 seedsm^{-2}.

The experiment was conducted on five durum wheat genotypes: CIMMYT 7803, CIMMYT 7849, CIMMYT 7896, which originating from International Maize and Wheat Improvement Center – CIMMYT, and L-34/id and L-120/idzz that have been bred at Maize Research Institute Zemun Polje.

In this field trial wheat has been cultivated according to the principles of organic production, where pesticides and other assets that are not allowed in organic farming have not been applied. Protecting plants from weeds was done mechanically.

Harvesting was performed at the stage of full maturity at 13th of July, when the moisture content in grain was less than 14%.

Three yield and two quality components were studied: spike length, grain number per spike, grain weight per spike, thousand grain weightand test weight.

The mean value ($\bar{X}$), coefficient of variation (CV) and analysis of variance were calculated as indicators of trait and genotype variability. Correlation coefficients was used to determine the independence of the traits. Statistical calculations were performed using the statistics program „IBM SPSS Statistics version 20“.

3. RESULTS AND DISCUSSION

3.1 Variabillity and analysis of variance of yield components

The average value of spike length at observed genotypes was 7.41 cm. No statistically siniffican differences were found between genotypes in this trait. Spike length showed moderate values for the coefficient of variation (CV=12.92%) (Table 1). These results are in agreement with previous reported by Gorjanović and Kraljević-Balalić (2006) and Zečević et al. (2008).Zečević et al. (2008) indicate spike lenght expression highly depended to genetic factors.

Grain number per spike is one of important yield components, which directly affect genetic yield potential (Zečević et al., 2010).

The highest mean value ofgrain number per spikehas been estabilished at L-120/idzz genotype (52.07) and the lowest one has been observed at L-34/id genotype (47.13). Statistically significant difference ($LSD_{0.05}$) was found between L-120/idzz and L-34/id genotypes (Table 1).

Grain number per spike showed significant coefficient of variation (CV=21.04%) at analyzed genotypes (Table 1). Similar results were obtained by Zečević et al. (2008, 2010), Ali et al., 2008 and Petrović et al. (2007). Grain number per spike is a quantitative trait whose expression depends on a large number of genes that are strongly influenced by environmental factors that cause high variability (Zečević et al., 2010). Grain number per spike is variable trait and dependson number of spikelets per spike and fertilization success (Petrović et al., 2007; Zečević et al., 2010).

The grain weight per spike is very variable trait because it depends on grain number and grain chemical composition. This trait is very important yield components, which directly influence to harvest index and yield (Zečević et al., 2010).

The highest mean value for grain weight per spike has been estabilished at L-120/idzz genotype (3.19 g) and the lowest value has been observed at CIMMYT 7803 genotype (2.51 g). Analisys of variance showed statistically high significant difference ($p<0.01$) between L-120/idzz and CIMMYT 7803 genotypes, and significant difference ($p<0.05$) between CIMMYT 7849 and CIMMYT 7896 genotypes.

It has been estabilished a significant coefficient of variation (CV=25.09%) for grain weight per spike at investigated genotypes. The lowest variability was observed in L-120/idzz genotype (CV=20.38%) and the highest one in CIMMYT 7803 (CV=27,49%) (Table 1). Gorjanović and Kraljević-Balalić (2006) reported similar results for coefficient of variation (CV=27.87%) in first year of their investigation, while in second year grain weight per main spike showed moderate values. Zečević et al. (2010) concluded that grain weight per spike is very variable trait and its expression depends highly on the environmental factors.

Table1. Mean value, coefficient of variationandanalysis of variance of spike length,grainnumber per spike and grain weight per spike in durum wheat genotypes

Genotype	Spike length (cm)		Grain number per spike		Grain weight per spike (g)	
	($\bar{X}$)	(CV%)	($\bar{X}$)	(CV%)	($\bar{X}$)	(CV%)
CIMMYT 7803	7.04	11.08	50.07	19.79	2.51	27.49
CIMMYT 7849	7.43	18.98	51.47	24.44	2.99	25.41
CIMMYT 7896	7.41	13.9	52.1	20.29	2.72	28.3
L-34/id	6.68	9.43	47.13	19.2	2.72	23.88
L-120/ idzz	8.47	11.22	59.57	21.47	3.19	20.38
Average	7.41	12.92	52.07	21.04	2.83	25.09
$LSD_{0.01}$	2.90		13.61		0.59	
$LSD_{0.05}$	1.99		9.35		0.41	

3.2 Variability and analysis of variance of quality components

The thousand grain weight and test weight are indicators of physical seed quality(Mladenov et al., 2001).

The average mean value for thousand grain weight was 56,61 g, while the average value for durum wheat should be from 41 to 45 g. Denčić (1989) in his researchconcluded that thousand grain weight should be about 40 g or slightly higher.

The highest mean value for thousand grain weight has been observed in L-34/id genotype (65.4 g), while the lowest one has been established at CIMMYT 7896 genotype (48.2 g). Genotype L-34/id has a highly significantly higher ($p<0.01$) mean value for thousand grain weight in relation to other genotypes. Significant difference has beenfound between CIMMYT 7803 and CIMMYT 7849 genotypes (Table 2). Analyzed genotypes showed a moderate value of coefficient of variation (CV=1,96%) for this trait (Table 2).

The test weight depends on many factors such as moisture, texture, grain structure, the proportion of impurities in the grain mass (Đurić and Mladenov, 2007).

The highest average value of test weight has been established at L-120/idzz genotype (82,3 kg hl^{-1}), while the lowest one has been observed at CIMMYT 7896 genotype (78,07 kg hl^{-1}) (Table 2). According to the *Regulations on the quality of agricultural products*durum wheat should hasat least 78 kg hl^{-1}test weight.

The analysis of variance for test weight showed highly significant differences ($p<0.01$) amongst L-120/idzz and CIMMYT 7896 genotypes, and significant differences ($p<0.05$)between CIMMYT 7849 and CIMMYT 7896 genotypes, as well as L-120/idzz and L-34/id genotypes (Table 3).

Low variability of test weight was found in all investigated genotypes. Results showed the average coefficient of variation of 1.12% (Table 2).

Table 2. Mean value, coefficient of variation and analysis of variance of thousand grain weight andtest weightin durum wheat genotypes

Genotype	Thousand grain weight (g)		Test weight (kg hl^{-1})	
	($\bar{X}$)	(CV%)	($\bar{X}$)	(CV%)
CIMMYT 7803	58.3	1.47	80.5	0.87
CIMMYT 7849	57.6	1.65	80.7	1.44
CIMMYT 7896	48.2	1.97	78.07	0.7
L-34/id	65.4	1.07	80.0	1.67
L-120/ idzz	53.6	3.64	82.3	0.91
Average	56.61	1.96	80.32	1.12
$LSD_{0.01}$	3.59		2.92	
$LSD_{0.05}$	2.47		2.01	

3.3 Correlations among yield and quality components

Correlation is a pragmatic approach to developing selection criteria for accumulating an optimum combination of yield contributingtraits in a simple genotype (Munir et al., 2007).

Spike length was in highly significant and positive correlation with grain number per spike (r=0.990**) and grain weight per spike (r=0.850**). Zečević et al. (2004) and Munir et al. (2007) observed a strong positive correlation between spike lenght and other components of spike.Grain number per spike and grain weight per spike were in highly significant and positive correlation (r=0.773**). This is in agreement with resultates obtained by Hristov et al. (2011).Thousand grain weight was in negative correlation with grain number per spike (r=-0.368) and spike lenght (r=-0.261). Akram et al. (2008) found negative correlations between thousand grain weight and spike lenght.Test weight was highly significantly and positively correlated with grain weight per spike (r=0.618**), spike lenght (r=0.577**) and grain number per spike (r=0.561**) (Table 3).

Table 3. Correlations among analyzed components

	Spike length	Grain number per spike	Grain weight per spike	Thousand grain weight	Test weight
Spike length	1				
Grain number per spike	0.990**	1			
Grain weight per spike	0.850**	0.773**	1		
Thousand grain weight	-0.261	-0.368*	0.137	1	
Test weight	0.577**	0.561**	0.618**	0.173	1

***(p<0.01); *(p<0.05)*

4. CONCLUSION

According to the obtained results, the following can be concluded:

Genotype L-120/idzz achieved the highest mean values in most of investigated characteristics, while CIMMYT 7896 genotype was the closest to the average mean values for all evaluated traits.

The lowest variability has been established in test weight (CV=1.12%), while the highest variability was found in grain weight per spike (CV=25.09%). Genotype L-34/id showed the highest homogeneity, while CIMMYT 7849 genotype had the highest variability in relation to the analyzed characteristics.

Statistical analysis of variance showed highly significant differencesbetween analyzed genotypes for grain weight per spike, thousand grain weight and test weight. Significant differences have been observed between genotypes for grain number per spike. No significant differences have been found between genotypes in spike length.

High significant and positive correlation has been presented betweenall traits of spike. Test weight had a high significant correlation with all traits of spike, while thousand grain weighthad significant negative correlation with grain number per spike.

Knowledge of correlation between yield and quality components is of great importance for selection and plant breeding, and represents an approach that would increase the grain yield.

Based on this research it is possible successful production of durum wheat under the principles of organic agriculture.

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