

## EFFECT OF GENOTYPE AND ENVIRONMENT ON SPRING BARLEY AND OATS QUALITY

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### Abstract

The investigation was carried out on the experimental field of Small Grains Research Center, Kragujevac. This paper presents the results of Kragujevac cultivars of spring barley (Jadran and Dinarac) and spring varieties oats (Slavuj, Lovcen and Vranac). Grain yield, 1000 kernel weight and test weight in grain two cultivars of barley and three cultivars of oats was determined in a three-year field experiment.

Average grain yield of barley cultivars ranged from 1.925 t/ha to 5.667 t/ha, as well the oat cultivars ranged from 2.140 t/ha to 4.518 t/ha. Grain yield differed significantly between years and the average of all cultivars was higher in 2009, compared to 2010, and 2011. Average values of 1000 grain weight of barley cultivars varied in the range from 40.20 to 45.40 g, as well of oat cultivars varied of 25.58 to 30.90 g. Based on obtained data from variance, it could be concluded that there are very significant differences in grain yield regarding the year of investigation, while among the investigated barley cultivars the differences were not significant. Significant differences in 1000 grain weight at investigated oats cultivars were found relative to the cultivar and very significant differences at yield and grain test weight relative to environmental factors, respectively the year of investigation.

**Key words:** *barley, grain yield, oat, 1000 grain weight*

### Introduction

Grain quality is a qualitative characteristic affected by genetic and environmental factors, as well as their interactions, and therefore the cultivar in individual years can acts as a beer or forage cultivar, what can be test determined and that way the grain can be direct for a particular purpose.

Barley is is used as an important component of beer and malt production, important and quality component in animal feeding, partially in human nutrition as well as a component in processing industry (Djekic et al., 2012.a). In pigs' diet barley can be used without any limitation as the only or primary source of energy. As a top-quality forage crop plant, barley is used as fodder unit in meals balancing in animal feed (Djekic et al., 2010).

Creation of genotypes with high yield potential, expressed through the yield components in appropriate environmental conditions, which in some of the new varieties successfully combined with good technological quality and high tolerance to drought represent barley production improvement (Malesevic et al., 2010). Agronomic cultivar value depends not only on its genetic potential for yield, but also on its ability to achieve genetic potential under different conditions of production (Mladenovic et al., 2009). Yield is largely dependent on the genetic potential, which could be defined as yield of variety which was

grown in conditions on which it had been adapted, with adequately amounts of water and nutrients and efficient control of pests, diseases, weeds and other stresses (Djekic et al., 2011). Yields considerably vary primarily as a result of agro-ecological conditions during the growing season (Djekic et al., 2010).

Barley cultivars which were in production until the end of the eighties were characterized by the lower yields, good technological quality and higher stem sensitive on lodging. Lower resistance on lodging, these cultivars were grown at modest soils and therefore they had lower yields due to. New varieties are characterized by good technological quality, better resistance on lodging and diseases, shorter stem and more efficient assimilates usage (Przulj et al., 2004). Malting barley is expected to have 1000 grain weight of 40 and 46 g and test weight of 68 to 75 kg/hl (Paunovic et al., 2006).

The oat is very important small grains cereal by many aspects. Its seed and straw have specific chemical quality. The seed is rich by qualitative and soluble protein, oil and vitamins. However, the oat is desirable as in rehabilitate diet however in children and older one, too. The oat grain is used in food, cosmetic and other industries for getting so plenty products (Nikolic et al., 2004). The most the widest oat using is in feeding, of course, addition its grain and straw in feeding of horses, cows, hens contribute to getting more qualitative animal origin products (Djekic et al., 2012.b).

The aim of this study was determination of the cultivars and ecological environmental which influence on affect differences in stability and adaptability of cultivars regard the grain yield, 1000 grains weight and test weight of tested spring barley and oats cultivars, as well as specificity cultivars exploring regard growing seasons conditions.

## **Materials and methods**

### **Materials and field trials**

Two cultivars of spring barley (Jadran and Dinarac) and three cultivars of spring oat (Slavuj, Lovćen i Vranac) were investigated cultivated in the Center for Small Grains in Kragujevac during 2009, 2010 and 2011 growing seasons. Experiments have been conducted in randomized block systems, with a plot size of 10 m<sup>2</sup> (2 m x 5 m) in two replicates. The usual techniques for barley and oat production were applied, and it was done in the optimum sowing time. 250 kg/ha of fertilizer NPK 15:15:15 was added in the fall on the investigated plots, while during the spring fertilization, 250 kg/ha (KAN) was supplemented. The following properties were analyzed: grain yield (t/ha), 1000 grain weight (g) and test weight (kg/hl).

On the basis of achieved research results the usual variational statistical indicators were calculated: average values, error of the mean (arithmetic) and standard deviation. Statistical analysis was made in the module Analyst Program SAS/STAT (SAS Institute, 2000.).

### **Soil and weather conditions**

Before the commencement of the experiment soil samples were taken from the sample surface and the chemical analysis of soil was performed. According to obtained results it was revealed that the soil belongs to the smonitza type, with relatively high clay content, and unfavorable physical properties. The humus content in the surface layer of soil was low (2.15-2.85%), and a substitution and total hydrolytic acidity were quite high (pH H<sub>2</sub>O=5.35-6.20, KCl=4.25-5.15). The soil was medium provided with total nitrogen (0,11-0,13% N) and easily accessible potassium (11-15 mg/100 g soil K<sub>2</sub>O), while the available phosphorus content was low (under 10 mg/100 g of soil P<sub>2</sub>O<sub>5</sub>).

Table 1. Middle monthly air temperature ( $^{\circ}\text{C}$ ) and precipitation amount (mm), Kragujevac

Interval	Months						Average
	III	IV	V	VI	VII	VIII	
Average	Mean monthly air temperature ( $^{\circ}\text{C}$ )						
2009	6.8	13.4	17.8	20.2	22.5	22.3	17.17
2010	7.2	12.1	16.5	20.2	23.1	22.1	16.87
2011	7.2	12.0	15.8	20.9	22.8	22.9	16.93
1980-2004	6.1	11.6	16.7	19.8	22.2	21.1	16.25
Average	The amount of rainfall (mm)						
2009	40.3	16.8	46.0	137.8	25.2	56.2	322.3
2010	43.3	142.2	116.7	196.7	14.8	59.6	573.3
2011	20.4	20.8	65.8	32.3	62.4	27.1	228.8
1980-2004	56.3	67.8	51.8	68.3	59.6	94.2	398.0

The area of Kragujevac characterized by moderate continental climate, which general feature is uneven distribution of rainfall by month. The data in Table 1 for the investigated period (2009-2011) clearly indicate that the years in which the researches were conducted differed from the typical multi-year average of Kragujevac region regard the meteorological conditions. The average air temperature in 2009, 2010 and 2011 years, increase  $0.92^{\circ}\text{C}$ ,  $0.62^{\circ}$  and  $0.68^{\circ}\text{C}$ , respectively in the 2010 years more research to 175.3 mm and 75.7-169.2 mm lower than the average of 2009 and 2011 years and with a very uneven distribution of precipitation per month. Spring months April, May and June 2010 were with overly precipitation, which affected unfavorable on the crops. During the April in 2010 it was 142.2 mm of rainfall, what was 74.4 mm more compared with the perennial average. In May of 2010 it was 116.7 mm of rainfall, what was 64.9 mm more compared with the perennial average. In June of 2010 the amount of rainfall was 128.4 mm higher compared to the average precipitation, while during 2011 it was lower by 36.0 mm compared to the perennial average. In the second year 2010 recorded large amounts of precipitation in April, May and June, leading to crop lodging and lower grain yield compared to the second year of research.

### Results and discussion

Average values of yield (t/ha), 1000 grain weight (g) and test weight (kg/hl) of investigated Kragujevac's spring barley and oat cultivars grown at the Center for Small Grains in Kragujevac during three growing seasons, 2009, 2010 and 2011 years, presented in the Table 2.

Barley and oat yields have varied considerably in the 2009-2011 period. All genotypes had statistically significantly higher yields in 2009 compared to 2010 and 2011. Average grains yield observed in the of 2009 and 2010 years was the highest at Dinarac variety (5.667 t/ha and 2.037 t/ha). During the first year of investigations, cultivar of oats Lovćen achieved the highest grains yield (4.518 t/ha), followed by Slavuj (4.481 t/ha), while the lowest yield was at Vranac cultivar (3.383 t/ha). During the second year of investigations (2010), the yield of Lovćen cultivar was the highest with 2.592 t/ha, while the slightly lower yield was realized by Slavuj cultivar (2.333 t/ha). Vranac cultivar achieved significantly lower yields (2.140 t/ha). Achieved yields on tested varieties of barley in 2011 year were not significantly different. Average grains yield of barley observed in the three-year period was the highest at Dinarac variety (3.421 t/ha). The average yield for all investigated varieties oats was 3.143 t/ha, and varied from 2.977 t/ha (Vranac) to 3.293 t/ha (Slavuj). According Paunovic et al.

(2006), Jelic et al. (2007) and Djekic et al., (2011) considerable variation on yield depending on years were established.

Table 2. Average values of investigated barley and oats cultivars characteristics

<b>Spring barley</b>		<b>Grain yield, (t/ha)</b>		
Cultivars	2009	2010	2011	Average
Jadran	5.148	1.925	2.571	3.215
Dinarac	5.667	2.037	2.560	3.421
Average	5.407	1.981	2.565	3.318
		<b>1000 grain weight, (g)</b>		
Jadran	41.70	42.60	45.40	43.23
Dinarac	40.20	42.30	43.20	41.90
Average	40.95	42.45	44.30	42.56
		<b>Test weight, (kg/hl)</b>		
Jadran	61.40	59.86	56.60	59.29
Dinarac	57.30	58.87	58.20	58.12
Average	59.35	59.36	57.40	58.70
<b>Spring oats</b>		<b>Grain yield, (t/ha)</b>		
Slavuj	4.481	2.333	3.036	3.283
Lovcen	4.518	2.592	2.393	3.168
Vranac	3.383	2.140	3.409	2.977
Average	4.127	2.355	2.946	3.143
		<b>1000 grain weight, (g)</b>		
Slavuj	29.52	25.58	28.14	27.75
Lovcen	30.72	27.08	26.90	28.23
Vranac	30.90	27.27	28.85	29.01
Average	30.38	26.64	27.96	28.33
		<b>Test weight, (kg/hl)</b>		
Slavuj	47.15	45.45	46.25	46.28
Lovcen	46.95	43.90	44.80	45.22
Vranac	47.85	46.00	46.30	46.72
Average	47.32	45.12	45.78	46.07

Statistically significantly higher yields in 2009 primarily were achieved because of the result of heavy rainfalls and their good distribution as well as favorable air temperatures during the vegetation period (Tab. 1). Djekic et al. (2012.a) in his research states that the air temperatures and the rainfall amount and distribution during the barley growing season have the greatest impact on high yields and grain quality. Yield is largely dependent on the genetic potential, which could be defined as yield of variety which was grown in conditions on which it had been adapted, with adequately amounts of water and nutrients and efficient control of pests, diseases, weeds and other stresses (Popovic et al. (2011).

Average 1000 grain weight observed in the period 2009, 2010 and 2011 years was the highest at barley Jadran variety. During the 2009, 2010 and 2011 years of investigation, Vranac cultivar achieved the highest average 1000 grain weight (30.90 g; 27.27 g and 28.85 g) compared with other tested oats cultivars. During the three-year period was of investigation the lowest average value of 1000 grain weight achieved the barley Dinarac cultivar (41.90 g), and oats by Slavujcultivar (27.75 g).

The highest test weight, 2009 and 2010, was achieved barley Jadran cultivar (61.40 kg/ha and 59.86 kg/ha). The oat cultivar Vranac has achieved the highest test weight in three years of investigation compared to other tested oat cultivars (47.85 kg/hl; 46.00 kg/hl and

46.30 kg/hl). The average three-year value of test weight at barley Jadran cultivar was 59.29 kg/hl, while the highest average three-year value was at oats Vranac cultivar (46.72 kg/hl).

Grain of investigated barley and oats cultivars was characterized by good physical characteristics; especially regard the test weight and 1000 grain weight. Realized average values of these characteristics in the study were slightly higher than the values obtained by Nikoli et al. (2004) and Djekic et al. (2011).

Table 3 Analysis of variance of the traits of spring barley and oats

Parameter	$F_{exp}$		$F_{exp}$	
	Cultivar	Year	Cultivar	Year
	Spring barley		Spring oats	
Grain yield, (t/ha)	0.019	142.962**	0.069	10.020**
1000 grain weight (g)	0.875	4.706	0.304	13.500*
Test weight (kg/hl)	0.613	0.753	1.288	5.365**

Based on the analysis of variance, it can be concluded that there are very significant differences in grain yield regard the year of investigation ( $F_{exp}=142.962^{**}$ -barley and  $F_{exp}=10.020^{**}$ -oats), while among the investigated barley and oats cultivars the differences were not significant. Significant differences in 1000 grain weight at investigated oats cultivars were found relative to the year and very significant differences at grain test weight relative to environmental factors, respectively the year of investigation. Our results are consistent with the results of Djekic et al. (2010), where the authors state that the growing conditions in the observed years had a significant impact on yield.

### Conclusion

Based on the gain results during three-year investigation on four Kragujevac's two cultivars of spring barley and three cultivars of spring oat, it can be concluded that the highest yield achieved the barley Dinarac cultivar 3.421 t/ha, and spring oata Slavuj cultivar 3,283 t/ha. During 2009, statistically significantly higher grain yield per area unit as well as was achieved, compared with 2010 and 2011. Average values of 1000 grain weight of barley cultivars varied in the range from 40.20 to 45.40 g, during of oat cultivars varied of 25.58 to 30.90 g. Highly significant affect of the year on grain yields was established at investigated spring barley and oats cultivars by variance analysis. Significant differences in 1000 grain weight at investigated oats cultivars were found relative to the cultivar and very significant differences at grain test weight relative to environmental factors.

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