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STABILITY OF WHEAT YIELD ON ACID SOIL IN THE PRODUCTION OF SAFE FOOD

Abstract

The investigation was carried out on the experimental field of Small Grains Research Center, Kragujevac. This paper presents the results of winter wheat varieties (Takovčanka, KG 100, KG 56S, Ana Morava and Lazarica). Grain yield, 1000 kernel weight and test weight in grain the investigated wheat cultivars was determined in a two-year field experiment. Average grain yield of wheat cultivars ranged from 3.011 t/ha to 3.774 t/ha. Grain yield differed significantly between years and the average of all cultivars was higher in 2006/07. By examining the physical properties of grain, Ana Morava was achieved the highest average yield in both growing seasons (3.049 t/ha; 4.499 t/ha). Average values of 1000 grain weight of wheat varied in the range from 36.23 to 42.70 g.

Key words: 1000 grain weight, grain yield, wheat

INTRODUCTION

Winter wheat (*Triticum aestivum* L.) is one of the most important crops in Serbia, and sown on about 530,000 ha per year. The average yield of wheat last 10 years in the major production areas of Serbia ranging from 4.5 to 8.0 t/ha. For a

successful and stable wheat production is necessary synergism high-yielding varieties, optimal growing conditions, application of modern agricultural practices and plant protection. Grain yield is a complex trait that depends on the genotype and the environmental conditions in which plants are grown (Đekić et al., 2010; Đurić et al., 2012, 2013; Milovanović et al., 2011; Perišić et al. 2011). Production of wheat with high grain yield and quality is appropriate only possible choice of high-quality varieties, but with the proper growing conditions and appropriate production technologies.

Development of new production technologies and quality improvement of traditional wheat products are important for the competitiveness and food safety of these products both on domestic and international markets. Quality of wheat-based products is the key factor which secures their position on the market. In other words, it calls for continual development of high-yielding wheat varieties as a way of creating a brand name of high quality raw materials for the milling and baking industries (Kosanović, 2007).

Vegetation during the year (2005/07) in field trials in the grounds of the Center for Small Grains, Kragujevac examined the five varieties of winter wheat, with the aim of determining the selection of the best varieties for the production requirements Serbia.

MATERIALS AND METHODS

Materials and field trials

During the 2005/06 and 2006/07 growing seasons, five cultivars of winter wheat were investigated, cultivated at the Center for Small Grains in Kragujevac. The cultivars Takovčanka, KG 100, KG 56S, Ana Morava and Lazarica had been investigated. Experiments have been conducted in randomized block systems, with a plot size of 10 m² in five replicates. The usual techniques for wheat production were applied, and it was done in the optimum sowing time in late October. 120 kg/ha N, 100 kg/ha P₂O₅ i 80 kg/ha K₂O of fertilizer NPK 8:24:16 was added in the fall on the investigated plots, while during the spring fertilization, AN (17% N) 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. On the basis of obtained results it was revealed that the soil belongs to the vertisol type, with relatively

high clay content, and unfavorable physical properties. The humus content in the surface layer of soil was low (2.22%), and a substitution and total hydrolytic acidity were quite high (pH H₂O=5.39, KCl=4.43). The soil was medium provided with total nitrogen (0.11-0.13% N) and easily accessible potassium (10-14 mg/100 g soil K₂O), while the available phosphorus content was low (under 10 mg/100 g of soil P₂O₅).

Table 1. Middle monthly air temperature and precipitation amount (Kragujevac)

Months	Mean monthly air temperature (°C)			The amount of rainfall (mm)		
	2005/06	2006/07	Average	2005/06	2006/07	Average
VIII	20.0	20.7	22.7	117.8	141.9	58.5
IX	17.4	17.7	16.6	115.6	57.4	62.7
X	11.5	13.3	12.5	49.0	16.7	45.4
XI	5.7	7.6	6.9	54.8	13.7	48.9
XII	3.4	3.5	1.9	47.9	51.9	56.6
I	1.4	-1.7	0.5	36.6	27.9	58.2
II	-1.7	1.5	2.4	66.9	38.1	46.6
III	4.7	5.6	7.1	44.5	116.1	32.4
IV	11.6	12.7	11.6	69.0	86.3	51.9
V	16.5	16.4	16.9	70.2	29.6	57.6
VI	19.3	19.7	20.0	50.8	84.8	70.4
VII	21.7	23.0	22.0	86.2	22.4	71.5
Average	11.0	11.7	11.8	809.3	686.8	660.7

Kragujevac area is characterized by a moderate continental climate, which general feature is uneven distribution of rainfall by month. The data in Table 1 for the investigated period (2005-2007) 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 2005/06 and 2006/07 years, an reduced of 0.8°C and 0.1°C, and precipitation in the same years more research to 148.6 mm and 26.1 mm lower than the average of many years and with a very uneven distribution of precipitation per month. Spring months April, May and June 2005/06 were with overly precipitation, which affected unfavorable on the crops. During the Mart in 2006/07 it was 116.1 mm of rainfall, what was 83.7 mm more compared with the perennial average. In May of 2005/06 it was 70.2 mm of rainfall, what was 12.6 mm more compared with the perennial average.

RESULTS AND DISCUSSION

Average values of yield (t/ha), 1000 grain weight (g) and test weight (kg/hl) at investigated Kragujevac's winter wheat cultivars grown at the Center for Small Grains in Kragujevac during two growing seasons, 2005/06 and 2006/07, are presented in the

Table 2.

During the first year of investigations, cultivar Ana Morava achieved the highest grains yield (3.049 t/ha), followed by KG 56S (3.001 t/ha), while the lowest yield was at KG 100 cultivar (2.300 t/ha). During the second year of investigations, the yield of Ana Morava cultivar was the highest with 4.499 t/ha, while the slightly lower yield was realized by Lazarica cultivar (4.014 t/ha). Average grains yield observed in the two-year period was the highest at Ana Morava variety (3.774 t/ha), while the lowest yield was obtained by KG 100 cultivar (3.011 t/ha). Considerable variation in grain yield on years depending of research have established Đekić et al. (2010), Đurić et al. (2012, 2013) and Perišić et al. (2011).

Table 2. Average values of the traits of wheat

Cultivars	2005/06		2006/07		Average	
	\bar{x}	S	\bar{x}	S	\bar{x}	S
Grain yield (t ha ⁻¹)						
Takovčanka	2.445	0.558	3.856	0.705	3.150	0.955
KG 100	2.300	0.598	3.723	0.765	3.011	0.991
KG 56S	3.001	0.550	3.744	1.054	3.372	0.884
Ana Morava	3.049	0.819	4.499	1.132	3.774	1.205
Lazarica	2.961	0.606	4.250	1.774	3.605	1.423
Average	2.751	0.661	4.014	1.097	3.383	1.100
1000 grain weight (g)						
Takovčanka	40.080	3.140	38.420	3.887	39.250	3.444
KG 100	38.520	0.487	40.620	1.731	39.570	1.632
KG 56S	42.760	0.493	42.640	2.327	42.700	1.587
Ana Morava	39.980	2.198	38.260	2.764	39.120	2.523
Lazarica	37.020	1.226	35.440	2.373	36.230	1.966
Average	39.672	2.561	39.076	3.501	39.374	3.051
Test weight (kg hl ⁻¹)						
Takovčanka	71.890	3.976	77.040	4.908	74.465	5.010
KG 100	66.500	2.015	74.450	1.497	70.475	4.512
KG 56S	71.730	3.192	77.020	1.394	74.375	3.629
Ana Morava	72.730	1.853	73.730	4.014	73.230	2.994
Lazarica	70.920	3.950	72.930	1.246	71.925	2.958
Average	70.754	3.639	75.034	3.265	72.894	4.047

Achieved statistically significantly higher yields in 2006/07 were, primarily, the result of heavy rainfall and their good distribution as well as favorable air temperatures during the vegetation period (Table 1). Đekić et al. (2012) in his research states that the air temperatures and the rainfall amount and distribution during the wheat growing season have the greatest impact on high yields and grain quality.

The wheat KG 56S cultivar achieved the highest average 1000 grain weight during the both years of investigation (42.76 g and 42.64 g) compared with other tested barley cultivars. During the both years of investigation the lowest average value of 1000 grain weight achieved the Lazarica cultivar (37.02 g and 35.44 g). A number of

authors (Đekić et al. 2010, 2012; Đurić et al. 2012; Jelić et al. 2013) underline that 1000-grain weight is a cultivar-specific trait, with considerably higher variations being observed among genotypes than among treatments or environmental factors.

The average two-year value of test weight at Takovčanka cultivar was (74.465 kg/hl) and KG 56S cultivar (74.375 kg/hl), while the lowest average two-year value was at KG 100 cultivar (70.475 kg/hl).

Grain of investigated wheat 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 lower than the values obtained by Đekić et al. (2010, 2012).

Table 3. Analysis of variance of the traits of wheat (ANOVA)

Effect of year on the traits analyzed				
Traits	Mean sqr Effect	Mean sqr Error	F(df1,2)	p-level
Grain yield (t/ha)	19.9510	0.82007	24.328**	0.000010
1000 grain weight (g)	4.4402	9.40908	0.472	0.495417
Test weight (kg hl ⁻¹)	228.9800	11.95132	19.159**	0.000065
Effect of cultivars on the traits analyzed				
Traits	Mean sqr Effect	Mean sqr Error	F(df1,2)	p-level
Grain yield (t/ha)	0.98727	1.23034	0.802	0.530082
1000 grain weight (g)	52.66330	5.45384	9.656**	0.000010
Test weight (kg hl ⁻¹)	28.91205	15.26656	1.894	0.128014
Effect of the year x cultivars interaction on the traits analyzed				
Traits	Mean sqr Effect	Mean sqr Error	F(df1,2)	p-level
Grain yield (t/ha)	0.22074	0.863284	0.256	0.904470
1000 grain weight (g)	6.78670	5.345900	1.269	0.297976
Test weight (kg hl ⁻¹)	19.47325	9.503050	2.049	0.105791

*Statistically significant difference ($P < 0.05$) **Statistically high significant difference ($P < 0.01$)

Based on the analysis of variance, it can be concluded that there are very significant differences in grain yield regard the year of investigation ($F_{\text{exp}}=24.328^{**}$), while among the investigated wheat cultivars the differences were not significant. Very significant differences in 1000 grain weight at investigated wheat cultivars were found relative to the cultivar and very significant differences at grain test weight relative to environmental factors, respectively the year of investigation. Our results are consistent with the results Đekić et al. (2010, 2012) and Jelić et al. (2013), where the authors state that the growing conditions in the observed years had a significant impact on yield.

CONCLUSIONS

Based on the gain results during two-year investigation on five Kragujevac's winter wheat cultivars, it can be concluded that the highest yield achieved the cultivar Ana Morava. Takovčanka, KG 56S and Lazarica cultivars have achieved satisfactory results, while the poorest results were achieved by the cultivar KG 100. During 2006/07, statistically significantly higher grain yield per area unit as well as 1000 grain weight and test weight was achieved, compared with 2005/06. Highly significant influence of the year on grain yields and test weight was established at investigated winter wheat cultivars by variance analysis, while genotype influence on 1000 grain weight was very statistically significant.

Environmental conditions (weather and soil) have a significant effect on grain yield and quality in wheat. Grain yield shows a tendency to increase in the years having a higher total amount and better distribution of rainfall during critical plant development stages.

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