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EFFECT OF GROWING SEASONS ON SOME QUALITY PROPERTIES OF WINTER WHEAT GENOTYPES

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Abstract

In this research, 16 genotypes of winter wheat (*Triticum aestivum* L.) were analyzed where 15 genotypes represent perspective lines created in Center for Small Grains in Kragujevac and one standard cultivar. Field experiment was conducted in three growing seasons (2012/13, 2013/14 and 2014/15) on the experimental field of Center for Small Grains in Kragujevac (Serbia). Some grain quality parameters (hectoliter weight and 1000 grain weight) were analyzed in this paper. In average for three years, values of hectoliter weight varied from 76.65 kg hl^{-1} (KG-60-3/3) to 80.05 kg hl^{-1} (KG-1/6). The analyses of variance showed highly significant differences in hectoliter weight between genotypes (F=4.554**) and investigated years (F=150.082 **), but interaction genotype x year was significant (F=1.629*). The highest values of 1000 grains weight expressed line KG- 52/23 (46.75 g) and the lowest line KG-28/6 (39.90 g). Compared to the standard cultivar Pobeda, 10 genotypes had higher values of 1000 grains weight. There were highly significant differences in the weight of 1000 grains among genotypes (F=25.011**), investigated years (F=117.267**), as well as their interaction (F=8.684**).

Key words*: wheat, growing seasons, hectoliter weight, 1000 grain weight.*

Introduction

Genetic potential for yield and quality of specific cultivar has a huge influence in its production. However, the true value of cultivar as well as its impact on wheat production depends not only of its productivity, but of its stability in different environmental conditions (Hristov *et al.*, 2007).

The way genotype reacts to different environmental conditions shows stability and it is very useful in selection and agricultural production. The lower the value of the genotype x environment interaction (GE), the more stable the genotype is. Intensive genotypes, such as high-yield cultivars of wheat which require intensive agricultural technology, are very sensitive to agricultural environment and show greater GE interaction (Dimitrijević *et al*., 2006).

When breeding bread wheat, there is always a tendency appropriate breeding terms high-yield and stable genotypes. Wheat yield is very complex and depends on quantitative traits as its compontents. Yield depends on number of spikes per surface area, number of grains per spike and mass of grains per spike (Kraljević-Balalić *et al*., 2001). However, these quanitative traits affect genes with minor effect whose expression depends on enviromental conditions. Research of behavior of genotypes in different agricultural conditions and their interactions with enviroment in which they grow, helps to choose an ideal genotypes for specific areas of growth. It is preferable that new cultivars of wheat, besides high yield potential and quality of grain, has a lower variability of these traits in different agroecological conditions (Zečević *et al*., 2013).

In Centre of Small Grains in Kragujevac, high yield cultivars were always a tendency as well as lower stem and earlier maturity and higher resistance to main biotic and abiotic factors of enviroment (Milovanović *et al*., 2003; Milovanović *et al*., 2012). Besides high yield, maturity and other traits, KG cultivars possess an excellent technological quality for production of bread and pastry (Milovanović *et al*., 2008).

The goal of this research is investigation of influence of ecological factors, genotypes and their interactions on some wheat quality traits.

Material and Methods

In this research, 16 genotypes of winter wheat (*Triticum aestivum* L.) were analyzed where 15 genotypes represent perspective lines created in Center for Small Grains in Kragujevac (KG – 27/6, KG- 244/4, KG – 199/4, KG – 307/4,KG – 331/4, KG – 28/6, KG – 162/7, KG – 40-12/1, KG – 40-39/3,KG – 52/23, KG – 60-3/3,KG – 52/3, KG – 47/21, KG – 191/5-13 and KG – 1/6) and one standard cultivar (Pobeda). The experiment was done in field conditions, on the experimental field of the Center for Small Grains in Kragujevac, during three growing seasons (2012/13, 2013/14 and 2014/15).

The experiment was a randomized complete block design with three replicates on a plot of $5m^{-2}$. It was carried out by the standard technology of scientific farming production of wheat.

Wheat quality characteristics (hectoliter weight and weight of 1000 grains) were analyzed.

Hectoliter weight was determined according to the JUS E.B1.200 method, and the weight of 1000 grains according to JUS E.B1.200 method. The results of the research were studied by Analysis of Variance (ANOVA) according to completely randomized block design with two main factors (genotype and year) and using MSTAT-C statistical program. Evaluation of the importance of difference between average values of studied characteristics was tested by separate LSD test (Hadživuković, 1991). Components of variance (genetic, interaction and environment) were calculated by Falconer (1981).

Results and Discussion

The obtained results are shown in the table 1. The highest average value of 1000 grains weight was achieved by the line KG -52/23 (46.75 g), and the lowest by the line KG – 28/6 (39.91 g).

According to the growing season of research, in all three growing seasons the highest average 1000 grains weight was achieved by the line KG-52/23 (49.06 g, 44.39 g and 46.82 g). In the years 2012/13 and 2013/14 the lowest average 1000 grains weight had the line KG-28/6 (39.6 g and 37.41 g, respectively), while in the third year of the research (2014/2015) the lowest average value of 1000 grains weight had the line KG-27/6 (38.60 g), table 1. The highest average value of 1000 grains weight for all researched lines of wheat was achieved during the year 2012/2013 (45.58 g), and the lowest (41.90 g) during the year 2013/14.

Table 1. Mean values for 1000 grains weight in different growing seasons

Genotype	1000 grains weight (g)			
	Year			Average
	2012/13	2013/14	2014/15	
KG-27/6	43.85ghijklmn	38.96xyz	38.60yz	40.47g
KG-244/4	48.71ab	43.79hijklmn	42.36lmnopqrs	44.95b
KG-199/4	41.66opqrstuv	44.32fghijkl	41.02qrstuvw	42.34f
KG-307/4	44.52fghijk	43.44hijklmno	45.90cdef	44.62bc
KG-331/4	40.41stuvwxy	40.89qrstuvwx	40.10vwxy	40.47g
KG-28/6	39.60wxy	37.41z	42.72klmnopqr	39.91g
KG-162/7	45.46efgh	43.65hijklmno	43.17ijklmnop	44.09bcd
KG-40-12/1	49.67a	43.30ijklmno	45.83defg	46.27a
KG-40-39/3	44.89efghij	42.16mnopqrstu	41.92nopqrstuv	42.99def
KG-52/23	49.06a	44.39fghijk	46.82bcde	46.75a
KG-60-3/3	45.18efghi	40.33tuvwxy	40.86rstuvwx	42.12f
KG-52/3	49.46a	40.86rstuvwx	44.05fghijklm	44.79bc
KG-47/21	48.76ab	41.15pqrstuvw	43.87ghijklmn	44.59bc
KG-191/5-13	47.88abc	40.70rstuvwx	45.42efgh	44.67bc
KG-1/6	47.76abcd	42.91jklmnopq	40.14uvwxy	43.60cde
Pobeda	42.35lmnopqrst	42.15mnopqrstu	43.98fghijklm	42.83ef
Average	45.58a	41.90b	42.92b	-

Distinct letters in the row indicate significant differences according to LSD test ($P \leq 0.05$).

In comparison to the standard cultivar Pobeda, 10 lines had higher average value of the weight of 1000 grains, what indicates that the most of the perspective KG lines are characterized by grains of medium to large size.

Table 2. Analysis of variance for 1000 kernels weight

Source	DF	MS	F	LSD		Components of variance	
				0.05	0.01	σ^2	%
Genotype (A)	15	36.873	25.011**	1.220	1.686	2.675	23.76
Year (B)	2	172.885	117.267**	1.066	2.460	3.335	29.62
AB	30	12.802	8.684**	2.024	2.726	3.776	33.53
Error	94	1.474	-	-	-	1.474	13.09
Total	143	-	-	-	-	11.260	100

* Significant at P = 0.05 level; ** significant at P = 0.01 level

Through the analasys of variance high significant differences were detemined among 1000 grains weight of different genotypes (F=25.011**), then among years of research (F=117,267**), and their interactions as well (F=8.684**). Results of this research are in accordance with the previous research (Hristov *et al*., 2007). Analysis of variance's components has shown that the biggest share in it have the interaction genotype x environment (33.53%), and the year (29.62%), table 2.

Table 3. Mean values for hectoliter weight in different growing seasons

Genotype	Hectoliter weight (kg hl^{-1})			
	Year			Average
	2012/13	2013/14	2014/15	
KG-27/6	79.42bcdefghij	73.06r	77.80hijklmn	76.76f
KG -244/4	80.63abcde	75.78mnopq	77.87ghijklmn	78.09bcdef
KG-199/4	80.70abcde	76.05mnopq	77.37ijklmno	78.04cdef
KG-307/4	78.00fghijklm	74.78qr	77.73hijklmn	76.84f
KG-331/4	78.77efghijk	77.20jklmnop	80.22abcdefg	78.73abcd
KG-28/6	79.00defghij	73.05r	79.20cdefghij	77.08ef
KG-162/7	81.73ab	75.52nopq	79.63bcdefghi	78.96abcd
KG-40-12/1	80.02abcdefgh	74.92pqr	79.97abcdefgh	78.30abcde
KG-40-39/3	80.62abcde	75.72mnopq	80.37abcdef	78.90abcd
KG-52/23	81.43abc	75.65mnopq	79.70bcdefghi	78.93abcd
KG-60-3/3	78.68efghijkl	74.92pqr	76.38lmnopq	76.66f
KG-52/3	80.95abcde	75.98mnopq	81.57abc	79.50ab
KG-47/21	80.68abcde	75.65mnopq	79.70bcdefghi	78.68abcd
KG-191/5-13	81.03abcde	76.45klmnopq	80.70abcde	79.39abc
KG-1/6	81.16abcd	75.85mnopq	82.17a	79.73a
Pobeda	77.52ijklmno	75.25opqr	79.90abcdefgh	77.56def
Average	80.02a	75.36b	79.39a	-

Distinct letters in the row indicate significant differences according to LSD test ($P \leq 0.05$).

The achieved results for the hectoliter weight are shown in the table 3. In period of growing seasons average values of hectoliter weight varied from 76.66 kg hl^{-1} (KG-60-3/3) to 79.73 kg hl^{-1} (KG-1/6). In the first year of the research, the highest average value of the hectoliter weight had the line KG-162/7 (81.73 kg hl^{-1}), and in the second year the line KG-331/4 (77.20 kg hl^{-1}). In the year 2014/2015 the line KG-1/6 had achieved the highest average value of the hectoliter weight (82.17 kg hl^{-1}). The highest average value of hectoliter weight of all researched wheat lines was determined in the 2012/13 growing season (80.02 kg hl^{-1}), and the lowest (75.08 kg hl^{-1}) in the 2013/14 growing season. In comparison to the standard cultivar (Pobeda), 11 lines had higher value of hectoliter weight.

Analysis of variance (Table 4) has shown highly significant differences in hectoliter weight among genotypes (F=4.554**), researched years (F=150.082**), as well as the differences in interaction genotype x year (F=1.629*). The results are in accordance with the previously

obtained results (Kaya and Akcura, 2014; Ayalew *et al*., 2014; Zečević *et al*., 2012). Through the analysis of the variance's components it was determined that the biggest share of the variance has year (66.59 %).

Table 4. Analysis of variance for hectoliter mass

Source	DF	MS	F	LSD		Components of variance	
				0.05	0.01	σ^2	%
Genotype (A)	15	9.301	4.554**	1.436	1.985	0.664	7.08
Year (B)	2	306.536	150.082**	1.255	2.895	6.247	66.59
AB	30	3.328	1.629*	2.383	3.209	0.429	4.57
Error	94	2.042	-	-	-	2.042	21.76
Total	143	-	-	-	-	9.382	100

* Significant at P = 0.05 level; ** significant at P = 0.01 level

Hectoliter weight and the 1000 grains weight are genetically controled traits, which can vary a under the influence of the environment. Lines examined in these researches had different values of hectoliter and 1000 grains weight in the years of examination what indicates to the reaction of a genotype to different conditions during its development. Moreover, it was determined that among the examined lines of wheat the analyzed traits were also different, what indicates that these genotypes are specific.

Conclusion

Values of the examined traits of wheat's quality were different in different years of research, what indicates variabilty of results for the influence of genetical and ecological factors, and their interaction. It is also detemined that the values of hectoliter weight varied from 76.66 kg hl^{-1} (KG-60-3/3) to 79.73 kg hl^{-1} (KG-1/6). Analysis of variances established highly significant differences among the 1000 grains weight between genotypes, years of research and their interaction.

The line KG- 52/23 (46.75 g) had the highest average value of 1000 grains weight, but the lowest value was achivedby KG-28/6 (39.91 g). In this research, highly significant differences were established in the weight of 1000 grains between genotype x year and their interactions.

Hectoliter weight and 1000 grains weight can be used as preliminary indicators for evaluation of productivity and quality of wheat cultivars. For the expression of these characteristics, enviromental factors as well as genetic factors are very important.

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