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EFFECT OF GENOTYPE AND ENVIRONMENT ON WHEAT QUALITY

Veselinka ZEČEVIĆ[1], Desimir KNEŽEVIĆ[2], Jelena BOŠKOVIĆ[1] and Milomirka MADIĆ[3]

[1]Megatrend University Belgrade, Faculty of Biofarming Bačka Topola, Serbia,
[2]Faculty of Agriculture, Zubin Potok, Serbia
[3] Faculty of Agronomy, Čačak, Serbia

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Five winter wheat cultivars created in Small Grains Research Centre of Kragujevac (Ana Morava, Toplica, Vizija, Takovčanka and Lazarica) were grown at the macro field trial in three locations (Kragujevac, Sombor and Bačka Topola) during three years (2004-2006). Influence of genetic and agro-ecological conditions of locations on wheat quality components (sedimentation value and wet gluten content) was investigated. The analysis of variance suggested there were highly significant differences

Corresponding author: Prof. dr Veselinka Zečević, Megatrend University Belgrade, Faculty of Biofarming, Maršala Tita 39, Bačka Topola, Serbia, phone + 381 24 718515, e-mail: joca@kg.ac.rs

among genotypes (G), investigated years (Y) and locations (L) for sedimentation value and wet gluten content. Apart from individual influence of the factors, their interactions (G x Y, G x L, Y x L, G x Y x L) were also high significant for both investigated traits. In average the highest sedimentation value (40.6 ml) and wet gluten content (31.85 %) established at Bačka Topola locality. The highest value of all investigated cultivars and localities established at cultivar Vizija (45.3 ml) in Bačka Topola, while the lowest at Lazarica (31.7 ml) in Sombor. The highest wet gluten content was measured at Bačka Topola locality by cultivar Toplica (38.53 %). In this investigation Bačka Topola locality was favourable for both investigated quality traits.

Key words: genotype-environment interaction, gluten content, quality, sedimentation value, wheat

INTRODUCTION

The successful process of wheat breeding based of the knowledge of characteristics of the genotypes as well as the interaction genotype and location. Understanding of the cause of genotype by environment interaction can be used to established breeding objectives, identify ideal test conditions, and formulate recommendations for areas of optimal cultivar adaptation (WEIKAI and HUNT (2001). The presence of genotype-environment interaction complicates selection of superior genotypes and understanding of environmental and genotypic causes of significant genotype-environment interaction is important in all stages of plant breeding (DHUNGANA *et al*., 2007). Environmental factors play a main role in the expression of genotype characteristics (PETERSON *et al*., 1998). The ideal cultivar for high grain yield and technological quality need to express genetic potential in different environmental factors of growing.

The success of plant breeding and production depents not only on genetic but on environmental factors as well. There are significant phenotypic differences among wheat genotypes with regard to grain and flour quality (MLADENOV *et al*., 2001). In addition to the genotypic mean for any trait, the breeder is also interested in its stability, which depends on genotype x environment interaction.

The aim of this work was to study the effect of genotype and environment on the technological quality of winter wheat cultivars.

MATERIALS AND METHODS

Five winter wheat cultivars created in Small Grains Research Centre of Kragujevac (Ana Morava, Toplica, Vizija, Takovčanka and Lazarica) were grown at the macro trial at experimental field in three locations (Kragujevac, Sombor and Bačka Topola) during three years (2004-2006). Influence of genetic and agro-ecological conditions of locations on wheat quality components (sedimentation value

and wet gluten content) was investigated. The quality analysis of Zeleny sedimentation test and wet gluten content were determined according to ICC standard methods No. 116/1 and 106/2, respectively (1972, 1984).

The analysis of variance was calculated according to randomize complete block design with three factors: genotype (G), year (Y) and location (L). The significant differences among the means evaluated according to least significant difference (LSD) test (HADŽIVUKOVIĆ, 1991).

RESULTS AND DISCUSSION

Zeleny sedimentation.-The sedimentation value varied in accordance with genotype, locations and years (Table 1). Average sedimentation value ($\bar{x}$ **G**) ranged from 34.2 ml (Lazarica) to 37.5 ml (Ana Morava). Genotypes reacted differently on investigated locations. According to locations means, the highest sedimentation value for all cultivars achieved in Bačka Topola (40.6 ml), while the lowest in Sombor (33.7 ml). Location Bačka Topola was favourable for both investigated quality traits. The highest value of all investigated cultivars and localities for sedimentation value established in Bačka Topola locality by cultivar Vizija (45.3 ml), while the lowest in Sombor locality by cultivar Lazarica (31.7 ml).

Analysis of variance showed highly significant differences among genotypes (G) investigated years (Y) and locations (L) for sedimentation value. Apart from individual influence of the factors, their interactions (G x Y, G x L, Y x L, G x Y x L) were also high significant for this trait (Table 1). The strongest individual influence for sedimentation value had location ($F=142.103^{**}$) and year ($F=112.333^{**}$), and than interaction Y x L ($F=29.822^{**}$). Genotype and environment had stronger influence on the variance for the sedimentation value than the genotype x environments effects. PETERSON *et al*. (1998) and BARIĆ *et al*. (2004) also obtained low G x E interaction for quality traits. Similar results for investigation of genotype-environment interactions for quality traits established by several authors (PETERSON *et al*., 1998, ZEČEVIĆ *et al*., 2006, DREZNER *et al*., 2007, MORIS *et al*., 2009).

Wet gluten conten.- Wet gluten content was significantly different between analyzed cultivars, years and locations (Table 2). All of analyzed cultivars had wet gluten content above 26 %, what mean that they possess good bread-making quality. Cultivar Toplica had wet gluten content above 34 % on all of three locations in average for three years. The highest wet gluten content was measured at location Bačka Topola by cultivar Toplica (38.53 %). This cultivar had the highest value of wet gluten content in average for all investigated locations (36.04 %), while cultivar Takovčanka had the lowest wet gluten content in average for all locations (27.46 %). According to locations means, the highest wet gluten content was measured at location Bačka Topola (31.85 %), while the lowest at location Kragujevac (29.18 %).

Statistically significant differences for wet gluten content were found among genotypes (G), years (Y) and locations (L). Among from individual influence of the factors, their interactions (G x Y, G x L, Y x L, G x Y x L) were also high significant (Table 2). The strongest individual influence for wet gluten content had

genotype (F=464.644**) and than location (F=119.917**). It means that grain quality of winter wheat cultivars is genetically determined (SOUZA *et al*., 2004, EREKUL and KÖHN, 2006, ZEČEVIĆ *et al*., 2007). The interaction of genotype and year (F=171.523**) had strong and highly significant influence on wet gluten content. Similar results described by DREZNER *et al*. (2006, 2007) and BARIĆ *et al*. (2004).

Table 1. Mean values (ml) and analysis of variance for sedimentation value

Genotype (G)	Location (L)			*x* **G**	
	Kragujevac	Sombor	Bačka Topola		
Ana Morava	39.0	34.7	38.7	37.5	
Toplica	34.0	32.7	45.0	37.2	
Vizija	33.0	34.0	45.3	37.4	
Takovčanka	34.0	35.3	39.7	36.3	
Lazarica	36.7	31.7	34.3	34.2	
x **L**	35.3	33.7	40.6	36.5	
				LSD	
Source	DF	MS	F	0.05	0.01
Genotype (G)	4	88.60	20.087**	1.587	2.632
Year (Y)	2	495.50	112.333**	1.905	4.394
G x Y	8	58.07	13.165**	2.283	3.322
Location (L)	2	626.81	142.103**	1.905	4.394
G x L	8	88.66	20.100**	2.283	3.322
Y x L	4	131.54	29.822**	2.129	3.531
G x Y x L	16	83.18	18.859**	3.635	5.009

Table 2. Mean values (%) and analysis of variance for wet gluten content

Genotype (G)	Location (L)			*x* **G**	
	Kragujevac	Sombor	Bačka Topola		
Ana Morava	29.57	31.52	32.47	31.19	
Toplica	34.23	35.35	38.53	36.04	
Vizija	28.51	29.82	30.58	29.64	
Takovčanka	26.64	27.25	28.48	27.46	
Lazarica	26.94	28.69	29.19	28.27	
x **L**	29.18	30.53	31.85	30.52	
				LSD	
Source	DF	MS	F	0.05	0.01
Genotype (G)	4	311.126	464.644**	0.618	1.026
Year (Y)	2	48.375	72.245**	0.742	1.713
G x Y	8	114.852	171.523**	0.890	1.295
Location (L)	2	80.296	119.917**	0.742	1.713
G x L	8	3.622	5.410**	0.890	1.295
Y x L	4	2.908	4.343**	0.830	1.376
G x Y x E	16	2.624	3.919**	1.417	1.952

Environmental factors through different investigated years strongly influenced the sedimentation value and wet gluten content, even though there was also a significant genotype effects shown by analysis of variance. This large difference in variance between environmental and genotypic influences clearly demonstrates the importance of growing-season weather impact on quality for adapted bread wheat genotypes and strategies to mitigate these (FINLAY *et al.*, 2007). This strong influence of environment on quality traits of wheat is in agreement with results of previous investigations (DREZNER *et al.*, 2007, ZEČEVIĆ *et al.*, 2007, WILLIAMS *et al.*, 2008). Grain quality is a complex character that depends on a number of traits, and the individual contribution of each trait varies depending on specific reaction to environmental conditions. For an effective selection for a particular trait, it is important to define the conditions of its maximum phenotypic expression (MLADENOV, 2001). The information on different types of genotype x environment interactions is necessary when allocating material and effort to replications, locations and years. Significant genotype x environment interaction was found for both quality traits studied. This would mean that evaluation of breeding lines of several environments would give a more accurate estimate of their quality potential (BHATT and DERERA, 1975).

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UTICAJ GENOTIPA I EKOLOŠKIH FAKTORA NA KVALITET PŠENICE

Veselinka ZEČEVIĆ[1], Desimir KNEŽEVIĆ[2], Jelena BOŠKOVIĆ[1]
i Milomirka MADIĆ[3]

[1]Megatrend univerzitet, Fakultet za biofarming, Bačka Topola, Srbija
[2] Poljoprivredni fakultet, Zubin Potok, Srbija
[3]Agronomski fakultet, Čačak

I z v o d

U radu je ispitivano pet sorti ozime pšenice (Ana Morava, Toplica, Vizija, Takovčanka i Lazarica) stvorenih u Centru za strna žita u Kragujevcu. Analizirani su parametri tehnološkog kvaliteta (sedimentaciona vrednost i sadržaj vlažnog glutena) na uzorcima iz makroogleda koji su izvedeni na tri lokaliteta (Kragujevac, Sombor i Bačka Topola) tokom tri godine (2004-2006). Ispitivan je uticaj genotipa i ekološkoh faktora na tehnološki kvalitet pšenice. Analizom varijanse utvrđene su visoko značajne razlike između sorti, ispitivanih godina i lokaliteta za obe osobine kvaliteta. Osim pojedinačnih uticaja ispitivanih faktora (sorta, godina i lokalitet), ustanovljene su visoko značajne razlike i za sve njihove interakcije. U proseku, najveće vrednosti sedimentacije (40.6 ml) i vlažnog glutena (31.85 %) utvrđene su na uzorcima sa lokaliteta Bačka Topola. Sorta Vizija je pokazala najveću vrednost sedimentacije (45.3 ml) na lokalitetu Bačka Topola, a sorta Lazarica (31.7 ml) najmanju sedimentacionu vrednost na lokalitetu Sombor. Na lokalitetu Bačka Topola ostvarena je i najveća vrednost za vlažan gluten kod sorte Toplica (38.53 %). U ovim istraživanjima, lokalitet Bačka Topola se pokazao kao najpogodniji za ispitivane parametre tehnološkog kvaliteta ozime pšenice.

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