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KERNEL NUMBER PER SPIKE STABILITY OF WHEAT GENOTYPES GROWN ON MELIORATED SOIL (SOLONETZ)*

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SUMMARY: In this work was analyzed number of grains per spike stability for 11 bread wheat varieties, on halomorphic soil, solonetz type, in Banat. Stability have been followed in two vegetation periods on null control, and two melioration levels of 25 t/ha, and 50 t/ha phosphor-gypsum. Genotype by environment interaction was quantified using AMMI model. According the results, wheat varietes in the exam reacted differently to different levels of melioration, depending not only on genotype, but also on environmental conditions.

Key words: *wheat, number of grains per spike, solonetz,G/E interaction, AMMI.*

INTRODUCTION

Wheat is one of the most important food crops for a large part of the world population. Also, it was one of the first plants to be cultivated, grown about more then thousands years ago. The wheat is agricultural crop which requires suitable soil in respect to fertility, physical characteristics and chemical reaction.

In Vojvodina province the most of agricultural soils are with good quality, but there is still a significant part of halomorphic soil, solonetz type, not convenient for agricultural production (Vuković, 2009).

The main problem related with solonetz is Bt,na horizon, which is positioned at 40-60 cm depth, with high clay content, presence of adsorbed sodium and high pH value. Halomorphic soil, solonetz type, could be utilized for wheat growing by using

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ameliorative measures, using phosphor - gypsum (Belić et al., 2003). Stability of grain yield and quality characteristics over different soils and years are important. Wheat shows highly significant genotype by environment interaction (G x E) (Reynolds et al., 2002; Vargas et al., 1999). Good variety should have a high mean yield combined with a low degree of fluctuation, when grown over diverse environments (Tarakanovas and Ruzgas, 2006).

The objectives of this research were to examine the effect of solonetz amelioration, using phosphor-gypsum in amount of 25 and 50 t/ha, on stability grains number per spike of different wheat varieties.

MATHERIAL AND METHODS

The trials were conducted on solonetz type of soil at Kumane, Banat, Northwest part of Serbia, during two consecutive crop years of 2004/2005 and 2005/2006. Ten Serbian wheat varietes: Mina (G1), Sofija (G2), Tiha (G3), Anastazija (G4), Nevesinjka (G5), Evropa 90 (G6), NSR-5 (G7), Dragana (G8), Ljiljana (G9), Simonida (G10) which were obtained from Institute of Field and Vegetable crops in Novi Sad and one variete obtained from Cereal research institute in Szeged, Hungary, GK Zügoly (G11). The experiment was set up according to completely randomized block design with 3 replications and 3 treatments. The sowing was done in rows 2 m long at the inter-grain spacing in a row of 10 cm and inter-row spacing of 20 cm. The seeds in both seasons were planted at 15 Oktobar and plants were harvested at 10-15 July. The first treatment was soil without amelioratin, second treatment was amelioration using phosphor-gypsum in amount of 25 and third treatment was amelioration using phosphor-gypsum in amount of 50 t/ha. The NPK (15:15:15) application was split, 50 kg for each tretman. In this trial each treatmen at the season was analysed like specific agro-ecological environment, so we got 6 different environments (tables 1). Data of number of grains per spike were at full of maturity recorded. Analyze of genotype by environment interaction (G x E) was done by AMMI model (Aditive main effects and multiplicative interaction) developed by Zobel et al. (1988). AMMI analysis was processed using the program GenStat for Windows 8th edition.

Table 1. Labels of 6 environments (phosphor-gypsum melioration/years) on solonjetz soil that 11 wheat varietes were grown up
Tabela 1. Oznake 6 agroekoloških sredina u kojima je gajeno 11 sorti pšenice u ogledu na solonjecu

No. *Red. br.*	Labels *Oznake korišćene u radu*	Growth season *Godina gajenja*	Phosphor-gypsum.treatment *Tretman fosfo-gipsom*
E1	$K_{04/05}$	2004/2005	Control, without treatment (Ø) *Kontrola, bez tretmana*
E2	$T25_{04/05}$	2004/2005	Treatment with 25 t/ha *Tretman sa 25 t/ha*
E3	$T50_{04/05}$	2004/2005	Treatment with 50 t/ha *Tretman sa 50t/ha*
E4	$K_{05/06}$	2005/2006	Control, without treatment (Ø) *Kontrola, bez tretmana*
E5	$T25_{05/06}$	2005/2006	Treatment with 25 t/ha *Tretman sa 25 t/ha*
E6	$T50_{05/06}$	2005/2006	Treatment with50 t/ha *Tretman sa 50t/ha*

RESULTS AND DISCUSSION

The AMMI analyses of variance of wheat number grains per spike of the 11 genotypes tested in six environments showed that environment was highly significant, genotype and G x E interaction were significant. The significant G x E effects demonstrated that genotypes responded differently to the variation in environmental conditions of different meliorated levels. The obtained data showed that 47,7 % of total sum of squares was attributable to environmental effects, only 12,5 % to genotypic effects and 39,9% to G x E interactions effects (Table 2). The environments were diversed and caused the most variation on number grains per spike. Genotype sum of squares was about 3 times less than G x E sum of squares, which determined very important differences in genotypic response across environments. The first PCA accounted for 36,1 % of the G x E sum of squares using 14 degrees of freedom (df) in the interaction and it was significan at $P < 0,05$. This obtained results confirm that AMMI is suitable model and made it possible to construct the biplot and calculated genotypes and enviroments effects (Gauch and Zobel, 1996; Yan and Hunt, 2001; Tarakanovas and Ruzgas, 2006).

Table 2. AMMI analysis of variance for number grains per spike of the 11 wheat varietes grown in 6 environments in two years

Tabela 2. AMMI analiza varijanse za broj zrna po klasu 11 sorti pšenice ispitivanih u 6 eko sredina

Source Izvori varijacije	Degree of freedom Stepeni slobode	Sum of squares Sume kvadrata	Mean square Sredine kvadrata	F Value F Vrednosti	F – table F- tablica		Explaned Objašnjeno %
					0,05	0,01	
Total Ukupno	197	9476	48,1	*			
Treatment Ogled	65	5359	82,4	** 2,78	1	1	
Genotype Genotip	10	668	66,8	* 2,25	1,83	2,32	12,5
Environment Εκο-sredina	5	2554	510,7	**11,0	2,21	3,02	47,7
Block/Blok	12	557	46,4	1,57	1,75	2,18	5,8
Interaction Interakcija	50	2138	42,8	* 1,44	1,35	1,52	39,9
IPCA 1	14	773	55,2	* 1,86	1,75	2,18	36,1
Residue Ostatak	36	1365	37,9	1,28	1,46	1,69	14,4
Error Pogreška	120	3560	29,7	*			

The biplot in AMMI is constructed so that the genotype and environment means are plotted on the abcissa and the IPCA scores for the same genotypes and environments on the ordinate. The IPCA scores of genotype in the AMMI analysis are an indication of the stability over environments. If their IPCA scores are close to zero than the more stable the genotype are across their testing environments, which contribute little to the interaction. The biplot shows not only the average of number grains per spike of a variety but also their stability. The graph space of Fig. 1 is divided into 4 quadrants from high number grains per spike environments in quadrants 2 and 3 to lower number grains per spike of wheat in quadrants 1 and 4. The varietes G1, G3, G4, G10 and G11 posed in quadrant 1 show that they have good adaptation in a wide range environments (Fig. 1). In this groups of the varieties the genotype G11 (GK Zügoly) was posed close to zero of IPCA 1 and showed that it is more stable genotype and adapted to lower sites, but also very near of genotype grand means. The varietes G6 (Evropa), G7 (NSR-5) posed in quadrant 3, both with higher genotype means. Genotype G6 was posed on zero of IPCA 1 what confirmed that was the most stable genotypes with the grandest mean value in this trial, therefore, it may be characterised by specific adaptation in favourable environments. The least stabled of all varietes, with the highest G x E inteaction was genotype G7 (NSR-5).

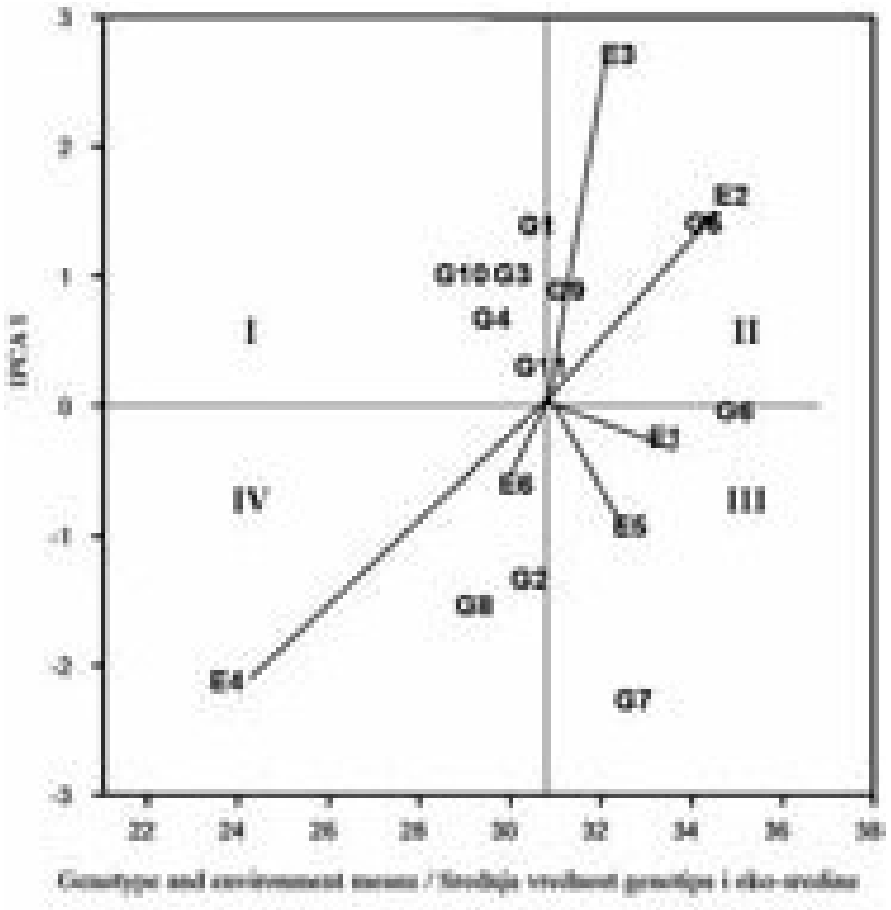

Fig. 1. Biplot of the AMMI model for wheat trial, consisting of 11 varieties grown in 6 environments. Environments codes are given in Matherial and method. Mean values of number grains per spike and the grand mean are labeled on x-axes

Slika 1. Biplot AMMI modela za ogled pšenice, sa 11 sorti u 6 agroekoloških sredina. Oznake su date u Materijalu i metodu. U grafiku je na apscisi data vrednost broja zrna po klasu i označena je srednja vrednost ogleda

The varietes G8 (Dragana) and G2 (Sofija) posed in quadrant 4, were outlying of zero IPCA 1 and showed also G x E interaction, with low grand mean value. The varietes G5 (Nevesinjka) and G9 (Ljiljana) posed in quadrant 2. The genotype G5 (Nevesinjka) was outlying of zero IPCA 1 and showed quite high G x E interaction and showed higher mean value opposed the genotype G9 (Ljiljana) which indicated highly stability with a grand mean value. Considering the point of environment means, we saw that they showed largely depends of climatic conditions in both year. Environmenrs of the first crop year were grouped in qudrants 2 and 3, with higher grains number, except E5 (melioration levels of 50 t/ha in 2004/2005), which is also located in this group. The biplot also accounts the number of grains per spike of genotype at individual site.The genotye G6 (Evropa 90) was the best for high number grains sites in E1 (control, in 2004/2005), also in E2 (melioration levels of 25 t/ha in 2004/2005) and E5 (melioration levels of 25 t/ha in 2005/2006). The greatest interaction and thus showed the lowest stability, were in environments E3 (melioration levels of 50 t/ha in 2004/2005) and E4 (control in 2005/2006). The most of genotypes reacted favorably to the conditions of repair melioration levels of 25 t/ha in both season (Fig. 1).

CONCLUSION

The AMMI analysis of variance of 11 wheat genotypes in 6 environments shows that environment (E) was highly significant, genotype (G) and their interaction (GE) were significant. The first PCA was also significant and participated in the overall variation seen 36%. AMMI model was very effective for studying GE interaction.

Wheat varietes in the exam reacted differently to different levels of melioration, depending not only on genotype, but also on environmental conditions. Most of them have a good performance and good stability and they can be used in commercial production on these soils. The biplot shows that the genotype Evropa 90 (G6) was the most stable and had the highest mean value of the investigated genotypes in wheat trial.

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STABILNOST BROJA ZRNA PO KLASU GENOTIPOVA PŠENICE GAJENIH NA MELIORISANOM ZEMLIŠTU (SOLONJEC)

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Izvod

U radu je analizirana stabilnost broja zrna po klasu 11 genotipova pšenice, na halomorfnom zemljištu, tipa solonjec u Banatu. Stabilnost je praćena u dve vegetacione sezone, na kontroli i dva nivoa popravke zemljišta fosfogipsom. Interakcija genotip/spoljna sredina procenjena je AMMI modelom. Zapažena je različita reakcija sorti pšenice na nivo popravke zemljišta, u odnosu na svaki tretman i vegetacionu sezonu.

Ključne reči: pšenica, broj zrna po klasu, solonjec, G/E interakcija, AMMI.

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