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MULTIVARIATE INTERACTION ANALYSIS OF BREAD WHEAT GROWN IN HALOMORPHIC SOIL

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ABSTRACT

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The bread wheat requires fertile soil, having good physical and chemical characteristics. Halomorphic soil, solonetz type, could be utilized for higher level of agricultural production with measures of amelioration, only.

The article deals with the effect of amelioration using phosphor gypsum in two application levels (25t/ha and 50t/ha) on grain yield per spike, as a sensitive quantitative trait, yield component in wheat. A set of eight wheat varieties has been examined aiming genotypes that show good reaction to amelioration in order for better use of less productive soil.

Key words: wheat, grain weight per spike, AMMI, solonetz, amelioration

Introduction

Bread wheat (*Triticum aestivum ssp. vulgare)* is considered as one of the most important crops. Being of significant value as a source of plant proteins, wheat is a subject of intensive breeding efforts. The main goal is high yield, as well as good quality. The yield represents a total force of plant to live and survive in a certain environment. It consists of a number of traits strongly influencing yield, called the yield components. The main stream breeding programs commonly create wheat varieties suitable for intensive agro-ecological conditions, assuming good soil productivity.

However, there is a vast potential in so called less productive soils. These soils could be intensively utilized using ameliorative measures and suitable crops (Belić et al. 2003). In Banat area in Vojvodina Province (North Serbia) there is about 80.000ha of halomorphic solonetz soil, predominantly used as pasture (Ministarstvo poljoprivrede,vodoprivrede i šumarstva 1997). The aim of this work is to examine genotype by environment interaction in order to evaluate wheat varieties grown on solonetz soil for stable reaction of some yield components. Grain yield per spike that was investigated in the article represents an important component of yield shoving the potentials of an individual plant. The other aim was to study genotype by environment interaction having in mind that less productive environments diminish differences between genotypes, enhance error and enhance multivariate component of total variation (Dimitrijević & Petrović 2005). The ultimate goal is, having complex investigations and results, to select varieties suitable for these particular agro-ecological conditions, not only for growing itself, but also as potential parents for obtaining desirable genetic variability in breeding program with special aim.

Material and Methods

Eight varieties of *Triticum aestivum ssp. vulgare* were in study: Evropa 90, NSR-5, Dragana, Ljiljana, Rapsodija, Simonida, Cipovka, and Nevesinjka, all from the Institute of Field and Vegetable Crops in Novi Sad. Random Block Design trial with three replications on solonetz soil has been established at the locality in Kumane village (Banat) in 1m long rows separated by 20 cm. Plants were

Tab. 1. a) Mean values for grain weight per spike (g) and PCA1 values of AMMI model, and b) ANOVA table for AMMI model

a)

Environment	Genotypes								Ex̄	PCAe
	Evropa 90	NSR-5	Dragana	Ljiljana	Rapsodija	Simonida	Cipovka	Nevesinjka		
2004/2005 Control	1.47	1.41	1.37	1.19	1.41	1.25	1.37	1.38	1.35	0.06505
2004/2005 25t/ha	1.44	1.33	1.20	1.13	1.34	1.26	1.34	1.56	1.32	-0.21509
2004/2005 50t/ha	1.38	1.35	1.00	1.58	1.34	1.33	1.57	1.40	1.37	-0.1592
2005/2006 Control	1.00	1.00	0.92	0.97	0.99	0.83	1.03	0.75	0.94	0.24449
2005/2006 25t/ha	1.50	1.51	● 1.63	1.26	1.50	1.23	1.39	1.09	● 1.39	0.4914
2005/2006 50t/ha	1.32	1.31	1.30	1.17	1.30	1.11	1.28	1.06	1.23	0.27299
2006/2007 Control	0.47	0.47	● 0.27	0.58	0.46	0.36	0.59	0.31	● 0.44	0.10677
2006/2007 25t/ha	0.99	0.90	0.75	0.75	0.90	0.82	0.93	1.06	0.89	-0.16367
2006/2007 50t/ha	0.92	0.75	0.44	0.62	0.76	0.80	0.86	0.86	0.75	-0.64274
Gx̄	● 1.16	1.11	● 0.98	1.03	1.11	1.00	● 1.15	1.05	1.08	
PCAg	-0.00881	0.15691	0.51097	0.0973	0.14281	-0.11992	-0.0227	-0.75656		

b)

Source	df	SS	MS	F	F 0.05	F 0.01
Total	215	35.250	0.1640			
Treatments	71	26.900	0.3789	** 6.75	1.00	1.00
Genotypes	7	0.890	0.1277	* 2.27	2.01	2.64
Environments	8	21.020	2.6280	** 37.15	1.94	2.51
Block	18	1.270	0.0707	1.26	1.57	1.87
Interactions	56	4.980	0.0890	** 1.58	1.35	1.52
IPCA 1	14	2.450	0.1747	** 3.11	1.75	2.18
Residuals	42	2.540	0.0604	1.08	1.35	1.52
Error	126	7.080	0.0562			

spaced 10cm in a row. Fertilizer NPK 15:15:15 was applied at the amount of 50kg/ha.

Three treatment were created: control- natural pasture, two levels of amelioration 25t/ha and 50t/ha phosphor gypsum. With three vegetation periods of investigation (2005/05., 2005/06., and 2006/07.) that created nine environments for AMMI analysis that was conducted following Gauch and Zobel (1997).

Results and Discussion

The greatest overall mean value for grain weight per spike were denoted for two wheat varieties, Evropa 90 and Cipovka, the smallest value belongs to variety Dragana. Environmental average was the highest for the vegetation period 2005/06 at the melioration level of 25t/ha, while the lowest was in 2006/07 control variant. Variety Dragana exhibited the greatest individual variation, ranging from 0.27g (2006/07 control) to 1.63g (2005/06 25t/ha). According to the results amelioration of 25t/ha phosphor gypsum had somewhat better effect than 50t/ha (tab. 1a). Screening overall variability expressed in the trial, it could be concluded that treatments and environment were greater source of variability than genotypes. However, AMMI ANOVA picked up a significant genotype variation. GE interaction had highly significant variation, predominantly caused by one source carried out by PCA1 axes (tab. 1b).

Groping in AMMI diagram reveals more details on variation. Varieties were clearly grouped the way that shows fairly stable reaction, especially Evropa 90 and Cipovka, with the smallest GE interaction expressed, and the highest overall average of grain weight per spike. Nevesinjka and Dragana showed enhanced GE interaction. Sources of variation differ obviously. In 2004/05 season the greatest overall stability was denoted. Variation due to treatment was not significant in main effects, but more obvious in GE interaction. Following 2005/06 season was absolutely different, exhibiting main variation in main effect, and considerably smaller in GE interaction. Finally, 2006/07 season was the most complex, showing variation in main effects, as well as, in GE interaction. The last, but not the least, it is clear that weather conditions influenced the effect of amelioration. In 2004/05 the effect of ameliorative measures was the smallest. The rest two seasons were with more obvious amelioration effects on examined trait, but at different average value. In both these seasons 25t/ha phosphor gypsum had better effect, as a trend, than 50t/ha. Varieties Nevesinjka and Dragana had the most expressed reaction to amelioration (fig. 1).

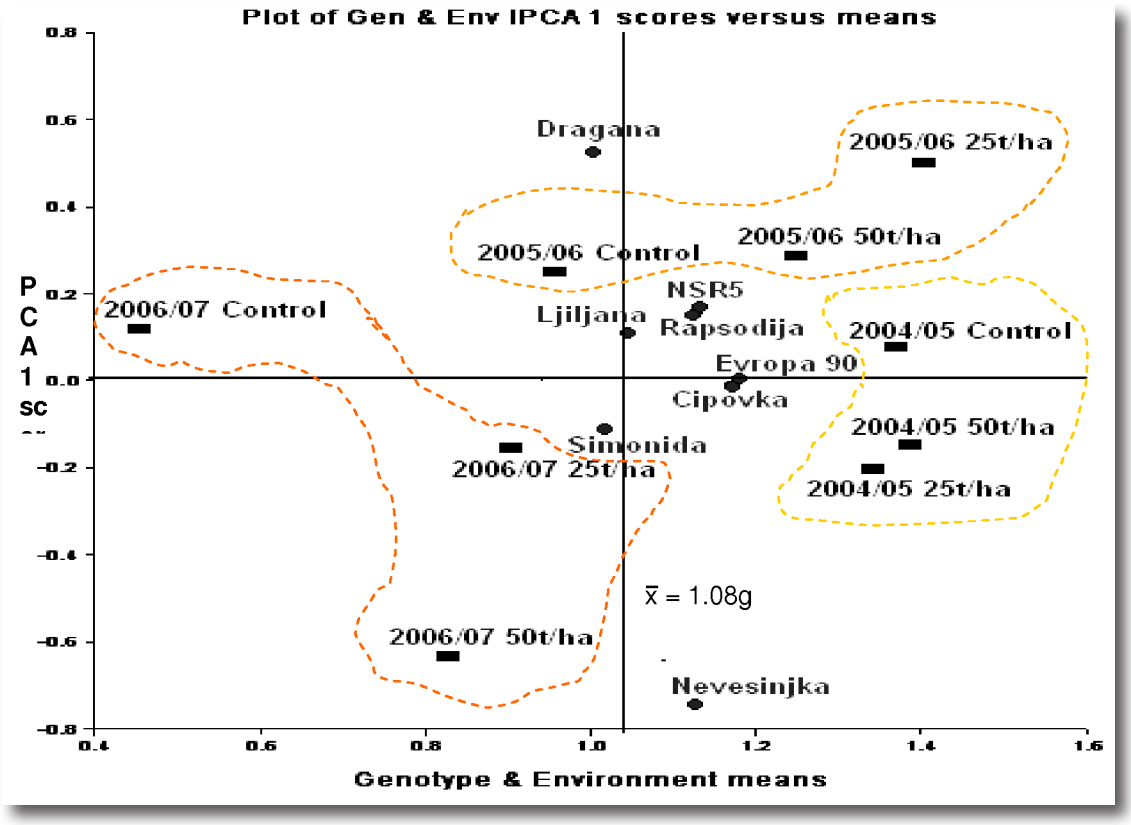
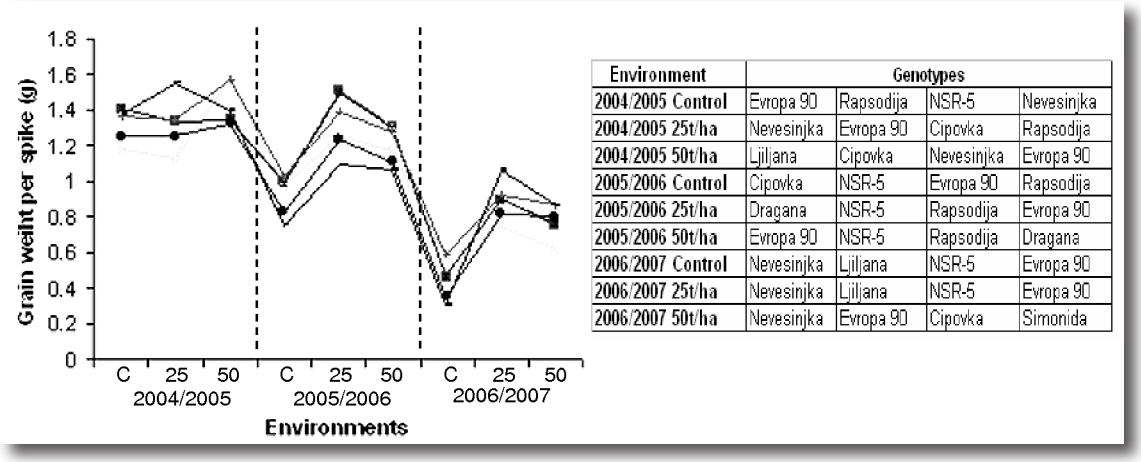


Fig. 1. Mean values of eight wheat varieties grown in nine environments (3 years x 3 treatments), main and multivariate (genotype by environment interaction) effects



Environment	Genotypes			
2004/2005 Control	Evropa 90	Rapsodija	NSR-5	Nevesinjka
2004/2005 25t/ha	Nevesinjka	Evropa 90	Cipovka	Rapsodija
2004/2005 50t/ha	Ljiljana	Cipovka	Nevesinjka	Evropa 90
2005/2006 Control	Cipovka	NSR-5	Evropa 90	Rapsodija
2005/2006 25t/ha	Dragana	NSR-5	Rapsodija	Evropa 90
2005/2006 50t/ha	Evropa 90	NSR-5	Rapsodija	Dragana
2006/2007 Control	Nevesinjka	Ljiljana	NSR-5	Evropa 90
2006/2007 25t/ha	Nevesinjka	Ljiljana	NSR-5	Evropa 90
2006/2007 50t/ha	Nevesinjka	Evropa 90	Cipovka	Simonida

Fig. 2. Additional analysis of genotype behavior concerning vegetation periods and treatments, as well as ranked recommended varieties for particular environments

Growing conditions during the vegetation period diminish or enhance the effect of amelioration. This is in accordance to previously reported results (Petrović et al., 2007). The differences between varieties grown on three environments in three vegetation periods were expressed through averages for given trait. In a first year of study the effect of amelioration on examined genotypes, in general, was not that obvious. The yield level per spike, however, had the highest overall level, comparing to other two following vegetation periods. In 2005/2006, and 2006/2007, environmental conditions influenced greater differences between control environment, and environments including certain level of amelioration, at the different level of main effect for the trait in study (fig.2).

Conclusions

The method applied, was efficient enough to evaluate genotype by environment interaction of wheat genotypes in study. As expected, the predominant sources of variation were treatments, and particularly environmental conditions. Though the nature of variation in less favorable environments like halomorphic soil appeared to be more complex than in normal growing conditions concerning soil (chernozem soil), it is possible to winnow varieties of better reaction to amelioration, having smaller genotype by environment interaction through seasons under certain ameliorative treatment. Finally, according to the results the level of amelioration of 25t/ha of phosphor gypsum appeared to have the best effect on examined trait.

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Summary

There is a number of multivariate models in use for analysis of different sources of variation on yield and the yield components variability in wheat. This article is dealing with the experiment of bread wheat growing on solonetz soil with and without meliorative measures. The main sources of variation and the level of genotype response have been studied using AMMI model. The final goal is to mark wheat varieties suitable for stable and economicaly justified yield being grown on halomorphic soil.