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STABILITY OF SPIKE WEIGHT AND GRAIN WEIGHT PER SPIKE OF DIFFERENT WHEAT GENOTYPES

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Abstract

In this paper, the stability of ten divergent wheat varieties was investigated, where two traits were analyzed: spike weight and grain weight per spike. The trial was conducted on the experimental field of the Center for Small Grains in Kragujevac during three growing seasons. The expressions of the analyzed traits were statistically significant and showed additive and non-additive sources of variation. The AMMI analysis showed significant effect of the genotype x environment interaction, where two main components were significant (PCA1 and PCA2). The first principal component (PCA1) expressed the largest share of the genotype x environment interaction. The genotypes reacted differently to different environmental conditions. Genotype Szegedi 765 had the highest value of analyzed traits, but moderate to low stability. Genotypes Sterna and Gruza expressed the highest stability, while genotype Mironovskaya 808 showed the highest instability in terms of both traits. The investigated genotypes had the highest stability in the second year of investigation, and the lowest stability in the first year. In terms of stability, these genotypes can be used in wheat breeding programs.

Key words: *Stability, AMMI, wheat, interaction, PCA*

Introduction

Wheat, as one of basic grains in the human diet, has always taken a central role in agricultural production. Wheat is mainly used in human nutrition as shown by the fact that it takes about 53% of total production in developed, and 85% in developing countries (Peña, 2007).

The main goal in a crop breeding program is the development of genotypes which are stable or adapted to a wide range of diversified environments (Farshadfar *et al.,* 2011). Stability is important for breeders in terms of changing ranks of genotypes under the influences of different environments, which can influence selection’s efficiency. On the other hand, for famers, high yielding characteristics of genotypes are most important, regardless of the change ranks of genotypes (Crossa *et al.,* 2002). In wheat breeding programe it is important to identify genotypes which are adapted or stable to different environmental conditions (Hagos and Abay, 2013).

The genotype x environment (GE) interaction is major problem especially in the study of quantitative characteristics, which are influenced with few genes. Because of it, predictions and interpretation of genetic experiments are very complicated (Amiri *et al.,* 2013). The additive main effect and multiplicative interaction (AMMI) method proposed by Gauch (1992) was a significant advance in the analysis of genotype x environment interpretation. The AMMI model separates the additive variance from non-additive, multiplicative, variance, and includes the principal component analysis (PCA) to the interaction. This model explains in more detail the interaction pattern (Thillainathan and Fernandez, 2001).

The main objectives of this study are investigating stability of spike weight and grain weight per spike in different wheat genotypes and identifying stable genotypes by evaluating GE interaction using AMMI model and biplot analyses.

Material and Methods

The experiment was conducted in the experimental field of the Center for Small Grains in Kragujevac (Serbia) during three different vegetation seasons. Ten wheat genotypes (Arsenal, KG-56, Gruza, Mironovskaya 808, Norin 10, Rana Niska, Spartanka, Sterna, Osjecanka, and Szegedi 765) were evaluated in a randomized complete block design with three replications. Rare sowing was performed where seeds were sown in 1 m long rows, with 20 cm space between the rows and 10 cm distance between each seed in a row. Because of this rare sowing method, genotypes could express their maximal genetic potential for tillering and other spike characteristics. Genotype and environment interaction was tested using AMMI (Additive Main Effects and Multiplicative Interaction) proposed by Gauch (1992) and Zobel (1988). Biplot analyses were, also, created due to graphical visualization in the relationship between genotype and environment. AMMI and biplot analysis were performed using GenStat Trial Version 18.1.0.17005 (https://www.vsni.co.uk/).

Results and Discussion

Spike weight and grain weight per spike could be of the importance for grain yield formation. Saed-Moucheshi *et al*. (2013) established that spike weight had the highest correlation with yield in wheat. Results of AMMI analysis of mean spike weight and grain weight per spike showed significant differences ($p<0.01$) among the genotypes, the environments and GE interaction. The significance of GE interaction effects demonstrated that genotypes responded differently to variations in environmental conditions. AMMI analysis of spike weight showed that 20.98% of the total sum of squares was attributable to genotype effect, only 5.77% to environmental effects, and 11.65% to GE interaction.

Table 1. AMMI ANOVA for spike weight and grain weight per spike of ten wheat genotypes in three years

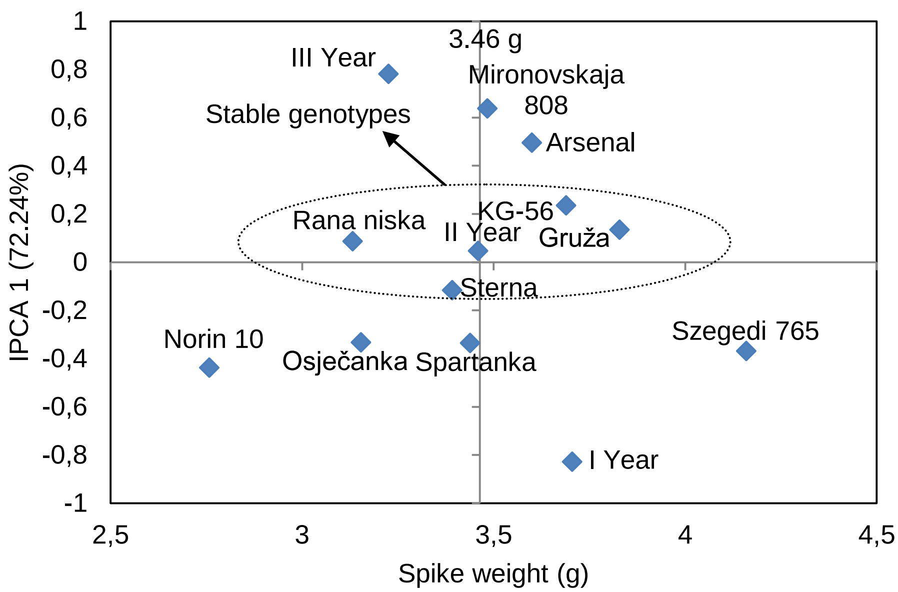
Source of variation	Spike weight				Grain weight per spike			
	df	SS	MS	F-value	df	SS	MS	F-value
Total	899	600.289			899	402.989		
Genotypes	9	125.93	13.998	32.92**	9	47.74	5.304	17.86**
Environments	2	34.63	17.317		2	34.84	17.418	
Interactions	18	69.96	3.886	9.14**	18	62.02	3.446	11.60**
IPCA1	10	50.54	5.054	11.89**	10	35.06	3.506	11.80**
IPCA2	8	19.42	2.428	5.71**	8	26.96	3.370	11.35**
Error	870	369.77	0.425		870	258.39	0.297	

** p<0,01

The AMMI analysis of variation for grain weight per spike showed that genotype accounted for 11.84% and environment for 8.64% of the total experiment variation. The GE interaction had the largest share in the total variation (15.39%) for grain weight per spike. Petrović *et al.* (2013) and Dimitrijević *et al*. (2005) also found a significant effect of GE interaction on grain weight per spike (Table 1).

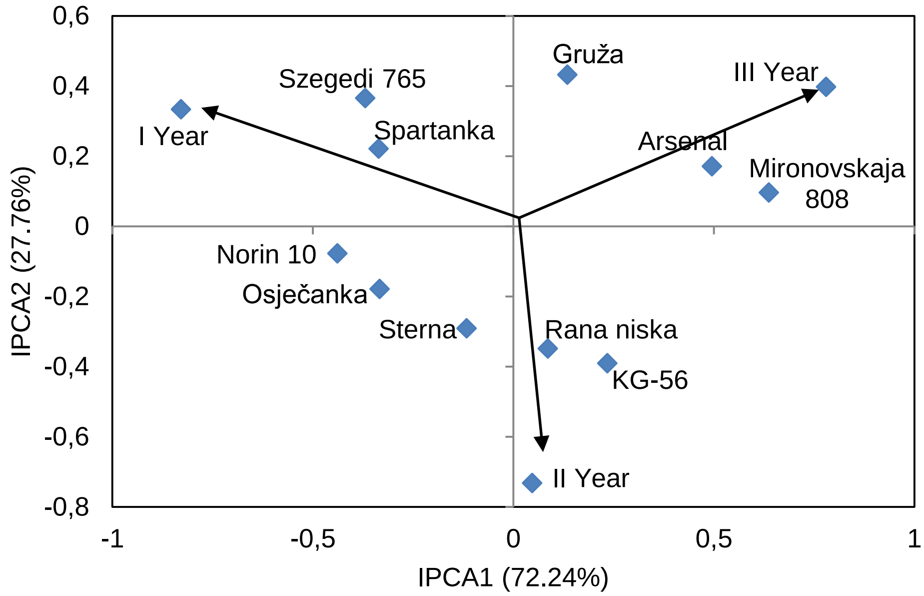
In both analyzed traits, the first two main components (IPCA1 and IPCA2) were highly significant, which indicate that interaction was agronomically significant. The greatest contribution to genotype and environment interaction gave IPCA1, with participation of 72.24% for spike weight, and 56.53% for grain weight per spike of the interaction sum of squares (Table 1). The prediction assessment indicated that AMMI with only two interaction principal component axes was the best predictive model (Motamedi *et al.*, 2013).

The GE interaction is considered in detail using AMMI 1 biplot. The genotypes that are located close to the origin, Rana Niska, Sterna, Gruža and KG-56, considered to be stable genotypes. These stable genotypes have good adaptation to a wide range of environments. In relation to all stable genotypes, genotype Gruža had the highest value of spike weight. Genotype Szegedi 765, with the highest value of spike weigh was middle stable genotype, which indicates that it is harder to achieve stability in genotypes with high value of certain trait. Saleem *et al.* (2015) reported that genotypes which showed yield above the grand mean yield were less stable than genotype which was close to the zero of PCA score with low yield. Also, middle stable genotypes are Norin 10, Osječanka, Spartanka, Szegedi 765 and Arsenal. Genotype Mironovskaja 808 is unstable and expresses the greatest interaction with the environment. Analysed genotypes had the highest stability in the conditions that prevailed in the second year (Graph 1).



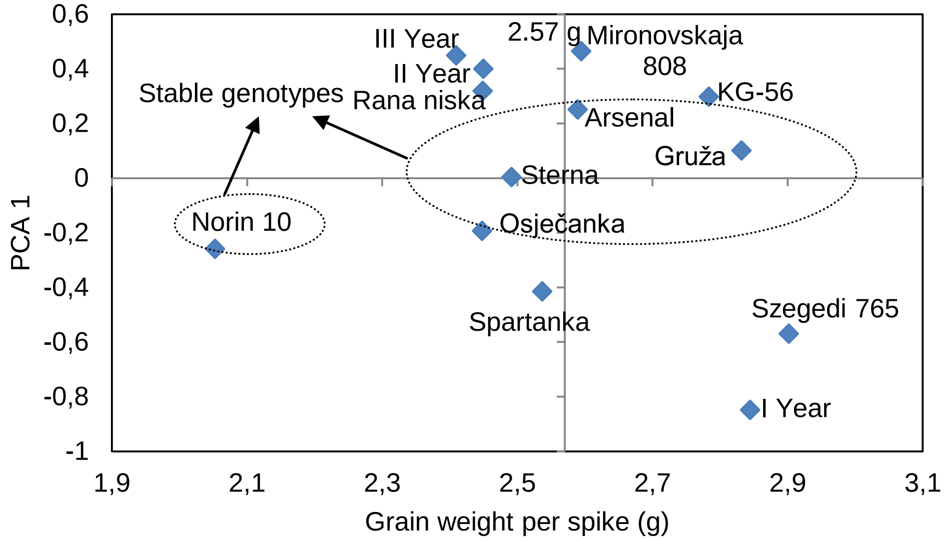
Graph 1. AMMI 1 biplot for the spike weight of 10 wheat genotypes in three years

In order to obtain a more precise analysis of the GE interaction, the AMMI 2 biplot (IPCA1 *vs.* IPCA2) is created. Genotypes with large IPCA1 or IPCA2, or both, have high interactions, whereas genotypes with IPCA1 or IPCA2 scores near zero have low interactions for the corresponding axis (Motamedi *et al.*, 2013). Genotype Sterna is located the nearest to the biplot origin, which indicates that this genotype is the most stable. Stable genotypes are Rana niska, Spartanka, KG-56 and Gruža, as well. Genotype Mironovskaja 808 has the longest IPCA1 vector and thus expresses the greatest interaction with the environment. The distance from the origin to the points of environmental conditions indicate that no genotype has superior performance of spike weight in all environments. However, the genotypes that are close to a vector of specific environment considered to be stable for the given conditions. Therefore, genotypes Rana niska, Sterna and KG-56 are close to a vector of environmental conditions in the second year. Genotypes Arsenal, Mironovskaja 808 and Gruža are close to a vector of the third year and considered to be stable in this year, while genotypes Szegedi 765, Spartanka, Norin 10 and Osječanka may be characterised by specific stability in environment of the first year (Graph 2).



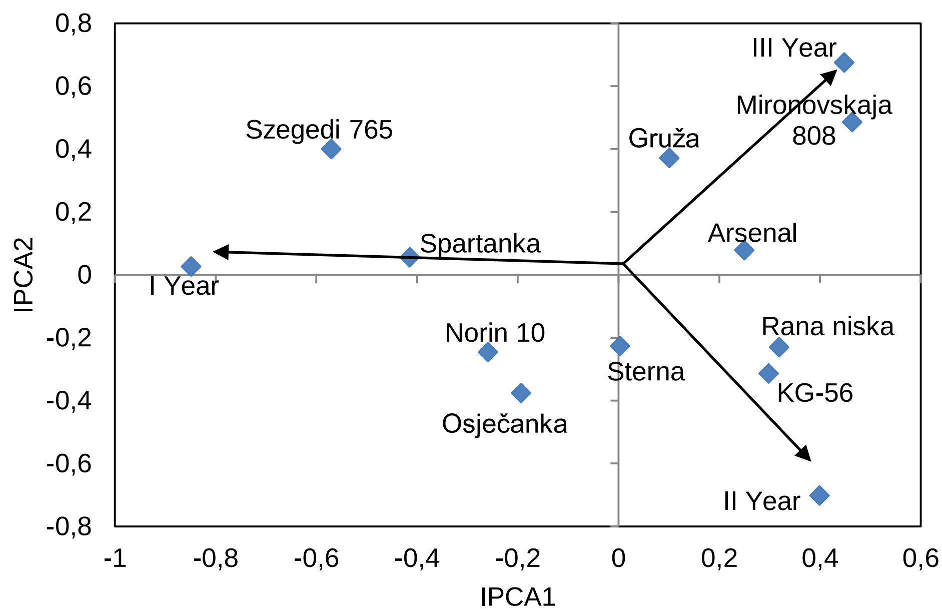
Graph 2. AMMI 2 biplot for the spike weight of 10 wheat genotypes in three years

Genotypes that are stable or less sensitive to environmental influences are found near the biplot origin, and in this case, these genotypes are Sterna, Gruža, Osječanka, Arsenal and Norin 10. Genotype Norin 10, in addition to being stable, is characterized by the lowest value of grain weight per spike, while the genotype Gruža has the highest value of this trait in relation to all stable genotypes. The middle stable genotypes are Rana niska and KG-56, while unstable genotypes are Mironovskaja 808, Szegedi 765 and Spartanka. Genotype Szegedi 765, with the highest value of grain weight per spike, is the most unstable genotype. Genotypes showed the greatest stability in the second year of investigation and the lowest one in the first year (Graph 3).



Graph 3. AMMI 1 biplot for the grain weight per spike of 10 wheat genotypes in three years

Genotypes Sterna, Arsenal, Norin 10, Gruža and Osječanka are located near biplot origin and are considered to be more stable in relation to other genotypes. According to Motamedi *et al.* (2013), the greater the PCA scores, either negative or positive, indicates that genotypes are more specifically adapted to certain environmental conditions. Therefore, genotype Mironovskaja 808, with high positive IPCA1 and IPCA2 values, is well adapted to the conditions in the third year, while genotype Szegedi 765 with high positive IPCA2 and high negative IPCA1 value is well adapted to specific conditions in the first year. Genotypes Arsenal and Gruža are close to a vector of the third year, while genotypes, Spartanka and Norin 10 are well adapted to conditions of the first year. The genotypes that are adapted to environment of the second year are Rana niska, KG-56 and Sterna (Graph 4).



Graph 4. AMMI 2 biplot for the grain weight per spike of 10 wheat genotypes in three years

Conclusion

The AMMI analysis showed significant effect of the additive and non-additive sources of variation on the expressions of the spike weight and grain weight per spike. No genotype has superior performance in all environments, but genotypes Gruža and Sterna are the most stable in wide range of environment. On the other hand, genotypes Mironovskaya 808, Szegedi 765 and Spartanka were located away from biplot origin and are considered specifically adapted genotypes to certain environments. Genotype Mironovskaya 808 expresses high instability for both analyzed traits. Genotype Szegedi 765 had the highest value, but moderate to low stability for both investigated traits. This indicates that it is very difficult to achieve stability in genotypes which are characterized by high values of the certain trait. Stable genotypes, which are adapted to wide range of environments can be used in plant breeding programs.

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References

Amiri, E., Farshadfar, E., Jowkar, M.M. (2013). AMMI analysis of wheat substitution lines for detecting genes controlling adaptability, International journal od Advances Biological and Biomedical Research, 1(9), 1112-1123.

Crossa, J., Cornelius, P.L., Yan, W. (2002). Biplots of linear-bilinear models for studying cross-over genotype x environment interaction, Crops Science, 42, 612-633.

Dimitrijević, M., Petrović, S., Belić, M., Hadžić, V., Kraljvić-Balalić, M., Nešić, Lj., Kapor, Z., Beljanski, N., Vuković, N. (2005). Genetička varijabilnost sorti pšenice na solonjecu u uslovima popravke zemljišta (Genetic variability of wheat cultivars on solonetz in conditions of soil repairs). Letopis naučnih radova Poljoprivrednog fakulteta 29(1): 100-112.

Farshadfar, E., Mahmodi, N., Yaghotipoor, A. (2011). AMMI stability value and simultaneous estimation of yield and yield stability in bread wheat (*Triticum aestivum* L.), Australian Journal of Crop Science, 5(13), 1837–1844.

Gauch, H. G. (1992). Statistical analysis of regional yield trials: AMMI analysis of factorial designs. Elsevier, Amsterdam, Netherlans.

Hagos, H., Abay, F. (2013). AMMI and GGE biplot analysis of bread wheat genotypes in the northern part of Ethiopia, Journal of Plant Breeding and Genetics, 1, 12-13.

Motamedi, M., Safari, P., Mohammadi, G. (2013). Additive main effect and multiplication interaction analysis of grain yield in bread wheat genotypes across environments, International Journal of Biosciences 3(8), 218-225.

Peña, R. J. (2007). Current and future of wheat quality needs, In: Buck, H. T., Nisi, J. E., Salomon, N. (Eds.), Wheat protection in stressed environments, Developments in Plant Breeding, 12, 411-424

Petrović, S., Dimitrijević, M., Banjac, B. (2013). Spike traits variability in wheat grown on solonetz and humogley. Fourth International Scientific Agricultural Symposium "Agrosym 2013", Faculty of Agriculture, East Sarajevo, Jahorina, 178-183.

Saed-Moucheshi, A., Pessarakli, M., Heidari, B. (2013). Comparing relationships among yield and its related traits in mycorrhizal and nonmycorrhizal inoculated heat cultivars under different water regimes using multivariate statistics, Internaional Journal of Agronomy, 1-14.

Saleem, N., Ahmad, M., Vashnavi, R., Bukhari, A., Ahmad, Dar, Z. (2015). Stability analysis in wheat: An application of additive main effects and multiplicative interaction. African Journal of Agricultural Research 10(4): 295-300

Thillainathan, M., Fernandez, G.C.J. (2001). SAS applications for Tai's stability analysis and AMMI model in genotype x environmental interaction (GEI) effects, Journal of Heredity 92(4), 367-371.

Zobel, R. W., Wright, M. J., Gauch, H. G. (1988). Statistical analysis of a yield trial, Agronomy Journal, 80, 388–39.

https://www.vsni.co.uk/ Accessed on the 15th of May 2016.