PHENOTYPIC VARIATION OF SPIKE INDEX OF WINTER WHEAT (*Triticum aestivum* L.) GROWN UNDER LIMITED SOIL CONDITIONS

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INTRODUCTION

Soil and climatic conditions are one of the most important factors affecting grain yield of wheat. The ability of a wheat cultivar to produce high and stable yield over a wide range of environments plays a major role in food security. Changes in certain yield traits and yield stability have led to an increase in the genetic potential of the genotypes, mostly through the increased tolerance to biotic and abiotic stress factors. However, since different morpho-physiological traits have been proposed as key traits associated with grain yield potential of wheat, its assessment could greatly contribute to improve grain yield. Contribution of each individual yield component could vary in different environmental conditions and therefore testing in different environments provides additional useful information and GEI component can be estimated. The objective of this research was to estimate the responses of eleven winter wheat genotypes (G1, G2, G3, G4, G5, G6, G7, G8, G9, G10 and G11) under specific growing conditions of halomorphic soil, solonetz type. During the two vegetation seasons, phenotypic variability and genotype by environment interaction (GEI) for spike index of wheat genotypes was studied.

MATERIALS AND METHODS

The experiment trial was set up on the solonetz soil and consisted of control, which presents non-ameliorated solonetz soil and treatments with two levels of soil amelioration using phosphor gypsum, in amounts of 25 and 50 tha^{-1}. The additive main effects and multiplicative interaction (AMMI) models were used to quantify the genotype by environment interaction (GEI). Genotype by environment interaction (GEI) was estimated using AMMI (additive main effects and multiplicative interaction) analysis developed by Zobel et al. (1998). The AMMI model was is presented as the following formula:

$$Y_{ger} = \mu + \alpha_g + \beta_e + \Sigma\lambda_n\xi_{gn}\eta_{en} + \Theta_{ge} + \varepsilon_{ger},$$

where y_{ge} is the mean of yield or other observed trait for genotype *g* in the environment *e*, μ—grand mean, α_g—genotypic mean deviations, β_e—environmental mean deviations, n—number of PCA axis retained in the adjusted model, λ_n—eigenvalue of the PCA axis *n*, ξ_{gn}—genotype score for PCA axis n, η_{en}—score eigenvector for PCA axis n, Θ_{ge}—residual and ε_{ger}—experimental error. The AMMI model incorporates analysis of variance (ANOVA) and principal components analysis (PCA) into a single statistical model. In the AMMI model, the ANOVA separated additive effects from the interaction, while additional GEI analysis was carried out by principle component analysis (PCA). The biplot graphic representation showed both the main and interaction effects for genotypes and environments simultaneously and provides analysis of the G × E interaction

RESULTS AND DISCUSSION

Analysis of the variance of the spike index of wheat revealed a high significance of the value of the square for the blocks and significance of the environments. In the total variation of the experiment, the main effects of the analysis of variance, genotype and eco-environment, account for 56.2 % of the sum of the squares of the experiment. The combined ANOVA showed that the phenotypic expression of spike index was significantly influenced by environmental variations, because the significant variance explained 48.8 % of the total variation, while genotype contributed with 7.8 % of the total variation of the experiment. Genotype by environment interaction expressed no significant mean square, while additional analysis of GEI using the IPCA (Interaction Principal Components) analysis showed a statistical significance of the first main component IPCA1. First source of variation IPCA1 explained 55.6 % of the GEI variation for the spike index of wheat. The obtained results presented in the biplot graphs indicated that the examined genotypes differed both in the variation of GEI and in the variation of the main effects from treatment to treatment

Table 1. AMMI analysis of variance for the harvest index (%) of ten winter wheat varieties examined across six environments.

Source of variation	DF	SS	MS	F values	The Share of Total Variation (%)
Total	197	1,2953	0,00657	*	
Trial	65	0,5509	0,00847	**2.09	
Genotype	10	0,0427	0,00427	1.05	7.8
Environments	5	0,2668	0,05336	*2.49	48.4
Block	12	0,2573	0,02144	**5.28	46.7
Интеракција	50	0,2414	0,00483	1.19	43.8
IPCA 1	14	0,1343	0,00959	*2.36	24.4
Residuals	36	0,1071	0,00298	0.73	19.4
Error	120	0,4871	0,00406	*	

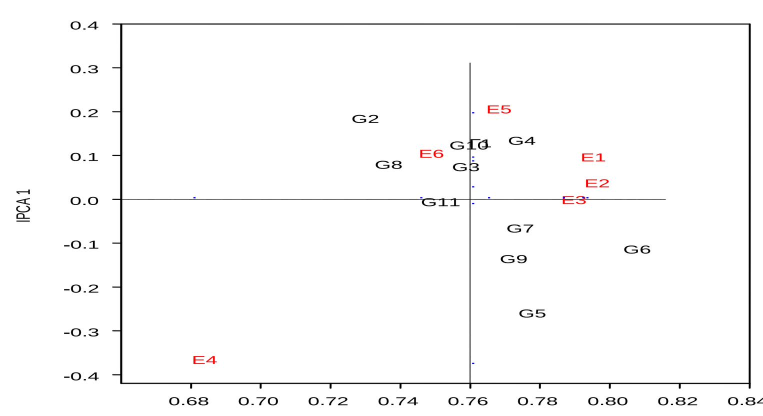

Figure 1. AMMI 1 biplot of 11 wheat cultivars across six environments (two years × three treatments) for the estimation of main and multivariate (GEI) effects for the spike index of wheat.

CONCLUSION

The results of this study showed that wheat genotypes responded differently to different levels of soil amelioration and significant wheat spike index variation was noticed due to different environment conditions, but also depended on tested genotype, as well as from vegetation season. The varieties G11,, G1, G6, G4, G7 and G3 showed the most stable reaction to extremely variable agroecological conditions in the experiment. The cultivar G6, showed as the most stable cultivars, characterized by the highest mean genotypic values in the overall experiment. The lowest stability, enhanced GEI was shown by the cultivar G2, but it reacted favorably to the repair measures of 25 t / ha of phosphogypsum, which to a certain extent also applies to the cultivar Nevesinjka. Genetics analysis of different wheat genotypes grown in different agro-ecological conditions contributes to their better utilization, as well as selection for crosses in wheat breeding programs.

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