Biblid: 1821-4487 (2016) 20; 1; p 33-35
UDK: 007.2

Original Scientific Paper
Originalni naučni rad

VARIABILITY OF SEED PARAMETERS IN BREAD WHEAT CULTIVARS

VARIJABILNOST SEMENSKIH PARAMETARA SORTI HLEBNE PŠENICE

Velimir MLADENOV[*], Borislav BANJAC[*], Miodrag DIMITRIJEVIĆ[*], Sofija PETROVIĆ[*], Dragana LATKOVIĆ[*], Bojan JOCKOVIĆ[**], Sandra BOGDANOVIĆ[***]
[*]University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia
[**]Institute of Field and Vegetable Crops, Maksima Gorkog 30, 21000 Novi Sad, Serbia
[***]Seed Association of Serbia, Bulevar Oslodođenja 69/1, 21000 Novi Sad, Serbia
e-mail: vmladenov@polj.uns.ac.rs

ABSTRACT

Expansion and intensification of cultivation are among the predominant global changes of this century. Constant growth of the world population and rising demand for food conditional on improving the quality /quantity of crop products. This could be achieved by synergy among breeding improvement and dedicated seed production. Accordingly, advanced and modern production of bread wheat allows the creation of new genotypes with better adaptability to different environmental conditions. The aim of this study was to investigate the influence of genotype, environment and their interactions on yield and randman of seed using AMMI model. Ten bread wheat varieties were investigated (Evropa 90, NSR 5, Pobeda, Renesansa, Ljiljana, Cipovka, Dragana, Simonida, NS 40S and Zvezdana) across three growing seasons (2009/10, 2010/11, 2011/12) and two locations (Novi Sad and Pančevo). Based on the interaction of genotypes and agro-ecological environments for yield and randman of seed on AMMI1 biplot it was noted that the genotypes differed more in several multivariate part of the total variation than in additive effect.

Key words: *bread wheat, variability, AMMI.*

REZIME

Stalan rast svetske populacije i porast potreba za hranom zahtevaju poboljšanje kvaliteta i prinosa semena poljoprivrednih kultura. Ovo se postiže oplemenjivačkim radom i predanim semenarstvom. U skladu sa tim, napredak u savremenoj proizvodnji hlebne pšenice omogućuje stvaranje novih genotipova, sa boljom adaptabilnošću na različite agroekološke uslove. Pravilnim održavanjem i umnožavanjem sorti teži se smanjenju gubitaka deklarisanog semena, koji su usko povezani sa iskoristljivošću semena, odnosno randmanom, koji je pokazatelj kvalitetnog višegodišnjeg semenarstva i efikasnosti dorade naturalnog semena. Cilj istraživanja je bio da se ispita uticaj genotipa, spoljašnje sredine i njihove međusobne interakcije na randman i prinos semena primenom AMMI modela. Ispitivano je deset sorti hlebne pšenice (Evropa 90, NSR 5, Pobeda, Renesansa, Ljiljana, Cipovka, Dragana, Simonida, NS 40 S i Zvezdana) tokom tri vegetacione sezone (2009/10, 2010/11, 2011/12), na dva lokaliteta (Novi Sad i Pančevo). Na osnovu prikaza interakcije genotipova i agroekoloških sredina za randman i prinos semena, u obliku AMMI1 biplota, zabeleženo je da su se genotipovi više razlikovali u multivarijacionom delu ukupne varijacije ogleda, nego u aditivnom efektu. Na nivou celog ogleda genotipovi su bolji randman semena ostvarili na lokalitetu Pančevo, dok su uslovi lokaliteta Novi Sad bili povoljniji za ostvarivanje većeg prinosa. Genotip Dragana je imao najveći randman semena (93,49%) dok je genotip Simonida bio najprinosniji (8.12 t·ha^{-1}). Genotipovi koji su imali malu interakcijsku vrednost genotip/spoljna sredina odnosno bolju stabilnost od ostalih su: Ljiljana, kada se posmatra randman semena i Renesansa, kada je u pitanju prinos.

Ključne reči: *hlebna pšenica, varijabilnost, AMMI.*

INTRODUCTION

Expansion and intensification of cultivation are among the predominant global changes of this century. Intensification of agriculture by use of high-yielding crop varieties, fertilization, irrigation, and pesticides has contributed substantially to the tremendous increases in wheat production over the past 30 years. Land conversion and intensification, however, also alter the biotic interactions and patterns of resource availability in ecosystems and can have serious local, regional, and global environmental consequences *(Matson et al., 1997)*. Constant growth of the world population and rising demand for food conditional on improving the quality /quantity of crop products. This could be achieved by synergy among breeding improvement and dedicated seed production. Accordingly, advanced and modern production of bread wheat allows the creation of new genotypes with better adaptability to different environmental conditions. Proper maintenance and multiplication of cultivars tends to reduce the losses of declared seeds, which are closely related to randman of seed or waste percentage, which is an indicator of the quality and efficiency of seed processing. Yield and seed quality features are traits of primary importance in bread wheat breeding programs *(Groos et al., 2003)*. Yield is obviously a major determinant of farmer's incomes, it presents the most important quantitative trait affected by multiple components *(Banjac et al., 2014)* while the second trait investigated in this manuscript will be the one which is very important for the physical quality of seed. It could be defined as a seed-kernel ratio and randman of seed is a proper term. It is not directly connected to technological/seed quality, rather indirectly, but helps in explanation of first trait and complements the wider picture for the quality of seed. Accurate evaluation of these traits is made by the importance of the genotype x environment interaction - GEI *(Robert et al., 2001)*. There is no better way for investigating traits than setting an experiment on different locations across multiply years. That's why multi-environmental trails are so important for wheat breeding and highest interaction among genotypes, environments and their mutual interaction can be recorded right there. An ideal genotype is defined as one that is the highest yielding across different environments and is absolutely stable in performance. Although such an ideal genotype may not exist in reality, it can be used as a reference for genotype evaluation *(Ahmadi et al., 2012)*. AMMI analysis enables in finding and identification of previously mentioned ideal genotype. The advantage of this mathematical model in relation to other is *disjecta membra* of all variation sources (genotype, environment and GEI). An understanding of the cause of the GEI can help to identify superior genotypes based on investigated traits *(Mladenov et al., 2012)*.

The objectives of the present research were two-fold (i) to determine influence of genotype; environment and their interaction on yield and randman of seed as a seed quality represent; (ii) to evaluate stability through AMMI model.

MATERIAL AND METHOD

Grain samples were obtained from ten winter wheat cultivars grown in 2009/10, 2010/11, 2011/12 at two locations in Serbia: Novi Sad (E1, E2, E3) and Pančevo (E4, E5, E6). These locations are characterized by semiarid conditions, with dry, hot spring and summer, neutral autumn and moderately cold winter (Table 1). The ten winter wheat cultivars used in this study were: Evropa 90, NSR-5, Pobeda, Renesansa, Ljiljana, Cipovka, Dragana, Simonida, NS 40 S and Zvezdana. The wheat cultivars were planted in a randomized complete block design with three replications. Plots of 5 m^2 with 10 rows spaced 12.5 cm apart were seeded at a rate of ≈230 $kg \cdot ha^{-1}$. Sowing in all three growing seasons was completed by the end of October, while harvest was ended in first ten-day of July.

Table 1. Genotype, year of release of 10 winter wheat cultivars and environments description

Genotype	Year of release	Environment	
Evropa 90	1990		
NSR-5	1991		
Pobeda	1990	*Code*	*Location-Veg. season*
Renesansa	1994		
Ljiljana	2000	E1	Rimski Šančevi-2009/10
Cipovka	2002	E2	Rimski Šančevi-2010/11
Dragana	2002	E3	Rimski Šančevi-2011/12
Simonida	2003	E4	Pančevo-2009/10
NS 40 S	2005	E5	Pančevo-2010/11
Zvezdana	2006	E6	Pančevo-2011/12

Yield - YLD ($t \cdot ha^{-1}$) was determined in field. Randman of seed - RND (%) was determined when 4x100 g of natural seed was sifted through rectangular aperture size 2.2 mm. The remaining seeds on the sieve were measured and expressed as percentage (%). All tests were performed on the harvested seed of each cultivar for each replication.

Genotype by environment interaction (GEI) was tested using AMMI (Additive Main Effects and Multiplicative Interaction) analysis given by *Zobel et al. (1998)*. Data processing was performed in GenStat 9th Edition VSN International Ltd (www. vsn-intl.com), trial version. The accuracy of a yield trial can be increased by improved experimental techniques, more replicates, or more efficient statistical analyses. The third option involves nominal fixed costs, and is therefore very attractive.

RESULTS AND DISCUSSION

At the level on entire experiment cultivar Simonida had the highest YLD (8.12 $t \cdot ha^{-1}$), while the cultivar NS 40S was behind with 8.00 $t \cdot ha^{-1}$. In the terms of highest achieved RND Dragana (93.49 %) and Ljiljana (93.14 %) distinguished, Figure 1.

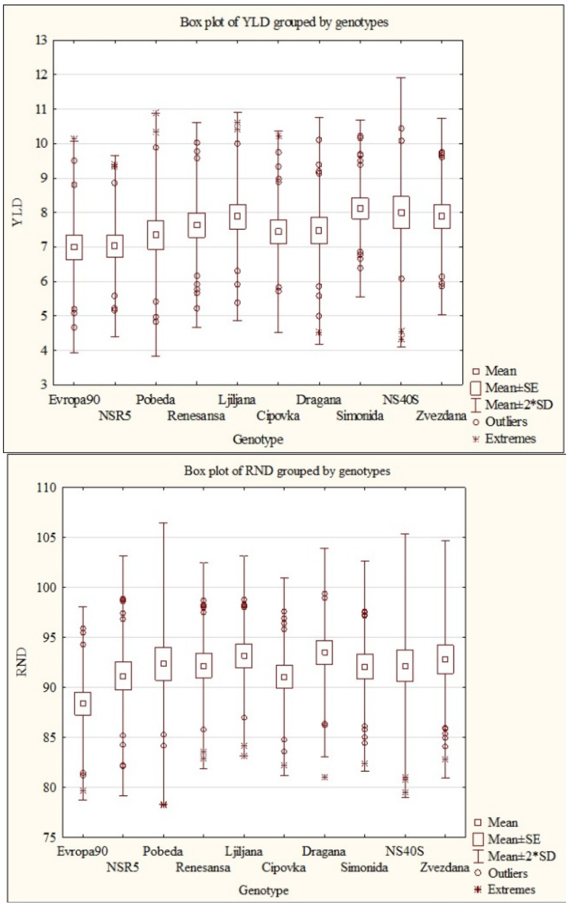

Fig. 1. The box plots for YLD and RND for 10 examined wheat cultivars

The statistical analysis recommended here combines the additive main effects and multiplicative interaction (AMMI) model with a predictive assessment of accuracy. AMMI begins with the usual analysis of variance (ANOVA) to compute genotype and environment additive effects. It then applies principal components analysis (PCA) to analyze non-additive interaction effects *(Zobel et al., 1988)*. Multivariate ordination such as AMMI and PCA help in interpreting the genetic control of multiple traits *(Ormoli et al., 2015; Cvejić et al., 2015)*. AMMI analysis of variance for YLD showed that the total sum of squares attributed to the impact of environments 79.8 %, GEI was represented with 9.2 % and 5.8 % was the effect of genotype, while the variation of RND was mainly determined by the influence of environment (84.5 %), GEI (7.6 %) and genotype (5.9 %). All sources of variation were statistically significant (Table 2), which is in accordance with previous results of *Mladenov et al., 2012*. AMMI 1 biplot shows that the most genotypes achieved YLD about the grand mean of the experiment (7.58 $t \cdot ha^{-1}$). Smaller average values were achieved at Pančevo (E4, E5, E6) in relation to Rimski Šančevi. Meteorological conditions (data not shown) during the 2010/11 at this site were favorable for the achievement of high yields and satisfactory stability of genotypes. Cultivars Renesansa, Ljiljana and Simonida distinguished in comparison to other genotypes.

Dispersal of environmental points indicates that tested agro-ecological locations differed in the additive and multivariate part of whole variation.

Table 2. AMMI analysis of variance for 10 wheat cultivars examined across 6 environments

Source	df	YLD		RND	
		F calc.	Total share %	F calc.	Total share %
Total	179	-	100.0	-	100.0
Treatments	59	**	94.8	**	98.0
Genotypes	9	**	5.8	**	5.9
Environments	5	**	79.8	**	84.5
Block	12	**	1.0	ns	0.3
Interactions	45	**	9.2	**	7.6
$IPCA_1$	13	**	69.3	**	67.4
$IPCA_2$	11	**	18.1	**	15.2
Residuals	21	-	-	-	98.0
Error	108	-	-	-	-

df: degree of freedom; F calc: F value calculated; YLD: Yield; RND: Randman of seed; Level of statistical significance: * P < 0.05; ** P < 0.01; ns: not significant.

Their grouping showed that major differences among genotypes results as a impact of growing season, rather than difference among locations. Genotypes achieved lowest values of interaction in E6, while E1 and E5 where the least favorable for stable interaction of genotypes. However, comparing these two environments genotypes had lower YLD achieved in E5 (Figure 2A).

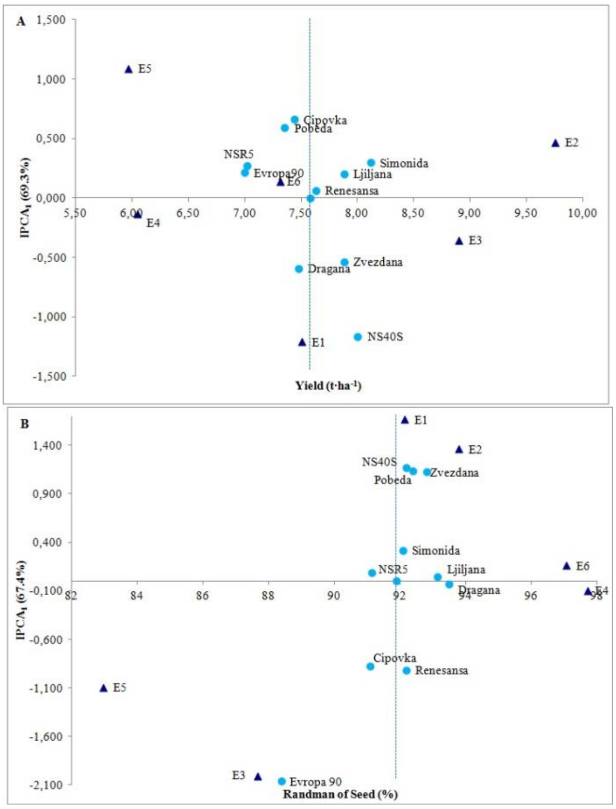

Fig. 2. Biplot of the AMMI 2 model for tested traits (YLD and RND) for 10 examined wheat cultivars grown across 6 environments; A-yield; B-randman of seed

The genotypes differ more in achieving realized interaction with environment than in average values of RND. Most cultivars had an average values of this trait close to average of the whole experiment. Larger RND had Dragana i Ljiljana, while Evropa 90 achieved the smallest. Evropa 90 had highest interaction with environment and was the least stable, but on the other hand it managed to use positive conditions of E3, which was the worst in terms of weather conditions. That fact indicates on good adaptability of this genotype. At the site of Pančevo during the 2009-10 season (E4) and 2011/12 (E6) all genotypes realized the highest average value of RND interaction with small interaction values (Figure 2B). Assessing the average value of tested traits along with stability, in different environmental conditions, as the most desirable genotypes, Ljiljana and Simonida distinguished themselves *(Mladenov et al., 2012; Banjac et al., 2014)* In comparison with other genotypes Evropa 90 showed better adaptability to poor growing conditions. For both traits the positive interaction of Evropa 90 is achieved with the worst weather conditions across both locations (E3 and E6).

CONCLUSION

In multivariate analysis, the number of environments necessary for this kind of experiment is confusing. According to some authors higher number of environments is more optimal for this kind of analysis, while others stress that influence of the year is more valid. In both cases, what is needed is more environments across different years, basically multi environmental trails. In this manuscript variability along with stability for two important agronomic has been explained and special attention has been given to use of multi environmental trails-field exams in different locations across multiply years.

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Received: 17.03.2016. Accepted: 04.04.2016.