PERFORMANCE OF NS SUNFLOWER HYBRIDS IN ROMANIA

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Summary

Performance of 25 new sunflower hybrids at three locations in Romania were estimated using AMMI model. Seed yield per plot were recorded on plants in middle rows to avoid edge effect. The most productive hybrid was NS-6 (4.31 t/ha), while the least productive was NS-13 (2.80 t/ha). The highest yield was obtained by hybrid NS-24 in location Valul lui Traian with seed yield of 5.03 t/ha, while the lowest seed yield was 1.43 t/ha obtained by hybrid NS-13 in location Dalga. AMMI analysis showed that variations in seed yield were mostly due to additive effects, genotype (32.45%) and environment (41.62%), but interaction effect (25.92%) was also not negligible. The most productive hybrids with high yields and low values of interaction were NS-1, NS-2, NS-4, NS-5, NS-6, NS-9, NS-10, NS-11 and NS-16.

Key words: performance, sunflower, hybrids, AMMI model, seed yield

Introduction

Sunflower (*Helianthus annuus* L.), being important oil seed and food crop, is grown on 22.9 million hectares (Seiler and Jan, 2010). High and stable yields are characteristics of greatest importance in commercial production. Ideal hybrid in terms of seed yield is the one that is capable to use its genetic potential to the maximum in different environments. Sunflower is grown over a wide range of environments across the world and because of that it is important that this crop has good adaptability. Hybrids and different environments are in interaction and of the size of that interaction it depends stability and the extent of the individual hybrids. Multi environment trials are important part of breeding program in order to select superior genotypes for specific region (Branković et al., 2012). Therefore, finding the most productive hybrid for specific environmental conditions is possible via testing in different environments. These yield trials are used to provide information on three sources of variation: genotype effects (G), environment effects (E) and their interaction (GxE). Most frequently used statistical models

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for assessment of these effects are analysis of variance (AOV), linear regression (LR) and principal component analysis (PCA). Main disadvantage of these models is because they do not provide complete information on these complex agronomic sources of variation. For a precise insight into G, E and GxE effects in recent years two frequently used statistical models have been AMMI (*Additive Main Effects and Multiplicative Interaction*) and GGE (Genotype main effects and Genotype x Environment interaction effects). These models are based on singular value decomposition (SVD) also called principal component analysis (PCA) and are combo of AOV and SVD (Gauch, 2006). According to Gauch (2006) AMMI is the unique analysis for agricultural research purposes that completely and always separates G, E and GxE which is not always the case with GGE. AMMI model accurately characterizes significance of GxE interaction with an agronomic point of view and then partition this interaction into the complex multivariate relationships of genotype and environment, thus expressing agronomically important observations (Dimitrijević and Petrović, 2000). AMMI is the model of first choice when main effects and interaction are both important (Zobel et al., 1988). AMMI analysis reveals a highly significant component of the interaction that has appropriate agronomic meaning. The extent of the interaction shows the influence of environmental factors on the stability and adaptability (Yan i Hunt, 2003). Multivariate AMMI analysis enables us to better understand the effects of genotype, environment and complexity of their interaction (Raju, 2002; Babić et al., 2011). AMMI analysis has been successfully used by many researches for determining adaptability, stability and GxE interaction (Kaya et al., 2002; Misra et al., 2009; Balalić et al., 2010; Sadeghi et al., 2011).

This study was undertaken to give more accurate investigation about performance of 25 new sunflower hybrids in Romania in order to identify those most promising for better exploitation of yield potential.

Material and method

The experimental matherial for this study consisted of 25 new sunflower hybrids developed at Institute of field and vegetable crops, Novi Sad. The experiment was carried out in 2011 at three locations in Romania (Valul lui Traian, Teleorman and Dalga). The machine sowing was performed in a randomized block design in three replicates. Basic plots were 4 rows with length of 10 m. Plant spacing was 70 cm between rows and 25 cm between plants within row. The common cultural practices were applied. Seed yield date were recorded on plants from middle rows to avoid edge effect. Data were processed using statistical software Biplot and singular value decomposition macros for Excel (Lipkovich and Smith, 2002).

Results and discussion

Creating hybrids with high and stable seed yield is the main goal in sunflower breeding. Because seed yield is complex trait and depend on various parameters it is very susceptible to the influence of environmental factors.

Results of mean values of seed yield at 3 locations in Romania shows that most productive hybrids were NS-6 (4.31 t/ha), NS-11 (4.29 t/ha), NS-5 (4.25 t/ha) and NS-7 with seed yield of 4.14 t/ha. The least productive was NS-13 with seed yield of 2.80 t/ha. Comparing productivity in the individual locations the highest yield was obtained by hybrid NS-24 in location Valul lui Traian with seed yield of 5.03 t/ha, while the lowest seed yield was 1.43 t/ha obtained by hybrid NS-13 in location Dalga (Tab. 1).

Table 1. Average seed yields (t/ha) and genotypic PCA values of 25 new sunflower hybrids at three locations in Romania
Tabela 1. Prosečan prinos semena (t/ha) I genotipske PCA vrednosti 25 novih hibrida suncokreta u tri lokaliteta u Rumuniji

Hybrids	Locality			$\overline{X}$	Rang	IPCAg
	Valul lui raian	Teleorman	Dalga			
NS-1	4.58	3.70	3.83	4.03	7	0.00
NS-2	4.45	3.92	3.93	4.10	6	-0.08
NS-3	4.38	3.74	3.53	3.89	13	-0.16
NS-4	4.48	3.81	3.73	4.01	8	-0.10
NS-5	5.00	4.03	3.72	4.25	3	-0.17
NS-6	4.84	3.72	4.36	4.31	1	0.23
NS-7	4.68	3.37	4.35	4.14	4	0.40
NS-8	4.08	3.38	3.44	3.63	19	-0.04
NS-9	4.11	3.93	3.89	3.98	10	-0.12
NS-10	4.41	3.97	3.99	4.13	5	-0.08
NS-11	4.87	3.90	4.09	4.29	2	0.03
NS-12	4.55	3.11	3.16	3.61	20	0.02
NS-13	3.39	3.58	1.43	2.80	25	-1.03
NS-14	4.08	3.55	3.29	3.64	18	-0.19
NS-15	4.03	3.85	3.10	3.66	17	-0.42
NS-16	4.48	3.73	3.77	3.99	9	-0.05
NS-17	3.85	2.89	3.70	3.48	22	0.29
NS-18	4.28	3.56	3.85	3.90	12	0.05
NS-19	4.12	2.72	3.48	3.44	23	0.31
NS-20	4.18	3.61	3.61	3.80	15	-0.08
NS-21	4.46	3.30	3.88	3.88	14	0.21
NS-22	4.24	2.50	3.74	3.49	21	0.54
NS-23	4.61	2.91	3.82	3.78	16	0.40
NS-24	5.03	3.26	3.68	3.97	11	0.17
NS-25	3.75	3.18	3.06	3.33	24	-0.13
$\overline{X}$	4.36	3.49	3.61	3.82		
σ^2	0.19	0.21	0.40			
IPCAe	0.20	-1.16	1.00			
LSD	5%			0.30		
	1%			0.40		

AMMI analysis of variance showed that genotype and environmental factors, as additive effects, as well as their interaction had highly significant proportion in total variation of the experiment (Tab. 2). Analysis showed that genotype and environments, as main effects, were responsible for 74.07% and interaction for 25.92% of the variance. When choosing a genotype only effects that are important are effects of genotype and GxE interaction. Within the main effects genotype accounted for 32.45% while environment represented 41.62% of the treatment SS. The largest part of the total variability that is explained by the first principal component (IPCA 1), caused by the effect of genotype and eco-environment, was highly significant and makes 78.60% of the total interaction. Marinković et al. (2011) reported similar results. The second principal component (IPCA 2) which represent the rest of unexplained variance that remains after seclusion of the IPCA1 was also highly significant and made 21.40% of total interaction (Tab. 2).

Table 2. AMMI analysis of variance of 25 new sunflower hybrids

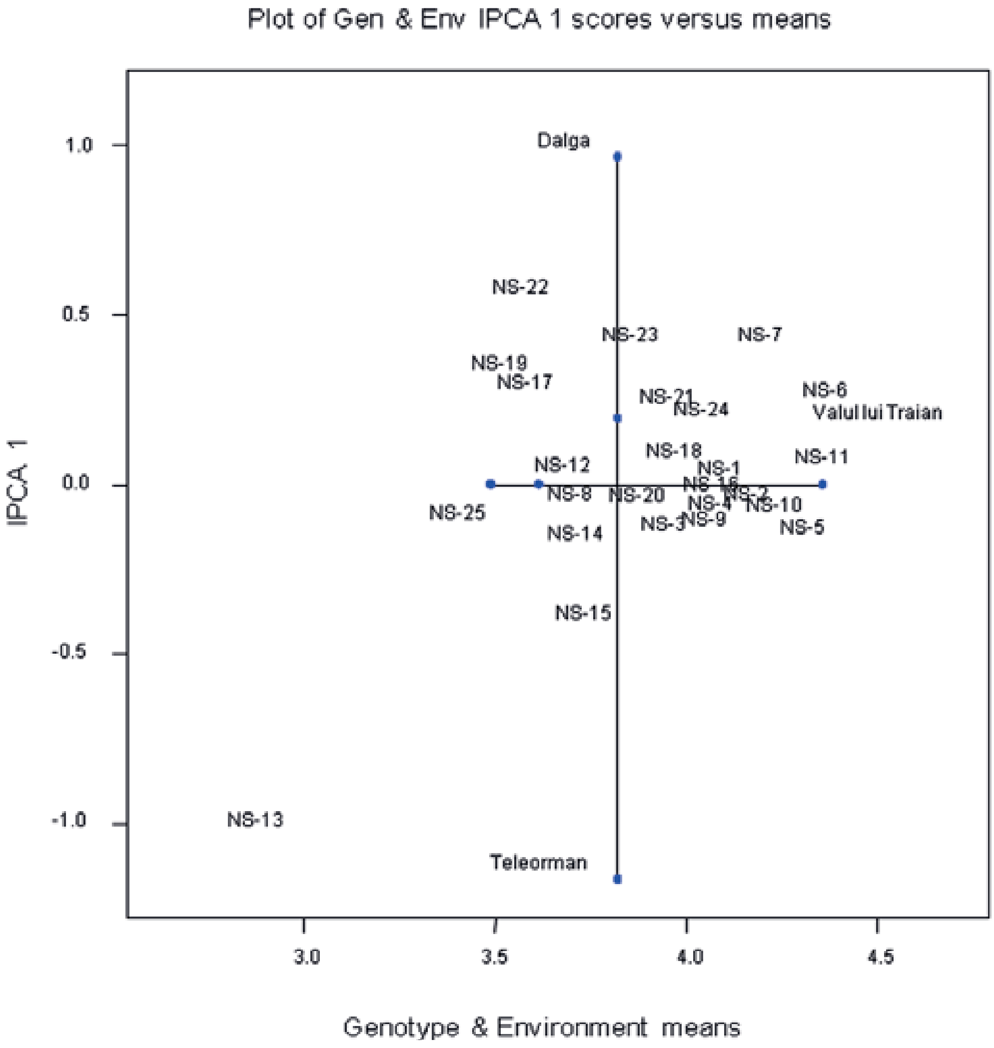
Tabela 2. AMMI analiza varijanse 25 novih hibrida suncokreta

Source of variation	D. F.	S. S.	M. S.	F-values
Block	6	0.90	0.150	2.07
Treatment	74	79.51	1.074	14.86**
Genotype	24	25.80	1.075	14.87**
Environments	2	33.09	16.547	110.40**
Interaction	48	20.61	0.429	5.94**
IPCA 1	25	16.20	0.648	8.96**
IPCA 2	23	4.41	0.192	2.65**
Residue	0	0.00	-	-
Error	144	10.41	0.072	-
Total	224	90.82	0.405	-

*= $p<0.05$
**= $p<0.01$

On two-dimensional graph are shown average values of genotype, environment and interaction (Figure 1). According to Gauch and Zobel (1997) genotype effects (abscissa) control the wide sense adaptability while the interaction effects (ordinate) control the narrow sense adaptability. As presented on figure 1 we can se that hybrids grouped around abscissa exhibited low effect of the interaction and those hybrids are characterized by good

Figure 1. Estimate of genotype to environment interaction on seed yield of 25 new sunflower hybrids in three locations in Romania
Figura 1. Procena interakcije genotipa i sredine na prinos semena 25 novih hibrida suncokreta u tri lokaliteta u Rumuniji



stability, but however our primary goal is high yield and special attention should be given to hybrids with low effect of the interaction and high values of yield such as NS-1, NS-2, NS-4, NS-5, NS-6, NS-9, NS-10, NS-11 and NS-16. The worst performing hybrid was NS-13 who exibited the lowest yield and the highest effect of the interaction. As for the environments in which hybrids were grown we can see that locality Valul lui Traian had the lowest interaction and hybrids were best performing in that environment, while localities Dalga and Teleorman were unstable environments for hybrids because of high interaction.

Conclusions

Based on the obtained results we can conclude that sunflower hybrids developed at Institute of Field and Vegetable Crops Novi Sad are suitable for high yield production in tested locations in Romania. The most promising are hybrids NS-6 who had the highest average yield, NS-1, NS-2, NS-4, NS-5, NS-9, NS-10, NS-11 and NS-16 which had low values of the interaction and high yields. The best performing environment was Valul lui Traian with low interaction and highest yields. AMMI analysis of variance showed that additive effects, genotype and environment, accounted for 74.07% in total variance and genotype effect was 32.45%. Interaction effect was 25.92% which is not negligible. Multi location trials contain valuable information that is useful for better understanding the genotypes, environments and their interaction, so whenever it is possible multivariate models (AMMI) should be used to increase the accuracy of decisions that are based on obtained data.

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PERFORMANSE NS HIBRIDA SUNCOKRETA U RUMUNIJI

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Izvod

Proučavane su performanse 25 novih hibrida suncokreta u 3 lokaliteta u Rumuniji primenom AMMI modela. Prinos semena po parcelici je zabeležen na biljkama iz srednjih redova kako bi se izbegao rubni efekat. Najproduktivniji hibrid je bio NS-6 (4,31 t/ha), dok je najmanje produktivan bio hibrid NS-13 (2,80 t/ha). Najveći prinos je ostvario hibrid NS-24 u lokalitetu Valul lui Traian sa prinosom od 5,03 t/ha, dok je najniži prinos semena bio 1,43 t/ha ostvaren od strane hibrida NS-13 u lokalitetu Dalga. AMMI analiza je pokazala da je varijacija u prinosu semena najvećim delom bila uslovljena aditivnim efektima, genotipom (32,45%) i spoljašnjom sredinom (41,62%), ali i efekat interakcije (25,92%) takođe nije bio zanemarljiv. Kao najproduktivniji sa visokim prinosom i niskom vrednošću interakcije pokazali su se hibridi NS-1, NS-2, NS-4, NS-5, NS-6, NS-9, NS-10, NS-11 i NS-16.

Ključne reči: performanse, suncokret, hibridi, AMMI model, prinos semena.

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