INVESTIGATION ON THE EFFECTS OF THE GENOTYPE X ENVIRONMENT INTERACTION IN SOME NEW BULGARIAN COMMON WINTER WHEAT CULTIVARS

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Abstract

Fifteen new Bulgarian common winter wheat cultivars were investigated for ecological plasticity and stability in four replicates of a randomized experiment during 2014 – 2016. The applied two-factor dispersion analysis proved the different genetic potential of the group of cultivars according to the investigated indices to the highest degree of statistical significance, as well as the effect of the climatic conditions. The genotype x ecological conditions interaction was significant for all indices, which was a necessary prerequisite to apply AMMI models for evaluation of the cultivars' ecological plasticity and stability according to the investigated indices. The use of the AMMI models allowed the evaluation of the ecological plasticity on the basis of the statistical parameters ASV, and of the ecological stability on the basis of the reliability index I. According to the index *yield*, cultivar Laska was with the highest plasticity and stability, ranking first among all cultivars. Cultivars Laska, Progress, Enola, Bezostaya 1, Kristi and Yantur demonstrated high ecological plasticity and stability according to the complex of all investigated traits.

Keywords: *Triticum aestivum* L , ecological plasticity and stability , AMMI models.

Introduction

Wheat is a main agricultural crop in Republic of Bulgaria. It is grown on millions of ha of arable land. The climatic changes are ostensible during the last decade in different regions of the country. The investigation on the response of the major cultivars used in production to these changes is important both for the farmers and the breeders. The estimation of the ecological plasticity and stability of winter wheat varieties is permanent investigated (Penchev 2004). Different models for evaluation of the interaction "genotype-enviroment" are compared and discussed their pryorities and disadvantages (Penchev 2005). Tsenov (10) discussed the importance for breeders and farmers to study the interaction "genotype x ecological conditions" and it influence at the productivity of winter wheat. A set of 25 advanced breeding lines and released varieties of wheat (*Triticum aestivum* L.) developed by different breeding centers in India were assessed for their adaptation in 18 different environments across the Indo-Gangetic plains. The study was aimed at identifying genotype(s) with high yield stability across the environments in general and heat stress environments in particular.(Rane J. at all). The contemporary methods for evaluation of the *genotype x environment* interaction such as the AMMI models (Abamu, J.; Nachit M, Lee) allow precise estimation of the ecological plasticity and stability of the investigated genotypes.

Material and methods

In our three years experiment the analyses of plasticity and stability were by using fifteen new Bulgarian winter – wheat varieties . The results of our research proved that the method, applied can be efficiently used to analyse the environmental responses, the behaviour under varying environmental conditions of different varieties. Varieties can adapt themselves differently to favourable and unfavourable environmental conditions. The cultivars were examined for ecological plasticity and stability in a randomized experiment of four replicates during 2014 – 2016.The experiment was taken in three different regions in Bulgaria at the north and south part of the

country: General Toshevo, Russe and Sadovo. The following actual for the praxis cultivars were investigated: Antitsa, Bezostaya 1, Galateya, Dobrudzhanka, Dona, Enola, Karat, Korona, Kristi, Kristora, Laska, Liliya, Ludogorie, Progress and Yantur. The indices yield, 1000 kernel weight, plant height, spike length, weight of grain per spike and number of grains per spike were subjected to analysis. These indices were measured on 10 randomly chosen spikes.
The dispersion analysis carried out according to the model:

Yijk = Y.. + Gi + Yj + Zk + (GY)ij + (GZ) ik + (YZ)jk + (GYZ)ijk + Eijk,

where Gi is the factor genotype, Yj is the climatic conditions ,Zk is the region and Eijk is the error. The linear regression models were calculated by last square method. The means for plasticity and stability of the studied indices and the varietal adaptability to the changeable environment were estimated by AMMI models (2). The experimental data were processed with statistical packages SPSS 19.0 and Biostat 6.0.

Results and discussion
Table 1 presents the results from the dispersion analysis carried out according to the model.

Table 1. Dispersion analysis of the investigated indices

	Yield	Height	Length of spike	Number of spikelets	Number of grains	1000 kernel weight
G	19089,8 [c]	5108,3 [c]	11 [c]	6306 [c]	518,8 [c]	471,4 [c]
Y	7793 [c]	776,8 [c]	38,8 [c]	5936 [c]	463,8 [c]	244,6 [c]
Z	47726,6 [c]	6643,6 [c]	101,55 [c]	20375,2 [c]	19523,1 [c]	7475,6 [c]
G x Y	1416,1 [c]	357 [c]	1,68 [c]	576,1 [c]	70,3 [c]	226,4 [c]
G x Z	438,1 [a]	87 [b]	0,32	97,8	46,2	2,8
Y x Z	4061,7 [c]	2915,2 [c]	2,55 [c]	714,8 [c]	479,7 [c]	112,2 [c]
G x Y x Z	474,3	82,8 [b]	0,22	158,7 [a]	25	24,1 [a]
Error	221,4	17,9	0,16	76	15,9	8,5

a – statistical significance at P=0,05, b – statistical significance at P=0,01, c – statistical significance at P=0,001

The applied F criterion proved the different genetic potential of the group of cultivars according to the investigated indices to the highest level of statistical significance, as well as of the other two investigated factors – climatic conditions and regime of drought. The *genotype x ecological conditions* interaction was significant for all indices and this was the necessary prerequisite to apply AMMI models for evaluation of the ecological plasticity and stability of the cultivars according to the investigated indices. Interesting results were obtained for the interaction *genotype x regime of drought*; it was significant only for the indices yield and plant height.
The application of the AMMI models allowed the estimation of the ecological plasticity on the basis of the statistical parameters ASV, and of the ecological stability on the basis of the reliability index I. According to the index *yield*, cultivar Laska demonstrated the highest plasticity and stability and ranked first among all cultivars. It was followed by cultivars Progress, Enola, Yantur, Galateya, Karat, Dona and Bezostaya 1; in these cultivars the productivity was less influenced by the variable climatic conditions and they can be evaluated as having good ecological plasticity and stability. Cultivars Kristi, Kristora and Dobrudzhanka were marginal, while Liliya, Ludogorie, Korona and Antitsa had susceptible reaction of this index under changeable climatic conditions and showed low ecological plasticity and stability. According to the index *plant height*, cultivars Liliya, Dona, Karat, Kristora, Progress and Bezostaya 1 had good ecological plasticity and stability, the values of the ASV parameters being below 0.200, and the reliability indices – higher than 1.5.

Table 2. Results from application of AMMI models

Cultivar	Yield			Height			Length of spike		
	Rank	ASV	I	Rank	ASV	I	Rank	ASV	I
Laska	1	0,022	2,432	12	0,327	0,744	9	0,289	0,976
Progress	2	0,084	2,213	5	0,178	2,121	1	0,085	2,433
Enola	3	0,111	1,945	15	0,356	0,627	8	0,252	1,255
Yantur	4	0,165	1,929	7	0,224	1,442	7	0,224	1,422
Galateya	5	0,180	1,896	10	0,318	0,795	13	0,348	0,855
Karat	6	0,187	1,854	3	0,108	2,224	3	0,128	2.261
Dona	7	0,208	1,805	2	0,088	2,247	6	0,198	1,724
Bezostaya 1	8	0,233	1,725	6	0,207	1,562	2	0,105	2,315
Kristi	9	0,276	1,664	9	0,284	0,829	10	0,312	0,955
Kristora	10	0,285	1,525	4	0,312	2,188	5	0,175	1,988
Dobrudzhanka	11	0,297	1,332	13	0,339	0,731	4	0,147	2,105
Liliya	12	0,332	1,031	1	0,003	2,571	15	0,379	0,832
Ludogorie	13	0,397	0,944	11	0,328	0,827	12	0,331	0,864
Korona	14	0,412	0,866	14	0,351	0,811	11	0,322	0,897
Antitsa	15	0,434	0,813	8	0,259	1,013	14	0,365	0,849

Cultivars Enola, Korona, Dobrudzhanka, Laska and Ludogorie showed susceptible reaction according to this index: the values of the AVS parameters were higher than 0.31, while the I indices were lower than 1. According to the index *length of spike*, cultivar Progress ranked first; it had only slight reaction to the changes of the climatic conditions. The value of the ASV parameter was 0.085, and the reliability index of this cultivar was 2.433. The cultivars with highest ecological plasticity and stability according to this index were Bezostaya 1, Karat, Dobrudzhanka, Kristora, Dona and Yantur; their ASV parameters were less than 0.24, and their reliability indices were higher than 1.5. Susceptible was the reaction of cultivars Galateya, Antitsa, Liliya, Ludogories, Korona and Kristi, the ASV parameters of which were higher than 0.31, and the reliability indices – lower than 1. Cultivars Progress, Karat, Dona, Yantur and Bezostaya 1 can be pointed out as having good ecological plasticity and stability by all three indices.

Table 3. Results from the use of the AMMI models

Cultivar	Number of spikes			Number of grains			1000 kernel weight		
	Rank	ASV	I	Rank	ASV	I	Rank	ASV	I
Laska	1	0.078	2,377	5	0.188	1.915	3	0.122	2.062
Progress	2	0.095	2.364	9	0.295	1.235	12	0.318	0.881
Liliya	3	0.117	2.107	11	0.327	0.915	15	0.345	0.794
Kristi	4	0.124	2.119	12	0.334	0.896	1	0.098	2.217
Korona	5	0.196	1.842	2	0.122	2.217	6	0.177	1.732
Enola	6	0.227	1.622	10	0.311	1.211	5	0.162	1.826
Bezostaya 1	7	0.271	1.327	4	0.182	2.080	8	0.194	1.527
Dobrudzhanka	8	0.286	1.248	1	0.118	2.235	10	0.258	1.466
Yantur	9	0.295	1.124	8	0.279	1.521	7	0.182	1.569
Dona	10	0.319	0.925	3	0.135	2.104	14	0.336	0.822
Karat	11	0.321	0.882	15	0.339	0.816	9	0.229	1.474
Galateya	12	0,327	0.880	6	0.209	1.742	4	0.147	1.953
Antitsa	13	0.372	0.628	13	0.347	0.884	11	0.289	0.973
Ludogorie	14	0.385	0.601	7	0.226	1.588	2	0.103	2.168
Kristora	15	0.394	0.595	14	0.356	0.852	13	0.329	0.846

According to the index *number of spikes*, high ecological plasticity was demonstrated by cultivars Laska, Progress, Liliya, Kristi, Korona, Enola, Bezostaya 1, Dobrudzhanka and Yantur with values of the statistical parameter ASV< 0.3 and of the reliability index I >1. Cultivars Dona, Karat, Galateya, Antitsa, Ludogorie and Kristora responded with susceptible reaction to the climatic conditions; their values of the statistical parameters were ASV > 0.3 , I < 1. According to the index number of grains per spike, high ecological plasticity and stability was observed in cultivars Dobrudzhanka, Korona, Dona, Bezostaya 1, Laska, Galateya, Ludogorie and Yantur, and the reaction of cultivars Progress, Enola, Liliya, Kristi, Antitsa, Kristora and Karat was susceptible. With regard to the index *1000 kernel weight*, the application of the AMMI models revealed that cultivars Kristi, Ludogorie, Laska, Galateya, Enola, Korona, Yantur and Bezostaya 1 were slightly influenced by the variable climatic conditions, while cultivars Karat, Dobrudzhanka, Antitsa, Progress, Kristora, Dona and Liliya exhibited more susceptible reaction.

Conclusions

According to the complex of all indices, cultivars Laska, Progress, Enola, Bezostaya 1, Kristi and Yantur demonstrated high ecological plasticity and stability. High susceptibility was found in cultivars Antitsa, Liliya, Ludogorie and Korona. According to the index *productivity*, cultivars Laska, Progress, Enola and Yantur were with high ecological plasticity. Cultivars Liliya, Ludogorie, Korona and Antitsa responded with susceptible reaction.

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