YIELD PLASTICITY AND STABILITY OF TRITICALE VARIETIES (X *TRITICOSECALE* WITTM.) UNDER INCREASING NITROGEN FERTILIZATION NORMS.

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***Abstract**: Used were three years data for yield of grain from triticale varieties with a different genotype, cultivated under conditions on an experimental field of the Crop Science Department at Agricultural University – Plovdiv: AD-7291 (standard), Sadovec and Zaryad (wheat type), Rakita and Rojen (rye type). With increasing of the nitrogen fertilization norm, the variation of the plasticity index between the varieties, is the lowest and in all of them b_k values are about a zero. Average values of plasticity coefficient define varieties Rakita and Sadovec as ecological plastic. The lowest ecological plasticity manifests the standard AD-7291. Almost all varieties show the highest stability coefficient at the highest fertilization norm, except variety Zaryad, where the most stable yield was determined by fertilization with N120. Rye type varieties manifest higher stability than wheat triticale sorts.*

***Key words:** triticale, plasticity, stability, yield,*

INTRODUCTION

Climate changes force searching of new solutions, related to the production of agricultural produce (SHUKLA, 1972; SCHLICHTING, 1986). One, from the possible alternatives, is the imposition of cultures with higher resistance to unsuitable climatic conditions, what is the case with triticale – an artificial hybrid, made up of cross between wheat and rye.

Despite the proved drought-resistance, resistance to diseases and to acid soils, the varieties specification is large, because of the different combination between rye and wheat genome during the selection process. Namely the different genotype characteristic of the triticale varieties is the main reason not only for their remoteness, but also for their ecological plasticity, stability and productivity (FERREIRA ET AL., 2015; MÜHLEISEN ET AL., 2014).

Excepting the variety, the ways of cultivation such as tillage, fertilization, choice of predecessor, which can be modified, can exert an influence on the productivity. One, from the most powerful factors that influences the yield is fertilization, especially the nitrogen fertilization (GERDZHIKOVA ET AL., 2013; GERDZHIKOVA, 2014; TYAGI ET AL., 2016; LIDANSKY ET AL., 1997; GONCHARENKO ET AL., 2015).

Object of the research is to determine the influence of different nitrogen fertilization rates on yield plasticity and elasticity of triticale varieties.

MATERIAL AND METHODS

Used were three years data for yield of grain from triticale varieties with a different genotype, cultivated under conditions on an experimental field of the Crop Science Department at Agricultural University – Plovdiv: AD-7291 (standard), Sadovec and Zaryad (wheat type), Rakita and Rojen (rye type).

The model of Eberhart and Russel (1) was applied:

(1) $Yijk = Y .. + Gi + Pj + rij + eijk$,

where G is the effect of the genotype, and P – of the examined area.

The modified appearance of the model (PENCHEV AND STOEVA, 2004) (2) was also used:

(2) $Y_{ijk} = Y.. + G_i + Q_j + GQ_{ij} + e_{ijk}$,

where G is the effect of the genotype, Q – of the climatic conditions and GQij – interaction GxQ .

RESULTS AND DISCUSSION

The regression coefficient and the deviations from the regression line were being estimated and so the diffraction can be determined by use of dispersion analysis (table 1).

The model of Eberhart and Russel can be applied under condition that the interaction ,,genotype G x climatic conditions Q'' is statistically significant, because it is supposed, that the changes in the feature are based on genetic and plants will change estimated parameter by different environment. To give a mathematical expression of the terms ,,ecological plasticity'' and ,,stability'' Eberhart and Russel give them the following definition: under ecological plasticity is to understand the average variety reaction to environmental changes, and under stability – the deviation of the empirical data from this average reaction at any condition of the environment.

Table 1.

Analysis of dispersion.

Sourse	SS	MS	df	F
Total	410126			
Repeats	7399			
G (genotype)	29594	7398	4	2,31
Q (climatic conditions)	5254	2627	2	0,82
GxQ	233435	29179**	8	9,11**
error	134442	3201,01	42	

** - statistical significant by p=0.01

The coefficients b_k of the linear regressions characterize the average variety reaction to changes in the climatic conditions, show his plasticity and give opportunity to prognosticate the researched parameter in the range of the investigated conditions.

Geometrical the regressions coefficients b_k can be interpreted as an angular coefficients of the regression straight lines. It is clarified, that by b_k increase the variety will be more responsive to the growing conditions. In most cases b_k coefficients are positive, but they can also acquire a negative values, as for example yield decrease as result from lodge or disease attack. If the coefficient $b_k > 0$, it means that the variety does not react to the environmental changes.

Table 2.

Ecological plasticity of triticale varieties under increasing nitrogen fertilization, b_k.

Variety	Nitrogen fertilization norm, t ha^{-1}				Average for the variety
	0	60	120	180	
AD-7291	0.785	0.582	0.900	0.900	0.792
Rakita	1.591	1.528	1.140	1.290	1.387
Sadovec	0.927	1.215	1.230	0.940	1.078
Rojen	0.917	0.943	0.740	0.930	0.883
Zaryad	0.780	0.732	0.990	0.940	0.861

Ecological plasticity of the examined triticale varieties vary depending on the nitrogen fertilization (table 2). In unfertilized with nitrogen triticale varieties, the yield plasticity vary from 0,780 in Zaryad to 1,591 in Rakita variety. While the standard AD-7291 and Zaryad manifest the

smallest plasticity, Rakita and Sadovec are with the highest values of b_k coefficient at nitrogen fertilization value 60 t ha-1. When the nitrogen fertilization norm increases to N120, the lowest plasticity manifest Rojen variety, while Rakita and Sadovec are with the highest values for plasticity. At the highest fertilization norm of N180 the plasticity variation index among varieties is the lowest and by all of them the b_k coefficient values are about a one.

Reaction of triticale varieties against fertilization norm in case to their plasticity is different. So for example, AD-7291 and Zaryad shows the highest plasticity at higher fertilization norms, while in Rakita and Rojen the highest b_k coefficient values can be established by lower nitrogen fertilization. In sort Sadovec the highest plasticity was determined at average nitrogen fertilization norm. Average values of plasticity coefficient from all of the applied fertilization norms define Rakita and Sadovec as ecological plastic. The lowest ecological plasticity was determined in the standard AD-7291 (b_k = 0,792).

The main parameter, which estimates the variety stability, is the dispersion Sk. The more the dispersion of the stability S_k to zero tends, the less the empirical values of the signs distinguish from the theoretical values, located on the regression line. According to the applied models of Eberhart and Russel, as a goal for ,,ecological plastic and stable variety'' can be accepted any sort who possess the both values: $b_k > 1$ and $S_k > 0$.

Rates of dispersion S_k which define the variety stability, are in the present research positive in every varieties and at any fertilization norm, what according to Eberhart and Russel them as stable determine, concerning the received yield (table 3).

In the varieties AD-7291, Rakita and Rojen the increase of the nitrogen norm lead to increased yield stability. The highest dispersion values can be determined at the highest fertilization norm and in almost all varieties, except Zaryad, that the most stabile yield is to find out by fertilization with N120.

Average Sk values from all of the applied fertilization norms define Rakita and Rojen as the most stabile varieties with dispersion $S_k > 1$. The common between them is the fact, that both belong to the rye triticale type. About wheat triticale types like AD-7291, Sadovec and Zaryad the average stability of the sign is between 0,416 and 0,694.

Table 3.

Stability of grain yield of triticale varieties under increasing nitrogen fertilization, S_k

Variety	Nitrogen fertilization norm, t ha^{-1}				Average for the variety
	0	60	120	180	
AD-7291	0.215	0.304	1.077	1.180	0.694
Rakita	0.651	0.801	1.354	2.547	1.345
Sadovec	0.422	0.517	0.487	0.913	0.585
Rojen	0.446	0.579	1.407	1.600	1.008
Zaryad	0.600	0.543	0.196	0.324	0.416

CONCLUSIONS

With increasing of the nitrogen fertilization norm, the variation of the plasticity index between the varieties, is the lowest and in all of them b_k values are about a zero. Average values of plasticity coefficient define varieties Rakita and Sadovec as ecological plastic. The lowest ecological plasticity manifests the standard AD-7291.

Almost all varieties show the highest stability coefficient at the highest fertilization norm, except variety Zaryad, where the most stable yield was determined by fertilization with N120. Rye type varieties manifest higher stability than wheat triticale sorts.

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