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COMPARATIVE INVESTIGATION OF RYE TYPE TRITICALE VARIETIES, GROWN IN THE AGROECOLOGICAL CONDITIONS OF THRACE VALLEY

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Abstract

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A field trial has been carried out in the period 2007-2009 on the experimental field of Crop Sciences Department in Agricultural University - Plovdiv. Seven varieties of rye type triticale – Rakita (Standard), Attila, Accord, Kolorit, Frontera, Alter and Scudo are studied. The following traits has been investigated: Grain yield, ($t.ha^{-1}$); Plant height, cm; Number of productive tillers; Length of main spike, cm; Number of spikeletts per spike; Weight of grains per spike, g; Test weight, kg; 1000-grain weight, g. Differences in genotypes of triticale, measured by average yield of grain allows them to be displayed in the following ascending order - Alter <Rakita <Frontera <Scudo <Kolorit <Attila <Accord. Variation in the length of spike and the number of spikeletts per spike by years in each of the varieties is very low, from which it can be concluded that this feature is genetically determines and is influenced to a greater extent by genotype, rather than the climatic conditions of the year.

Key words: triticale, varieties, yield, productivity components

Introduction

Triticale (*X Triticosecale* Wittmack) is a cereal crop which was developed by man rather than through natural evolution. Wheat (*Triticum*) – rye (*Secale*) cross, triticale was initially developed to combine the positive traits of both parent types: vigor and winter hardiness as well as the higher protein content of rye combined with higher quality gluten and the baking properties of wheat. The higher yield potential and plumper kernels of modern triticale cultivars have resulted in lower kernel protein levels, which are similar to those of common bread wheats (Ewert and Honermeier, 1999; Royo, 1992; Skovmand et al., 1984).

High potential for grain yield in triticale can be best appreciated when comparing yields the best performance with other cereals. One of the main advantages of triticale is precisely its high productive potential. This is mainly due to higher productivity of the structural elements of the culture - a highly productive tillering and the large number of grains in spike (Brignall et al., 1988; Kirchev, 2006; Kirchev et al., 2005; Kolev and Ivanova, 2004; Royo and Blanco, 1999; Timofeev et al., 1986).

The selection of the more distinguished triticale varieties with higher participation of rye genome as a highly productive (Baychev, 1996; Panayotov et al., 2000). The purpose of the study was to determine productivity and its components of rye type triticale varieties in agricultural and climatic conditions of Plovdiv.

Material and Methods

A field trial has been carried out in the period 2007-2009 on the experimental field of Crop Sciences

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Department in Agricultural University - Plovdiv. Studied are seven varieties of rye type triticale – Rakita (Standard), Attila, Accord, Kolorit, Frontera, Alter and Scudo.

The experiment has been conducted on the block method in four replications in total adopted agrotechnics culture after predecessor grain maize (Terziev et al., 2007). The grain yield, ($t.ha^{-1}$) is determined by harvesting plots 10 m^2. The following traits has been investigated: Plant height, cm – PH; Number of productive tillers – NPT; Length of main spike, cm – LMS; Number of spikeletts per spike – NSS; Weight of grains per spike, g – WGS; Test weight, kg – TW; 1000-grain weight, g – TGW.

The study used rye triticale varieties established in different selection centers:

- Rakita, Attila, Accord, Kolorit, created in Dobroudja Agricultutal Institute – Gen. Toshevo, Bulgaria.
- Frontera, Alter and Scudo, created in selection company PRO.SE.ME. – Italia.

The analysis on the variances of the individual factors and the correlations between the investigated factors were performed with the help of the statistical software SPSS 16.0.

Results and Discussion

Climatic data for the years of the study are presented in Figure 1. The first year of the study was extremely hot and dry, with high levels of precipitations on May and June. In 2008, distribution of precipitations during the vegetation is uneven by month. The autumn is comparatively wet while the amount of precipitations in November is higher compared to the climatic norm for the month. The amount of precipitations in February, March and April are less compared to the long-standing period. The period of the grain forming has values close to the climatic norm while the amount of precipitations in June is 3.5 mm higher in comparison with the typical for the region amount. January 2009 is warm with higher average monthly temperature compared to the climatic norm. The amounts of precipitations are evenly distributed during the autumn of 2009. The periods of the beginning of vegetation as well as of the ripening of the grain have values close to the average values for a long-standing period.

In the three years of study triticale realize its productive potential by the magnitude of grain yield to varying degrees under the influence of tested factors

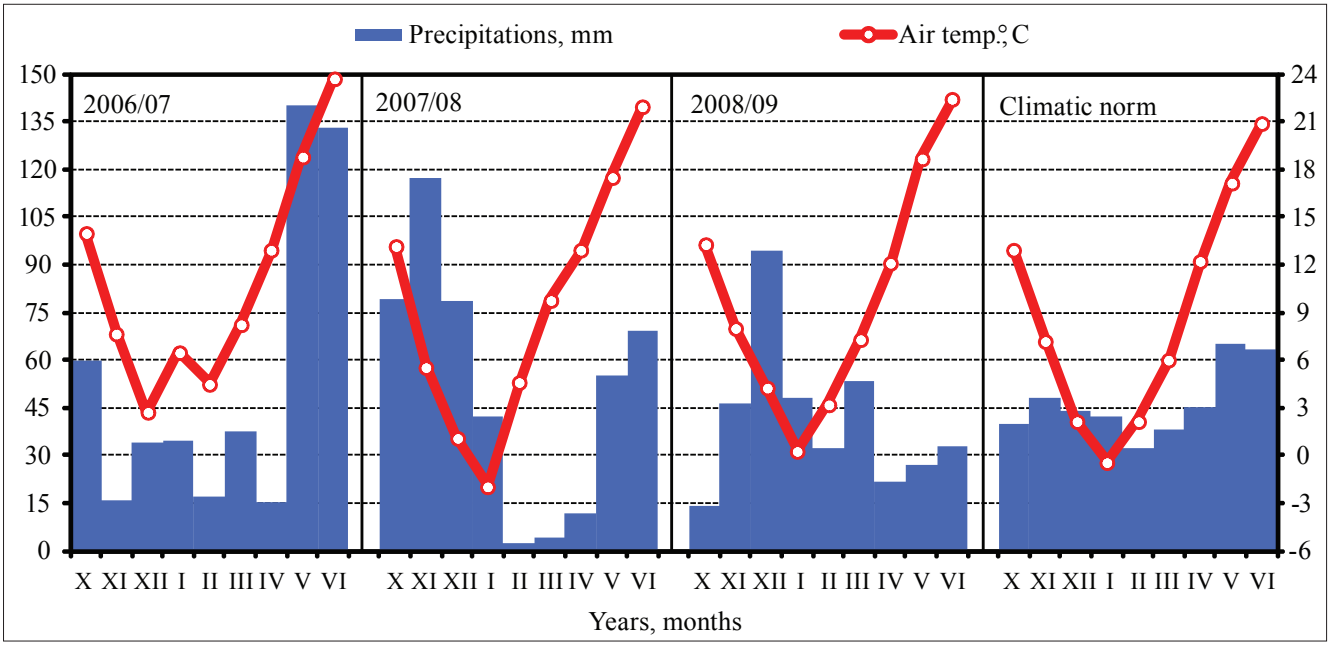

Fig. 1. Climatic data for the years of the investigation

(Table 1). The yield of grain of triticale varieties tested in terms of Plovdiv, varies by year as follows: between 2.480 (variety Alter) and 3.380 t.ha^{-1} (variety Accord) in 2007; between 3.010 (variety Alter) and 3.450 t.ha^{-1} (Accord variety) in the harvest in 2008, and among 4.190 (Rakita variety) and 5.590 t.ha^{-1} (Attila variety) in 2009 (Table 1). Therefore, differences in productivity of the tested varieties are susceptible: 0.900 t.ha^{-1} in the first year, 0.440 t.ha^{-1} in the second, and 1,400 t.ha^{-1} in the third year of study. These differences relative to the average yield of triticale up in three consecutive years, respectively, 363, 146 and 334 g.kg^{-1}.

Maximum yields in years in terms of Plovdiv are obtained as follows:

- 3.380 t.ha^{-1} - in 2007 from a variety Accord.
- 3.450 t.ha^{-1} - in 2008 from a variety Accord;
- 5.590 t.ha^{-1} - in 2009 from a variety Attila;

Lowest yield in the first year is obtained from a variety Alter – 2.480 t.ha^{-1} and the average crop yield is 3.020 t.ha^{-1}. During the 2008 the lower yield is obtained from a variety Alter – 3.010 t.ha^{-1}and the average yield for triticale is 3.220 t.ha^{-1}. Third year, characterized by favorable agro-climatic conditions for growth and development of culture is the highest average yield – 4.830 t.ha^{-1} and with the lowest yield this year is Rakita – 4.190 t.ha^{-1}. Data on minimum and maximum yields of grain in quite fully characterize the productive capacity of the tested varieties and their implementation in the agricultural and climatic conditions of Plovdiv. It is therefore not accidental that the average period for a variety Accord realizes the highest grain yield – 4.090 t.ha^{-1}, which exceeds by 108 g.kg^{-1} average for the conditions of the study yield of triticale (3.690 t.ha^{-1}). The lowest average yield for the period of the study was obtained from a variety Alter – 3.360 t.ha^{-1}, with 98 g.kg^{-1} below the average of three years of general study of all varieties of triticale.

As components of yield in this study recognized the structural elements - height of plants and the components of the spike - the spike length and number of spikeletts per spike (Table 2). During the introduction period, the height of the plants in 2008 ranged between 108 cm at the lowest variety Frontera and 130 cm for the highest Kolorit, between 110 and 132 cm in 2009 and 104 and 125 cm in 2007. As for the three years of study and research period average, as the low variety can be distinguished Frontera - 107 cm, and the highest

Table 1
Grain yield in years and an average for the period

Variety	Grain yields, t.ha^{-1}			Average t.ha^{-1}
	2007	2008	2009	
Rakita	3.080 b	3.160 a	4.190 a	3.480 b
Attila	3.260 c	3.360 c	5.590 c	4.070 c
Accord	3.380 c	3.450 c	5.430 c	4.090 c
Kolorit	3.120 c	3.220 b	5.060 c	3.800 c
Frontera	2.850 b	3.080 a	4.530 b	3.490 b
Alter	2.480 a	3.010 a	4.600 b	3.360 a
Scudo	2.970 b	3.260 a	4.380 b	3.540 b
LSD 5%	211	203	183	197

*Values with the same letters do not differ significantly

Table 2
Main structural components of the plants

Variety	Height of the plants, cm			Average
	2007	2008	2009	
Rakita	112	113	118	114
Attila	123 *	128 *	131 *	127
Accord	118	120	121	120
Kolorit	125 *	130 *	132 *	129
Frontera	104 *	108	110	107
Alter	118	120 *	121	120
Scudo	108	112	116	112
Length of the spike, cm				
Rakita	14	14.1	14.2	14.1
Attila	15.0 *	15.1 *	15.2 *	15.1
Accord	13.9	14	14.2	14
Kolorit	12.8 *	13.0 *	13.3 *	13
Frontera	16.5 *	17.2 *	18.9 *	17.5
Alter	15.5 *	16.4 *	17.4 *	16.4
Scudo	13.3	15.3 *	16.4 *	15
Number of spikeletts per spike				
Rakita	31	32	35	32.7
Attila	33	33	34	33.3
Accord	35 *	34	36	35
Kolorit	33	34	37	34.7
Frontera	25 *	28 *	29 *	27.3
Alter	23 *	23 *	24 *	23.3
Scudo	25 *	26 *	28 *	26.3

*Significance by differences in comparison with Rakita ($P < 0.05$).

- variety Kolorit form - 129 cm, it confirms the thesis that the height of the stem is a sign of varieties. Conditions of the year affect the height of the stem, with the highest average seed culture is formed in the third year - 121 cm, and lowest in 2007 - 115 cm.

Length of spike varies and amended by years - between 13.0 and 17.2 cm in 2008, between 13.3 and 18.9 cm in 2009 and between 12.8 and 16.5 cm in the first year of study. With the shortest spike features a variety Kolorit - 13 cm on average years of study, and the longest spike - Frontera - 17.5 cm. Varieties, created in terms of Bulgaria have a shorter class, which, however, seems to be no negative determinant of their performance. Variation in the length of spike by years in each of the varieties is very low, from which it can be concluded that this feature is genetically determines and is influenced to a greater extent by genotype, rather than the climatic conditions of the year.

At least spikeletts per spike are formed in the first year of study, which is characterized by adverse weather conditions - 29.3 averages for all varieties, but the largest number spikeletts per spike are formed in the third year - 31.9. During the harvest in 2008, the average number of spikeletts per spike is 30. Averages for the three years of study with most spikeletts per spike is distinguished variety gave the highest grain yield - Accord, with the average number spikeletts per spike 35, but as the lowest yield variety Alter 23.3 spikeletts per spike are formed.

The main structural components directly influencing the ear formation and the productivity of the different sorts of triticale can be viewed separately as factors – variety and conditions during the year (Table 3).

The height of the stem varies depending on the sort from 107 cm for Frontera to 127 cm for Kolorit. The differences between the seven sorts have been statistically verified, which confirms the thesis that the height of the stem is a genetically determined sign. The influence of the conditions during the year has been proven for all three years of the study.

The formation of productive shoots is one of the main factors that have a direct influence on the productivity of the crop. The quantity of productive shoots varies for the different sorts between 2.1 and 3.5 shoots per plant. However, these differences have been proven only for Accord and the other sorts can be united into two groups based on their productive shoots – group *a*: (Rakita, Frontera,Alter and Scudo) and group *b*: (Attila and Kolorit). During the first and the second years, equal numbers of shoots were formed and in 2009, when the largest grain yield was obtained, the forming of shoots was the highest.

The length of the spike and the number of the spikeletts on it has been statistically proven different

Table 3
Differences between the main productivity components

Indices	PH	NPT	LMS	NSS	WGS	TW	TGW
Varieties							
Rakita	114.3 b	2.10 a	14.10 b	32.7 c	2.8 a	66.8 a	35.5 a
Attila	127.3 c	3.20 b	15.10 c	33.3 c	3.6 c	71.8 b	36.7 a
Accord	119.7 c	3.50 c	14.03 b	35.0 c	3.8 c	73.2 c	37.5 b
Kolorit	129.0 c	2.80 b	13.03 a	34.7 c	3.1 b	67.9 a	36.9 a
Frontera	107.3 a	2.50 a	17.53 c	27.3 b	2.4 a	66.7 a	36.8 a
Alter	119.7 c	2.20 a	16.43 c	23.3 a	2.2 a	67.3 a	36.7 a
Scudo	112.0 b	2.70 a	15.00 c	26.3 b	3.0 b	71.4 b	36.3 a
Years							
2007	115.4 a	2.60 a	14.40 a	29.30 a	2.40 a	65.80 a	35.26 a
2008	118.7 b	2.88 a	15.00 b	30.00 a	3.28 b	68.74 b	36.30 a
2009	121.3 c	3.40 b	15.70 b	31.90 a	3.70 c	70.20 c	36.80 a
LSD 5%	3,3	0,61	0,42	4,32	0,54	2,43	1,32

*Values with the same letters do not differ significantly

for the triticale varieties. The longest spikes formed Attila and all varieties, created in PRO.SE.ME. The largest number of spikeletts is formed by the sort that gave the highest average grain yield – Accord, based on which we can draw the conclusion that this component is of primary importance for the productive capacity of the certain sort of triticale. The weight of the grain on the spike is the highest for the sort Accord and can be regarded as one of the main indicators for obtaining higher grain yield. The influence of the conditions during the year on this sign is obvious and has been proved differently during the three years of the study.

The test weight and the 1000-grain weight are the indices characterizing the quality of grain. The test weight is influenced by the sort and the highest values of this index are observed for the sort Accord – 73.2 kg and the lowest test weight – Frontera. 1000-grain weight is less influenced by the tested factors.

Conclusions

Differences in genotypes of triticale, measured by average yield of grain allows them to be displayed in the following ascending order - Alter <Rakita <Frontera <Scudo <Kolorit <Attila <Accord.

Plant height is a sign of varieties, as the lowest variety can be distinguished Frontera, while the highest variety is Kolorit.

Variation in the length of spike and the number of spikeletts per spike by years in each of the varieties is very low, from which it can be concluded that this feature is genetically determines and is influenced to a greater extent by genotype, rather than the climatic conditions of the year.

More spikeletts per spike formed variety gave the highest grain yield - Accord, while the lowest yield variety Alter formed less spikeletts per spike.

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