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EFFECT OF ACID SOILS FERTILIZATION ON MORFOLOGICAL AND PRODUCTIVE CHARACTERISTICS OF TRITICALE

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Abstract

This paper presents the results of some morphological and productive characteristics in two cultivars of triticale depending of fertilization systems of acid soils.
The experiment is included three different fertilizer rates and two triticale cultivars (KG-20 and Tango). The I variant of fertilization included NPK 80:80:60 combinations, II variant is a combination of nutrients and had 80:100:60, and the III variant with NPK fertilizer 80:80:60 had added 4 t ha^{-1} of lime fertilizer "Njival Ca" and 20 t ha^{-1} of manure. With the use of mineral fertilizers with a higher dose of phosphorus, as well as a combination of mineral fertilizers with lime and organic fertilizers, there was a significant increase in all morphological and productive characteristics of triticale. The highest yield of both cultivars was achieved with the one that had a combination of mineral, lime and organic fertilizers. The yield of cultivar Tango in that variant was 7.41 t $ha^{-1,}$ and cultivar KG-20 6.68 t ha^{-1} This yield was significantly higher than the yield achieved in the variant I, where was applied mineral fertilizer 80:80:60. Statistically, there were no significant differences in grain yield between variants I and II, and between II and III. Also, differences were apparent between cultivars. Plant height, spike‘s length, absolute grain mass, hectoliter grain mass and grain yield were higher in Tango cultivar in relation to the cultivar of KG-20.

Key words: triticale, fertilization, absolute mass, hectoliter mass and yield.

Introduction

Triticale is a cross between wheat and rye with the idea to combine the high level of proteins in wheat with high yield and quality of rye proteins. (Radecki & Miller, 1990),
According to many researchers (Borojević, 1981; Cvetkov, 1982; Đokić, 1988) triticale has a high genetic potential for high yield and good nutritional value and is considered to be a promising plant species.
To achieve high and stable yields it is necessary to have favorable agro-climatic conditions of the area, assortment and fertilization.
In our country, acidic soil is a serious problem in crop production. These soils are poor in water-air and physical-mechanical characteristics, and on these soils crop production is unstable. According to Aniola and Madeja (1996) the highest tolerance to acid soils exhibit rye, triticale and wheat, while barley is the most sensitive. Numerous studies here and abroad show that appropriate application of lime fertilizers in combination with organic and mineral is the most effective way to eliminate unfavorable production characteristics of acid soils and affect in yield increase. (Jovanović et al., 2006; Kovačević et al., 2006; Jelić et al., 2006).
When choosing the type and quantity of fertilizer it is necessary to take into account the state of soil fertility. In order to achieve the same yield it is necessary to put less fertilizer on fertile soils than on poor soils. The aim of our study was to determine some morphological and

productive characteristics of triticale on acid soil, depending on the system of fertilization and variety.

Materials and methods

Tests were conducted at the Center for Agricultural and Technological Research in Zaječar municipality during 2008/09 and 2009/10. The experiment is situated like block design in three replications and it included two cultivars of triticale (KG-20 i Tango) and three variants of fertilization. The I variant of fertilization included NPK feed 80:80:60 combinations, II variant is a combination of feed and had 80:100:60 combination, and the III variant with NPK fertilizer 80:80:60 had added 4 t ha^{-1} of lime fertilizer "Njival Ca" and 20 t ha^{-1} of manure. Primary treatment was performed in a classical way (to 25 cm depth) immediately after corn harvest and corn removal. Sowing was in October. Triticale harvest was performed in the stage of full maturity, when plant height, spike's length, number of grains in spike, absolute grain mass, hectoliter grain mass and grain yield were determined. The yield was adjusted to 14% moisture. Results are presented as the average two-year and were analyzed statistically using analysis of variance.

Soil and climatic conditions

The following table shows an overview of chemical properties of soil.

Table 1. Chemical characteristics of soil

Zaječar municipality- vertisol					
Depth (cm)	pH		N (%)	Easyaccessible (mg/100 g soil)	
	H_2O	nKCl		P_2O_5	K_2O
0-20	5.23	4.84	0.12	16.68	29.53
20 - 40	5.54	5.15	0.11	12.34	27.22

Soil in Zaječar municipality is non-calcareous vertisol type and is characterized by high acidity (pH u KCl-u 4,84 -5.15). The nitrogen content in the profile to 20 cm is 0.12% and decreases with depth. The content of available phosphorus in profile up to 20 cm is 16,68 mg /100 g, and in the deeper layers 12.34 mg. This soil is very rich in potassium (29,53 mg/ 100 g in the upper layers). It belongs to the category of minute soils, which means that the optimal deadline for processing is very short. It has to be improved, in order to have good yield.

Table. 2. Meteorological conditions during the experiment (2008-2010)

Months	Average monthly temperature of air (^{0}C)		Monthly sum of precipitation (mm)	
	2008/09	2009/10	2008/09	2009/10
X	11.9	11.0	28.2	106.2
XI	6.1	7.3	29.9	106.3
XII	1.8	1.1	98.1	123.1
I	-1.3	-2.2	67.3	54.1

II	1.3	0.4	91.1	108.0
III	6.0	6.0	58.3	64.3
IV	12.1	11.9	15.4	73.5
V	17.8	16.6	18.0	58.9
VI	20.6	20.8	76.4	95.1
Average Sum	**8.4**	**8.1**	**482.7**	**789.5**

Average monthly temperatures, in both years, were similar. Temperatures were within optimal limits and did not have the impact on yield. Higher rainfall was in 2009/10, which resulted with better yield compared with the previous year. During October, November and December 2009/10 rainfall was 335.6 mm resulting higher winter moisture. In the same year, higher rainfall in Junu did not have good impact on triticale, when the plants were at the stage of grain filling and ripening. Rainfall distribution during the growing season, was different every year.

Research results and discussion

Morphological characteristics

Morphological characteristics were mainly varietal characteristics, although depend on the conditions of production and agrotechnics. Table 3. presents some morphological characteristics of triticale depending on fertilizing system.

Table. 3. Some morphological characteristics of triticale depending on fertilizing system.

Fertilization variants	Morphological characteristics					
	Plant's height (cm)		*Spike's length* (cm)		*Number of grains in spike*	
	KG-20	Tango	KG-20	Tango	KG-20	Tango
0. Control	62.0	75.2	7.0	9.0	31	34
I. NP_1K	92.0	102.4	9.2	11.9	36	40
II. NP_2K	91.3	102.8	9.2	12.7	36	42
III. $NP_1K+CaCO_3$+manure	92.0	102.5	9.9	13.0	38	43
Average	**84.3**	**95.7**	**8.8**	**11.7**	**35.2**	**39.7**
LSD- test						
5 %	4.32	4.84	0.78	0.82	2.17	2.51
1 %	5.13	5.56	0.92	0.95	2.49	2.73

Plant height is varietal characteristic and largely depends on the conditions of production. It is very important for plant lodging. Lower stem plants have greater resistance to bad weather conditions. Average triticale height was 84.3 cm in cultivar KG-20 up to 95.7 cm in cultivar Tango. In both cultivars, plant height in all variants of fertilization, was significantly higher compared to the control variant, while between the variants of fertilization there were no statistically significant differences.

Spike's length and number of grains in spike are characteristics with significant affect on yield. Average spike's length was from 8.8 cm in cultivar KG-20 up to 11.7 cm in Tango cultivar. In all variants, in both cultivars, plants had significantly higher spike's length than

plants in control variant. Tango cultivar spike's length in variant III was significantly higher than in the variant I. Average number of grains in spike was 35.2 in cultivar KG-20 up to 39.7 in Tango cultivar. Both cultivars in variants with fertilization had significantly greater number of grains in spike, than in control variant, while Tango cultivar had greater number of grains in spike in variant III than in variant I. It was concluded that there were no statistically significant differences between variants I and II and between variants II and III in all examined characteristics. Tango cultivar in all variants of fertilization had higher values than cultivar KG-20 in examined characteristics. Wiegand and Cuellar (1981) assert that number of spikes and number of grains in spike are very important for yield which needs good weather conditions in different growth stages.

Productive characteristics

Productive characteristics directly affect the yield. Especially important is the advantage of agro-climatic factors. Table 4. provides an overview of some productive characteristics depending on fertilization system.

Table. 4. Some productive characteristics of triticale depending on fertilization system

Fertilization variants	Productive characteristics					
	Absolute mass (g)		Hectoliter mass (g)		Grain yield (t ha^{-1})	
	KG-20	Tango	KG-20	Tango	KG-20	Tango
0. Control	42.1	43.2	68.8	70.3	2.25	3.00
I. NP_1K	41.0	43.0	70.0	74.3	5.95	6.85
II. NP_2K	42.3	43.2	70.2	74.6	6.10	7.05
III. $NP_1K+CaCO_3$+manure	43.0	44.0	70.4	74.0	6.68	7.41
Average	**43.1**	**43.3**	**69.8**	**73.3**	**5.24**	**6.07**
LSD- test						
5 %	3.62	3.43	4.13	4.28	0.59	0.54
1 %	3.72	3.61	4.67	4.91	0.68	0.68

Absolute grain mass is grain size indicator and mostly depends of plant density and climate factors. Triticale have large grain (40-65 g) larger than wheat and rye (Pržulj et al.,1989).

In our researches, between fertilization variants and between cultivars there were no statistically significant differences in absolute grain mass. It is important to emphasize that absolute grain mass in control variant was approximately equal to the one in fertilized variants. This is justified with the fact that in the control variant plants were thiner and skipes had less grains which were replenished and massy. Wiegand and Cuellar (1981) emphasize that yield primarily depends on grain mass.

Average hectoliter grain mass was 69.8 kg in cultivar KG-20 up to 73.3 kg in Tango cultivar. Differences in hectoliter mass were bigger between the cultivars than in between fertilization variants, especially in cultivar KG-20. Statistically significant difference in hectoliter grain mass, in Tango cultivar, was between variants I and II comparing to control variant which had significantly lower grain mass.

Grain yield is very important category for all manufacturers. Grain yield is influenced by a number of factors and the most important are cultivar, agrotechnics and climate. If we compare yield with fertilizers and without fertilizers (control), the highest yield in both cultivars was in variant with the fertilizers. Average yield in cultivar KG-20 was 5.24 t ha^{-1} and in Tango cultivar 6.07 t ha^{-1}. The lowest yield was in control variant and was

significantly lower than in variants with fertilizers. The highest grain yield in both cultivars (6.68 t ha^{-1} i 7.41 t ha^{-1}) was in variant III, with combination of mineral, lime and organic fertilizers. Yield was significantly higher than in variant I. The difference in the highest yield (variant III) between Tango and KG-20 cultivar was 730 kg ha^{-1} in favour of Tango cultivar. There were no significant differences in grain yield in both cultivars between variants I and II, and between II and III. Considering that there were no statistically significant differences in grain yield between variants II and III, variant (II) with increased phosphorus content is recommended as the most rational considering the price of lime and organic fertilizers.
Other authors (Jelić et al., 1998; Jovanović et al., 2006; Kovačević et al., 2006) also had positive effect, with increased doses of phosphorus fertilizers, on wheat yield.
Numerous previous studies and our results have shown that on acid soils usage of NPK, lime fertilizer and manure have positive effect on grain yield (Ognjanović et al., 1994; Jelić et al., 1995; Jelić et al., 2004)

Conclusion

The study of the influence of fertilization systems and the cultivars on morphological and productive characteristics of triticale showed:
Fertilization systems and cultivars had significant effect on morphological and some productive characteristics of triticale.
Plant height, spike's length and number of grains in spike, in both cultivars, were significantly higher in variants with fertilizers.
Determined values of morphological characteristics were higher in Tango cultivar than in cultivar KG-20.
There were no significant differences in both cultivars, in absolute grain mass between control and fertilization.
Hectoliter mass, in cultivar KG-20, showed no significant differences, both between control and fertilization, nor between fertilization variants.
Tango cultivar in a variant with higher dosage of phosphorus had significantly higher hectoliter grain mass compared to the control variant.
Grain yield, in both cultivars, was much higher in variants with fertilizer than in control variant.
The highest yield, in both cultivars, was in variant with combination of mineral, lime and organic fertilizer.
There were no statistically significant differences in grain yield between variants III and II, Variant (II) with increased phosphorus content is recommended.
According to all parameters, Tango cultivar was better than KG-20. It is recommended for growing in this area.

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