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EFFECTS OF FERTILIZATION AND VARIETY ON YIELD AND YIELD COMPONENTS OF WINTER TRITICALE

SUMMARY

In the research carried out in the vicinity of Bijelo Polje (Montenegro) for a period 2009-2012. the effect of fertilization and variety on yield and yield components of winter triticale. The trial was set in random complete block design with three replications and included the five varieties (Odisej, Kg-20, Trijumf, Rtanj i Tango). The soil on which the experiment was performed was of alluvium type and the size of the experimental plot was 6 m². Unfertilized plot (the control), the lowest rate of nitrogen (60 kg N ha⁻¹) alone and three steps of N fertilization (60 + 90 +120 kg N ha⁻¹) on the same level of P and K (80 kg P₂O₅ + 80 kg K₂O kg ha⁻¹) were applied. Results of the study showed significant effect of fertilization and varieties on yield and yield components of winter triticale.

Tango had the highest average grain yield (5,3 t ha⁻¹) while Kg-20 had the lowest (4,4 t ha⁻¹). Also, Tango had the highest value of the 1000 grain mass, while Triumph had the highest value of hectoliter weight. The application of fertilizers has led to a very large and significant increase of yield compared with the control. Accordingly, all studied cultivars had the highest yield when the three nutritious elements, N, P and K, were used (120 kg ha⁻¹ N, 80 kg ha⁻¹ P₂O₅ and 80 kg ha⁻¹ K₂O). These results are evidence for importance and role of fertilization and variety in expression of yield and yield components of winter triticale.

Keywords: triticale, fertilization, variety, yield, yield components

INTRODUCTION

Triticale (*X Triticosecale Wittmack*) is a plant species which is originated by crossing wheat and rye with an idea to unite the high level of wheat protein with a high level of yield and protein quality of rye (Radecki and Meller, 1990).

Many investigators are of the opinion that triticale has the high genetic potential for yield and favourable nutritive values (Borojević, 1981; Cvetkov, 1982; Đokić, 1988) so it is considered as perspective plant species.

Given the emergence of new, more demanding assortment, with constant changes in the level of fertility and agricultural conditions, there is still a need for research and determining the optimal amount and ratio of nutrients in specific agro-ecological conditions.

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The grain yield per unit area is one of the most important factors that affect the profitability and efficiency of production. Beside the genotype, the grain yield of triticale is greatly affected by fertilization which should comply with the conditions of soil and climate, as well as with the demands of variety.

Biberdžić et al. (2012) point out that acid soils represent a serious problem for crop production, because it is characterized by poor water-air and physico-mechanical properties, which organized the production makes them unstable. The same authors state that the appropriate application of fertilizers is the most effective way to mitigate the negative properties of these soils, causing the increase in yield and grain quality.

The quality of triticale depends on the genotype, and environmental conditions of their interaction and can be improved by applying nitrogen fertilizers. Nitrogen fertilization influences the increase of grain yield and protein as well as the content of crude protein and non-protein nitrogen (Zecevic et al., 2010; Lestingi et al. 2010). Nitrogen plays an important role in feeding triticale contributing to the increased productivity (Kinaci and Gulmezoglu, 2007; Lalević et al., 2012). Biberdžić et al. (2013) point out that the yield was conditioned by the effect of a large number of factors which are most affected by cultivar, cultural practices and weather conditions during the experiment.

The objective of this study was to evaluate the effect of different fertilization systems on the grain yield and yield components of winter triticale in this area of production. According to the research results, the producers of this type of grain would get the reliable recommendations for the selection of the variety in a given production area, because the production potential of varieties can be utilized only by the use of varietal agro-technology, by the education of the producers and the fast transfer of knowledge in the production.

MATERIAL AND METHODS

In the experiment which was carried out in the period 2009-2012, in the highland area of Montenegro, in the vicinity of Bijelo Polje – Sutivan (43° 01' 45" north latitude and 19° 44' 44" east longitude) on the alluvial type of soil, five cultivars of winter triticale were tested (Odisej, Kg-20, Triumph, Rtanj and Tango).

The experiment was set out in randomized block system with three replications and experimental plot size of 6 m². Unfertilized plot (the control), the lowest rate of nitrogen (60 kg N ha⁻¹) alone and three steps of N fertilization (60 + 90 + 120 kg N ha⁻¹) on the same level of P and K (80 P₂O₅ + 80 K₂O kg ha⁻¹) were applied. Common agronomical practices were used in the experiment. Sowing was carried out by manual method in optimal term (October). Phosphorus and potassium were used in equal amounts (80 kg ha⁻¹) before the sowing period, while nitrogen was used in small amount before the sowing period, and the rest of the planned amount was used as the fertilization at the end of March. The average results of yield of dry grain, hectoliter weight and 1000 grain mass, are presented in this paper, for analyzed period of three years. The obtained results were statistically processed using method of variance analysis, whereby the significance of the average treatments were tested with LSD test, with significance threshold of 1 and 5 %.

RESULTS AND DISCUSSION

Soil and climatic conditions

The soil on which the experiment was performed is weakly calcareous, the total content of carbonate being 2.4 – 2.44 %. Based on pH value in saline extract the tested soil is of acid-based reaction. The soil is quite humic: 3.35-3.96 % with low phosphorus 5.12 – 4.24 mg/100g soil) and potassium content (7.5 – 3.8 mg/100g soil). Data in Table 1. indicates the difference in average monthly temperatures between years in which the research was conducted.

Table 1. Average monthly air temperature and precipitation amount

| Year | Months | | | | | | | | | | Average |
|--|--------|------|------|-------|-------|------|-------|-------|-------|-------|------------|
| | X | XI | XII | I | II | III | IV | V | VI | VII | |
| Monthly rainfall (mm) | | | | | | | | | | | |
| 2009-10 | 135 | 94 | 94 | 101 | 80 | 70 | 78 | 80 | 63 | 86 | 881 |
| 2010-11 | 65 | 131 | 147 | 36 | 76 | 31 | 46 | 121 | 33 | 79 | 765 |
| 2011-12 | 36 | 7 | 55 | 79 | 183 | 57 | 47 | 46 | 34 | 8 | 552 |
| 1961-90 | 80 | 115 | 91 | 87 | 68 | 60 | 70 | 76 | 72 | 64 | 783 |
| Average monthly temperatures (°C) | | | | | | | | | | | |
| 2009-10 | 9.77 | 5.95 | 4.06 | 1.31 | 2.4 | 6.39 | 10.93 | 15 | 18.11 | 20.95 | 9.5 |
| 2010-11 | 10.1 | 8.54 | 2.05 | -0.65 | 0.94 | 6.03 | 10.54 | 14.5 | 18.9 | 21.23 | 9.2 |
| 2011-12 | 9.3 | 3.25 | 2.17 | -1.72 | -3.52 | 5.96 | 10.8 | 15.02 | 20.67 | 24.63 | 8.7 |
| 1961-90 | 9.4 | 4.7 | 0.2 | -1.3 | 0.7 | 4.9 | 9.0 | 13.3 | 16.3 | 17.9 | 7.5 |

During the season 2009/10, from October to July, the rainfall was 881 mm, while in the same period in 2010/11 and 2011/12 the amount of rainfall was lower (765 and 552 mm, respectively). From the data in the table it can be noted that conditions for germination and autumn plant development were considerably favorable during the first two years compared to the third year of research. Also, the amount of rainfall in the period from April to June in the first year of research were higher compared to the other two years of research. Considering that the amount of rainfall and temperature in these months are extremely important for the development of small grains, the first year of research can be characterized as the most optimal in terms of weather conditions for growing triticale in this area.

Yields and grain quality

Yields and grain quality of winter triticale are basically the most important indicators of the performance of its production. Grain yield, as the main goal of every production attempt, was generally satisfactory.

The average yield of winter triticale for all cultivars and fertilization variants during the three years of research period was 4917,8 kg ha⁻¹. Fertilization had a significant effect on grain yield (Table 2.). In average for all cultivars the highest yield (5,6 t ha⁻¹) was achieved with variant (IV) of fertilization while the average grain yield was the lowest in the variant without fertilization. In the three-year period, the highest average grain yield for all tested variants, variety Tango achieved the highest yield (5,3 t ha⁻¹), whereas the lowest yield was achieved with Kg-20 (4,4 t ha⁻¹).

Our results are in accordance with the results of Dodig *et al.* (2006) which highlighted Tango as a cultivar of high genetic potential for yield with ability of its manifestation on different localities. Differences in the yield between cultivars in our research are largely determined by genetic factor.

Complete application of all three elements (NPK) in the form of fertilizer had very positive influence on the yield. Research indicates that the winter triticale achieves high yields when nitrogen is used in the amount of 120 kg ha⁻¹ and phosphorus and potassium in the amount of 80 kg ha⁻¹. Lalević and Biberdžić (2014) state that the positive effect of the complete application of fertilizer is the result of lower pH value of the soil, as well as the low content of available phosphorus and potassium in this soil which, for this reason, must be added in the form of fertilizer, which is confirmed by the results of this study.

Table 2. Impact of nitrogen fertilization on properties of winter triticale cultivars

| Winter triticale properties (3-year means: 2010-2012) | | | | | | |
|---|--|---------------|---------------|---------------|---------------|----------------|
| Cultivar (A) | Nitrogen fertilization (kg ha⁻¹)* - the factor | | | | | Average |
| | 0 | I | II | III | IV | |
| | Control | N60 | N60+PK | N90+PK | N120+PK | |
| Grain yield (kg ha⁻¹) | | | | | | |
| Kg-20 | 3632,2 | 4428,9 | 5274,4 | 5357,8 | 5626,7 | 4864,0 |
| Trijumf | 3232,9 | 4010,1 | 4840,0 | 4865,0 | 4882,8 | 4366,2 |
| Rtanj | 3667,8 | 4647,8 | 5584,4 | 5573,3 | 5598,3 | 5014,3 |
| Tango | 3614,4 | 4677,8 | 5490,4 | 5597,8 | 5821,7 | 5040,4 |
| Average B | 3845,0 | 4837,2 | 5883,3 | 5863,3 | 6091,1 | 5304,0 |
| | 3598,5 | 4522,3 | 5414,5 | 5451,4 | 5604,1 | 4917,8 |
| | | | A | B | AB | |
| | | 0,05 | 241,9 | 241,9 | 541,1 | |
| | | 0,01 | 341,2 | 341,2 | 767,3 | |
| Mass of 1000 grain (g) | | | | | | |
| Odisej | 39,9 | 42,0 | 41,5 | 42,9 | 45,3 | 42,3 |
| Kg-20 | 28,8 | 32,3 | 34,2 | 33,3 | 35,1 | 32,7 |
| Trijumf | 40,2 | 42,9 | 43,4 | 43,1 | 45,0 | 42,9 |
| Rtanj | 42,1 | 45,8 | 45,5 | 45,5 | 46,1 | 45,0 |
| Tango | 44,4 | 47,6 | 47,8 | 49,2 | 50,3 | 47,9 |
| Average B | 39,1 | 42,1 | 42,5 | 42,8 | 44,4 | 42,2 |
| | | | A | B | AB | |
| | | 0,05 | 1,015 | 1,015 | 2,270 | |
| | | 0,01 | 1,439 | 1,439 | 3,219 | |
| Hectoliter weight (kg) | | | | | | |
| Odisej | 65,9 | 72,2 | 71,5 | 70,8 | 70,2 | 70,1 |
| Kg-20 | 65,2 | 65,92 | 66,7 | 65,98 | 68,6 | 66,5 |
| Trijumf | 70,3 | 72,8 | 71,9 | 72,7 | 72,9 | 72,1 |
| Rtanj | 67,0 | 68,3 | 67,3 | 67,8 | 68,3 | 67,7 |
| Tango | 68,4 | 70,0 | 69,2 | 68,3 | 70,4 | 69,3 |
| Average B | 67,4 | 69,9 | 69,3 | 69,1 | 70,1 | 69,1 |
| | | | A | B | AB | |
| | | 0,05 | 1,54 | 1,54 | 3,44 | |
| | | 0,01 | 2,18 | 2,18 | 4,87 | |

* PK = 80 kg P₂O₅ and 80 kg K₂O per hectare

A 1000 grain mass is cultivar characteristic which is the reason for bigger variations between different genotypes than between variants of mineral nutrition (Jelić *et al.* 2002; Lalević *et al.* 2012).

Data given in Table 2. indicate that the average value of absolute mass for all cultivars and fertilization variants for three-period research was 42,2 g. Cultivar Kg-20 has the lowest value of absolute mass with the control variant of fertilization, while cultivar Tango has the highest value with the (IV) variant off fertilization. Application of fertilizer had a significant effect of absolute mass value in all cultivars. Accordingly, a 1000 grain mass was considerably higher with all variants of fertilization in comparison to control. Our results are in accordance with the results of Milošev *et al.* (2006) i Jaćimović *et al.* (2008), Lalević and Biberdžić (2014), who found that a 1000 grain mass was significantly higher with more intensive fertilization treatments, especially in cases when nitrogen was used.

Hectoliter weight is an indicator of grain quality, particularly grain monetary value. Average hectoliter weight was 66,5 kg in variety Kg-20 up to 72,1 kg in Triumph variety. Each cultivar had the lowest hectoliter weight value in the control. The application of fertilizers made the hectoliter weight grow significantly and it reached its highest level with the (IV) variant of fertilization (70,1 kg). There is a strong dependence of hectoliter weight of the dose of nitrogen applied. The tested cultivars had mostly positive reaction to the application of the complete nutrient, as well as to growing doses of nitrogen, which is in accordance with the results previously presented by Lalević *et al.*, 2012.

CONCLUSION

The study of the effects of fertilization and variety on yield and yield components of winter triticale showed:

- Fertilization and variety had significant effect on yield and yield components of winter triticale.

- Grain yield, 1000 grain mass and hectoliter weight in all of five tested varieties, were significantly higher in variants with fertilizers.

- The highest grain yield with all variants of fertilization and in average was achieved with cultivar Tango, and the lowest with the cultivar Kg-20.

- The highest value of a 1000 grain mass had cultivar Tango (50,3 g) with (IV) variants of fertilization and the lowest had cultivar Kg-20 (28,8 g) in the control.

- The lowest hectoliter weight had cultivar Kg-20 (65,2 kg) in the control, and the highest had cultivar Triumph (72,9 kg) with (IV) variant of fertilization.

- The application of fertilizers significantly increased the values of all tested parameters compared to the control.

- For the tested area winter triticale cultivar Tango and (IV) variant of fertilization are recommended considering that this cultivar, with quantity and quality of its yield, suits best the given climatic conditions.

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