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THE CHARACTERISTICS OF TRITICALE CULTIVATED IN RURAL AREAS

ABSTRACT

In the research conducted in the north of Montenegro during the years of 2005-2007, we studied the possibility of growing triticale as a relatively new plant species in this production area. We studied the influence of the variety, the climate conditions and the fertilisation on pheno-phases and grain yield. The experiment was set up in a randomised block system with four replications on alluvial soil with a plot size of $10m^2$, this included two varieties of winter triticale (Favorit and Kg20) and three doses of nitrogen fertilisers.

The tests have shown considerable variation in grain yield and its quality, depending on the cultivated genotype, the meteorological conditions during the test years and the fertilizer doses.

In both test years, the Kg20 variety of winter triticale has achieved significantly higher grain yield (5.99 $t.ha^{-1}$) than the other tested variety, Favorit (5.16 $t.ha^{-1}$). In addition, the Kg20 variety had a higher value of 1000 grain mass and hectolitre mass, when compared with the Favorit variety. The climate conditions during the test years have exerted a great influence on the quantity and quality of the yield. With extremely high temperatures accompanied by a lack of rainfall in the second year, this led to a shortening in certain pheno-phases, which resulted in the decrease of the yield and grain quality. The greatest impact on the yield was nitrogen fertilisation, where the optimal dose was 100 $kg.ha^{-1.}$ Since triticale demonstrates great adaptability in these agro-ecological conditions, and has achieved a stable yield of satisfactory quality, the area of cultivation for this crop should be increased.

Keywords: triticale, fertilisation, yield, 1000 grain mass, hectolitre mass

INTRODUCTION

Triticale is a new kind of wheat stubble, created by the hybridisation of wheat and rye. The goal was to combine the positive properties of wheat (high and stable yield, early maturity, good grain quality, resistance to lodging) with the positive properties of rye (good resistance to diseases, pests, cold, drought, a large number of spikelets per spike etc.). Thanks to this, triticale is suitable for cultivation at high altitudes, in soils with poor physical and chemical properties, such as acidic and saline soils (Naeem et al, 2002). Because of its high

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adaptability, triticale is suitable for cultivation in mountainous areas, where even the application of lower growing technology achieves satisfactory yields. The number of areas for triticale cultivation in the world is increasing, indicating that due to the increase in population, triticale will be as important as other types of wheat**.** According to (Milovanović et al, 2007), triticale is grown on a scale of over 4 million acres all over the world. Compared with the grain yield, modern varieties of triticale have the same yield as the leading varieties of wheat, and are even better than the varieties such as rye, barley and oats (Milovanović et al, 2004). Since its nutritional value is greater than the nutritional value in corn, triticale is recommended by experts for nutrition in all species of domestic animals (Đekic et al, 2009b).

MATERIAL AND METHODS

In the two-year research study (2005-2007) conducted in the north of Montenegro, two varieties of winter triticale (Favorit and Kg20), created in the Center for Small Grains in Kragujevac, were tested, alongside three doses of nitrogen fertilisation (80, 100 and 120 $kg.ha^{-1}$). The experiment was set up in a randomised block system with four replications. The plot size was $10m^2$ and the soil was alluvial. Common technology for the production of triticale was used in the experiment. The harvest was conducted manually at the stage of full maturity, where the 1000 gram mass was measured, as well as the hectolitre mass, and the grain yield was corrected for 14% moisture. The studied properties were given in average values, and then processed by the analysis of variance method, while the score significance was tested by an LSD test.

RESULTS AND DISCUSSION

Since the studied area does not have more extensive and intensive agricultural production due to bad conditions, primarily due to land and the fragmentation of land, this area can be considered rural.

Before beginning the research, the samples from the land, where the experiment was performed, were taken and analysed. The obtained results showed that the tested soil had a slight acid reaction, rich in humus 3.98-4.35% and poor in available phosphorus (5.68-8.71 mg per100 gr of soil) and potassium (4.47-3.71 mg per100 gr of soil).

Meteorological conditions, especially the precipitation and the temperature, largely determine the success of the production of winter triticale and other small grains.

The data in Table 1 indicates that the years in which this research was conducted varied in climate conditions. Air temperatures, which during the spring months in the second year were significantly higher when compared with the first, led to the disturbance in the flow of grain filling and its shortening, so that the second year maturation occurred 15 days earlier when compared with the previous year. The shorter period of grain filling in the second year had resulted in significantly lower yields than in the first year.

The triticale growing season, during the first year of study, had a rainfall of 280.5 mm, more than in the second year. Taking into account the above-mentioned increase in precipitation during the autumn, winter and spring months, and the not too high temperatures during grain filling, the first year of study was not only favourable for germination, emergence and overwintering crops, but also for yield formation in relation to the second year.

Tab.1. Middle monthly air temperature and precipitation amount

Year	Month										Average
	X	XI	XII	I	II	III	IV	V	VI	VII	
Middle monthly air temperature (°C)											
2005-2006	9.7	3.3	1.2	-2.6	0.4	4.2	11.1	14.6	16.8	19.0	7.77
2006-2007	11.4	2.6	0.3	1.8	4.8	7.0	11.5	16.0	19.8	21.9	9.71
Precipitation amount (mm)											
2005-2006	85.2	116.1	182.5	36.6	87.7	180.8	58.4	78.6	119	52.9	997.8
2006-2007	39.5	74.6	182.5	92.9	45.8	104.7	15.7	60.8	76.9	23.9	717.3

Grain quality traits Absolute and hectolitre mass are physical properties, although they may be regarded as traits of grain quality. They are very significant, and exert a direct effect on the grain yield.

Absolute mass of grains The absolute mass of grains is the mass of 1000 seeds expressed in grams. This is one of the properties that directly affect the grain yield.

Tab.2. Absolute mass of grains in winter triticale

Cultivar (A)	Year (C)		(B) Fertilization ($kg.ha^{-1}$)				
			0	80	100	120	Average
Kg20	2006		33.5	36.2	37	38.6	36.32
Favorit			31	34.8	35.4	36	34.3
AVERAGE			32.2	35.5	36.2	37.3	35.3
Kg20	2007		33.6	36.7	36.9	37.3	36.12
Favorit			30.8	33	34.1	34.8	33.17
AVERAGE			32.2	34.85	35.5	36.05	34.65
Two-year average			32.2	35.2	35.8	36.7	34.9
LSD	A	B	AB	C	AC	BC	ABC
0.05	0.477	0.674	0.477	0.477	0.674	0.953	1.348
0.01	0.636	0.900	0.636	0.636	0.900	1.273	1.800

Both genotypes studied in the first year had the significantly higher mass of 1000 seeds compared with the second year, thanks to the favourable climate conditions that contributed to a better grain fulfilment in the first year of study. The results are consistent with those cited by Milovanović (1993).

The absolute mass of grains increased with the increasing doses of nitrogen of 120 kg.ha^{-1} in both varieties during both studied years.

Both varieties showed the highest values at 1000 grains mass at the maximum doses of nitrogen. The KG20 variety had the highest absolute mass (38.6 g) at fertilisation with 120 kg.ha^{-1} of nitrogen and the Favorit variety had the lowest (33 g) at fertilisation with 80 kg.ha^{-1} of nitrogen. The obtained average values, with the aforementioned characteristics, in this study were somewhat lower than the values obtained by Milovanović et al, 2006 and Đekić et al, 2010.

Hectolitre mass This represents the weight of one hectolitre as expressed in kilograms and reflects grain fulfilment. The results of our study are consistent with the literature, which highlight the fact that triticale is mostly characterised by large grains. Also, from this table we observe a strong dependence of hectolitre mass on the applied dose of nitrogen, so both varieties from both years show the highest values in hectolitre mass at the variant of 120 kg.ha^{-1} of nitrogen. Statistically, these values are significantly higher than the values achieved when using 80 and 100 kg.ha^{-1} of nitrogen. The KG20 variety demonstrated the highest hectolitre mass with the use of 120 kg.ha^{-1} of nitrogen, while the Favorit variety had the lowest with the nitrogen rate of 80 kg.ha^{-1}.

The data in the table indicates that this year had a significant impact on the value of the studied characteristics, because both genotypes in the first year showed a significantly higher value of hectolitre mass when compared with the results from the second year study. The dependence of hectolitre mass on weather conditions was previously pointed out by the authors in (Jelić et al, 1998.).

Tab.3. Hectoliter mass of winter triticale (kg)

Cultivar (A)	Year (C)		(B) Fertilization (kg.ha^{-1})				
			0	80	100	120	Average
Kg20	2006		67.8	69.4	72.5	74.3	71
Favorit			65.2	68.7	70.1	71	68.75
AVERAGE			66.5	69.05	71.3	72.65	69.9
Kg20	2007		63.3	66.8	67	68.1	66.3
Favorit			62.2	65.9	66.2	67	65.3
AVERAGE			62.75	66.35	66.6	67.55	65.8
Two-year average			64.6	67.7	68.9	70.1	67.8
LSD	A	B	AB	C	AC	BC	ABC
0.05	0.375	0.530	0.530	0.375	0.530	0.749	1.060
0.01	0.500	0.708	0.708	0.500	0.708	1.001	1.415

Grain yield Grain yield is a category that all producers strive for. The grain yield per unit area is one of the most important factors that determine the cost-effectiveness of production, and mineral nutrition shows a very large impact on the amount and quality of the yield.

The use of nitrogen showed a significant increase in the grain yield of triticale, when compared with the control variant. However, the differences in the grain yield of triticale, between the doses of nitrogen used, were low and not statistically significant. Both variants had the highest yield with the use of high doses of nitrogen as seen in both years of study. However, given that there were no statistically significant differences between the highest and lowest quantities of nitrogen, the recommended dose is 80 kg.ha^{-1}, not only as the optimum dose, but also as the most profitable for mass production. Our results are in agreement with the results from other authors, who emphasise the positive reaction of triticale with the ingestion of small quantities of nitrogen (Mazurek and Mazurek 1983, Ustimenko and Dmitisak 1984, Jelić et al, 1998.). In terms of grain yield, the differences were established in the tested varieties of triticale. In both years, the Kg20 variety demonstrated a significantly higher yield (5994 kg.ha^{-1}) in all fertilisation variants, when compared with the other tested variety, Favorit (5158 kg.ha^{-1}). Kg20 achieved the highest yield (6625 kg.ha^{-1}) with the dose of 120 kg.ha^{-1} of nitrogen in the first year of study, and Favorit variety achieved the lowest yield (5222 kg.ha^{-1}) at a dose of 80 kg.ha^{-1} of nitrogen in the second year of study.

Tab.4. Grain yield of winter triticale (kg.ha^{-1})

Cultivar (A)	Year (C)		(B) Fertilization (kg ha^{-1})				
			0	80	100	120	Prosek
Kg-20	2006		4930	6537.5	6615	6652.5	6183.75
Favorit			4107.5	5687.5	5730	5770	5323.75
AVERAGE			4518.75	6112.5	6172.5	6211.25	5753.75
Kg-20	2007		4500	6120	6260	6340	5805
Favorit			4000	5222.5	5350	5400	4993.12
AVERAGE			4250	5671.25	5805	5870	5399.1
Two-year average			4384.4	5891.9	5988.8	6040.6	5576.4
LSD	A	B	AB	C	AC	BC	ABC
0.05	181.04	256.04	362.101	181.041	256.044	362.101	512.088
0.01	241.81	341.91	483.541	241.807	341.915	483.541	683.830

In general, triticale can achieve significantly higher yields when sown in a soil with high fertility (late September and the first half of October) and when intensive agrotechnics are applied (Milovanović et al, 2007).

The climate conditions significantly affected the yield of triticale. So, the yield in both varieties during the first year was significantly higher than in the second year of study.

CONCLUSIONS

Based on two-year study results, the following can be concluded:

-Favourable climate conditions in the first year of research have influenced all the parameters to yield significantly higher results than in the second year of research.

-Kg20 had a greater absolute and hectolitre mass in both years, as well as the highest grain yield, when compared with the other tested variety, Favorit.

-Kg20 had the highest absolute mass (38.6 g) at the variant of 120 kg.ha^{-1} of nitrogen, while Favorit had the lowest (33 g) at the variant of 80 kg.ha^{-1} of nitrogen.

-Kg20 had the highest hectolitre mass (74.3 kg) at the variant of 120 kg.ha^{-1} of nitrogen, while Favorit had the lowest (65.9 kg) at the variant with nitrogen rate of 80 kg.ha^{-1}.

-Kg20 had the highest yield at a dose of 120 kg.ha^{-1} of nitrogen in the first year of study, while Favorit had the lowest yield (5222 kg.ha^{-1}) at a dose of 80 kg.ha^{-1} of nitrogen in the second year of study.

-Application of nitrogen fertilisers significantly increased the values of all measured parameters compared with the control.

-There were no significant differences in the yield between the doses of 80 and 100 kg.ha^{-1} of nitrogen.

-In the area of triticale production it is recommended to use 80 kg.ha^{-1} of nitrogen as the most profitable dose.

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NEKE KARAKTERISTIKE TRITIKALEA GAJENOG U RURALNIM PODRUČJIMA

SAŽETAK

U istraživanjima izvedenim na severu Crne Gore, tokom 2005-2007 godine, proučavane su mogućnosti gajenja tritikalea kao relativno nove biljne vrste u ovom proizvodnom području. Proučavan je uticaj sorte, klimatskih uslova i đubrenja na neke feno faze i prinos zrna. U ogledu, postavljenom po slučajnom blok sistemu u četiri ponavljanja, na aluvijalnom tipu zemljišta, sa veličinom ogledne parcelice od 10 m², uključene su dve sorte ozimog tritikalea (Favorit i Kg20) i tri doze azotnog đubriva.

Ispitivanja su pokazala znatno variranje prinosa zrna i njegovog kvaliteta u zavisnosti od uzgajanog genotipa, meteoroloških prilika u godinama ispitivanja i doze đubrenja.

U obe godine ispitivanja sorta ozimog tritikalea Kg20 ostvarila je značajno vrlo veći prinos zrna (5,99 $t.ha^{-1}$) u odnosu na drugu ispitivanu sortu, Favorit (5,16 $t.ha^{-1}$). Takođe, sorta Kg20 imala je i veće vrednosti mase 1000 zrna i hektolitarske mase u poređenju sa sortom Favorit. Klimatski uslovi u godinama ispitivanja su u velikoj meri uticali na visinu i kvalitet prinosa. Izuzetno visoke temperature, praćene nedostatkom padavina u drugoj godini, dovele su do skraćenja pojedinih feno faza, što je za posledicu imalo pad prinosa i kvaliteta zrna. Najveći uticaj na prinos imalo je đubrenje azotom, a optimalna doza je iznosila 80 $kg.ha^{-1}$.

S obzirom da tritikale ispoljava visoku adaptibilnost u ovim agroekološkim uslovima i postiže stabilne prinose zadovoljavajućeg kvaliteta, trebalo bi povećati površine pod ovom kulturom.

Ključne reči: tritikale, đubrenje, prinos, masa 1000 zrna, hektolitarska masa