XXIV INTERNATIONAL
ECO-CONFERENCE® 2020
23–25th SEPTEMBER

XI SAFE FOOD

PROCEEDINGS

NOVI SAD, SERBIA

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SAFE FOOD

PROCEEDINGS
2020.

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Official host of the XX International Eco-Conference® 2018
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THE ECOLOGICAL MOVEMENT OF THE CITY OF NOVI SAD: AN IMPORTANT DECISION OF ITS PROGRAMME COUNCIL

Since 1995, the Ecological Movement of the City of Novi Sad organizes "Eco-Conference® on Environmental Protection of Urban and Suburban Areas", with international participation. Seven biennial conferences have been held so far (in 1995, 1997, 1999, 2001, 2003, 2005, 2007, 2009, 2011, 2013 and 2015.). Their programs included the following environmental topics:

Session 1: Environmental spheres: a) air, b) water, c) soil, d) biosphere
Session 2: Technical and technological aspects of environmental protection
Session 3: Sociological, health, cultural, educational and recreational aspects of environmental protection
Session 4: Economic aspects of environmental protection
Session 5: Legal aspects of environmental protection
Session 6: Ecological system projecting (informatics and computer applications in the field of integrated protection)
Session 7: Sustainable development of urban and suburban settlements-ecological aspects.

Conference participants have commended the scientific and organizational levels of the conferences. Conference evaluations have indicated that some aspects are missing in the conference program. In addition, since a team of conference organizers was completed, each even year between the conferences started to be viewed as an unnecessary lag in activity.

Eco-Conference® on Safe Food

With the above deliberations in mind, a decision was made that the Ecological Movement of the City of Novi Sad should embark on another project – the organization of Eco-Conferences® on Safe Food. These Conferences were planned to take place in each even year. Preparations for the first Eco-Conferences® on safe food started after the successful completion of the Eco-Conference® '99.

So far four Eco-Conferences® have been held (in 2000, 2002, 2004, 2006, 2008, 2010, 2012 and 2014.) focusing this general theme.

Theme of the Eco-Conference®

By organizing the Eco-Conference® on Safe Food, the organizer wishes to cover all factors that affect the quality of human living. Exchange of opinions and practical experiences should help in identifying and resolving the various problems associated with the production of safe food.

Since 2007 Eco-Conference gained patronship from UNESCO and became purely scientific Conference.

Objectives of the Eco-Conference®

– To acquaint participants with current problems in the production of safe food.

– To make realistic assessments of the causes of ecological imbalance in the conventional agricultural production and the impact of various pollution sources on the current agricultural production.

– Based on an exchange of opinions and available research data, to make long-term strategic programs of developing an industrialized, controlled, integral, alternative and sustainable agriculture capable of supplying sufficient quantities of quality food, free of negative side effects on human health and the environment.

Basic Topics of the Eco-Conference®

Basic topics should cover all relevant aspects of the production of safe food.

When defining the basic topics, the intention was itemize the segments of the production of safe food as well as the related factors that may affect or that already have already been identified as detrimental for food safety and quality. The topics include ecological factors of safe food production, correct choice of seed (genetic) material, status and preparation of soil as the basic substrate for the production of food and feed, use of fertilizers and pesticides in integrated plant protection, use of biologicals, food processing technology, economic aspects, marketing and packaging of safe food.

To paraphrase, the envisaged topics cover the production of safe food on the whole, individual aspects of the production and their mutual relations, and impact on food quality and safety.

Sessions of the Eco-Conference®

1. Climate and production of safe food.
2. Soil and water as the basis of agricultural production.
3. Genetics, genetic resources, breeding and genetic engineering in the function of producing safe food.
4. Fertilizers and fertilization practice in the function of producing safe food.
5. Integrated pest management and use of biologicals.

6. Agricultural production in view of sustainable development
7. Production of field and vegetable crops.
8. Production of fruits and grapes.
9. Lifestock husbandry form the aspect of safe food production.
10. Processing of agricultural products in the framework of safe food production.
11. Economic aspects and marketing as segments of the production of safe food.
12. Food storage, transportation and packaging.
13. Nutritional food value and quality nutrition.
14. Legal aspects of protecting brand names of safe food.
15. Ecological models and software in production of safe food.

Attempts will be made to make the above conference program permanent. In this way will the conference become recognizable in form, topics and quality, which should help it find its place among similar conferences on organized elsewhere in the world.

By alternately organizing conferences on environmental protection of urban and suburban areas in odd years and conferences on safe food in even years, the Ecological Movement of the City of Novi Sad is completing its contribution to a higher quality of living of the population. Already in the 19th century, Novi Sad was a regional center of social progress and broad-mindedness. Today, owing first of all to its being a university center, Novi Sad is in the vanguard of ecological thought in this part of Europe.

It is our duty to work on the furtherance of the ecological programs of action and, by doing so, to make our contribution to the protection of the natural environment and spiritual heritage with the ultimate goal of helping the population attain e higher level of consciousness and a higher quality of living.

Director of the Ecological
Movement of Novi Sad
Nikola Aleksic

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ECO-CONFERENCE® 2020
ECOLOGICAL MOVEMENT OF NOVI SAD

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GENETIC POTENTIAL OF WINTER TRITICALE AS A HEALTHY SAFE FOOD

Abstract

The objectives of this study were to investigate: (1) the effects of cultivar, environment, and their interactions on the grain yield, test weight and 1000 kernel weight of winter triticale, and (2) the correlations between these traits in different environments. Based on the grain results during a three-year investigation with two cultivars, it can be concluded that the grain yield of triticale significantly varied across years, from 4.251 t/ha in 2010/11 to 5.791 t/ha in 2012/13 in the study.

The investigated period clearly indicates that highly significant effect of year was found on grain yield, test weight and 1000 kernel weight. Furthermore, test weight was highly significant regarding the interaction of the year and cultivar and significant for 1000 kernel weight.

Environmental conditions have had a significant effect on grain yield and quality in triticale. Grain yield shows a tendency to increase in the years having a higher total amount and better distribution of rainfall during critical plant development stages.

Key words: *cultivar, yield, quality, productivity, triticale*

INTRODUCTION

Triticale is cereal species gained by cross-breeding of wheat and rye. The yield per unit area is the result of the action of factors of variety fertility in interaction with environmental factors. Therefore, the yield is relative term and is determined by the

variety, environmental conditions and the level of applied technology. Yield is largely dependent on the genetic potential, which could be defined as yield of variety which was grown in conditions on which it had adapted, with adequate amounts of water and nutrients and efficient control of pests, diseases, weeds and other stresses (Đekić et al., 2014). Yields vary considerably primarily as a result of agro-ecological conditions during the growing season (Biberdžić et al., 2012; Bielski et al., 2020; Rajičić et al., 2020).

Triticale presented high tolerance regard the acid soils, as well as god productive results on sandy soils (Đekić et al., 2016). Soil acidity frequently affects agricultural production in Serbia. Triticale was planting where corn did not prosper, as well in the areas with moderate climate (Djekic et al., 2011; Biberdžić et al., 2017). It could be said that it inherited very good up to excellent tolerance regard the most important pathogens and small grains pests. Triticale presented high adaptability on local agro-ecological conditions, and it was influenced on stabile yield reaching.

New perspective triticale lines and varieties has more and better filled grain, higher yield, grain mass and farinaceous content, while proteins and lysine was smaller compared with older varieties (Milovanović et al., 2012; Kendal et al., 2016).

The objective of this study was to evaluate the effect of different fertilization systems on the grain yield and quality of triticale grown on a Pseudogley soil. The study was also aimed at optimizing fertilization for maximum profitability in the future triticale production in Western Serbia.

MATERIALS AND METHODS

Experimental design

During the three growing seasons, two cultivars of winter triticale (Trijumf and Odisej), cultivated at the experimental field in Valjevo were investigated. The experiments were conducted in randomized block systems, with a plot size of 50 m^2 (5 m x 10 m) in five replications. The sowing was carried out using a machine with row spacing of 12.5 cm. The soil on which the trial was conducted was uniform and well prepared. The amount of seed per square meter amounted to 400-450 viable seeds, depending on the characteristics of varieties. It was sown in the third decade of October, with 400 kg/ha of fertilizer NPK 15:15:15, which was added in the fall, while during the spring fertilization soil was supplemented with 300 kg/ha (KAN 27%N).

The following properties were analyzed: grain yield (t/ha), test weight (kg/hl) and 1000 kernel weight (g). Grain yields were measured for each plot and converted to yield tons per hectare on the basis of 14% grain moisture.

Soil Analysis

The trial was performed on soil that is characterized as pseudogley. According to the analysis, this is a soil of medium acidity, poor in humus, with a substitution and total hydrolytic acidity that were quite high (pH in H_2O=5.59, in KCl=4.50). The soil was moderately provided with total nitrogen, it is poor in easily accessible phosphorus

(P_2O_5=<15 mg/100 g of soil), a a good provided of easily accessible potassium (K_2O=23-35 mg/100 g of soil) was recorded.

Statistical Analysis

On the basis of achieved research results the usual variational statistical indicators were calculated: average values. Experimental data were analyzed by descriptive and analytical statistics using the statistics module Analyst Program SAS/STAT (SAS Institute, 2000) for Windows. All evaluations of significance were made on the basis of the ANOVA test at 5% and 1% significance levels.

Agroecologial conditions

This study was conducted over a three-year period in the Kolubara district, Šumadija region, Western Serbia, on a Pseudogley soil, at Valjevo location, 176 m a. s. l. (44°19′N 19°55′E), in a temperate continental climate having an average annual temperature of 11.4°C, typical of Šumadija districts in Western Serbia and a rainfall amount of about 787.7 mm. Valjevo area is characterized by a moderate continental climate, which in general is characterized by uneven distribution of rainfall by month.

Table 1. Middle monthly air temperature and precipitation amount (Valjevo)

Months											
Interval	X	XI	XII	I	II	III	IV	V	VI	VII	Aver.
Mean monthly air temperature (°C)											
2010/11	9.5	10.1	2.3	0.4	1.0	6.6	12.8	16.1	21.2	22.6	10.26
2011/12	10.7	2.9	4.1	0.8	–3.8	8.7	12.3	16.6	23.2	25.7	10.12
2012/13	13.4	9.4	0.9	3.1	4.2	6.5	13.7	17.6	20.5	22.8	11.21
Average	11.7	6.1	1.9	0.6	2.0	6.6	11.6	16.8	19.9	21.9	9.91
The amount of precipitation (mm)											
2010/11	83.3	39.4	56.7	53.0	75.9	76.1	65.6	117.8	216.8	121.0	905.6
2011/12	32.7	9.3	66.6	28.2	53.7	32.4	33.4	161.4	27.5	101.4	546.6
2012/13	31.0	21.2	105.2	95.4	67.5	14.6	86.6	115.1	28.2	19.4	584.2
Average	62.9	62.7	60.6	49.9	44.6	57.9	59.9	72.1	110.2	71.0	651.8

The data presented in Table 1 for the analyzed triticale growing season (2011-2013) clearly suggest differences in weather conditions between the years of the study and the long-term mean for the region. The average air temperatures were by 0.35°C, 0.21°C and 1.3°C higher in 2010/11, 2011/12 and 2012/13, respectively, as compared to the long-term mean, whereas the sums of rainfall were by 253.8 mm higher in 2010/11 years and lower by 105.2 mm and 67.6 mm in 2011/12 and 2012/13 as compared to the long-term mean. Compared to the long-term mean, total rainfall

values, especially in the first year, second and third year, were considerably higher in February, April and May, whereas total rainfall in April 2011/12 decreased by 26.5 mm. Given the high importance of sufficient rainfall amount during the spring months, particularly April and May, for triticale production, the distribution and amount of rainfall over the growing season 2012/13 were considerably more favorable, resulting in increased yields in this year. Apart from the rainfall deficiency during the spring months and the non-uniform distribution of rainfall across months, an increase in average air temperatures was also observed. The warmest month, on average, is July with an average temperature of 21.9°C. The coolest month on average is January, with an average temperature of 0.6°C.

Variations in the temperature, in the amount of precipitation during vegetation as well as in the soil moisture content are the most important factors of the yield instability (Popović et al., 2011; Biberdžić et al., 2012; Đekić et al., 2014; Jelic et al., 2015). It is known that individual or mutual influence of abiotic stress factors (high and low temperatures, drought, acidic and saline soil) in different triticale growth stages limit the expression of the maximum grain yield potential (Djekic et al., 2011; Biberdžić et al., 2017; Terzic et al., 2018; Rajičić et al., 2020).

RESULTS AND DISCUSSION

Grain yield, 1000 kernel weight and test weight

Average values of grain yield, 1000 kernel weight and test weight at investigated winter triticale varieties are presented in the Table 2. The grain yield of triticale significantly varied across years, from 4.251 t/ha in 2010/11 to 5.791 t/ha in 2012/13 (Table 2). During the first year of investigations (2010/11), variety Trujumf achieved the highest yield of grain (4.305 t/ha). During the second year of investigations (2011/12), the grain yield of variety Trujumf was the highest with 4.784 t/ha, while the slightly lower yield was realized by variety Odisej (4.605 t/ha). In 2012/13, yield significantly varied across cultivars, from 5.621 t/ha of variety Odisej to 5.961 t/ha of variety Trujumf (Table 2).

Table 2. Average values of investigated triticale varieties characteristics

Varieties	2010/11		2011/12		2012/13		Average	
	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S
Grain yield, (t/ha)								
Trijumf	4.305	0.490	4.784	0.241	5.961	0.503	5.016	0.822
Odisej	4.198	0.723	4.605	0.486	5.621	0.326	4.808	0.794
Average	4.251	0.585	4.694	0.374	5.791	0.438	4.912	0.801

Test weight (kg/hl)								
Trijumf	67.99	1.244	71.49	1.719	76.49	1.857	71.99	3.913
Odisej	63.44	1.345	73.97	1.635	76.69	2.455	71.37	6.163
Average	65.71	2.691	72.73	2.052	76.59	2.055	71.68	5.082
1000 kernel weight (g)								
Trijumf	38.86	0.727	39.58	1.050	42.60	1.114	40.35	1.906
Odisej	37.92	0.634	40.44	1.228	44.20	1.044	40.85	2.827
Average	38.39	0.812	40.01	1.168	43.40	1.322	40.60	2.383

Achieved statistically significantly higher yields in 2012/13 were, primarily, the result of heavy rainfalls and their good distribution as well as favorable air temperatures during the vegetation period (Table 1). Namely, the total rainfall is reflected on the multiannual average, but the distribution, especially in the critical stages of development, was significantly disrupted (Đekić et al.. 2014; Terzic et al., 2018; Rajičić et al., 2020). Đekić et al. (2016) in his research states that the air temperatures and the rainfall amount and distribution during the triticale growing season have the greatest impact on high yields and grain quality. Milovanovic et al. (2012), states that in the domestic production conditions, higher yields are achieved by varieties with shorter growing season because they manage to form the largest part of the yield before the advent of high temperatures. In this study, the triticale was not exposed to extremely high temperatures so early growth did not come into its own.

Table 2 presents average values for grain test weight across years and varieties. The average values for test weight significantly varied across years, from 65.71 kg/hl in 2010/11 to 76.59 kg/hl in 2012/13 (Table 2). During the first year of investigations, variety Trujumf achieved the highest test weight (67.99 kg/hl). During the 2011/12 and 2012/13, variety Odisej achieved the highest test weight (73.97 kg/hl and 76.69 kg/hl). Average test weight observed in the three-years period was the highest at Trijumf variety (71.99 kg/hl), while the lowest yield was obtained by Odisej cultivar (71.37 kg/hl). Generally, the test weight of triticale ranged from 63 to 72 kg/hl, while in dehulled triticale up to 80 kg/hl (Đekić et al., 2014; Kendal et al., 2016; Terzic et al., 2018; Rajičić et al., 2020).

The thousand kernel weight of winter triticale grain was variable, depending on environmental conditions. Thousand kernel weight in the test period was highest in 2012/13 (43.40 g), but significantly decreased in 2010/11 (38.39 g). Average thousand kernel weight observed in the three-years period was the highest at Odisej variety (40.85 g). Previously, many researchers have reported that the 1000-kernel weight values of triticale genotypes have ranged from 23.9 g to 54.9 g (Đekić et al., 2014; Kendal et al., 2016).

Analysis of variance between observed traits of triticale

The analysis of yield variance, test weight and 1000-kernel weight of tested winter triticale varieties grown at investigated Valjevo during three growing seasons, are shown in Table 3.

Table 3. Analysis of variance of the tested parameters (ANOVA)

Effect of year on the traits analyzed				
Traits	Mean sqr Effect	Mean sqr Error	F (2. 27)	p-level
Grain yield (t/ha)	6.2802	0.2245	27.968	0.000
Test weight (kg/hl)	303.9591	5.2248	58.176	0.000
1000-kernel weight (g)	65.3610	1.2570	51.999	0.000
Effect of cultivar on the traits analyzed				
Traits	Mean sqr Effect	Mean sqr Error	F (1. 28)	p-level
Grain yield (t/ha)	0.3261	0.6535	0.499	0.486
Test weight (kg/hl)	2.9141	26.6455	0.109	0.743
1000-kernel weight (g)	1.9253	5.8119	0.331	0.569
Effect of the year x cultivar interaction				
Traits	Mean sqr Effect	Mean sqr Error	F (2. 24)	p-level
Grain yield (t/ha)	0.0356	0.2361	0.151	0.861
Test weight (kg/hl)	32.1591	3.0766	10.453	0.001
1000-kernel weight (g)	4.2663	0.9783	4.361	0.024

Based on the analysis of variance, it can be concluded that there are highly significant differences in grain yield in regard to the year of investigation (F_{exp}=27.968**), while among the investigated triticale varieties the differences were not significant. Analysis of variance was found highly significant effect of year on the test weight (F_{exp}=58.176**) and 1000-kernel weight (F_{exp}=51.999**). The results of significance between years and yield of grain are in accordance with the results of other authors (Đekić et al., 2014 Terzic et al., 2018; Rajičić et al., 2020). Based on the analysis of variance, it can be concluded that there are no significant differences in grain yield, 1000-kernel weight and test weight at investigated triticale varieties were found relative to the cultivar of investigation (Table 3). The interaction of the investigated factors (Y x G) exhibits are no significant affect in grain yield ($p>0.05$), but significant affect in 1000-kernel weight and highly significant in test weight. The present results confirm the opinion of many authors that the traits analyzed are genetically determined but are strongly modified by the environment and weather conditions (Jelic et al., 2015; Đekić et al., 2016; Terzic et al., 2018; Rajičić et al., 2020).

Correlations between the analysed traits

The correlations of yield, test weight and 1000-kernel weight of tested winter triticale varieties during three growing seasons, are shown in Table 4.

Table 4. Correlations between the traits analyzed

Correlations between the traits analyzed in 2010/11			
Traits	Grain yield	Test weight	1000-kernel weight (g)
Grain yield (t/ha)	1.00	0.19	0.01
Test weight (kg/hl)		1.00	0.39
1000-kernel weight (g)			1.00
Correlations between the traits analyzed in 2011/12			
Grain yield (t/ha)	1.00	–0.28	–0.07
Test weight (kg/hl)		1.00	0.25
1000-kernel weight (g)			1.00
Correlations between the traits analyzed in 2012/13			
Grain yield (t/ha)	1.00	–0.21	0.02
Test weight (kg/hl)		1.00	0.35
1000-kernel weight (g)			1.00

Positive correlation coefficients, in 2010/11, were found between yield and test weight (0.19) and 1000-kernel weight (0.01) and were found between test weight and 1000-kernel weight (0.39), (Table 4). During the second year of investigation (2011/12), grain yield was negative but not significantly correlated with and test weight (–0.28) and 1000-kernel weight (–0.07). Test weight was positively correlated with 1000-kernel weight (0.14) in 2011/12. Positive correlation coefficients, in 2012/13, were found between yield and 1000-kernel weight (0.02) and between test weight and 1000-kernel weight (0.35). Insignificant negative dependencies were found between yield and test weight (–0.21), as shown in Table 4. Recorded significant correlations between analysed traits are in agreement with investigations of other authors (Đekić et al., 2014; Terzic et al., 2018; Rajičić et al., 2020).

CONCLUSIONS

Based on obtained results during the three-year investigation on two winter triticale varieties, it can be concluded that the largest three-year average and the best adaptability in the continental climate of Western Serbia at grain yield and test weight expressed the variety Trujumf.

The highly significant influence of the year on grain yields, test weight and 1000-kernel weight was established at investigated winter triticale varieties by variance analysis, while genotype influence on grain yields, test weight and 1000-kernel weight was not statistically significant.

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GENETSKI POTENCIJAL OZIMOG TRITIKALEA KAO ZDRAVSTVENO BEZBEDNE HRANE

Sažetak

Ciljevi ove studije bili su istražiti: (1) uticaje sorte, životne sredine i njihove interakcije na prinos zrna, hektolitarsku masu i masu 1000 zrna kod ozimog tritikalea i (2) povezanost tih osobina u različitim vegetacionim sezonama. Na osnovu dobijenih rezultata, tokom trogodišnjeg istraživanja dve sorte tritikalea, može se zaključiti da je prinos zrna tokom godina značajno varirao od 4.251 t/ha u 2010/11 do 5.791 t/ha u 2012/13. Analizom varijanse ustanovljen je izuzetno značajan uticaj godine na prinos zrna, masu 1000 zrna i hektolitarsku masu. Štaviše, hektolitarska masa bila je vrlo značajna i značajna za masu 1000 zrna kod interakcije godina x sorta.

Uslovi životne sredine su imali značajan uticaj na prinos zrna i kvalitet tritikalea. Prinos zrna pokazuje tendenciju rasta u godinama koje imaju veću ukupnu količinu i bolju raspodelu padavina tokom kritičnih faza razvoja biljaka.

Ključne riječi: *sorta, prinos, kvalitet, produktivnost, tritikale*

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