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ECONOMIC EFFECTS OF TRITICALE PRODUCTION ON ACID SOILS[1]

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Summary

Triticale production on acid soils requires significant investments in repairing bad qualities of those soils and it raises the question about the profitability of triticale growing.

The aim of our study was to determine the yield of triticale on acid soil depending on the dose and type of applied fertilizer, as well as economic feasibility of the application of fertilizers in the production of triticale on the acid soils. The experiment was performed at the Centre for Agricultural and Technological Research in Zaječar, during 2009-10 years. It was a set-by-bloc system with three repetition and included the control of three variants of fertilization, which were included in mineral (variant I and II) and a combination of mineral, lime and organic fertilizers (variant III). The survey results show a significant effect of fertilizers on grain yield increase of triticale, especially the combination of mineral, lime and organic fertilizers. The highest value of production, as well as the largest variable costs, is recorded in the III variant of fertilization. The highest profit was gained in the II variant of fertilizer. The most favourable indicators' values of economic efficiency (productivity, efficiency and profitability) were recorded in II variant of fertilization. The most economical is to organize the triticale production on acid soils using the fertilizers with the increased dose of phosphorous (II variant).

Kew words: *triticale, system of fertilization, yield, calculations, economic effects.*

JEL: *Q10, Q14*

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Introduction

According to many researches, the triticale is a plant species with a high genetic potential for yield and favourable nutritive values so that's why it is considered a promising plant species (Borojević, 1981, Cvetkov, 1982, Đokić, 1988).

According to the results of Impiglia (1987), triticale has modest requirements in relation to wheat and greater adaptability on acid soils, as well as greater resistance to the usual diseases. Vertisols are soils of bad water-aerial and physical-mechanical properties.

On such soils manufacturing of plants is unstable. According to the quotes of Aniola and Madeja (1996), the highest tolerance to acid soils exhibit rye, then triticale and wheat, while barley is the most sensitive. Numerous studies, both within our country or over the world, show that appropriate application of lime fertilizers in combination with organic and mineral is the most effective way to eliminate unfavourable production characteristics of acid soils and affect multiple increases in yield (Jovanović et al., 2006, Kovačević et al., 2006, Jelić et al., 2006).

In order to improve the acid soil the greater investments are indispensable and thereby production of wheat on such soils is more expensive. Due to the high price of mineral and organic fertilizers, on the one hand, and the low purchase price of wheat, on the other hand, the question is raised about the profitability of growing wheat. Ivanović Lana and collaborators (2010) point out that for the analysis of the agricultural farm must be developed a programme based on the calculations of variable costs. Analysis of the variable costs of production can serve as a basis for economic analysis in order that with less costs, to be provided profitable and quality production (Subić et al., 2010, Munćan et al., 2010, Bošnjak, Rodić, 2010).

The aim of our study was to determine the yield of triticale on the acid soil depending on dose and type of applied fertilizer, as well as economic feasibility of the application of fertilizers in production of triticale on acid soils.

Material and methods

The experiment was carried out at the Centre for Agricultural and Technological Research in Zaječar, during 2009-10 years. It was set-by-bloc system in three repetition and included the control of the three variants of fertilization, which were included in mineral -NPK (variants I and II) and a combination of mineral, lime ($CaCO_3$) and organic fertilizer (manure), variant III (Tab 1).

In the experiment was included a sort of triticale by name of Tango. Analysing the overall variable costs and value of triticale production there was performed calculations of production and elements of economic efficiency (productivity, efficiency and profitability) for all three variants of fertilization. Cover of the variable costs of production per hectare was done according to the formula:

CVC = Q – VC, when is Q = (qxc)

CVC - cover of variable costs,
Q - value of production,
VC - variable costs,
Q = quantity of products,
c - price of the product per unit of measure,

Calculation based on variable costs can be used to compare production when the investments are different.

The results of studies with discussion

The grain yield of triticale

Fertilization has shown a significant effect on grain yield of triticale (Tab 1). The yield on all variants of fertilization was higher compared to control variant. The highest yield (4053 kg ha^{-1}) was achieved in the variant III where a NPK combination was applied, lime and organic fertilizer. The yield in variants II and III was approximately equal. Variant with increased dose of phosphorous (II) showed good results in increase of yield. Also pronounced effect of NPK application with higher content of phosphorous is the result of high soil acidity and low content of available phosphorous in the soil. Positive effects of increased doses of phosphorous fertilizers on the yield level of wheat grain previously were obtained by other authors (Jelić et al., 1998, Jovanović et al., 2006, Kovačević et al., 2006).

Numerous previous studies have shown that in soils of acid reaction the full use of NPK, lime fertilizer and manure have a high effect on grain yield (Ognjanović et al., 1994, Jelić et al., 1995, Jelić et al., 2004), with which and our results are consistent.

Table 1. Grain yield of triticale depending on fertilization

Fertilization variants	Amounts of nutrients - (kg ha^{-1})					Grain yield (kg ha^{-1})
	N	P_2O_5	K_2O	$CaCO_3$	Manure	
0. Control	0	0	0	0	0	1.927
I. NP_1K	120	80	53	0	0	3.550
II. NP_2K	120	160	53	0	0	4.020
III. NP_1K+CaO_3 + manure	120	80	53	5.000	20.000	4.053

The compilation of calculations according to variable costs is based on determining the value of production on one hectare. Production value is obtained by multiplying the quantity of the product and its market price. From the production values are subtracted variable costs and the financial result or profit is obtained. In the production of triticale variable costs are included: the cost of materials (seeds, fertilizers and protective equipment), the cost of the plant machines and manpower. Since in our research work we're dealing with three various variants of fertilization, for each of them we've made a special calculation (Table 2, Table 3 and Table 4).

Table 2. Calculation of triticale production at I variant of fertilization

No	Elements of calculation	UM	Quantity	Price	Total	Structure of costs %
a)	Value of production				69225	
	Mercantile grain	kg	3.550	19.5	69225	
b)	Material (1+2+3)				25212	62.66
1.	Seeds	kg	300	39	11700	29.08
2.	Mineral fertilizers					
	NP1K	kg	253	45.5	11512	28.61
3.	Protective equipment	1	2,5	800	2000	4.97
c)	Services of the plant machines and worker's labour (4+5+6)				15020	37.34
4.	Tractors				7000	17.40
5.	Harvesters				5000	12.42
6.	Manpower	h	20	151	3020	7.52
d)	Overall variable costs (b+c)				40232	
e)	Belonging part of general costs				2012	
f)	Overall costs (d+e)				42244	
g)	Profit (a-f)				26981	

Table 3. Calculation of triticale production at II variant of fertilization

No	Elements of calculation	UM	Quantity	Price	Total	Structure of costs %
a)	Value of production				78390	
	Mercantile grain	kg	4020	19.5	78390	
b)	Material (1+2+3)				28852	65.31
1.	Seeds	kg	300	39	11700	26.49
2.	Mineral fertilizers					
	NP2K	kg	333	45.5	15152	34.30
3.	Protective equipment	1	2,5	800	2000	4.52
c)	Services of the plant machines and worker's labour (4+5+6)				15322	34.68
4.	Tractors				7000	15.85
5.	Harvesters				5000	11.32
6.	Manpower	h	22	151	3322	7.51
d)	Overall variable costs (b+c)				44174	
e)	Belonging part of general costs				2209	
f)	Overall costs (d+e)				46383	
g)	Profit (a-f)				32007	

Table 4. Calculation of triticale production at III variant of fertilization

No	Elements of calculation	UM	Quantity	Price	Total	Structure of costs %
a)	Value of production				79034	
	Mercantile grain	kg	4053	19.5	79034	
b)	Material (1+2+3)				56012	76.16
1.	Seeds	kg	300	39	11700	15.91
2.	Mineral fertilizers					
	NP1K	kg	253	45,5	11512	15.65
	Protective equipment	kg	5000	2,16	10800	14.68
	Services of the plant machines and worker's labour (4+5+6)	kg	20000	1	20000	27.20
3.	Tractors	1	2,5	800	2000	2.72
c)	Harvesters				17530	23.84
4.	Manpower				8000	10.88
5.	Overall variable costs (b+c)				5000	6.80
6.	Belonging part of general costs	h	30	151	4530	6.16
d)	Overall costs (d+e)				73542	
e)	Profit (a-f)				3677	
f)	Value of production				77219	
g)	Mercantile grain				1815	

Triticale production value grew from I to III variants of fertilization, which is caused by the application of large quantities and types of fertilizers, thus increasing the yield. However, when it comes to total profit it's obvious that it grew from I to II variants of fertilization, and at III variants of fertilization the profit is the lowest. This is due to the increased costs of fertilizers and manpower at III variant.

Most of the variable costs belong to material costs and they were ranging from 62.66 % (I variant of fertilization) to 76.16 % (III variant of fertilization). Most of the cost of materials belonged to the costs of seeds and fertilizers. Costs of fertilizer varied depending on type and quantity, so the lowest were at I variant (28.61 %) and the highest at III variant of fertilization (57.53 %). In the studies of Todorović, Filipović (2009) is highlighted a significant share of the costs of fertilizers in the production of wheat (35.75 %). The rest of variable costs included the costs of plant machines and manpower, so that they were ranged from 23.84 % (III variant of fertilization) to 37.34 % (I variant of fertilization). Our results are similar to the results of Ivanović et al. (2010) which talk about the cover of the variable production costs of wheat in Serbia.

Variable costs per hectare were the lowest at I variant of fertilization, and the highest at III variant, which is understandable considering the quantities and prices of the applied fertilizers. The results of Todorović, Filipović (2009) also indicate that increasing of yield with the increased mineral nutrition causes increase of the variable production costs. They emphasis the great importance of fertilizers in increasing the profitability of wheat production.

Labour costs are calculated based on the spent working hours of the effective work and real market prices. However, to gain a fuller picture of profitability estimation, it is indispensable to consider other indicators of success. Relying on the obtained results in calculations it is possible to express the basic indicators of the degree of economic efficiency (productivity, efficiency and profitability).

Based on these micro-economic indicators was performed a comparison of triticale yield results for all three variants of fertilization. Method of natural expression of labour productivity shows quantum of products gained in time unit of measure.

Table 5. Productivity of production

No.	Elements	Variants of fertilization		
		I	II	III
1.	Quantity of obtained product	3550	4020	4053
2.	Total labour hours spent by h	20	22	30
3.	Labour productivity (kg/h) 1/2	177.5	182.7	135.1

The highest labour productivity (182.7) was achieved in II variant and the lowest (135.1) in III variant. This is expected due to the fact that for the variant III should be spent more hours at work than in other variants. By comparing the realized values of production and the incurred costs we provide valuable expression of production efficiency which is shown in Table 6.

Table 6. Production efficiency

No.	Elements	Variants of fertilization		
		I	II	III
1.	Value of production (din/h)	69225	78390	79034
2.	Costs of production (din/h)	42244	46383	77219
3.	Coefficient of efficiency 1/2	1.64	1.69	1.02

The coefficient of efficiency shows that at 1 dinar of investment funding is obtained from 1.02 to 1.69 dinars of production value, depending on the variant of fertilization. This tells us that the production of triticale was effective, especially at the II variant of fertilization. Results of Vukoje et al. (2011) show a higher rate of efficiency (2.24) in the production of spelt u in terms of organic production. The rate of profitability represents the ratio of the realized financial results and the value of production, as is presented in Table 7.

Table 7. Rate of production profitability

No.	Elements	Variants of fertilization		
		I	II	III
1.	Financial results (din/h)	26981	32007	1815
2.	Value of production	69225	78390	79034
3.	Rate of profitability 1/2 x100	38.98	40.83	2.30

Production of triticale, at all three variants of fertilization, has been profitable, as evidenced by the rate of profitability that ranged from 2.30 % to 40.83 %. The highest profitability was at II variant of fertilization, and the lowest (2.30 %) at III variant. Such a low rate of profitability is a low financial result realized at III variant of fertilization. The most favourable values of the indicator of economic efficiency are recorded at II variant of fertilization, and thus it can be regarded as the most profitable and the most efficient, no matter that the yield and production values were the highest at III variant of fertilization. When it comes to acid soils, their improvement and high yields you should not always be guided by the highest yield, because it's not often the most profitable, as demonstrated by our research. In view of the high cost of fertilizers, which significantly increase the cost of production, it is indispensable to choose the rational quantities of fertilizers that will be used to achieve satisfactory yield and the production to be the most profitable.

Conclusion

On the basis of stydying the influence of fertilization on triticale grain yield and its economic feasibility when applied to acid siols, can be concluded the following:

- Application of fertiliziers positively affected on increase of triticale grain yield.
- The highest yield was obtained by applying a combination of NPK, lime and organic (manure) fertilizier (variant III).
- In order to raise the fertility level of acid siols and increase the yield of cultivated plants, it is necessary to use a combination of NPK, lime and organic fertliziers, as well as application of NPK fertliziers with increased dose of phosphorous.
- The highest production value was recorded in III variant of fertilization.
- The highest variable costs were at III variant of fertilization.
- Costs of fertiliziers and seeds, in the production of triticale, represent most of the variable costs.
- The highest profit was gained at II variant of fertilization.
- The most favourable values of the indicator of economic efficiency (productivity, efficiency and profitability) were recorded at II variant of fertilization.
- The triticale production on acid soils is the most economical to organize using mineral fertiliziers with increased dose of phosphorous (II variant).

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EKONOMSKI EFEKTI PROIZVODNJE TRITIKALEA NA KISELIM ZEMLJIŠTIMA

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Rezime

Proizvodnja tritikalea na kiselim zemljištima iziskuje znatna ulaganja u popravku loših osobina tih zemljišta pa se postavlja pitanje isplativosti gajenja tritikalea.

Cilj naših istraživanja je bio da se utvrdi prinos tritikalea na kiselom zemljištu u zavisnosti od doza i vrste primenjenog đubriva, kao i ekonomska opravdanost primene đubriva u proizvodnji tritikalea na kiselim zemljištima. Ogled je izvedena u Centru za poljoprivredna i tehnološka istraživanja u Zaječaru, tokom 2009-10 godine. Postavljen je po blok sistemu u tri ponavljanja i obuhvatao je kontrolu i tri varijante đubrenja, gde su bila uključena mineralna (varijanta I i II) i kombinacija mineralnih, krečnih i organskih đubriva (varijanta III). Rezultati istraživanja pokazuju značajan uticaj đubriva na povećanje prinosa zrna tritikalea, posebno kombinacija mineralnih, krečnih i organskih đubriva. Najveća vrednost proizvodnje, kao i najveći varijabilni troškovi, zabeleženi su kod III varijante đubrenja. Najveća dobit ostvarena je kod II varijante đubriva. Najpovoljnije vrednosti indikatora ekonomske efikasnosti (produktivnost, ekonomičnost i rentabilnost) zabeleženi su kod II varijante đubrenja. Proizvodnju tritikalea na kiselim zemljištima najekonomičnije je organizovati uz upotrebu mineralnih đubriva sa povećanom dozom fosfora (II varijanta).

Ključne reči: *tritikale, sistem đubrenja, prinos, kalkulacije, ekonomski efekti.*

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