

**THE EFFECTS OF DIFFERENT FERTILIZERS ON
SPELT GRAIN YIELD (*TRITICUM AESTIVUM* SPP. *SPELTA*)**

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Summary

The paper examined the impact of fertilizers in organic farming technology on spelt grain yield (*Triticum aestivum* spp. *spelta*). In mountainous conditions at over 1000 m above sea level research was conducted so as to examine the microbiological effects of different fertilizers (Uniker and Slavol) and soil conditioner (zeolite) on spelt yield in organic farming systems. Organic farming technologies included conventional tillage of soil, where agricultural production has not been organized for ten years. Soil conditioners and fertilizers Uniker microbiological, and combinations thereof are applied by treating the soil just before sowing of spelt (cultivar Nirvana). Microbiological fertilizer (Slavol) was applied in top-dressing.

Applying the statistical analysis of data on grain yield, it was found that the greatest difference in yield was recorded between the investigation years: 4.60 t ha⁻¹ (2010/11) and 2.82 t ha⁻¹ (2011/12). When applying top dressing some differences were recorded, but they were not statistically significant (3.66 t ha⁻¹ : 3.76 t ha⁻¹). When it comes to a basic fertilization, the highest grain yield was recorded with a combination of microbiological fertilizers and soil conditioner (4.62 t ha⁻¹) and the lowest in the control (2.63 t ha⁻¹).

Key words: spelt, organic farming, fertilizer, grain yield.

Introduction

According to recent literature data spelt was created 7,000 years ago in the area of the Transcaucasus, northern from the Black Sea, most likely in spontaneous crossing of wild grass species. As in other European countries, spelt in Serbia began to grow at the beginning of the last century, especially in mountainous areas. Then for a long time spelt had been neglected as a species, primarily due to the cost of processing (flaking) of its chaff fruits.

Spelt (*Triticum spelta*) is an ancient grain which is related to common bread wheat (*Triticum sativum*) but has certain properties which make it in many respects quite different (Sans *et al.*, 2011). Having fallen from favour as a grain for cultivation in the 19th century following the rapid development in modern farming techniques, spelt is currently enjoying a resurgence in popularity as information about its value as a food source and its ability to be tolerated by many people with wheat sensitivities becomes more widely known.

The quality of grain spelt compared to the soft wheat grain showed increasing in the total protein content (about 19%), and also increasing in content of essential amino acids, B vitamins, oils and mineral salts (Glamo lija *et al.*, 2013). Moreover, it contains more zinc, copper and selenium as well as vitamins A, E and D (Andruszczak *et al.*, 2012). The protein in spelt is such that when the flour is turned into bread it bakes well and results in a very light, soft textured loaf with good keeping qualities which doesn't shed crumbs when sliced (Sans *et al.*, 2011). Spelt is recommended in the children diet, for convalescents and for the sick ones, due to its easy digestibility and healing properties of grain and whole plant in general, which

makes spelt suitable for organic farming. When it comes to organic field production it is necessary to choose species which are not in regular use (alternative) and that's what make them suitable for this type of production (Pearson *et al.*, 2004).

Being low yielding it also thrives without the application of fertilisers even on relatively poor soils. Spelt is also very resistant to frosts and other extreme weather conditions and the grain's exceptionally thick husk protects it from pollutants and insects.

Today, spelt wheat is mainly cultivated in German-speaking countries, but also in Italy, France, and since the 1990s also in the Czech Republic, Hungary and Slovakia. In Serbia interest in this cereal has been gradually growing, therefore more and more often the research is conducted which aims at developing proper agricultural techniques of spelt wheat cultivation under Serbian soil-climatic conditions.

The most suitable regions for spelt growing are those with an altitude of over 800 m, but in the same time in less optimal agro-ecological and soil conditions spelt can also give higher grain yields compared to the soft wheat. Based on the fact of modest requirements in terms of soil and crop management, the aim of this study was to examine the impact of soil conditioner (zeolite), microbial fertilizers (Uniker and Slavol) and their combinations on the yield of spelt grain.

Materials and methods

The following factors were included in investigations: Factor A – Years (2010/11 and 2011/12); Factor B – Top-dressing. In full tillering of spelt we applied 5 l ha⁻¹ microbial fertilizer "Slavol". Fertilization system is complete with this treatment because it is a natural microbial inoculant that contains two groups of bacteria and nitrogen fixers, as well as some biostimulators. The essence of this preparation consists in the fact that in addition to the supply of plants in nitrogen and phosphorus, and allows production entomotoxins that protect plants from insects. Factor C – Fertilization. The experiment tested four variants of fertilization (factor C): control C₀ without fertilization; C₁- fertilization with Zeolite (2.5 t ha⁻¹), C₂-fertilization with uniker + zeolite and C₃ fertilization with Uniker (10 l ha⁻¹).

The experiments were conducted at the locality of Nova Varoš, village Radijevi i (altitude 1100 m) during 2010/11 and 2011/12 year. Conventional plow tillage was performed at 25 cm depth in mid-September and seedbed preparation was with disc harrows and harrow immediately after plowing. Sowing was done in 01.11.2010 and 20.10. 2011.

As the material served late variety, very resistant to winter conditions (Nirvana), selected at the Institute of Field and Vegetable Crops in Novi Sad. The best results are realized on moderate fertile soils, this variety (with high stem) is sensitive to intensive nitrogen fertilization which can lead to the stem lengthening and than lodging. Yield potential is more than 4 t ha⁻¹. The favorable ratio of gliadin and gluten in spelt flour enable preparation of different bakery products with high nutritional value.

After harvest, the yield was measured by elemental plots immediately after threshing and reduced to a moisture level of 14%. All data were subjected to analysis of variance. For individual comparisons, we used the LSD test.

Meteorological conditions during the period of investigation

Meteorological data on the during vegetation period spelt crops 2010/11-2011/12. are shown in figure1. The data shows better meteorological conditions for winter wheat in initial year of this investigation. In the first year is characterized by large amounts of precipitation in autumn and winter months. Good distribution of precipitation in spring and early summer followed the same time a relatively high average monthly air temperature at all growth stages of winter wheat. The second year of investigation had a bad precipitation distribution in spring period compared with first year. Lack of soil moisture and very high temperature in the second year of this study resulted lower yield of spelt grain.

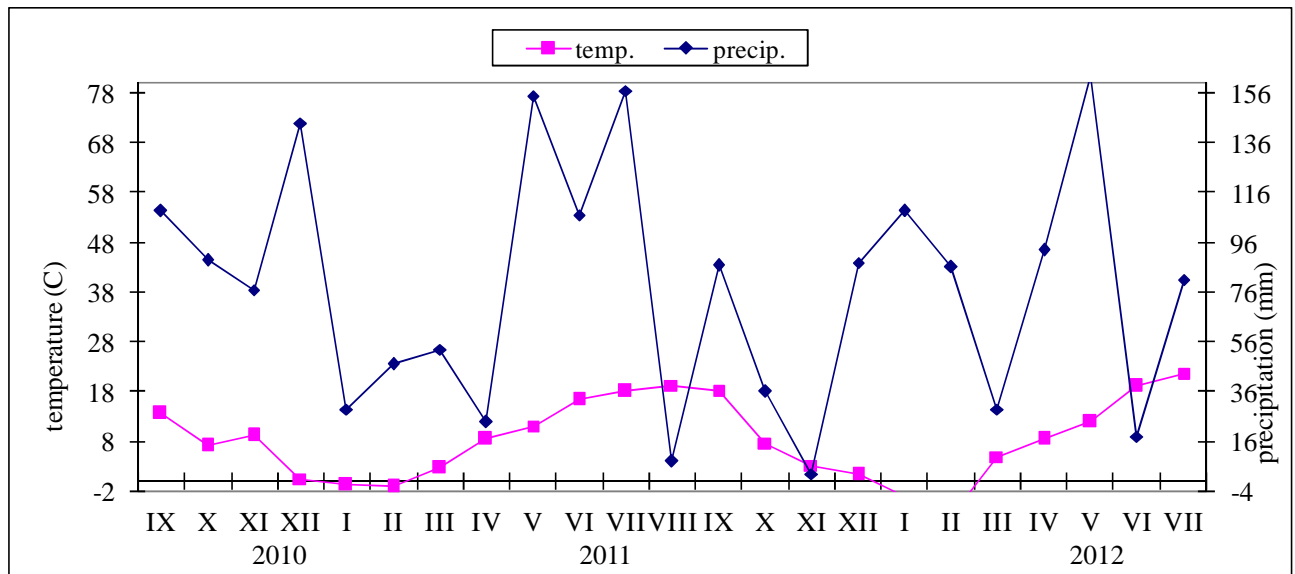


Fig.1. Meteorological data in investigation period on the Zlatibor

Results and discussion

The results of the effect of organic technology on grain yield of spelt shown in table 1. Based on these results show that grain yield of wheat was higher (4.60 t ha^{-1}) in first year (factor A) with better meteorological conditions compared with yield in the second year (2.82 t ha^{-1}). In the dry year of 2011/12 the best results were shown in variants with soil conditioners, as their impact were the greatest in the terms of water insufficiency in the soil. Fertilizers are important factor of organic field production technology alternative small grains (Kova evi *et al.*, 2011) as indicated by our results. The combination of and microbiological fertilizers and soil conditioners gave a significantly higher yield (4.45 t ha^{-1}) compared with control and variants with only microbiological fertilizers (2.61 and 3.05 t ha^{-1}). Interestingly, the differences between the two type of fertilization more pronounced in favorable years for winter wheat. In the less favorable meteorological conditions due to lack of moisture is missing the full effect of both type fertilizing. If we compare the interaction between of two AB factors (years x top-dressing) can be seen that all interactions in the first year of study had a significantly higher yields than the same interaction in the second years. Yield results in the interaction AC (years x fertilization) shows the same tendency as in the previous case.

The greater effect of fertilization was achieved in years with favorable meteorological conditions. In wheat growing areas with low rainfall levels and high air temperatures, better

results in spelt wheat cultivation are obtained when no-till is used, while plough tillage yields better results in areas with higher rainfall levels (Wo niak, 2013).

Under conditions of the conducted experiment, spelt wheat yielded on the level from 2.61 to 4.54 t ha⁻¹ (without top-dressing) and from 2.65 to 4.81 t ha⁻¹ (with top-dressing) and Andruszczak et al., (2011), stated interval grain yields of spelt from 4.07 to 4.45 t ha⁻¹, independent of the level of mineral fertilization and chemical protection. Furthermore, according to the same author's application of increased rates of mineral fertilizers increased the grain yield and number of ear-bearing culms per 1 m⁻², however it had no effect on the ear length, number and weight of grains per ear and the weight of one thousand grains.

Tab. 1. The effect of technology based on organic principles on grain yield of spelt (*Triticum aestivum* ssp. *spelta*) (t ha⁻¹)

Years (A)	Fertilizers (C) and Top-dressing (B)								Average (A)
	Control		Zeolite		Uniker+Zeolite		Uniker		
	B ₀	B ₁	B ₀	B ₁	B ₀	B ₁	B ₀	B ₁	
2010/11	3.00	3.11	5.78	5.90	5.53	6.15	3.73	3.63	4.60
2011/12	2.21	2.20	3.29	3.38	3.37	3.46	2.37	2.27	2.82
Average (AB)	2.61	2.65	4.54	4.64	4.45	4.81	3.05	2.95	3.71

B₀-without top dressing (Slavol); B₁- with top-dressing (Slavol)

LSD	A	B	C	AB	AC	BC	ABC
0.05	0.10	0.10	0.14	0.14	0.20	0.20	0.29
0.01	0.18	0.18	0.25	0.25	0.35	0.35	0.49

Dolijanovi et al., 2012 stated that the highest yields of grain spelt were obtained by a combination of organic and microbial fertilizers (5.84 t ha⁻¹), a microbiological (4.34 t ha⁻¹) and in the case of the control treatment without fertilizer (3.86 t ha⁻¹). In the dry year, yields were significantly lower, primarily due to the lack of full effects of the applied fertilizers.

Various alternative species of winter wheat such as (*Triticum durum*, *Triticum spelta* and *Triticum aestivum* ssp. *compactum*) can be very interesting for manufacturers because they are selected for specific purposes (Kova evi et al., 2007a). In the case of grain yield of above mentioned alternative species of winter wheat, in research of Kova evi et al., (2007b), the highest yield had *Triticum spelta*, which is species with modest requirements in soil condition and crop management as well as the specific purpose and quality.

Conclusions

According to the obtained results during two year investigations of effects four fertilization (3 and control) and top-dressing under organic farming practice, the following conclusions can be made:

The results of our investigation show that yield grain of wheat was higher in first year with better meteorological conditions. The effect of applied microbiological fertilizers and soil conditioners mainly was dependent of the amount and distribution of precipitation, especially during the growing season of crops.

Organic field crop technology that includes a combination microbial fertilizer in basic fertilization and top-dressing, with conditioner of soil in recharge gives the highest yield.

Spelt recharged with microbial formulation (Slavol) gave higher yields compared to the variant where was used only the basic fertilization. This results could be usefull for organic growers.

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