

EFFECT OF MICROBIOLOGICAL FERTILIZERS AND ZEOLITE ON YIELD OF WINTER RYE UNDER HIGH ALTITUDE CONDITION

Snezana OLJACA*, Zeljko DOLIJANOVIC, Dusan KOVACEVIC, Snezana OR EVI

University of Belgrade, Faculty of Agriculture, Nemanjina 6, 11080 Belgrade, Serbia

*(Corresponding author: soljaca@agrif.bg.ac.rs)

Abstract

Effect of microbiological fertilizers (Uniker and Slavol) and soil additive, zeolite on winter rye yield was investigated in this paper. Trial was set up in Akmadžici village in agroecological conditions of Zlatar mountain on altitude of 1065m, during two-year period 2010/11 and 2011/12. A randomized complete block design with three replications was employed. In organic cropping system three variants of microbiological fertilizer with zeolite were used prior to sowing (Zeolite, Uniker and Zeolite+Uniker). Half of each plot was treated with foliar microbiological fertilizer Slavol during crop growing period.

On the basis of two-year results it is obvious that meteorological conditions have very significant influence on winter rye yield. The big difference between temperature and precipitation has effect on significant differences between yield in two seasons. The second season, 2011/12 had weather pattern less favorable for the rye production due to severe drought. Different combinations of the microbiological fertilizers and the soil additive gave positive results specially in the first year of the trial. The best combination in organic cropping system was Uniker + Zeolite with foliar application of microbiological fertilizer Slavol, which resulted with the greatest yield of winter rye and this treatment can be recommended to producers. Winter rye performed very well under limited conditions of acidic soil on high altitude in organic cropping system and it can be recommended as very suitable crop for organic producers.

Key words: winter rye, microbiological fertilizer, soil additive, organic cropping system, grain yield.

Introduction

Winter rye is very cold tolerant and is the hardiest and most disease resistant of the winter cereals. Winter rye is earlier and faster growing in the spring than the other winter cereals, including wheat and barley (Malešević et al, 2008). It is an excellent source of organic matter, grows in marginal soils, reduces erosion and has an allelopathic action that suppresses weeds (Teasdale et al, 1991). Rye is one of the best cool season cover crops for outcompeting weeds. If climatic conditions favor grain development, it will produce a better crop than any other grain on infertile, poorly tilled soil, tolerates very acid soil conditions (Glamo lija, 2004). Therefore, rye is very suitable for growing in organic cropping system on high altitude plots (Olja a et al. 2010).

Rye's nutritional characteristics are similar to the other cereal grains, however rye is higher than wheat in fiber, vitamin E, riboflavin, folacin and pantothenic acid. Unusual for a cereal grain, rye contains twice as much of the amino acid, lysine as wheat. This is especially significant because lysine's the limiting amino acid in wheat and most other cereal grains which necessitates food mixing to develop a complete protein. This isn't a problem with rye as eating rye by itself gives you a well rounded protein (Diousse and Gaziano, 2007). Rye contains a lot of soluble fibre which slows down the release of carbohydrates and sugars, so that you feel satisfied for longer after eating it compared to wheat bread. The sugars in rye are largely "fructans" - a type of fructose, which accounts for the slightly sweet taste. Fructans allow this plant to thrive in relatively cool conditions. Many of the benefits of eating rye come from the fact that it ferments in the gut to produce valuable

nutrients such as short-chain fatty acids and arabinoxylan. Short-chain fatty acids help the immune system by promoting lymphocyte production and they also lower cholesterol production and stabilise blood sugar levels. Arabinoxylan is thought to act much like beta-glucan from oats. Beta-glucans are responsible for some of the heart-healthy attributes of oats and have a whole bundle of health benefits credited to them (Truswell, 2002).

Material and methods

Rye cultivar Raša were included in a complete randomized block design with three replications with sowing rate of 200 kg ha^{-1} . This cultivar created in Center for small grains in Kragujevac, has very good tolerance on cold temperature, drought and the most diseases (Milovanovic et al. 2005). The grain is slightly bigger than other cultivars and protein content is high 15,8 %. Trials were set up in Akmadžici village ($43^{\circ} 25' 27'' \text{ N}$, $19^{\circ} 52' 13'' \text{ E}$) under agroecological conditions of hilly-mountainous region of Zlatar (altitude 1043 m) during two-season period 2010/11 and 2011/12. Sowing was performed on October 05th and October 10th for growing seasons of 2010/11 and 2011/12 respectively, and harvesting on July 27th and 31th respectively. Weather data covering three seasons were collected from the nearest meteorological station Zlatibor (Figure 1). The season 2010/11 was characterized by higher mean temperature ($7,2^{\circ}\text{C}$) then in 2011/12 ($6,8^{\circ}\text{C}$). The lowest monthly mean temperature was recorded in February 2012 ($-7,3^{\circ}\text{C}$). Precipitation sum during vegetative period in 2010/11 was 882 mm and in 2011/12 it was 706 mm, which is lower than long-term average.

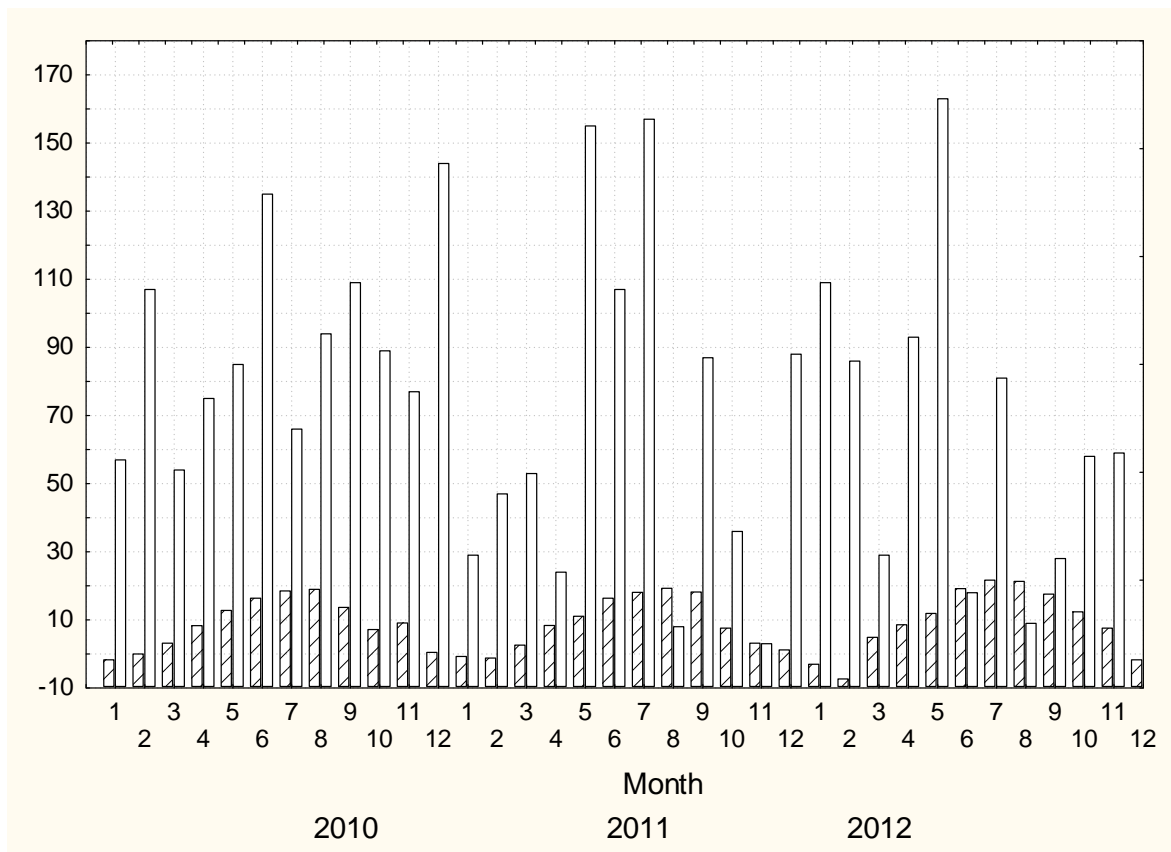


Figure 1. Meteorological conditions for Zlatibor in period 2010- 201

A plot size was 12m^2 and the soil was very acid with high content of humus, high reserve of mineral N, and very low content of P (Table 1). A randomized complete block design with three replications was employed. Soil additive zeolite ($2,67 \text{ t ha}^{-1}$) and microbiological fertilizer Uniker (10 l ha^{-1}) and their combination were applied on the top soil prior to sowing. In organic cropping

system three variants of microbiological fertilizer with zeolite were used (Zeolite, Uniker and Zeolite+Uniker). Half of each plot was treated with foliar microbiological fertilizer Slavol during crop growing period in amount of 7 l ha⁻¹. The microbiological fertilizers Uniker and Slavol are universal, certified fertilizers and can be used in organic agriculture. These are natural products without any chemical additives, thus having a positive influence on plants, soil and the environment. The soil additives zeolite is also allowed for application in organic agriculture. Zeolite can act as water moderators, in which they will absorb up to 55% of their weight in water and slowly release it under the plant's demand. This property can prevent root rot and moderate drought cycles.

Grain yield of winter rye (t ha⁻¹) were determined after harvest. The data were processed by ANOVA, using LSD test for comparison of means.

Table 1. Soil properties on experimental plots

Depth (cm)	pH		CaCO ₃	Humus	Total N	C/N	Available N			Available (Al-method)	
	H ₂ O	nKCl					%			NH ₄ ⁺	NO ₃ ⁻
			mg/kg				mg/100g				
0-10	5,00	4,00	-	5,32	0,297	10,6:1	17,3	17,6	34,9	1,1	15,1
20-40	4,63	4,07	-	4,04	0,210		18,1	12,2	30,3	0,5	9,6

Results and discussion

On the basis of two-year results it is obvious that meteorological conditions have very significant influence on the rye productivity. The first season, 2010/11 had weather pattern more favorable for the rye production with mild and moist winter and warm but rainy spring and summer. The big difference between temperature had effect on significant differences between yield in the two seasons. Significantly greater rye yield was recorded in 2010/11, because of very low temperature in winter 2011/12 and lack of precipitation in early summer 2012 (Table 2).

Different combinations of the microbiological fertilizers and zeolite gave positive results on grain yield compared with the control. The best combination in two-year average in organic cropping system was Uniker + Zeolite with foliar application of the microbiological fertilizer, which resulted with the greatest yield of winter rye (2.07 t ha⁻¹). It is obvious that foliar application of the microbiological fertilizer has very positive influence on rye productivity except in variant with Uniker. In variant of the control with no fertilizers but with foliar application of the microbiological fertilizer we obtain approximately the same result. This result is very much compatible with the results of Kovačević et al (2009, 2011) where significantly greater yields of different species of wheat (*Triticum spelta*, *T. durum*, *T. aestivum ssp. compactum*) and other small grains were obtained in similar treatments. It is also in accordance to the results of experiment with winter rye (Oljača et al, 2010) in organic cropping system under agroecological conditions of Valjevo region.

The highest yield improvement that has been achieved by application of the microbiological fertilizer was in the variant Uniker + Zeolite + Slavol fol. in 2010/11 with 2.14 t ha⁻¹ and this combination can be recommended to producers (Table 2). Yield in the control was not significantly lower in growing season 2010/11 compared with other treatments thanks to high reserve of nitrogen and humus in the soil. It is important to stress that soil on experimental plots was not used for agriculture for a long period of time, retain fertility and enabled greater crop productivity. Natural microbiological fertilizers such as Uniker and Slavol containing products of bacterial fermentation, natural vitamins, enzymes and growth stimulators helps the plant to more effectively bind useful substances from the soil, exploiting natural resources to the maximum, without polluting the soil. They aid the nutrition of plants by converting organic and hardly soluble compounds into accessible

forms which are directly delivered to the root systems. For organic producers, especially in neglected hilly-mountainous regions of Serbia, these results might be helpful.

Table 2. The effect of microbiological fertilizers and zeolite on yield of winter rye

Variant	Yield (t ha ⁻¹)		Average
	2010/11	2011/12	
Control	1.65	1.52	1.59
Control + Slavol fol. Zeolite	1.78	1.51	1.65
Zeolite	1.69	1.58	1.64
Zeolite + Slavol fol.	1.87	1.97	1.92
Uniker + Zeolite	1.95	1.90	1.93
Uniker + Zeolite + Slavol fol.	2.14	1.99	2.07
Uniker	1.82	1.72	1.77
Uniker + Slavol fol.	1.87	1.58	1.73
Average	1.85	1.72	

LSD 0,05	LSD 0,01	A-year, B-foiliar fertilizer, C-fertilizer
0,0466	0,0665	A
0,0680	0,1163	B
0,0785	0,1343	C
0,1111	0,1899	AC
0,0962	0,1645	AB
0,1360	0,2326	BC
0,2221	0,3799	ABC

Conclusions

According to the presented results of the research of different microbiological fertilizer combinations with soil additive zeolite in organic cropping system for winter rye during the seasons 2010/11 and 2011/12 following conclusions can be stated:

The first season, 2010/11 had weather pattern more favorable for the winter rye production. Organic cropping system under conditions of Zlatar hilly region gave significantly greater yield compared with the control specially in 2010/11 growing season. The best combination in two-year average in organic cropping system was Uniker + Zeolite with foliar application of the microbiological fertilizer Slavol which resulted with the greatest yield of rye. It is obvious that foliar application of the microbiological fertilizer has very positive influence on crop productivity in both years of the trial except variant with Uniker, which leads toward conclusion that this treatment can be recommended not only for rye but the other alternative small grains. On the other hand winter rye performed very well under limited conditions of acid soil on high altitude in organic cropping system and it can be recommended as very suitable crop for organic producers.

Acknowledgement

This work has been carried out with funding from the Ministry of Education, Science and Technological Development of the Republic of Serbia (project TR - 31066).

References

- Diousse L., Gaziano J.M. (2007). Breakfast cereals and risk of heart failure in the physicians health study I. *Arch Intern Med*, 167 (19), 2080-2085.
- Glamočlija . (2004). *Ratarstvo*. Izdavačka kuća Dragani, Beograd.
- Kovačević D, Dolijanović Ž, Oljača Snežana, Milić Vesna (2009). Prinos nekih alternativnih vrsta pšenice u organskoj proizvodnji. *Arhiv za poljoprivredne nauke*, 70, 17-25.
- Kovačević D, Oljača Snežana, Dolijanović Ž (2011). Grain yields of alternative small grains in organic field production. *Proceedings of 46th Croatian and 6th International Symposium on Agriculture, Opatija*, 80-83.
- Malešević M., Jakićević G., Babić Milica, Latković Dragana (2008). Upravljanje proizvodnjom ratarskih kultura. In Lazić Branka, Babović J. (2008). *Organska poljoprivreda*. Institut za ratarstvo i povrtarstvo, Novi Sad, 153-225.
- Milovanović M., Perišić V., Stojanović S., Staletić Mirjana, Marković B. (2005). Ozimaraž u SCG-stanje i perspektive. *Traktori i pogonske mašine*. 10, (2), 433-440.
- Oljača Snežana, Dolijanović Ž., Glamočlija ., Kovačević Snežana, Oljača Jasmina (2010). Productivity of winter rye in organic vs. conventional cropping system. *Journal of Agricultural Sciences*, 55, (2), 123-129.
- Teasdale, J.R., Beste C.E., Potts W.E. (1991). Response of weeds to tillage and cover crop residue. *Weed Science* 39, 195–199.
- Truswell A.S. (2002). Cereal grains and coronary heart disease. *Eur J Clin Nutr*, 56, (1), 1-14.