

# **BIOTECHNOLOGY IN ANIMAL HUSBANDRY**

**3<sup>rd</sup> INTERNATIONAL CONGRESS  
“New Perspectives and Challenges of Sustainable  
Livestock Production”**

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# CHARACTERISTICS OF SOME MACEDONIAN AND INTRODUCED OATS GENOTYPES CULTIVATED IN ORGANIC AND CONVENTIONAL PRODUCTION

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**Abstract:** In the period 2005-2007 trials with five oats populations (*Krivogastani, Trebenishta, Radolishta, Bugarija, Kuceviste*) and three oats varieties (*Rajac, Slavuj and Lovćen*), were carried out. The trials were set up in conditions of organic and conventional production. The main objective of this investigation was to determine the differences in some morphological characteristics of the tested genotypes, which directly or indirectly affect the yield, and also, to determine the differences that came up as a result of the different systems of production (conventional and organic production). The average height of the oats plant cultivated in organic production (114,4 cm) was higher absolutely by 2,2 cm or relatively by 2.0% than the height of the oats plant cultivated in conventional production. The system of production showed no effect on the length of the panicle. The yield of oats grain by panicle in organic production (3,30 g) was higher absolutely by 0,3 g or relatively by 9.1% than the yield of oats grain by panicle in conventional production (3,0 g). The system of production did not impact significantly on the percentage of the glumes. The lowest percentage of glumes in both systems of production gave variety *Rajac*.

**Key words:** oats, grain, panicle, organic, conventional, length, height

## Introduction

Oats (*Avena sativa* L.) is a crop which is mainly grown for grain. Studies have shown that 1kg of oats contain 81,8 g digestible proteins (8.18%) and 1,02 g nutrients (*Jeftić, 1992*). Also, the oats can be grown as green fodder, alone or in combination with annual leguminous such as peas and vetch. A diet with such fodder increases the lactation of the animals. Because of the high quality of oats grain, all other nutrients in the diet of cattle come down to the oat units (*Vasilevski, 2004*).

Areas under oats, worldwide are in constant decline, mainly due to low and unstable yields, compared with wheat and barley. Reasons for low productivity of oats are growing poorly productive varieties and inadequate agrotechnics. According to Moule (1964), quote by Bogdanović et al. (2000), the best indicator for the fertility of oats varieties is the number of oats grains into panicle and shorter stem.

World tendency of producing healthy food has imposed the need for greater representation of organic production of cereals, as the main crops which comprise a large proportion of the food consumed by humans and domestic animals. Organic production in Republic of Macedonia is defined in the rules of organic vegetable production (*Official Gazette br.60/2006*) and by the Law on Organic Agricultural Production (*Official Gazette of RM no. 146/2009*), which is in accordance with the laws of EU.

According to Gaile et al. (2004), oats is very suitable cereal crop for organic production.

Considering the above mentioned, in our investigations we made an analysis of some morphological characteristics of the oats genotypes, which directly or indirectly affect the yield, and we determined the differences that came up as a result of the different systems of production (conventional and organic production).

## Materials and Methods

The experiments were carried out in field and laboratory conditions.

The field trials were set up on the experimental field of the Faculty of Agriculture in Strumica, at Goce Delchev University, Stip. Five oats populations and three oats varieties were analyzed. Four of the populations were domestic populations: *Krivogastani*, *Trebenishta*, *Radolishta* and *Kuceviste*, and one oats population was introduced from Bulgaria. The three oat varieties, *Rajac*, *Slavuj* and *Lovćen*, were introduced from Serbia.

Two trials were set up, where all the above-mentioned genotypes of oats were represented, with the difference that in one experiment all varieties were cultivated in conditions of conventional production, and the other in conditions of organic production.

The experiments consisted of 8 variants in four repetitions, arranged according to the method of random block system with the dimension of basic parcel of 5 m<sup>2</sup>.

The seed rate in both systems of production was 550 grains per 1 m<sup>2</sup>, or 5.5 million grains per 1 ha. Throughout the examinations, the soil was prepared in an identical manner. Thus, in autumn the area was ploughed at the depth of 30 to 35 cm, followed by separation of surface and fertilization. On the area provided for conventional method of cultivation of oats, artificial NPK fertilizer (15:15:15) was applied in the amount of 300 kg ha<sup>-1</sup>, while on the area provided for organic

method of cultivation of oats, blown cow manure in quantities of 20 t ha<sup>-1</sup> was applied. After the application of the proper fertilizer on the area, it was further processed by milling and the area was flattened.

Throughout the examination, sowing was carried out during the month of March, more precisely: in 2005 on 17 March, in 2006 on 28 March, and in 2007 on 6 March, that is, when there were optimal conditions. Sowing was performed by hand in rows at a depth of 5-6 cm.

On the field, the height of twenty five oats plants, from all four repetitions, was measured and the average of 100 plants (4 x 25 plants) was taken.

In the laboratory on thirty plants of each parcel were analyzed: length of the panicle, the yield of oats grain by panicle and percentage of glumes in grain.

The results were statistically analyzed using the variance analysis method, and the differences were tested according to the LIMIT SIGNIFICANT DIFFERANS-test.

## Climatic conditions

During the three-year examinations meteorological indicators of monthly average air temperature in degrees Celsius and monthly amounts of precipitation in millimeters were monitored. Table 1 represents average monthly temperatures in degrees Celsius, annual sum of temperatures, average annual temperature and average annual temperature in the Strumica valley for ten years 1994/2004. Table 2 represents the sum of monthly precipitation in mm, annual sum of precipitation, as well as the average annual amount of precipitation for a period of ten years 1994/2004.

## Results and Discussion

Measuring the height of the plant was made at full maturity stage before the harvest of oats.

The results that are related to the height of oats plants in organic and conventional production are shown in Table 3.

Comparing the general averages of oats plant height in both systems of production, irrespective of the years, genotypes and climate conditions, and depending on the applied agrotechnical measures, we can say that in the organic system of production the height of the plants (114.4 cm) is higher absolutely by 2.2 or relative by 2.0% than the height of the plants in conventional production (112.2 cm).

According to *Georgieva (1995)*, in optimal climatic conditions the differences in plant height of oat varieties are minimal (4-5 cm or 7%). In our investigation that conclusion were confirmed. In the organic and conventional production the greatest height of oats plants was achieved in 2005, which means

that the climate conditions have more impact on the plant height than method of production.

**Table 1. Monthly average air temperature in degrees Celsius**

Year	Months												Annual sum of temperatures	Avg
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
2005	2,5	-0,1	7,8	12,9	18,7	21,9	25,0	23,8	19,4	13,2	5,4	4,2	4708,5	12,9
2006	-0,3	2,0	8,2	13,5	18,1	21,4	23,7	24,1	19,5	14,3	6,7	2,8	4672,0	12,8
2007	5,0	5,9	9,8	13,7	19,8	24,1	27,6	24,6	17,7	13,3	5,9	1,9	5146,5	14,1
1994/2004	1,1	4,0	7,8	12,3	18,4	22,6	25,0	24,0	18,7	13,2	7,3	2,7	4831,2	13,2

**Table 2. Sum of monthly precipitation in mm**

Year	Months												Annual sum of precipitations
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2005	48,9	96,4	43,5	36,7	50,0	12,9	35,5	75,9	63,9	58,0	34,2	52,1	608,0
2006	58,7	56,4	75,0	31,8	34,0	107	26,7	19,9	63,9	85,6	39,7	34,3	632,9
2007	16,5	24,0	39,7	2,2	107,5	45,6	0,3	73,9	41,0	127	74,8	41,4	593,7
1994/2004	48,0	33,7	36,4	48,9	51,5	49,3	57,8	34,9	53,8	57,7	60,3	81,9	614,2

**Table 3. Height of oats plants (cm) in organic and conventional production**

Variety/ Population	Organic production				Conventional production			
	Year			Avg	Year			Avg.
	2005	2006	2007		2005	2006	2007	
<i>Krivogas</i>	127.6	125.8	123.7	125.7	135.8**	117.3**	123.5**	125.5
<i>Trebenis.</i>	113.0	105.1	99.1	105.7	110.6	89.3	99.5	99.8
<i>Radolis.</i>	130.3*	130.3**	128.1**	129.6	137.7**	125.3**	126.9**	129.9
<i>Bulgaria</i>	119.4	106.5	105.9	110.6	119.6	97.1	100.3	105.6
<i>Kucevish</i>	109.6	109.6	111.6	110.3	121.1	100.9	102.0	108.0
<i>Rajac</i>	116.6	112.0	115.2	114.6	125.9	103.8	112.1	113.9
<i>Slavuj</i>	104.7	115.4	118.6	112.9	127.2	105.2	109.6	114.0
<i>Lovkjen</i>	111.2	105.9	100.1	105.7	109.5	95.0	98.5	101.0
Avg. year	116.5	113.8	112.8	114.4	123.4	104.2	109.0	112.2
LSD 0,05	3.0	2.33	2.0		5.68	1.77	2.44	
0,01	4.48	3.38	2.9		8.22	2.56	3.56	

The results related for the length of oats panicle in organic and conventional production are shown in Table 4.

**Table 4. Length of the oats panicle (cm) in organic and conventional production**

Variety/ Populatio n	Organic production				Conventional production			
	Year			Avg				Year
	2005	2006	2007		2005	2006	2007	
<i>Krivogas.</i>	31.6**	9.7*	28.0**	29.8	33.4**	30.7**	28.8**	30.9
<i>Trebenis.</i>	25.0	22.4	21.4	22.9	25.3	22.6	20.6	22.8
<i>Radolis.</i>	32.3	29.2	28.8	30.1	32.3	27.5	27.5	29.1
<i>Bulgaria</i>	25.0	24.5	21.1	23.5	24.1	23.5	21.1	22.9
<i>Kucevish.</i>	23.8	23.7	21.7	23.1	23.7	24.5	22.1	23.4
<i>Rajac</i>	28.2	25.1	23.1	25.5	27.9	24.5	23.4	25.3
<i>Slavuj</i>	27.6	26.5	23.5	25.9	28.1	28.2	25.0	27.1
<i>Lovkjen</i>	27.1	24.2	24.1	25.1	27.2	24.5	23.9	25.2
Avg.	27.5	25.6	23.9	25.7	27.7	25.7	24.0	25.8
LSD 0,05	2.46	6.0	1.10		2.09	4.96	1.72	
0,01	3.56	8.7	1.60		3.02	7.19	2.49	

Comparing the general averages of the length of oats panicle in both systems of production, irrespective of the years, genotypes and climate conditions, and depending on the applied agrotechnical measures, we can say that organic production has not shown an increase in the length of panicle, but insignificant decrease of 0,1 cm or 0.4%. The variety and year of production showed more impact on the length of panicle than the applied agrotechnics.

The results related for the oats grain yield by panicle in organic and conventional production are shown in Table 5. Comparing the general averages of the oats grain yield by panicle in both systems of production, irrespective of the years, genotypes and climate conditions, and depending on the applied agrotechnical measures, we can say that the oats grain yield by panicle in conditions of organic production (3,30 g) is higher absolutely by 0,30 g or relatively by 9.1% than oats grain yield by panicle in conditions of conventional production (3,0 g).

**Table 5. Oats grain yield by panicle (g) in organic and conventional production**

Variety/ Populatio n	Organic production				Conventional production			
	Year			Avg				Year
	2005	2006	2007		2005	2006	2007	
<i>Krivogas.</i>	2,83	2,80	2,90	2,84	2,50	2,40	2,40	2,43
<i>Trebenis.</i>	3,97**	3,10	3,20*	3,42	3,47	3,00**	2,60	3,00
<i>Radolis.</i>	3,32	2,70	2,80	2,94	2,80	2,40	2,20	2,46
<i>Bulgaria</i>	3,85*	3,10	3,20*	3,40	3,60*	3,00**	2,70*	3,10
<i>Kucevish.</i>	3,57	2,90	2,80	3,10	3,55*	3,00**	3,00**	3,20
<i>Rajac</i>	3,90*	3,20	3,10	3,40	3,60	3,10**	3,20**	3,30
<i>Slavuj</i>	4,00**	3,30	3,20*	3,50	4,00**	3,00**	2,80**	3,30
<i>Lovkjen</i>	3,87*	3,80**	3,60**	3,75	4,10**	3,10**	3,00**	3,40
Avg.	3,66	3,11	3,10	3,30	3,45	2,88	2,73	3,0
LSD 0,05	0,81	0,54	0,29		1,03	0,41	0,24	
0,01	1,10	0,78	0,42		1,49	0,60	0,35	

Irrespective of the years, soil and climate conditions, and applied agrotechnical measures, the best genotype of the tested varieties and populations to obtain a high grain yield by panicle is the variety *Lovcen*, which in the system of organic production has achieved an average grain yield by panicle of 3,75 g, and in the conventional system of production 3, 40 g.

The results related for the percentage of the glumes in systems of organic and conventional production of oats are shown in Table 6.

Comparing the percentage of glumes by years in both systems of production, irrespective of the years, genotypes and climate conditions, and depending on the applied agrotechnical measures, we can say that the manner in cultivation did not affect significantly on the percentage of the glumes.

Irrespective of the years, soil and climate conditions, and applied agrotechnical measures, the best genotype of the tested varieties and populations to obtain a high randman of pure grain, or a grain with a smaller percentage of glumes is variety *Rajac*, which in the system of organic production achieved an average percentage glumes of 20,3 and in the conventional system of production 20,4.

The results of the examinations show great dependence of the percentage of glumes of the variety and the year of cultivation.

According to the examinations of *Georgieva (1995)*, the lowest percentage in glumes was recorded in the driest year 1990, and the highest percentage of glumes was found in 1989, when heavy rains and strong winds caused lodging of the sowing, in the stage of oats tasseling.

According to *Gaile et al. (2004)*, that have performed examination of four oat varieties in conditions of organic production, the variety Arta proved good for food although was with the lowest yield, because had the lowest content of glumes and highest content of raw protein and fat.

Our results are in accordance with the results of these authors.

**Table 6. Percentage of the glumes in systems of organic and conventional production of oats**

Variety/ Populatio n	Organic production				Conventional production			
	Year			Avg				Year
	2005	2006	2007		2005	2006	2007	
<i>Krivogas.</i>	24,7	26,0	23,4	24,7	23,2	25,3	24,5	24,3
<i>Trebenis.</i>	19,5	22,2	20,7	20,8	20,4	20,2	21,2	20,6
<i>Radolis.</i>	21,0	25,5	22,5	23,0	23,4	24,2	22,6	23,4
<i>Bulgaria</i>	20,0	21,6	22,7	21,4	20,0	21,9	21,5	21,1
<i>Kucevish.</i>	20,5	25,0	23,6	23,0	20,5	20,2	19,6	20,1
<i>Rajac</i>	19,0	20,9	21,2	20,4	20,2	21,3	19,4	20,3
<i>Slavuj</i>	21,5	24,5	23,1	23,0	21,2	20,3	21,0	20,8
<i>Lovkjen</i>	20,2	20,5	19,5	20,1	20,5	21,5	20,6	20,9
Avg.	20,8	23,2	22,0	22,0	21,2	21,8	21,3	21,4
LSD 0,05	ns	H.C	H.C		H.C	H.C	H.C	
0,01	H.C	H.C	H.C		H.C	H.C	H.C	

## Conclusion

Based on three years of research on the specific characteristics of some Macedonian and introduced oats genotypes cultivated in a system of conventional and organic production, the following conclusions could be made:

- The height of the plants is characteristic of the variety, but depends on soil and climate conditions and applied agrotechnical measures. Highest average height in both systems of production is achieved in 2005, and the lowest in 2007 characterized by lowest amount of annual rainfall (593,7 mm). The system of production has not shown significant difference in height of plants. Comparing the general averages of oats plant height in both systems of production, we can say that in the organic system of production the height of the plants (114,4 cm) is higher absolutely by 2.2 or relative by 2.0% than the height of the plants in conventional production (112,2 cm).

- Populations that have loose panicle are characterized with higher length of the panicle. Such populations are Krivogastani and Radolishta which showed the highest length of the panicle in both systems of production (Krivogastani – 29,8 cm and 30,9 cm and Radolishta – 30,1 cm and 29,1 cm). Applied agrotechnic showed no effect on the length of the panicle.

- Comparing the general averages of the oats grain yield by panicle in both systems of production, we can say that the oats grain yield by panicle in conditions of organic production (3, 30 g) is higher absolutely by 0,30 g or relatively by 9.1% than oats grain yield by panicle in conditions of conventional production (3,0 g). The best genotype to obtain a high grain yield by panicle is the variety *Lovcen*, which in the system of organic production has achieved an average grain yield by panicle of 3,75 g, and in the conventional system of production 3, 40 g.

- The highest percentage of glumes in both systems of production was obtained in 2006. Factor that influenced the higher percentage of glumes is the amount of rainfall in 2006 (632,9 mm). The way of cultivation did not influence significantly on the percentage of the glumes. The best genotype of the tested varieties and populations to obtain a high randman of pure grain, or a grain with a smaller percentage of glumes is variety *Rajac*, which in the system of organic production achieved an average percentage glumes of 20,3 and in the conventional system of production 20,4.

- Organic production - a good way for production of oats with the purpose of processing for human nutrition.



## Karakteristike pojedinih makedonskih i uveženih genotipova ovsa gajenih u organskoj i konvencionalnoj proizvodnji

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### Rezime

U periodu 2005-2007. godine sprovedena su ispitivanja sa pet populacija (Krivogaštani, Trebeništa, Radolišta, Bugarija i Kučevište) i tri sorte ovsa (Rajac, Slavuj i Lovćen). Ogledi su postavljeni u uslovima organske i konvencionalne proizvodnje.

Osnovni cilj ovog istraživanja je bio da se utvrdi razlika u nekim morfološkim karakteristikama testiranih genotipova, koje direktno ili indirektno utiču na prinos, a takođe, da se utvrdi razlika koja je iskrsla kao rezultat različitih sistema proizvodnje (konvencionalna i organska proizvodnja).

Prosečna visina biljke ovsa gajena u organskoj proizvodnji (114,4 cm) je veća apsolutno za 2,2, cm, ili relativno za 2,0% od visine biljke ovsa gajene u konvencionalnoj proizvodnji.

Sistem proizvodnje nije pokazao nikakvog uticaja na dužinu metlice.

Prinos zrna ovsa po metlici u organskoj proizvodnji (3,30 g) je bio veći apsolutno za 0,3 g ili relativno za 9,1% u odnosu na prinos zrna ovsa po metlici u organskoj proizvodnji (3,0 g)

Sistem proizvodnje nije značajno uticao ni na procenat plevice. U oba sistema proizvodnje najmanji procenat plevice dala je sorta Rajac.

Sistem organske proizvodnje je dobar način proizvodnje ovsa, namenjen za obradu za ljudsku ishranu.

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