ANALYSIS OF THE QUALITY OF OATS (*AVENA SATIVA* L.) GROWN IN CONDITIONS OF ORGANIC PRODUCTION

Dragica Spasova[1], Adrijana Burovska[1], Biljana Atanasova[1], Dusan Spasov[1], Mite Ilievski[1]

Abstract

During 2015 and 2016 the research of 11 oats genotypes is conducted, in conditions of organic production. Three of the oats genotypes are domestic populations, *Krivogastani*, *Trebenista* and *Kuceviste*, and the others are introduced varieties: *Rajac*, *Slavuj* and *Lovken* from Serbia, *Kupa*, *Baranja*, *Eksplore*r, *Sampionka* and *Istra* from Croatia. The phenological surveys, during the research showed that the vegetation period of the spring oat genotypes, grown in condition of organic production, is 100 – 110 days. The oats was sown in March, and the full maturity was reached in July, in each year of the research. In both years of research, the highest absolute mass of the grain had variety *Istra* (34,60 g in 2015 and 29,60 in 2016), while, the lowest had the population *Krivogastani* (12,3 g in 2015 and 14,90 g in 2016). There are very significant statistical differences between the varieties. The hectoliter mass of the grain is statistically different in different varieties, in the both years of the research. *Rajac* variety showed the lowest hectoliter mass in both experimental years (23,66 kg/hl in 2015 and 31,5kg/hl in 2016). The highest hectoliter mass in 2015 had *Istra* variety (42,05 kg/hl), and in 2016, it was *Krivogastani* population (36 kg/hl). The highest oats plants, in both years of research, were *Krivogastani* population (116,7 cm in 2015 and 143,3 cm in 2016). The lowest plants were *Kupa* variety (78,3 cm in 2015 and 83,4 cm in 2016). The comparison between varieties showed that there are statistically significant differences.

Key words: Oats, organic production, absolute mass, hectoliter mass, height.

Introduction

The oats (*Avena sativa* L.) originates from the Middle East. During the Bronze Age (1500 – 1700 BC) the oats was introduced in the colder and more humid parts of Europe and is therefore considered as "European wheat". It is thought that oats originates mainly from two species: the wild oats (*Avena fatua* L.) and the red wild oats (*Avena sterilis* L) (Suttie, 2000)**.**

In the past it was used for production of bread, but with increasing the standards the oats began to be used for food production (oat flakes, flour, cereals, muesli). Acording to (Vasilcenko et al. 1985)*, (*Panajotova et al. 2003) *and (*Savova et al. 2005)*,* one of the most quality features of oats, that makes it important raw material in the food industry,

[1]"Goce Delcev" University, Faculty of Agriculture, Stip – Republic of Macedonia
biljana.atanasova@ugd.edu.mk, dragica.spasova@ugd.edu.mk

is the high protein content and the high absolute mass. The quality of the grain and the modest demands for cultivation give the oats special importance.

Compared to other cereals the oats contain up to three times more fat, and the protein are significantly digestible. The absolute and the hectoliter mass are in medium positive dependencies with the proteins, but in much stronger positive dependencies with the β glutens (Popov et al., 2009). The hectoliter mass is the basic physical indicator for determining the quality of the grain, which depends on the ratio between the essential substances that build grain (carbohydrates, proteins and fats), the absolute mass, the size and the fulfillment of the grain. It serves as indicator for the potential yields and quality or, the output of the flour (Zorovski et al., 2014).

Today, the great number of modern diseases is treated with healthy food. The organic production excludes the use of chemical means and allows protection of the plants only with natural resources. Studies of certain oats varieties in terms of organic farming, which committed (Galie et al. 2004), showed that oats is very suitable for organic production, taking into account the high yields he got, which ranged from 4 to 5 t/ha. Similar results got (Konstantinos, 2007), which cultivated new varieties of barley and oats in terms of organic production, which showed great stability in yield, good productivity and resistance to disease.

On the other hand, the development of farming and livestock production conditioned increasing of areas under crops, including oats. In the research of (Ilievski et al. 2015), it is concluded that the total production of oats in 2014 increased for 2 135 tons or 54.7%, compared with 2012.

Taking the above in mind, the goal of our research was to determine some important morphological and physical properties of oats grown in organic production, as well as the differences between the tested varieties and populations. The analysis will also determine which one is most suitable for growing in organic production in the Strumica region, i.e. which variety or population will guarantee high quality.

Material and methods

The research for organic production of oats began in 2015 and end up in 2016. The trials were conducted in field and laboratory conditions. The field trials were set on the experimental field of the"Goce Delchev" – University, Faculty of Agriculture – Strumica, and laboratory tests were conducted in the laboratories of the Faculty of Agriculture in Stip.

11 oats genotypes were analyzed, from which three were domestic populations (*Krivogastani, Trebenista* and *Kuceviste*), and the others are introduced varieties: *Rajac*, *Slavuj* and *Lovken* from Serbia, *Kupa*, *Baranja*, *Eksplore*r, *Sampionka* and *Istra* from Croatia.

The experiments, in both years of the research, were set in three repetitions, deployed by the method of random block system, with dimension of basic plot of 5 m^2.

The distance between the variants was 0,50 m, and between repetitions – 1,0 m. The distance between rows was 20 cm. The sowing rate was 550 grains per 1m^2, i.e. 5.5 million grains per 1ha. The preparation of the soil, in both years of the research was identical. The autumn basic processing of the soil was at a depth of 35 cm. Then, there

was additional processing and fertilization with 30 t/ha bio-fertilizer, according to the regulations for organic production. The sowing, in both years of the research was performed during March (23.03.2015 and 28.03.2016). Sowing was performed manually, in rows, at a depth of 5-6 cm. The harvest was in July (03.07.2015 and 07.07.2016). Before harvest, material from 1 m^2 was taken from each parcel, for laboratory tests (absolute and hectoliter mass of the grain, by the international methods of ISTA).

During vegetation the most important growing stages were monitored: emergence, tillering, booting, tasseling and maturity, by the method of Cooperman (1955).

Also, before harvest, the height of 10 plants from each parcel (30 plants of each variant) was measured.

The results were processed by analysis of variance method, and the differences were tested on LSD – test.

Results and discussion

1. Vegetative growing – phenological observations

The vegetative growth of oats goes through more stages, in which, the formation and growth of certain vegetative parts occur. Duration of the individual growing stages of oats depends on a number of factors: oats variety, soil fertility, climate and agrotechnique.

In our trials, the following growing stages were registered: emergence, tillering, booting, tasseling and maturity. The results are shown in Table 1.

From the results in the Table 1, could be seen that the sawing of oats in 2015 was made earlier compared with 2016. The reason was frequent rainfall that in turn allowed moist medium for the seed and immediate germination. The yield of oats grain is the most important quantitative feature of oats controlled by the influence of a number of genes with less individual impact, to whose expression largely affects external factors i.e. the term of sowing (Jukic et al., 2011). The period from sowing to emerging, in both years of the trials and all the tested variants, was 10 or 11 days and is coincided with the results of the surveys of (Spasova et al.2013), in which she examines the impact of the farming systems on the vegetative growth and reproductive development of oats.

The tasseling phenophase, in both years of the trials, began in the first half of June. From the results in the Table 1 could be noticed that variety *Istra*, both in 2015 and 2016, began the earliest this phenophase, i.e. 01.06. In 2015, the phenophase tasseling began with in a period of 8 days, at all examined variants, while in 2016, for the same phenophase it took 15 days.

All 11 variants, the full maturity phenophase reached at the end of June, or in the beginning of July, within a period of 2 – 3 days. In 2015 three of the variants reached the full maturity stage on 31. 06., while in 2016, the first signs of this phenophase are registered on 04.07. Up to 02.07. 2015 and 07.07.2016 all the variants have reached the full maturity. The yield, in the first year of examination was made on 03.07., and in 2016, on 07.07., i.e. when there were optimal conditions. Genotypes features and the climatic conditions, especially temperature and the humidity of the air, largely affect on the time of occurrence and duration of the vegetative stages.

Table 1. Phenological observations of oats per year in organic production

Variety / Population	Phenophases				
	Date of sowing	Date of emergency	Date of tasseling	Date of maturity	Date of harvest
2015					
Krivogastani	23.03	03.04	05.06	30.06	03.07
Trebenista	23.03	03.04	06.06	02.07	03.07
Kuceviste	23.03	03.04	08.06	02.07	03.07
Rajac	23.03	03.04	05.06	02.07	03.07
Slavuj	23.03	03.04	07.06	01.07	03.07
Lovken	23.03	03.04	07.06	30.06	03.07
Kupa	23.03	03.04	02.06	02.07	03.07
Baranja	23.03	03.04	05.06	01.07	03.07
Eksplorer	23.03	03.04	04.06	02.07	03.07
Sampionka	23.03	03.04	08.06	02.07	03.07
Istra	23.03	03.04	01.06	30.06	03.07
2016					
Krivogastani	28.03	07.04	15.06	07.07	07.07
Trebenista	28.03	07.04	08.06	04.07	07.07
Kuceviste	28.03	07.04	15.06	06.07	07.07
Rajac	28.03	07.04	04.06	04.07	07.07
Slavuj	28.03	07.04	13.06	07.07	07.07
Lovken	28.03	07.04	14.06	07.07	07.07
Kupa	28.03	07.04	08.06	06.07	07.07
Baranja	28.03	07.04	13.06	06.07	07.07
Eksplorer	28.03	07.04	02.06	04.07	07.07
Sampionka	28.03	07.04	14.06	05.07	07.07
Istra	28.03	07.04	01.06	04.07	07.07

2. Physical and morphological characteristics of the oats

The absolute mass is a mass of 1000 air dry grains expressed in grams. It is characteristic of the species and variety, and it could be different at the same variety, depending on the conditions of production.

The hectoliter mass means a mass of some seed in a volume of 100 liters or a mass of a one hectoliter expressed in kilograms. The hectoliter mass is a feature of the species and the variety, but it depends of the production conditions of the seed (agrotechnique, soil and climatic conditions).

The height of the plants depends mostly on the genotype, soil and climatic conditions and used agrotechnique. The height of the oats has great impact on the lodging of the plants. The higher stem is, so is more prone to lodging. The most suitable for production are varieties with low to medium high and firm stem (Spasova, 2008). In optimal climatic conditions the differences in the plant height at the different oats genotypes are minimal (4 – 5 cm, or 7%), (Georgieva, 1995).

These three features that are measure for the quality and yield of oats grain were analyzed in our biannual research, and the results are showed in Table 2.

Table 2. Absolute mass of the grain, hectoliter mass of the grain and plants height in oats in organic production by years

Variety/Population	Absolute mass of the grain (g)	Hectoliter mass of the grain (kg/hl)	Plants height (cm)
2015			
Krivogastani	12,3	26,80	116,7
Trebenista	24,7	32,00	88,1
Kuceviste	20,1	25,80	97,8
Rajac	17,8	23,66	95,7
Slavuj	20,5	29,30	94,6
Lovken	25,6	30,80	88,1
Kupa	26,4	34,00	78,3
Baranja	24,3	34,00	94,0
Eksplorer	27,7	33,50	87,0
Sampionka	22,0	34,40	90,8
Istra	34,6	42,10	87,4
LSD 0,05	2,77	1,80	6,17
0,01	5,50	3,50	8,80
2016			
Krivogastani	14,9	36.00	143,3
Trebenista	19,9	33,70	101,3
Kuceviste	20,0	31,90	103,1
Rajac	23,3	31,50	107,8
Slavuj	18,5	31,70	115,3
Lovken	19,3	32,30	100,1
Kupa	22,9	34,50	83,4
Baranja	16,0	31,90	139,5
Eksplorer	19,3	32,40	100,4
Sampionka	17,6	32,80	117,6
Istra	29,6	35,60	107,5
LSD 0,05	2,65	1,41	30,30
0,01	3,78	2,01	/

The results from our biannual research of oats organic production showed that, regardless the year of examination, the highest absolute mass of the grain has variety *Istra* (34,6g in 2015 and 29,6g in 2016). The lowest absolute mass has population *Krivogastani* (12,3g in 2015 and 14,9g in 2016). There is significant statistical variation between the varieties. The studies of other researchers present increasing of the absolute mass, at different varieties (Đekić et al., 2010).

The highest hectoliter mass in oats organic production, in 2015, has variety *Istra* (42,10kg/hl), and in 2016 it was population *Krivogastani* (36 kg/hl). The lowest hectoliter mass, in both years of examination reached variety *Rajac* (23,66 kg/hl in 2015 and 31,50 kg/hl in 2016). Our results does not coincide with the results of *Спасова*

(2008), in which the variety *Rajac*, grown in conditions of organic production reached the highest average hectoliter mass (37,88 kg/hl), and population *Krivogastani* had the lowest average hectoliter mass (33,61 kg/hl).

The oats plants height (Table 2) in both years of research is statistically different at different varieties. In both years of research the highest are plants of population *Krivogastani* (116,7 cm in 2015 and 143,3 cm in 2016). The lowest height in both years of research has variety *Kupa* (78,35cm in 2015 and 83,375 cm in 2016).

The difference in the plants height, compared by years, using the same agrotechnique, at the same genotypes, is due to the variety specificity, i.e. the specificity of the genetic characteristics that possess tested varieties and population (Spasova, 2008). The results of our research coincide with the results of the respected author.

Conclusion

Based on our biannual research on some morphological and physical properties of oats, in terms of organic production the following conclusions can be drawn:

The phenological surveys in both years of the research showed that the vegetation period of the spring oats genotypes tested in organic production is 100 – 110 days.

Among the tested varieties we can mention the Croatian variety *Istra* which entered the earliest into all phenophases of growth and development.

In both years of research the highest absolute mass of the grain has variety *Istra* (34,6g in 2015 and 29,6g in 2016). The lowest absolute mass has population *Krivogastani* (12,3g in 2015 and 14,9g in 2016). Consequently, we can expect that variety *Istra* to achieve the highest yield and quality.

The lowest hectoliter mass, in both years of examination reached variety *Rajac* (23,66 kg/hl in 2015 and 31,50 kg/hl in 2016). The highest hectoliter mass in oats organic production, in 2015, has variety *Istra* (42,10kg/hl), and in 2016 it was population *Krivogastani* (36 kg/hl).

In both years of research the highest are plants of population *Krivogastani* (116,7 cm in 2015 and 143,3 cm in 2016). The lowest height in both years of research has variety *Kupa* (78,35cm in 2015 and 83,375 cm in 2016). Compared between varieties, there are statistically significant differences.

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