PRODUCTIVITY AND QUALITATIVE INDICES OF GRAIN OF WINTER OATS, GROWN UNDER CONDITIONS OF ORGANIC AGRICULTURE

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Abstract
The investigation took place during 2006 – 2009 at the experimental field of the Institute of Agriculture and Seed Science "Obraztsov chiflik" – Rousse, with 4-pole ecological crop rotation and alternation soy-bean – wheat – beans – winter oats, under conditions of biological agriculture. The oats were RS2 variety, and the predecessor - field bean Obraztsov chiflik 12 variety.
The experiment was started after the block method in two variants – control (without fertilization) and leaf fertilization by humous fertilizer Humustim in 4 replications and the harvesting plot being 52,5 m^2. Technological schemes, according the requirements of the biological agriculture were applied during the crops growing in crop rotation.
Data analysis showed that the grain yield obtained from winter oats average for the period, in the variant without fertilization was 2400 kg/ha with variation from 710 kg/ha in 2006 to 3760 kg/ha in 2009. The leaf fertilization by humous fertilizer Humustim had a positive influence on yield, as the effect average for the period was 16% and varied, depending on the meteorological conditions in years. The yield obtained from oats, grown under conditions of organic agriculture, reported average for the period of the investigation was low and formed 48% in the variant without fertilization and 55% in leaf fertilization from the potential abilities of the variety.
The qualitative indices of the grain, formed under conditions of biological agriculture were determined. The grain obtained was ecologically pure and could be involved as a component in combined forage mixtures for feed of animals, bred under biological conditions and for production of dietetic human foods – oat flakes, semolina, etc.

Keywords: oats, productivity, qualitative indices, organic agriculture

1. INTRODUCTION

The oats grain is a valuable forage crop. In Bulgaria, it is grown primarily for grain, which has versatile use, because its high nutritional value. The rich content of protein, fat, assimilated minerals and vitamins, especially B group in oat grains make it particularly suitable as feed for young growing animals and as human food in the form of oats kernel, semolina and as a substitute for coffee. Over the past three years (2006-2008), the oats are grown on about 25 000 ha [2].
In the modern conventional farming the application of high chemicization (increased production and use of synthetic fertilizers and pesticides) has led to pollution of the soil and disturbance of biological balance in agro-ecosystems [1].
As a response to negative consequences of intensive agricultural production, was launched on a qualitatively new approach - a transition to organic farming. The organic farming as a system for production, excluding the use of synthetic compounds - chemical fertilizers and pesticides. It relies on the maximum degree of implementation of appropriate crop rotation, organic fertilizers, agro-technical and biological pest control. Experience of scientific and agricultural practices is considered that the rotations is a fundamental prerequisite for the functioning of organic farming as with a decisive significance are leguminous crops that are grown as the main or second crop [6], [1], [8]. Applying the principles of organic farming requires modification of the conventional technologies used so far.
The technology for organic cereal production found increasing application in many countries, such as studies are aimed at increasing production and improving product quality [10], [11], [12].
In our country the research on organic production of oats are in early stage. There are no scientific development and technologies,

which are tested productive capacity of the culture and quality of the grain.
In this connection the purpose of this study was to establish productivity and quality of grain of oats variety winter "RS-2", grown in conditions of organic farming in the region of northeastern Bulgaria.

2. MATERIAL AND METHOD

The investigation was conducted during 2006-2009 in the experimental field of the Institute of Agriculture and Seed Sciences "Obraztsov chiflik" - Rousse, with 4 - field ecological crop rotation and soybean rotation - wheat - beans, winter oats under conditions of organic farming. Oats are used in variety RS - 2 with predecessor dry bean variety Obraztsov chiflik 12.
The type of soil where the trial was started was strongly leached humus and was characterized with low humus content – 1,75 %, low provided with N (19,83 mg/1000 g soil) and variable P_2O_5 (5,6 mg/100 g soil) and well supplied with K2O (27,35 mg/100 g soil) in the layer 0-40 cm. The soil reaction is medium acid (pH in KCL – 5, 0 %).
The experiment is set in the block method in two variants - control (without fertilization) and leaf fertilization by humous manure "Humustim" in 4 iterations and size of the harvesting plot 52, 5 m^2.
In crops growing in rotations are applied technological schemes, according to the requirements of Regulation № 22 of 04.07.2001 [7] Ministry of Agriculture and Food concerning the biological production of lants, plant products and foods of plant origin.
The weeds control in oats cultivation was mechanically as two drags was made in preparation for sowing and one hand weeding during the vegetation. The leaf fertilization by humous manure "Humustim" was applied in the phases beginning of stalk shooting and beginning of mature milk at a dose 40 ml / da for one spraying. The used humous fertilizer is environmentally friendly organic product and do not contains chemical forms of nutrients. The liquid formulation of the fertilizer contains 58.95 % organic matter, of which 7.83 % potassium, 3 % nitrogen, 1.14 % phosphorus, humic acids - 23.40 %, and all microelements for plants in optimal quantities. It has an alkaline reaction with pH-9 [4].

For characterization of the meteorological conditions, data about precipitation and average monthly air temperatures registered at the meteorological station at the territory of the Institute were used.
The quality indices of the grain - crude protein, fat, density and time of boiling are established in the laboratory of the Institute, based on methodologies, registered under Bulgarian State Standard / ISO /.

3. RESULTS AND DISCUSSION

The period of study covers the years with different meteorological conditions Table 1.

Table 1. Weather conditions during the egetation period of winter oats RS 2 for the period 2 006-2009

Economic year	Rainfall amounts , mm					Average monthly air temperature, °C		
	X-VI	X-III	IV	V	VI	IV	V	VI
2005/2006	391	276	38,7	15,9	60,4	12,6	17,2	20,5
2006/2007	277	199	4,6	54,2	18,7	11,9	19,2	23,5
2007/2008	493	364	51,6	58,0	19,4	12,8	16,6	21,6
2008/2009	334	221	8,0	29,8	74,4	12,5	18,2	20,9
Average for the period 1961-2008	425	233	53	64	66	11,5	16,8	20,4

The rainfall sums totally for vegetation period (October - June) of oats are in the range of 277 mm/m2 for the economic year 2006/2007 to 493 mm/m^2 for 2007/2008 in the climatic norm 425 mm/m^2 average for long term (1961-2008 year). With close to values of rainfall to climatic rate are feature economics years 2005/2006 and 2008/2009, and 16.0 % higher in 2007/2008.

Unfavorable for growth and development of oats during the period of study were economics, the 2005/2006 and 2006/2007, the first was characterized by low winter temperatures in the last ten days of January of - 10 ° C and - 19, 2 ° C and the lack of snow cover, leading to 60 – 70 % crop frost in a second, rainfall sums of vegetation period were 34.8 percent lower than the climatic norm and uneven distribution in different months.

In addition to the scanty rainfall, economic 2006/2007 years are characterized by unfavorable temperature conditions during May and June, which exceeded the climatic norm by 14.3 % and 15.2 %, and influenced negative on feed and grain filling.

These characteristics of the meteorological conditions correspond with yield data shown in Table 2.

From the data shows that the resulting yield of oat in variants without fertilization (at conditions of natural cultivation), average for the period is 2400 kg / ha with a variation of 710 kg / ha in 2006 year to 3760 kg / ha in 2009 year.

The leaf fertilization by humous manure "Humustim" had a positive impact on the yields, as the effect average for the period is16% and is different in depending of the years conditions. In terms favorable weather in 2008 and 2009 the increase of yield compared to the control is by 840 kg / ha and 310 kg / ha i.e. 23 % and 8 %. In the negative 2006 and 2007 year despite that is a lower yield is obtained, the effect of leaf fertilization is also positive, as increasing the yield is respectively 24 and 9 %. In confirmation of the positive effects of leaf fertilization on the yield are data from analysis of variance, showing a differences in reliability, P = 0.95.

Harvested from oats grown in conditions of organic agriculture accounted on average for the period are low and constitute about 48 % in controls and 55 % in leaf fertilization of the potential of the variety used. This is permissible because of the literary sources [9]; [1] it is known that during the first three - four years after the introduction of organic production to receive - low yields, because it establishes a new system of farming and biological processes require time to be in balance.

Under the influence of weather conditions during the years of study and application of technological scheme of oat cultivation in organic farming, extent yields are amended and the quality of the grain Table 3.

Table 2. Yields of grain from winter oat variety, RS 2, under conditions of organic farming for the period 2006-2009

Year	Yield, kg/ha		Relative yield,%	Differen-ces, kg/ha	Significant, $GD_{5\%}$	
	Control	Leaf fertilization with Humustim			kg/ha	%
2006	710	880	124	170	161,70	22,77
2007	1520	1660	109	140	69,60	4,57
2008	3590	4430	123	840	52,12	14,51
2009	3760	4070	108	310	21,64	5,75
Average for the period	2400	2760	116	370	35,74	14,89

It is known from studies of individual authors [3] that the crude protein content in oat grains can vary from 9 to 22 % depending on variety, soil reserves and applied agrotechnology as a dominant importance of nitrogen fertilization.
From the data for crude protein content of grain can be seen that the average period for the control /at conditions of natural cultivation /, it is 10.04 %, while in leaf fertilization is 11.24 % i.e. the increase is 1,20 points. Depending of the conditions of the years, the content of crude protein is with the lowest values in 2007 and in two, variants, because of high temperatures recorded during the formation and grain filling, leading to the receipt of malnourished and shriveled seeds. In the remaining years of the crude protein values are close.

Tagged values of crude protein in grain of oats, grown in conditions of organic farming can be defined as low, probably due to the shortage of nitrogen in soil type strongly-leached black earth and the absence of mineral fertilization. Average fat content in the control period was 5.34 percent, while in leaf fertilization was 5.54 % i.e. a minor increase. They are generally less affected.
Other indicators, time of boiling, coefficient of water absorption are in - higher values, according to the known literature data. At the present stage in our country there is no still accepted standard.

The resulting grain is clean and can be included as a component in compound feed, fed to animals and organic production of foods for people - oatmeal, semolina, and etc.

Table 3. Parameters of the quality of grain from winter oat variety RS 2 in terms of organic farming for the period 2006-2009

Years	Variants	Qualitative indicators of oats				
		Crude protein,%	Fats, %	Chaff, %	Density, g/cm^3	Boiling time ,min
2006	Control (without fertilization)	10,90	5,10	28,9	1,19	37
	Leaf fertilization with Humustim	12,15	5,25	27,8	1,23	36
2007	Control (without fertilization)	8,90	5,70	30,9	1,18	31
	Leaf fertilization with Humustim	10,58	5,76	28,5	1,18	28
2008	Control (without fertilization)	10,61	5,32	28,5	1,21	36
	Leaf fertilization with Humustim	11,40	5,80	27,6	1,22	33
2009	Control (without fertilization)	9,75	5,25	30,3	1,18	42
	Leaf fertilization with Humustim	10,82	5,34	27,0	1,20	39
Average for the period	Control (without fertilization)	10,04	5,34	29,7	1,19	37
	Leaf fertilization with Humustim	11,24	5,54	27,7	1,21	35

4. CONCLUSIONS

The survey results show that the harvested yield of grain from wintering oats in variants without fertilization (at conditions of natural cultivation), average for the period is 2400 kg / ha with a variation of 710 kg / ha in 2006 to 3760 kg / ha in 2009 year.

The leaf fertilization with humous manure "Humustim" had a positive impact on yields, as the effect average for period is 16% and is varies depending of the whether condition in the investigated years.

Harvested yields from oats, grown in conditions of organic agriculture, accounted average for the study period are low and constitute about 48 % in controls and 55 % in leaf fertilization of the potential of the variety used.

Crude protein content in grain of oats, grown in conditions of organic agriculture is low, probably due to a deficiency of nitrogen in soil type strongly-leached black earth and the absence of mineral fertilization.

The resulting grain is clean and can be included as a component in compound feed, fed to animals and organic production of foods for people - oatmeal, semolina, etc.

5. REFERENCES

[1] Каров Ст., В. Попов, Пл. Параскевов, Ел. Благоева.1999. Преход към биологично земеделие. ВСИ Пловдив, 81-83.

[2] Кирилов, Ат. 2005. Овеса като фуражна култура – състояние и перспективи. Животновъдство, 2:23-25.

[3] Койнов, Г. 1979. Белтъчният проблем и растениевъдството. Овес. Земиздат, София, 121-126.

[4] Малинова Р. 2004. Хумустим и неговото значение за селскостопанското производство. „Агроспейс"ООД, Велинград, Агро BG селскостопански портал. http://agrobg.test.antipodes.bg/

[5] Министерство на земеделието и храните. 2009. Дирекция„ Агростатистика" бюлетин № 135 - 2009, http://www.mzh.government.bg

[6] Митова Т. 1998. Сеитбообращението и неговата роля в екологичното и устойчиво земеделие. Селскостопанска наука, 3, 67-89.

[7] Наредба № 22 от 4 юли 2001 за биологичното производство на растения, растителни продукти и храни от растителен произход и неговото означаване върху тях, Обн. ДВ бр. 68 от 3 август 2001 г., изм. ДВ, бр. 13 от 10 февруари 2006 г.

[8] Станчева Й., К. Костов. 2003. Основни видове екологични системи за земеделско производство. Екологичната земеделска ферма, Издателска къща при ЛТУ, София, 10-16.

[9] Стойнев К. 2004. Екологични и технологични аспекти на съвременното земеделие. София, 17-27.

[10] Coppola, F., Haugaard-Nielsen and all. Sustainability assessment of wheat production using Emergy. Poster presented at Cultivating the Future Based on Science: 2nd Conference of the International Society of Organic Agriculture Research ISOFAR, Modena, Italy, June 18-20, 2008.

[11] Fahong W., Zhonghu He and all. Wheat cropping systems and technologies in China, journal Field Crops Research, 2009.pp. 181–188,

[12] Fontaine L., Rolland B. and all. Contribution to organic breeding programmes of wheat variety testing in organic farming in France. Poster presented at Cultivating the Future Based on Science: 2nd Conference of the International Society of Organic Agriculture Research ISOFAR, Modena, Italy, June 18-20, 2008.