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PARTICIPATION OF ELEMENTS OF CROPPING IN THE FORMING OF THE CROP OF GLUMIFEROUS OATS GROWN USING TRADITIONAL AND ORGANIC SYSTEMS

Summary

A one factor field experiment was carried out under the Beskid Niski mountain conditions in order to determine the impact level of yielding components on differences in yields of glumiferous oats cultivated in a traditional and organic system. The obtained results showed that the number of panicles had the greatest impact on differences in grain yields of oats grown using the two studied systems. The impact of this element was 61.4%, which was almost three times greater than that of the mass of a thousand grains. Of all the components of grain yield structure, the quantity of grains in a wisp had the lowest impact on the decrease in the grain yield of oats cultivated in the organic system compared to the traditional system; this impact was 18.2%. An average grain yield of oats grown in the organic system was ca. 10% lower than that of oats grown in the traditional system.
***Key words**: components of yield, oats, organic farming, and traditional farming*

UDZIAŁ ELEMENTÓW PLONOWANIA W KSZTAŁTOWANIU PLONU OWSA OPLEWIONEGO UPRAWIANEGO W SYSTEMIE KONWENCJONALNYM I EKOLOGICZNYM

Streszczenie

W jednoczynnikowym doświadczeniu polowym przeprowadzonym w warunkach górskich Beskidu Niskiego badano udział elementów plonowania w kształtowaniu plonu owsa oplewionego wysiewanego w systemie konwencjonalnym i ekologicznym. W wyniku badań stwierdzono, iż największy wpływ na różnice w plonie ziarna owsa oplewionego uprawianego w badanych systemach rolniczych miała liczba wiech na powierzchni 1 m^2. Oddziaływanie tej cechy wynosiło 61,4% i było blisko trzykrotnie większe niż masy tysiąca ziaren. Udział liczby ziaren w wiesze w zmniejszeniu plonu ziarna owsa uprawianego w systemie ekologicznym w stosunku do konwencjonalnego był najmniejszy ze wszystkich elementów struktury plonu ziarna i wynosił 18,2%. Średni plon ziarna owsa uprawianego w warunkach górskich w systemie ekologicznym w porównaniu do systemu konwencjonalnego był mniejszy o ok. 10%.
***Słowa kluczowe**: elementy plonowania, owies, rolnictwo ekologiczne, rolnictwo konwencjonalne*

1. Introduction

The acreage of glumiferous oats is small because the grains are of very little use in poultry and livestock feed and because its yielding level is much lower compared to other grain crops [6]. On the other hand, growing oats is still popular in the mountain and hilly regions for those regions are especially suitable for this species [5, 15]. The diversified environmental and agro-technical conditions in those regions affect the variability of components of the structure of yield [7]. In the reference literature available, there are no publications containing information referring to the impact of farming system on the diversification of values of components of the oats yield structure. In the traditional farming system, the key components to modify those values are mineral fertilization, plant protection, dates of sowing, weather and its changes, and properties of a given cultivar.

For the purpose of this project, it can be assumed that the grain yield of oats grown in the organic farming system that does not use any artificially synthesized fertilizer nor pesticides will be lower than that in a traditional farming system. The number of panicles per 1 m^2 can have the greatest impact on the differences in the yield of oats grains.

The objective of the research study was to determine the impact level, in terms of percentage, of grain yield of oats grown according to the principles of traditional and organic farming.

2. Material and methods

The subject of the research study was a one factor field experiment carried out at the Mountain Experimental Station owned by the Department of the Agro-technology and Agricultural Ecology, situated in Czyrna near the town of Krynica Górska. The experiment was carried on over a period between 2008 and 2011. The Station is located in the south-western part of the Beskid Niski Mountain Range, its altitude is 545 m a.s.l.

The experiment was 4 times repeated. The surface area of one crop field to be harvested was 22 m^2, thereon glumiferous oats of the Borowiak cultivar were grown; the amount of oats seeds sown was 220 kg · ha^{-1} (650 sprouting seeds per 1 m^2). The experimental field consisted of a brown soil made up of flysh rock waste; the soil was from a granulometric group of medium, skeletal clays and it was classified into the 12th oats-potato-mountain complex of agricultural soils and into the 5th class of soil quality class. Usually, oats seeds were sown at the beginning of the second half of April, and, then, harvested in the second decade of August. The oats sown were cultivated using the following sequence of rotation crops: 1. potatoes in a soil enriched

Table 1. Monthly precipitation totals [mm]
Tab. 1. Miesięczne sumy opadów atmosferycznych [mm]

Lata *Years*	Miesiąc / *Month*												IV-VIII	I-XII
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
	Opady / *Precipitation* [mm]													
2008	43,1	25,4	95,2	46,8	40,3	39,7	185,1	60,6	124,0	68,5	60,9	68,0	372,5	857,6
2009	38,6	54,5	77,8	15,5	123,7	135,3	96,2	66,4	69,7	50,3	42,8	51,3	437,1	822,1
2010	31,9	33,3	26,9	65,8	234,2	226,6	131,6	144,5	172,1	28,4	30,1	45,3	802,7	1170,7
2011	36,7	15,1	27,6	106,3	72,1	44,4	278,4	85,6	15,9	34,0	1,1	15,0	586,8	732,2
1961-1990	58	47	48	62	85	105	115	98	79	56	44	51	465	848

Source: Own work / Źródło: opracowanie własne

Table 2. Grain yield (t · ha^{-1}) and yielding components of oats grown in traditional and organic systems
Tab. 2. Plon ziarna (t · ha^{-1}) oraz elementy struktury plonu owsa uprawianego w systemie konwencjonalnym i ekologicznym

Specification *Wyszczególnienie*	Farming system *System rolniczy*		Averagely *Średnio*
	Traditional *Konwencjonalny*	Organic *Ekologiczny*	
Grains yield (t · ha^{-1}) / *Plon ziarna (t · ha^{-1})* /			
2008	3,59	3,19	3,39
2009	3,55	3,12	3,33
2010	3,19	3,03	3,11
2011	3,89	3,52	3,70
Mean / *Średnio*	3,55	3,21	3,38
NIR /*LSD* $_{0,05}$	0,184		0,386
NIR /*LSD* $_{0,05}$ for combined effect / *dla współdziałania*	0,401		
Number of panicles per 1 m^2 / *Liczba wiech (szt. · m^{-2})*			
2008	365,9	314,2	340,0
2009	322,4	305,9	314,1
2010	315,8	293,1	304,4
2011	436,3	337,2	386,7
Averagely / *Średnio*	360,1	312,6	336,3
NIR /*LSD* $_{0,05}$	23,51		r.n. / n.s.
NIR /*LSD* $_{0,05}$ for combined effect / *dla współdziałania*	52,13		
Number of grains per panicle / *Liczba ziaren w wiesze*			
2008	34,7	32,3	33,5
2009	34,4	32,4	33,4
2010	37,5	35,5	36,5
2011	30,2	31,8	31,0
Averagely / *Średnio*	34,2	33,0	33,6
NIR /*LSD* $_{0,05}$	1,37		2,43
NIR /*LSD* $_{0,05}$ for combined effect / *dla współdziałania*	2,54		
Mass of 1000 grains, *g* / *Masa 1000 ziaren*			
2008	33,5	29,8	31,6
2009	33,0	30,6	31,8
2010	34,7	33,4	34,0
2011	30,0	32,2	31,1
Averagely / *Średnio*	32,8	31,5	32,1
NIR /*LSD* $_{0,05}$	1,61		2,35
NIR /*LSD* $_{0,05}$ for combined effect / *dla współdziałania*	2,47		

Source: Own work / Źródło: opracowanie własne

with farmyard manure (33 t · ha^{-1} of farmyard manure); 2. oats; 3. mixture of oats and spring vetch. Where the organic farming system was used, neither artificially synthesized mineral fertilizers nor pesticides were applied. In order to reduce the growth of weeds in the field, the oats field was harrowed in spring. Where the traditional farming system was applied, fertilizers were applied; their mass was calculated based on such factors as, among other things, soil nutrient availability and forecrop [2]. Prior to the pre-winter ploughing, phosphorus (P) in the amount of 34 kg per 1 ha and potassium (K) in the amount of 55.6 kg per 1 ha were added to the soil. The total dose of nitrogen (N) equalled 72 kg per 1 ha and it was divided into two sub-doses: the one was added prior to sowing and the second during the crops growth cycle. The growth of weeds was controlled by adding 24 g of Granstar per 1 ha at the end of the tillering phase. The structure of oat grain yield was determined using 100 panicles from each single field.

The research results were statistically elaborated using the analysis of variance method. The significance of mean

Table 3. Impact of individual yielding components on differences in yield of oats grown in traditional and organic system
Tab. 3. Wpływ elementów plonowania na różnice w plonie owsa uprawianego w systemie konwencjonalnym i ekologicznym

Yield and yielding components *Plon i elementy plonowania*	Farming system *System rolniczy*		*Effects of yielding components* Efekty elementów plonowania		
	Traditional *Konwencjonalny*	Organic *Ekologiczny*	*input* wkład /		percentage value *udział* [%][1)]
			dt · ha^{-1}	%	
Grains Yield *Plon ziarna* [dt · ha^{-1}]	35,5	32,1	–	–	–
Number of panicles *Obsada wiech* szt · m^{-2}	360,1	312,6	2,09	5,9	61,4
Number of grains per panicle *Liczba ziaren w wiesze*	34,2	33,0	0,62	1,7	18,2
Mass of 1000 grains *Masa 1000 ziarniaków* [g]	32,8	31,5	0,69	2,0	20,4
Total / *Razem*	–	–	3,40	9,60	100,0

[1)] percentage level of impact on the increase in the yield by dt · ha^{-1} with the traditional farming system applied in comparison to the organic system / *udział w zwiększeniu plonu o dt · ha^{-1} w warunkach uprawy konwencjonalnej w porównaniu z ekologiczną*

Source: Own work / Źródło: opracowanie własne

differences among individual objects was tested based on the Tukey's method, at a significance level of p = 0.05. The per cent impact level of yielding components on the changes in the oat yield was determined based on the methodology developed by Rudnicki [10].

A mean annual air temperature for the period of several years is 6.1°C and the vegetation period comprises 179 days. Considering the assumptions made and developed by Kaczorowska [3] and the monthly precipitation totals, the vegetation period in the 2008 year can be described as a dry period, in 2009 as an ordinary period, in 2010 as a very wet period, and in 2011 as a wet period (Tab. 1). When based on the criteria elaborated by Klima and Pisulewska [4], it is possible to say that the precipitation distribution during the ongoing experiment that was the most favourable for oats was in 2011.

3. Results and Discussion

The yield of oats grown in the organic system was, on average, 10% lower that that in the traditional system (Tab. 2). In the reference literature available, there are also research results showing an average reduction of 30% in the crops yield obtained for the organic system [11, 12]. From the experiment under this research study, a smaller difference was reported; this could be attributed, among other things, to generally low yields of oat grains obtained using either of the farming systems. Another reason of the only slight difference in the yields of oat grains obtained using the two farming systems could be a good forecrop (potatoes in the soil enriched with farmyard manure). The highest yield was obtained in 2011. This fact could be explained by a favourable distribution of precipitation that was optimal for oats according to the suggestion by Witkowicz and Pisulewska [17]. Based on the final combined effort of the factors present in a given year and the farming systems applied (Tab. 2), it can be concluded that the greatest differences in the yield, amount of panicles on the field and number of grains in one wisp occurred in 2009. It is quite probable that one of the reasons thereof was that the month of April in 2009 was very dry; this fact could cause the sprouting and the emergence of seedlings to be worse.

The data shown in Tab. 2 and 3 proved that the applied mineral fertilization and pesticides impacted most of all on the increase in the quantity of panicles. This particular component of the yield structure had the greatest percentage level of impact, which was almost 62% (Tab. 3), on differences in the grains yields under the two farming systems used. There are many publications to report the significant impact of fertilization on the increase in the number of ears and panicles of various cereals [1, 9, 13, 14]. The mass of 1000 grains component had a lower percentage level of impact, which was 20.4%. The grain filling degree is shaped during maturation. According to Wierzbicka-Kukułowa and Król [16], as well as to Zając et al. [18], in the foothill regions, this degree depends on the changing weather conditions rather than on the fertilization used, for, in the case of drought or the lodging during maturation, the application of mineral fertilizers prior to sowing does not exert any crucial impact on the grain filling.

In the present research, the quantity of grains in panicle had the lowest impact on differences in grain yield between the two farming systems. This fact could result from, among other things, later sowing. Noworolnik [8] accentuates this cause; according to this author, the number of grains in one panicle depends, to a large degree, on how early seeds are sown.

4. Conclusions

1. The number of panicles had the largest impact on differences in the grain yield of glumiferous oats grown in the traditional and organic farming systems. The effect of this component of the yield structure was almost three times higher than the effect exerted by the mass of 1000 grains component.
2. Of all the yield components, the impact of the component "number of grains in one panicle" on the decrease in the grain yield of oats cultivated in the organic system was the lowest and amounted, in terms of percentage, to 18.2%.
3. Compared to the traditional farming system, in the organic system of farming applied, the average decrease in the grain yield of oats grown under the mountain conditions was 10%.

5. References

[1] Gąsiorowski H. 1995. Owies. Chemia i technologia. PWRiL. Poznań.
[2] Gorlach E. 2003. Przewodnik do ćwiczeń z chemii rolnej. Wyd. AR w Krakowie; 1-162.

[3] Kaczorowska Z. 1962. Opady w Polsce w przekroju wieloletnim. Prace Geogr. IG PAN; 1-107.
[4] Klima K. Pisulewska E. 2004. Reakcja owsa oplewionego i nieoplewionego na warunki opadowo-termiczne w terenach górskich. Acta Agroph., 3(2); 271-280.
[5] Kopeć M., Noworolnik A. 1999. Fizykochemiczne właściwości gleb terenów podgórskich warunkujące uprawę owsa. Zesz. Nauk. AR w Krakowie, nr 349. Sesja Naukowa z. 64; 211-218.
[6] Kuś J., Smagacz J., Kamińska M. 2000. Regenerujące oddziaływanie owsa w warunkach długotrwałego stosowania płodozmianów zbożowych. Zesz. Problemowe Postępów Nauk Rolniczych, z. 470; 99-106.
[7] Mikoska P. 1990. Vynosove prvky u jarniho ovsa. Rostl. Vyroba, 36 (6); 627-636.
[8] Noworolnik K. 1994. Plonowanie mieszanek oraz czystych siewów jęczmienia jarego i owsa w zależności od terminu siewu. Fragm. Agron. XI, 4 (44); 67-72.
[9] Pisulewska E., Witkowicz R., Kidacka A.: 2010. Plon, komponenty składowe plonu oraz celność ziarna wybranych odmian owsa siewnego. Żywność. Nauka. Technologia. Jakość., nr 3(70); 117-126.
[10] Rudnicki F.: 2000. Wyznaczanie wpływu poszczególnych elementów plonowania na różnice plonów między obiektami doświadczalnymi. Fragm. Agron. 3 (67); 53-65.
[11] Skórnicki H.: 2007. Wyniki ekonomiczno-produkcyjne w wybranych gospodarstwach ekologicznych w latach 2005-2006. [W:] tom 4. Wybrane zagadnienia ekologiczne we współczesnym rolnictwie pod red. Z. Zbytka, Prace PIMR Poznań; 7-20.
[12] Solarska E.: 2007. Plonowanie i jakość pszenicy ozimej w zależności od systemu produkcji. [W:] tom 4. Wybrane zagadnienia ekologiczne we współczesnym rolnictwie pod red. Z. Zbytka, Prace PIMR Poznań; 21-32.
[13] Sułek A.: 2003. Wpływ dawek azotu na plon ziarna i jego komponenty u nowych odmian owsa. Biul. IHAR, 229; 125-130.
[14] Szafrański W.: 1995. Wpływ poziomu i sposobu nawożenia azotowego na plonowanie wybranych odmian jęczmienia jarego i owsa w zróżnicowanych warunkach siedliskowych Pogórza. Cz. II. Komponenty struktury plonu oraz jakość ziarna. Zesz. Nauk AR Kraków. Roln., 300, z. 32; 113-124.
[15] Tobiasz-Salach R., Bobrecka-Jamro D.: 2009. Wpływ dokarmiania dolistnego na plon i sksład chemiczny ziarna owsa. Annales UMCS, vol. LXIV, sec. E.; 19-28.
[16] Wierzbicka-Kukułowa A., Król M.: 1982. Produkcyjność owsa, jęczmienia jarego i mieszanki obydwu gatunków na glebach kompleksów górskich. Pam. Puł., 78; 189-206.
[17] Witkowicz R., Pisulewska E.: 2010. Wpływ nawożenia mineralnego i regulatorów wzrostu na transmisję promieniowania biologicznie czynnego przez łan owsa nagoziarnistego. Żywność. Nauka. Technologia. Jakość., nr 3(70); 182-189.
[18] Zając T., Oleksy A. Pinczuk G., Witkowicz R.: 2010. Porównanie plonowania i cech morfologicznych roślin owsa oplewionego uprawianego w siewie czystym i mieszanym na terenie powiatu sanockiego. Żywnośc. Nauka. Technologia. Jakość., nr 3(70); 148-159.