ISSN 1644-0625
ISSN 2300-8504 (online)
www.agricultura.acta.utp.edu.pl

Acta Sci. Pol. Agricultura, 15(2) 2016, 77-88

RESPONSE OF HULLED AND NAKED OAT TO FOLIAR FERTILIZATION

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Abstract. In agricultural practice, foliar fertilizers are applied in foliar additional plant feeding. Foliar additional feeding provides plants with nutrients in small doses which are immediately activated and uptaken by the leaves. The work presents the results of a strict field experiment set in 2009-2011 at the Didactic-Experimental Station of the University of Rzeszów in Krasne near Rzeszów. Response of naked (cultivar Cacko) and hulled (cultivar Bingo) oats grown on medium soil, good wheat complex to foliar fertilization with Bio-algeen S 90, Basfoliar 12-4-6+S, and Basfoliar 36 Extra was studied. Grain yield and chemical composition were determined, as well as canopy architecture. On the basis of the conducted research, it was demonstrated that foliar fertilizers caused an increase in oat grain yield. The highest yield was obtained after the application of Basfoliar 36 Extra and Basfoliar 12-4-6+S. Also positive effect of foliar additional feeding was found on the formation of such yield components as mass of 1000 grains and the mass and number of grains per panicle. It was demonstrated that the applied foliar fertilizers determined the decrease in protein content and increased the fat content in the grain. The most intense response occurred after the application of Bio-algeen S 90. Foliar fertilizers also diversified canopy architecture. After their application, an increase in the leaf area index (LAI) and a decrease in the mean tip angle (MTA) were demonstrated. The highest increase in LAI and decrease in MTA in both oat cultivars was found after the application of Basfoliar 36 Extra.

Key words: *Avena nuda*, *Avena sativa*, chemical composition of grain, leaf area index (LAI), mean tip angle (MTA), yield, yield components

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INTRODUCTION

Common oat (*Avena sativa* L.), due to the optimum composition of nutrients favourable for people and animal nourishment, arouses greater and greater interest in the world. At present, oat grain is first of all used as fodder, but also an increase in its use for consumption has been noted. It is anticipated that the use of oat for consumption is going to increase on the expense of lowering fodder use [Czubaszek 2006, Gambuś *et al*. 2006a, b, Gibiński and Berski 2006, Kawka and Górecka 2009, Gibiński *et al*. 2010, Kawka 2010].

Physical characteristics and chemical composition of oat grain depend on genetic and agrotechnical factors. They are diversified in hulled and naked forms. Naked oat is characterized by higher productive tillering, lower mass of panicle grain and of 1000 grains, as well as more favourable chemical composition of grain. It contains more protein and fat. On the other hand, hulled oat is characterized by higher grain yield (by circa 30%), which results from husk content in the grain, as well as contains more potassium and phosphorus in comparison with the naked forms [Pisulewska and Witkowicz 2000, Pisulewska *et al.* 2009, Gąsiorowska *et al*. 2011]. A condition for the obtainment of high grain yield is, among others, application of in-soil fertilization joint with foliar additional feeding, which is the most effective method of supplying plants with macro- and microelements [Ciepiela *et al*. 1999, Wróbel 2000].

Foliar fertilization acts almost immediately and makes it possible to obtain high effectiveness with the application of low component dose [Tobiasz-Salach and Bobrecka--Jamro 2003]. Among the currently applied foliar fertilizers, the following ones can be found: Bio-algeen S 90 (ecological fertilizer), Basfoliar 12-4-6+S, and Basfoliar 36. In literature, there is little information on the effect of those fertilizers on the yield and its characteristics, as well as canopy architecture of oat. It was assumed that naked oat cultivars, due to higher plant type would respond more strongly to the applied foliar fertilization in comparison with hulled cultivars. Therefore, study was taken up which aimed at the determination of the effect of foliar fertilizers on yield, its elements, grain chemical composition, and canopy architecture of hulled and naked oat.

Study hypothesis was assumed in the work which stated that the application of foliar fertilization would affect yield increase and chemical composition of hulled and naked oat grain and its yield-forming characteristics and would increase the assimilation area of the canopy.

MATERIAL AND METHODS

Field experiment was carried out in 2009-2011 at the Didactic-Experimental Station of the Faculty of Biology and Agriculture of the University of Rzeszów in Krasne (50°03’ N; 22°06’ E).

The experiment was set up as a split-plot design in four repetitions. The size of plots for harvest was 18 m^2. The experiment was established on good wheat complex soil. The soil was characterized by neutral pH (pH_{KCl} from 6.1 to 7.2). Assimilable element contents in the soil at the depth of 0-25 cm in $mg \cdot kg^{-1}$ were as follows: phosphorus 138.3, potassium 161.4, and magnesium 48.2. Microelement content was average and amounted to: B 1.6; Mn 149.1; Cu 4.6; Zn 8.6, and Fe 988.3 $mg \cdot kg^{-1}$.

Experimental factors (Table 1):

1) foliar fertilizers (I) applied at the following doses: control group with no foliar fertilization, Bio-algeen S90 2.0 $dm^3 \cdot ha^{-1}$, Basfoliar 12-4-6+S 10 $dm^3 \cdot ha^{-1}$, and Basfoliar 36 Extra 10 $dm^3 \cdot ha^{-1}$,
2) cultivars (II) Cacko (naked cultivar) and Bingo (hulled cultivar). Foliar fertilizers were applied twice during oat growth, namely at tillering (26 BBCH) and at the straw-shooting stage (35 BBCH) according to the recommended doses.

Table 1. Chemical composition of foliar fertilizers
Tabela 1. Skład chemiczny nawozów dolistnych

Fertilizer Nawóz	N	P_2O_5	K_2O	Mg	MgO	B	Fe	Cu	Mn	Zn	Mo
	$g \cdot kg^{-1}$										
Bio-algeen S90	0.2	0.06	0.96	0.21	–	0.016	0.0063	0.0002	0.0006	0.001	–
Basfoliar 12-4-6+S	120	40	60	–	2	0.2	0.1	0.1	0.1	0.05	0.05
Basfoliar 36 Extra	270	–	–	–	32	2	0.2	2	10	0.1	0.05

Sowing material was dressed with Baytan Universal 094 FS at the dose of 400 ml per 100 kg of grain. NPK fertilization amounted to 60 kg N in the form of ammonium nitrate 34% at two dates: before sowing 30 $kg \cdot ha^{-1}$ and 30 $kg \cdot ha^{-1}$ at tillering (21 BBCH). Phosphorus and potassium fertilization was applied in the autumn in the amounts of 35.2 $kg \cdot ha^{-1}$ P and 83 $kg \cdot ha^{-1}$ K in the form of granulated superphosphate 46% and potassium salt 60%.

Forecrop for oat was as follows: 2009 winter triticale, 2010 white mustard plant for seeds, and 2011 spring rapeseed. Oat sowing in the study years was carried out with the use of grain drill in rows every 12.5 cm in the first and second ten days of April, and plant density amounted to 550 $plants \cdot m^{-1}$. Plant protection treatments were carried out according to the recommendations by the Plant Protection Institute. During growth, in every study year, spraying was carried out with Chwastox Turbo in the amount of 2 $dm^3 \cdot ha^{-1}$, Falcon 460 EC in the amount of 0.6 $dm^3 \cdot ha^{-1}$, and Bi 58 Nowy in the amount of 0.5 $dm^3 \cdot ha^{-1}$.

During growth, at the stage of full earing (59 BBCH), measurements of oat canopy architecture were done, leaf area index (LAI) was determined, as well as mean tip angle (MTA) with the LAI – 2000 device by LI-COR, Inc.

Before harvest, from every plot, 10 representative plants were randomly uptaken in order to carry out yield structure analysis (number and mass of grains per panicle). Also, panicle density per 1 m^2 was determined.

In every growth season, oat grain harvest was done in the first ten days of August, at the stage of full grain ripeness. During harvest, grain from every plot was weighed and samples were uptaken (circa 2 kg) in order to mark grain moisture, mass of 1000 grains and grain chemical composition. Grain yield from the plots and mass of 1000 grains were given at 15% grain moisture.

Basic chemical composition of grain was determined with the following methods: total protein content with the Kjeldahl method, which was calculated on the basis of total nitrogen content and conversion factor 6.25 [PN-A-04018], crude fat with the Soxhlet method, crude fibre with the Henneberg-Stohman method with Pruszyński's modifications, crude ash by burning the material at the temperature of 600°C, and grain humidity with the dryer-weight method. Nitrogen free extract content was calculated from the differences in protein, ash, fat, and fibre contents.

The obtained results were statistically processed with the analysis of variance using the program ANALWAR – 5FR. For the evaluation of the significance of differences between the average plot values, the Tukey’s test was used at the significance level of $p = 0.05$.

Meteorological data was given on the basis of the data from ‘‘Biuletyn Agrometeorologiczny” by the Institute of Meteorology and Water Management in Warsaw, according to the records from the Meteorological Station in Jasionka near Rzeszów.

RESULTS AND DISCUSSION

Study period 2009-2011 was characterized by a changeable arrangement of temperature and precipitation (Table 2). Mean daily temperatures in the subsequent growth seasons were similar, only slightly lower temperatures were noted in April 2010. Precipitation was diversified in the study years. In 2009, precipitation sum was low during the emergence and reached the lowest level in the entire study period. Year 2010 was characterized by very abundant precipitation. In May and June, precipitation was above average, whereas in 2011 it was evenly distributed in the entire growth period, which contributed to the obtainment of the highest grain yield.

Table 2. Weather conditions during oat growth period according to the Meteorological Station in Jasionka near Rzeszów
Tabela 2. Warunki meteorologiczne w okresie wegetacji owsa według Stacji Meteorologicznej w Jasionce k. Rzeszowa

Year – Rok	Month – Miesiąc					
	March marzec	April kwiecień	May maj	June czerwiec	July lipiec	August lipiec
Temperature – Temperatura, °C						
2009	2.4	11.1	13.3	16.6	20.0	19.5
2010	2.7	8.9	14.3	17.9	20.8	19.5
2011	2.8	10.3	13.9	18.1	18.6	19.0
Mean for growth period Średnia za okres wegetacji	2.6	10.1	13.8	17.5	19.8	19.3
Precipitation – Opady, mm						
2009	8	3	102	146	98	87
2010	22	49	177	126	200	98
2011	20	50	49.2	88.5	233.7	28.6
Mean for growth period Średnia za okres wegetacji	16.7	34.0	109.4	120.2	177.2	71.2

According to numerous authors [Dzieżyc 1989, Mazurek 1993, Gąsiorowski 1995, Michalski *et al*. 1999, Pisulewska and Witkowicz 2000, Kukuła 2001, Kołodziej 2003], the prerequisite for obtaining high oat grain yield is high precipitation sum and its favourable distribution during growth. Longer drought may result in yield decrease even by 35%. The thesis was confirmed in the conducted research. Precipitation sum in June and July 2011 contributed to good grain fulfilment and high mass of 1000 grains, which resulted in the obtainment of the highest oat grain yield of 5.57 $t\cdot ha^{-1}$.

In every growth season (with the exception of Bio-algeen S 90 in the years 2009 and 2010), oat grain yield increased significantly after foliar additional plant feeding (Table 3). The highest yield increase in relation to the control group was noted in 2010 after the application of Basfoliar 36 Extra (by 25%) and Basfoliar 12-4-6+S (by 17.5%). In the three-year-long study period, the highest grain yield increase in relation to the control group was found after the application of Basfoliar 36 Extra (by 21.7%) and Basfoliar 12-4-6+S (by 15.5%). Biological preparation Bio-algeen S 90 caused lower yield increase (6.2%). Similar results after the application of the above preparation, but with different oat cultivars and in different temperature conditions, were obtained by Tobiasz-Salach and Bobrecka-Jamro [2003] and Tobiasz-Salach *et al.* [2007, 2008], whereas with wheat and tuber crops by Truba *et al.* [2012], Piskier [2006] and Szymczak-Nowak [2009]. Naked cultivar Cacko gave significantly lower yield than hulled cultivar Bingo, and the differences in the yield resulted mainly from the genetic characteristics (higher content of husk in the grain of hulled forms). Only in 2010, significant interaction between the cultivars and the applied foliar additional feeding was observed (Table 3). Hulled cultivar Bingo responded with yield increase after the application of all foliar fertilizers, and the highest increase in relation to the control group was found after the application of Basfoliar 36 Extra. In naked cultivar Cacko, yield increase was found after the application of Basfoliar 12-4-6+S and Basfoliar 36 Extra.

Table 3. Oat grain yield depending on the applied foliar fertilization, $Mg\cdot ha^{-1}$
Tabela 3. Plon ziarna owsa w zależności od stosowanego nawożenia dolistnego, $Mg\cdot ha^{-1}$

Fertilization Nawożenie (I)	Cultivar Odmiana (II)	2009	2010	2011	Mean for Średnia dla lat 2009-2011
Control – Kontrola	Cacko	3.74	3.02	4.23	3.38
	Bingo	5.53	3.71	6.02	4.62
Bio-algeen S 90	Cacko	3.95	3.10	4.77	3.52
	Bingo	5.86	4.12	6.47	4.99
Basfoliar 12-4-6+S	Cacko	4.46	3.30	4.78	3.88
	Bingo	6.14	4.60	6.48	5.37
Basfoliar 36 Extra	Cacko	4.65	3.56	4.91	4.10
	Bingo	6.44	4.84	6.92	5.64
LSD – NIR I × II	–	ns – ni	0.282	ns – ni	ns – ni
Control – Kontrola	–	4.63	3.36	5.12	4.00
Bio-algeen S 90		4.90	3.61	5.62	4.25
Basfoliar 12-4-6 +S	–	5.30	3.95	5.63	4.62
Basfoliar 36 Extra	–	5.54	4.20	5.92	4.87
$LSD_{0.05}$ – $NIR_{0,05}$		0.336	0.297	0.216	0.188
	Cacko	4.20	3.24	4.67	3.72
	Bingo	5.99	4.31	6.47	5.15
$LSD_{0.05}$ – $NIR_{0,05}$	–	0.145	0.141	0.192	0.176
Mean – Średnia	–	5.09	3.78	5.57	4.44

ns – ni – non-significant differences – różnice nieistotne

Different authors' views on the effect of foliar fertilization on the particular yield structure elements vary. Tobiasz-Salach and Bobrecka-Jamro [2003] and Tobiasz--Salach *et al.* [2008] claim that foliar fertilization has a positive effect on the number of spikelets and the mass of grains per panicle. On the other hand, Szumiło and Rachoń [2006a, b] state that fertilization has a positive effect on canopy content and on the increase in protein concentration, but at the same time increases grain fragmentation. In the conducted research, yield components such as mass of 1000 grains, grain mass, and the number of grains per panicle were determined by the applied foliar additional feeding (Table 4). In the present research, regardless of the cultivar, an increase was found in the mass of 1000 grains on average by 13.8%, the number of grains per panicle by 11.4%, and the mass of grains per panicle by 7.5%. The remaining preparations Bio-algeen S 90 and Basfoliar 12-4-6+S caused an increase only in the mass of 1000 grains. However, no significant effect of foliar additional plant feeding was found on panicle density. Cultivar Cacko obtained higher panicle density by 10.2% than cultivar Bingo. This resulted from the genetic characteristic of the cultivar, since according to Nita [2003] and Śmiałowski [2003] naked oat forms have a higher productive tillering coefficient than the hulled forms.

Table 4. Yield components (mean values for 2009-2011)
Tabela 4. Elementy składowe plonu (średnia dla lat 2009-2011)

Fertilization Nawożenie (I)	Cultivar Odmiana (II)	Panicle density Obsada wiech szt.·m^{-2}	Mass of 1000 grains MTZ g	Grain number per panicle Liczba ziaren z wiechy, szt.	Panicle grain mass Masa ziarna z wiechy g
Control – Kontrola	Cacko	447	20.4	34.6	0.86
	Bingo	389	28.8	38.5	1.26
Bio-algeen S 90	Cacko	456	22.4	36.1	0.81
	Bingo	399	29.5	40.1	1.19
Basfoliar 12-4-6 + S	Cacko	440	23.8	39.3	0.94
	Bingo	405	30.9	39.9	1.23
Basfoliar 36 Extra	Cacko	430	24.5	40.9	1.00
	Bingo	413	31.4	40.8	1.28
LSD – NIR I × II	–	ns – ni	ns – ni	1.883	ns – ni
Control – Kontrola	–	418	24.6	36.6	1.06
Bio-algeen S 90		428	26.0	38.1	1.00
Basfoliar 12-4-6 + S	–	422	27.4	39.6	1.09
Basfoliar 36 Extra	–	422	28.0	40.8	1.14
$LSD_{0.05}$ – $NIR_{0,05}$		ns – ni	1.096	2.437	0.045
	Cacko	443	22.8	37.7	0.90
	Bingo	402	30.2	39.8	1.24
$LSD_{0.05}$ – $NIR_{0,05}$	–	29.38	0.488	1.050	0.037
Mean – Średnia	–	422	26.5	38.8	1.07

ns – ni – non-significant differences – różnice nieistotne

Studied cultivars responded significantly to the increase in the number of grains per panicle as a result of the applied foliar additional feeding (Table 4). In naked cultivar Cacko, the application of Basfoliar 12-4-6+S caused an increase in the number of grains per panicle in relation to the control group by 13.5%, whereas the application of Basfoliar 36 Extra by 18.2%. In hulled cultivar Bingo, an increase in this characteristic by 5.9 % was noted only after the application of Basfoliar 36 Extra. However, no response in regard to this characteristic was demonstrated to the applied preparation Bio-algeen S 90. Positive effect of Basfoliar 12-4-6+S and Basfoliar 36 Extra on the increase in the number of grains per panicle was also demonstrated in previous research by Tobiasz-Salach and Bobrecka-Jamro [2003] and Tobiasz-Salach *et al*. [2008].

Oat grain is a valuable source of nutrients. Total protein content in de-husked grain amounts to, on average, 11.5% and is higher by 10%-25% than in other cereals. An important oat protein characteristic is the fact that it contains a high amount of essential amino acids, which the human body is unable to synthesize by itself. It is common knowledge that the factor that affects the most strongly the content and composition of protein compounds in the plant is nitrogen fertilization, but also fertilization with microelements [Fabijańska *et al*. 2002, Gąsiorowski 1995, Kozera *et al*. 2006]. In the conducted research, significant decrease in protein content in oat grain after the application of foliar fertilization was demonstrated (Table 5). Spraying with Bio-algeen S 90 and Basfoliar 12-4-6+S caused a decrease in protein content by 1.6%, and with Basfoliar 36 Extra by 0.8% in relation to the control group. Lower decrease in protein after the application of Basfoliar 36 Extra in relation to the remaining foliar fertilizers was caused probably by higher nitrogen content in its chemical composition. On the other hand, Kozera *et al*. [2006], after foliar additional feeding with copper, molybdenum, manganese, and zinc demonstrated a significant increase in protein content.

Table 5. Chemical composition of grain (mean values for 2009-2011)
Tabela 5. Skład chemiczny ziarna (średnia dla lat 2009-2011)

Fertilization Nawożenie (I)	Cultivar Odmiana (II)	Total protein Białko ogólne	Crude fat Tłuszcz surowy	Fibre Włókno	Ash Popiół	Nitrogen free extract BZW
		$g \cdot kg^{-1}$ dry matter – s. m.				
Control – Kontrola	Cacko	148	73.5	30.3	16.7	732
	Bingo	104	37.1	111.7	27.8	719
Bio-algeen S 90	Cacko	147	74.1	35.3	16.6	727
	Bingo	102	42.5	111.8	28.2	716
Basfoliar 12-4-6 + S	Cacko	145	76.5	35.0	17.1	726
	Bingo	102	37.3	112.9	28.0	720
Basfoliar 36 Extra	Cacko	147	77.2	35.1	16.7	724
	Bingo	103	38.1	104.1	28.2	727
LSD – NIR I × II	–	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni
Control – Kontrola	–	126	55.3	71.0	22.2	726
Bio-algeen S 90		124	58.3	73.6	22.4	722
Basfoliar 12-4-6 + S	–	124	56.9	73.9	22.6	723
Basfoliar 36 Extra	–	125	57.6	69.6	22.5	725
$LSD_{0.05}$ – $NIR_{0,05}$		0.92	1.62	ns – ni	ns – ni	ns – ni
	Cacko	147	75.3	33.9	16.8	727
	Bingo	103	38.7	110.1	28.0	720
$LSD_{0.05}$ – $NIR_{0,05}$	–	2.35	2.41	5.35	0.41	2.99
Mean – Średnia	–	125	57.0	72.0	22.4	723

ns – ni – non-significant differences – różnice nieistotne

Fat content in oat grain reaches on average 6.5% [Gąsiorowski 1999]. Oat fat is rich in polyunsaturated fatty acids and therefore is exceptionally valuable from the physiological and nutritional point of view. Higher fat content was found in naked than in hulled oat forms [Biel *et al*. 2009, Pisulewska *et al*. 2009, 2011]. In the conducted research, fat content was significantly higher in relation to the control group after the application of Bio-algeen S 90 (by 5.4%) and Basfoliar 36 Extra (by 4.1%) (Table 5). Similar results were obtained by Tobiasz-Salach *et al.* [2008] and Wróbel [2006]. Naked oat form (cultivar Cacko) was characterized by higher protein and fat contents in the grain than the hulled form (cultivar Bingo), which is confirmed by Podolska *et al.* [2006] and Pisulewska *et al*. [2009, 2011].

Canopy architecture must create suitable conditions for the proper course of plant development processes [Czerednik and Nalborczyk 2000]. Maximum LAI value for cultivated plants is diversified depending on the species. It may amount to circa 4 or 5, and full radiation absorption (up to 90%-95%) occurs when the value reaches a 3 and higher [Bochenek and Grzesiuk 2002]. According to Petr *et al*. [1988] and Jameison *et al*. [1995], the LAI value for cereal canopy reaches from 2 to 4, and for highly productive cultivars it may reach even 7.5 [Nieróbca and Faber 1996]. In the conducted research, the LAI value was determined by the applied foliar fertilization (Table 6). In naked cultivar Cacko, the application of spraying with Basfoliar 12-4-6+S and Basfoliar 36 Extra caused an increase in LAI in comparison with Bio-algeen S 90, respectively by 3.5% and 21.8%. In hulled cultivar Bingo, after spraying with Basfoliar 36 Extra, an increase in the LAI value by 9% was found, in relation to the application of Bio-algeen S 90.

Table 6. Canopy architecture indicators (mean values for 2009-2011)
Tabela 6. Wskaźniki architektury łanu (średnia dla lat 2009-2011)

Fertilization – Nawożenie (I)	Cultivar – Odmiana (II)	LAI	MTA
Control – Kontrola	Cacko	3.64	61.3
	Bingo	4.14	62.9
Bio-algeen S 90	Cacko	3.66	60.6
	Bingo	4.41	63.9
Basfoliar 12-4-6 + S	Cacko	3.79	58.3
	Bingo	4.48	58.1
Basfoliar 36 Extra	Cacko	4.46	56.3
	Bingo	4.83	55.1
LSD – NIR I × II	–	0.12	1.19
Control – Kontrola	–	3.89	62.1
Bio-algeen S 90		4.04	62.3
Basfoliar 12-4-6 + S	–	4.13	58.2
Basfoliar 36 Extra	–	4.65	55.7
$LSD_{0.05}$ – $NIR_{0,05}$		0.16	0.67
	Cacko	3.89	59.1
	Bingo	4.46	60.0
$LSD_{0.05}$ – $NIR_{0,05}$	–	0.06	0.58
Mean – Średnia	–	4.18	59.5

The highest decrease in mean tip angle in relation to the control group was found after the application of Basfoliar 36 Extra. This relation occurred both in cultivar Cacko and Bingo (Table 6). It was also demonstrated that regardless of the cultivar, the applied preparations caused an increase in LAI and a decrease in MTA. Naked cultivar Cacko was characterized by lower LAI and MTA values in comparison with hulled cultivar Bingo, and the results are in agreement with literature on the subject [Jaśkiewicz 2005, Nieróbca and Faber 1996]. According to Jaśkiewicz [2007], nitrogen fertilization has a significant effect on LAI. With higher doses of the element, leaf assimilation index increases, as well as the duration of leaf activity and productive tillering. The above thesis was confirmed in the conducted research. The highest LAI values were obtained by oat plants after the application of Basfoliar 36 Extra, which was characterized by the highest nitrogen content (Tables 1 and 6).

CONCLUSIONS

1. In the three-year-long study period, foliar fertilizers affected oat grain yield increase, and the highest increase was obtained after the application of Basfoliar 36 Extra. Hulled cultivar Bingo gave higher grain yield in comparison with naked cultivar Cacko. Differences in the yield of the studied cultivars resulted from the genetic characteristics.
2. Foliar additional feeding of oat plants positively affected the increase in the mass of 1000 grains, and the highest increase, in relation to the control group, was found after spraying with Basfoliar 36 Extra. Cultivar Bingo, regardless of the studied foliar preparations, was characterized by a higher mass of 1000 grains, the number and mass of grains per panicle, and lower panicle density in comparison with cultivar Cacko.
3. Foliar fertilizers caused a decrease in protein content and an increase in fat content in oat grain. This relation occurred especially after the application of Bio-algeen S 90. Cultivar Cacko, regardless of the applied foliar additional feeding, was characterized by higher protein and fat contents in comparison with cultivar Bingo.
4. Application of foliar fertilization resulted in an increase in LAI and a decrease in MTA. In cultivar Bingo, increase in the LAI values in relation to the control group was demonstrated after the application of Bio-algeen S 90, Basfoliar 12-4-6+S, and Basfoliar 36 Extra, whereas in cultivar Cacko after the application of Basfoliar 36 Extra. MTA values decreased in both cultivars Bingo and Cacko after the application of Basfoliar 12-4-6+S and Basfoliar 36 Extra.

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REAKCJA OPLEWIONEJ I NIEOPLEWIONEJ FORMY OWSA NA NAWOŻENIE DOLISTNE

Streszczenie. W praktyce rolniczej nawozy dolistne stosuje się do pozakorzeniowego dokarmiania roślin. Poprzez dolistne dokarmianie dostarcza się roślinom składniki pokarmowe, w małych dawkach, które są natychmiast uruchamiane i pobierane przez liście. W pracy przedstawiono wyniki ścisłego doświadczenia polowego prowadzonego w latach 2009-2011 w Stacji Dydaktyczno-Badawczej w Krasnem k. Rzeszowa. Badano reakcje owsa nieoplewionego (odmiany Cacko) i oplewionego (odmiany Bingo) uprawianego na glebie średniej, kompleksu pszennego dobrego, na nawożenie dolistne preparatami Bio-algeen S 90, Basfoliar 12-4-6+S i Basfoliar 36 Extra. Określono plon i skład chemiczny ziarna oraz wskaźniki architektury łanu. Na podstawie przeprowadzonych badań wykazano, że nawozy dolistne powodowały wzrost plonu ziarna owsa. Najwyższy plon otrzymano po zastosowaniu Basfoliaru 36 Extra i Basfoliaru 12-4-6+S. Stwierdzono także dodatni wpływ dolistnego dokarmiania na kształtowanie takich elementów składowych plonu, jak: masa 1000 ziaren, masa i liczba ziarna z wiechy. Wykazano, że aplikowane nawozy dolistne decydowały o spadku zawartości białka, a zwiększały zawartość tłuszczu w ziarnie. Najintensywniej reakcja ta wystąpiła po zastosowaniu preparatu Bio-algeen S 90. Nawozy dolistne różnicowały także wskaźniki architektury łanu. Po ich zastosowaniu wykazano wzrost wskaźnika LAI i spadek MTA. Największy wzrost LAI i spadek MTA u obydwu odmian owsa wykazano po zastosowaniu Basfoliaru 36 Extra.

Słowa kluczowe: *Avena nuda*, *Avena sativa*, elementy plonowania, MTA, plon, skład chemiczny ziarna, wskaźniki architektury łanu LAI

Accepted for print – Zaakceptowano do druku: 15.02.2016

For citation – Do cytowania:

Tobiasz-Salach, R., Bobrecka-Jamro, D., Pyrek-Bajcar, E., Buczek, J. (2016). Response of hulled and naked oat to foliar fertilization. Acta Sci. Pol. Agricultura, 15(2), 77-88.