ACTA SCIENTIARUM POLONORUM *Acta Sci. Pol., Hortorum Cultus 10(1) 2011, 147-158*

THE INFLUENCE OF ORGANIC-MINERAL FERTILIZERS ON YIELD AND RAW MATERIALS QUALITY OF CHOSEN PLANTS OF THE *Lamiaceae* FAMILY FROM ORGANIC CULTIVATION

Wiesława Rosłon, Ewa Osińska, Katarzyna Bączek, Zenon Węglarz
Warsaw University of Life Sciences

Abstract. In modern horticultural production attention is paid to creating the best conditions for growth and development of plants in order to increase crop yielding. Such task is to be met by, among others, modern organic-mineral fertilizers. In the experiment the effect of Aminoplant, Goëmar BM 86 and Goëmar Goteo on the growth, development, crop yield and quality of some herbs from *Lamiaceae* family was estimated. The applied preparations did not significantly affect the height of plants and the number of shoots in tested plants (sweet basil and marjoram) except of peppermint. The content of essential oil in herb of marjoram and peppermint was lower in plants watered with the investigated fertilizers then in the control and in sweet basil it was clearly lower only in the herb of plants watered with the preparation Goëmar Goteo as compared with herb harvested from the control plots and plots watered with Aminoplant and Goëmar BM 86. The biggest amount of total polyphenoles was noted in the herb of sweet basil harvested from plots watered with Goëmar BM 86 preparation, the least from plots watered with Goëmar Goteo. The highest mean content of flavonoid compounds in the green parts of peppermint was characteristic for plants from the control plots.

Key words: Aminoplant, Goëmar Goteo, Goëmar BM 86, essential oil, polyphenols, flavonoids

INTRODUCTION

Cultivation of medicinal plants in Poland has a centuries-old tradition. At present, about 80 species are cultivated but that number increases from year to year, due to introducing into cultivation wild growing species or species of foreign origin. It is also highly probable that the surface of herb cultivation will further increase because of a growing number of recipients of herbal raw material. However, the increasing market

Corresponding author – Adres do korespondencji: Wiesława Rosłon, Department of Vegetable and Medicinal Plants, Warsaw University of Life Sciences, ul. Nowoursynowska 159, 02-787 Warszawa, Poland, e-mail: wieslawa_roslon@sggw.pl

possibilities do not absolve the growers from their proper care of that product quality. Growers have to face bigger and bigger requirements concerning the applied methods and ways of cultivation as well as the quality of the obtained raw material. More and more often it is recommended to cultivate herbs applying ecological or very close to ecological methods (e.g. biodynamic cultivation). In modern horticultural production (including herb production) attention is paid not only to creating the best conditions for growth and development of plants but also to limiting stress factors (connected, e.g. with adverse climatic conditions). Such task is to be met by, among others, modern organic-mineral fertilizers, the merit of which is their natural composition, often based on plant elements (e.g. sea-weeds) with the addition of compounds directly isolated from plants (amino-acids, hormones, vitamins, and others). Their role is to improve plant metabolism and thus to increase crop yielding and plant resistance to the adverse weather conditions (freeze, drought, salinity, infections) and protection against herbicides stress [Horoszkiewicz-Janka and Bartos 2004, Podymiak 2006, Kositorna and Smolinski 2008, Szabó and Hrotkó 2009].

The aim of the presented research was the examination of the effect of Goëmar Goteo, Goëmar BM 86 and Aminoplant (all preparations were distributed by Arista LifeSciences-Poland) on the growth, development, yield and quality of raw material obtained from chosen herbs of the *Lamiaceae* family.

MATERIAL AND METHODS

The experiment was performed on the mapped out experimental plots of the Department of Vegetable and Medicinal Plants, on the heavy alluvial soil with a 1.9–2.3% content of organic matter, for 2008 and 2009 (the field possesses the ecological certificate). All agricultural steps were tailored to the specifics of the system. Cultivation works relied on manual weeds removing. The investigations included local populations of three species from the *Lamiaceae* family: sweet basil (*Ocimum basilicum* L.), marjoram (*Origanum majorana* L.*)* and peppermint (*Mentha* × *piperita* L.) and three organic-mineral fertilizers applied: Aminoplant, Goëmar BM 86 and Goëmar Goteo. Particular species were sown or planted in strips with the surface of 16 m^2 (1.0 × 16.0 m). Next, all strips were divided into 4 plots with the surface of 4 m^2 each. The plot of sweet basil was started by planting the seedlings, which were produced in the greenhouse of the Department of Vegetable and Medicinal Plants. The seeds were sown at the end of April into multiplates filled with peat substrate. When the seedlings had 4–5 regular leaves, they were subjected to hardening and then planted on the plot at 20 × 20 cm spacing. In both years of the experiment plants were planted after 20th May. Marjoram plantation was established with the sowing of seeds directly into the field. Seeds were sown in the second decade of April in rows every 30 cm. For 16 m^2 of the field, 10 g of seeds were used. In both years of the experiment the field of peppermint was started using the rhizomes-shoot cuttings obtained from the nursery on the experimental plot of the Department. They were planted directly after obtaining them (in the second decade of April) at 20 × 40 cm spacing. For 16 m^2 plot, 288 cuttings were used. The experiment was set up in three replications.

In June and July watering plants was performed with chosen organic-mineral fertilizers using the dilution 1 cm^3 of preparation for 1 dm^3 of water. For the peppermint and the sweet basil the first watering was performed two weeks after planting, for the marjoram – three weeks after the plants germination. Watering was done three times, every 2–3 weeks.

Each plot was watering with 15 dm^3 of fertilizer solution and in the case of control plots 15 dm^3 of water were used. The harvest of raw material, depending on species was performed from July to October. The harvest of sweet basil and marjoram was done when the plants were at the phase of full bloom (in the second decade of July) by cutting them 5 cm over the ground. The harvest of peppermint was performed twice; first time at the beginning of July (10 cm over the ground) when the plants were at the blooming phase. The second harvest was in October when the regrowth reached about 50 cm in height (plants were at the beginning of the blooming phase). During harvest, biometric measurements were taken on 30 randomly chosen plants from each investigated species. The measurements included the height of plants, number of shoots on one plant and the share of leaves in herb. After harvest fresh mass of herb was determined for a surface unit, next the obtained raw material was dried in dryer chamber at temperature of 35°C. Until the time of chemical analyses the dried material was stored in paper bags in a dry and airy place. The contents of essential oils, flavonoids (peppermint) and total content of polyphenoles (sweet basil, marjoram) were determined in air dry raw material. All chemical analyses were performed in accordance to the recommendations of Polish Pharmacopoeia VI [2002], in three replications. Essential oil was extracted from herb (20 g) by hydrodistillation in a Deryng apparatus. Content of flavonoids were quantified by using the chelating properties of the molecules towards $AlCl_3$, with quercetin used as standard. The raw materials was extracted with acetone. The hydrolysis of flavonoids was done by using of hydrochloric acid. Absorbance of the obtained flavonoids solution was measured at 425 nm length wave. Content of total phenols (calculated as pyrogalol) was made from aqueous solution with Folin-Ciocalteus reagent. Absorbance measurements were made at 760 nm. It the measurements were executed was on spectrophotometer the PV-8740 UV – the VIS of Philips. Because in 2008 and 2009 there were similar relationships the present results are mean of two years investigations.

The obtained results were subjected to statistical analysis using the computer programme Statgraphics Plus 4.1. The significance of differences was determined with the HSD test – Tukey's with the significance level of $p < 0.05$. The results presented in this paper are means for two year investigations.

RESULTS AND DISCUSSION

The presented investigation aimed at checking the effect of some chosen organic-mineral fertilizers on growth, development, yielding and quality of herb of three species of the *Lamiaceae* family (sweet basil, marjoram and peppermint). These species are popular spices and medicinal plants with wide spectrum of action, which causes the fact

that their raw materials are sought after in the herb market [Djouvinov et al. 1997, Opalchenova and Obreshkova 2003, Busatta et al. 2008].

The organic-mineral fertilizers used in the research differently affected the investigated functional parameters (height of plants, their spreading and the weight of raw material obtained from the surface unit). While analyzing the effects of the applied preparations on growth and development of sweet basil it was noted that they did not significantly affect the height of plants, number of produced shoots and the share of leaves in the herb. The average yield of the herb air dry matter obtained in this experiment amounted to 0.32 $kg \cdot m^{-2}$ (3.2 $t \cdot ha^{-1}$) and was close to the results reported by other authors [Jadczak 2007, Kucharski and Mordalski 2009]. Watering plants with Aminoplant resulted in increasing mass of air dry herb from the surface unit, as compared to the control, however the differences were not statistically significant. Watering plants with Goëmar BM 86 preparation caused statistically significant decrease of herb mass as compared to both: plants watered with Aminoplant preparation and the control (tab. 1).

Table 1. Evaluation of morphological and developmental characteristic, fresh and air dry mass of sweet basil herb

Tabela 1. Ocena cech morfologiczno-rozwojowych oraz świeża i powietrznie sucha masa ziela bazylii pospolitej

Fertilizer Nawóz	Height of plants Wysokość roślin cm	Number of shoots Liczba pędów szt.	Leaves share in herb Udział liści w zielu %	Fresh mass Świeża masa $kg \cdot m^{-2}$	Air dry mass Powietrznie sucha masa $kg \cdot m^{-2}$
Control – Kontrola	34.20	5.20	51.60	1.00	0.33
Aminoplant	35.60	5.40	56.80	1.10	0.34
Goëmar Goteo	37.80	5.20	52.00	0.98	0.28
Goëmar BM 86	31.40	5.80	55.00	1.08	0.31
Mean – Średnio	34.75	5.40	53.85	1.04	0.32
$LSD_{0.05}$ $NIR_{0,05}$	n.s. r.n.	n.s. r.n.	n.s. r.n.	n.s. r.n.	0.04

n.s. – differences not significant at $\alpha \leq 0.05$; r.n. – różnice nieistotne przy poziomie $\alpha \leq 0,05$

Also in the case of marjoram no effect of watering with the fertilizers applied in the experiment on the biometric traits was observed. The average plant height under the conditions of the experiment amounted to 25.55 cm and was lower for marjoram than the results obtained by other authors. For example, Nurzyńska-Wierdak and Dzida [2009] obtained the average height of over 31 cm, and Dzida and Jarosz [2006] of over 42 cm. In the described experiment the highest plants were obtained after treating them with Aminoplast preparation (28.60 cm) and the smallest in the case of Goëmar Goteo treatment (23.80 cm). Reversed relations were observed for the number of produced shoots, which were most numerous in plants watered with Goëmar Goteo preparation (9.60 shoots per plant, on the average), and the least numerous in plants watered with

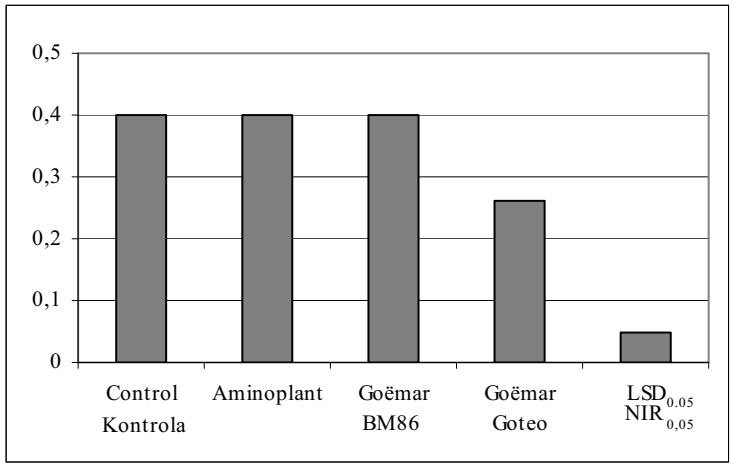

Fig. 1. Essential oil content in sweet basil herb, ml · 100 g^{-1}
Ryc. 1. Zawartość olejku eterycznego w zielu bazylii pospolitej, ml · 100 g^{-1}

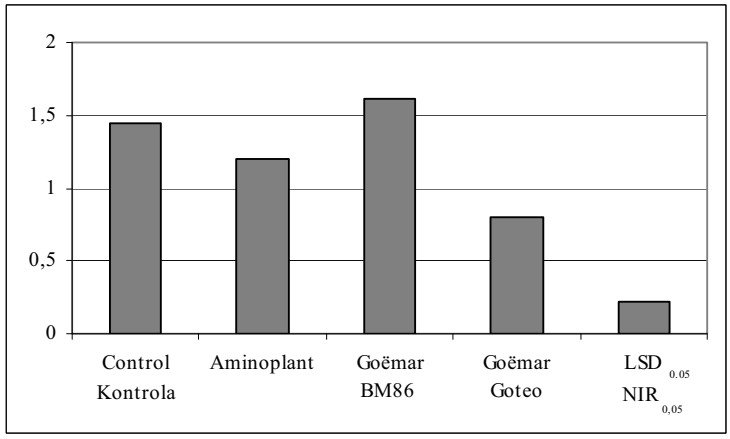

Fig. 2. Total polyphenols content in sweet basil herb, %
Ryc. 2. Zawartość polifenoli ogółem w zielu bazylii pospolitej, %

Aminoplast preparation (7.00 shoots per plant, on the average). On the average, marjoram produced 8.55 shoots per plant, thus more than were observed in the investigations by Nurzyńska-Wierdak and Dzida [2009]. The average yield of marjoram plants obtained from 1 m^2 amounted to 0.16 kg·m^{-2} for air dry raw material which agrees with the data in literature [Nurzyńska-Wierdak and Dzida 2009, Zawiślak 2008]. The best results were obtained for the control plants where 0.17 kg of air dry herb was harvested from 1 m^2. All the organic-mineral fertilizers used in the experiment decreased the mass of herb collected from 1 m^2 and the significant differences were observed only in fresh matter of herbs when marjoram was watered with Goëmar Goteo and Goëmar BM 86 preparations (tab. 2).

Table 2. Evaluation of morphological and developmental characteristics, fresh and air dry mass of marjoram herb.

Tabela 2. Ocena cech morfologiczno-rozwojowych oraz świeża i powietrznie sucha masa ziela majeranku ogrodowego

Fertilizer Nawóz	Height of plants Wysokość roślin cm	Number of shoots Liczba pędów szt.	Fresh mass Świeża masa kg · m^{-2}	Air dry mass Powietrznie sucha masa kg · m^{-2}
Control – Kontrola	25.40	9.58	0.75	0.17
Aminoplant	28.60	7.00	0.72	0.16
Goëmar Goteo	23.80	9.60	0.65	0.15
Goëmar BM 86	24.40	8.00	0.61	0.14
Mean – Średnio	25.55	8.55	0.68	0.16
$LSD_{0.05}$	n.s.	n.s.	0.06	n.s.
$NIR_{0,05}$	r.n.	r.n.		r.n.

n.s. – differences not significant at $\alpha \leq 0.05$; r.n. – różnice nieistotne przy poziomie $\alpha \leq 0,05$

In the case of peppermint, watering plants with the investigated organic-mineral fertilizers significantly affected their height and the number of produced shoots. The highest plants originated from the plot watered with Goëmar Goteo (94.40 cm) and the smallest those watered with Goëmar BM 86 preparation (77.20 cm), the last ones were also most poorly tillered (2.40 shoots per plant, on the average). Clear differences were also observed in the share of leaves in herb. The least amount of leaves in herb was noted in plants watered with Aminoplant (29.2%), and the biggest amount in plants treated with Goëmar BM 86 (36.80%). The obtained mass of peppermint herb was significantly affected by both the harvest time and the applied organic-mineral fertilizer. In July, more than twice higher amount of that raw material was obtained (1.79 kg · m^{-2}, on the average) compared with the October one (on average 0.74 kg · m^{-2}). The highest total mass of herbs from two harvests was obtained from the combination in which the plants were watered with Goëmar Goteo (3.05 kg · m^{-2} for fresh matter), the second result in a row was obtained from the control plot (2.60 kg · m^{-2}). The lowest yield of herb was obtained from the combination in which plants were watered with Aminoplant preparation (2.20 kg· m^{2}) (tab. 3).

Assessing the effect of the fertilizers used on the content of essential oil it was observed in marjoram and peppermint that all the applied preparations decreased its content and in the case of the Goëmar BM 86 preparation (for both species) and Goëmar Goteo (for marjoram) these differences were statistically significant. In the case of peppermint the content of essential oil was also affected by the term of herb harvest. Clearly more of essential oil was determined in herb harvested on the first term than on the second one. Mean essential oil content from both harvests in all variants of the experiment were similar and varying from 2.22 to 2.43 ml · 100 g^{-1} (fig. 3, tab. 4). In sweet basil that component occurred in much smaller amounts in plants watered with Goëmar Goteo as compared with the remaining variants (the content of essential oil in herb harvested from the control plots as well as those watered with Aminoplant and Goëmar BM 86 was identical and amounted to 0.4%). Components of the analyzed raw

Table 3. Evaluation of morphological and developmental characteristics, fresh and air dry mass of peppermint herb (*Mentha × piperita*)
Tabela 3. Ocena cech morfologiczno-rozwojowych oraz świeża i powietrznie sucha masa ziela mięty pieprzowej (*Mentha ×piperita*), kg · m^{-2}

Fertilizer Nawóz	First time of harvest I termin zbioru					Second time of harvest II termin zbioru	
	Height of plants Wysokość roślin cm	Number of shoots Liczba pędów szt.	Leaves share in herb Udział liści w zielu %	Fresh mass of herb Świeża masa ziela kg·m^{-2}	Air dry mass of herb Powietrznie sucha masa ziela kg·m^{-2}	Fresh mass of herb Świeża masa ziela kg·m^{-2}	Air dry mass of herb Powietrznie sucha masa ziela kg·m^{-2}
Control – Kontrola	78.80	4.00	30.80	1.86	0.69	0.74	0.12
Aminoplant	81.40	4.60	29.20	1.60	0.43	0.60	0.10
Goëmar Goteo	94.40	4.20	34.80	2.00	0.61	1.05	0.20
Goëmar BM 86	77.20	2.40	36.80	1.68	0.52	0.55	0.08
Mean – Średnio	82.95	3.80	32.90	1.79	0.56	0.74	0.13
$LSD_{0.05}$ $NIR_{0,05}$	14.2	0.24	1.12	A = 0.12 B = 0.06 A × B = 0.12 B × A = 0.17	A = 0.01 B = 0.02 A × B = 0.02 B × A = 0.03	A = 0.12 B = 0.06 A × B = 0.12 B × A = 0.17	A = 0.01 B = 0.02 A × B = 0.02 B × A = 0.03

A– harvest time/ termin zbioru;
B – type of fertilizer/nawóz

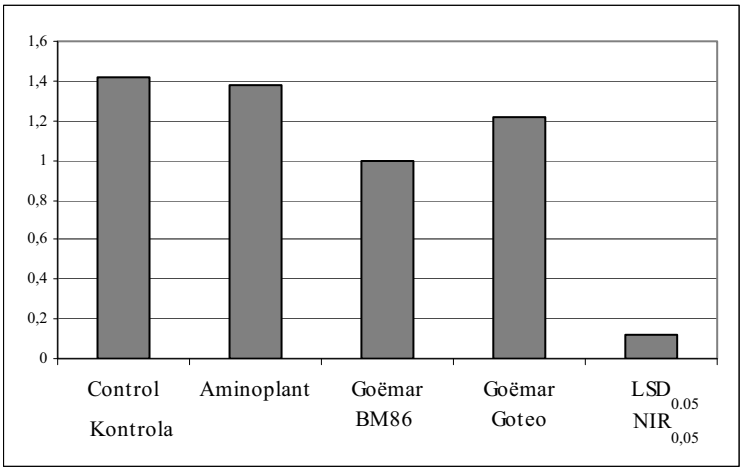

Fig. 3. Essential oil content in marjoram herb, ml · 100 g^{-1}
Ryc. 3. Zawartość olejku eterycznego w zielu majeranku ogrodowego, ml · 100 g^{-1}

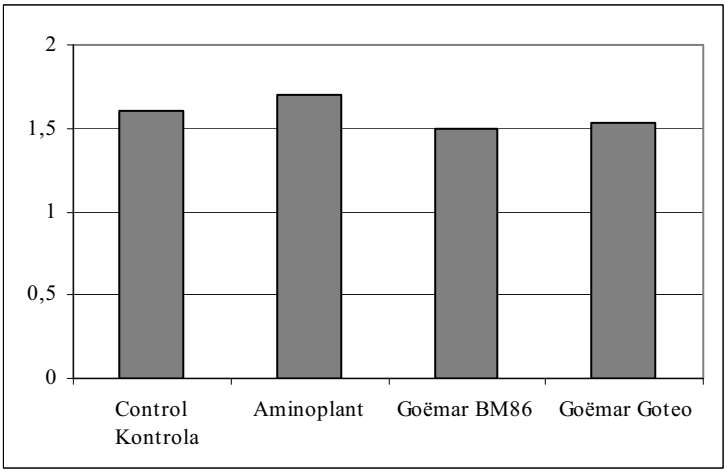

Fig. 4. Total polyphenols content in marjoram herb, %
Ryc. 4. Zawartość polifenoli ogółem w zielu majeranku ogrodowego, %

materials, important from the pro-health point of view, are the polyphenolic compounds. Many authors point to the presence of such groups of polyphenols as tannins, polyphenolic acids and flavonoids in the plants of sweet basil, marjoram and peppermint [Liu et al. 2008, Sellami et al. 2009, Wong et al. 2006, Yoo et al. 2008]. In the present investigation the total content of polyphenols (sweet basil and majoram), and the flavonoids content (peppermint) was determined in the investigated raw materials. Results obtained by Dobrzański et al. [2008] who examined the effect of extracts from

algae (Algaminoplant and Leonardyt-Humiplan) on the content of soluble phenols and total phenols in carrot roots indicate that application of above organic fertilizers increase phenol content.

Table 4. Essential oil content in peppermint herb, ml · 100 g^{-1}
Tabela 4. Zawartość olejku eterycznego w zielu mięty pieprzowej, ml · 100 g^{-1}

Fertilizer Nawóz	First time of harvest I termin zbioru	Second time of harvest II termin zbioru	Mean for two harvests Średnia z dwóch zbiorów	$LSD_{0.05}$ for B $NIR_{0,05}$ dla B
Control	2.45	2.40	2.43	0.21
Aminoplant	2.55	2.26	2.41	
Goëmar Goteo	2.65	2.15	2.40	
Goëmar BM 86	2.30	2.14	2.22	
Mean –Średnio	2.49	2.24		
$LSD_{0.05}$ for A $NIR_{0,05}$ dla A	0.18			

A – harvest time – termin zbioru; B – type of fertilizer – nawóz

Table 5. Flavonoids content in peppermint herb, %
Tabela 5. Zawartość flawonoidów w zielu mięty pieprzowej, %

Fertilizer Nawóz	First time of harvest I termin zbioru	Second time of harvest II termin zbioru	Mean for two harvests Średnia z dwóch zbiorów
Control	0.54	0.71	0.63
Aminoplant	0.45	0.65	0.55
Goëmar Goteo	0.55	0.64	0.60
Goëmar BM 86	0.42	0.71	0.57
Mean – Średnio	0.49	0.68	
$LSD_{0.05}$ for – $NIR_{0,05}$ dla A – harvest time – terminu zbioru = 0.02 B – type of fertilizer – nawóz = 0.03 A × B = 0.04; B × A = 0.05			

The total content of polyphenols in marjoram herb is assessed as 0.7–4.7% [Gramza-Michałowska et al. 2008, Sellami et al. 2009]. In the present investigation the determined content of those compounds was from 1.5–1.53% (Goëmar BM 86) to 1.7% (Aminoplant). Watering with the investigated preparations did not significantly affect that trait (fig. 4). In sweet basil the total content of polyphenols reported by other authors varied within wide limits from 0.2 to 14.7% [Lee and Scagel 2009, Hinneburg et al. 2005, Wong et al. 2006]. In the present experiment the content of polyphenolic compounds was determined as 0.8–1.61% and it was observed that their content was modified by the organic-mineral fertilizers used. The highest content of total polyphenols was observed in plants harvested from plots watered with Goëmar BM 86 preparation, and a little smaller content (not significant statistically) was characteristic for raw mate-

rial collected from the control plots. Plants watered with Aminoplant and Goëmar Goteo contained significantly less of those compounds as compared to the control and to plants watered with Goëmar BM 86. The least amount of total polyphenols was found in sweet basil herb harvested from plots watered with Goëmar Goteo (fig. 2). The content of flavonoids in peppermint was significantly affected by the time of harvest and the applied organic-mineral fertilizer. Raw material harvested in October was characterized by a clearly higher content of flavonoids (0.68%, on the average) as compared to raw material collected in July (0.49%, on the average). In the case of first term of harvest the highest content of those compounds was characteristic for the control plants and those watered with Goëmar Goteo (0.54% and 0.55%, respectively), while on the second term apart from the control plants, a high flavonoids content was also determined in plants watered with Goëmar BM 86. The highest mean content of flavonoids, significantly higher than in the remaining variants of the experiment was characteristic for plants harvested from the control plots. The least amount of those compounds was determined in plants obtained from plots watered with Aminoplant (tab. 5).

CONCLUSIONS

1. The applied organic-mineral fertilizers affected the yielding of sweet basil, marjoram and peppermint.

2. Watering sweet basil with Goëmar BM 86, marjoram with Goëmar Goteo i Goëmar BM 86 and peppermint with Aminoplant decreased the yield of herbs obtained from the surface unit.

3. Watering peppermint plants with Goëmar Goteo resulted in the increase of the weight of herb harvested from the surface unit.

4. All the investigated fertilizers decrease the content of essential oils in herb of marjoram and peppermint

5. Watering with Aminoplant and Goëmar Goteo caused the decrease of the content of polyphenols in sweet basil herb.

6. The content of flavonoids in herb of peppermint depends on the time of harvest. Raw material collected in October was characterized by a clearly higher content of flavonoids (0.68%, on the average) as compared to raw material harvested in July (0.49%, on the average).

REFERENCES

Busatta C., Vidal R.S., Popiolski A.S., Mossi A.J., Dariva C., Rodrigues M.R.A., Corazza M.L., Oliviera J.V., Cansian R.L., 2008. Application of *Origanum majorana* L. essential oil as an antimicrobial agent in sausage. Food Microbiology 25, 207–211.

Djouvinov D., Pavlov D., Ilchen A., Enev E., 1997. Peppermint (*Mentha piperita* Huds.) and basil (*Ocimum basilicum* L.) etheric oil by-products as roughages for sheep feeding. Animal Feed Sci. Technology 68, 287–294.

Dobrzański A., Anyszka Z., Elkner K., 2008. Response of carrots to application of natura extracts from seaweed (*Sargassum* sp.) – Algaminoplant and from Leonardite-Humiplant. J. Res. Applic. Agric. Engin. 53 (3), 53–58.

Dzida K., Jarosz Z., 2006. Plonowanie i skład chemiczny majeranku ogrodowego (*Origanum majorana* L.) w zależności od zróżnicowanego nawożenia azotowo-potasowego. Acta Agrophysica 7(3), 561–566.

Gramza-Michałowska A., Abramowski Z., Jovel E., Hes M., 2008. Antioxidant potential of herbs extracts and impact on HEPG2 cells variability. Acta Sci. Pol., Technologia Alimentaria 7(4), 61–72

Hinneburg I., Dorman H.J.D., Hiltunen R., 2005. Antioxidant activities of extracts from selected culinary herbs and spices. Food Chemistry 97, 122–129

Horoszkiewicz-Janka J., Bartos M., 2004. Stymulatory wzrostu i odporności alternatywą dla tradycyjnych środków ochrony roślin. Agrotechnika, 1. Wyd. Hortpress, 16–17.

Jadczak D., 2007. Wpływ terminu siewu i odległości rzędów na plonowanie bazylii pospolitej (*Ocimum basilicum* L.). Roczniki AR, 383, Poznań, 505–509.

Kositorna J., Smolinski M., 2008. Biostimulators can protect sugar beet from stress caused by herbicides. Biostimulators in modern agriculture. Book of abstracts. Laboratory of Basic Research in Horticulture. Faculty of Horticulture and Landscape Architecture. Warsaw University of Life Sciences.

Kucharski W.A., Mordalski R., 2009., Bezpestycydowa uprawa bazylii pospolitej-ważnej rośliny przyprawowej. Progr. Plant Protect. 49 (3), 1543–1546.

Lee J., Scagel C.F., 2009. Chicoric acid found in basil (*Ocimum basilicum* L.) leaves. Food Chemistry 115, 650–656.

Liu H., Qiu N., Ding H., Yao R., 2008. Polyphenols contents and antioxidant capacity of 68 Chinese herbals suitable for medical or food uses. Food Res. Intern. 41, 363–370.

Nurzyńska-Wierdak R., Dzida K., 2009. Influence of plant density and term of harvest on yield and chemical composition of sweet marjoram (*Origanum majorana* L.). Acta Sci. Pol. Hortorum Cultus 8(1), 51–61.

Opalchenova G., Obreshkova D., 2003. Comparative studies on the activity of basil and essential oil from *Ocimum basilicum* L. against multidrug resistant clinical isolates of the genera Staphylococcus, *Enterococcus* and *Pseudomonas* by using different test methods. J. Microbiol. Methods 54, 105–110.

Podymniak M., 2006. Biostymulator, czyli pobudzenie do życia. Ochrona Roślin, 4, 18–19.

Polish Pharmacopoeia VI. 2002. PTF, Warsaw, 150 (in Polish).

Sellami I.H., Maamouri E., Chahed T., Wannes W.A., Kchouk M.E., Marzouk B., 2009. Effect of growth stage on the content and composition of the essential oil and phenolic fraction of sweet marjoram (*Origanum majorana* L.). Industrial Crops and Products 30, 395–402.

Szabó V., Hrotkó K., 2009. Preliminary results of biostimulator treatments on *Crategus* and *Prunus* stockplants. Bull.UASVM Horticulture 66(1), 223–228

Wong S.P., Leong L.P., Hoe J., Koh W., 2006. Antioxidant activities of aqueous extracts of selected plants. Food Chemistry 99, 775–783.

Yoo K.M., Lee Ch.H., Lee H., Moon B., Lee Ch.Y., 2008. Relative antioxidant and cytoprotective activities of common herbs. Food Chemistry 106, 929–936.

Zawiślak G., 2008. Dependence on harvest date and yielding og marjoram (*Origanum majorana* L.) cv. 'Miraż' cultivated from seedling. Acta Sci. Pol. Hortorum Cultus 7(2), 73–81.

WPŁYW NAWOZÓW ORGANICZNO-MINERALNYCH NA PLONOWANIE I JAKOŚĆ ZIELA WYBRANYCH GATUNKÓW Z RODZINY *Lamiaceae* UPRAWIANYCH METODĄ EKOLOGICZNĄ

Streszczenie. W nowoczesnej produkcji ogrodniczej zwraca się uwagę na stworzenie roślinom optymalnych warunków wzrostu i rozwoju w celu poprawy ich plonowania. Takie zadanie mają do spełnienia między innymi nowoczesne nawozy organiczno-mineralne. W pracy oceniono wpływ preparatów Aminoplant, Goëmar BM 86 oraz Goëmar Goteo na wzrost, rozwój, plonowanie i jakość wybranych ziół z rodziny jasnotowatych. Zastosowane preparaty nie wpłynęły istotnie na wysokość roślin i liczbę pędów u bazylii pospolitej i majeranku ogrodowego oraz istotnie u mięty pieprzowej. Zawartość olejku eterycznego w zielu majeranku ogrodowego i mięty pieprzowej była niższa u roślin podlewanych badanymi nawozami w porównaniu z kontrolą, u bazylii pospolitej wyraźnie mniej tego składnika było tylko w zielu roślin podlanych preparatem Goëmar Goteo w porównaniu z zielem zebranym z poletek kontrolnych oraz podlanych Aminoplantem i Goëmar BM 86. Najwięcej polifenoli ogółem zawierało ziele bazylii zebrane z poletek podlanych preparatem Goëmar BM 86, najmniej z poletek podlanych preparatem Goëmar Goteo. Najwyższą średnią zawartością związków flawonoidowych w zielu mięty charakteryzowały się rośliny zebrane z poletek kontrolnych.

Słowa kluczowe: Aminoplant, Goëmar Goteo, Goëmar BM 86, olejek eteryczny, polifenole, flawonoidy

Accepted for print – Zaakceptowano do druku: 10.01.2011