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# YIELD AND QUALITY OF SWEET MARJORAM HERB DEPENDING ON HARVEST TIME

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**Abstract.** One of the more important species of herbal plants, grown in many countries for medical and nutritional purposes is sweet marjoram. The marjoram herb is an abundant source of valuable biologically active substances and mineral components. Considering the vast application of this plant studies were undertaken on the assessment of growth and yielding of sweet marjoram, depending on harvest time. The studies were conducted in the years 2004–2005. The sweet marjoram plantation was established from seedlings produced in a glasshouse. The marjoram herb was collected in two harvest time: in mid July (beginning of flowering) and in early September. The yields of fresh, air dry and grated herb were assessed. The contents of essential oil in grated herb, as well as the mineral composition of the herb were determined. The significant effect of harvest time upon the yield of fresh, air-dried and grated herb was demonstrated: the greater yield was achieved in the second harvest time (early September). The herb collected at the beginning of September contained more essential oil than that cut in mid July. Total nitrogen content was significantly greater in marjoram herb from the first harvest than in that from the second harvest.

**Key words:** *Origanum majorana* L., essential oil, macro- and microelements

## INTRODUCTION

Herbal plants assist humans in their daily lives. They are used as spices and medicines. One of the plants widely used for these purposes is sweet marjoram from Lamiaceae family. In our climatic conditions it is grown from sowing directly into the field or from seedlings. Growing from seedlings is more laborious, but smaller quantities of seeds are used and one can obtain plants of equal size on a plantation when climatic and soil conditions are unfavorable. The studies conducted by Jadczak and Orłowski [1998] indicate that better agrotechnical effects are achieved in growing marjo-

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ram from seedlings than from direct sowing seedlings into the field. According to Rumińska [1991] greater yield is obtained from growing marjoram from seedlings.

One of important aspects of herbal production is, besides the yield of raw material, also its quality, determined, in. a. by the contents of active substances and mineral components. The presence of mineral components in herbal raw materials can make their curative properties much wider than what could be expected of the presence of main biologically active substances. The deficiency of these elements may contribute to serious metabolic disorders and increase the risk of various diseases [Ożarowski 1983, Friedrich 2002].

The marjoram herb slightly activates gastric juice secretion, has light anti-spastic and anti-inflammatory effect within the alimentary tract. It is recommended in dyspepsia. Due to its advantageous effect upon the alimentary tract, it is recommended as a seasoning. In order to use herbal materials optimally one should pay attention to the circumstances influencing their chemical compositions. The concentration of biologically active substances, as well as of mineral compounds, depends not only on the species, or kind of raw material, but also on the weather conditions during harvest. That is why the conducted studies were aimed at the assessment of marjoram yielding, depending upon the harvest time. The contents of essential oil and mineral components in the raw material were also determined.

## MATERIAL AND METHODS

The experiment was conducted in the years 2004–2005. Marjoram was grown from seedlings produced in a glasshouse of the Experimental Farm of the Vegetables and Medicinal Plants Department at the University of Life Sciences in Lublin. The marjoram seeds came from the Firm PNOS Ożarów Mazowiecki. The experiment was established in a system of random blocks, in four replications. The seedlings were planted after the 15$^{th}$ day of May in the spacing of 30×40 cm. The plot surface was 2.4 m$^2$. During vegetation the manual weeding was performed on the plantation and the inter-rows were aerated. Before the herb harvest the height of plants was determined on 20 randomly chosen plants. The herb harvest was conducted at the beginning of blossoming, i.e. in mid July (1$^{st}$ harvest) and in early September (2$^{nd}$ harvest). In the first harvest the plants were cut at 5 cm above the ground surface, and in the second term it was slightly higher – about 10 cm over the ground, leaving the lignified parts of stems. After harvest the fresh herb weight was determined, and after drying in natural conditions – the weight of air-dry herb, as well as the weight of grated herb. Grated herb was obtained by passing the air-dry herb through sieves of mesh diameter of 4–5 mm. In the dried raw material the essential oil content was assessed in accordance with pharmacopoeia method [Polish Pharmakopoeia VI 2002], through distillation with water vapor.

The chemical analyses of grated herbs were performed in the extract of 2% acetic acid, using the universal method, according to Nowosielski [1988]. The total nitrogen was determined with the use of Kjeldahl's method, phosphorus with ammonium metawanadate, and sulfur with $BaCl_2$, were determined colorimetrically. After dry burning in the temperature of 550°C, after solving the ash with hydrochloric acid diluted 1:2, po-

tassium, calcium and magnesium were determined with the use of ASA atomic spectrophotometric method (Perkin-Elmer).

The obtained results were statistically elaborated with the use of variance analysis method for single classification at the significance level of $\alpha = 0.05$.

## RESULTS AND DISCUSSION

The thermal conditions in the years 2004 and 2005 were favourable for the growth and development of sweet marjoram plants, which are thermophilous (tab. 1). The mean air temperature from May to September was close to the mean multiannual temperature.

The height of marjoram before the first herb harvest was, on average 28.9 cm (fig. 1). The plants were slightly higher before the second harvest – they grew up to be 32.9 cm high. In the studies conducted by Martyniak-Przybyszewska and Wojciechowski [2004] marjoram reached the height of 30.8 cm, and in the experiment conducted by Nurzyńska-Wierdak and Dzida [2009] – 31.5 cm.

Table 1. Air temperature and total precipitation in 2004 and 2005 years against a background of many-year averages

Tabela 1. Średnie temperatury powietrza oraz sumy opadów w latach 2004 i 2005 na tle średnich wieloletnich

| | Month<br>Miesiąc | 2004 | | | | 2005 | | | | 1951–1995 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | decade – dekada | | | mean<br>średnio | decade – dekada | | | mean<br>średnio | |
| | | I | II | III | | I | II | III | | |
| Temperature<br>Temperatura<br>°C | V | 13.6 | 10.8 | 11.4 | 11.9 | 10.8 | 10.5 | 18.0 | 13.1 | 13.0 |
| | VI | 15.7 | 15.8 | 16.1 | 15.9 | 13.4 | 17.2 | 17.4 | 16.0 | 16.4 |
| | VII | 17.1 | 17.3 | 20.0 | 18.1 | 18.9 | 19.9 | 20.4 | 19.7 | 17.9 |
| | VIII | 19.0 | 19.2 | 17.0 | 18.4 | 16.5 | 16.4 | 17.8 | 16.9 | 17.2 |
| | IX | 14.0 | 14.3 | 10.4 | 12.9 | 16.8 | 14.4 | 13.5 | 14.9 | 12.9 |
| | | | | | Σ | | | | Σ | |
| Precipitation<br>Opady<br>mm | V | 10.1 | 11.3 | 16.6 | 38.0 | 32.8 | 65.0 | 0.2 | 98.0 | 57.2 |
| | VI | 3.7 | 25.9 | 20.3 | 49.9 | 47.1 | 7.4 | 1.4 | 55.9 | 65.9 |
| | VII | 4.7 | 27.5 | 58.3 | 90.5 | 0.0 | 22.4 | 87.4 | 109.8 | 73.6 |
| | VIII | 14.7 | 9.1 | 24.7 | 48.5 | 103.9 | 3.2 | 1.6 | 108.7 | 71.1 |
| | IX | 1.2 | 0.4 | 12.6 | 14.2 | 0.0 | 8.9 | 9.1 | 18.0 | 51.4 |

In the year 2004 the height of marjoram before the first harvest, i.e. in mid July was greater than in the year 2005, which proves that there is an interdependence between plant growth and weather conditions. This was caused by small precipitation in the 2nd and 3rd decade of June, as well as drought in the 1st decade of July 2005 (tab. 1). However, such weather conditions did not significantly affect marjoram yielding. The fresh herb yield, collected in mid July 2004 (first harvest) equaled 0.61 $kg \cdot m^{-2}$, whereas in 2005 it was slightly smaller – 0.58 $kg \cdot m^{-2}$.

The obtained results indicate the significant effect of the harvest time upon the yield of fresh air-dry herb and the grated sweet marjoram herb (tab. 2), which was also indicated in the work by Zawiślak [2008], as well as by Nurzyńska-Wierdak and Dzida

[2009]. The significantly greater yield was obtained during the second cutting. The fresh herb yield collected in the first term (beginning of blooming) was on average 0.59 kg·m$^{-2}$, and in the second term – 0.78 kg·m$^{-2}$. In the studies condudcted by Seidler-Łożykowska et al. [2008] at the beginning of blooming two times smaller yield of fresh marjoram herb was obtained – 0.25 kg·m$^{-2}$. according to Nurzyńska-Wierdak and Dzida [2009] the fresh marjoram yield in the flower-bud phase equaled on average 0.42 kg·m$^{-2}$. The authors demonstrated that the density of planting also significantly affects the quantity of marjoram herb yield, the plants growing in the smallest congestion (spacing: 40×40 cm) were characterized by the greatest fresh and air-dry herb.

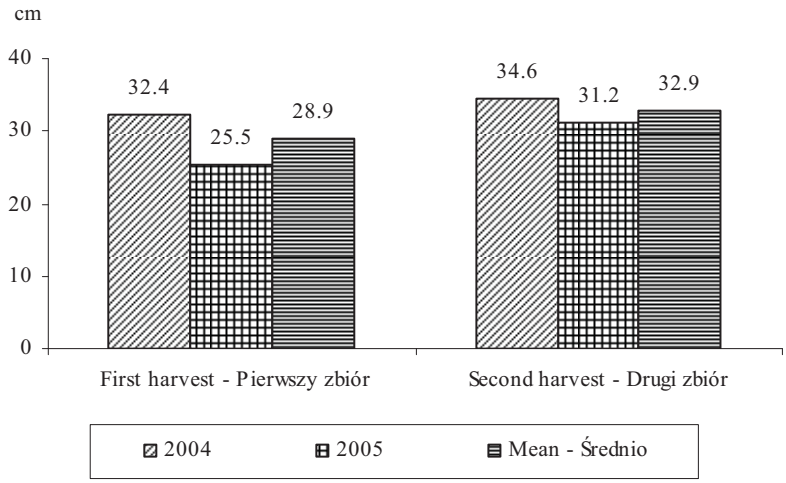


Fig. 1. Height of marjoram plants
Ryc. 1. Wysokość roślin majeranku

A significantly greater yield of air dry and grated herb was obtained from the harvest performed in early September (respectively 0.28 kg·m$^{-2}$ and 0.16 kg·m$^{-2}$) (tab. 2). Seidler-Łożykowska et al. [2009] demonstrated that the participation of stems in sweet marjoram herb may range from 22.1 to 41.1%, depending on where the plantation is located. According to Frąszczak [2004] the grated herb constitutes about 70% of the collected raw material. In the conducted experiment the participation of grated herb in the air dry herb was smaller and more than 40% were the stems. The grated herb, coming from the first swath (mid July) was characterized by similar participation of the stems. Therefore, it can be said that the harvest time did not significantly affect the degree of lignification of the stems, which are discarded when the material is grated.

According to Frąszczak [2004] the most economically recommendable and justifiable is harvesting the herbs twice. The first harvest should be performed when the plants are flowering (late June – early July), and the second one – in early October, without waiting for flower buds to appear. This is how better quality of the material can be achieved.

Table 2. Yield of marjoram plants and essential oil content in the grated herb
Tabela 2. Plon majeranku oraz zawartość olejku eterycznego w zielu otartym

| Harvest time<br>Termin zbioru | Yield of fresh herb<br>Plon świeżego ziela<br>kg·m$^{-2}$ | | | Yield of air dry herb<br>Plon powietrznie suchego ziela<br>kg·m$^{-2}$ | | | Yield of grated herb<br>Plon ziela otartego<br>kg·m$^{-2}$ | | | Participation of grated herb in air dry herb<br>Udział ziela otartego w powietrznie suchym zielu<br>% | | | Essential oil content<br>Zawartość olejku eterycznego<br>% | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2004 | 2005 | mean<br>średnio | 2004 | 2005 | mean<br>średnio | 2004 | 2005 | mean<br>średnio | 2004 | 2005 | mean<br>średnio | 2004 | 2005 | mean<br>średnio |
| First<br>Pierwszy | 0.61 | 0.58 | 0.59 | 0.22 | 0.15 | 0.18 | 0.12 | 0.09 | 0.10 | 54.5 | 60.0 | 57.2 | 2.05 | 1.85 | 1.95 |
| Second<br>Drugi | 0.82 | 0.74 | 0.78 | 0.31 | 0.26 | 0.28 | 0.17 | 0.16 | 0.16 | 54.8 | 61.5 | 58.1 | 2.23 | 2.56 | 2.39 |
| Mean<br>Średnio | 0.71 | 0.66 | 0.68 | 0.26 | 0.20 | 0.23 | 0.14 | 0.12 | 0.13 | 54.6 | 60.0 | 57.6 | 2.14 | 2.20 | 2.17 |
| LSD NIR$_{0.05}$<br>harvest time<br>termin zbioru | 0.101 | n.s. | 0.095 | 0.046 | 0.086 | 0.054 | n.s. | 0.064 | 0.033 | | | | 0.093 | 0.093 | 0.199 |
| year– lata | | | n.s. | | | n.s. | | | n.s. | | | | | | n.s. |

Table 3. Chemical composition of marjoram herb (% d.m.)
Tabela 3. Skład chemiczny ziela majeranku (% s.m.)

| Harvest time<br>Termin zbioru | N-total – N-og | | | P | | | K | | | Ca | | | Mg | | | S | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2004 | 2005 | mean<br>średnio | 2004 | 2005 | mean<br>średnio | 2004 | 2005 | mean<br>średnio | 2004 | 2005 | mean<br>średnio | 2004 | 2005 | mean<br>średnio | 2004 | 2005 | mean<br>średnio |
| First<br>Pierwszy | 3.73 | 3.32 | 3.72 | 0.22 | 0.19 | 0.20 | 2.61 | 2.58 | 2.59 | 1.44 | 1.00 | 1.22 | 0.10 | 0.12 | 0.11 | 0.19 | 0.20 | 0.19 |
| Second<br>Drugi | 3.31 | 3.08 | 3.19 | 0.23 | 0.16 | 0.19 | 2.62 | 2.26 | 2.44 | 1.16 | 0.88 | 1.02 | 0.11 | 0.08 | 0.09 | 0.21 | 0.17 | 0.19 |
| Mean<br>Średnio | 3.52 | 3.40 | 3.46 | 0.22 | 0.17 | 0.19 | 2.61 | 2.42 | 2.51 | 1.30 | 0.94 | 1.12 | 0.10 | 0.10 | 0.10 | 0.19 | 0.18 | 0.19 |
| LSD NIR$_{0.05}$<br>harvest time<br>termin zbioru | 0.216 | 0.137 | 0.176 | n.s. | n.s. | n.s. | n.s. | 0.203 | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. |
| year– lata | | | n.s. | | | n.s. | | | n.s. | | | n.s | | | n.s. | | | n.s. |

The content of active compounds in herbal raw materials is one of quality determinants. In sweet marjoram herb the essential oil is an important biologically active substance.

On the basis of the conducted laboratory tests it was demonstrated that the content of essential oil in the grated herb depended on the time of collecting the raw material (tab. 2). Significantly more essential oil was found in the herb harvested in the second time (2.39%), than in the raw material from the first swath (1.95%). Less oil was revealed by the studies of Nurzyńska-Wierdak and Dzida [2009]. The authors report that mean content of oil in the herb collected at the beginning of flowering was 1.51%, while the raw material obtained from the second harvest time contained 1.74% of oil. According to Matławska [2005] the occurrence of essential oil in the herb may range from 0.2 to 2.5%. In the studies conducted by Czarnecki and Załęcki [1986] the oil content ranged from 1.18 to 1.58%, and in the work by Tabanca et al. [2004] it occurred on the level of 1.18–1.58%. Frąszczak [2004] reports that the oil content in marjoram herb of 'Miraż' cultivar may range from 1.4 to 1.6%. According to Zawiślak [2008] it ranged from 1.7 to 2.2%, whereas Seidler-Łożykowska et al. [2009] demonstrated the oil content in sweet marjoram herb of 'Miraż' cultivar on the level of 2.0%.

The analysis of sweet marjoram herb chemical composition demonstrated a significant effect of harvest time upon the total nitrogen content (tab. 3). The herb coming from the first swath contained the most total nitrogen (3.72% d.m.). Similar results were obtained by Dzida and Jarosz [2006]. In the studies by Nurzyńska-Wierdak and Dzida [2009] the total nitrogen content in the herb was smaller and equaled 2.99% d.m. No significant dependence, however, was found between harvest time and accumulation of the remaining elements. Nevertheless, on average more phosphorus, potassium, calcium and magnesium was found in the raw material from the first than from the second harvest. These differences were more distinct in particular years when the studies were conducted, which indicates the effect of weather conditions in harvest period upon the contents of mineral components in the marjoram herb.

The phosphorus content ranged from 0.19 to 0.20% d.m. And was comparable to that determined by Dzida and Jarosz [2006], as well as by Nurzyńska-Wierdak and Dzida [2009]. The concentrations of potassium, calcium and magnesium in marjoram herb was higher than in the studies by Nurzyńska-Wierdak and Dzida [2009]. According to Dzida and Jarosz [2006] calcium content in marjoram herb may range from 0.66 to 1.59% and depends upon nitrogen-potassium fertilization.

## CONCLUSIONS

1. The influence of weather conditions upon growth of sweet marjoram plants was confirmed. The height of marjoram before the first harvest in the year 2005 was lower than in the year 2004, which was related to smaller precipitation.

2. Significant influence of harvest time upon sweet marjoram yielding was demonstrated. The highest yield of fresh, air dry and grated herb was obtained in the second harvest time (early September).

3. The essential oil content in marjoram herb was significantly dependent upon harvest time; the herb collected in early September (2nd swath) contained more essential oil than that collected in mid July (1st swath).

4. The effect of harvest time upon total nitrogen content was revealed. The most nitrogen was found in the raw material collected in mid July. No significant effect was demonstrated upon the contents of phosphorus, potassium, calcium, magnesium and sulfur. The herb harvested in the first time generally contained more of the above-mentioned elements than the herb collected in the second harvest time.

## REFERENCES

Czarnecki M., Załęcki R., 1986. Wpływ sposobu uprawy majeranku ogrodowego (*Origanum majorana* L.) na plon i wartość surowca. Herba Pol. XXXII, 3–4, 217–223.

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.

Friedrich M., 2002. Składniki mineralne w żywieniu ludzi i zwierząt. Wyd. AR w Szczecinie.

Frąszczak B., 2004. Majeranek na dwa pokosy. Warzywa 1, 30–31.

Jadczak D., Orłowski M., 1998. Wpływ niektórych zabiegów agrotechnicznych na plonowanie majeranku ogrodowego. Zesz. Nauk. AR Wrocław, Rol. 42, 89–93.

Martyniak-Przybyszewska B., Wojciechowski T., 2004. Plonowanie wybranych gatunków roślin przyprawowych w rejonie Olsztyna. Folia Univ. Agric. Stetin., Agricultura 239 (95), 245–248.

Matławska I., 2005. Farmakognozja. AM w Poznaniu, 328.

Nowosielski O., 1988. Zasady opracowywania zaleceń nawozowych w ogrodnictwie. PWRiL Warszawa.

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.

Ożarowski A., 1983. Ziołolecznictwo. Poradnik dla lekarzy. PZWL Warszawa.

Polish Pharmakopoeia VI., 2002. Polskie Towarzystwo Farmaceutyczne, Warszawa.

Rumińska A., 1991. Poradnik plantatora ziół. PWRiL Warszawa.

Seidler-Łożykowska K., Golcz A., Wójcik J., 2008. Field and quality of sweet basil, savory, marjoram anh thyme Raw materiale from organic cultivation on the composted manure. J. Res. Appl. Agric Engin. 53 (4), 63–66.

Seidler-Łożykowska K., Mordalski R., Kucharski W., Golcz A., Kozik E., Wójcik J., 2009. Economic and qualitative value of the raw material of Chojen species of madicinal plant IV. Yield and quality of herb and seed yield of sweet marjoram (*Origanum majorana* L.). Acta Sci. Pol., Agricultura 8 (4), 55–61.

Tabanca N., Özek T.,Baser K. H. C., Tümen G., 2004. Comparison of the Essential Oils of *Origanum majorana* L. and *Origanum* × *majoricum* Cambess. J. Essent. Oil Res. 16, 248–252.

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

# PLON I JAKOŚĆ ZIELA MAJERANKU OGRODOWEGO W ZALEŻNOŚCI OD TERMINU ZBIORU

**Streszczenie.** Jednym z ważniejszych gatunków roślin zielarskich uprawianych w wielu krajach dla celów leczniczych i spożywczych jest majeranek ogrodowy. Ziele majeranku jest bogatym źródłem cennych substancji biologicznie aktywnych oraz składników mineralnych. Mając na uwadze szerokie zastosowanie tej rośliny, podjęto badania nad oceną wzrostu i plonowania majeranku ogrodowego w zależności od terminu zbioru. Badania przeprowadzono w latach 2004–2005. Plantację majeranku ogrodowego założono z rozsady wyprodukowanej w szklarni. Ziele majeranku zebrano w dwóch terminach: w połowie lipca (początek kwitnienia) oraz na początku września. Oceniono plon świeżego, powietrznie suchego oraz ziela otartego. Określono zawartość olejku eterycznego w zielu otartym oraz skład mineralny ziela. Wykazano istotny wpływ terminu zbioru na plon świeżego, powietrznie suchego i ziela otartego, większy plon uzyskano w drugim terminie zbioru (początek września). Ziele zebrane na początku września zawierało więcej olejku niż ścięte w połowie lipca. Zawartość azotu ogółem była istotnie większa w zielu majeranku z pierwszego niż drugiego zbioru.

Słowa kluczowe: *Origanum majorana* L., olejek eteryczny, makro- i mikroskładniki

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