

THE EFFECT OF THE METHOD OF PLANTATION ESTABLISHMENT AND HARVESTING TIME ON SOME MORPHOLOGICAL FEATURES OF PLANTS AND ESSENTIAL OIL CONTENT IN LOVAGE ROOTS (*Levisticum officinale* Koch.)

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Abstract. The field studies were carried out in 2002–2004 on brown soil of loess origin. In the experiment the following methods of plantation establishment were compared: direct sowing in the field (control); direct sowing in the field with cover of polypropylene sheet; by seedlings from plastic house; by seedlings produced in multicell propagation trays. There were two dates of leaf cutting: in August and before root harvest (October). Plants cultivated from seedlings were significantly higher and formed greater number of leaves as well as greater weight of above and under ground parts than in the cultivation from direct seeding, but the best results were obtained in the object with seedlings produced in multicell propagation trays. The use of polypropylene sheet positively affected the above ground parts of lovage, however caused significant decrease in root mass. Leaf cutting in the summer was connected with decrease in fresh root weight (by 40% in relation to plants with no leaf harvest) and essential oil content (from 0.85 to 0.52%). More active substances in lovage roots were accumulated in the plants obtained from direct seeding than from transplants.

Key words: lovage, *Levisticum officinale*, method of plantation establishment, harvesting time

INTRODUCTION

Lovage (*Levisticum officinale* Koch), belonging to the *Apiaceae* family, is a perennial herbaceous plant with a characteristic celery-like flavour and smell. It is well known as medicinal and seasoning material. The roots, containing above 0.7% of essential oil are used for expectorant, stomachic and stimulant activities. Lovage roots may also function as a medicine possessing antispasmodic, diuretic and carminative proper-

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ties. In the food processing industry the under ground parts of the plants are used in the manufacture of bouillon cubes or liquid stock. Besides, young and fresh leaves can be eaten as vegetable while dried leaves may be employed as flavouring in soups, sauces and salads [Blank and Schieberle 1993, Hogg et al. 2001, Forycka 2002].

The recommended methods of lovage cultivation are sowing the seeds directly in the field or planting seedlings [Kordana and Kordana 1999]. Previous research concerning the cultivation of this plant do not unequivocally indicate relationships between the development of plants, active compounds content and the methods of plantation establishment. The present studies assessed the possibility of introducing into the agronomical practices of lovage a system of seedling production using propagation trays and the polypropylene sheet to cover the soil immediately after sowing the seeds. Such methods are successfully used in the cultivation of other plants [Lutomirska 1995, Słodkowski 1999, Sugier 2004], therefore it seems worthwhile to conduct experiments on this problem. The aim of this study was to determine the effect of the method of plantation establishment and the date of leaf cutting on some morphological features of lovage plants as well as the essential oil content in roots.

MATERIAL AND METHOD

The studies were conducted in the years 2002–2004 at the Experimental Station in Zamość on brown soil of loess origin, characterising with a medium humus and magnesium content, a very high phosphorus and potassium content, and a neutral reaction. In the experiment the following methods of plantation establishment were compared: 1) direct sowing in the field (control object); 2) direct sowing in the field with cover of polypropylene sheet; 3) by planting seedlings obtained from a plastic house; 4) by planting seedlings produced in multicell propagation trays. The secondary factor was the date of leaf cutting: in August (from half of the plants within each object) and before root harvest in October (from all the plants within each object). The experiment was performed using random blocks in four replications on 20-square-meter plots. Each year the following doses of mineral fertilizers were applied ($\text{kg}\cdot\text{ha}^{-1}$): 70 N, 25 P and 90 K. In order to obtain seedlings, the seeds of lovage were sown in a heated plastic house in the middle of March, on a peat substrate as well as onto multicell propagation trays filled with the same peat substrate. Seeds were sown in the field in mid-April. Immediately after sowing, the designated plots were covered with polypropylene sheet that was later removed when the plants reached the height of 15 cm. The seedlings were transplanted to the field in early May. For all objects the row spacing of 50×40 cm was applied. During the harvest the height of plants and the number of leaves were determined, and also the fresh weight of above and under ground parts of plants were recorded (based on 20 plants from each object). After drying (at a temperature of 35°C) the essential oil content in the root samples was determined by means of steam distillation method, using the Deryng apparatus. The figures obtained were worked out statistically and the lowest significant differences were calculated applying Tukey's confidence intervals at 5% error margin.

RESULTS AND DISCUSSION

The results proved the significant effect of the method of plantation establishment on morphological features of lovage plants. Independently of the harvesting time, plants in objects with seedlings were significantly higher and had more leaves than in objects where direct sowing was used, but the method of seedling production had no significant influence on these features (tab. 1). The use of polypropylene fibre cover contributed to the development of the above ground parts of plants. According to Lutomirska [1995] and Prośba-Białczyk and Mydlarski [1998], polypropylene sheet accelerates the emergence and the development of the assimilation area. The present studies showed that the covered plants formed significantly more leaves in the rosette, but their height was virtually identical to the control object. Similar results were obtained by Słodkowski et al. [1999] in the case of garden dill.

Table 1. Some morphological features of lovage depending on the method of plantation establishment and harvesting time (mean for years 2002–2004)

Tabela 1. Wybrane cechy morfologiczne lubczyku ogrodowego w zależności od sposobu zakładania plantacji i terminu zbioru liści (średnio w latach 2002–2004)

Method of plantation establishment Sposób zakładania plantacji	Harvest time Termin zbioru	Height of plants Wysokość roślin (cm)	Number of leaves (No.) Liczba liści (szt.)	Fresh matter of leaves (g per plant) Świeża masa liści (g-rośl. ⁻¹)
Sowing in the field – control	1	66.0	23.4	299
Siew w pole – obiekt kontrolny	2	23.1	12.8	58
	3	68.4	25.2	392
Mean – Średnio		52,5	20,5	250
Sowing in the field + cover of polypropylene	1	67.2	25.8	363
Siew w pole + agrowłóknina	2	22.6	12.7	67
	3	69.2	27.4	417
Mean – Średnio		53,0	22,0	282
Seedlings from plastic house	1	78.3	31.2	504
Rozsada z tunelu	2	50.4	28.6	262
	3	81.3	33.8	534
Mean – Średnio		70,0	31,2	433
Seedlings from multiplates	1	80.6	32.8	545
Rozsada z tac wielokomórkowych	2	46.3	26.1	223
	3	84.3	34.6	616
Mean – Średnio		70,4	31,2	461
Mean for harvest times	1	73.0	28.3	428
Średnio dla terminów zbioru	2	35.6	20.0	153
	3	75.8	30.2	490
NIR _{0,5}				
Method of plantation establishment A – Sposób zakładania plantacji A		1.5	1.2	21
Harvesting time B – Termin zbioru B		1.2	0.9	17
Interaction A × B – Interakcja A × B		3.3	2.6	47

1 – The first harvest (in summer) – Pierwszy zbiór liści (latem)

2 – The second harvest (in autumn) – Drugi zbiór liści (jesienią)

3 – Single leaf harvest (in autumn) – Jednokrotny zbiór liści (jesienią)

The fresh weight of leaves depended to a large extent on the method of plantation establishment, whereas statistically significant differences were achieved between all the objects. The greatest increase of the weight was obtained in the object with seedlings produced in multicell propagation trays (on average by 84.4%, as compared to the control object).

The morphological features of lovage plants significantly depended on the date of leaf cutting. Independently of the method of plantation establishment, the most developed plants (the tallest, with the greatest number and weight of leaves) were observed during the autumn harvest, whereas significantly lower values of the examined features were recorded when cutting the above ground parts in summer. However, the lowest plants, also characterized by the lowest number and weight of leaves, were obtained during a repeated harvest in October. Interestingly, after cutting the leaves in summer, plants cultivated from seedlings regenerated considerably faster, as compared to the direct seeding. In consequence, during the autumn harvest the weight of the leaves in the case of objects with seedlings was four times higher than in the control.

The fresh weight of lovage roots depended to a large extent on the method of plantation establishment, whereas statistically significant differences were observed between all experimental objects (tab. 2). Much better results were achieved when plants were propagated from seedlings than from direct sowing, but the most successful method of plantation establishment was by transplanting seedlings produced in multicell propagation trays (independently of the harvesting time, the root weight was significantly higher by 97.7%, as compared to the control object). The results obtained were confirmed by research conducted by Sugier [2004], in which she demonstrated that cultivation of common dandelion from seedlings gave much better results than direct sowing in the field.

Table 2. Fresh roots weight depending on the method of plantation establishment and harvesting time (g per plant)

Tabela 2. Świeża masa korzeni lubczyku w zależności od sposobu zakładania plantacji i terminu zbioru liści (g-rośl.⁻¹)

Method of plantation establishment Sposób zakładania plantacji	Single leaf harvest Jednokrotny zbiór liści	Double leaf harvest Dwukrotny zbiór liści	Mean Średnio
Sowing in the field – control Siew w pole – obiekt kontrolny	228	115	172
Sowing in the field + cover of polypropylene Siew w pole + agrowłóknina	185	130	158
Seedlings from plastic house Rozsada z tunelu	360	237	299
Seedlings from multiplates Rozsada z tac wielokomórkowych	439	249	344
Mean – Średnio	303	183	243

NIR_{0,05}
 Method of plantation establishment A – Sposób zakładania plantacji A 13
 Harvesting time B – Termin zbioru B 7
 Interaction A × B Interakcja A × B 22

The lowest root weight was recorded in the object where polypropylene sheet was used (significantly lower by 8.1%, as compared to the cultivation with no cover). The results achieved do not confirm the results of research conducted by Słodkowski [1998] and Wadas et al. [2001] who found that using polypropylene sheet increased the yield of carrot roots and potato tubers by 69% and 29%, respectively. The poorer development of lovage roots under the cover probably resulted from increased infestation, which was also observed by Lutomirska [1995]. She proved that good thermal and humidity conditions in covered soil not only facilitate the development of cultivated plants, but, above all, they are conducive to the germination of weeds.

The fresh weight of lovage roots significantly depended on the harvesting time. The additional leaf cutting in August caused a significant decrease of root weight (on average by 40%, as compared to plants harvested once – at the end of the growing season). The same tendency was observed by Galambosi and Szebeni-Galambosi [1992]. Furthermore, the authors of the study proved that harvesting leaves in the vegetation season has a negative impact on the accumulation of essential oil in the roots, which was also confirmed by this experiment (fig. 1). Leaving the above ground parts of lovage until autumn increased the active component in roots from 0.52% to 0.85%. Independently of the date of leaf harvest, growing lovage from direct seeding was more profitable than cultivation from transplants, but the highest content of essential oil was achieved on the object where plants were propagated from direct sowing with leaf cutting in autumn.

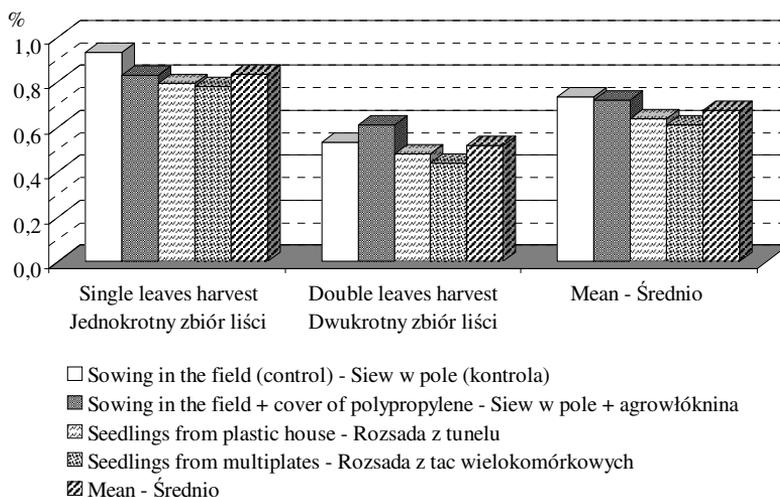


Fig. 1. Essential oil content in lovage roots depending on the method of plantation establishment and harvesting time (mean for years 2002–2004)

Ryc. 1. Wpływ sposobu zakładania plantacji i terminu zbioru liści na zawartość olejku eterycznego w korzeniach (średnio w latach 2002–2004)

CONSLUSIONS

1. Lovage plants cultivated from seedlings were significantly higher and formed significantly greater number of leaves as well as the weight of above and under ground parts of plants, as compared to the cultivation from direct sowing in the field.

2. From among four methods of plantation establishment the best results were observed in the case of planting seedlings produced in multicell propagation trays. This method of cultivation significantly increased the fresh weight of lovage leaves and roots in relation to the object with seedlings obtained from plastic house.

3. Using the cover of polypropylene sheet positively affected the weight of above ground parts of plants but caused a significant decrease of root weight (by 8.1% in comparison with the cultivation without covering).

4. The additional leaf cutting in August was connected with significant decrease of root weight (by 40%, as compared to plants harvested at the end of the growing season) and essential oil content in raw material (from 0.85% to 0.52%).

5. Independently of the date of leaf harvest, higher essential oil content in lovage roots was achieved when the plants were propagated from direct sowing in the field than from transplants.

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WPLYW SPOSOBU ZAKŁADANIA PLANTACJI I TERMINU ZBIORU LIŚCI NA WYBRANE CECHY MORFOLOGICZNE LUBCZYKU OGRODOWEGO (*Levisticum officinale* Koch.) I ZAWARTOŚĆ OLEJKU ETERYCZNEGO W KORZENIACH

Streszczenie. Doświadczenie przeprowadzono w latach 2002–2004 na glebie brunatnej pochodzenia lessowego. Porównywano następujące metody zakładania plantacji: wysiew nasion w pole (kontrola); wysiew nasion w pole z przykryciem agrowłókniną; wysadzanie rozsady uzyskanej w tunelu foliowym; wysadzanie rozsady wyprodukowanej w tacach wielokomórkowych w tunelu foliowym. W doświadczeniu zastosowano dwa terminy zbioru liści: w sierpniu oraz na początku października (bezpośrednio przed wykopaniem korzeni). Rośliny uprawiane z rozsady były istotnie wyższe, tworzyły więcej liści w roziecie oraz większą świeżą masę części nadziemnych i korzeni w porównaniu z roślinami uzyskanymi z siewu nasion w pole, jednakże najlepsze efekty dało wysadzanie rozsady wyprodukowanej w tacach wielokomórkowych. Zastosowanie agrowłókniny dodatnio wpłynęło na rozwój części nadziemnych, jednak przyczyniło się do istotnego zmniejszenia masy korzeni. Ścinanie liści lubczyku w sierpniu wiązało się ze zmniejszeniem masy korzeni (śr. o 40%) i zawartości olejku eterycznego w surowcu (śr. z 0,85% do 0,52%) w odniesieniu do roślin, których część nadziemną pozostawiono do jesieni. Więcej olejku gromadziły rośliny uzyskane z wysiewu nasion wprost do gruntu niż z rozsady.

Słowa kluczowe: lubczyk, *Levisticum officinale*, sposób zakładania plantacji, termin zbioru

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