Effect of Cultivation Techniques on Mint Oils in Northern Finland

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Among different aromatic plants grown in Finland are various mints, of which peppermint (*Mentha piperita* L.) in particular is interesting for several reasons. Every year approximately 61 tons of different essential oils are imported to Finland.[1] Of those 61 tons, 20 tons are peppermint oil.

Peppermint is a long-day plant requiring at least 15 h of daylight, and it is a relatively cold-tolerant species.[2] In North Ostrobothnia the average day length is 18 h in May, 21 h in June, 20 h in July, and 17 h in August. Moreover, the content of heavy metals such as lead and cadmium in herbal plants has been found to be less in Finland than in Central Europe.[3]

Most Finnish entrepreneurs involved in herbal production are farmers who grow herbs as an additional source of income.

The initial aim of this study was to solve the problem of overwintering. Usually mint plants that are older than three years overwinter poorly. Also, over a three-year period, the amount of weeds increases while the quantity and quality of oil produced decreases. For these reasons, it is important to find winter-hardy clones, and to determine if mint can be grown as an annual or as a two-year plant. For this purpose, it was necessary to determine the most favorable planting time in the northern climate. A second objective of this study was to find the optimal planting density of mint.

Material and Methods

This study was carried out in 1994 and 1995 at experimental fields at the North Ostrobothnia Research Station of the Agricultural Research Centre of Finland. The fields were located at Ruukki (64°40'N, 25°05'E) 250 km below the Arctic circle. The soil type was fine sand with a pH of between 5.2 and 6.2. Chemical fertilizer provided nitrogen at a rate of 40 kg/ha. Hay mulch was used as a weed control immediately after planting. Plants were usually harvested at the end of August.

The mint plants were micropropagated in the Department of Botany in the University of Oulu. Essential oil constituents were determined in the Department of Chemistry in the University of Oulu by gas chrom-atography[a] with a flame ionization detector and identified by GC/MS with an ion trap detector[b].

In our study, we looked at three variables: mint type, planting density and planting time.

Mint type: In order to investigate the volatile oil composition and yield, we planted six peppermint clones of different origin (Table 1) and four other species of mints in four experimental plots of 7.5 m^2 each on May 30, 1994. The inter-plant distance was 50 cm between each row and 30 cm between plants in a row.

Planting density: To investigate the effect of plant density, we planted three plots each of peppermint from Hungary on June 3, 1994 and June 7, 1995. The inter-plant distance was 50 cm between each row and 10, 20 or 30 cm between plants in a row.

Planting time: To study the best planting time of annual or two-year plants, we planted four plots of peppermint from Hungary, one each on May 27, June 2, June 9 and June 16, 1995. The May date was immediately after the snow had melted and the frost was over. The inter-plant distance was 50 cm between each row and 10 cm between plants in a row.

Results and Discussion

Mint types: The yield of fresh biomass for the first year of growth differed among the six *M. piperita* clones from different origins, and this difference was determined to be statistically significant (p=0.0185). The highest yield was found to be 10,800 kg/ha for the peppermint of Polish origin. The oil content was in the range 1.33-2.26%, but the

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[a] Fractovap 4160, Carlo Erba, Milan, Italy
[b] Perkin-Elmer, Norwalk, Connecticut

Table 1. Mints, planting densities and planting times used in the study

Botanical name	Source	Planting date	Spacing* (cm)	Planting date	Spacing* (cm)
Mint types					
Mentha x *piperita* L.	China	May 30	30		
Mentha x *piperita* L.	Bulgaria	May 30	30		
Mentha x *piperita* L.	Hungary	May 30	30		
Mentha x *piperita* L.	USA	May 30	30		
Mentha x *piperita* L.	Poland	May 30	30		
Mentha x *piperita* L.	Finland	May 30	30		
Mentha arvensis L.	China	May 30	30		
Mentha arvensis var. *sacchalinensis* Briq.	China	May 30	30		
Mentha suaveolens Ehrh.	Helsinki	May 30	30		
Mentha gentilis var. *parviflora*	Helsinki	May 30	30		
Plant density					
Mentha x *piperita* L.	Hungary	June 3	10	June 7	10
			20		20
			30		30
Planting time					
Mentha x piperita L.	Hungary			May 27	10
				June 2	10
				June 9	10
				June 16	10

* This is the within-row spacing. Spacing between rows was constant at 50 cm.

differences were not statistically significant (p=0.0580). The main components of the six oils of *M. piperita* can be seen in Table 2. There was a statistically significant difference (p=0.0231) in the oil content of *M. piperita* and other mint species.

M. arvensis contained the highest oil percentage (2.48%). The main components of the two forms of *M. arvensis*, which were found to be similar, are summarized as follows:

limonene (1.9-2.5%)
1,8-cineole (0.1-0.2%)
menthone (20.2-24.6%)
menthyl acetate (0.4-2.5%)
menthol (62.1-69.8%)

The main components of *M. suaveolens*, a European species, were determined to be:

limonene (15.8%)
1,8-cineole (4.6%)
β-bourbonene (2.2%)
β-caryophyllene (1.7%)
l-carvone (62.3%)
δ-cadinene (1.8%)
isopiperitenone (1.2%)

Analysis of *M. gentilis* var. *parviflora*, an uncommon mint, can be summarized as follows:

β-pinene (4.6%)
3-octanone (5.6%)
limonene (8.4%)
1,8-cineole (4.6%)
3-octanol (22.0%)
β-caryophyllene (5.1%)
carvone (35.5%)

Table 2. The main components (%) of the peppermint (*M. piperita*) clones

Compound	1	2	3	4	5	6
limonene	8.1	2.3	2.7	2.6	1.4	1.4
1,8-cineole	5.3	4.9	7.5	6.7	4.3	4.7
menthone	58.5	64.9	48.3	50.3	71.3	68.0
menthyl acetate	2.2	0.5	1.1	1.1	1.0	0.9
menthol	14.5	16.1	26.2	19.5	11.9	15.3

Legend: 1 = Chinese origin; 2 = Bulgarian origin; 3 = Hungarian origin; 4 = US origin; 5 = Polish origin; 6 = Finnish origin

The differences in oil components of *M. piperita* L., *M. arvensis* and *M. arvensis* var. *sacchalensis* of different origin were statistically significant (p=0.0001). Generally, the content of menthol in *M. piperita* was lower (10-25%) than the menthone content (50-75%). In both *M. arvensis* types, the menthol and menthone contents were closer to those recommended in various European pharmacopeias.

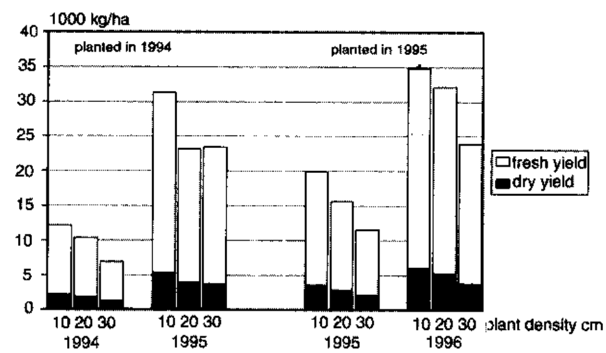

Figure 1. Effect of planting density (space between plants in a row) on fresh and dry biomass yield from *M. piperita* ("Mitcham" from Hungary) planted in 1994 and 1995 (Space between rows was constant at 50 cm)

Table 3. Main components (%) of peppermint plants (*M. piperita* from Hungary) in the second year after planting at three different planting densities

Compound	10 cm	20 cm	30 cm
limonene	0	0.3	0.5
1,8-cineole	5.0	4.7	4.9
menthone	48.6	54.5	50.8
menthyl acetate	2.5	2.4	2.3
menthol	28.0	23.2	25.9

Plant density: A higher planting density produced a higher yield of fresh and dry biomass (Figure 1), but the difference was not statistically significant. There was a statistically significant effect on the second-year yield. With a low density (spacing of 30 cm), the biomass yield was significantly less than with higher densities ($F=17.26$ and $p=0.0108$). The effect of plant density on the oil content was not significant. The amount of menthol in the second year was highest with the greatest plant density (a spacing of 10 cm) (Table 3).

Planting time: The effect of the planting time on the fresh and dry biomass yields of peppermint in the first year (1995) was statistically significant ($F=20.60$ and $p=0.0015$, $F=25.25$ and $p=0.0008$). The highest yield was obtained from the earliest planting time. The trend of the second-year yield was similar to that of the first year, but it was not statistically significant (Figure 2). In the first year, the percentage of dry leaves was 57% and the height of plants at cutting time was 71 cm when planted in the early spring versus 69% and 53 cm when planted three weeks later. In early planting, the overwintering was about 8% more than in later planting.

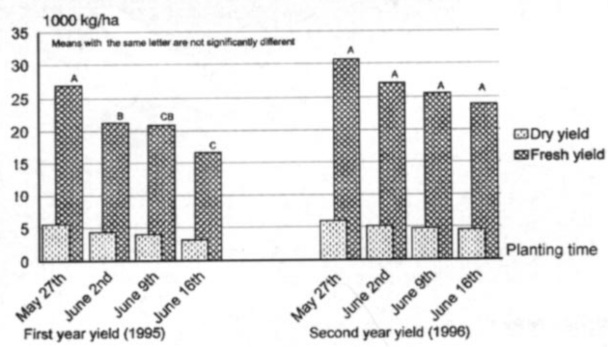

Figure 2. Effect of planting time on the first- and second-year biomass yield of *M. piperita* ("Mitcham" from Hungary) planted in 1995

Conclusions

The content of menthol in peppermint grown in Finland is low in comparison to international standards. Further studies are needed to find out the reason for this.

M. arvensis from China had the highest menthol content (70%). The highest menthol percentage was obtained with the highest plant density (spacing of 10 cm). The highest yield was achieved by planting in the early spring.

References

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1. *Ulkomaankauppa 1994, osa 3,* written and published by The Finnish National Board of Custom STV, Helsinki (1995) p 472
2. C Franz, J Hölzl , A Ceylan and A Vömel, Influence of the growing site on the quality of *Mentha piperita* L. oil, *Acta Hort* **144** 145-150 (1984)
3. B Galambosi and J Kumpulainen, Heavy metal content of herbs grown in Finland and Central Europe. *Abstracts of the 20th International Symposium on Essential Oil,* Wurtzburg, Germany (1989) p 28