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Melissa officinalis: Comparison of the new selection Lorelei with different cultivars*

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Introduction

Lemon balm (*Melissa officinalis* L.) is well known especially for the pleasant aromatic and therapeutic properties of its leaves. Essential oil is considered to be the main therapeutic principle, but plant phenolics, especially rosmarinic acid, are involved too. Rosmarinic acid has become a compound attracting much interest amongst the active principles of lemon balm in the last years (1, 2, 3). In Switzerland, lemon balm is one of the principal aromatic plants cultivated. It is used primarily by food industry for the production of candies, herbal teas or ice tea.

To improve the performance of lemon balm, Agorscope ACW conducted a breeding programme. The recently created cultivar Lorelei was compared to 10 other cultivars from Germany, France and Switzerland in 2005 and 2006. The aim of this study was to examine the agronomic, aromatic and therapeutic properties of these cultivars.

Materials and methods

11 cultivars (Table 1) were tested in Bruson (VS, altitude 1060 m, north-eastern exposure; 10 % of slope, sandy soil). The experimental design was a complete randomised block with 4 replications.

After sowing the different cultivars, on March 29 in 2005 and transplantation to trays 4 weeks later, the seedlings were planted in the field on June 1 at Bruson (5 plants/m^2). Fertilisers authorized in organic farming (Biorga NR, Granuphos, Patentkali) were used according the guidelines for fertilisation of lemon balm (in kg per hectare: 110 N, 50 P_2O_5, 160 K_2O and 30 Mg) (3).

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Table 1. **Characteristics of the 11 cultivars analysed in the trial in Bruson from 2005 to 2006**

Cultivar	Breeder	Country
Lorelei	Agroscope ACW / DSP AG	Switzerland
Landor	Agroscope ACW / DSP AG	Switzerland
Quedlinburger Niederliege	N.L. Chrestensen	Germany
Citronnella	N.L. Chrestensen	Germany
Erfurter Aufrechte	N.L. Chrestensen	Germany
Stamm NLC	N.L. Chrestensen	Germany
Aufrechter Typ	Pharmassaat	Germany
Lemona	Pharmassaat	Germany
VS 1	Iteipmai	France
VS 2	Iteipmai	France
VS 3	Iteipmai	France

The nitrogen application was split (in spring and after the 1st harvest). The balm crop was irrigated. No plant protection treatment was applied. Weeding was made manually between the plants and with a harrow between the lines. The harvested plants were dried at a temperature of 35°C. The number of trichomes of the last fully developed leaf on the stem was counted with a binocular (5 leaves per replication).

Hydrodistillation was made according to the European Pharmacopoeia. The composition of essential oil was quantified with gas chromatography (GC/FID) and the rosmarinic acid and the phenylpropane derivatives (expressed as caffeic acid) with HPLC/UV by the laboratory ILIS Sàrl, Bienne, Switzerland. Sensory analysis of herbal tea based on lemon balm was conducted in an adapted laboratory with a semi-trained panel. The panel (15 persons) evaluated the intensity of the lemon flavour of 5 hot herbal teas of different cultivars on a scale from 1-9. For the preparation of herbal teas 30 g of dried leaves were put in 1 l of boiling water. After 3 min. the herbal tea was filtered using a fine mesh and was kept in isothermal containers.

Results and discussion

The cultivars Lorelei, Landor, Erfurter and Stamm gave the highest yields (Figure 1). The erect growth habitus of these 4 cultivars in the first year after plating and in autumn allowed them to produce a higher yield during this period compared to the other cultivars. In the opposite, the cultivars with a procumbent growth habitus in the first year and for some cultivars also in autumn such as Quedlinburger Niederliege, Citronella, Aufrechter Typ, Lemona and VS 1 the dry matter yield was significantly lower. For some other agronomic traits, high differences could also be detected between the cultivars. The

homogeneity of the cultivars was quite well excepting the cultivar VS3 and to a lesser extent Aufrechter Typ. Concerning the resistance to plant diseases it appeared that the cultivar Stamm was very sensitive to powdery mildew.

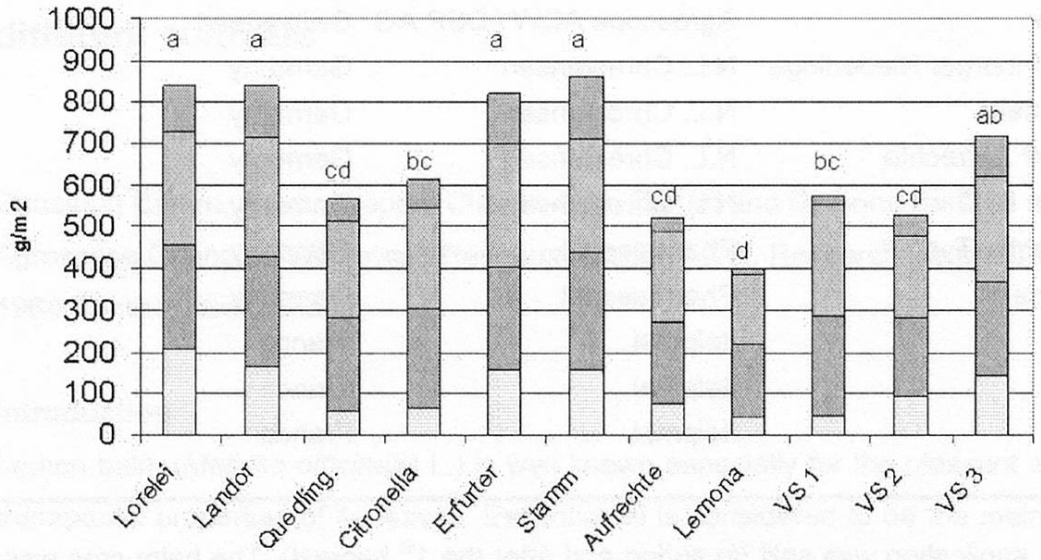

Figure 1: **Dry matter yield (bars indicating harvest 2005, 1st, 2nd, 3rd harvest 2006; bottom up) of 11 cultivars of lemon balm in Bruson. Different letters indicate significant differences between the cultivars (p<5%).**

Table 2: **Content of essential oil of the leaves of 11 cultivars of lemon balm for 4 harvests in Bruson**

Cultivar	Content of essential oil (ml/100g)			
	harvest 05	1st harvest 06	2nd harvest 06	3rd harvest 06
Lorelei	0.13 cd	0.07 de	0.37 cd	0.26 c
Landor	0.12 d	0.06 e	0.32 d	0.24 c
Quedlingburger N.	0.16 bcd	0.09 de	0.50 abc	0.31 abc
Citronella	0.15 bcd	0.11 bcd	0.52 ab	0.24 c
Erfurter	0.12 d	0.06 e	0.33 d	0.25 c
Stamm	0.19 ab	0.06 e	0.32 d	0.35 ab
Aufrechter Typ	0.15 bcd	0.10 cde	0.43 cd	0.25 c
Lemona	0.18 abc	0.17 a	0.60 a	0.26 bc
VS 1	0.19 ab	0.13 abc	0.58 a	0.32 ab
VS 2	0.22 a	0.14 ab	0.58 ab	0.37 a
VS 3	0.18 abc	0.08 de	0.36 cd	0.28 bc
mean	*0.16*	*0.10*	*0.44*	*0.28*

Different letters indicate significant differences between the cultivars per harvest (p<5%)

The content of essential oil of the leaves was strongly influenced by cultivars and by harvest periods (see Table 2). The cultivars with a high content of essential oil such as VS 2, Lemona, VS 1, Quedlinburger Niederliege and Citronella are in general preferred by distillers due to the lower costs for the extraction of the essential oil. However, the biomass production of these cultivars was limited. There is a tendency that cultivars with a high content of essential oil in the leaves are characterised by a lower biomass production for the spring and summer harvests (Figure 2 and 3). However, for the harvest in autumn there was not a significant relation between these two parameters.

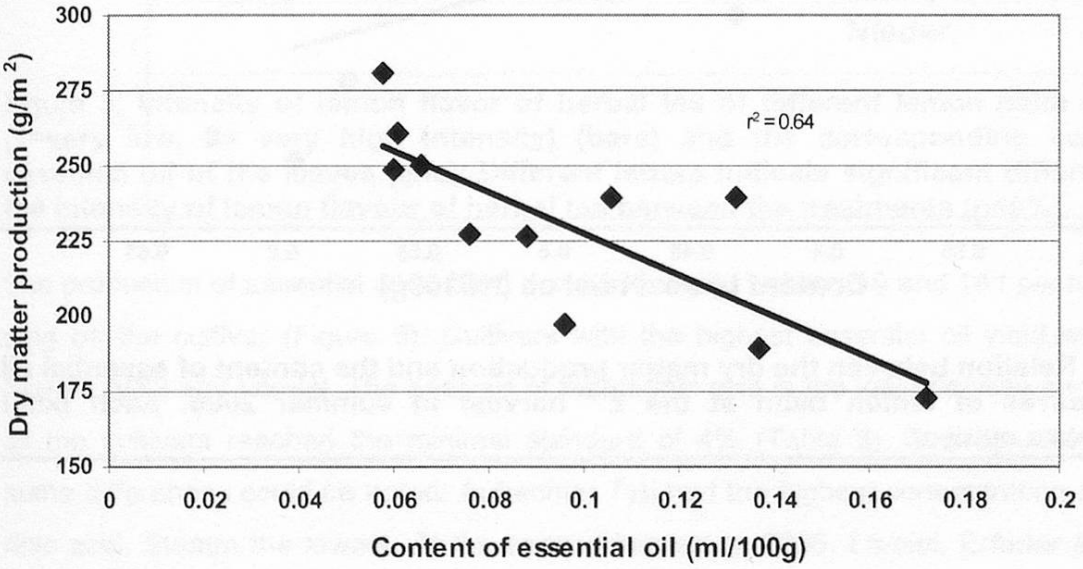

Figure 2: **Relation between the dry matter production and the content of essential oil in the leaves of lemon balm at the first harvest in spring 2006. Each point represents a cultivar.**

The essential oil in the leaves is accumulated in trichomes (5). To explain the differences in the essential oil content in the leaves of the different cultivars, the number of glandular trichomes, located at the underside of the leaves, was counted. The content of essential oil of the leaves was not strongly related to the number of trichomes (Figure 4).

Other factors are probably involved to explain the differences between cultivars such as the size as well as the amount of essential oil per unit of these trichomes. The composition of the essential oil was similar for all the cultivars (results not shown). The main compounds for all the cultivars were geranial and neral.

The aromatic quality of some cultivars was tested with a descriptive sensory analysis. The panel could significantly distinguish the intensity of lemon flavour of the herbal teas, created with different cultivars (Figure 5). VS2 showed the highest lemon flavour intensity, followed by Quedlinburger Niederliegende. Lorelei, Landor and Erfuter had the lowest

intensity. The intensity of lemon flavour evaluated by the panel was very well related to the concentration of essential oil in the leaves (r^2=0.88). It seems that the description of the intensity of lemon flavour by a sensory panel could be a good selection criterion for breeding new cultivars with a high content of essential oil.

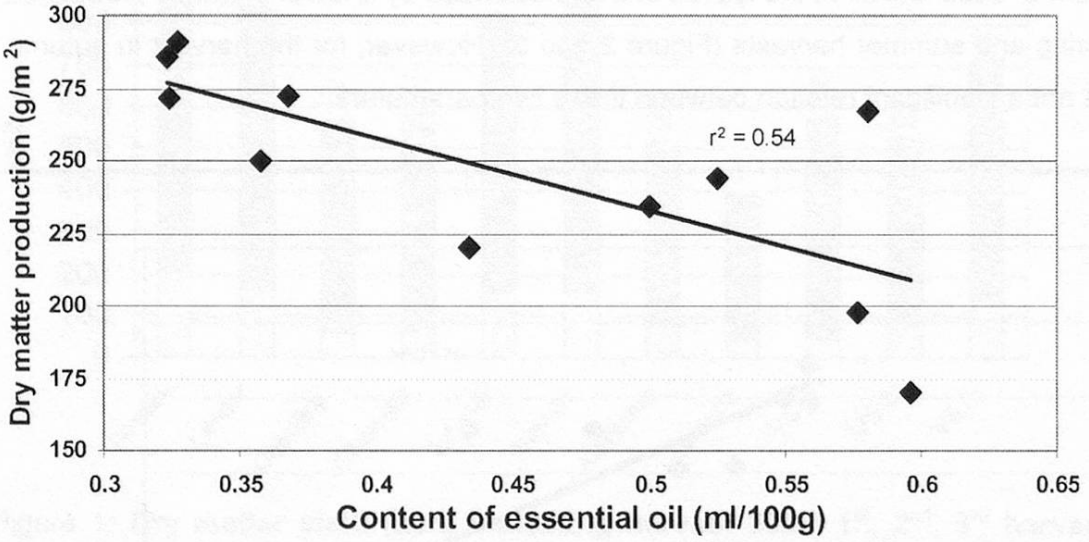

Figure 3: **Relation between the dry matter production and the content of essential oil in the leaves of lemon balm at the 2nd harvest in summer 2006. Each point represents a cultivar.**

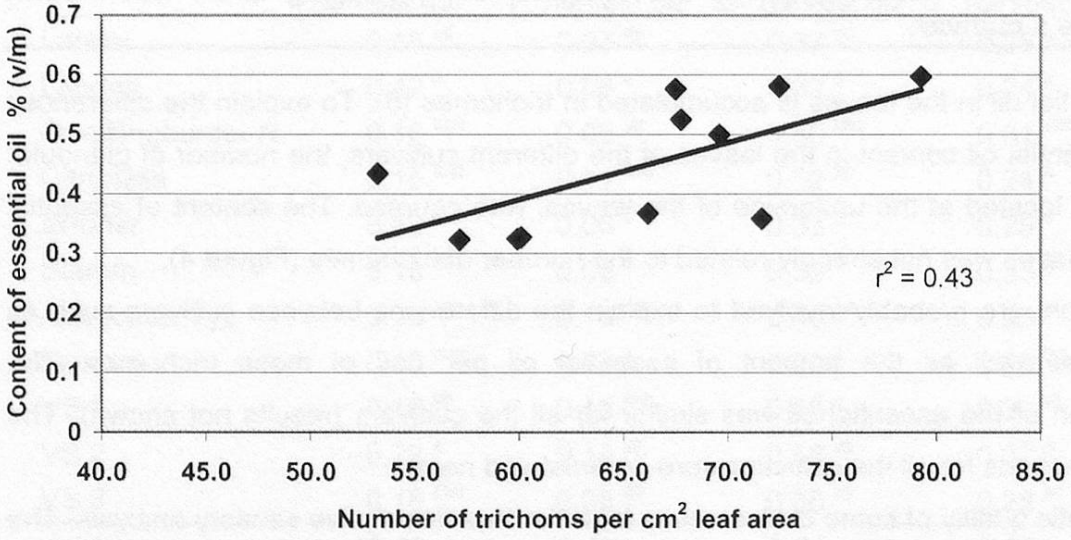

Figure 4: **Relation between the content of essentail oil of the leaves of lemon balm and the number of trichomes per cm^2 leaf area (of the last fully developed leaves at the 2nd harvest in 2006 in Bruson.**

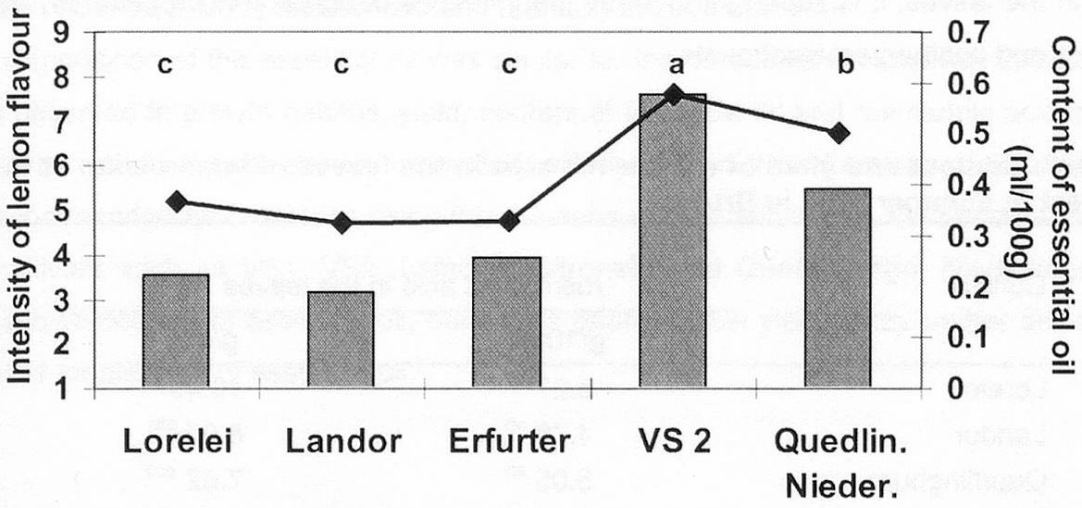

Figure 5: **Intensity of lemon flavor of herbal tea of different lemon balm cultivars (1=very low, 9= very high intensity) (bars) and the corresponding content of essential oil of the leaves (line). Different letters indicate significant differences of the Intensity of lemon flavour of herbal tea between the treatments (p<5%).**

The production of essential oil in 2005 and 2006 varied between 9 and 14 l per ha depending on the cultivar (Figure 6). Cultivars with the highest essential oil yield were VS1, Stamm, VS2 and Lorelei. The analysis of rosmarinic acid in the leaf analyses showed that all the cultivars reached the minimal standard of 4% (Table 3). Between the cultivars some differences could be noted. Aufrechter Typ had the highest concentration of rosmarinic acid, Stamm the lowest. At the second harvest in 2006, Lorelei, Erfurter and VS 1 produced the highest yield of rosmarinic acid. The concentration of rosmarinic acid in the leaves was about 10 % higher in summer than in spring and autumn (results not shown).

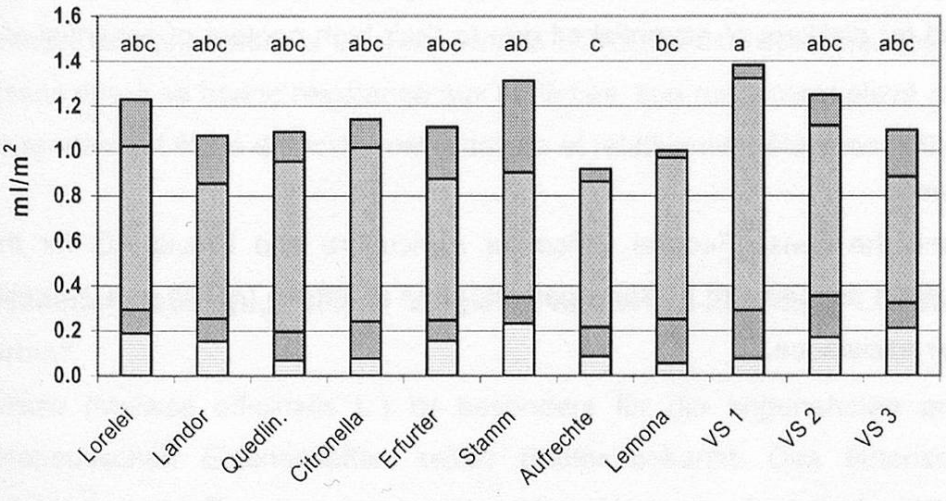

Figure 6: **Essential oil yield (bottom up: harvest 2005, 1st, 2nd, 3rd harvest 2006) of 11 cultivars of lemon balm in Bruson. Different letters indicate significant differences between the treatments (p<5%).**

To get a better understanding of the processes involved in the formation of rosmarinic acid in the leaves, it is important to study the influence of agronomic procedures, climate factors and postharvest treatments.

Table 3. **Content and yield of rosmarinic acid in the leaves of lemon balm at the 2nd harvest in summer 2006 in Bruson**

Cultivar	rosmarinic acid in the leaves	
	g/100g	g/m^2
Lorelei	5.27 ^{ab}	10.49 ^{a}
Landor	4.78 ^{ab}	8.90 ^{abc}
Quedlingburg	5.05 ^{ab}	7.62 ^{bcd}
Citronella	5.53 ^{ab}	8.21 ^{abcd}
Erfurter	4.99 ^{ab}	9.68 ^{ab}
Stamm	4.54 ^{b}	8.01 ^{bcd}
Aufrechter Typ	5.89 ^{a}	8.63 ^{abc}
Lemona	4.88 ^{ab}	5.77 ^{d}
VS 1	5.23 ^{ab}	9.31 ^{ab}
VS 2	5.21 ^{ab}	6.84 ^{cd}
VS 3	5.46 ^{ab}	8.47 ^{abc}

Different letters indicate significant differences between the cultivars ($p<5\%$)

In conclusion, the cultivars Lorelei and Erfurter can be recommended to producers for food industries due to their high yield in dry matter, high yield in rosmarinic acid and relatively high yield in essential oil. On the other hand, the group of cultivars with principally VS1 and VS2, as well as Lemona, Citronella and Quedlinburger Niederliegende are more adapted for distillers of essential oil due to their high content of essential oil in the leaves.

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Summary

To improve the agronomic, aromatic and therapeutic performance of lemon balm (*Melissa officinalis* L.), Agroscope ACW conducted a breeding programme. The new cultivar Lorelei was recently created and compared to 10 other cultivars from Germany (Quedlinburger

Niederliegende, Citronnella, Erfurter Aufrechte, Stamm NLC, Aufrechter Typ, Lemona), France (VS1, VS2, VS3) and Switzerland (Landor) in 2005 and 2006.
The composition of the essential oil was similar for the 11 cultivars. However, differences were observed in growth habitus, yield, content of essential oil and rosmarinic acid in the leaves as well as the resistance to powdery mildew. The cultivar Lorelei and Erfurter can be recommended for industries using intact leaves or rosmarinic acid. On the other hand, the cultivars such as VS1, VS2, Lemona, Citronella and Quedlinburger Niederliegende with a high content of essential oil, but with a relatively low yield of dry matter are more adapted for distillers of essential oil.

Résumé : „Mélisse: Comparison la nouvelle sélection LORELEI avec d'autres variétés"
La mélisse (*Melissa officinalis* L.) est bien connue pour les propriétés aromatiques et thérapeutiques de ses feuilles. L'huile essentielle est considérée comme la principale source thérapeutique, mais des composés phénoliques, particulièrement l'acide rosmarinique, sont aussi impliqués. Afin d'améliorer la performance agronomique, aromatique et thérapeutique de la mélisse un programme de sélection a été conduit par Agroscope ACW. La nouvelle variété ACW, LORELEI, a été comparée à 10 autres cultivars d'Allemagne (Quedlinburger Niederliegende, Citronnella, Erfurter Aufrechte, Stamm NLC, Aufrechter Typ, Lemona), de France (VS1, VS2, VS3) et de Suisse (Landor) en 2005 et 2006. Entre les onze variétés de grandes différences de port de croissance, de rendement en matière sèche, de la teneur en huile essentielle des feuilles et de la résistance à l'oïdium ont été perçues. Cependant, la composition d'huile essentielle, comme la teneur en acide rosmarinique dans les feuilles était semblable pour toutes les variétés. En conclusion, la nouvelle variété LORELEI est recommandée aux producteurs suisses due à sa bonne résistance aux maladies, son rendement élevé en matière sèche, son rendement élevé en acide rosmarinique et relativement élevé en huile essentielle.

Zusammenfassung: „Melisse: Vergleich der neuen Züchtung LORELEI mit anderen Sorten"
Melisse (Melissa officinalis L.) ist besonders für die angenehmen aromatischen und therapeutischen Eigenschaften seiner Blätter bekannt. Das ätherische Öl wird zu therapeutischen Zwecken verwendet. Verschiedene phenolische Verbindungen, im besonderen die Rosmarinsäure, haben dabei ebenfalls gewisse Bedeutung. Mit dem Ziel, das agronomische, aromatische und therapeutische Potential der Melisse zu verbessern,

wurde ein Züchtungsprogramm durch Agroscope ACW durchgeführt. Die daraus resultierende neue Sorte LORELEI wurde im Jahre 2005 und 2006 mit 10 anderen Sorten aus Deutschland, aus Frankreich und aus der Schweiz verglichen. Zwischen den 11 Sorten wurden grosse Unterschiede bezüglich Wachtumsform, Trocken-substanzertrag, Gehalt an ätherischem Öl der Blätter und Resistenz gegen den echten Mehltau gefunden. Dagegen waren die Zusammensetzung des ätherischen Öls sowie der Gehalt an Rosmarinsäure in den Blättern bei allen Sorten ähnlich. Die neue Melissesorte LORELEI wird für die Schweizer Produktion empfohlen aufgrund der guten Widerstandskraft gegen den echten Mehltau, des hohen Trockensubstanzertrages, des hohen Ertrages an Rosmarinsäure und des relativ guten Ertrages an ätherischem Öl.

***Keywords**: essential oil, lemon balm, rosmarinic acid, sensory quality, trichomes, yield*

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