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Organic Cultivation of Lemon Balm (*Melissa officinalis*) in Macedonia

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Abstract: The possibility for perspective growing of medicinal, aromatic and spice plants, can be expected only if their cultivation is based on the principles of organic farming. The cultivation of this group of plants is usually associated with satisfactory yield level and raw materials with uniform quality. This paper contains the most important features of lemon balm (*Melissa officinalis*), and methods of cultivation. Data of two annual activities are presented and they are related with organic system of cultivation in the central part of Macedonia. The objective of this study is to analyze, determine and demonstrate the economic viability of lemon balm organic production with irrigation. In the first year, there were only two moving, yielding 500 kg/ha of above-ground plant dry mass. In the second year, there were three moving, yielding 6,775 kg/ha of above-ground plant dry mass. Economic analysis is proved that profitability in organically produced lemon balm is obtained in the second year of growing when the profit reached \$6,150/ha.

Key words: Organic, lemon balm, yield, pofitability.

1. Introduction

Member of the *Lamiaceae* (mint) family, lemon balm (*Melissa officinalis*) belongs to a genus which includes five species of perennial herbs native to Europe, Central Asia and Iran [1]. *Melissa officinalis* originates primarily from Southern Europe but nowadays is naturalized throughout the world (North America to New Zealand) [2]. Medicinal, aromatic and the spice plants are widely used in pharmaceutical, food, cosmetics and alcoholic beverage industries as well as in chemical (pesticide) industry. Up to the mid 1950s of the last century, these plants were used as raw material from wild flora of these species, and some plants are still used as growing wild plants. World Health Organization (WHO) has estimated that more than 80% of the world's population in developing countries when satisfying basic health care

needs depend primarily on herbal medicine [3]. Approximately two thirds of the 50,000 different medicinal plant species in use are collected out in the wilderness [4]. Similarly, in Europe, only 10% of medicinal species that in commercial use are cultivated [3]. Cultivation of some herbs has proved difficult due to low germination rate or specific ecological requirements [3]. The benefit of cultivated growing of medicinal, aromatic and spice plants, lays in the opportunity to increase production, balancing between increased demand and limited supply. Such approach optimizes yields with uniform high quality product, and gives contribution to the preservation of endangered species and genetic diversity of natural habitats. Controlled growth systems also make it feasible to contemplate manipulation of phenotypic variation in the concentration of medicinally important compounds present at harvest [5]. The Latin species name *Melissa* is shortened version of Classical Greek *Melisso-phyllon* (bee-leaf); the plant is rich in nectar and commonly planted to feed bees. That name is akin

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to Latin *mel*-honey and also the British term for orange rind jelly, marmalade [6]. The Macedonian name *matochina* (bee-feeding) represent characteristic of lemon balm. Macedonian *matitsa* (bee queen), derived from Common Slavic MAT' mother. Similar remarks apply to Czech *meduňka*, Slovak *medovka*, Serbian, Croatian *matičnjak* and other similar forms. Lemon balm is traditional European medicinal herb, but its use in cooking, garnishing and as refreshing tea is increasing. It is considered to have carminative and antispasmodic activity and is used to treat various kinds of ailments including insomnia, cramps, headache and toothache. It has a reputation of a cure-all and is often used in herbal mixtures to disguise the taste of other, less pleasant herbs. Lemon balm is less a spice than a medical herb. In past times, much is used against stomach ailment and nervous conditions. It has, however, some value as spice, due to its fresh and pure lemon taste which makes it a perfect substitute for fresh lemon grass [6]. *Melissa officinalis* contains both vitamin C and Thiamin (vitamin B). One study detected an average of 254 mg vitamin C/100 mL of solution [7]. Crops of lemon balm are rarely grown for essential oil production. Yields of essential oil are quite low (usually less than 0.05% or 0.5 mL oil/kg herb). The oil can be extracted from fresh or dried flowering tops of the herb [8]. Lemon balm essential oil, obtained from fresh or dried flower, leaf and branches of this plant by water-steam distillation or chemical extraction, has fresh lemon odor and light yellow color [9]. In the essential oil obtained from leafs of *M. officinalis* in before-flowering stage, 37 compounds were identified. On the other hand, in post flowering stage only 16 different compounds were identified in the essential oil obtained from the leafs of *M. officinalis* [9]. An essential oil, called melissa oil, can be extracted from lemon balm, but yields are very low. The oil is usually heavily adulterated with other lemon-scented oils such as lemon grass and lemon oil. Lemon balm extracts and oil are used to flavour alcoholic and non-alcoholic

beverages, confectionary and processed food products. The essential oil is sometimes used as an ingredient in perfumes. Hot water extracts of lemon balm (equivalent to herb tea) have strong anti-viral activity against a range of virus infections including mumps. The essential oil has been reported to have antibacterial and antispasmodic activity *in vitro* [8]. Republic of Macedonia has very favorable geographic position, diversity soil types and low contamination of the natural resources which fulfill all the conditions for cultivation of aromatic, spicy and medical plants. The advantages of the Macedonian territory for organic cultivation of the medicinal aromatic and spicy plants are:

- areas with low degree of pollution or unpolluted resources (soil, water, air);
- favorable geographical position, diverse landscape;
- fertile river valleys, flat lowlands and mountain slopes;
- diverse types of the soils.

There are weak points too and these are:

- unused agro-environment potentials;
- lack of Macedonian literature;
- lack of exploration experience in this area;
- lack of skills on farmer level in growing methodology for certain aromatic spices and medicinal plants;
- lack of devised strategy for cultivation medicinal plants that can penetrate the market;
- lack of information on potential yields, prices and markets for this group of the plants.

Ovche Pole valley suffers negative affect by being overlapping area of two climate types. The Mediterranean and continental climate, which are the main reason for non-permanent and not uniform precipitation, especially in the summer when there are significant low precipitation values [10].

2. Materials and Methods

Lemonbalm (*Melissa officinalis* L.), is a vigorous

perennial herb with pleasant lemon scent. Balm leaves contain no more than 0.1% of essential oil which is of complex and variable composition. However, over 100 chemicals in *Melissa officinalis* have been identified [6]. Between more than 50 identified aroma compounds, citronellal (dominantly the (R) enantiomer), β -caryophyllene, neral, geranial, citronellol and geraniol amount to about 70% of the oil [7].

2.1 Soil and Climatic Conditions

As far as soil conditions are concerned, lemon balm grows easily in most soil types, but prefers friable loam soil with good drainage. Best results are obtained when grown on moist but well-drained loam with a pH between 4.5 and 7.6 [1]. It will tolerate partial shade and damper soils than most other herbs, but will not thrive in waterlogged or very dry conditions. It has been suggested that lemon balm develops better scent and flavour when grown in harder conditions [11]. Harvesting before flower appearance and at flowering stages were found to be the best stages to harvest the plant to obtain the highest yield of essential oil [9]. However, production of dried herb material respond very strongly to good irrigation and fertilizer management, as the case in the areas was subject to analysis. Plants can often self-sow so freely as to become a menace. It is a useful plant to try in difficult dry places [12]. Results of the trials are obtained on the basis of two-year analysis (2009 and 2010) in the region of Ovche Pole (altitude 230 als, geographic coordinates: 41°49'N, 21°59'E). The soil on the field on which lemon balm was cultivated according to the principles of organic farming, belongs to the type vertisol (total area of 4/ha).

2.2 Production Technology

Lemon balm is probably one of the easiest herbs to grow and is ideal for beginners. Lemon balm can be established from seed by cuttings or by plant division.

Some variability occurs between plants are grown from seed. Seed should be sown in a nursery bed or cell trays and later transplanted in open field. Plants can be moved outside if they have been matured enough but not later than one month before the end of frost-free period [1]. Lemon balm self-seeds easily in the field, so seed with a high germination percentage may be established directly in the field [8]. Seed can be sown directly in the ground in spring or early fall, covered only with a small amount of soil [1]. In our case lemon balm was sowed at the beginning of March (March 1st), by sowing in covered beds, with the quantity of seed 7 g/m² (1 g \approx 160 seeds). In about 45 days, the seedlings reached an average height of about 15 cm, suitable for transplanting in the open. Width of rows should be designed so that vehicles can straddle the crop without damaging it during mechanised weed control, harvesting procedures etc. [8].

Recommended sowing distance: between 50 cm and 30 cm in the rows, or approximately 66,000 plants/ha. The new plants were watered immediately after transplanting. During vegetation, the prevention of weeds was conducted with two treatments between rows with cultivator. In-row weeds were reduced manually. Between each mowing, irrigation was applied using sprinklers providing 50 mm of water. In the first year of cultivation, due to juvenile stadium of the growing crop only two mowing were performed. The next year, the number of mowes was increased by one. In order to achieve best possible drying process two to four days after mowing, the plant material was over turned, by use of wheel rakes. One to two days after previous activity, the hay was baled.

3. Results and Discussion

3.1 Biomass Productivity

The area of Ovche Pole is characterized by low average annual rainfall (450-500 mm) [10], which affect the yield of studied crop. Unstable market and frequent oscillatory prices, affect the stability of the economic effects of the production of organic lemon balm. There are many options when it comes to

pruning and harvesting lemon balm. Leaves can be harvested as needed. In extreme warm conditions, plants tend to become brown around the edges. It is nearly impossible to over-prune/over-harvest lemon balm [1]. The yield of dried lemon balm herb at different locations in New Zealand varies from 870 kg/ha in year of establishment, up to 13,010 kg/ha (established crop) [6]. Table 1 presented the yield of dry lemon balm herb by category, which included leaves, stems, leaves and stems, and ratio between dry leaves and stems. Production of dried lemon balm herb in these analyses ranged from 500 kg/ha in year of establishment (2009), up to 6,775 kg/ha in the following year (2010, established crop). The plant's stage of development reflected to the obtained yields by cutting and by year of exploitation, as presented in Fig. 1. Furthermore, there were differences in the obtained categories of yield from one cutting to another and by year of exploitation, as can be seen in Fig. 2. Dried leaves can be stored for up to one year in glass containers in a dark and dry place. For a few days keeping, glass containers can be stored in refrigerator or in case we need to keep the material a bit longer, it should be packed in double food storage plastic bags and stored in freezer [1]. Citation from Ref. [1] applies to small quantities of lemon balm, meant for home use. The analysis of organic lemon balm production (baled dry mass), subject of this paper are grouped in accordance and mutual dependence of applied specific agricultural techniques and administrative expenses.

3.2 Calculation of the Costs in the Year of Establishment

To succeed in production and finding optimal solutions, it is necessary to determine the economic effects of the cultivation of each crop [13]. Calculation of the economic effects of the production of organic lemon balm, provides opportunities for:

Greater visibility, monitoring and planning of all activities in accordance with cost operations;

Economic analysis of investments (costs) and income provide visibility to the economic viability of growing organic lemon balm.

In this research the following methods were applied: analytical, mathematical, statistical and comparative [14]. Calculation of the costs and incomes in the production of organic lemon balm in the first production year (in the year of establishment 2009), includes many elements. These can be grouped depending on the price of certain agro-technical measures and certain administrative costs (Table 2). Total cost (\$7,460) and the cost per unit of product (\$3.33/kg) in the year of establishment are larger. Table 1 shows the calculation of crop's establishing cost (included the full costs for normal cultivation and collecting of lemon balm, baled). The level of production cost depends a lot on the market price of raw materials and services at the time of necessity. All costs are grouped in following groups: soil cultivation, organic manure and its application, seedlings and planting, irrigation, harvesting and collecting, as well as insurance costs and certification for organic production. Table 2 presents that the costs of organic manure and its application are with the biggest share (26.8%). Due to the large volume of investments in the first year of establishment, the cost per unit is high (\$3.33/kg, Table 2). For the reasons mentioned previously, in the first year of production profit is not obtained. On the contrary, loss is made (\$965/ha).

3.3 Calculation of the Expenses in the Second Production Year 2010

In the second production year, the total cost (\$4,100), and the cost per unit (\$0.15/kg) are significantly smaller. The total income refers to \$28,700 (Table 3) and the income per unit area is \$7,175/ha. Calculation of costs and incomes in the second year of production of organic lemon balm is presented in Table 3. Data in this table do not refer to costs for: soil cultivation, organic manure, organic manure application and costs of seedlings' transplant, since the crop is in its second

Table 1 Yield of dried lemon balm herb (kg/ha).

Year	Leaves	Stems	Leaves + stems	Ratio (leaves:stems)
2009	350	150	500	2.3:1
2010	3,925	2,850	6,775	1.4:1

Comparative yields per year of exploitation.

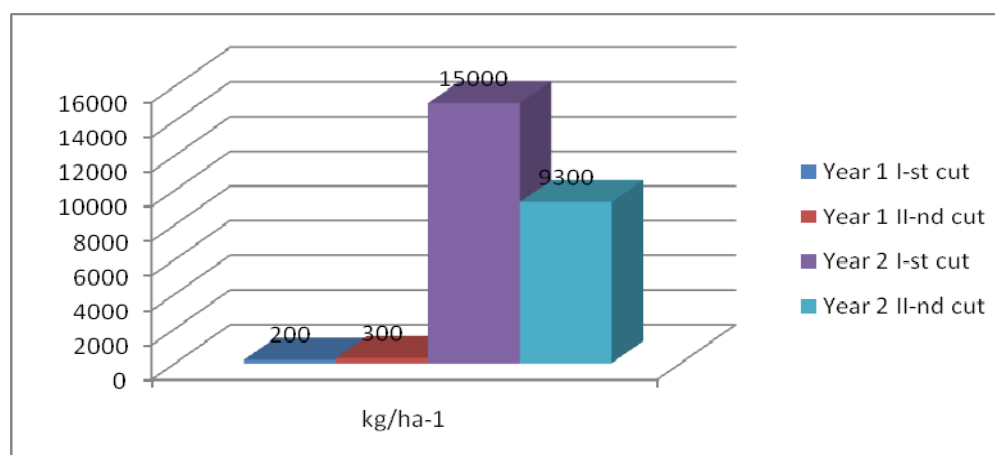


Fig. 1 As the diagram clearly points significant yield difference can be seen. This is due to plants immaturity in the first year of establishment. Due to season's characteristic and the time-frame, only two cuts were performed. On the other hand, year two of establishment presents the lemon balm's full potential by producing 24,300 kg/ha.

Table 2 Revenues and incomes in the first production year (2009).

2009	Unit	Qty	Price per unit (\$)	Total (\$)	Part of total income/cost (%)
Income obtained from production	kg	2,000	1	2,000	55.5
Income from subsidies	ha	4	400	1,600	44.5
Total revenues				3,600	100.0
Soil cultivation	ha	4	310	1,240	16.6
Organic manure and application	t	80	25	2,000	26.8
Seeding & planting	ha	4	230	920	12.3
Irrigation cost	ha	4	250	1,000	13.4
Harvesting and collection cost (three mowing: 3 × \$200)	ha	4	400	1,600	21.4
Crop insurance cost	ha	4	75	300	4.0
Certification cost	ha	4	100	400	5.5
Total costs				7,460	100.0
Cost of production unit (\$/kg)			3.33		
Profit/loss per unit area (\$/ha)			965		

Biomass production in year two (2010).

year of utilization (Table 3).

At the second year in production, the cost for harvesting and collecting, account for the biggest share (58.5%), in the all over cost structure. When out of the total income (\$28,700), total costs are deducted (\$4,100), obtained value refer for second year profit (2010), which amounts to total of \$24,600 or profit per unit area of \$6,150/ha.

4. Conclusions

The commercial viability of the organic cultivation of lemon balm offers multiple benefits. The analysis of investments (costs) and income gives visibility to the economic profitability of growing organic lemon balm. The advantages of this production mode consist in:

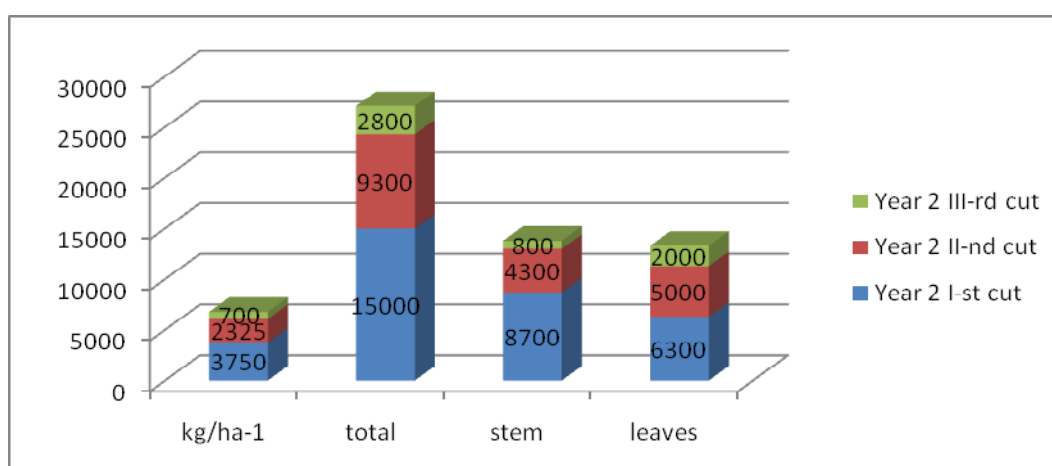


Fig. 2 As the diagram presents the highest yields were obtained on the first cutting, followed by second and third, respectively. Same stands for yielding stems and leaves as well.

Table 3 Costs and incomes in the second production year (2010).

	Unit	Qty	Price per unit (\$)	Total (\$)	Part of total income/cost (%)
Income obtained from production	kg	27,100	1	27,100	94.4
Income from subsidies	ha	4	400	1600	5.6
Total income				28,700	100.0
Irrigation cost	ha	4	250	1,000	24.4
Harvesting and collection cost (three mowing: 3 × \$200)	ha	4	600	2,400	58.5
Crop insurance cost	ha	4	75	300	7.3
Certification cost	ha	4	100	400	9.8
Total costs				4,100	100.0
Cost of production unit (\$/kg)			0.15		
Profit/loss per unit area (\$/ha)			6,150		

(1) The characteristics of the obtained product is suitable for extended storage in controlled conditions, provide opportunities for monitoring and market analysis and possibly getting a higher price;

(2) The excluded application of synthesized chemicals for nutrition and protection of the growing crop, providing agro-ecosystem sustainability through maintenance of biodiversity and anti pollution impact on natural ecosystems for future generations;

(3) The benefit of growing lemon balm is: opportunities to optimize yield and achieve uniform high quality product;

(4) Relatively high profit through organic way of production and relatively swift return of investment (in the second year), can be understood as a great business idea for the farm and family business;

(5) Growing lemon balm according to the organic

principles can be of great importance, especially for organic honey producers;

(6) From agricultural engineering point of view growing lemon balm can successfully become a part of multi annual crop-rotation system in organic farming;

(7) At last, but no less important, following the profitability results of growing organic lemon balm (from seed or plantlets), it appears that this production orientation could be of great business opportunity for Macedonian farmers, especially for those whose properties have soil type are less favorable.

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