HANDBOOK FOR CULTIVATION OF MEDICINAL AND AROMATIC PLANTS

MACEDONIAN FORESTS
in partnership with nature

BIOSELENA
FOUNDATION
FOR ORGANIC
AGRICULTURE

Perrotis College
Agriculture · Environment · Life Sciences

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Preface

Medicinal and aromatic plants comprise a very special group of flora with an extensive range of uses. They have been used since ancient times for health reasons, such as disease recovery and wound healing. They are special ingredients adding excellent taste to foodstuff while they are the basic material for perfumes and cosmetics. Although they were used for millennia, MAPs have recently started to be systematically cultivated. Packaging facilities are found all over the country while distilleries are located in the northern part of Greece. There are a few companies that make exports of high added value products and certainly there is room for more.

The Global market for medicinal and aromatic plants is very large showing a constant upward trend. Balkan Peninsula has been blessed with having many indigenous MAPs and many biotypes have been evolved through millennia because of the diversity of microclimates. Furthermore topography and variety in terms of different environmental conditions prevailing in several areas, render MAPs as one of the best choices that can produce excellent crop in marginal land without being demanding crops. It has been shown that there is a great potential for MAPs sector while new jobs can be created not only farm relevant ones but industrial, scientific, jobs in sales and marketing, tourism and new technologies. However if this potential will finally be transformed into capacity it depends on those who will be involved and will manage it.

General remarks for cultivation of MAPs

In the beginning we have to emphasize that cultivation of MAPs is agriculture activity, and basic knowledge about usual work operations – cultivation practices (land preparation, fertilization, seedlings production, plant establishment, weed control, combatingpests and diseases, irrigation, harvesting) have to be very good preparedfrom future MAPs producer.Preparation for cultivation of MAPs starting with collection of literature, learning and exploring best experiences from existing producers, processorsend traders in home country.The next step is to compare climate conditions and naturalsurroundingsfor future production field, to check the soil composition and fertility of land, and in the endto choose species and variety of plants suitable forcultivation in that environment.The plant variety is one of most important factor for future successful cultivation and profitability of farmer's production.It iscrucial to understand plant biological demands and connection with soil and climate conditionson production field for future successful production.

All this questions have to be answered to farmers before start of cultivation MAPs:

- Which species are adapted to the region?
- Which are the environmental parameters of the region?
- What are their needs for irrigation?
- What kind of machinery do I need?
- What will be the final product?
- Where will I sell it?

Experience from Greece about recommended approach is very clear:

- Select model of production: MAPsfor dry products (tea, spices or aromas) ,or MAPs for distillation - essential oil,
- Selectspeciesforannual or perennial crops for best quality products
- Propagation material for sexual (seeds), or asexual propagation (seedlings or roots and cuttings)
- Organic or conventional quality system in production
- Basic equipment and facilities (establishment of fields, irrigation, weeding, harvesting, drying, storage, packaging)
- Connection with other MAPs producers, processors and traders in the region for practical advice and exchange experiences

The best results in MAPs production can be achieved with the model of pilot establishments of 4-5 species in an area of 0.2 – 0.5 ha, for prospective farmer to get familiar with the crops, their need and the cultivation practices.

The training and education programs for cultivation of MAPs are very useful for future producers to understand specific requirements for high quality final products, market demands, trade channelsand economic benefits from this production. Also

the list of national institutions, faculties, laboratories organizations and companies in this sector will provide important information for future MAPs producers.

This Guide has the same purpose to lead the future MAPs farmer through basic knowledge and education, and to connect them with the similar farmers in the Balkan Region. ThisERASMUS + program for education will establish a networking between MAPs producers from Greece, Bulgaria and Macedonia for their future successful cooperation.

Part I: This part was prepared for the CULT project by the Perrotis College of the American Farm School

1.SAGE – Salvia spp.

Introduction

Sage species (*Salvia* spp.) have been used extensively as pharmaceutical herbs since antiquity. Infusions from dry or fresh plant parts are used against abdominal pains, coughs, throat-aches, stomatitis, gingivitis, tooth-aches, diarrhea, stomach-aches, diabetes, hypertension, rheumatism and skin diseases. They are also used as abortifacients, expectorants, cerebral sedatives, psycho-tropics, stomach stimulants, for hair care, cleaning of crockery etc. Most of the product is still collected from natural stands, especially in the Eastern Mediterranean, whereas systematic cultivation is carried out in Italy, the U.K. and the U.S.A. In view of the globally increasing demand for natural products and, in particular, of the increasing trends in market demands of the main importers, sage cultivation may be a promising alternative to collection. Furthermore, it will provide a means of diversification in agriculture, with a potential for exploitation of marginal lands in the Mediterranean region.

Figure 1. Salvia Officinals plant

Figure 2.Salvia seedlings in nursery -Container system

Of the many existing Salvia species, those of the main economic importance are the Greek sage (Salvia fruticosa Miller=Salvia triloba L.), the Dalmatian, garden or common sage (Salvia officinalis L.), the apple sage (Salvia pomifera ssp. PomiferaL.=Salvia calycina Sibth. & Sm.), and the claries or muscatel sage (Salvia sclarea L.). In all species, the essential oils are located in the glandular hairs of all aerial parts with an average concentration between 1.3–3.6% on a dry weight basis. The concentration is

maximum in leaves, intermediate in flowers and minimal in stems. The chemical composition of the essential oil varies among species, seasons, and habitats, a fact that leads to significant qualitative differentiations.

Plant description

Sage species are perennial shrubs. Stems are long, angular and erect reaching heights between 50 to 100 cm, depending on species and environmental conditions. A number of branches (usually 3 to 5) are produced from lateral buds of the main stem. Branching is more intense after cutting. Leaves are opposite, simple, ovate, and petiolate. The inflorescence is a terminal verticillaster consisting of 4 to 10 violet, blue, lilac or pale-blue flowers. All above ground parts are covered by glandular hairs which impart a silver color to mature plants. Flowering starts from mid March to June, depending on climatic conditions, and lasts for about one month.

Plants tend to regrow easily after cutting, both in height and branching, especially after the second year from planting. There is evidence that sage crops can be productive for more than 10 years when grown in a suitable environment and under the appropriate husbandry.

All four species originate from Southern Europe. S. officinalis grows along the northern part of the Mediterranean (from Spain to the Balkans), whereas S. fruticosa and S. pomifera are endemic in the Central and Eastern Mediterranean. *S. sclarea* grows within a broader region extending from Spain to Southern Russia.All species can grow from sea level up to altitudes of 1500 m. Consequently, their favorable habitats are found in most subdivisions of the Mediterranean climate, whereas considerable frost damage occurs in more acute climatic conditions. Both herbage and oil yields are reduced in cold and shady environments which induce a reduction in plant size and the density of peltate hairs. In general, essential oil concentration tends to be higher in warmer and drier regions. Oil chemical composition was also found to depend on environmental conditions.

Propagation

Sage species can be propagated both sexually and asexually.

Sexual Propagation:Seed production from sage plants is abundant. Seeds are spherical, of a fair size (1000 seed weight between 6 to 7g) in comparison with the other Lamiaceae species. Optimal temperatures for seed germination lie between 10 and 20 °C for S. pomifera and S. fruticosa. In the latter species a high germinability was also observed in 25°C. Seeds of *S. officinalis* also germinate satisfactorily within the range of 10 to 25 °C, whereas those of *S.sclarea* have a broader range of optimal temperatures (10 to 30 °C).Seed germination is favored by darkness. There seems to be a slight enhancement by light only in *S. pomifera*.

Sage seeds are dormant to a considerable extent at harvest. This dormancy can be broken by means of either dry storage at 20 °C for 1.5 month or cold treatment at 5 °C for one week. Storage in air-tight bags for as long as 6 years at 5 °C does not affect seed germinability.

Seeds are either drilled directly in the field or hand-sown in nurseries. In the former case seed rate varies between 3 to 5 kg/ha. In the nursery, the rate is 8 to 10 g/m^2. 70 to 80 m^2 of nursery are required for one hectare of a sage crop. Nurseries are set up either in August or in March depending on the scheduled time of transplanting (winter or spring respectively). Seedling care in nursery includes regular watering, fertilizer application, and weddings.

Asexual Propagation: Sage plants are asexually propagated by means of cuttings, secondary stems, and tissue culture. Since tissue culture is the subject of a separate chapter, only the first two techniques are discussed here.

- Cuttings

They are segments of 8 to 12 cm length cut from the annual stems and then planted for rooting in pots or trays containing mixtures of soil, perlite and manure. Sage cuttings do not produce roots easily when compared with other Lamiaceae species. Rooting can be promoted by dipping the cuttings in indolylbutyricacid solutions for 5 sec. The usual concentrations are 500 ppm.

- Secondary stems

Root-bearing secondary stems can be detached from more than one year-old mother plants. This can be done by carefully excavating around the selected plants. The material obtained can then be successfully transplanted in the field.

Cultivation

Land preparation

The main aim of land preparation in transplanted crops is weed control. Soil surface is not necessary to be finely ground. If the field is heavily infested by noxious perennial weeds, a deep plugging in the summer preceding plant establishment is recommended. In this way, the underground propagating organs of the weeds (rhizomes, bulbs) are excavated and desiccated by summer drought.

Plant establishment

Planting is carried out in autumn (October-November) or early spring (end of February-March). Autumn planting is more preferable, since a better plant establishment is promoted, except in areas with very cold winters. The choice of the most appropriate plant spacing strongly depends on local conditions (soil fertility, climatic conditions, weeds) and varies from 50-60×25-40 cm. Denser stands reduce the numbers of primary and secondary stems as well as plant dry matter production. Plants are transplanted either manually or using transplanting machines.

Figure 3.Plant establishment 70x 30

Figure 4.Production field after 4 months

Fertilization

The supply of inorganic nutrients is known to affect plant growth and development. Nitrogen application promotes plant height, branching, and herbage yields. No significant effect of nitrogen on essential oil concentration was observed. However, essential oil yields increase significantly with N-application mainly because of the observed promotion by nitrogen in herbage yield.

Vegetative growth is promoted by phosphorus in solution culture up to a concentration of 34 ppm. The peak in phosphorus demand is observed later than that of nitrogen, namely at the seed formation stage. No phosphorus effect on essential oil concentration is detected.The presence of mycorrhizal hyphae from vesicular arbuscular fungi (VAM) in the roots of *S. pomifera* and *S. fruticosa* implies that the uptake of nutrients (particularly phosphorus) and water can be facilitated to a considerable extent even in dry soils of low fertility.

In practice, fertilization has to be applied before planting to help a quick and efficient crop establishment as well as during growth in order to meet the seasonal crop demands. The recommended rates depend on the levels of the available macronutrients in soil: 2-3tonnesof manure per hectare in autumn would supply the plants with necessary nitrogen quantities. It is better to be mechanically incorporated into the soil.

Irrigation

Sage species, as xerophytes, might exhibit a reduction in their essential oil concentration with increased water supply as a result of the reduction in the concentration of glandular hairs per unit leaf area due to a more intensive cell enlargement. It is recommended that sage crops can be irrigated in spring to induce a rapid plant growth. A second irrigation after the first cutting considerably helps re-growth and makes possible a second cut in autumn. More than two irrigations are usually not necessary.

Weed control

Weed competition is among the major problems in sage cultivation. The periods of marginal crop cover, e.g. the period after planting and those following harvests, are critical in terms of weed control. Hand-weeding is the most labour requiring though the most effective mean of control. Mechanical weeding can be expensive in weedy fields because of the numerous treatments required.

Pests

Sage has been reported to be infested by sucking insects such as mites, thrips, aphids, spittlebugs and whiteflies. These can be treated with insecticidal soap. Caterpillars, the larval form of moths and butterflies, are destructive pests that can strip a sage plant quickly therefore immediately when they are noticed we should use some *Bacillus thuringiensis* based pesticide.

Diseases

Salvia has been reported to be infected by powdery mildew. There should be constant monitoring of the plant and in case of appearance Sulphur can be applied for the control of that disease.

Harvest

The timing of harvest strongly depends on the expected quantity and quality of the product. Fresh matter yield is highest in spring while dry matter yield is highest in summer. Essential oil concentration is lowest in spring (0.7– 2.2%), highest in early autumn (2.0-3.4%), and intermediate in winter (1.7–2.5%). There also exists seasonal variation in the main components of sage essential oil. Consequently, essential oil quality also differs with harvesting time. It seems that the best quality crop of *S. officinalis* (silver leaf color, higher than 1.5% essential oil concentration, high in thujones and low in camphor) was obtained by harvesting in July, and again in October-November. In Greece, the first harvest starts from May in mild climates and ends in July in hilly and mountainous areas. In any case, the period starting from full bloom and ending to seed-set is the more suitable for the first cut for all sage species.

Figure 5. Manual (left) and mechanical (right)sage harvest

The number of harvests/year depends on the age of the crop. First year crops are harvested only once, in the summer. From the second year onwards crops are harvested usually twice a year (June-July and October-November). More than two cuts per year may be feasible in very mild climates and irrigated crops. In this case, the first harvest takes place in spring (May), the second in middle summer (July), and the third late in autumn (October-November).

In *S. fruticosa, S. officinalis,* and *S. pomitera* crops whole plants are cut to a height of 10 to 15 cm from ground surface using mowers or other motorized cutters. Cutting to a height of 5 cm is less successful by restricting re-growth. For *S. sclarea*, however, only the flowering stem is harvested, and, therefore, the machines are adjusted to cut at a higher level.Herbage yields vary from 3 to 12 tn/ha of dry matter, depending on crop density, soil fertility and water availability. Yields from the first year crop are significantly lower than those from the second year onwards. Leaves are the main yield components followed by stems, and flowers. Essential oil yields also vary between 11 and 20 kg/ha. Increased leafiness brings about higher oil yields, in view of the highest oil concentration observed in leaves.

Postharvest treatment

The harvested biomass is air-dried under shade. Exposure to direct sunlight has to be avoided in order to prevent evaporation of the volatile compounds of the essential oil. Artificial drying of the essential oil can also be applied at 40 °C for 48 h. Whole plants or plant parts can be used for infusions. Leaves can be mechanically separated from the stems using special equipment, if required, bearing in mind that leaf oil is richer in 1, 8-cineole and myrcene and poorer in a-pinene and camphor than that of stems and inflorescences. In the case of extraction for essential oil, only fresh material (such as flowering stems in S. sclarea) has to be used. Storage of the dried plant material in darkness for about two years was found to reduce essential oil concentration by 15 to 25%. Low temperatures during storage (-2 and -18°C) do not offer any advantage in comparison with normal temperatures (20 °C).

Figure 6. Sage tea from loose leaf and tea bags

Packing also affects product quality. An examination of films used for packaging of dried sage tissues has shown that increasing thickness reduces film permeability to volatile substances thus maintaining the quality of the plant material for longer. For a given thickness, polypropylene is less permeable than poly-ethylene. Other characteristics of the films, such as resistance to mechanical strength, thermo-sealing properties, uv- and light-penetration may also be important.

Sage tea products are in the market in two forms: a) as loose leaf teas and b) as ready to use tea bags. For the production of the latter specialized machinery are needed for its packaging.

Essential oils production

Essential oils yields of sage fluctuate from 0.2 to 2.9% depending on the genetic variability, variation among different plant parts and their different stages of development and environmental factors effects. *S. officinalis* is considered to have the highest essential oil yield among Salvia species.

Figure 7. Steam distillation

Figure 8. Clary sage essential oils

The major components of the essential oil of S. officinalis are a- and ß-thujones (35–50%, mainly α). Others include 1, 8 cineole, borneol, camphor, caryophyllene and linalyl acetate. Commercial sage may be substituted with *S. fruticosa* (*S. triloba*) the principal essential oil componet of which is 1, 8-cineole, with a-thujone only accounting for 1– 5%. Steam distillation yields a reduced amount of the less volatile compounds, and the accuracy of determination is significantly lower than in the case of extraction. Owing to the observed variability of the essential oil composition of *S. officinalis*, the relative contents of a-thujone,

ß-thujone and camphor have to be totaled in order to form a significant parameter for the characterization of Salvia species. Consideration of this parameter, together with the amount of 1, 8-cineole [eucalyptol] (*S. officinalis* 2.8–23%, S. fruticosa 55–75%), permits the differentiation between these species and respective mixtures.

2. OREGANO – Oreganum spp.

Introduction

The name oregano is derived from the Greek oros meaning 'mountain' and ganos meaning 'joy'. The plant grows wild in the mountains of Greece and is commonly called wild marjoram. The Greeks used it as a poultice for wounds, and Pliny recommended it for scorpion and spider bites. The colonists carried it to America, where it escaped into the wild.

Figure 9.Greek oregano plants

There are at least 61 species of 17 genera belonging to six families mentioned under the name oregano. The family Lamiaceae (Labiatae) is considered to be the most important group containing the genus Origanum that provides the source of well known oregano spices – Turkish and Greek types. Two genera of the Verbenaceae family (Lanata and Lippia) are used for production of oregano herbs. The other families (Rubiaceae, Scrophulariaceae, Apiaceae and Asreraceae) have a restricted importance. However, we frequently encounter the herbs of the above mentioned families under the name of oregano in the market.

Today, oregano plant parts and biochemical extracts (herb, leaf, essential oil, etc.) are commonly used in the food industry as a spice. Oregano can be considered one of the most important spices both on Mediterranean countries and elsewhere.The popularity of oregano is increasingly growing as a result of scientific developments achieved in the area of its cultivation and utilization. More and more new interesting varieties are being produced, thus contributing to broadening the horizon of its actual application.

Plant description

Oregano (Lamiaceae family) has square stems with opposite aromatic leaves. The flowers are arranged in clusters at the base of the uppermost leaves or in terminal spikes. The individual flowers have two lips, the upper ones two-lobed and the lower three-lobed. Each flower produces, when mature, four small seed like structures. The foliage is dotted with small glands containing the volatile or essential oil that gives to the plant its aroma and flavor.

Oregano is a perennial species that grows spontaneously in areas across the Mediterranean region, particularly in high locations. In these areas oregano is harvested mainly from wild populations, once or twice a year, at flowering stage.

Main representative species

Origanum majorana L.

Marjoram, *Origanum majorana* L., is a tender perennial herb native to North Africa and south-west Asia and naturalized in southern Europe. Formerly classified as Majorana hortensis Moench, and also sweet or knotted marjoram, the plant reaches a height of 20–40 cm, has thin square, glabrous to tomentose, reddish stems, and has small, grey-green, ovate leaves, pink or purple flowers, and erect, stems. Marjoram is cultivated in France, Greece, Hungary, the United States, Egypt, and several other Mediterranean countries.The life zone of marjoram is 6–28 °C with an annual precipitation of 0.5–2.7 m and a soil pH of 4.9–8.7. The plant is adapted to well-drained, fertile loam soils. The cold-sensitive plant cannot survive northern climates.

Origanum vulgare

Oregano originates from the Mediterranean and is closely related to marjoram. It grows to a height of about 20 cm, with woody stems and dark green leaves around 2 cm long. Small, white flowers are borne on long spikes. The plant protects the inclined soils, and it is quite tolerant to cold and dryness. During the winter the aerial parts are destroyed, but the roots maintain their vitality for the re-vegetation in spring. Oregano grows in medium soils, and in areas with high elevation and cool summer.Plant seeds in warm soil in late summer (August). Plants can be moved outdoors after three to four months (October–November).

Wild oregano (wild marjoram, common oregano, Origanum vulgare)

Wild oregano is an herbaceous perennial, native to Asia, Europe and North Africa. It is a beautiful plant, flowering in heady corymbs, with reddish bracts and purple corollas. The plant is rangy and sprawling if not cut back. The foliage is finely textured and grey-green; the variety 'Aureum' (Golden Oregano) has yellow leaves. Flowers come in late summer, grow in spikes, and are purplish white. Height is 30–60 cm with com-parable width.Along with Greek Oregano, it is the source of highly antiseptic essential oils including carvacrol and thymol. There has been much commercial focus on carvacrol as a heal-ing agent, but it is the whole herb that does the work, including all the essential oils as well as the tonifying tannins found in the plant. And, carvacrol itself occurs at therapeutic levels in many medicinal herbs besides Oregano.Optimum pH is 6.8.Wild oregano grows well in shade, the cultivated sub-species O. v. hirtum does not.

Propagation

Sexual Propagation

The seeds are germinated over a low temperature range, with an optimum temperature around 15–20 °C. Germination is also dependent upon the age of the seeds, old seeds germinated to a higher percentage than fresh ones. Essential oils in the calyx inhibit germination. This essential oil-induced dormancy is overcome under natural conditions by leaching of the inhibitors by rainwater. Germination is promoted in higher nitrogen levels of soil and with irrigation.

Asexual Propagation

Oregano plants are asexually propagated by means of cuttingsand secondary stems.

- Cuttings

Cuttings can be put in substrate made of peat and perlite. Rooting can be promoted by dipping the cuttings in indolylbutyric acid at 1000 ppm. Rooting process duration is usually 15 days.

- Secondary stems

Root-bearing secondary stems can be detached from more than one year-old mother plants. This can be done by carefully excavating around the selected plants. The material obtained can then be successfully transplanted in the field. There are reports of even 50 new plants can be acquired by detaching side secondary root bearing stems from an old plant.

Cultivation

Due to its multipurpose use as kitchen herb, in the food as well as in the flavor industry the demand on oregano has grown tremendously within recent years and is still increasing. To avoid a threatening overexploitation even of a species as widely distributed in the Mediterranean as oregano and to improve the market supply, efforts have been made to introduce oregano into systematic cultivation. Since Origanum sp. shows a high biodiversity especially also regarding phytochemical characters, the question arises which oregano is grown for which purpose based on which specifications.

Phenotypic diversity of aromatic plants was detected very early because of their striking sensorial properties, and this is true also for oregano. The main reasons for the above heterogeneity are

- the individual genetic diversity,
- the morpho- and ontogenetic variability, and
- modifications due to environment (including cultivation practices).

Land preparation

The main aim of land preparation in transplanted crops is weed control. Soil surface is not necessary to be finely ground. If the field is heavily infested by noxious perennial weeds, a deep ploughing in the summer preceding plant establishment is

recommended. In this way, the underground propagating organs of the weeds (rhizomes, bulbs) are excavated and desiccated by summer drought.

Plant establishment

Planting is carried out in autumn (October-November) or early spring (end of February-March). Autumn planting is more preferable, since a better plant establishment is promoted, except in areas with very cold winters. The choice of the most appropriate plant spacing strongly depends on local conditions (soil fertility, climatic conditions, weeds) and varies from 70×30 cm. Plants can be productive for 10-12 years, while full production can be achieved by the second year. Acceptable temperatureszone ranges from 4-33^{o}C while optimum temperatures are 18-22^{o}C. MAP's are not especially subject to serious damage by disease or insect pests, particularly when grown on a small scale. This may be due in part at least to the repellent or inhibitory action of their aromatic oils. When they are grown on a commercial scale, however, certain diseases and insect pests do cause damage under some conditions. In unusually dry weather the red spider mite may cause some damage to oregano by developing brown leaf spots, but these diseases and pests are of infrequent occurrence and seldom cause serious damage. The aphids can be controlled easily with commercial dusts or spray solutions containing rotenone, or pyrethrum.

Figure 10.Oregano field in full plant development

Fertilization

Soil pH range can optimally be 6.5 to 7.5. In soil that has adequate levels of nitrogen the oregano plants have a better performance in relation to soil with poor nitrogen content.In organic cultivation we usually use manure or compost. It prefers dry well drained soil.

Irrigation

Oregano can be cultivated as non irrigated cultivation. However plants have a better performance when irrigated at least twice until harvest. Irrigation increasesdry matter yield by 20-30% and seed yields and germination rates by 10%.

Weed control

Weed competition perhaps the major problem. The period after planting and those following harvests are critical in terms of weed control. Hand-weeding is the most labor requiring though the most effective mean of control. Mechanical weeding can be expensive in weedy fields because of the numerous treatments required.

Pests

Generally oregano has not severe pests. However there are occasional infestations by aphids and spider mites. Mild infestations can be controlled by using insecticidal soap (aphids) or sulphur based acaricides (spider mite).

Diseases

Origanum plants do not generally have many disease problems in the fileld when good agricultural practices are applied and plants have plenty of sun exposure and aeration.. Rust fungi (*Pucinnia* sp.)cause circular spots on the leaves. *Origanum vulgare* can be infested by*Fusarium oxysporum*. Other fungi that may afflictOriganum plants include *Botrytis* spp., *Phytopthora* and *Pythium*, which can cause damping off and various forms of rot.

Harvest

Agronomical Characters

Agronomical characters are of great importance for a higher productivity of the crop but in some cases also prerequisites for certain cultivation techniques (like e.g. seed weight). The most significant features are:

- Yield of dry matter;
- Upright growth (to avoid soil contamination and spoilage of leaves);
- Ratio of leaves to stem (of special interest for herb-processing companies);
- Quick development of young plants (especially for marjoram which is a slowly established crop and is rather weak when facing weed problems);
- Resistance to pathogenes (for example, *O. majorana* is severely affected by *Alternaria* and *Fusarium*);
- Salt and drought tolerance (a much desired trait in Mediterranean areas);
- Winterhardiness (desired for biennial/perennial production in Central Europe).

Harvest is done by the ending of flowering season usually in July. The plants are cut about 8-10 cm above ground level. In case of very favorable weather conditions there is a chance for a second harvesting during the year usually late in autumn. Harvest can be done manually or by specialized machinery (oregano harvesters).

Harvested biomass varies from 15000 to 19000 Kg per hectare while essential oils content ranges from 4-7%.

Postharvest treatment

Seasoning material production

The harvested biomass is air-dried under shade. Exposure to direct sunlight has to be avoided in order to prevent evaporation of the volatile compounds of the essential oil. Artificial drying can also be applied at 40 °C for 40-48 h. A good practice for small production quantities is to make small bunches and hang them upside down in shade or even in dark using natural ventilation. Oregano when used as seasoning material should follow the steps that are described below:

1. Separation of leaves (marketable plant part) from stems and branches
2. Grinding of leaves
3. Filtration and sizes separation

Then the product is ready to be sold to food industry, restaurants and households.

Figure 11. Dried oregano leaves in plastic (left) and glass (right) packaging

Essential oil production

Essential oils are produced by distillation of fresh material. Immediately after harvest the produce is transported to distillation facilities. Essential oils are obtained through steam distillation. The steam and vaporous oil pass into a condenser coil that cools the steam and vaporous oil down into a liquid. The liquid pours into a flask where the essential oil naturally separates and floats on top of the water.

Essential Oil Path

A. 0Still
B. Cowl
C. Swan neck
D. Condenser coil
E. Receiver flask

Distiller Components

1. Plant material
2. Steam & vaporousessential oil
3. Steam inlet
4. Condenser
5. Circulation of cold water (in)
6. Circulation of cold water (out)
7. Essential oil layer
8. Floral water layer (aromatic water)

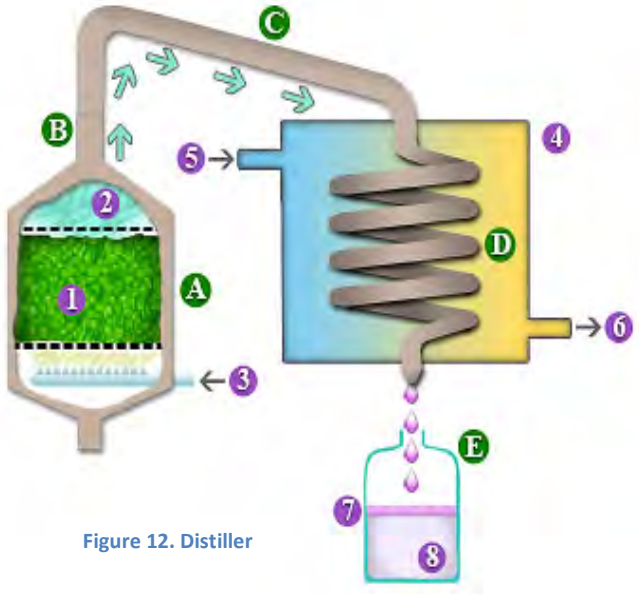


Figure 12. Distiller

(Source: http://www.honest-essential-oils.com/eobbd-essential-oils/extraction-method/)

Essential oil composition

There is a clear quality profile for “oregano” to be observed: carvacrol is regarded as the valuable sensorial as well as important antimicrobial compound. Breeding must therefore focus mainly on the optimization of the carvacrol content with as less other compounds present as possible to not interfere with sensorial/antimicrobial properties of the end product. Selecting the right chemotype means at first of course selecting for the presence of carvacrol, but on the second hand also selecting against other compounds like e.g. cis- and trans-sabinene hydrate, linalool or even thymol.

Apart from the typical “oregano” profile correlated with the carvacrol content, the enormous inter- and infraspecific chemical polymorphism of *Oregano* sp. offers a wide range for selection towards the production of specific monoterpenes as fine chemicals, new odour and flavour profiles. In *O. syriacum*, for instance, a certain geraniol and geranyl-esters as well as ethylcinnamate content is responsible for “a tender desert note” of the herb. And some of the minor compounds of *O. vulgare* ssp. hirtum have shown a very high antioxidant effect.

Figure 13. Oregano oil in containers

3. THYME – Thymus spp.

Introduction

The name Thyme, in its Greek form, was first given to the plant by the Greeks as a derivative of a word which meant 'to fumigate,' either because they used it as incense, for its balsamic odour, or because it was taken as a type of all sweet-smelling herbs. Others derive the name from the Greek word thumus, signifying courage, the plant being held in ancient and mediaeval days to be a great source of invigoration, its cordial qualities inspiring courage. People have known and used plants from the Labiate family for many centuries, Thyme being one of these, due to its medicinal and flavoring properties that have long been recognized. The demand has always increased with the growth of the human population, especially in the last decades withtheinvestigation of itspharmacological properties. A continually growing demand for thyme products is not likely to be supported by natural populations, which are threatened by destructive gathering methods and insufficientrainfall in traditional source areas. Additionally, the interests of the pharmaceutical/food industries do not focus on all chemotypes available in nature, but only on a few, namely thymol-, carvacrol- and linalool-types. Therefore an increase in the demand of thyme of cultivated origin must be expected with standardized composition and yield of the essential oils and with uniform organoleptic properties of the leaves.

Figure 14.Thyme plants

Plant description

Thyme is a low growing to almost prostrate, wiry stemmed perennial.Thyme is highly aromatic with a hint of clove and mint fragerance.There are many Thymus species, however only few of them are of commercial significance, namely *T. vulgaris L., T. zygis* L. ssp. *gracilis* Boiss. (red thyme), T. *satareioides* Cosson, T.*serpyllum* L. (wild thyme) and T. *capitatas* Hoffmanns. T. *vulgaris* is the only species, which is cultivated commercially in reasonable amounts. *Thymus vulgaris* (common thyme) is a perennial with a woody, fibrous root. The stems are numerous, round, hard, branched, and usually from 10 to 25cm high. The leaves are small, only about 3 mm long and 1.5 mm broad, narrow and elliptical, greenish-grey in color, reflexes at the margins, and set in pairs upon very small foot-stalks. The flowers terminate the branches in whorls. The calyx is tubular, striated, closed at the mouth with small hairs and divided into two lips, the uppermost cut into three teeth and the lower into two. The corolla consists of a tube about the length of the calyx, spreading at the top into two lips of a pale purple color, the upper lip erect or turned back and notched at the end, the under lip longer and divided into three segments. There are three varieties usually grown for use, the broad- leaved, narrow-leaved and variegated: the narrow-leaved, with small, greyish-green leaves, is more aromatic than the broad-leaved, and is also known as winter or German Thyme. The fragrant Lemon Thyme, likewise grown in gardens, has a lemon flavor, and rather broader leaves. Another variety, the Silver Thyme, is the hardiest of all and has perhaps the best flavor. There is a variety, also, called the Orange Thyme.

Propagation

Sexual Propagation

The seeds are covered by a thin layer of soil for protection from drying out while in germination. Seedling can be transplanted to the field when they have reached a height of5-8 cm.

Asexual Propagation

Thyme plants are asexually propagated by means of cuttings.Cuttings should be taken from healthy, vigorous plants by taking a clipping about 7.6 cm in length from the end of a branch.The leaves should be removed from the lower half of the cutting before planting in light textured potting media to root. The cutting should be watered regularly and kept moist, but not wet while they root. The new plants will be ready for transplanting after approximately 8 weeks after hardening and are planted in the same way as seed-grown transplants.

Cultivation

Land preparation

The main aim of land preparation in transplanted crops is weed control. Soil surface is not necessary to be finely ground. If the field is heavily infested by noxious perennial weeds, a deep ploughing in the summer preceding plant establishment is recommended. In this way, the underground propagating organs of the weeds (rhizomes, bulbs) are excavated and desiccated by summer drought.

Plant establishment

Planting is carried out early in autumn (October)just after first rains or early spring after heavy cold periods (March). Autumn planting is more preferable, since a better plant establishment is promoted, except in areas with very cold winters. The choice of the most appropriate plant spacing strongly depends on local conditions (soil fertility, climatic conditions, weeds) and varies from 70-100 × 25-35 cm. Plants are transplanted either manually or using transplanting machines. Plantation is productive for 6-8 years.

Figure 15. Thyme cultivation

Fertilization

Thyme has a rather small demand for nutrients. Nitrogen, phosphorus and potassium are needed for the good development in small quantities. It has been proven though that when these elements are in satisfactory levels growth is quite good. Increasing nitrogen levels has produced bigger yield. The same stands for phosphorus in terms of fresh produce. Essential oils content however does not increase with fertilization rates, but their yield increase as a result of increased dry matter quantity.

The recommended rates depend on the levels of the available macronutrients in soil: 2-3 tones of manure per hectare in autumn would supply the plants with necessary nutrient quantities. It is better to be mechanically incorporated into the soil.

Irrigation

Thyme can be cultivated without irrigation. Thyme can be irrigated in spring to induce a rapid plant growth. Satisfactory soil humidity levels contribute significantly to production increase especially in long periods of drought.

Weed control

Weed competition is among the major problems in thyme cultivation. The period after planting and those following harvests are critical in terms of weed control. Hand-weeding is the most labour requiring though the most effective mean of control. Mechanical weeding can be expensive in weedy fields because of the numerous treatments required. Weeds must be removed 4 or 5 times during the season to maintain the culture adequately.

Pests

There are not severe pests of thyme

Diseases

The only fungus that causes economical damage to thyme plant is *Alternaria brassicicola*. This can be the result of inappropriate plant density and bad ventilation. In case of appearance all affected plants should be removed and destroyed by fire.

Harvest

Thyme is harvested during full blossoming period in May or June depending on the area of plantation. The period of vegetation and blooming can be different in various geographical zones depending on their climatic conditions. All the above ground plant part is being collected. In irrigated fields there is a chance of more than one harvest per year (2 or 3). Yield reaches 1500-2000 Kg per hectare (dry plant material)in the second year and a yield of 3500-5000 kg per hectare is achieved at third year. The harvest is carried out during dry and sunny weather by hand or using motorized shears or a harvester with an adequate cutting bar. Cutting should be done at a height of 10-15 cm above the soil level. Weather conditions during the day of harvest are important. In general, sunny days should be preferred, after morning dew has disappeared. The plants harvested after rain or with dew moisture are difficult to dry; they deteriorate much faster, their color and useful properties become inferior.There are two aspects that influence the quality:

- The proportion of leaves and stems, leaves presenting a higher quality, and
- The content of essential oil.

With respect to productivity four criteria are used to characterize the yields and quality of each variety

- Yield in dry matter
- Yield in leaves
- Percentage of essential oil
- Yield in l/ha of essential oil

Postharvest treatment

Shelf life of fresh herbs is usually very short and therefore, traditionally, herbs have been used as dehydrated (dry) products. Drying is the most critical process due to the volatility and susceptibility to chemical changes of the contained volatile oil.It should be done in shady place with an optimum temperature ranging from 30-43^{o}C. In higher temperatures essential oils evaporate and final yield is reduced. Under these conditions drying takes 2-3 days(10-12percentmoistureas a maximumattheendof the process). The essential oils content ranges from 1 to 3%.

Drying methods can be divided into thermal and non-thermal drying. Thermal methods:

- natural direct drying (air drying with the aid of sun energy),
- solar indirect drying, and
- artificial drying (with the aid of heat, cold or IR).

Non-thermal drying can be performed by using:

- moisture-absorbing materials,
- drying agents and
- electrolytes

Cleaning can be achieved by using appropriate equipment. The equipment can consist of magnets, sifters, air tables, destoners, air separators, indent separators and spiral separators. After that purification and particle size selection can be done with course cutters, crushers or breakers, sieves and mills.

Packaging and storage ensures a long shelf life of thyme. The stability of thyme depends on the following aspects:

- moisture content,
- comminution method (finer grinding means lower stability),
- quantity and package size (bigger package brings higher stability),
- packaging material (lower permeability to water and air results in higher stability). Optimal packaging materials are glass and metals because both are completely impermeable and provide the best protection of aroma.
- effect of light and humidity (higher humidity and light access causes lower stability) and,

storage temperature (lower temperature means higher stability).In general storage below -18 ^{O}C provides unlimited storage time, at 5-7 ^{O}C dried herb can be stored more than 12 months, whereas at room temperature stability considerably decreases.

Figure 16. Dry thyme (left) and thyme essential oil (right)

4. Mountain tea – Sideritis spp.

Introduction

Mountain tea has been famous in Greece since ancient times and it is reported in Theophrastus (372-287 B.C.)and Dioscourides (1stcentury A.D.). It`sscientificnamederivesfromtheGreeknameofiron “σίδηρος” which has been given to the plant because of its potential to cure wounds made by iron objects. According to another explanation this name was given because of the fact that the plant is a natural iron source since beverages made by it are rich in iron. A third aspect is that this name was given due to the calyx shape that resemblesthat of a spearhead.

The sideritis species are native to Mediterranean countries and mainly in Greece. Due to the fact that in recent years the consumption of products made using mountain tea has increased there is an high demand in terms of quantity and quality. This is the reason why cultivation of mountain tea has an increasing trend in terms of cultivating area. Dryblossomingstemsareusedforteapreparation.

Figure 17.Sideritis scardica plant

Plant description

Sideritis species are perennials, densely white-tomentose or glabrescent, with tiny glandular hairs all over berb. The base of the stem is woody producing erect flowering shots 15-30 cm long. Basal leaves are light green or green-yellowish, coriaceous, lanceolate or oblong-lanceolate, acute, usually dentate, attenuate at base, 40-60 x 7-12 mm (including petiole). Middle and upper stem leaves coriaceous, strongly reticulate, rounded or cordate at base, lanceolate or oblong lanceolate, semiaplexicaul, perfoliate, 30-50 x 9-16 mm. Inflorescence is usually unbranched, 2-22 cm long. Verticillasters 4-10, compact below, more or less distant above. Bracts entire, ovate-triangular, 2-3 times as long as flowers, acuminate 25-25 x 15-22 mm with acumen 10-15 mm long, becoming shorter and narrower towards the apex of inflorescence. Calyx is campanulate, glandular all over, with englandular hairs only towards the teeth 4mm long. Corolla is yellow with two stripes on the two lobes of the upper lip, 12-14.5 mm long.

Mountain teabelongstoLamiaceaefamilyandgenusSideritis, which includes about 140speciesthat are found mostly in Mediterranean countries. The most important species in Greece are:

- *Sideritis athoa*
- *Sideritis clandestina*
- *Sideritis scardica*
- *Sideritis raeseri*
- *Sideritis syriaca*
- *Sideritis euboea*

Propagation

Sexual Propagation

The seeds are germinated over a low temperature range, with an optimum temperature around 15–20 °C. Germination rates range between 60-70%.A gram contains about 600 seeds. About 150 grams are enough to create plants for the cultivation of a hectare. This quantity of seeds is sown in seedbed covering 50 square meters. It is best to be done from August to October. When seedlings have developed 4-6 leaves they are ready for transplanting. We must be very carefully with plant density in nursery. Very dense sowing will lead to increased stress and less aeration witch will result to root rots.

Asexual Propagation

Tea plants are asexually propagated by means of cuttings and secondary stems.

- Cuttings

Cuttings can be put in substrate made of peat and perlite. Rooting can be promoted by dipping the cuttings in indolylbutyric acid at 1000 ppm. Rooting process duration is usually 15-20 days.

- Secondary stems

Root-bearing secondary stems can be detached from more than one year-old mother plants. This can be done by carefully excavating around the selected plants. The material obtained can then be successfully transplanted in the field. Cultivated sideritis plants produce more secondary stems than wild populations due to better conditions and plant vigorounness.

Cultivation

Mountain tea grows at altitudes higher than 1000 m above sea level in alpic and sub-alpic areas. Although it is tolerant in cold there is a big susceptibility in high temperatures and drought. It prefers limy and rocky soil and can exploit soil resources in very poor fields. In order to keep quality and price we should provide the same conditions (altitude and soil) to cultivated plants as those preferred by wild populations.

Land preparation

The main aim of land preparation in transplanted crops is weed control. Soil surface is not necessary to be finely ground. If the field is heavily infested by noxious perennial weeds, a deep ploughing in the summer preceding plant establishment is recommended. In this way, the underground propagating organs of the weeds (rhizomes, bulbs) are excavated and desiccated by summer drought.

Plant establishment

Planting is carried out either in autumn (October-November) or early spring (February-March). Autumn planting is more preferable, after the first rains, since a better plant establishment is promoted. The choice of the most appropriate plant spacing strongly depends on local conditions (soil fertility, climatic conditions, weeds etc.) and varies from 50-60 ×40-50 cm. Planting can be done manually or by using transplanting machines (i.e. tobacco or tomato trans-planters). Immediately after transplanting we should water the plants in order to assure a better establishment rate.

Fertilization

Soil pH range can optimally be 6.5 to 8. There is not enough information about fertilization of mountain tea. Generally mountain tea has not big demands for nutrients and can perform quite well in poor soil. In case weak vegetation is observed there must be addition of 3-4 units of nitrogen and 4-5 units of phosphorous late in autumn. We should be very careful with nitrogen because in excess vegetation is developed at the expense of inflorescence resulting in less quantity of produce.

Irrigation

Mountain teas cultivated as non irrigated cultivation.In case of severe drought we should irrigate just to keep plants alive. Otherwise excessive irrigation leads to quality deterioration and lower trade price.This happens because the aromas in the inflorescence are not so strong due to smaller concentration of aromatic compounds.

Weed control

Weed competition is a major problem. The period after planting and those following harvests are critical in terms of weed control. Especially in mountain tea wither is a great competition between plants and weeds for nutrients and soil humidity. Weed competition leads to decreased production life of the plants. Hand-weeding is the most labor requiring though the most effective mean of control. Mechanicalweedingcanbedonealso.

Pests

There is not a severe pest for sideritis plants.

Diseases

Root rots have been reported in fields that retain water and have a heavy soil with bad drainage.

Harvest

Harvest is done in the full flowering season usually in July. The whole inflorescenceis removed with a part of shoot about 5-8 cm using a sharp knife or sickle. Each field can be productive for 5-8 years. Production is increasing until the fifth year and after that it is declining. Typical yields are 100 Kg per hectare (first year), 500-600 in the second and maximizes at 900-1000 Kgr/hectare in third to fourth year (dry material).

Postharvest treatment

The harvested biomass is air-dried under shade. Exposure to direct sunlight has to be avoided in order to prevent evaporation of the volatile compounds of the essential oil. Iron plate covered drying facilities should be avoided because the temperature is higher, resulting in discoloration of the material. A good practicefor small production quantities are to make small bunches and hang them upside down in shade or even in dark using natural ventilation. Afterdryingeachshouldweightabout80 grams.

Mountain tea can be used for beverages. The main forms that it is available in the market is in the form of bunches, as loose leaf tea and in teabags.

Figure 18.Mountain tea tin (left) and plastic bag packages (right)

5. Rosemary – Rosemarinus spp.

Introduction

Rosemary (*Rosmarinus officinalis*) is a member of the mint family (*Lamiaceae*) that is native to the Mediterranean region and grows well near the sea. It was long ago introduced widely in Europe. It is used as an herb to savor meat, savory dishes, and salads. It is used sparingly in herb mixes because of its intense scent. The essential oil is used in cosmetics and in some pharmaceutical preparations.

Rosemary's history is rooted in ancient times. The Greeks and Romans made mention of its medical and mystical properties in addition to more realistic uses in the kitchen. Rosemary found its way into the folklore of many countries where it was thought to ward off evil spirits as well as being a symbol of the fidelity of lovers. With its attractive spike-adorned stems, rosemary also found its place in Christmas decorations as it is easily added to wreaths and sprays.

It is native in the Mediterranean; it grows in large areas of southern Europe and is cultivated worldwide. Most of the sources interpret its name as “dew of the sea”.

Plant description

Rosemary is an erect, bushy shrub that may reach 2 m in height. Its evergreen leaves are dark green above and white hairy below. The leaves are 2 to 3.5 cm in length and are folded inward along the margins. The violet-blue or whitish flowers are borne in small axillary (i.e., emerging from the angle between the leaf and stem) racemes. The calyx (the collective term for all the sepals of a flower) and corolla (the collective term for all the petals in a flower) are two-lipped, the latter around 1.25 cm in length and enclosing two stamens the male sex organs in a flower.

Figure 19.2 Rosemary plants

Rosemary plants are self-compatible (i.e., they can fertilize themselves), but as is also typical for the family, the anthers (male pollen-producing structures in each flower) are finished producing pollen before the stigmas (female parts) in the same flower mature. Thus, the plants rely on insect pollinators to move their pollen from one flower to another. Often, pollen from one flower is moved to a mature stigma on another flower on the same plant, resulting in self-fertilization. Self-fertilization in Rosemary plants tends to result in fewer and lighter seeds than cross-fertilization (i.e., fertilization of a flower by pollen from a flower on a different individual plant), an example of inbreeding depression. Like many species in the *Lamiaceae*, rosemary is gynodioecious, i.e., populations are composed of some plants with hermaphrodite flowers, which are functionally both male and female, and others whose flowers are functionally female, with the male organs reduced and sterile.

There are many varieties available in the market nowadays. Most famous are Benenden Blue, Flora Rosa, Tuscan Blue, Majorca Pink, Arp, Albiflorus, Hundington Carpet, McConnels Blue, Irene, Holly Hyde and Hill Hurdy. The plant parts that are used for the production are leaves together with flowers. Flowers derived essential oils are considered to be of higher quality than those that are distilled from leaves due to comfort lower content however almost all quantities in the market come from leaves that are harvested just before flowering.

Propagation

Sexual Propagation

The seeds are germinated over a temperature around 20 °C. In a container with starting mixture we place the seeds and cover them slightly with the mixture. We keep the soil evenly moist. The seeds sprout in 14 to 21 days. When they are about 7-9 cm tall the plants are ready to be transplanted in their permanent position in the field.

Asexual Propagation

Rosemary plants are asexually propagated by means of cuttingsand secondary stems.

- Cuttings

Cuttings 10-15 cm long after the removal of 2/3 of their lower leaves can be put in substrate made of peat and perlite leaving out of the substrate no more than 1/3 of their length. Rooting can be promoted by dipping the cuttings in indolyl-butyric- acid at 1000 ppm. Rooting process duration is usually 15-30 days.

- Secondary stems

Root-bearing secondary stems can be detached from mother plants. This can be done by carefully excavating around the selected plants. The material obtained can then be successfully transplanted in the field.

Early spring is the best period for transplanting young plants to their permanent position in the fields. October – November is another period for late season transplanting.

Cultivation

Land preparation

Rosemary does not have a good development in heavy clay soil. Before establishment of the plantation we should check the soil properties and in necessary enrich soil organic matter by adding animal manure or other suitable materials. The main aim of land preparation in transplanted crops is weed control. Soil surface is not necessary to be finely ground. If the field is heavily infested by noxious perennial weeds, a deep ploughing in the summer preceding plant establishment is recommended. In this way, the underground propagating organs of the weeds (rhizomes, bulbs) are excavated and desiccated by summer drought.

Plantestablishment

Rosemary is aplant that can tolerate a big temperature range and for this reason it is established in a great area of southern Europe. It has a good development at day temperatures around 20-25 ^{o}C.Rosemary is a sun demanding plant. Therefore rows should ideally be oriented from east to west side of the field. When the field are not flat the rows orientation should have a southwester direction.Plantspacingvariesfrom 100-120 × 40 - 50 cm. Rosemary develops in several soil types with pH values ranging from 5.5-8, while clay content can not exceed 30%.

Fertilization

Adequate levels of nitrogen, phosphorus and potassium as well a sulphur are necessary for satisfactory yields. Rosemary responds well in additional nitrogen applied to the soil especially in the period just after harvest. This nitrogen quantity triggers the re-vegetation process. However excessive nitrogen levels could negatively affect essential oils quality.

Irrigation

Rosemary has a quite big demand for irrigation especially from planting till full plant development. Mature plantations can be drought tolerant however critical in stages irrigation is necessary. The irrigations that will be applied depend on a series of factors like rainfall soil structure, field variability. In areas with low rainfall for the full establishment of transplanted plants irrigation is absolutely necessary. In areas though that has at least 500mm of annual rainfall and when plants have reached development maturity irrigation is necessary only in critical drought periods. Finally in humid areas soil drainage is one issue of big importance to keep plants healthy.

Weed control

Weed control in rosemary cultivation is very significant for the production of good quantities and qualities produce especially that of essential oil. Weed can be done manually or mechanically. Generally 2-3 weddings per year are usually enough to keep weeds population and development in acceptable levels. When mechanical methods are applied we should be very careful and avoid destruction of rosemary roots. When rosemary plants are developed enough they prevent weeds from sun exposure and their population is further suppressed. Drop irrigation also provides less favorable space to weeds for development. We should remove weeds in time especially for annual ones that time should be before they form their seeds.

Pests

Rosemary is vulnerable to spider mites aphids and mealybugs. They suck plant sap while the latter secret honeydew where fungi develop affecting photosynthesis and deteriorating quality. Mites create spider threads and heavy infestation can lead to plant drying. Thrips such plant sap also and secret honeydew. There must be good monitoring procedures and when populations are high appropriate pesticides should be applied. In organic agriculture sulphur based products can be used for mites and insecticidal soap could be applied for the rest of the pests.

Diseases

Powdery mildew and root rots may appear in heavily irrigated crops especially in soil that has not a good drainage of excess humidity.

Harvest

Rosemary is harvested once or twice a year depending on the prevailing environmental conditions and on the intended use (seasoning material or essential oil production). It can be harvested from the first year however it is recommended that harvest starts from the second year on.Harvest can be done manually or by specialized equipment.

- Rosemary can be harvested and used as fresh. In these cases we choose to harvest when plants are in re-vegetation stage. We only harvest tender new vegetation with small and green shoots so that they are suitable to be added in food as ingredient. Its harvest is done very early in the morning and the harvested quantity is stored in the fridge at 5 °C until reaching the market. Under this temperature the product can be stored for 2-3 weeks.Fresh product yield can reach 7500 – 10000 Kg per hectare.
- When intended use is the production of dry seasoning material rosemary is harvested just before flowering start because dry material should contain only the leaves.Dry material yield is about 2500 – 3500 Kg per hectare.
- When harvested for distillation (oil production) the plants should be at blossoming stage. Mechanic harvesting is the preferred by farmers way because rosemary has a very prolonged flowering period. Frequent harvest leads to bigger yields since there is a constant re-vegetation of the plants. Essentialoilsyieldrangesfrom 20-80 Kg per hectare.

Postharvest treatment

After drying, harvested rosemary is processed in order to remove leaves from stems. Then product passes through sieves for the removal of other materials. Finally only leaves remain. Drying can be done naturally or mechanically in drying facilities. In mechanical drying, temperatures should not exceed 40 °C in order to avoid loss of essential oil by evaporation and to ensure that the leaves will keep the characteristic green color.

Rosemary essential oil from flowers has a strong mint scent and it is colorless to pale yellow. The practice of getting oil only by the tips of stems that bear flowers is more demanding in terms of work but produced far better quality and the essential oils are more expensive. When the essential oils are produced by all harvested plant parts camphor levels are elevated and the oil is considered as lower quality.

Rosemary can be sold to the market directly as fresh. I that case it should be packed in appropriate packaging material.

Dry rosemary as food seasoning can be packed in glass or plastic containers. These should be of dark color and storing temperature should not exceed 18 ˚C.

Essential oils should be packed in dark glass vials with airtight lids in order to protect the content from light, humidity and evaporation. They should be stored in cool and dry place. Extra care should be taken regarding contact with skin because it is highly irritating (skin and eyes). Also contact is prohibited for persons that have epilepsy, high blood pressure and during pregnancy. Also extra care should be taken to keep away from children vicinity.

Figure 20. Dry rosemary (left) and rosemary essential oil (right)

Part 2: This part was prepared for the CULT project by the Foundation "BIOSELENA"Karlovo, Bulgaria

6. Bulgarian rose from Kazanluk- Rosa damascena Mill.

Figure 21. Rosa damascene Mill.Rosa centifoliaRosa gallica

Origin and History

The oil-yieldingrose is considered to originate from Iran where Rosa damascena,Rosa centifolia and Rosa gallica grow free in nature.

I.The soil and climatic conditions: There are particular and specific requirements for climate and soil conditions to obtain high yields of roseblossomandquality rose oilfrom **Rosa damascena Mill**.

1.Requirements to soil – the oil-yielding rose grows and develops best in deep water permeable soils with a neutral reaction. In Bulgaria rose production has been developed a variety of soil types:

- talus deposits in the process of soil formation,leached and slightly podzolized maroon.The soil reaction is acidic (pH = 3. 0 to 6. 1) to neutral and slightly alkaline (pH = 6. 6 to 8. 0).
- cinnamon-colored forest (eroded,leached and podzolized) and talus deposits in the process of soil formation,with a tiny fraction and less porosity.The soil reaction is acidic to moderately acidic (pH = 4. 2 to 5. 1).
- maroon forest soils,mostly eroded and leached,skeletal, with low porosity,poor water-air mode,medium acidic to acidic.

2.Heat requirements -moderate temperature and high atmospheric humidity,especially during the rose picking are the most favorable.The development of Rosa damascena Mill of Kazanluk starts at average daytime temperatures of 4º C,flower buds are appear at 10-12º C,and bloom in May-June run at 18-20º C.Well pronounced day-night temperature range (the difference between day and night temperatures) is crucial for the development of plants,laying of flower buds,synthesis of oil and duration of flowering.Bushes freeze in winter at temperatures below -25º C and windy weather.Rosa damascena Mill is sensible to spring frost.Warm weather in February,followed by a sharp cold snap cause damages such as freezing of some branches or even whole bushes.Young twigs are more resistant to low temperatures.

3.Moisture requirements - Rosa damascena Mill has a highly developed root system. In order to obtain high and stable yields during the vegetation period the soil moisture should be about 70-75% oflimit field moisture absorptionand sudden droughts should be avoided.The microclimate of the crops is suitable when most rainfall is in May-June when buds are growing and rose-picking begins.Thus conditions are created for the retention of high atmospheric humidity,which is crucial to obtain high yields of blossoms and oil.

4.Light requirements - Rosa damascena Mill is a light-demanding plant.Shading slows growth and reduces the content of essential oil.

II.Varieties:

1. **Local** - average yield of 3500 kg/ha,maximum,about 8000.The blossoms contain between 0.04 - 0.052% rose oil.

2. ***Iskra*** - average yield of 6000 kg/ha,maximum - about 8500,the average content of essential oil is0.56%.

3. ***Svezhen*** - average yield about 5800 kg/ha, maximum-about 8500,the average content of essential oil is 0.056%.

4.***Elayna*** - average yield about 8000 kg/ha, maximum-about 11000,the average content of essential oil is 0.052%.

5.***Yanina*** - average yield about 7000 kg/ha,maximum-about 10000,the average content of essential oil is 0.045%.

III. Treatment of Rosa damascena Mill

1.Preparation of the area for planting:Rosa damascena Mill has been grown for more than 30 years.Unfavorable conditions for growing plants,slow down their growth and development,which affects the duration of their lives and yields of blossom and rose oil.Rose gardens should be created near settlements to reduce transport costs for workers and products at the time of rose picking.

2.The basic cultivation consists of clearing old trees,bushes,stones and leveling.Plowing is preceded by fertilizing with manure,lumbri-compost or other fertilizers.Plowing is carried out from May to August,depending on the available weeds and the previous plant.It should be performed one year before planting.When roses are planted in the year of plowing it should be effected early enough to allow pre sowing treatments and settling of the soil. It should be followed by leveling.

3. Pre sowing tillage of the soil.The plot should be kept free from weeds by means of summer plowing and repeated disking and cultivating.

4.Creating plantations:The most favorable time for planting roses is the autumn-winter period until the end of February.In case of delay in planting in the spring over 40% of roses can die,regardless of the provided irrigation.Before planting,if necessary fertilizer can be applied by stockpiling fertilization.It is based on data from soil analysis, nutrients extracted by the crops from the soil,the expected yields, the content of nutrients in the applied fertilizers.Approximately 50-70 t/ha manure,200-250 kg / ha P_2O_5 and potassium could be used.

High yields depend mostly on the planting schedule.The highest extraction of rose blossom is obtained by providing 5, 000 plants per hectare.This is achieved by spacing of2, 80 m and 0, 70 m between the rows of plants.

Planting is effected by means of drills (for vineyards) with seedling machines,but most often in furrows opened in advance.Planted roses are irrigated if necessary and wrapped with loose soil.The soil around each rose bush is compacted well to ensure a high rate of interception,and shortly before the winter can be wrapped.

5.Care for young crops without blossoms:In the first years after planting,cares are aimed at creating an optimum watering, airing and nutrition, that ensure rapid growth and development.In early spring the rows are cultivated as soon as possible to a depth of 14-16 cm.The next treatments during the vegetation period are 3-4 cultivations to a depth of 8-10 cm.At the end of the vegetation period the plowing of the plots to the rows should not exceed10-12 cmabove the soil surface.

The treatments of the lines in the row in outside moors are effected manually.During the vegetation period 3-4 timely earthlings are required.

In the first year if necessary the tops of the twigs are cut for the proper formation of the bushes.All the rose buds are removed, that hinder the growth of the young plants.In the spring of the second year the bushes are formed bypruning is done at a height of 80-90 cm from the soil surface to form bushes.

In irrigated areas,if necessary through vegetation irrigations are performed with 300-400 m^3 /ha water in gravity irrigation or sprinkling 6-8 times with 100-150 m^3 water / ha.Best effect is achieved by drip irrigation.

In the autumn at the end of the first growing season the fallen plants must be filled up.Any delay or postponement results in poor garnishing of the plantation and creates additional difficulties for the subsequent practices over the years of cultivation and yields are smaller compared to the well-garnished rose gardens.

IV.Fertilization

Two periods of intense absorption of nutrients are established for Rosa damascena Mill:

- During this period,the shoots grow rapidly and form flower buds and the roses bloom intensively.Bushes absorb about 58% of nitrogen, 64% of phosphorus and 54% of potassium required.
- The second period is the period of secondary growth,characterized by the rapid growth of shoots after blossoming.The intensity of this growth is vital for the yields in the subsequent year.Plants absorb about 32% of nitrogen,26%of phosphorus and 33% of potassium

The blossom-yielding rose gardens are fertilized every 3-5 years with manure,compost or other fertilizers. The fertilization is carried out in the autumn period – October,November,before the autumn treatment of the crops. The rose gardens if necessary are fertilized several times during the year on the leaves or in the soil during the irrigation.The fertilization should be effected at least twice – in early spring and immediately before rose picking.

The yield of 100 kg rose blossom the oil-yielding rose extracts about 2, 0 kg N; 0, 5 kg P_2O_5 and 1, 5 kg K_2O**.**

Figure 22.Rose damascene M. in full production

V. Picking

Rosa damascena Mill blooms from mid-May to mid-June.At high atmospheric humidity and at lower temperatures the blooming can last 25-30 days and in dry and sunny weather it is about 15-20 days.The essential oil begins to evaporate after the opening of the blossom,so the roses are picked between 5 and 10 am.The blossoms are picked with the blossom cup,the blossom is stored in plastic bags until transported to the rose-processing facility as soon as possible and should be processed immediately.If this is impossible,the blossom is filled with water in special containers to be processed by the end of the day.Rose oil is extracted by means of steam distillation,yielding also rose water.Rose concrete is obtained by means of extraction with solvent.One kilogram of rose oil is obtained from the average 2500-3000 kg blossom.

Figure 23. Process ofoil distillationof rose blossom

Plant protection - main diseases and pests

I. Diseases

Rust (Phragmidium mucronatum Pers.), Black leaf spots (Diplocarpon rosae Wolf), Gray mould disease (Botrytis cinnerea Er.), Cancer Bacteria (Agrobacterium tumefacies Conn), Mosaic

II. Pests

Agrilus(Agrilus mokrzeckii Obend), Bud holes (Rhynchites hungaricus Fuss.), Green rose aphid (Macrozphum rosae L.), Bud perokrilka (Platyptilia rododactilus F.), Rosetta spherical Panelboard aphis (Rhodococcus bulgariensis Wiim.), Cicadas: yellow (Edwarsiana nicolovae); usual (Edwarsiana rosae),Leaf-attacking caterpillars (Geometridae), Leaf-rollers: (Limantria dispar L.); (Spilonota ocelana F.),Beetles: (Epicometis histra Poda); (Oxythyrea funesta Poda); Phylloperta horticola, Mites.

Indirect methods to control the diseases:

- Compliance of interlinear and spacing in order to ventilate the plantation
- Well balanced fertilization with moderate amounts of nitrogen (up to 100 kg / ha.)
- Plowing the leaves gently in order to facilitate their decay
- Avoiding copper-containing chemicals on hot days
- Burning attacked branches and leaves

Indirect pest control methods:

- Cutting and burning infested twigs
- Cuttingand burning bushes from the same family,located near the plantation
- Creatingcrops away from the old,abandoned plantations
- Creating conditions for nesting birdsthat are their natural enemies.

Direct control:

Conventional production:

- Dry twigs are removed and burnt in winter and spring.
- Lands should be treated regularly

Chemical control:

Against diseases (rust,black leaf spots):

- with 2% bordeaux solution February-March
- 2-3 times before blossoming and 2-3 times after blossoming – Bajkor 25 -0, 2 %;Bajkor 300EC – 0, 15 %;Saprol 19 EC – 0, 2%; Impact 12, 5 – 0, 1 %;Tilt 250 EC – 0, 05 %;Folikur plus – 0,05%

Against pests (agrilus,aphids,caterpillars etc.)

- duringblossoming,rose picking for should be stopped for 1 day and the plot should be treated with Vaztak 10 EC – 20 ml/dka; Decis 2, 5 EC - 50 ml/dka; Karate 5 EC – 25 ml/dka;
- before blossoming Dimilin 25 – 100 g/dka

Akari: Apollo 50 EC – 0, 2 %; Ortus 5 – 0, 05 %; Talstar 10 EC –0, 02 %; Dinitol 10 EC – 0, 075 %; Cascade 5 EC – 0, 15 %.

The chemicals could be mixed,except bordeaux solution.

Biological production:

Rust - during the non-vegetative period until bud burst - 2% bordeaux solution, to which adhesive (ex. soap) must be added.

- first spraying, when upper buds develop,
- second spraying - when all lower buds appear;
- third straying immediatelybefore flowering;

- fourth spraying , after the end of picking,
- fifth spraying (in a wet year)

Black leaf spots-after pruning during the winter period with sulphur-lime solution 1: 10; 1% bordeaux solution (adhesive) in summer when the weather is rainy with adanger of mass spread of the disease.

Late winter - with sulphur-lime solution

Vegetative oils – with rape oil,fennel

Winter treatment with mineral oils

For pests – natural Pyrethrum,Piros,Bionim plus

Treatment:

- Winter treatments with 2 % bordeaux solution at the end ofFebruary or the beginning of March
- Before blossoming: 2 – 3 times sprinkling with Pyrethrum and Funguran
- Duringblossoming: sprinkling with Nim-Azal
- Afterblossoming: 2 – 3 times sprinkling with Pyrethrium,Nim-Azal (every 5-10 days),Мико-Син

Products from Rosa damascena:

- rose oil-applicable in perfumery,aroma therapy,medicine etc.Possesses antibacterial and antiviral properties as an antiseptic to treat colds,flu,cough,runny nose,skin infections,acne,eczema,rashes,dandruff and stretch marks on the skin ,etc.
- rose absolute - medicine,perfumery and cosmetics.Possesses antibacterial and antiviral properties.It is used for skin irritations,sores and eczemas. Activates,refreshes and softens the skin
- rose concrete - medicine and cosmetics.There are strong antimicrobial properties.It is used to soothe,activate problem skin etc.
- rose water - activating and refreshing agent.Applicable in cosmetics for skin problems,rashes,eczema etc.; in medicine for kidney stones,for total body strengthening etc.
- dry rose blossom - medicine,cosmetics -stimulates skin renewal,improves blood circulation,soothes the skin,making it soft like velvet,elastic and whiten, heals skin inflammation,etc.
- rose liquor - a refreshing low-alcohol drink with proven diuretic effect
- rose jam -high energy food,designed for athletes and physically active people
- rose honey - high energy additive,suitable for daily use for athletes,and for physically active people

7. Lavender - Lavandula L.

Figure 24. Lavanda in full bloom

I. Soil–climatic conditions

1.Soil requirements.WildLavandula L.grows in mountains on poorer and skeletal plots.High yields could be obtained in deep soils rich in nutrients.The alkaline reaction of the soils should be neutral to alkaline.

2.Heat requirements. Lavandula L.is cold-resistant.Well developed bushes resist temperatures as low as -33º C.The leaves of the tufts in spring appear at temperature 8-9º C.Higher temperatures in spring allow the accumulation of more essential oil.

3.Moisture requirements.Lavandula L.in Bulgaria develops very well as crops, not requiring irrigation. Due to the well developed root system it grows well at higher altitude as well.

4.Light requirements.Lavandula L.Grows best on sunny places, on south and south-west slopes. Shading of the tufts reduces the essential oil content.

II.Varieties:

1. ***Kazanluk.*** The tuft is upright,up to 70 cm high, having about 800 blossoming stems.It is violet.The essential oil content in the blossom is 0, 9%, of linalyl acetate in oil-51, 5%.

2. ***Karlovo.***The tuft is leveled, up to 65 cm high , having about 700 blossoming stems.It is violet.The essential oil content in the blossom is 1%, of linalyl acetate in oil-55%.

3. ***Svezhest.***The tuft is well shaped, up to 60 cm high, having about 1100 blossoming stems.It is pale violet.The essential oil content in the blossom is 1, 13%.

4. ***Hemus.***The tuft is upright, up to 60 cm high, having about 700 blossoming stems.The color is pale violet to blue.The essential oil content in the blossom is 1, 82%,of linalyl acetate in oil-58, 9%.The average yield per 1 hectare is 125 kg oil.One of the best Bulgarian varieties.

5. ***Druzhba.***The tuft is tight,powerful,up to 70 cm high,c about 1000 blossoming stems.It is violet.The essential oil content in the blossom is 2%, of linalyl acetate in oil-49%.

6. ***Jubilee.***The tuft is tight, rounded, up to 60 cm high , having about 500 blossoming stems.It is violet.The essential oil content in the blossom is 2, 7%.The yield of fresh sprouts is 5500 kg/ha,of essential oil-max 140 kg.

7. ***Seutopolis.***The tuft is tight, rounded,up to 65 cm high,having about 300 blossoming stems.It is pale violet.The essential oil content in the blossom is 2, 6%.The yield of fresh sprouts is 6200 kg/ha,of essential oil-max 150 kg.

8. ***Hebar.***The tuft e tight, rounded, up to 65 cm high.It is dark violet.The essential oil content in the blossom is 2, 3%.The yield of fresh sprouts is 7550 kg/ha,of essential oil - max 170 kg.

9. ***Raya.***The tuft e tight, rounded, up to 65 cm high.It is dark violet.The essential oil content in the blossom is 2, 8%.The yield of fresh sprouts is 6730 kg/ha,of essential oil-max 172 kg.

III. Treatment of Lavandula L.

1.Preparation of the area for planting - Lavandula L.has been grown here for 25-30 years.Sunny places with deep soil should be selected for the crops. The mechanical treatment is possible on slopes with inclination not more than 10%. On higher inclinationLavandula L.could be picked only manually.In such case it plays an anti-erosion role.

2.The basic cultivation consists in clearing bushes,stones and leveling in spring.Plowing is preceded by fertilization with manure,lombricompost or other fertilizers.The plot is deep plowed at 40-50 cm, and in August – September is plowed again 25 cm deep.Saturating lime is added to acid soils.

3.Pre sowing tillage of the soil.The plot should be kept free from weeds by repeated plowing and disking and cultivating.

4.Creating plantations – in autumn or spring. Before planting,if necessary fertilization could be carried out. They could be planted by seedling machines or manually by sword or furrows.Standard planting material is used (the cut outs should be 15cm long above the ground, the root system-8 cm,of the root base -5 cm).The planting distances are 140 cm per 30-35 cm (20000-24000 plants per ha).The plants are placed in the soil to the first branches, and the soil must be pressed.

5. Care for young crops without blossom-early in spring the empty spots should be filled in.In the first year the sprouts must be removed as soon as they appear. It happens several times in June-August.The treatment is carried out 4-5 times between the rows not more than 15cm deep, buffer area of 20-25 cm and 2-3 treatments between the rows according to the conditions of the soil and the available weed. Every 8-10 yearsrejuvenation should be made (cutting the parts of the plants above the ground at a height of 5-6 cm) for replacing the old non-productive branches with new ones.

IV.Fertilization

Crops, if necessary, should be fertilized several times each year. Theis added on the leaves or in the soil by irrigation. It is better the fertilizer to be applied twice a year – in early spring and immediately after the harvesting, in order to stimulate branching.

V.Picking

The lavender blossoms are picked at the stage of 50-100% blossoming in dry,calm,sunny weather,in the hot hours of the day,at the timeof the highest essential oil content in the sprouts.They are picked by machines or manually along with 10-15 cm of the blossom stem.After harvesting the blossoms should be sent immediately for distillation or extraction in order not to become musty.

Plant protection

Lavandula L.is not attacked by economically important diseases and pests

I.Diseases

Septoria lavandulae Desm);Phoma lavandulae Gabot).

II.Pests– problems could be caused by locusts,caterpillars of Loxostege sticticalis and Heteroderidae Meloidogyne.The most important requirement to combat the diseases is observing the technical farming requirements:

- proper choice of location (areas should be avoided with shallow ground water)
- good soil tillage before planting
- use of sane and authentic planting material
- regular monitoring the phytosanitary state of the plantation and if necessary taking the necessary steps in-time.

8. Mint- Mentha L.

Figure 25. Mentha L. fields

I. Soil–climatic conditions.Mint is one of the widest distributed essential oil crops in the world.Dry leaves and oil are used from it.

1.Soil requirements – Mint grows and develops best on permeable, loose, light soilswith light mechanical composition, rich in organic substances with a neutral to acidic pH 5-7.

2.Heat requirements–moderately thermophilic.

Mass sprouting of buds on the roots begins at average daily temperatures 10-12º C, Mint grows and develops best at temperatures 15-30º C. The roots freeze in case of sharp cooling (temperatures below -5º C), preceded by warming in February-March.

3.Moisture requirements-Mint is hydrophilic. In order to obtain high and stable yields in vegetation soil moisture should be about 85-90% of limit field moisture absorbing and to prevent sudden droughts. Depending on the rainfall 4-8 irrigations should be made. Mint can be grown in places close to groundwater.

4.Light requirements- Mint is a light-demanding plant. To obtain essential oil well-lit places should be selected. Shading slows growth and reduces the essential oil content. For the preparation of dry leaves mint can also be grown in young fruit plantations.

II. Varieties:

1. ***Local (Bulgaromicham)***- *yielding very high quality* oil, but planting material is hardly offered.

2.***Kliment***-the plants are powerful (80-85 cm).The large leaves are colored in anthocyan. Second harvest is also possible.Highly resistant to rust, but attacked by verticillium.Yield of oil from both harvests - max 70 kg/ha.

3.***Sofia*** - the plants are strong,high with many leaves, frequently laying down. The leaves are large, dark green. Yields up to 80-100 kg/ha oil (42% methanol) and 56000kg/ha green mass.

4.***Tundza*** - the plants are high, not laying down. The leaves are large, rust resistant, but attacked by verticillium.Yields up to 80-90 kg/ha oil and 53000kg/ha green mass.

5.***Zephyr*** – similar as the Tundza variety, the oil has a higher methanol content.

6.***Mentholina 18***- the plants are upright,not laying down.The leaves are large, with folded surface.Yields up to 80-100 kg/ha high-quality oil (methanol over 70%).

7.***Nana*** - the plants are upright, tender. The leaves are large, rust resistant.Max yields 25-30 kg/ha oil.Suitable for production of tooth pastes.

8.***Mizia***- the plants are tender, not laying down. The leaves are green, elongated.Max yields 20-30 kg/ha oil.

9.***Dream***- the plants are high, not laying down. The leaves are covered with white pappus, rust resistant, but attacked by verticillium.Max yields - 115 kg/ha oil and 47000kg/ha green mass.

10.***Lina***- the plants are high (70 cm), laying down. The leaves are narrow,covered withpappus.Max yields - 110 kg/ha oil and 35000kg/ha green mass.

III. Treatment of the Mint

1. Preparation of the area for planting - Mint is grown as one-year, two-year and perennial crop.Good predecessors are the ones that remain the soil in good structural condition and free of weeds (tobacco, fodder maize, winter cereals).

2. The main preparation includes clearing stones and leveling, due to the numerous subsequent irrigations.Until planting, the soil should be kept free from weeds by means of cultivation or harrowing.

3. Pre-planting tillage of the soil.It is effected by means of cultivation 15-18 cm deep. Fertilizers are added during this tillage, if necessary.

4. Creating plantations.Mint is propagated by: roots, planted in autumn, spring, or summer; seedlings in spring; rooted cuttings in spring or autumn.

The most favorable time for planting mint is the autumn(October) by roots.The roots are placed continuously in furrows opened in advance,deep 12-15 cm,70 cm away from each other, covered with 8-10 cm soil.The planting norm is 2000-2500 kg/ha.The same procedure applies for the planting in spring, but the norm is 1000-1500 kg/ha.The summer one is carried out in August,with cut roots 10-12 cm, at norm 500-600 kg/ha.

The propagations by seedling in spring in April, with manually torn up plants 10-15 cm high, predominantly from two-yearcrops. The seedlings are planted by a seedling machine with a row of 70 cm and distance 14-20 cm between the rows (70-100 th.plants per ha).

The cuttings are rooted in perlite or wet sand for about 2 weeks.The ready cuttings are planted on the area in May (70-100 th.plants per ha.) or in August-September (60-70 th.plants per ha.).

5. Care for young crops - Ten days after planting row cultivation is carried out, and if necessary fertilizer can be added as well. Row cultivation continue to budding phase. After the first burst fertilizer can be added again, if necessary.

IV. Fertilization

The stocking fertilization is effected with manure,lumbricompost or other fertilizers.They are plowed 25 cm deep with the deep plowing in July-August.

V. Harvesting.

When mint is grown for essential oil, it is harvested at a flowering stage of 50-100%.

The plants are cut back to the level of the lowest leaves in a calm and sunny weather. Oil is extracted by steam distillation. When intended for dry leaves, mint is mown at the budding phase. The leaves may be pre-separated from the stems or could be dried with them, depending on market requirements. The mown grass should be dried in driers (on frames or shelves) spread in 20-30 cm layers. The yield from 100 kg of fresh mass is 10-12 kg dry leaves.

Plant protection

I. Diseases

Puccinia menthae Pers.; Erisiphe cichoracearum D. C.; Sphaceloma menthae J.; Verticillium dahliaeKleb.; Crispness;Yellows.

II. Pests

Chrysomella menthastri Suffr.; Phytoecia vigula Charp.;Cassida viridis Subr.; Longitarsus licopi Foudr. Chloridea peltigera Schiff; Aphis attinis Guere.;Eriophyes menthae Moll.;Tetranichus urticae Koch.

Indirect methods of diseases and pests control:

Proper selection of the site, to avoid uneven, not aired areas with heavy waterproof soils. Spatial isolation of old mint crops.

The processing of the soil should be quality and timely in order to destroy the debris.

Healthy seedlings, resistant and tolerant varieties should be used.

Fertilization should be well balanced with moderate amounts of nitrogen and irrigation norms.

Direct combat-if necessary - authorized agents should be used.

9. Camomile - Chamomilla recutita L.(Matricaria chamomilla L.)

Figure 26. Production field of Chamomile

I. The soil and climatic conditions.

1. Soil requirements.Chamomile is tolerant to soil conditions. Grows best in light to heavy soils, having low acid to alkaline reactions (pH 6-7, 5). Most suitable are the deeply permeable soils (alluvial, alluvial-delluvial,slightly carbonate). The compacted The Hardened, highly clayey soils with shallow groundwater are not appropriate.

2. Heat requirements-chamomile grows in temperate climate.The seeds germinate at 6-8º C,the optimum temperature e 15-20º C.One month later the plants develop a rosette of 5-8 leaves.In our conditions it hibernates successfully. The optimum temperature during the growing season is18-25º C.

3. Moisture requirements-chamomile is drought-resistant.Critical of moisture are the phases - germination and vegetation. In case of excessive humidity the vegetative mass increases, the plants lay down, the oil content decreases.

4. Light requirements - light – demanding plant.The thickening of the crops results in decreased quantity of clusters and increased vegetative mass.

II. Varieties-There a numerous varieties and forms of chamomile.The tetraploid variety ***Lazur***is grown in Bulgaria.

III. Treatmentof chamomile

1.Preparation of the area for planting

Chamomile is a one-year culture. Good predecessors are those releasing the area earlier and leave the soil well stocked with nutrients and free of weeds (winter wheat, early vegetables, legumes).

2. The basic cultivation consists of clearing stones and leveling. The small seeds require a garden state of the soil.The soil is plowed not later than 40 days before the sowing of the seeds, followed by disking. Before planting the soil should be maintained free from weeds by cultivation or harrowing.

3. Pre sowing tillage of the soil is performed by cultivating at a depth of 15-18 cm, harrowing, milling, disking and rolling. These treatments should guarantee a state allowing quality sowing or planting. Before sowing the soil should be leveled and rolled to obtain a solid bed and if necessary fertilizer should be added.

4. Creating plantation. Chamomile is propagated by direct sowing (September, end of November or January-February) or by seedling (November or March-April). The most favorable time for sowing chamomile is in the autumn (September -October), after rains, moisturizing the surface layer. It is sown by hand or with a drill. The sowing rate is 2-3 kg/ha, and the seeds were pre-mixed with sand in the ratio 1: 5. Distances between the rows in diploid varieties are 25-30 cm, 45-60 cm - for tertraploid varieties. The seeds are sown on the surface of the soil, as light is required for germination. Then the soil is rolled immediately.

In small areas it can be sown by hand in pre-made 3-4 cm deep furrows. The seeds, mixed with sand, are placed at the bottom of the furrows without being buried, the area is rolled. The practice in the recent years is creating crops by producing seedlings.

5. The care for young crops-at direct sowing consists of 2-4 earthlings and weddings. The first hoeing is done after the first leaves appear, in neat rows, taking care not to fill the seedlings with soil to avoid destroying them. The second treatment is about 2 weeks later. When themoisture of the soil drops down to 50-60% of the limit field moisture, the crops should be irrigated according to the norm of 300-400 m^3 /ha. When seedlings are applied immediately after planting, the plants should be irrigated. After about 2 weeks the field is cultivated and the rows are dug. A second treatment could be necessary before harvesting.

IV. Fertilization

Stocking fertilization with manure, lumbricompost or other fertilizers is performed before the main processing. If necessary feeding is carried out during the hoeing.

V. Harvesting

For diploid varieties harvesting begins in early May, and for tertraploid varieties in late May and ends about a month later. It is carried out in dry, sunny weather after lifting the dew at the stage of full bloom when the white blossomsare in a horizontal position, when 40-50% of the tubular flowers in the clusters are blooming and when the flower bed has not yet reached a conical shape. Picking is effected with special chamomile- picking machineswith combs. The clusters are harvested with or without handles up to 2 cm,they should not be stored more than 2-3 hours in piles or bags, in order not to brew, but they could be temporarily spread in a layer of 4-6 cm on canvas in shade. The clusters could be collected step-by-step (2-5 times). Drying takes place immediately in airy premises in shade(on frames, racks or mats of natural matter) and layers should not be thicker than 1 cm. The complete overground mass is used for essential oil where all the flowers in the blossom cup are blooming, and some of the seeds are already ripe. The plants are cut as close as possible to the surface of the soil. The output is processed fresh.

Plant protection

Chamomile is not attacked by economically important diseases and pests.If sown in late spring it could be attacked by:Erysiphe polyphaga;Peronospora leptosperma; Aphids

Indirect methods:

- Observing the optimum time for sowing and selecting the appropriate areas;Correct treatments;
- Timely removal of diseased plants outside the plantation, and use of resistant varieties
- *Direct control*-if necessary the authorized organic preparations or recipes should be used.

10. Common Balm - Melissa officinalis L.

Figure 27. Melissa production field

I. Soil–climatic conditions.

1. Soil requirements.Common Balm is very demanding to soil requirements. Itdevelops best in fertile, loose soils, rich in humus. Sandy soils with low nutrients content with insufficient water supply and drift bed, etc are not suitable.

2. Heat requirements-Common Balm is a cold-resistant plant.Vegetation begins when the temperature of the soil exceeds 8º C.

3. Moisture requirements- Common Balm is hydrophilic. Throughout the growing season there is a high demand on soil and air humidity. Insufficient moisture can cause the formation of little and lower stems with tiny leaves, and defoliation as in later stages of development.Excessive moisture may lead to attack by fungal diseases and root rot.

4. Light requirements- less demanding, can be grown as a sub-crop in young fruit gardens. But the light positively influences the essential oil content.

II. Varieties:

1. ***Melissa 2***- The essential oil content is about 1%,and of dry mass- 2500 kg/ha,of dry leaves-1200 kg/ha.The stems reach the height of 1m.

2. ***Quedlinburger Niderliegende***- The essential oil content is about 2%.

3. ***Citronella*** -The essential oil content is about 4%.Compact variety,the stems reach the height of 30-40 cm..

III. Treatment

1. Preparation of the area for planting

Common Balm is a perennial grass plant.Good predecessors are the ones that release the area early and leave the soil well stocked with nutrients and free from weeds (winter cereals).

2. The main preparation includes clearing stones and destruction of weeds in the roots.Insummer the soil is plowed 18-20 cm deep. In August 30-32 cm deep plowing is performed, the required fertilizers are added and the area is leveled.

3. Pre-planting tillage of the soil. Before planting, the soil should be kept free from weeds by cultivation 16-18 cm deep.These treatments should guarantee a state, allowing quality sowing or planting. Before sowing the soil is leveled and rolled to obtain a solid bed and fertilizer should be added, if necessary. With manual planting the area is roughened to a depth of 15-18 cm

4. Creating plantations.Common Balm is propagated by direct sowing (October-November or March) or by seedling (April-June).The most favorable time for planting garden tea is the autumn.It is sown by a seed drill. Metering rate is 8-10 kg/ha. Distances between rows are 60 cm,depth is 2-4 cm. It recommended only in irrigated areas, while at the beginning of vegetation

(at 3-5 true leaves), crops are thinned or replanted. The recent practice provides creating crops by producing seedling, and on limited areas - by division of the roots.

5. Care for young crops - in direct sowing consists of 2-4 times earthling and weeding. The first cultivation is effected after the mass germination in the spring. When the plants form 3-5 true leaves, they are thinned at a distance of 25-30 cm from each other, by planting the removed ones in empty places. Simultaneously, fertilizer could be added as well. During the vegetation 4-6 irrigations are recommended (in the spring by sprinkling, from summer to autumn – by gravity irrigation). Another tillage is hoeing in rows (1-2 times). During the vegetation the area is cultivated 3-4 times if necessary. During the last cultivation the plants are compacted and compost is added.

IV. Fertilization

The stocking fertilization is effected with manure, lumbricompost or other fertilizers prior to the main tillage. In the next years fertilization takes place before the start of vegetation and after the first harvest of the output.

V. Harvesting

Harvesting could happen in September, if seedling has been planted the period of May-June. In the coming years it is effected two or three times. The most appropriate time is in the hot hours of the day, as soon as the dew disappears, before blossoming, manually 5-7 cm above the soil surface. The output is immediately transported in small volumes without being pressed or sealed. It should be stored in a shady place and the leaves should be removed from the stems. They may be removed from the roots as well (similarly as tobacco). The fresh leaves are spread immediately in a thin layer on frames and dried in a drier (up to 40º C) or in the shade under a canopy (in ventilated rooms).

Plant protection

Melissa is not attacked by economically important diseases and pests.The greatest damage is caused by fungus Septoria melissae,that attacks seedlings and crops and causes defoliation.

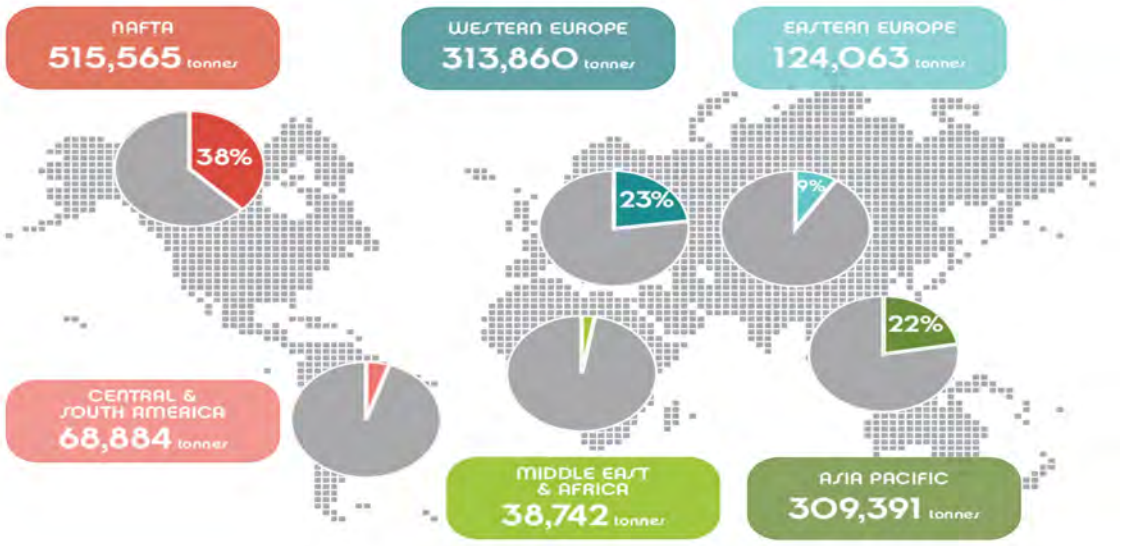
Indirect methods:

- Destruction of debris;Observing the optimum time for sowing;
- Selecting the appropriate areascorrect treatments;
- Timely removal of diseased plants outside the plantation;
- Use of resistant varieties;
- Direct combat,and if necessary,using authorized agents.

11. THE MAP's MARKET

World market

Demand for natural ingredients increases globally. This is mainly based on the implementation of good sourcing practices in primary health care and traditional medicine. In addition, UN organizations, such as WHO and FAO, have developed several Good Practices in the last 15 years related to the industry. Global market in 2008 for herbs and spices was about 1.5 million tons or 6 billion dollars with main markets to be North America, Western Europe and Asia Pacific.



	WESTERN EUROPE	EASTERN EUROPE	NAFTA	CENTRAL & SOUTH AMERICA	ASIA PACIFIC	MIDDLE EAST & AFRICA
Volume usage	313,860 tonnes	124,063 tonnes	515,565 tonnes	68,884 tonnes	309,391 tonnes	38,742 tonnes
Volume growth rate 2004 to 2009	1.5%	4.0%	1.8%	4.3%	3.2%	2.5%
Market value	$1.3 billion	$0.5 billion	$2.0 billion	$0.4 billion	$1.4 billion	$0.2 billion
Forecast value growth rate 2009 to 2014	1.7%	2.9%	1.6%	3.4%	2.9%	2.1%
Key Markets	UK Germany France Spain Italy	Russia Ukraine Poland	USA	Brazil	China Japan India	Turkey
Highlights	> **UK** is the largest market by volume > Usage in **Spain** is forecast to grow by 4.9% > **Meat & savoury** products is the largest sector	> **Russia** is the largest market > **Snacks** is one of the fastest growing sectors for seasonings > The market in **Ukraine** is forecast to be worth $115m by 2014	> **USA** accounts for 87% share of the market by volume > **Snacks** is the largest sector > Usage in **Mexico** is forecast to grow by 4.9%	> **Meat & savoury** products is the largest sector > **Brazil** is the fastest growing market	> **China** is the largest market > Usage in **India** is forecast to grow at a rate of 5.2% > **Sauces & dressings** accounts for 25% of seasonings usage	> **Meat & savoury** products accounts for almost half total usage of seasonings > **Turkey** is the largest market

Figure 28.World market for spices and herbs, year 2009. (Modified from RTS resource, 2011)

Essential oils Imports and Exports

The world market of essential oils is more than 25 billion dollars, while the transacted quantities are 1.5 billion kilograms. There is a constantly increasing trend both in terms of total turnover and kilograms traded.

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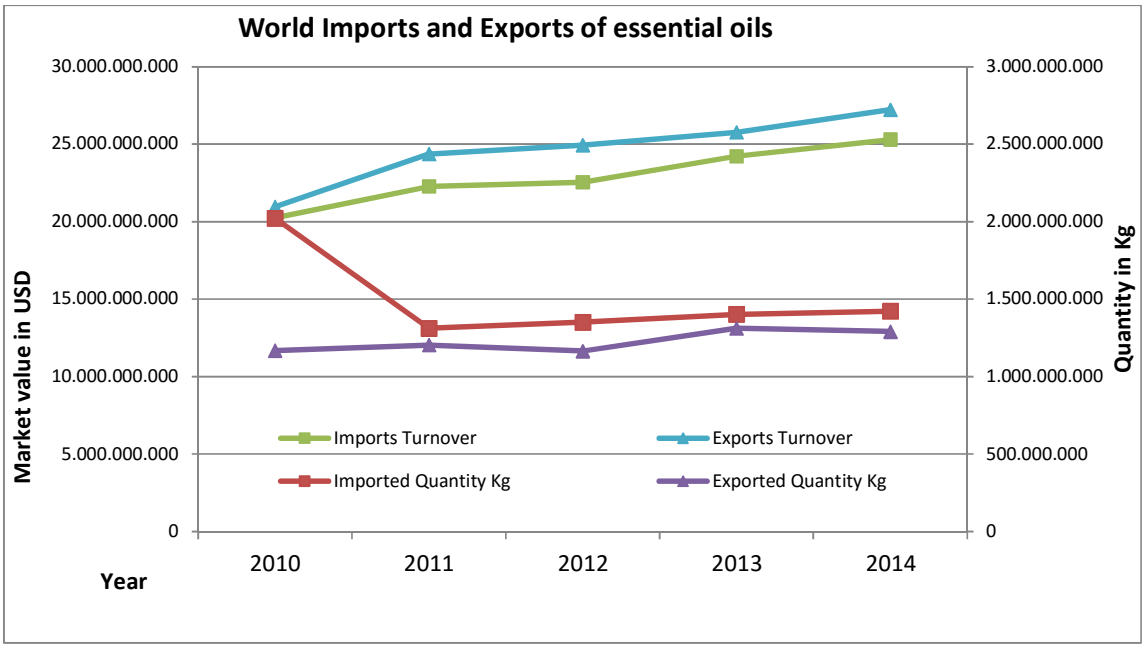

Figure 29.3 World imports and exports of essential oils

The comparison of world price of essential oils and those achieved in Greece reveals two interesting conclusions. First conclusion is the fact that Greece used to import essential oils in a price far higher than world mean price, but nowadays there is no practical difference. Second conclusion is that the prices Greece exports essential oils are lower than world mean price. A more detailed analysis is necessary to understand the reasons why this is happening, however due to lack of data regarding specific essential oils and their price this was not feasible in this study. There is a general belief that the prices achieved by Greek firms when selling products abroad are worse that prices achieved by companies based in other countries.Classic example is the lavender oil that is sold to French cosmetics and perfumery companies and Greek companies sell to them indirectly through Bulgarian mediator companies.

Spices Market

The world spice market is about 9 billion dollars and the traded quantity is about 6 million tons.

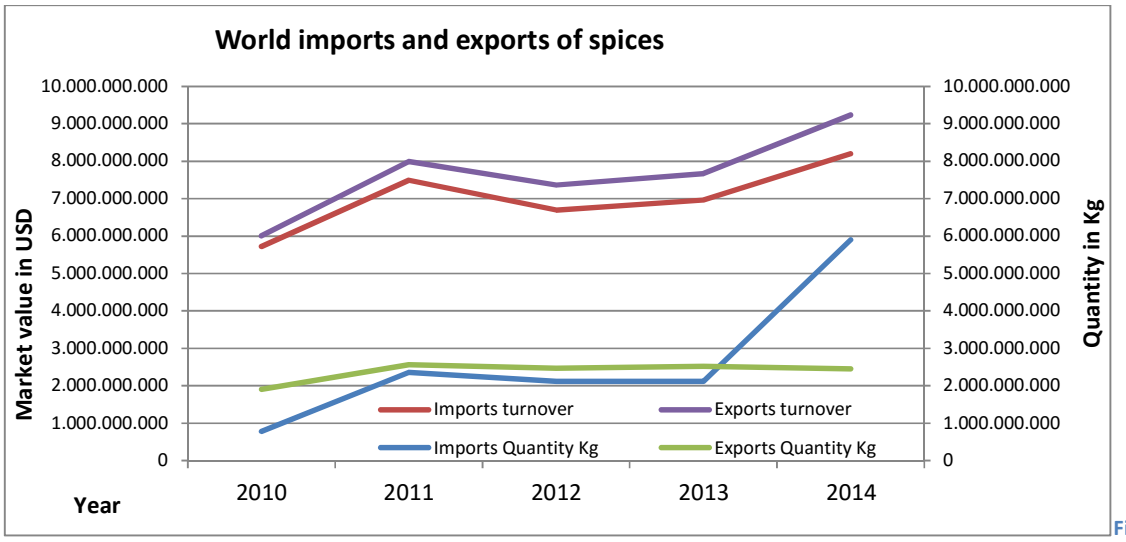

Figure 30. World imports and exports of spices in Kg and USD

Regarding mean import and export prices Greek imports are generally realized in higher than mean world price. However in exports the Greek companies achieve far better prices than mean world spice price.

The main exporting countries in terms of trade value are India, Viet Nam, China, Indonesia and Netherlands followed by Brazil, Singapore, Germany, Spain and Madagascar.

European Market

Health ingredients

European market regarding health ingredients production has been mainly concentrated in Germany, Italy, France, and UK while Eastern Europe is stronger in wild collection. An overview of the main EU markets and their characteristics is presented in the following Table.

Country	Production	Processing	Trade	Herbal medicinal products market	Food supplement market
Germany	Large EU producer of MAPs	Largest extraction industry	Largest importer, highest share imports from developing countries	Largest market EU, also interest in aromatherapy	Large market
Italy	Large EU producer of MAPs	Strong extraction industry	Main importer MAPs/extracts	Medium market	Largest market
France	Large EU producer of MAPs (use in cosmetics)	Strong extraction industry	Main importer MAPs/extracts	Large market EU, also interest in aromatherapy	Large market
UK	Small EU producer of MAPs		Strong traders MAPs/extracts	Medium market (relatively large Interest Ayurveda/TCM)	Large market; focus on multi-herb products
Eastern Europe	Large and growing producers, strong in wild-collection, sourcing from Ukraine, Russia, Poland	Strong extraction industry (Poland) for Western Europe, e.g. Germany	Latvia and Poland are regional trader, between Eastern and Western Europe (e.g. Germany)	Growing markets (Poland, Romania, Slovakia, incl. in terms of exports to and from Russia, Ukraine)	Growing markets (incl. in terms of exports to Russia)

Figure 31.Main EU markets for health ingredients and their characteristics

Biggest suppliers of MAPs in EU are Egypt, Morocco, China and Turkey.

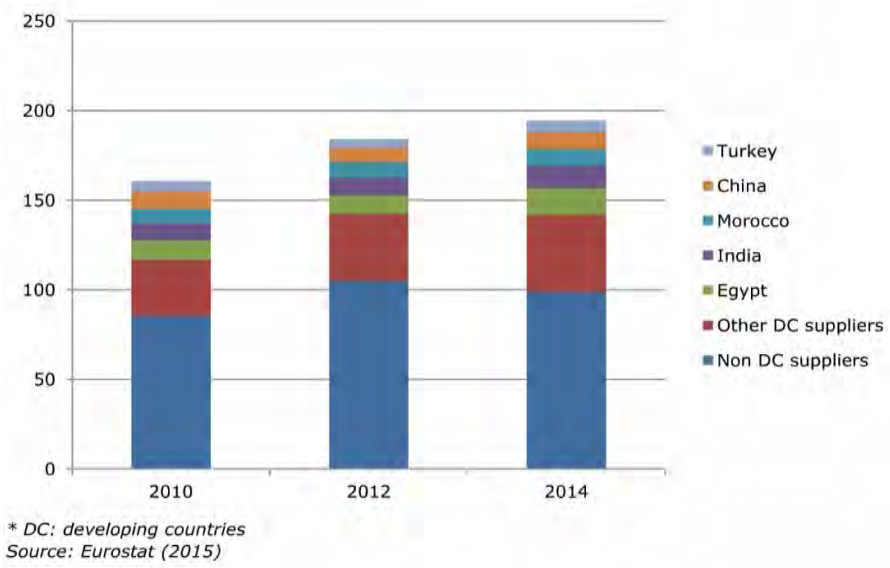

Figure 32. Leading suppliers of European imports of MAPs 2010-2014, in 1000 tones

Regarding **extracts** imported to EU the biggest suppliers is China, followed by Iran, Brazil, Mexico and India. Netherlands used to be the leading European importer of extracts until 2012. It seems that this has changed and now Germany has replaced it closely followed by France. Spain, Italy UK and Belgium are big importers also.

According to European Spice Association (ESA) European **spice** and seasonal market is constantly growing. The per capita consumption of spices, herbs and seasonings in Europe is approximately 900 gr. The European Spice and Seasoning Industry, hence, represents approximately 6.5 Billion EUR in annual turnover, as such being part of the much bigger food and drink industry, with a share of stomach of less than 1%.

Tea Market

European tea market shows an increasing trend. Market value has constantly been growing for the last decade and there is a strong tendency to continue growing. All types of tea show this tendency, however it is happening in greater degree at RTD tea.

Market prices are formed based on demand and supply of the commodities. Regarding MAPs in Europe it seems that organic certification contributes significant added value to the products. In the following table prices of the same period (Dec 2009 and Jan 2010) there is a comparison of prices of the same MAP in organic and conventional status.

Figure 32 : Comparison of prices of the same MAP in European market for organic and conventional products

	Product	Price	
		Organic (Dec 2009)	Conventional (Jan 2010)
1	Cardamom	20.7	€ 20.9 - € 13.9
2	Caraway seed	6.10 – 6.45	€ 2 - €1.7
3	Cinnamon bark	14.25	€ 7
4	Cloves	9.70 – 9.90	€ 3.5 - € 3,3
5	Coriander seed	3.6 – 7.7	€ 1.2 - € 1.2
6	Ginger	7.4 – 8.60	€ 1.3 - € 1.2

USEFUL BALKAN LINKS

BULGARIA:

Branch organizations, MAP's(Браншови организации, МАР)

1. Bulgarian National Association Essential oils, Perfumery and cosmetics (BNAEOPC)http://www.bnaeopc.com/; (Българска Национална Асоциация Етерични масла, Парфюмерия и Козметика - БНАЕМПК)
2. Bulgarian Association of herbs and mushrooms collectorshttp://www.babg.net/ (Българска асоциация на билкарите и гъбарите)

Scientific and academic institutions(Научни и академични институции)

1. Agricultural University – Plovdiv; Аграрен университет, Пловдив; http://www.au-plovdiv.bg/
2. Faculty of Agriculture, Trakia University - Stara Zagora;Аграрен факултет, Тракийски университет - Стара Загора;http://www.uni-sz.bg/truni2/
3. Faculty of Biology, University of Plovdiv;Биологически факултет, Пловдивски университет;https://bio.uni-plovdiv.bg/bg/
4. Faculty ofBiology, Sofia University;Биологически факултет, Софийски университет;https://www.uni-sofia.bg/index.php/bul/universitet_t/fakulteti/biologicheski_fakultet2
5. Geology and Geography Faculty, Sofia University; Геолого-географски факултет, Софийски университет;https://www.uni-sofia.bg/index.php/bul/universitet_t/fakulteti/geologo_geografski_fakultet
6. Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences;Институт по биоразнообразие и екосистемни изследвания, БАН;http://www.iber.bas.bg/
7. Institute of Plant Genetic Resources - Sadovo; Институт по растителни генетични ресурси – Садово;http://www.ipgrbg.com/
8. National Agricultural Advisory Depratment; Националната служба за съвети в земеделието(НССЗ) http://www.naas.government.bg/bilki/
9. University of Forestry in Sofia;Лесотехнически университет, София;http://www.ltu.bg/
10. Faculty of Science, University of Shumen;Факултет по природни науки, Шуменски университет;http://shu-bg.net/faculties/fpn
11. Faculty of Pharmacy, Medical University, Sofia;Фармацевтичен факултет, Медицински университет, София;http://mu-sofia.bg/node/26

Links to sites of projects(Линкове към сайтове на проекти)

1. **Sustainable Herbal Harvest in Bulgaria** Project LIFE12 INF BG 000105(Проект „Популяризиране на устойчиво ползване на лечебните растения в България")http://susherbsbg.eu/bg/

2. Project **"Model for conservation and sustainable use of medicinal plants at the municipal level with the participation of organizations civil society, local communities and the media "to Foundation "Information and Nature Conservation"**http://herbvaluebg.org/ (Проект „Модел за опазване и устойчиво ползване на лечебните растения на общинско ниво с участието на организациите на гражданското общество, местните общности и медиите" на Фондация „Информация и природозащита")

3. IPA Crossborder,other ?

GREECE:

Branch organizations, MAP's

1. Ministry of Rural Development and Food, Acharnon 2 Athens Postal Code101 76, Greece, Phone: Call Center 210 212 4000, http://www.minagric.gr/index.php/el/
2. Association of Medicinal and Aromatic Plants of Greece (AMAPs of Greece), P.O. BOX D6217 Thermi, Thessaloniki, info@eaffe.org
3. Hellenic Society of Ethnopharmacology**,** Chalkokondili 1 Athens, Post Code 10677 Tel: +30 210 9968507 FAX: 210 9920073 www.ethnopharmacology.gr

Scientific and academic institutions

1. ELGO-DIMITRA, Kourtidou 56-58 Athens, Postal Code11145, Tel.+30 210 8392000
2. Fax: +30 210 8231438, http://www.elgo.gr/
3. BENAKI PHYTOPATHOLOGICAL INSTITUTE (BPI), 8 Stefanou Delta Street, Kifissia, Athens, Postal Code 14561, Tel. +30210-8180206 | FAX. +30210-8077506, http://en.bpi.gr/
4. Agricultural university of Athens, Iera odos 75, Postal Code 11855, Athens, School of Agricultural Production, Infrastructure and Environment, Department of Crop Science
5. Tel: +30 210 5294522, http://www2.aua.gr/el
6. *Aristotle University of Thessaloniki School of Agriculture, Postal Code54124, Thessaloniki, Greece, Telephone number: +30 2310 996000, http://www.agro.auth.gr/*
7. University of Thessaly, School of Agricultural Sciences, Fytokoy Str, Postal Code 384 46, N.Ionia, Magnisia, http://www.agr.uth.gr/
8. Democritus University of Thrace, Department of Forestry and Management of theEnvironment and Natural Resources, Contact Phone: +30 25520-41171, 2, 3**Fax: +30 25520-41192, Postal Code** 68200 – Orestiada, **http://www.geo.duth.gr**
9. Alexander Technological Educational Institution of Thessaloniki, P.O BOX 141, GR - 574 00 Thessaloniki, Macedonia, GREECE, Tel: +30 31 791100, 791111, 791129 Fax: +30 2310 799152 http://www.teithe.gr/modules/content/index.php?id=16
10. Technological Educational Institution of Thessaly, Zip 411 10, Larissa, Phone: +30 2410 684200, Fax: +30 2410 610803, http://www.teilar.gr/index_en.php
11. Technological Educational Institution of Epirus, Arta, Arachthos Bridge, 47100, Phone. 26810 50001/50036, Fax: 26810 76404/76405, http://tegeo.teiep.gr/
12. Technological Educational Institution of Kalamata, Antikalamos 241 00 Kalamata Greece, Phone:+ 30 - 27210- 45100, Fax: +30 - 27210 - 45200, 69047, http://www.tg.teikal.gr/
13. Technological Educational Institution of Crete, Heraklion 71500, Phone:+030 2810 379403,+030 2810 379411, +030 2810 379412,Fax:+030 2810 379427, https://www.teicrete.gr/agr/el
14. Technological Educational Institution of Western Macedonia, Terma Kontopoulou, 53100 Florina, Phone: +30 23850 54610, +302385054620, +30 2385054622, FAX: +30 2385054621, http://agrotech.teiwm.gr/index.php?lang=el
15. Technological Educational Institute of Western Greece, Address: Megalou Alexandrou1 str., Koukouli, Patra, Greece, Postal Code.: 263 34, Tel.: +30 2610 325 101, http://www.teiwest.gr/index.php/schools/farming-school/agritech

National and International MAP`s projects

1. LONG LIFE TRAINING AS A TOOL FOR IMPROVEMENT OF EMPLOYABILITY & COMPETITIVENESS with acronym EMPLOCOMP which GEOTEE – BRANCH OF EASTERN MACEDONIA IMPLEMENTS as PP5 UNDER O.P. GREECE-BULGARIA 2007-2013 and is co-funded by the EUROPEAN UNION (ERDF) AND NATIONAL FUNDS OF GREECE & BULGARIA, European Territorial Cooperation Programme GREECE-BULGARIA 2007-2013 http://www.emplocomp.eu/
2. Nutritional Products and Sustainable Development in the Cooperation Areas, European Territorial Cooperation Programme: 2007 - 2013 Greece - Cyprus (EL-CY), http://www.keep.eu/keep/project-ext/11993