

Lavender production



**agriculture,
forestry & fisheries**

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REPUBLIC OF SOUTH AFRICA

Lavender production



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(Photo: W.G. Alberts)

Part I: General aspects

1. CLASSIFICATION

Scientific name: *Lavandula angustifolia*

Common names: (*L. angustifolia*) true lavender, English lavender; (*L. dentata*) French lavender; (*L. latifolia*) spike lavender; (*L. stoechas*) French or Spanish lavender; hybrids of *L. angustifolia* x *L. latifolia* are referred to as lavandin

Family: Lamiaceae



Lavandula angustifolia in France

(Photo: Provided by members of SAEOPA and KARWIL Consultancy)

2. ORIGIN AND DISTRIBUTION

Most lavender originates in the Mediterranean basin, in rocky, calcareous areas. Lavender occurs over North Africa, the Mediterranean, Europe and Western India. Lavender was cultivated by the ancient Greeks and Romans, and in Elizabethan England. The name “lavender” comes from the Latin verb lavare “to wash” or “to bathe.” Spike lavender grows wild over a large part of the Mediterranean area, preferring warmer and lower regions than lavender and lavandin.

3. PRODUCTION LEVELS

South Africa

True lavender yields 8 to 30 kg and lavandin 40 to 220 kg essential oil per hectare (ha), and 500 to 1 000 kg dried flower stems per hectare, depending on location, management and cultivar. Small producers should aim at high quality, value-added markets for essential oil and flower production.

Internationally

The world production of high-quality lavender oil is 200 metric tons per year. The ratio of lavender to lavandin production worldwide is 1:5. The price of lavandin is lower than for lavender oil. Lavandin plants produce more oil and are hardier than lavender plants. The world production of lavandin oil is 1 000 metric tons per year.

The major producing areas of lavender oil are in Bulgaria, England, France, USSR, Yugoslavia, Australia, USA, Canada, South Africa, Tanzania, Italy and Spain. True lavender for perfume is mainly cultivated in Europe, especially France.

Lavandin is mostly cultivated in Spain, France, Italy, the Balkan Peninsula, Australia and Tasmania. In recent years Bulgaria has become a major producer.

Spike lavender has its main production areas in Spain but grows wild over a large part of the Mediterranean area, preferring warmer and lower regions than lavender and lavandin. Worldwide production of spike lavender oil is 150 to 200 tons per year.

4. MAJOR PRODUCTION AREAS IN SOUTH AFRICA

Lavender is cultivated in the Western and Eastern Cape, KwaZulu-Natal, Free State, Gauteng, Limpopo and Mpumalanga provinces. The weather conditions in the Western Cape are very similar to the Mediterranean climate.



Lavender in the KZN Midlands and Limpopo Province
(Photos: W.G. Alberts)



(Photo: W.G. Alberts)

5. DESCRIPTION OF THE PLANT

Stem

Lavender is a perennial, bushy shrub growing 0,3 to 1,2 m high. True lavender has a compact and rounded growth form.

Leaves

The aromatic evergreen leaves are completely opposite and up to 5 cm long.

Flowers

Flowering occurs in summer. The flowers form interrupted spikes and have a very sweet fragrance.

Essential part

The plant parts used for oil distillation are the flowers and, in smaller quantities, leaves. Essential oil from only the flowering tops is of higher quality than oil



Lavandula angustifolia (true lavender, English)

(Photos: Provided by members of SAEOPA and KARWIL Consultancy)

obtained from the leaves. For dried flower production the flowers with stems are cut longer.

6. CULTIVARS

There are 48 species of lavender with hundreds of various genotypes differentiated by variations ranging from growth form to chemical composition of essential oil.

There are three main species within the genus producing lavender essential oil.

- ◆ *L. angustifolia* (true lavender, English)
- ◆ *L. latifolia* (spika, broad leaves)
- ◆ *L. angustifolia* x *L. latifolia* (lavandin)

The following six sections exist, each with hybrids and subspecies: Lavandula, Dentata, Stoechas, Pterostoechas, Chaetostachys, Subnuda.

The following are mostly farmed with on a commercial scale for essential oils:

- ◆ True lavender oil, which is derived from *Lavandula angustifolia* (synonym *L. officinalis*, *L. vera*, *L. spica*)



Lavandin cultivars from left to right: Grappenhall, Provence, Grosso, Dutch Mill, Abriali and Seal



True lavender from left to right: Vera, Munstead, Hidcote and Jean Davis

(Photos: Provided by members of SAEOPA and KARWIL Consultancy)

- ◆ French lavender oil from *L. dentata*
- ◆ Spike lavender oil, which is derived from *L. latifolia* (syn. *L. spica*).
- ◆ Spanish lavender oil from *L. stoechas*.
- ◆ Lavandin oil is derived from *L. angustifolia* x *L. latifolia* hybrids

These lavender essential oils are each unique in composition and used in different applications. Under these main species there are several cultivars that are being planted for commercial production of essential oil.



***L. stoechas* (Spanish lavender)**

(Photo: Provided by members of SAEOPA and KARWIL Consultancy)

When choosing a lavender cultivar for essential oil production, the following information has to be considered:

- ◆ Lavandin varieties (*Lavendula x intermedia*) produce both the highest yields of flowers and highest concentrations of essential oil per hectare.
- ◆ Lavandins produce large, long-stemmed flowers which are slightly grey in colour. The best lavandin cultivars for commercial essential oil production in South Africa are Grosso, Super, Provence, Abriali and Seal.
- ◆ English lavender (*Lavendula angustifolia*) varieties produce shorter-stemmed flowers with a blue colour when dried.
- ◆ English lavender varieties are better suited for dried flower production than lavandin varieties which also produce sweeter oil preferred by the perfume industry. *L. vera* is the preferred cultivar.
- ◆ *L. stoechas*, *L. dentata* and *L. latifolia* are produced in lesser quantities in South Africa.



Lavandula dentata (English lavender)
(Photo: Provided by members of
SAEOPA and KARWIL
Consultancy)

7. CLIMATIC REQUIREMENTS

Temperature

Lavender can tolerate moderate frost and drought. Spike lavender cannot tolerate frost. All lavenders are sensitive to high humidity. High summer temperatures adversely affect oil quality.

In its natural state true lavender grows as high as 1 700 m above sea level, while spike lavender grows only in lower regions, and is native in the range 200 to 700 m above sea level. Lavandin can be found frequently at heights of 700 to 1 000 m above sea level. Oil yields tend to increase with altitude as plants flower more abundantly in cooler conditions.

Because there are such variable types of lavender, some will grow well in different climatic zones from cold to subtropical. Different varieties should be tested to see which of these will grow best in each microclimate.

Rainfall

Lavender can produce well with an annual rainfall range from 300 to 1 400 mm per year. Allow the soil to dry well between irrigations and do not over-irrigate.

8. SOIL REQUIREMENTS

Lavender requires well-drained light, sandy, or sandy loam, or gravelly soils in full sun. Low-fertility soils are still suitable. Soil pH should be between 5,8 and 8,3. Too moist soils will cause poor plant growth, diseases or kill the plant. English lavenders prefer alkaline soils, whereas the lavandin varieties require slightly more acidic soils.

Part II: Cultivation practices

1. PROPAGATION

Lavender is mainly propagated by seed, cuttings, layering, tissue culture and division of roots. To ensure genetic uniformity propagation by seed should not be used.

Cuttings

Cuttings should be made from strong and healthy plants grown out of doors. Rooting hormones can be used to encourage rooting. Cuttings of 10 to 15 cm in length are made from young top shoots. The bottom two thirds are stripped from leaves. The cutting is inserted in a proper growing medium, half to two thirds of the length and propagated in trays or seedbeds. A mixture of 30 % fine compost and 70 % sand works well. A mist bed with heated floor produces the best results.

Layering

To propagate by layering, select a long, healthy flexible stem and remove 10 to 15 cm of foliage, leaving 10 cm of foliage at the tip of the branch. Cover the

bare section with moist soil. The branch will root at the soil level. Once rooted, cut the new plants from the mother plants. After the onset of roots (from 6 to 12 weeks), the plants can be replanted in the prepared land. A liquid organic feed can be given on a weekly basis.

Tissue culture

Tissue culture methods are used for the mass propagation of lavender from selected mother plants. It produces disease-free, genetically identical plants. Tissue culture is the most expensive way of propagation.



Lavender ready for transplanting
(Photo: W.G. Alberts)

Seed

Propagation by seed is not recommended for commercial lavender production. Plants grown from seed are variable in growth habit, colour and essential oil composition. If seeds are to be used, these should be sown in late spring or early summer. Germination rates are low and seedlings are slow to reach transplanting size.

2. SOIL PREPARATION

Herbal and essential oil crops grown on natural soils yield products that are of high quality and in demand globally.

Soil sampling and analysis

- ◆ Take soil samples according to correct guidelines.
- ◆ Have the soil analysed at a laboratory that will be able to check for mineral deficiencies and excesses, organic status and carbon ratios.

- ◆ A soil analysis will guide the producer in correcting the nutritional status of the soil in order to provide the crop with optimum growing conditions such as a balanced mineral status and correct pH.
- ◆ Organic matter content, soil texture, structure and type, nutrient and mineral status and the relationship thereof have to be known to ensure that there is no degradation taking place and improvement can be monitored.
- ◆ Use soil laboratories that can monitor nutrients as well as soil life and give appropriate advice.
- ◆ Good topsoils have an abundance of good soil life and high humus content, balanced with minerals and sufficient plant nutrients.

Producers who treat their soil correctly will have the benefit of producing crops of high value with less input in terms of weed, pest and disease control.

3. PLANTING

Slope

Lavender can be planted on slopes provided that practical farming operations can still be carried out. When placed on sloping land facing to the North or North West to receive maximum sunshine and heat, there will be benefits on oil production.



(Photo: Provided by members of SAEOPA and KARWIL Consultancy)

Planting density/spacing

Lavender is normally planted in row widths of 1,2 to 2,0 m apart, with 30 to 60 cm between plants, which gives a plant density of 8 000 to 28 000 plants per hectare. Spacing is done according to available moisture and species, and cultivar size as well as for mechanical cultivation and harvesting. Higher densities mean higher establishment costs but also higher early yields. Plants also tend to support each other, so are more stable and last longer. A good vigorous plantation should be ready for harvest in

**Adapt plant population
to available soil moisture.
Dry areas – low density**



(Photo: W.G. Alberts)

the second year. Lavender plants can last for 10 to 15 years or longer if managed correctly. Seedlings should be hardened off before being put into the land.

Planting date

In mild climates, autumn planting is best as the plants can get established just before winter and in spring will grow quicker. In areas with very cold winters, spring planting is the only option. Planting should be started as soon as danger of frost is past.

4. FERTILISATION

Lavender produces well on soils that are nutrient deficient for most other crops. Excessive applications of nitrogen can decrease oil quality, make plants unhealthy and will increase weed competition. For the production of 100 kg of inflorescence, lavender extracts 0,8 kg of nitrogen, 0,2 kg of phosphorus and 0,8 kg of potassium from the soil, (Polydeonny, Sotnik & Hilapzew, 1979).

The recommended nitrogen rate is 80 to 100 kg/ha applied in 3 to 4 dressings throughout the growing season. Phosphorus and potassium requirements are low and will vary according to soil type and nutritional status. Periodic liming may be necessary to keep the pH at 6,0 or higher. A proper soil analysis has to be done before planting. Correct interpretation of soil analysis results according

to soil type will provide guidance to deficits and excesses and the soil has to be adapted to achieve the correct balance.

5. IRRIGATION

Irrigation is needed for the first 2 years until the crop has been established. If lavender is produced on lighter soil types where rainfall is unreliable or low, irrigation at crucial stages might still be necessary. Plants should not be water stressed at flower initiation. Irrigation may increase production in mature plantings. Overhead irrigation will increase disease problems and will cause older plants to break open in the middle. Drip irrigation is recommended as it will also assist with weed control.

6. WEED CONTROL

Hand-hoeing and mechanical weeding with a tractor-drawn cultivator is recommended for the control of weeds. Take care not to damage the roots. Mulching also reduces the weed incidence and increases soil moisture retention. Plant density and quick formation of a canopy will decrease the weed population. Drip irrigation suppresses weed growth between rows. Generally, 2 to 3 weeding sessions are necessary during the year.

Distillation waste of this crop applied as organic mulch is found to be effective for controlling weeds in the crop. A better option is to utilise the distillation waste in making organic compost and to apply the compost as mulch. Exclusion of sunlight is one of the best weeding practices. Therefore lavender should be planted so that it forms a canopy quickly. Cover-cropping practices with plants that inhibit weed growth is advised. Mulching with compost or grass will inhibit weed growth. Care should be taken not to mulch too thickly as the mulch might trap too much water against the stem and may cause disease or damage.

Very little information exists on herbicides that can be used. Until proper trials can be done, no recommendation can be made.

Weed control guidelines

- ◆ Do not allow weeds to seed in the land.
- ◆ No-till practices result in fewer weeds.

- ◆ Shade out weeds by plant canopy, high plant density, closer row width, if moisture content of soil and crop specification allow for it.
- ◆ Use manual or mechanical control.
- ◆ Organic control measures such as flame weeding and UV radiation can be used where applicable, and if the crop can tolerate the method.
- ◆ Some seeds germinate when exposed to sunlight. Use night ploughing as an option for fewer weeds.

7. PEST CONTROL

Very few pests occur on lavender in South Africa as the plant is a natural pest repellent. If present, the numbers are not significant.

Extension officers of the Department of Agriculture, Forestry and Fisheries and researchers of agricultural institutes should be contacted for further information on the identification of insects and for recommended controls.

Use the publication* *A guide for the control of plant pests – 2002*, compiled by Annette Nel, Mareli Krause, Neervana Ramautar & Kathy van Zyl.

8. DISEASE CONTROL

No serious diseases have been reported on this crop. The same disease control guidelines provided in the document on the general production of essential oils should be utilised.

9. OTHER CULTIVATION PRACTICES

Pruning

Flowerbuds should be pruned off in the first 2 years to assist the plants to develop to their best potential, and to create a sturdy plant framework. In later years, pruning will have to be carried out in a separate operation after harvesting, usually in autumn. The reason for this is that harvesting the flowers for oil, leaves

* Obtainable from the Resource Centre, Directorate Agricultural Information Services, Private Bag X144, Pretoria, 0001. Tel: 012 319 7141/7085. Fax: 012 319 7260



Hand harvesting



Hand harvesting with sickle



Mechanical harvesting in France



The Ochiai harvesting machine

(Photos: Provided by members of SAEOPA and KARWIL Consultancy)

most of the stalks on the plants. Prune back the plant, leaving 2 to 3 leaf-bearing nodes for vigorous growing cultivars. Prune less severely for slower growing cultivars. Pruning can be mechanised by the use of specialised trimmers.

10. HARVESTING

Maturing time and methods

The harvesting of lavender for essential oil should be undertaken when the flowers are well developed and the lower half is starting to open. Harvesting is

usually done at the end of December and early January, according to season. The harvest time may be 4 to 10 days and after that the quality will drop. Planning the harvest, especially with big plantations, during a time of fine weather, is crucial, because free water in contact with the oil during the preheating stage of distillation reduces oil quality and extraction efficiency.

Harvesting should not be carried out in too hot weather and very windy conditions as significant volumes of oil can be lost through evaporation. Very cold weather prevents the development of esters, and harvesting has to be delayed until the weather is warmer. The flower spikes are cut 15 to 20 cm below the flowers. It can be hand harvested by means of sickles or shears or with mechanical devices designed for the task.

The cutting of flowers for the fresh and dried markets usually takes place at a stage of a week later than for oil production. Flowers are also cut having longer stems.

Part III: Post-harvest handling

1. SORTING AND DISTILLATION

Steam distillation

Once picked, the lavender is distilled. Distillation can determine the value of the oil or reduce the value of the oil. If the pressure or the temperature is too high it may change the molecular structure of the fragrance molecule, altering the chemical constituents. The yield of the oil may vary considerably from one season to the next, as the age of the bushes and the weather will affect both the quantity and quality of the product.

Solvent extraction

A smaller quantity of lavender and lavandin concretes is produced by solvent extractions. Concretes are excreted from fresh plant material



(Photo: Provided by members of SAEOPA and KAR WIL Consultancy)

using solvents such as toluene and hexane and petroleum ether. The solvents are evaporated off, leaving residue called concretes. Concretes find uses in the perfumery industry (particularly soaps) and a further refinement is to mix the concretes with ethanol. The mixture is then cooled and filtered, and then the ethanol is evaporated to produce a wax-free residue called an absolute. There is a frequency of 50 % loss from concrete to absolute. Absolutes are more widely used in fine perfumery.

Dried flowers

After harvesting the flowers, these are tied in bundles and hung up to be dried in the shade. Some flowers are stripped from the spikes after drying and are then packed into boxes or cases lined with paper. Generally, 8 to 10 kg of fresh flowers are necessary to produce 1 kg of dry flowers.

2. GRADING

The sweet smell of the plant is basically controlled by two of these esters, linalyl acetate and linalyl butyrate. The grading of lavender essential oil is done by chemical analysis of the quantity of esters contained within the plant.

Chemical composition

The main components of the steam-distilled products from gas chromatography are shown in the table below. Physical measurements such as density are also required to suit international standards. As with most essential oil products, the final test for quality will be the organoleptic (taste or smell) opinion of the flavourists.

The table below shows the major characteristics found in three oil groups.

Character	Lavender	Lavandin	Spike lavender
Density	0,876 – 0,892	0,885 – 0,897	0,895 – 0,917
Camphor (%)	0,51 – 1,00	04 – 11	10 – 20
Caryophyllene (%)	03 – 12		
Cineole (%)	01 – 02	05 – 10	20 – 30
Linalool (%)	30 – 49	30 – 40	40 – 50
Linalyl acetate (%)	30 – 45	20 – 30	1
Ocimene (%)	2,5 – 6,0		
Pinene (%)			01 – 03

(Source: [Bienvenu, 1995] Table provided by members of SAEOPA and KARWIL Consultancy)

3. PACKAGING AND STORAGE

Essential oils are volatile and therefore have to be handled with care. Keep the oils in dark, air-tight glass bottles and do not expose to heat or heavy metals. Deterioration begins if the liquid is much darker or more viscous than normal. With proper care essential oils remain potent for 6 months to 2 years; if freshness is suspect the oil should be discarded. Other storage vessels are fluorinated plastic, treated aluminum, and dark glass or ceramic containers. Within the value-adding market the packaging should be clearly labelled, neat and professional.

4. MARKETING

Lavender essential oil and other products can be marketed in many ways (i.e. as dried, fresh, or processed products) by the local producers as there are so many options available.

The market of essential oils in South Africa is divided into local buyers and international buyers. The local buyers include marketing agents and companies from chemical and pharmaceutical, as well as food and flavouring industries. The international buyers are divided into flavour and fragrance houses, cosmetics and personal health care, aromatherapy and food manufacturers who buy in large quantities.

The major market in the world for essential oils is the United States, followed by Japan and Europe. However, production continues to be concentrated in Europe, with seven of the world's largest essential oil processing firms. In the United States, the major users of essential oils are the soft drink companies. Japan accounts for 10 % of the world demand. The Canadian market is dominated by the United States perfume and flavouring industry.

Part IV: Production schedules

As farming enterprises are so diverse, a very basic schedule is proposed. Producers have to adapt the schedule to their own needs.

When scheduling production, the important factor to bear in mind is to have sufficient knowledge of the crop that you are farming with

General crop schedule – lavender												
Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Field preparation												
Rip and plough												
Disking												
Prepare seedbed												
Planting, cultivation and harvesting												
Plant and transplant												
Weed control												
Pest control												
Disease control												
Irrigate												
Harvest												

Part V: Utilisation

Lavender essential oil obtained from the flowers combats halitosis, is antiseptic, antispasmodic, aromatic, carminative, cholagogue, diuretic, nervine, sedative, stimulative, stomachic and tonic. It is rich in linalyl acetate and linalool and further aroma components are β -ocimene, cineol, and caryophyllene epoxide, even coumarin derivatives (coumarin, dihydrocoumarine, herniarin, umbelliferone) are present.

1. INDUSTRIAL

Applications are in soap making, high-quality perfumes such as eau de cologne, candles, incense sachets, potpourri, wands, pillows, flower bundles, dried arrangements, wall hangings, wreaths and many more. Lavender is also used as a detergent and cleaning agent. The aromatic leaves and flowers are used in potpourri and as an insect repellent in linen cupboards. The flowering stems, once the flowers have been removed for use in potpourri, can be tied in small bundles and burnt as incense sticks. It is also used in bath products such as soap, shampoo, bath oil, lotion, bath salt. The fresh leaves repel mice. Lavender, in combination with rosemary essential oil, is used as organic pesticide at a 2 % solution.

2. COSMETIC

Lavender is incorporated extensively in cosmetic preparations owing to its safety and sedative action. It is used in creams; it soothes the skin and can prevent the formation of permanent scar tissue.

3. PHARMACEUTICAL AND THERAPEUTIC

Lavender is a frequently used household herbal remedy. It is not often used internally, though it is a useful carminative and nervine. It is mainly used externally when rubbed into the temples, and it can cure a nervous headache. Its powerful antiseptic properties are able to kill many of the frequent bacteria such as typhoid, diphtheria, streptococcus and pneumococcus, as well as being a powerful antidote to some snake venoms. It is very useful in the treatment of burns, sunburn, scalds, bites, vaginal discharge, and anal fissure. The essential oil is used in aromatherapy. The leaves are also added to bath water for fragrance and their therapeutic properties.

4. FOOD AND FLAVOURING

Lavender is used for a variety of food flavourings such as lavender jelly, cookies, ice cream, culinary herb blends, lavender tea, honey and salt. It is used as a strewing herb to impart a sweet smell to rooms and to deter insects.

5. OTHER

Lavender is used as ornamental plants in gardens all over South Africa.

6. SAFETY DATA

Lavender is one of the safest essential oils and can be used undiluted. Essential oils can be harmful if swallowed and should be kept out of children's reach.

REFERENCES*

- AFOLOYAN, A. 2005. How safe are essential oils, in: *IFEAT conference proceedings: 2006. Essential oils and aromatic plants symposium*. Cape Town, South Africa: ASNAPP.
- CHARLES, D. 2005. Selecting organic essential oil from a new supplier—Buyers perspective, in: *IFEAT conference proceedings: 2006. Essential oils and aromatic plants symposium*. Cape Town, South Africa: ASNAPP.
- CURTIS, B. 2005. *Lavender production and marketing*. Washington State University (WSU) Cooperative Extension Bulletin. Online: <http://www.smallfarms.wsu.edu/crops/lavender.html>. Accessed 19 August 2006.
- HOLMES, R. 1999. Australia new rural industries. *Lavender oil: A handbook for farmers and investors*. Online: <http://www.newcrops.uq.edu.au/newslett/ncnl1218l.htm>. Accessed 18 August 2006.
- MAGANGA, A. 2004. Influence of variety and organic cultural practices on yield and Essential Oil Content of Lavender and Rosemary in Interior BC. Prepared for South Thompson Organic Producers Association (STOPA). BC: Ecorational Technologies, Kamloops.
- POLYDEONNY, V.I., SOTNIK, V.F. & D HILAPZEW, E.E. 1979. *Medicinal and Aromatic Plants*. Moscow: Kolos Press.
- SIMON, J.E., CHADWICK, A.F. & CRAKER, L.E. 1984. *Herbs: An indexed bibliography. 1971–1980. The scientific literature on selected herbs, and aromatic and medicinal plants of the temperate zone*. Hamden, CT: Archon Books.
- TEUBES, C. 2005. Market opportunities, in: *IFEAT conference proceedings: 2006. Essential oils and aromatic plants symposium*. Cape Town, South Africa: ASNAPP.

* Further information on references could be obtained from members of SAEOPA and KARWYL Consultancy.

