

Start Up Manual

on

LAVENDER

(CULTIVATION & PROCESSING)



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A: 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

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:

True lavender yields 8 to 30 kg and lavandin 40 to 220 kg essential oil per hectare (ha), and 500 to 1000 kg dried flower stems per hectare, depending on location, management and cultivar.

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 harder than lavender plants. The world production of lavandin oil is 1000 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.

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 parts

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



Lavandula angustifolia (English/True lavender)

6. Cultivars:

Genus *Lavendula* is represented by 39 species and 17 hybrids, with hundreds of various genotypes differentiated by variations ranging from growth form to chemical composition of essential oil.

From the commercial point of view only four species have economic importance:

1. *Lavendula angustifolia* commonly known as English Lavender
2. *Lavendula latifolia*, commonly known as Spike lavender
3. *Lavendula stoechas* commonly known as Spanish Lavender
4. *Lavendula intermedia*, commonly known as Lavandin



Lavandin cultivars



True lavender cultivars

The lavender essential oils are each unique in composition and used in different applications.

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 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.

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 1700 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 1000 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 1400 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.

B: 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.

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.



Lavender ready for transplanting

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 under expert guidance.
- 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.



Lavender plantation on slopes

Planting density/spacing

Lavender is normally planted in row widths of 1 to 2 m apart, with 30 to 60 cm spacing between the plants, which gives a plant density of 8000 to 10000 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 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.



Lavender plantation in uniform rows

Intercropping

Lavender can be suitably integrated with apple as an intercrop under Kashmir conditions thus permits increased harvest per unit, better economic returns for the farming community.



Lavender plantation in apple orchards as an Intercrop

Planting season

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 over.

4. Fertilization:

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. 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 (*application of calcium and magnesium rich materials to soil*) 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 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 (*Mulch is simply a protective layer of a material that is spread on top of the soil for protection and helping provide a better growing environment*) 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 (*Intercropping*) 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.

Weed control guidelines

- Do not allow weeds to seed in the land.
- 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 & Disease control:

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

Experts from the Department of Agriculture, and researchers of agricultural institutes (IIIM & SKUAST) should be contacted for further information on the identification of insects and for recommended controls.

No serious diseases have been reported on this crop.

8. 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 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.



Hand harvesting



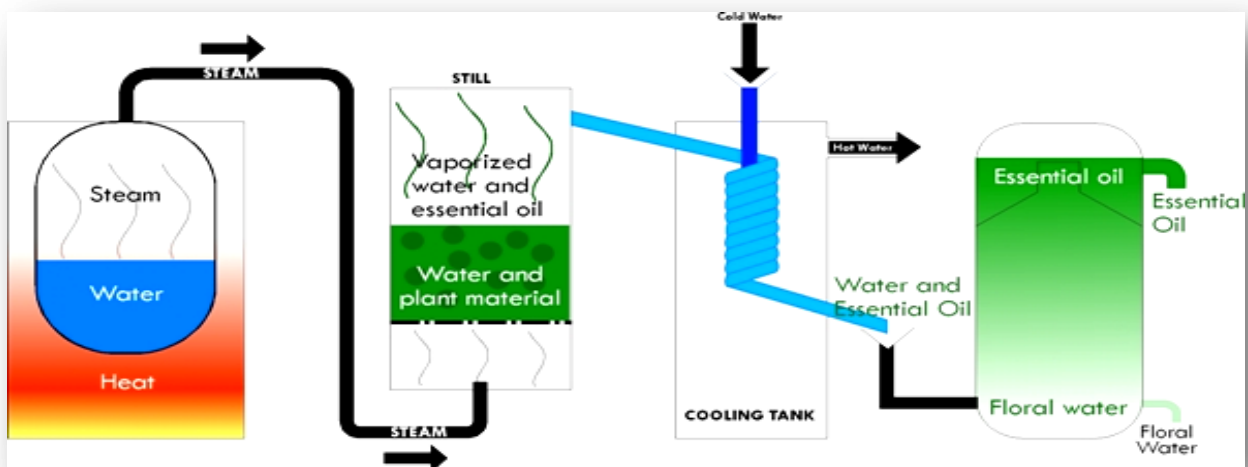
Sickle harvesting

C: 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.



Steam Distillation Process

Solvent extraction

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

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 valueadding market the packaging should be clearly labelled, neat and professional.

4. Marketing:

Lavender products can be marketed in many ways viz. as dried, fresh, or processed products.

The market of essential oils is divided into local buyers and international buyers. The local buyers include florists & decorators, households (on special occasions like religious festivals, marriage ceremonies and temple offerings), local hoteliers and tour operators and chemical and pharmaceutical industries as well as food and flavouring industries. The international buyers include flavour and fragrance houses, cosmetics and personal health care, aromatherapy and food manufacturers.

The major market in the world for essential oils is the United States, followed by Japan and Europe. In the United States, the major users of essential oils are the soft drink companies. Japan accounts for 10 % of the world demand.

D: Products & Uses

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.



Lavender products on display

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 an ornamental plant in gardens all over the world. *Lavender oil is one of the safest essential oils and can be used undiluted.*

E: Relevant govt. departments

- Revenue department - *For Land Registrations.*
- Ministry of Food Processing Industries (MOFPI) - *For Product Certifications.*
- Indian Institute of Integrative Medicine (IIIM), Srinagar/Jammu- *For Expert Advice.*
- Department of Floriculture, Directorate of Agriculture, Kashmir - *For Expert Advice.*
- Sher-e-Kashmir University of Agricultural Sciences and Technology (SKUAST), Srinagar/Jammu - *For Expert Advice.*
- Agricultural and Processed Food Products Export Development Authority (APEDA)- *For Exports Advice.*