

# Good Agricultural Practices for Patchouli, Geranium and Lemongrass



National Research Centre for Medicinal and Aromatic Plants  
Boriavi, Anand - 387310, Gujarat, India

---

# **Good Agricultural Practices for Patchouli, Geranium and Lemongrass**

*by*  
**Satyabrata Maiti**  
**Saravanan Raju**  
**Geetha K. A.**  
**Kunal Mandal**



**National Research Centre for Medicinal and  
Aromatic Plants**  
**Boriavi, Anand - 387310, Gujarat, India**

---

---

Published by : Dr. Satyabrata Maiti, Director,  
National Research Centre for Medicinal and  
Aromatic Plants,  
Boriavi, Anand - 387 310, Gujarat, India  
Phone : 0091-0268-2578602  
Fax : 0091-0268-2578601  
E-mail : [director@nrc-map.org](mailto:director@nrc-map.org)  
Web address : [www.nrc-map.org](http://www.nrc-map.org)

Printed : March 2006  
Copies : 1000

Front Cover :

Patchouli

Geranium

Lemongrass

---

Printed at Anand Press, Anand 388001, Gujarat  
E-mail: [apa@jesuits.net](mailto:apa@jesuits.net)

---

---

## Content

Preface.....	i
Patchouli .....	1
Name of the Plant.....	1
Part to be employed in aromatic oil extraction .....	1
Characteristics of the plant.....	1
Major production areas.....	2
Characteristics of strain(s) for cultivation .....	2
Cultivation methods .....	2
Quality evaluation of essential oil .....	5
Cultivation calendar .....	6
Geranium.....	8
Name of the Plant.....	8
Part to be employed in aromatic oil extraction .....	8
Characteristics of the plant.....	8
Major production areas.....	9
Characteristics of strain(s) for cultivation .....	9
Cultivation methods .....	10
Quality evaluation of essential oil .....	13
Comparative summary table of the characteristics of different cultivated strains .....	14
Cultivation calendar .....	14
Lemongrass .....	16
Name of the Plant.....	16
Part to be employed in aromatic oil extraction .....	16
Characteristics of the plant.....	16

---

---

Major production areas.....	17
Characteristics of strain(s) for cultivation .....	17
Cultivation methods .....	17
Quality evaluation of essential oil .....	20
Comparative summary table of the characteristics of different cultivated strains .....	20
Cultivation calendar .....	21

---

## Preface

*Poor quality of raw material of medicinal and aromatic plants is due to various reasons and most important of these is non-compliance of Good Agricultural Practices (GAP) as promoted by World Health Organization (WHO). The situation has arisen because of non-availability of GAP guidelines for medicinal and aromatic plants in India. These speciality crops are now being cultivated without following the standards in cultivations practices. In many places substandard water (effluent from the industries) is used for irrigation, city garbage is used as manure and also unsuitable land is used for cultivation; obviously resulting substandard material.*

*Therefore, we have tried to compile GAP guidelines for three important aromatic crops on the basis of available information. However, we feel that this bulletin is not the final or ultimate in GAP guidelines of these crops. We presume that this bulletin would serve as a basic model for further development and refinement of GAP for these crops in various agro-climatic zones. The challenge before us is not only preparation of a model GAP document for various medicinal and aromatic crops but also its implementation in its true spirit. A series of activities now to be initiated to train farmers and sensitised other associated personnel.*

*We would feel our efforts useful if this bulletin serves the farmers to understand the GAP and also use it for production of quality material acceptable to end users and also to the extension workers engaged in these speciality crops.*

*We take this opportunity to express our sincere gratitude to Dr. Mangala Rai, Secretary, DARE & Director General, ICAR and Dr. Gautam Kalloo, Deputy Director General (Horticulture & Crop Sciences), ICAR for their constant encouragement for this publication. Secretarial assistance rendered by Mr. Suresh Patelia is also thankfully acknowledged.*

Anand  
March 17, 2006

Authors

## Patchouli



### 1. Name of the plant

- 1.1. Scientific name: *Pogostemon cablin* Benth (Family: Labiatae)
- 1.2. Local names: Peholi (Hindi), Pachtetene (Kannada), Kadirpachai (Tamil)

### 2. Part to be employed in aromatic oil extraction

The dried shoots of 40-50 cm having four to five internodes are used for the extraction of essential oil through hydro-distillation.

### 3. Characteristics of the plant

Patchouli is a perennial, branched, aromatic herb. The leaves are soft, opposite, ovate to oblong-ovate, serrate with hairs on both surfaces. The stem is densely haired with swollen nodes. The plant grows upto 90-100 cm and flowers during the month of February-March, if harvesting is not done at mature stage. The crop can be harvested two or three times a year. The tertiary sesquiterpene alcohol (-)patchoulol is the major olfactory component (27-35%). However, nor-patchoulenol, present in

only 0.4-1.0% is thought to play critical role in the overall odour profile of patchouli oil. These unique constituents make it difficult to develop synthetic substitute for patchouli oil.

#### **4. Major production areas**

Patchouli grows wild in Malaysia, Indonesia and Singapore. In India, it is cultivated in coastal areas of South India, West Bengal, Assam, Karnataka and coastal regions of Gujarat. It thrives well in coastal region having 80-90% relative humidity and well-drained, sandy loam soil with a pH of 6.0-6.8 and a temperature range of 20-35°C. Since the demand for patchouli oil is increasing in domestic and international markets, there is huge scope to increase its production by increasing its area.

#### **5. Characteristics of strain(s) for cultivation**

The commonly cultivated strains are Johore, Singapore and Indonesian. Of these, Johore yields the best quality of oil in terms of chemical composition and odour characteristics. Singapore and Indonesian strains produce more herbage and oil yield, however the oil quality is inferior.

#### **6. Cultivation methods**

- 6.1. Propagation: Patchouli is propagated through rooted stem cuttings. However, tissue cultured plants are also available for cultivation. Since the cost of tissue cultured plants are higher, one can raise the nursery for the production of rooted stem cuttings to avoid excess input cost.
- 6.2. Soil condition: Patchouli grows luxuriantly in fertile loamy to sandy loam soils with good drainage. Water logged soils with poor drainage are detrimental for the growth of the crop and must be avoided. Soils with neutral to slightly acidic pH is suitable for this crop. When the soil is alkaline in nature, application of gypsum 10-12 tonnes per ha is found to be beneficial to the crop growth.
- 6.3. Climate: Patchouli grows at its best in hot and humid climate with even distribution of rainfall. The seasonal average temperature of 25-35°C will be ideal for crop growth. This is a shade loving plant and hence partial shade enhances the crop growth. Under the shade, leaves grow larger with more hairs/trichomes and hence oil recovery is high.

- 6.4. Planting time: June-March with assured irrigation is recommended for planting of patchouli. Once planted, the plants can provide economic yield up to three years.
  - 6.5. Raising of nursery: Patchouli is propagated through vegetative means and rooted stem cuttings are prepared in the nursery for planting in the main field. Since the cost involvement will be substantial for the rooted cuttings initially, nursery can be established for the production of planting material few months before the actual planting. Five hundred mother plants are required for the production of 25,000-30,000 rooted cuttings, which is sufficient for planting in a hectare. Stem cuttings of 10-15 cm length with 2-3 internodes will be used for production of healthy rooted cuttings. The cuttings may be dipped in 1500 ppm of indole-3-butyric acid (IBA) for few seconds to enhance root production in the cuttings. Proper shade and frequent watering should be given for survival of cuttings and for healthy root development. Seedlings are kept in nursery for about 6-7 weeks after that those become ready for planting.
  - 6.6. Planting: The land is ploughed thoroughly and 20 tonnes of FYM is added per ha and mixed thoroughly. Ridges and furrows at a distance of either 60 cm or 90 cm are prepared. The rooted cuttings are planted at a distance of 60 cm or 45 cm within row.
  - 6.7. Crop nutrition: The fertilizer requirement of this crop is heavy. Since the herbage is harvested at three to four times a year, to maintain a good crop stand the recommended dose is 150:100:100 kg of NPK per ha. Full dose of P & K and  $\frac{1}{4}$  of N is applied as basal. Rest of N is applied in three equal splits, one after each harvest. Micronutrients mixture is to be sprayed at a rate of 0.5-1% when the leaves show deficiency symptoms of chlorosis and browning. However, now-a-days requirement for organically grown material is increasing, therefore, it can be cultivated with organic inputs only as per the norms of organic cultivation.
  - 6.8. Application of gypsum: When the soil is alkaline in nature, application of gypsum at 10-12 tonnes per ha is recommended for better crop growth.
  - 6.9. Irrigation: The crop is irrigated at 3-4 days intervals immediately after planting and 10-12 days afterwards depending upon the
-

moisture availability in soil. In summer months, frequent irrigation may be given depending upon the soil water availability. Irrigation at regular intervals is a must for good herbage yield in low rainfall areas.

- 6.10. Intercultural operations: The crop requires weeding at early stages of its growth. The plots should be kept weed free during the first 2-3 months. During the hoeing operations, care should be taken to avoid the damage to roots.
- 6.11. Nipping of shoot: Nipping of apex shoots of the plants at 20-30 days after planting is essential for further development of lateral shoots and uniform spread of canopy.
- 6.12. Intercrop: Patchouli can also be cultivated in partial shade of mango, custard apple and other fruit trees and in coconut plantations with drips so as to avoid excess irrigation to the fruit trees.
- 6.13. Diseases and pests: Root knot nematode infects the crop when the crop get established in the field. The infection will be visible from the stunted growth and presence of galls in roots. Heavy infestation causes the death of the plant. The problem of root knot build-up in the soil can be reduced by applying high quantum of organic manures during field preparation along with application of *Trichoderma* spp. in sufficient quantities.

Patchouli is susceptible to Rhizoctonia wilt. To control the spread of the disease, wilt infected plants should be removed at the early stage of the disease. Application of biocontrol agent is recommended.

Patchouli is relatively free from major pests. If infestation of pest becomes serious, botanical pesticides may be applied.

- 6.14. Harvesting: The first harvesting may be done after 4 to 5 months after planting. Further harvesting can be done at every 3-4 months interval depending upon the cultural conditions. Harvesting is done by cutting the shoots of four to five nodes from the apex. The length of the cutting ranges from 40-50cm. It is necessary to leave few sprouts in the basal portion of the stems for rapid re-growth of the shoots.
- 6.15. Processing: The harvested biomass is dried in shade for 7-10 days with frequent turning of the layers for even drying and to avoid

growth of mold. Leaves are packed in gunny bags when moisture level is brought down to about 6%. The bags can be stored under well ventilated place for about few months without any loss in quality.

The dried leaves are subjected to steam distillation for extracting the essential oil. Maintaining appropriate steam pressure inside the system is essential for proper oil recovery. An interchange of 1.4-3.5 kg/cm<sup>2</sup> to low and high pressure produces better yield. The duration of distillation varies from 6-8 hours. Prolonged distillation yields higher quality oil with better recovery. The oil yield varies from 2.5-3.5% from dried leaves.

- 6.16. Expected yield: A good crop may yield 10-25 tonnes per hectare of fresh herbage and 3-5 tonnes per hectare per year dry herbage. The oil yield is about 60-100 kg per hectare.

## 7. Quality evaluation of essential oil

- 7.1 The oil should have the following characteristics to be of standard quality:

Appearance	: Yellowish to reddish brown clear liquid with variable viscosity.
Odour	: Characteristic dry leafy/campharaceous herbal woody with tenacity.
Specific gravity at 20°C	: 0.952 to 0.975
Refractive index at 20°C	: 1.5050 to 1.5150
Optical rotation at 20°C	: -60 to -40
Acid value (max.)	: 4
Ester value (max.)	: 10
Flash point	: 116°C
Solubility	: 1 vol. of oil in 10 vol. of 90% alcohol.

- 7.2 Gas Liquid Chromatography composition of patchouli oil: The constituents of patchouli oil are beta patchoulene (1.8-3.5%), alpha guaiane (11-16%), beta caryophyllene (2-5%), seychellene (1-3%), bulnesene (13-21%), nor patchoulene (0.4-1.0%), patchouli alcohol (27-35%), pogostol (1.0-2.5%), copaene (0-0.5%)

## 8. Cultivation calendar

The following cultivation calendar will provide general guide lines for cultivation of patchouli by utilising the monsoon rainfall for the better establishment of patchouli crop. However, this crop can be planted in the field any time during June to November and February to April except extreme winter and summer months in most parts of the country. The duration of each activity mentioned below will be useful for successful cultivation of patchouli. Its is not advisable for anyone to strictly adhere to the proposed schedule for individual months considering the varying climatic and weather conditions prevailing in various regions of the country. One has to exercise due diligence in raising the crop according to the available resources at his/her disposal.

Major activity	Month	Activity details
Nursery	March-April	Nursery preparation and raising of rooted cuttings
Land preparation	April-May	Land preparation, Application of FYM, Fertilizer application as basal dose
Transplanting	June-July	Planting in the main field, gap filling, weeding (at regular intervals during initial months) and intercultural operations
Irrigation	—	Life-irrigation after planting in the absence of rainfall. There after at regular intervals to maintain sufficient moisture
Pinching	August	Pinching of apical shoot buds to increase the lateral bud development
Harvesting	October	First harvest. Post harvest activity including shade drying, packaging to distillation. Application of nitrogen as top dressing

Major activity	Month	Activity details
Intercultural operations	November	Intercultural operations like weeding, earthing-up and plant protection measures
Harvesting	January	Second harvest. Post harvest activity including shade drying, packaging to distillation Application of nitrogen as top dressing
Intercultural operations	March	Intercultural operations like weeding, earthing-up and plant protection measures
Harvesting	April-May	Third harvest. Post harvest activity including shade drying, packaging to distillation Application of nitrogen as top dressing

As this crop can be maintained up to three years, the above schedule shall be followed for the remaining period with suitable alterations.

## Geranium



### 1. Name of the plant

- 1.1. Scientific name: *Pelargonium graveolens* L' Herit. (Family: Geraniaceae)
- 1.2. English name: Rose scented geranium or scented geranium

### 2. Part to be employed in aromatic oil extraction

Leaves and tender shoots of the plant are used for the extraction of rose scented essential oil.

### 3. Characteristics of the plant

Geranium is a perennial bushy plant growing to a height of 1 m. Stem is cylindrical, green when young and turns to brown at maturity. Leaves are simple, alternate, 5-7 lobed, pubescent and aromatic. Flowers are rose pink to pink, arranged in an inflorescence. Flowering is more profuse in higher altitudes. Flowering occurs in February-March in Nilgiris and in Bangalore profuse flowering occurs in April-May.

---

#### 4. Major production areas

Geranium is a native of South Africa, tropical Africa, Syria and Australia. The species was introduced to India in 1915 and now the crop is in cultivated in Tamil Nadu, Karnataka, Andhra Pradesh, Himachal Pradesh, Uttaranchal and Uttar Pradesh.

The species is also cultivated in different parts of the world viz., France, Belgium, Spain, Morocco, Madagascar, Egypt, Reunion Islands, Congo, China, and the former USSR countries. China and Egypt are the major producers of geranium oil in the world. Annual world production of the oil is about 500-750 tonnes. In India, about 20 tonnes of geranium oil is produced annually and majority of India's requirement is fulfilled by import.

The crop is grown as rain-fed in hilly areas and as irrigated in plains. Generally, the crop grows well in temperate, subtropical and tropical climates at an altitude range of 1000-3000 m.

#### 5. Characteristics of strain(s) for cultivation

The geranium in trade is the common name given to a number of species belonging to the genus *Pelargonium*. The major species that is cultivated for the commercial geranium oil is *P. graveolens*. It is also known as rose scented geranium or scented geranium. There are mainly two types of *P. graveolens* i.e., Algerian or Tunisian and Bourbon or Reunion. The former is with dark pink flowers and not suitable for wet conditions and the latter is with light pink flowers and suitable for wet conditions. Reunion type (Bourbon oil of commerce) is the better type which is rich in citronellol content having heavy rose and mint odour. Algerian oil has delicate odour than that of Reunion oil. Egyptian type is another strain identified for cultivation in plains, which is geraniol rich and resistant to wilt compared to Bourbon. Other important species are *P. capitatum* Ait., *P. fragrans* Willd., *P. odoratissimum* Ait., *P. quercifolium* Ait. and *P. radula* L' Herit.

KKL-1 (Algerian type) and Sel-8 (Reunion type) are two high yielding varieties recommended for cultivation in Kodaikkanal area and Bangalore, respectively. *Hemanti*, *Bipuli* and *Kunti* are the superior varieties developed for cultivation in the plains of North India. Other varieties are *Kelkar* and *Ooty*.

## 6. Cultivation methods

- 6.1. Propagation: The crop is propagated by stem cuttings and also by root suckers. Seed setting is generally not found in the crop. Commercially the crop is propagated by stem cuttings.
- 6.2. Soil condition: Porous, open and calcium rich light soil with pH of 5.5-8.0 is suited for the crop. Reddish sandy loam soil with low water retention capacity is found good for its cultivation.
- 6.3. Climatic condition: Locations having warm winter and mild summer with well-distributed annual rainfall of 100-150 cm are ideal for crop growth. Temperature throughout the growing season between 25-30° C is preferred. However, Egyptian type can tolerate high temperature, up to 43° C. High humidity, heavy rainfall coupled with mist or fog, frost and water logging conditions are detrimental to crop growth and favour disease development.
- 6.4. Raising of nursery: Nursery is prepared under shade conditions. An area of about 80 m<sup>2</sup> is sufficient for developing cuttings for one hectare of the crop. Raised nursery beds of about 3 x 1.5 m sizes are prepared by adding sufficient farmyard manure (FYM) in the soil. Terminal cuttings of about 20 cm having about 8 nodes are selected and a slanting cut is made at the 6<sup>th</sup> or 7<sup>th</sup> node using a sharp blade and planted on the wet beds at 5 cm spacing. A light watering by hand is also given immediately after planting, followed by regular watering (3-4 days intervals) so as to maintain the moisture in the beds. Rooting can be enhanced by dipping the stem cuttings in either IBA (250 ppm) or NAA (125 ppm). If mist chambers are available, rooting can be obtained within one month. Cuttings can also be raised in polybags filled with sand and FYM mixture, which ensures better survival percentage in the field.  
November to January is best suited for nursery preparation, however, with proper precaution of maintaining the shade, temperature and humidity, nursery can be prepared in the other months also. In hilly areas where the crop is grown as rain-fed, the nursery is developed in the month of March-April. Plants become ready for transplanting within 45-60 days
- 6.5. Planting time: Planting time varies depending upon the availability of first rain from location to location. However, under assured

irrigation facilities, generally planting is done in the month of December-February.

- 6.6. Planting: The field is prepared by adding FYM, thoroughly ploughed, leveled and laid into furrows and ridges. Planting is done on the ridges at a spacing of 60 x 60 cm. A light irrigation is given immediately after transplanting.
- 6.7. Crop nutrition: Well-decomposed FYM at 10-15 tonnes per hectare is applied in the soil at the time of land preparation. Geranium responds well to inorganic fertilizers. Application of nitrogen at the rate of 120 kg per hectare (in 3-4 splits, one as basal and the rest after each harvest), 30 kg  $K_2O$  and 60 kg  $P_2O_5$  per hectare, depending upon the soil status increase the herbage yield and oil quality. However, nowadays, requirement of organically grown material is increasing and the crop can be grown as per the norms of organic cultivation by adding only organic inputs.
- 6.8. Irrigation: Under irrigated condition, the crop is irrigated daily for 3-4 days immediately after transplanting, subsequently on alternate days for 10-15 days and there after twice in a week.
- 6.9. Intercultural operations: The crop is kept weed free by regular weeding for the first 1-2 months since crop growth is very slow initially and thereafter at about 45 days interval. After each harvest, a hoeing is done followed by irrigation, which make the crop ready for harvest within the next four months.
- 6.10. Intercropping: Intercropping can successfully be practised in the crop along with suitable crops depending upon the locations. It is grown as inter crop along with plums, peaches, pears and also sometimes with silver oak in the hilly areas.
- 6.11. Diseases and pests: Major disease of the crop is wilt caused by *Fusarium oxysporum* var. *radolens*, *Botryodiplodia theobromae*, *B. obtuse*, *Rhizoctonia solani*, *Pythium* sp, and *Phytophthora* spp.

Various crop management measures to control the disease are dipping of cut end of the stem in 0.2% carbendazim at the time of nursery development, avoiding transplantation in summer months, avoidance of excessive water, careful removal of lower branches close to the ground during harvesting without injuring

much the main branches, use of closer spacing (45 x 45 cm) to reduce lodging of lower branches and change of land after every three years.

Other minor disease, which affects the crop is tip rot caused by *Gleosporium* spp. where brown spots appear on the leaf tips and other tender parts causing defoliation and decay of plant.

There is no serious pest outbreak reported in this crop however, nematodes and termite sometimes affect the crop stand.

- 6.12. Harvesting: The crop becomes ready for harvest four months after transplanting when the leaves become light green or yellow and the lemon odour of the leaf is changed to rose-scented. For higher and quality oil yield, harvesting of the herbage is done before flowering. Terminal branches of about 10-12 leaves are cut with a sharp sickle, keeping one branch intact in the plant. Harvesting is usually done on sunny days in the morning. The crop is perennial and a total of three harvests per year is obtained for about 3-4 years.
- 6.13. Processing: The harvested fresh herbage is distilled by steam distillation within 72 hours of harvesting. The distillation process is completed in 3-4 hours. Oil recovery percentage is about 0.8-0.125%. The oil obtained by distillation is made moisture free by sprinkling anhydrous sodium sulphate at 20-30 g per litre, stirring for about 15 minutes and filtering through a good filter paper. Normally, the oil is stored in aluminium or stainless steel containers.

Geranium oil particularly of reunion type is used for the extraction of commercial rhodinol (a mixture of citronellol, geraniol and other alcohols). This is of superior quality range and is used for the preparation of higher grade perfumes. The essential oil extracted from the species blends well with all kinds of perfumes and is used in cosmetics and perfumery.

- 6.14. Expected yield: Yield of the plant depends upon the plant population and crop maturity. A minimum plant population of 25000 plants per hectare yields about 25000-30000 kg fresh herbage per year, which on distillation yields about 25-30 kg oil. Market rate of the oil is 3000-4000 per kg.
-

## 7. Quality evaluation of essential oil

7.1. As per IS-587-1988 essential oil of geranium should have following characteristics:

Colour and appearance	: Yellowish and brown liquid
Odour	: 0.8824-0.8966
Relative density at 27° C	: -7 to -11
Optical rotation	: 1.4633-1.4728
Refractive index at 30° C	: 50-76
Ester value (using 2.5 g of oil)	: 10
Acid value Max.	: 16
Carbonyl compound (calculated as isomenthone %) percent by mass, Max. (using 1 g of oil, standing time 30 minutes by hydroxyl ammonium chloride method)	: 205-230

7.2. Essential oil GC profile (%): Major constituents of geranium oil are citronellol (19.8- 40.23 %) and geraniol (6.45- 19.90%). Other important constituents are lilanool (3.9- 12.9%), isomenthone (5.2- 7.2%), geranyl acetate (0.80), geranyl formate (5.77%), geranyl butyrate (0.98- 1.35), monoterpenes (4.65%), citronellyl formate (5.57-6.02%) citronellyl acetate (0.10-1.88%), citronellyl butyrate (0.52-0.62%), eudesneol (3.41%), guaidience (0.28%), menthone (1.52%), nerol (0.50%) and rose oxides (0.35%). However, individual constituents of the essential oil vary considerably depending upon the strain and climatic conditions.

## 8. Comparative summary table of the characteristics of different cultivated strains

Characters	Algerian or Tunisian	Bourbon or Reunion
Cultivated condition	Note suitable for wet conditions	Wet conditions
Growing elevation	Higher elevations (Hills)	Plains
Flower colour	Dark pink	Light pink
Characteristic of oil	Delicate odour than that of Reunion oil.	Oil is rich in citronellol content having heavy rose and mint odour

## 9. Cultivation calendar

Major activity	Hills (rain-fed)		Plains (irrigated)	
	Month	Activity details	Month	Activity
Nursery	March-April	Nursery development	November-January	Nursery development
Land preparation	April-May	Land preparation and applications of FYM & NPK basal dose	December-February	Land preparation and application of FYM & NPK
Transplanting	June-July	Transplanting of rooted cuttings depending upon the rain fall.	December-March	Transplanting of rooted cuttings, followed by daily irrigation for 3-4 days. Subsequently on alternate days for 10-15 days and thereafter twice a week.
Intercultural operations	June-August	Regular weeding for initial 1-2 months and thereafter at every 45 days interval	December-April	Regular weeding for initial 1-2 months and thereafter at every 45 days interval

Major activity	Hills (rain-fed)		Plains (irrigated)	
	Month	Activity details	Month	Activity
Harvesting	October-November	First harvesting, oil distillation, etc	April-July	First harvesting, oil distillation, etc.
Intercultural operations	November-December	Split dose of N application, hoeing, etc	May-August	Split dose of N application, earthing-up, hoeing, etc
Harvesting	February-March	Second harvest, oil distillation, etc.	August-November	Second harvest, oil distillation, etc.
Intercultural operations	March-April	Split dose of N application, earthing-up, hoeing, etc	September-November	Split dose of N application, earthing-up, hoeing, etc.
Harvesting	May-June	Third harvest, oil distillation, etc.	December-March	Third harvest, oil distillation, etc.

The crop is grown for 3-4 years and the above schedule shall be repeated for the remaining period with suitable alterations

## Lemongrass



### 1. Name of the plant

- 1.1. Scientific name: *Cymbopogon flexuosus* (Steud.) Wats (Family: Poaceae)
- 1.2. Local name: Lili chaa (Gujrati), Maiji gehlu (Kanada, Telegu), Patichaha (Marathi), Guhyobeej (Sanskrit), Karpoor pullu (Tamil)

### 2. Part to be employed in aromatic oil extraction

Green vegetative parts, mostly the leaves are used for hydro-distillation of essential oil.

### 3. Characteristics of the plant

The plant is a monocot belonging to grass family having no proper stem. However, leaf sheaths of several leaves form a strong tubular structure up to 10-25 cm from the ground level. Plant height varies from 1.5 to 2.5 m. Leaf sheath glabrous, hairy at the junction of the blade, blade about 1 m long, 1.5 cm wide. Linear sessile spikelets are 4.5-5.0 mm long. Upper glumes are boat shaped and lower glumes are nerved.

---

The leaves yield 0.5-0.9% oil depending upon the cultivars. Major constituent of the oil is citral (75-85%).

#### 4. Major production areas

This particular species is indigenous to India. The crop can be grown in tropical to semi-arid regions. Commercially, the crop has been successfully grown in the north Indian plains, Kerala, Assam, West Bengal, etc.

#### 5. Characteristics of strain(s) for cultivation

Three different species of *Cymbopogon* viz. *C. flexuosus* (Steud.) Wats, *C. citratus* Stapf and *C. pendulus* are called as East Indian, West Indian and North Indian lemongrass, respectively. All of them are grouped under the common name lemongrass because of the characteristic lemon like odour of their essential oil due to high citral content (75-85%). *C. flexuosus*, also known as Malabar or Cochin grass, is indigenous to India. *C. citratus* is mostly cultivated in West Indies, Guatemala, Brazil, etc. Essential oil from the third species differ from the other two in lower solubility in 70% alcohol. This is due to presence of myrcene, which readily polymerises on exposure to air and light.

Several cultivars viz. Sugandhi (OD 19), Pragati (LS48), Praman (Clone 29), RRL 16, CKP 25, Krishna, Cauvery, Chiraharit, Jama Rosa, etc. have been released from different institutes.

#### 6. Cultivation methods

- 6.1. Propagation: The crop is propagated through seed or slips.
- 6.2. Soil condition: The crop is traditionally grown in the poor lateritic soil of hilly regions of Kerala. However, growth and yield increase in good sandy-loam and loam soils. It can not withstand water logging. It can be grown in soils having acidic to alkaline pH. Leaf yield, oil content and citral content increase with increase in pH from 4.8 to 7.5. It is also successfully grown in sodic soil having 9.8 pH and exchangeable sodium of 55%. The crop is found to grow in saline soil having electrical conductivity of 10 dSm<sup>-1</sup> without much loss in herbage and oil yields.
- 6.3. Climate: The crop is well suited for warm humid climate. Traditionally, it is grown in the areas receiving well-distributed

high rainfall. However, it can be grown in semi-arid regions with irrigations. Oil content in leaves and citral content in oil is reduced in high rainfall areas though leaf yield increases. Low winter temperature inhibits the growth of this crop. Hence, leaf yield reduces in the areas having long winter season.

- 6.4. Planting time: The crop can be planted after winter (February-March) or during rainy season (June-July). Planting after winter is possible in the areas having assured irrigation. This also helps in minimising the weed competition compared to rainy season planting.
- 6.5. Preparation of planting material: In Kerala, the crop is propagated through seeds. However, in other parts of the country, propagation through slips is practised.

Direct seeding does not give good stand hence not recommended. To raise the nursery, land is ploughed repeatedly to produce fine tilth. Nursery area of 1/10<sup>th</sup> that of main land is sufficient. Raised beds of 1-1.5 m wide of convenient length are prepared. Seeds at 3-4 kg per hectare are uniformly applied over the beds and covered with a thin layer of soil. Adequate soil moisture is maintained by watering. Seeds germinate within 5-6 days and seedlings get ready for transplanting at the age of 50-60 days.

For planting of slips, clumps are trimmed from 20-25 cm above ground and dug out without injuring the roots. The individual slip or a group of 2-3 slips having enough healthy root system are separated just before planting. This minimises drying loss of the roots.

- 6.7. Planting: In north-eastern hilly regions, close planting (30 x 30 cm) is done while wide spacing (45 x 60, 50 x 60, 60 x 60 cm) is practised in the northern plains. To avoid water logging, planting may be done on ridges in areas receiving high rainfall. Seedlings/slips are planted firmly in the soil but not deep into the soil.
- 6.8. Crop nutrition: Lemongrass responds well to the applied nutrients. In general, 100 kg nitrogen (217 kg urea), 30 kg phosphorous (187 kg single super phosphate) and 40 kg potash (68 kg muriate of potash) are applied for 1 ha land. Phosphorous and potash are applied as basal with one fourth of nitrogen. Rest of the nitrogen is applied in three equal split doses (after each harvesting). To avoid chlorosis, a mixture of 0.25% FeSO<sub>4</sub> and 0.25% citric acid is

sprayed 3-4 times at an interval of 7-10 days. However, now-a-days requirement for organically grown material is increasing, therefore, it can be cultivated with organic inputs only as per the norms of organic cultivation.

- 6.9 Irrigation: It is generally grown as rain fed crop and no irrigation is required in the areas receiving well-distributed rainfall. However, 2-3 irrigations during hot summer months and one irrigation after each harvest can be applied to get higher yield.
- 6.10 Intercultural operation: Keeping the crop weed free during early establishment is essential to get good harvest. One or two times weeding after planting and one more weeding within 30 days after first harvest are recommended. Once the crop covers the land area, usually weed growth is reduced.
- 6.11. Diseases and pests: Diseases like leaf blight (*Curvularia* spp., *Dreschlera* spp. and *Colletotrichum graminicola*) rust (*Puccinia nakanishiki*), smut (*Tolyposporium christensenii*) and grassy shoot (*Balansia sclerotica*) are noticed in this crop. However, none of them cause much damage to the crop.

Among the insect pests, stem boring caterpillar of *Chilotrea*, scale insect (*Duplachinoaspis divergens*), white fly (*Tetralaurodes semilunaria*) and spittle bug (*Cloira bipurctata*) are important. Like diseases, the crop is not much damaged by the insects. However, if infestation of pests becomes serious, botanical pesticides may be applied.

- 6.12. Harvesting: Harvesting of tender crop is not advisable as oil and citral content remain in the lower side. Over mature and dried leaves also do not yield good oil. Under good rainfall areas first harvesting can be done at 3-4 months after transplanting. Thereafter, the crop can be harvested at a regular interval of 55-60 days. A total of 3-4 harvests in the first year and 4-5 in subsequent years are possible. Crop is harvested with sickle at 10-15 cm above ground level. Harvesting should not be scheduled at rain. Oil yield is increased with the age reaching maximum at third to fourth year. Citral content of oil also increases with age of the crop. A well-maintained cultivation can provide economic returns up to 5 years. Flowering shoots need to be removed to reduce biological degeneration.

- 6.13. Processing: Oil in the herbage is distilled by hydro-distillation. Depending upon the distillation unit, complete distillation takes 3-6 hours. Chopping the grass before loading in the still for distillation allows packing of 40-45% more material and about 10% increase in oil yield with savings of fuel. Anhydrous sodium sulphate may be added in the oil and should be allowed to stand overnight and filtered to remove moisture and insoluble particles. To clean the dark coloured oil steam rectification can be done. Oil should be stored in glass bottles or container made of stainless steel, GI, aluminium, etc depending upon the quantity.
- 6.14. Expected yield: Fresh herbage yield of 25-40 tonnes are obtained from 1 hectare per year. An oil yield of 80-100 kg is expected from 1 hectare.

## 7. Quality evaluation of essential oil

According to IS-327-1991, lemongrass oil should have the following characteristics

Colour and appearance	: Dark yellow to light brown, mobile liquid
Odour	: Lemon like
Relative density at 27°C	: 0.886-0.896
Optical rotation	: (-)3° to (+)1°
Refractive index at 27°C	: 1.4774 to 1.4834
Citral content % by volume minimum	: 75
Solubility	: 3 volume of ethyl alcohol (70%) occasionally with slight turbidity

## 8. Comparative summary table of the characteristics of different cultivated strains

Varieties	Characters
Sugandhi (OD 19)	A red stemmed variety with plant height 1-1.75 m and profuse tillering. It is adapted to a wide range of soil and climatic condition. The oil yield ranges from 80-100 kg per ha with 85-88% citral under rain-fed conditions. Aromatic and Medicinal Plants Research Station, Odakkali, Kerala released this variety.

Varieties	Characters
Pragati (LS 48)	It is a tall growing variety with dark purple leaf sheath suitable for north Indian Plains and Tarai belt of subtropical and tropical climate. Average oil content is 0.63% with 8%. This variety is a clonal selection from OD 19 developed at Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow.
RRL 16	Average yield of this variety is 15-20 tonnes per ha per year giving 100-110 kg oil. Oil content varies from 0.6-0.8% with 80% citral. Evolved from <i>C. pendulus</i> and released for cultivation from Regional Research Laboratory (RRL), Jammu.
CKP 25	A hybrid between <i>C. khasianum</i> x <i>C. pendulus</i> . Gives 60 tonnes per ha herbage in North Indian plains under irrigation. Oil contains 82-85% citral.
Praman (Clone 29)	Evolved through clonal selection at CIMAP, Lucknow and belongs to species <i>C. pendulus</i> . It is a medium sized variety with erect leaves and profuse tillering. The oil yield is high with 82% citral. It was developed at RRL, Jammu.
Jama Rosa	Selection from interspecific cross, very hardy with vigorous growth. The variety yields about 35.0 tonnes per hectare of herbage containing 0.3-0.4% oil. The variety yields up to 300 kg oil in 4-5 cuts in 16-18 months growing period (RRL Jammu).
Chirharit	An evergreen variety gives oil yield of 250-260 kg per ha with citral content 75-82%. The variety is developed by CIMAP, Lucknow

## 9. Cultivation calendar

The crop can be planted after winter (February-March) or during the rainy season. However, following cultivation calendar have been prepared to utilise the monsoon rainfall for the better establishment and will provide general guidelines for cultivation of lemongrass. Its is not advisable for anyone to strictly adhere to the proposed schedule for individual months considering the varying climatic and weather conditions prevailing in various regions of the country. One has to exercise due diligence in raising the crop according to the available resources at his/her disposal.

Major activity	Month	Activity details
Land preparation	May-June	Land preparation and application of FYM & basal dose of N-P-K
Plantation	June-July	Transplanting of slips
Intercultural operations	July-August	Two times weeding and hoeing to suppress the weed growth
First harvest	September-October	Harvesting and post-harvest activity – distillation of essential oil
Irrigation and Fertilizer application	September-October	One supplemental irrigation (if it does not rain) and top dressing of N after harvesting
Intercultural operations	October	One weeding and hoeing 15-20 days after harvest to suppress the weed growth
Second harvest	November-December	Harvesting and post-harvest activity – distillation of essential oil
Irrigation and Fertilizer application	November-December	One supplemental irrigation (if it does not rain) and top dressing of N after harvesting
Intercultural operations	December	One weeding and hoeing 15-20 days after harvest to suppress the weed growth
Third harvest	February-March	Harvesting and post-harvest activity – distillation of essential oil
Irrigation and Fertilizer application	February-March	One supplemental irrigation (if it does not rain) and top dressing of N after harvesting
Fourth harvest	May-June	Harvesting and post-harvest activity –distillation of essential oil
Irrigation and Fertilizer application	May-June	One supplemental irrigation (if it does not rain) and top dressing of N after harvesting
Intercultural operations	June	One weeding and hoeing 15-20 days after harvest to suppress the weed growth

As this crop can be maintained for 3-5 years, the above schedule shall be followed for the remaining period with suitable alterations.

