INSTITUTIONAL TRAINING REPORT
ON
CULTIVATION AND PROCESSING OF AROMATIC PLANTS

COLLEGE OF HORTICULTURE
V.C.S.G UTTARAKHAND UNIVERSITY OF HORTICULTURE & FORESTRY
BHARSAR, PAURI GARHWAL, UTTARAKHAND – 246 123

SUBMITTED BY

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(B.Sc. 4th year)

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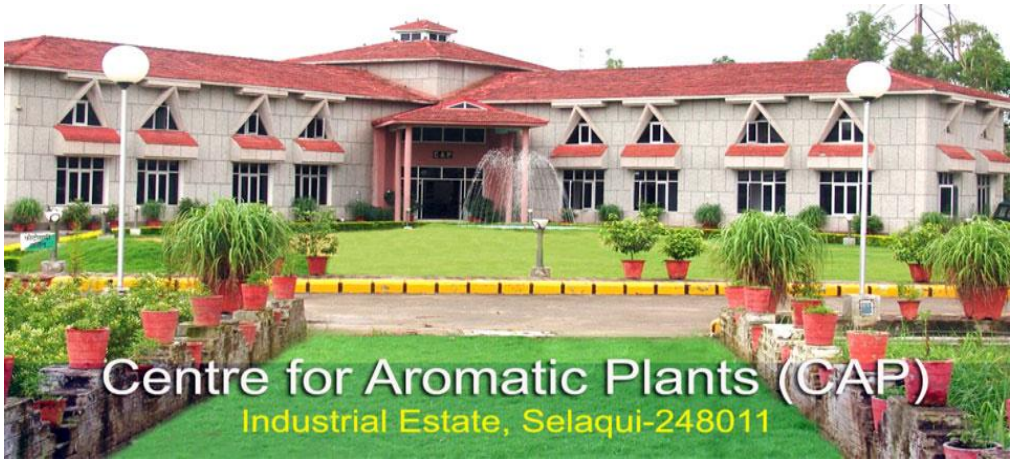

Centre for Aromatic Plant (CAP)

(Government of Uttarakhand)

Industrial Estate Selaqui - 248011, Dehradun , Uttarakhand

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CONTENTS

Introduction

- Cultivation of Aromatic Crops seems to be a viable solution for raising the economy of the farmers of uttarakhand as aromatic crops can be grown successfully in stress and adverse conditions.
- The State Government in 2003 declared Uttarakhand as a ***"Herbal State".***
- The State has established the Centre for Aromatic Plants (CAP) at Selaqui in district Dehradun as a nodal agency of Aromatic sector for large scale cultivation, processing and marketing of aromatic produce and essential oils in the state.
- These benefits have been generated with the help of the Centre for Aromatic Plants (CAP) that works on aromatic plants used in cosmetics, soaps, and perfumes.
- Intercropping of aromatic plants with food grains can also help diversify the income basket for small and marginal farmers.
- Efforts have been made to develop aromatic sector in uttarakhand as a major driver for upliftment of rural economy and to achieve this goal.
- Centre for Aromatic Plants (CAP) was conceived in 2003 at Selaqui, Dehradun. It was registered under society act -1860 by Govt. of Uttarakhand.
- CAP is steering multi-disciplinary high quality research and extension activities in the field of aromatic plants with head quarter Selaqui (Dehradun).
- CAP has been developed in such a way where all the required facilities for the research and provide the motivation to all the farmers.

DEFINITION OF AROMATIC PLANTS :

Aromatic plants are those plants which are rich in secondary metabolites and contains essential oils or Plants that produce and exude aromatic substances (largely ether oils) , which are used in making perfumes , in cooking , and in food , pharmaceutical ,and liquor industries.

Essential oils are mainly complex mixture of acyclic and monoterpenoids.

SOURCES OF NATURAL ESSENTIAL OIL

Essential oils are generally derived from one or more plant parts, such as flowers (e.g. rose, jasmine, carnation, clove, mimosa, rosemary, lavander), leaves (e.g. mint, *Ocimum* spp., lemongrass, jamrosa), leaves and stems (e.g. geranium, patchouli, petitgrain, verbena, cinnamon), bark (e.g. cinnamon, cassia, canella), wood (e.g. cedar, sandal, pine), roots (e.g. angelica, sassafras, vetiver, saussurea, valerian), seeds (e.g fennel, coriander, caraway, dill, nutmeg), fruits (bergamot, orange, lemon, juniper), rhizomes (e.g. ginger, calamus, curcuma, orris).

EXTRACTION METHODS OF NATURAL ESSENTIAL OILS :

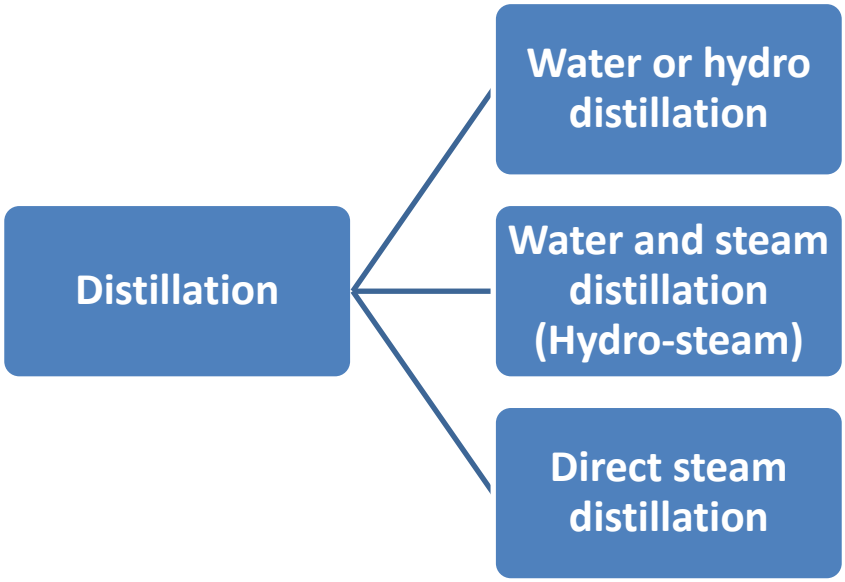
Essential oils are used in a wide variety of consumer goods such as detergents, soaps, toilet products, cosmetics, pharmaceuticals, perfumes, confectionery food products, soft drinks, distilled alcoholic beverages (hard drinks) and insecticides. The world production and consumption of essential oils and perfumes are increasing very fast. Production technology is an essential element to improve the overall yield and quality of essential oil. The traditional technologies pertaining to essential oil processing are of great significance and are still being used in many parts of the globe. Water distillation, water and steam distillation, steam distillation, cohobation, maceration and enfleurage are the most traditional and commonly used methods.

METHODS OF PRODUCING ESSENTIAL OILS

Regarding hydrodistillation, the essential oils industry has developed terminology to distinguish three types: water distillation; water and steam distillation; and direct steam distillation.

Distillation

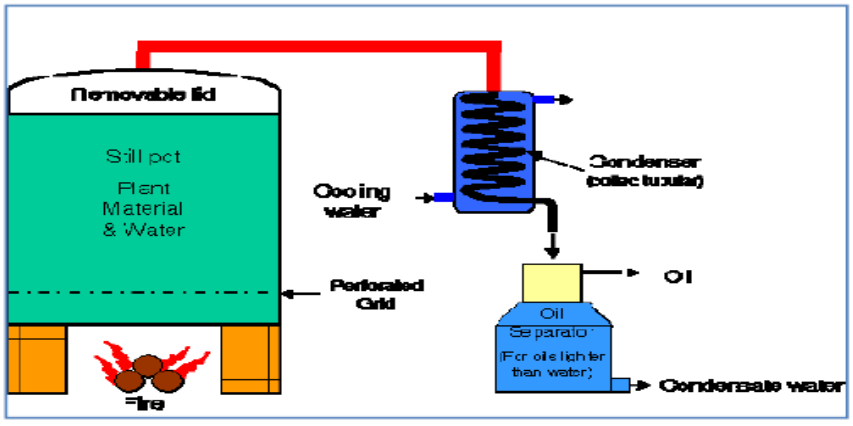
In this process the aromatic plant material is packed in a still and a sufficient quantity of water is added and brought to a boil; alternatively, live steam is injected into the plant charge. Due to the influence of hot water and steam, the essential oil is freed from the oil glands in the plant tissue. The vapor mixture of water and oil is condensed by indirect cooling with water. From the condenser, distillate flows into a separator, where oil separates automatically from the distillate water. There are three types of distillation for isolating essential oils from plant materials:



1. Hydrodistillation

In this method, the material is completely immersed in water, which is boiled by applying heat by direct fire. The main characteristic of this process is that there is direct contact between boiling water and plant material. The laboratory apparatus recommended for

trial distillations is the Clevenger system. During water distillation, all parts of the plant charge must be kept in motion by boiling water; this is possible when the distillation material is charged loosely and remains loose in the boiling water. For this reason only, water distillation possesses one distinct advantage, i.e. that it permits processing of finely powdered material or plant parts that, by contact with live steam, would otherwise form lumps through which the steam cannot penetrate. Other practical advantages of water distillation are that the stills are inexpensive, easy to construct and suitable for field operation. These are still widely used with portable equipment in many countries. The main disadvantage of water distillation is that complete extraction is not possible. Besides, certain esters are partly hydrolyzed and sensitive substances like aldehydes tend to polymerize. Water distillation requires a greater number of stills, more space and more fuel. It demands considerable experience and familiarity with the method. The high-boiling and somewhat water-soluble oil constituents cannot be completely vaporized or they require large quantities of steam. Thus, the process becomes uneconomical. For these reasons, water distillation is used only in cases in which the plant material by its very nature cannot be processed by water and steam distillation or by direct steam distillation.



2. Water and Steam Distillation

In water and steam distillation, the steam can be generated either in a satellite boiler or within the still, although separated from the plant material. Like water distillation, water and steam distillation is widely used in rural areas. Moreover, it does not require a great deal more capital expenditure than water distillation. Also, the equipment used is generally similar to that used in water distillation, but the plant material is supported above the boiling water on a

perforated grid. In fact, it is common that persons performing water distillation eventually progress to water and steam distillation.

Advantages of Water and Steam Distillation over Water Distillation

- ✓ Higher oil yield.
- ✓ Components of the volatile oil are less susceptible to hydrolysis and polymerization (the control of wetness on the bottom of the still affects hydrolysis, whereas the thermal conductivity of the still walls affects polymerization).
- ✓ If refluxing is controlled, then the loss of polar compounds is minimized.
- ✓ Oil quality produced by steam and water distillation is more reproducible.
- ✓ Steam and water distillation is faster than water distillation, so it is more energy efficient. Many oils are currently produced by steam and water distillation, for example lemongrass is produced in Bhutan with a rural steam and water distillation system.

Disadvantages of Water and Steam Distillation

- ✓ Due to the low pressure of rising steam, oils of high-boiling range require a greater quantity of steam for vaporization -hence longer hours of distillation.
- ✓ The plant material becomes wet, which slows down distillation as the steam has to vaporize the water to allow it to condense further up the still.

3. Direct Steam Distillation

As the name suggests, direct steam distillation is the process of distilling plant material with steam generated outside the still in a satellite steam generator generally referred to as a boiler. As in water and steam distillation, the plant material is supported on a perforated grid above the steam inlet. A real advantage of satellite steam generation is that the amount of steam can be readily controlled. Because steam is generated in a satellite boiler, the plant material is heated no higher than 100° C and, consequently, it should not undergo thermal degradation. Steam distillation is the most widely accepted process for the production of essential oils on large scale. Throughout the flavor and fragrance supply business, it is a standard practice. An obvious drawback to steam distillation is the much higher capital

expenditure needed to build such a facility. In some situations, such as the large-scale production of low-cost oils (e.g. rosemary, Chinese cedarwood, lemongrass, litsea cubeba, spike lavender, eucalyptus, citronella, cornmint), the world market prices of the oils are barely high enough to justify their production by steam distillation without amortizing the capital expenditure required to build the facility over a period of 10 years or more.

Advantages of Direct Steam Distillation

- ✓ Amount of steam can be readily controlled.
- ✓ No thermal decomposition of oil constituents.
- ✓ Most widely accepted process for large-scale oil production, superior to the other two processes.

Disadvantage of Direct Steam Distillation

- ✓ Much higher capital expenditure needed to establish this activity than for the other two processes.

Essential Oil Extraction by Expression

Expression or cold pressing, as it is also known, is only used in the production of citrus oils. The term expression refers to any physical process in which the essential oil glands in the peel are crushed or broken to release the oil.

SOME IMPORTANT AROMATIC PLANTS AND THEIR INFORMATION

S. No.	Common Name	Botanical Name	Family	Plant part used	Major constituents	Uses
1.	Davana	*Artimesia pallens*	Asteraceae	leaves	hydrocarbons	Bouquets, cosmetics
2.	Geranium	*Pelargonium graveolens*	Geraniaceae	Leaves and flowers	geraniol	Perfumes ,powders
3.	Japanese mint	*Mentha arvensis*	Labiatae	leaves	Menthol,linalool	Scenting in the supari
4.	Damask rose	*Rosa damasena*	Rosaceae	flowers	Citronellol	Rose oil
5.	Lemon grass	*Cymbopogon flexuosus*	Gramineae	leaves	Citral	Lemon tea
6.	Patchouli	*Pogostimon patchouli*	Laminaceae	leaves	patchouliol	Fixative property
7.	Vitiver grass	*Vitiveria*	Viteveraceae	roots	viteverol	Carminative

		zizanoides				property
8.	Java citronella	*Cymbopogon winterianus*	Graminae	leaves	citronellal	Mosquito repellants
9.	Palmrosa grass	*Cymbopogon martini*	Graminae	leaves	geraniol	Soaps
10.	Keweda	*Pandanus fassicularis*	Pandanaceae	flowers	lipulin	Kewada water
11.	Jamalagota	*Croton tiglium*	euphorbiaceae	fruits	-	Violent purgative
12.	Indian basil	*Occimum basilium*	lamiaceae	leaves	Methyl chavicol	Flavouring

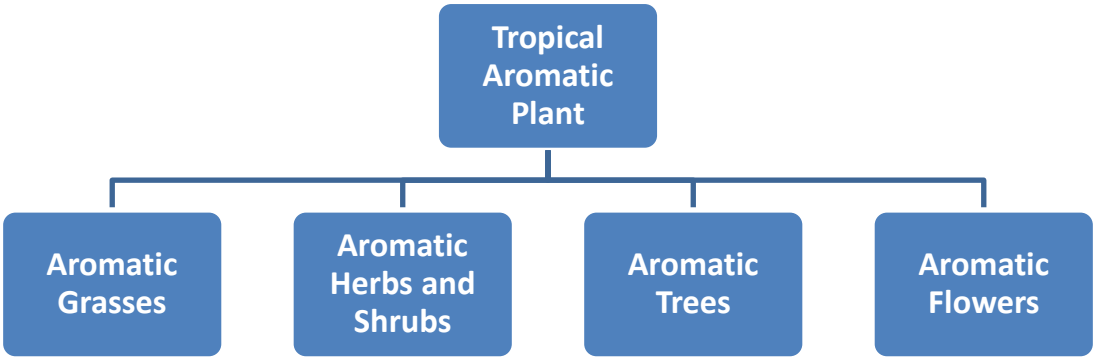
Classification of aromatic Plant

❖ Classification of aromatic plant based on their scented plant Part

1. **Plant with scented leaves :**
   Artimesia pallens , Mentha sp. , Pogostimon patchouli , Abies balsamea , A. pindrow , Aegle marmelos , Eucalyptus globuls, Melissa officinalis , Racinus communis
2. **Plant with scented young twigs , flowering tops , needles and adherent leaves :**
   Abies alba , Aegle marmelos , Cupressus sempervirens ,Eucalyptus sp. , Pinus sp. ,
3. **Plant with scented flowers :**
   Rosa domascena , Pelargonium graveolens , Humulus lupulus , Acacia cavenina , A. faresiana , Anthemis nobilis ,Boronia megastigma , Cannagium odoratus
4. **Plant with aromatic wood :**
   Aquilaria agallocha , Balnesia sermienti , Betula lenta , Cedrus deodara , Ocotea cymbarum,
5. **Plant with aromatic bark :**
   Altingia excels , Betula lanta , Croton eluteria , Guglans regia ,
6. **Plant with aroamatic gums :**
   Abies grandis , Amyris punctate ,Canarium villosus , C. cypricus , c. edule
7. **Plant with scented underground parts :**
   Acorus calamus , Allium cepa , Costus speciosus , Valeriana officinalis
8. **Plant with scented fruits and berries :**
   Aegle marmelos , Atherosperma moschata , Bersera delpechiana
9. **Fruit with scented Peel:**
   Citrs lemon and C. limenttioides
10. **Plants with aromatic seeds :**
    Apium graveolens , Abelmoschus moschatus ,Anethum graveolens , Brassica nigra , Carum ajowan
11. **All Part of Plants Scanted :**
    Rosemarius officinalis , Melissa officinalis , Anthemis Sp., Artemisia diff . Species ,Ocimum sp., Mentha sp.,

❖ TROPICAL AROMATIC CROPS :

Four broad groups are as follows:-



a) Aromatic grasses: Lemongrass, palmarosa, citronella, vetiver.

b) Aromatic herbs and shrubs: Mints, ocimums, patchouli, rosemary, clarysage, thyme, celery, coriander, cumin, fennel, ajowan, davana, chamomile, geranium, cardamom, ginger, kacholam.

c) Aromatic trees: Sandalwood, eucalyptus, clove, camphor, cinnamon, nutmeg, linaloe.

d) Aromatic flowers: Rose, jasmine, tuberose, marigold, champaca.

Essential oil in Therapeutics (In Aromatherapy):

Aromatherapy means treatment or prevention of disease by use of essential oils.

Lavender oil: increases alpha waves in the brain and helps us to relax

Jasmine oil: increases beta waves associated with increased alert state

i) Generally essential oil are utilised in aromatherapy as Inhalants ,Bathing, and Massage

ii) Common medicinal properties of essential oils include: analgesic, antimicrobial, antiseptic, anti-inflammatory, astringent, sedative, antispasmodic, expectorant, diuretic, and sedative.

Commercially important Essential oils for creation of perfume

S. No.	Herbs & their Essential oils	Perfumery Note
1.	Bergamot	Sweet freshness, lemony
2.	Lemon grass	Citrus
3.	Cedar wood oil	Use as such in perfume and cosmetic
4.	Citronella oil &hydroxyl citronellol	Directly used in perfume
5.	Clover leaf oil	Spicy
6.	Geranium oil	Fine perfumery Rose base
7.	Jasmine	Most precious floral use

MAJOR THERAPEUTIC PROPERTIES OF SOME COMMON ESSENTIAL OIL

Sl. No.	Therapeutic properties	Oils	Botanical Name
1.	Sedatives	Sandal wood	*Santalum album*
		Lavender	*Lavandula officinalis*
		Bergamot	*Cirus bergamia*
		Chamomile	*Matricaria chamomilla*
		Sweet marjoram	*Majorana hortensis*
2.	CNS stimulant	Basil	*Ocimum basilicum*
		Clove	*Syzgium aromaticum*
		Jasmine	*Jasminum officnale*
		Peppermint	*Mentha piperita*
		Ylang Ylang	*Cananga odorata*
		Chamomile	*Matricaria chamomilla*
		Achillea	*Achillea millefolium*
		Cajuput	*Melaeeuca leucadendron*
3.	Adaptogen	Geranium	*Pelargonium graveolens*
		Ylang Ylang	*Cananga odorata*
4.	Bronchitis	Eucalyptus	*Eucalyptus globulus*
		Angelica	*Angelica archangelica*
		Ginger	*Zingiber officinale*
		Black pepper	*Piper nigrum*
		Pumilio pine	*Pinus mugo*
5.	Antiseptic	Geranium	*Pelargonium graveolens*
		Sandal wood	*Santalum album*
		Thyme	*Thymus vulgaris*
6.	Antistress	Cedarwood	*Cedrus deodara*
		Borneol	*Drybalanops aromatica*
		Lemon	*Citrus lemon*
		Patchouli	*Pogestmone patchouli*
7.	Muscle relaxant	All spice	*Pimento dioica*

8.	Carminative	Dill Spearmint Peppermint Chamomile Ajowan Caraway Fennel Thyme	*Anethum graveolens* *Mentha spicata* *Mentha piperita* *Matricaria chamomilla* *Trachyspermum ammi* *Carum carvi* *Foeniculum vulgare* *Thymus vulgaris*
9.	Haemostatic	Achillea	*Achillea millefolium*
10.	Antispasmodic	Clove Thyme	*Syzgium aromaticum* *Thymus vulgaris*
11.	Analgesic	Clove	*Syzgium aromaticum*
12.	Prostaglandin inhibitor	Nutmeg	*Myristica fragrans*

Storage conditions oils:

- ✓ Essential oil must be stored in dark, airtight, glass bottles.
- ✓ All essential oil needs to be kept cold the ideal temperature for storage is 25-30 degree Celsius.
- ✓ Any essential oil should first be treated to remove metallic impurities , free from moisture and clarified and then be stored in well filled , tightly close containers at low temperature and Protected from light.
- ✓ Bottles of hard and dark coloured glass are suitable for small quantities of oil but larger quantities have to be stored in metal drums heavily lined if possible.
- ✓ A layer of carbon dioxide or nitrogen gas is blown into the container before it is sealed will replace the layer of air above the oil and there by assure added protection against oxidation.

Chromatography:

Chromatography is a method used by scientists for separating organic and inorganic compounds so that they can be analyzed and studied. By analyzing a compound, a scientist can figure out what makes up that compound. Chromatography is a great physical method for

observing mixtures and solvents. Chromatography is a process in which we identify organic and inorganic compounds and also identification, purification and separation of these compounds. The word chromatography means **"color writing"** which is a way that a chemist can test liquid mixtures. While studying the coloring materials in plant life, a Russian botanist invented chromatography in **1903**. His name was **M.S. Tswett.**

Classification of Chromatographic Methods

- Planar Chromatographic
- Paper Chromatographic
- Thin layer Chromatographic (TLC)
- Column Chromatographic
- Gas chromatography
- High performance liquid chromatography
- Ion chromatography
- Supercritical fluid chromatography

Type of Chromatography	Applications in the Real World	Why and What is it
Liquid Chromatography	Test water samples to look for pollution	Used to analyze metal ions and organic Compounds in solutions. It uses liquids which may incorporate hydrophilic, insoluble molecules.
Gas Chromatography	Detect bombs in airports, identify and quantify such drugs as alcohol, used in forensics to compare ibers found on a victim	Used to analyze volatile gases. Helium is used to move the gaseous mixture through a column of absorbent material.
Thin-Layer Chromatography	detecting pesticide or insecticide residues in food, also used in forensics to analyze the dye composition of fibers	Uses an absorbent material on flat glass plates. This is a simple and rapid method to check the purity of the organic compound.
Paper Chromatography	separating amino acids and anions, RNA fingerprinting, separating and testing histamines, antibiotics	The most common type of chromatography. The paper is the stationary phase. This uses capillary action to pull the solutes up through the paper and separate the solutes.

Cultivation Techniques:

Lemon Grass

Lemon grass ***(Cymbopogon flexuosus)***, family Poaceae, is the source of lemon grass oil obtained from the leaves and shoots of the plant. Lemon grass oil is mainly used in the manufacture of perfumes for soaps, hair oils, scents and medicines. It also has antibacterial properties. Ionone prepared from the citral present in lemon grass oil was one of the most important raw materials for the preparation of Vitamin A. In addition to its use in perfumery, Ionone is used in certain kinds of confectionary and liquors. The oil can be used to improve the flavour of some fish and can be used to flavour wines and sauces. It can be used for headache, tooth aches, baths, and as a diuretic agent for fever.

Origin and Distribution:

The species is considered to have originated in India. It grows wild in many tropical and subtropical parts of Asia, Africa and America. .

Varieties: *Sugandhi,* Pragathi, *Praman*.

Soil Requirement: Rich loam to poor laterite.

Climate Requirement:

It requires a warm, humid climate with plenty of sunshine and a rainfall ranging from about 200-250cm.

Propagation Method: Lemon grass is generally propagated through seeds, vegetative propagation and rooted slips.

Nursery Raising:

For raising the seedlings required for planting 1ha of land, a 1000m area is required. The area is well prepared and raised beds of 1 to 1.5m width and convenient length are made. The recommended seed rate is 3 to 4 kg/ha. The seeds are uniformly broadcasted on the beds and are covered with a thin layer of soil, followed by watering at regular intervals. The seeds collected during the month of January – February are usually sown in the nursery during April – May.

Transplanting: A wider spacing of 60cm x 45cm for seedlings and 90 cm x 60 cm for slips has been recommended for fertile, irrigated land under North Indian conditions.

Manures and Fertilizers Requirement:

Lemon grass required 275 kg N, 25 kg P_2O_5 and 175 kg K_2O/ha/annum).

Harvesting and Yield:

The crop is perennial in nature and gives good yields for 5 years. Harvesting is done by cutting the grass 10cm above the ground level. During the first year of planting 3 cuttings are obtained and subsequently, 5-6 cuttings per year are taken subject to weather conditions. The harvesting season begins in May and continues till the end of January. The first harvest is done about 90 days after planting. The interval from sowing to harvest exerts a considerable influence on the yield and the quality of oil. Both immature and over mature grass gives a lower quantity of oil. For the local type of lemon grass, the optimum interval is 40-50 days. The optimum period of harvesting, when grown on hill tops and low lying areas are 60 and 55 days, respectively. Herbage yield 15t/harvest and oil recovery about 0.3 – 0.5% from fresh grass can be expected. The oil is obtained by steam distillation. Oil yield of about 350- 400 kg/ha from the second year onwards is considered satisfactory.

Factors influencing the oil –yield:

The factors influencing the oil production during distillation are: i) Storage of the plant material ii) Treatment of the material iii) The method of distillation. The cut grass is kept in a dry atmosphere with limited air circulation. The grass when stored in the shade can increase the oil recovery up to 96 hours and storage for a further period will only decrease the oil yields. The essential oils are enclosed in the oil glands, oil sacks and glandular hairs of the plant. Therefore before distillation, the plant material must be cut into small pieces to enable them to directly expose as many oil glands as is practically possible. Once the plant material has been reduced in size it must be distilled immediately. Otherwise, the essential oil being volatile will be lost by evaporation. Dipping the chopped lemon grass in sodium chloride solution for 24 hr at 1-2 % concentration before distillation has been found to increase the citral content.

Mint (*Mentha* sp)

Botanical Name: Mints (Mentha sp)
Family: Lamiaceae

Description of the Species of Mint

M. arvensis (Japanese mint) is a downy, perennial herb, spreading by root-stocks which creep along the ground or just under the surface and root at the nodes. There are three horticultural varieties in this species.

M. piperita spreads by a system of branching, underground rootstocks and grows to a height of 45 to 90 cm (l.5 to 3 ft).

M. citrata grows up to 30-60 cm height, with decumbent branches and erect ends. The leaves are 1.25-5.0 cm long, thin, bronzy-green, petiolate; smooth.

Varieties:

A) Japanese Mint: *Himalaya, Kalka, Shivalik, Kosi*

B) Peppermint: *Kukrail*

C) Bergamot Mint: *Kiran.*

D) Spearmint: Punjab *spearmint-l*

Cultivation Soil: Medium to fertile deep soil, rich in humus is ideal for the cultivation of mint. A pH range of 6-7.5 is best.

Climate Requirement:

Japanese mint can be grown in all tropical and subtropical areas under irrigation. However, it does not tolerate damp winters which cause root-rot. A temperature of 20-25°C promotes vegetative growth, but the essential oil and menthol are reported to increase at a higher temperature of 30°C under Indian conditions. Peppermint and spearmint cannot be grown profitably in tropical and subtropical area. Bergamot mint can be grown both in temperate as well as sub-tropical areas.

Propagation Method: Mints are propagated through the creeping stolons or suckers.

Planting: The stolons are cut into small pieces (7-10 cm) and planted in shallow furrows about 7-10 cm deep with a row-to-row distance of 45-60 cm.

Pests and Diseases Management:

A large number of insect pests attack mints. Among them, the important ones are the leaf-roller, pyralid, the hairy caterpillar and termites. These can be effectively con-trolled by the application of 3% Heptafan @ 50 kg/ha to the soil before planting.

Diseases: Rust, powdery mildew, wilt, leaf-blight

Harvesting:

Harvesting of Japanese mint is generally harvested after 100-120 days of planting, when the lower leaves start turning yellow. o If the harvesting is delayed the leaves start falling, resulting in loss of oil. Further, harvesting should be done in bright sunny weather. o Harvesting consists of cutting the green herb by means of a sickle 2-3 cm above the ground. A second harvest is obtained about 80 days after the first harvest and the third one after about 80 days from the second harvest. o Whereas, in peppermint, spearmint and bergamot mints which are grown in temperate climates, the first crop is ready by the end of June and the second in September or October. A good crop of Japanese mint can give as high a yield as 48 t/ha of fresh herb. However, the average yield of mints from three cuttings is 20-25 t/ha. The fresh herb contains 0.4 % oil.

Distillation and Storage of Oil:

Mint oil is obtained by distilling either the fresh or the dry herb. The distillation is done both in primitive and modern stills; in the former the principle of water and steam-distillation is followed, while in the latter steam generated in a separate boiler is employed. The stems are removed from the dried material prior to distillation, because they constitute 30 to 50 % of the material and contain only traces of the oil. The average yield of oil is 50-70 kg/ha. Although bergamot mint as well as Japanese mint gives an average yield of 70-100 kg/ha, the yield of peppermint oil is lower with an average of 50 kg/ha.

Storage of oil Mint oil is a light and golden-coloured, motile liquid and it should be completely free from moisture before storage. It is stored in large steel, galvanized steel or

aluminum containers, filled up to the brim to protect against any air remaining inside and placed in a cool storage godown, away from light and humidity.

Field Work and Daily Dairy

1. INTERACTION

We interact with the scientists co-in charge, Scientists, RA, JRF, Field Staff . they tell us future prospects about the aromatic sector, uses of essential oils in public and private sector. They also tells us about the cultivation practices of different aromatic plants like geranium, lemon grass, artemesia, etc.

2. IDENTIFICATION

We identify the different aromatic plants on the basis of their morphology like leaves, fruits, stems, flowers, etc.

3. SOIL SAMPLING

In this we make the Layout in the artemesia field. We also Collect the soil samples from artemesia field according to their replication and filling them with respect to their accession no.74&76.

4. GAP FILLING

Gap filling of Salvia is done in the field with the help of farmer. In this process there are some plants missing in the field of Salvia and we transplant some new seedlings in the empty space.

5. NURSERY RAISING OF ARTEMESIA

Firstly we take a crate and then mix it with soil and compost. After that we take sand (500gm) and put the artemesia seeds into it. And mix it properly. Seed is broadcasted into the crate. Then we cover it with a thin layer of coco-peat. At last we sprinkled it with the water.

6. TAGGING

We tied up the crates of different accession no. with the help of tags and mention the dates, replication and accession no. into it.

7. PREPARATION OF ESSENTIAL OILS

We also prepare the essential oils of lemon grass and geranium in the distillation unit. For lemon grass, we take a dry lemon grass (10q) and put it in the distillation unit (10q) with the help of workers. Then fire should be given and water should be given with the help of pipe connected to the distillation unit. After 1-2 hr. some amount of oil was collected for the purpose of sample. Oil is yellow in colour.

For geranium, in this we use a small unit of distillation of 20kg unit. Preparation is done by putting some amount of water into the unit, after that the geranium plant is kept into it . The total plant material is 15kg. Then the fire is given and after 2-3hrs Oil is collected from the distillation unit. The total oil sample collected is 12ml.

8. CALCULATION OF OIL CONTENT %

We calculate the oil content for geranium crop. We calculate it with the use of formula:-

$$\text{Oil content\%} = \frac{\text{volume of oil obtained}}{weight\ of\ plant\ material} \times 100$$

$$= 12/15 = 0.8\text{ml}$$

9. VISIT TO THE LIBRARY

We visit to the library for collecting the information about the different aromatic plants. We also read different magazines , journals related to aromatic plants.

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