JHARKHAND
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PRODUCTION TECHNOLOGY FOR ORNAMENTAL CROPS, MAPs AND LANDSCAPING

Practical Manual

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Objective: Identification and description of trees and shrubs

Theory:

- Annuals are the group of plants which complete their life cycle in one season or one year.
- They are easy-to-grow plants.
- They vary widely in form, habit, colour and size of flowers.
- They beautify the surroundings and exhibit a good show of blooms at low cost and labour.
- They bring a change in the look of the garden with change in the season and keep gardeners busy in raising them throughout the year.

Selected list of annuals

S. No.	Name of plant & family	Height	Colour of flowers	Time of flowering	Method of propagation	Blooming period	Remarks
1.	*Ageratum* sp. (Floss flower) Compositae	6" – 24"	White, blue	August - September	Seeds	2 ½ - 3 months	Full blooming useful for edging, massing in beds and for mixed borders
2.	*Althaea rosea* (Hollyhock) Malvaceae	4 – 6 ft.	Various colours	August - September	Seeds	9 months after sowing	Large single or double flowers; useful for screens, borders and for background, suited to hills
3.	*Amaranthus* sp. Amaranthaceae	2 – 3 ft.	Various colours	August - September	Seeds	1 ½ - 2 months	Foliage or blooms are different coloured Foliage types: A. tricolor, *A. salicifoliu, A.*

							melancholius ruber
4.	*Antirrhinum majus* Snap-dragon Scrophulariaceae	6" – 18"	Various colours	December - February	Seeds	2 months	For bedding, borders, pots Flower colour - pink, rose, apricot, orange, crimson, white, yellow flowers.
5.	*Callistephes chinensis* (China aster) Compositae	9" – 36"	Various colours	Aug - Sep. and Jan-Feb.	Seeds	2 months	Suited for borders, can be grown throughout the year .
6.	*Coreopsis* spp. (Tick seed) Compositae	12" – 18"	Yellow brown or Crimson brown	Aug - Sep Dec - Jan	Seeds	2 months	For borders and flower beds, flowers single or double; yellow, orange and crimson
7.	*Celosia* spp. Cock's comb Amaranthaceae	9" – 24"	Fasciated flowers of varying colours	Throughout the year	Seeds	2 ½ - 4 months	Suited for , flower colour – red, pink, yellow, white, etc.
8.	*Cosmos bipinnatus* Compositae	2" – 5"	White, crimson, rose & purple	Aug - Sep Dec - Feb	Seeds	2 – 2 ½ months	Popular rainy season annual with graceful foliage, can be grown throughout the year.
9.	*Dendranthema grandiflora* *(Chrysanthemum)* Compositae	18"	Yellow, white, pink, red, etc.	Sep - Oct	Seeds and suckers	2 ½ - 4 months	Hardy annual or perennial single or double flowers, useful for mixed border, bedding and pot culture.
10.	*Dianthus barbatus* *(*Sweet William) Caryophyllaceae	10" – 12"	Various colours	Aug - Sep Dec - Feb	Seeds	2 – 2 ½ months	Popular rainy season annual with graceful foliage, can be grown throughout the year, useful for pots and

							borders
11.	*Gaillardia pulchella* (Blanket flower) Compositae	1" – 1 ½"	Red yellow	Aug - Sep Dec - Feb	Seeds	2 – 2 ½ months	Suitable for beds, borders and as cut flowers; single or double flowered heads.
12.	*Gomphrena globosa* (Globe amaranthus or Bachelor's button) Amaranthaceae	4" – 6"	Pink, Purple & Orange	Throughout the year	Seeds	1 month	Suitable for beds, borders and as cut flowers; thrives well in any garden soil.
13.	*Gerbera jamesonii* (Gerbera) Compositae	6" – 12"	Various colours	Aug - Sep Dec - Feb Apr - May	By divisions or suckers	Throughout the year	Suited for beds and borders, wide range of flower colour.
14.	*Helianthus* sp. Sunflower Compositae	2" – 8"	Yellow with brown (dark) colour	Aug- Sep Dec - Feb Apr - May	Seeds & Cuttings	2 – 2 ½ months	Staking the plants is essential in the case of tall and unbranched varieties.
15.	*Helichrysum* sp. Compositae	10" – 20"	Various colours	Aug - Sep Dec - Feb	Seeds	2 – 3 months	Suited for pots and borders – Everlasting flower.
16.	*Impatiens balsamina* (Balsam) Balsaminaceae	9" – 12"	Rose like and variegated	Aug - Sep	Seeds	2 months	Suited for borders, can be grown throughout the year
17.	*Kochia* Chenopodiaceae	12" – 24"	Minute Brownish Pink	Aug - Sep Dec - Feb Apr - May	Seeds	3 months	Suited for pots and as ornamental leaves for flower arrangements. Green in open sunny situations.
18.	*Lathyrus odoratus* (Sweet pea) Leguminaceae	16" – 18"	Sweet fine colour	Aug - Sep Dec - Feb	Seeds	3 months	Grown in open sunny situations. Suited for hills

				Apr - May			
19.	*Petunia* sp. Solanaceae	18" – 24"	Various colours	Sep - Oct Dec - Jan	Seeds	3 – 4 months	Suited to flower beds, mixed borders, pot plants, window borders and hanging baskets.
20.	*Phlox* Polemoniaceae	12"	Various colours	Sep - Oct Dec - Jan	Seeds	1 month	Suited for beds, pots
21.	*Pimpinella monoica* Lady's Lace	24" – 48"	Small lacy white flowers	Dec – Feb	Seeds	2 months	Coriander like smell of leaves – Small lacy white flowers – Suited for medium high elevations.
22.	*Poppy* *Papaver* sp. Papaveraceae	24" – 48"	Various colours	Dec - Feb	Seeds	2 months	There are four species useful for cut flowers – Suitable for high attitudes.
23.	*Portulaca grandiflora* Portulacaceae	3" – 4"	Various colours	Dec - Feb	Seeds	3 ½ - 4 months	Trailing stem with short thick leaves – Resembles roses – Suited as an edge plant.
24.	*Salvia splendens* Lanbiatae	24" – 30"	Scarlet blue Purple pink	Aug-Sep. Dec-Feb.	Seeds	2 ½ months	Can be grown throughout the year – Suited for beds and borders – Pinching back the shoots in early stages builds up better plants
25.	*Schizanthus* sp. Solanaceae	12" – 18"	Various colours	Aug - Sep Dec - Feb	Seeds	2 ½ months	Cold season annual, pretty foliage of green colour, orchid like flowers of various colours.

26.	*Tagetes erecta* African marigold Compositae	24" – 36"	Yellow orange variegated	Apr - May Sep - Oct	Seeds	3 months	Tall and erect growing annuals, single or double flowers, effective in beds and mixed borders. Flowers are grown on commercial scale also.
27.	*Tagetes patula* (Pot marigold Compositae	24" – 36"	Bright yellow, lemon yellow, orange	Aug - Nov	Seeds	2 – 3 months	Suited for beds and borders
28.	*Tithonia speciosa* (Mexican sunflower) Compositae	48" – 72"	Reddish orange flowers	May - Sep Oct & Dec - Jan	Seeds	3 months	Reddish orange flowers on long stalks, can be grown throughout the year, suitable borders and beds
29.	*Verbena hybrida* Verbenaceae)	6" – 12"	White, purple and pink	Throughout the year	Suckers, cuttings layers	2 ½ months	Trailing plants, annuals and perennials useful in shrubberies, hanging baskets, rockeries, flower beds and in pot culture.
30.	*Vinca rosea* *(Syn: Catharanthus roseus)* (Periwinkle) Apocynaceae	24"	Pure white red	Throughout the year	Suckers, cuttings layers	2 ½ months	Attractive foliage, smooth green leaves, useful for flower beds, plants, borders, rockeries, etc.
31.	*Viola tricolor*(Pansy) Violaceae	6" – 9"	Violet, blue, yellow, white	Dec - Feb	Seeds	2 – 3 months	Suited for borders and pots – Pretty brilliant coloured flowers.
32.	*Zinnia elegans*	12" – 30"	Various colours	Dec - Jan Apr - May	Seeds	2 months	Hardy plant, flowers in profusion for a long period, single or double flowers borne on long stalks. Attractive in

Objective: To study sowing and seed bed preparation.

Theory:

Sowing and Bed preparation

- The seeds of annual flowers are sown in nursery beds, earthen pots, seed pans or wooden seed trays.
- The seeds of a few annuals like sweet pea, morning glory, lupin, nasturtium and hollyhocks which have bold seeds can be sown directly at permanent places.
- The seed compost should consist of one part each of garden soil, coarse sand, farmyard manure and leaf-mould.
- For preparing the nursery beds, the soil should be dug up thoroughly and sufficient farmyard manure should be mixed in soil.
- Raised nursery beds of convenient size (normally 60cm wide and 15cm high) should be prepared.
- If soil is heavy, some quantity of sand may be added. It is better if the soil of nursery bed or earthen pots is sterilized with 2% formalin. For this, soil is drenched with formalin solution and is covered with polythene sheet for 45hr. Then afterwards the polythene is removed and soil is dried before sowing the seeds.
- Before sowing, the seeds should be treated with Cerason (0.2%) and Captaf (0.2%) to prevent the seedlings from damping off disease.
- The seeds should be sown thinly and evenly as thick sowing causes damping off of seedlings.
- Mixing of fine sand in very small seeds is advisable for even sowing.
- The seeds of echium, lobelia and flowering tobacco do not germinate unless first exposed to sunlight, while seeds of nigella and cineraria germinate only in dark.
- The seeds recently harvested from the plant, although given required conditions, fail to germinate.
- This may be due to physical condition or chemical reaction of seed coat of seeds. Seeds of clianthus need stratification or scarification for germination.
- Some seeds require after ripening period for germination. In nursery beds, the seeds are sown in rows spaced 6cm apart.
- Then, they are covered with finely sieved leaf-mould.
- Watering is to be done with a watering can having a fine rose both in beds and pots.
- In beds, when germination is over, water is given for proper moisture.
- Thereafter, the beds should be kept weed-free

Objective: Training and Pruning of Ornamentals

Theory:

General Recommendation

1. Remove all limbs and branches that obstruct walks and drives.

2. Prune back to clear all doors and windows.

3. Remove all broken, diseased, or dead branches from all trees and shrubs.

4. Go back to prune your plants for form, shape, vigor, and beauty!

5. It is usually is best to prune deciduous trees and shrubs during early spring before full leaf.

6. Evergreens, especially shrubs, should where practical, be encouraged to grow and branch to the ground. This not only gives a more healthy plant, but in most cases a much better looking plant.

Purposes of Pruning

1. To control habit of growth.

2. To remove all dead, broken, or diseased plant parts.

3. To produce desired shape and form.

4. To improve flowering and fruiting.

5. To improve chances of survival (usually at transplanting).

Some Pruning Tools

1. Hand Shears (7-1/2 inches long)

2. Pruning Loppers (26 inches long)

3. Pruning Saw (folding)

4. Pole Tree Saw (10 foot handle)

Botany of Pruning

Trees grow, above the ground, primarily from two areas:

1. Branches elongate from buds.

2. Branches increase in diameter from the cambium. Water and mineral nutrients travel up from the roots through the wood or xylem into the leaves. Here, in the leaves, food is manufactured and sent back through the phloem out to feed all parts of the plant, twigs, buds, flowers, roots, etc. If the terminal buds are removed, or twig end cut off side branching is induced, and a more compact habit of growth is obtained. If side branches or laterals are removed, a more upright form results.

Types of Pruning

• Thinning out

• Heading Back

• Bulk Pruning

• Thin wood Pruning

- Thinning out: When a shoot is entirely removed from the point of its origin and no re-growth is allowed to occur from the cut ends.

– do not invigorate the tree

- Heading back: When the terminal portion of branch/shoot is removed and it encourages lateral growth from the remaining shoot.

– In other words, if a portion of a shoot is removed and the growth can develop from the remaining portion.

– Heading back promotes the growth of lower buds as well as several terminal buds below the cut.

– When lateral branches are headed into one year old wood, the area near the cut is invigorated.

– The headed branch is much stronger and rigid, resulting in lateral secondary branching.

- Thin wood pruning: refers to the removal of slow growing, weak, under hanging branches or shoots which are either not fruiting or producing fruits of low quality

Principle of Training

• The principle object in training a young tree is to develop strong framework of scaffold branches.

– All methods of training must stand or fall by their ability to achieve a tree capable of bearing high yielding fruits without undue breakage.

• Trunk: Main stem of the plant.

• Head: Point on the trunk from which first branch arise

• Scaffold branches: Main branches arising from the head are known as scaffold branches.

– Low headed tree: Trees in which scaffold branches arise within 0.7-0.9 m height from ground level. Low headed trees come into bearing comparatively much earlier, are able to resist stormy winds more effectively and their spraying and harvesting expenses are less.

– High headed tree: Trees in which scaffold branches come out from the trunk above 1.2 m. In the tropical climate, high headed trees are unsuitable as their exposed trunks are subjected to sunscald in summer.

• Crotch: The angle made by scaffold limb to the trunk or the secondary branch to scaffold limb is called crotch. The crotch should be broad and not narrow.

• Leader: The main growing branch from ground level upto the tip dominating all other branches.

• Spur: Numerous shoot growth which are abundant over the fruit trees and upon which most of the fruit is borne.

• Water shoots: These are extraordinary vigorous vegetative shoots which grow from the high points on the main branches in upright direction at the expense of main branches.

• Suckers: arise from adventitious buds on the roots or underground parts of the stem of the tree.

Training Systems

•Central Leader

•Open-Centre

•Modified Leader

Central Leader System

•Main trunk extends from the soil surface to the total height of the tree

•Several side branches grow at different heights in various directions.

•Advantages:

–Such trees arestructurally best suited to bear crop load and to resist the damage from strong winds.

•Disadvantages:

–Trees under this system grow too tall and are less spreading.

–Tree management (spraying, pruning, thinning and harvesting) is difficult.

–Shading effect on interior canopy (the lower branches of such trees may be so much in shade that the fruit may not be able to develop proper colour).

Open Centre System

•Main trunk is allowed to grow upto1.0 m by cutting within a year of planting.

•3-5 lateral branches are allowed to develop from short main stem.

•Widely used fro peaches and is good for mechanical harvesting.

•Advantages:

–The trees so trained allowmaximum sunshine to reach their branches.

–Better clourationof fruits on the interior side of the tree.

–Trees are more fruitful and low spreading tree greatly facilitate operations like spraying, pruning, thinning and harvesting.

•Disadvantages:

–Such trees are structurally weak, and their limbs are more likely to break with crop load and strong winds.

–This system does not only need severe pruning to start with but also constant effort to maintain its form through drastic pruning treatment.

Modified Leader System

•This training system is most acceptable for commercial fruit cultivation.

•This system combines the best qualities of the central leader and open centre systems.

•A leader develops on the young tree until it reaches the height of 2-3 m and then the growth is restricted.

•Laterals are selected to ascent in a spiral fashion up the central trunk and are cut until the proper number and distribution of branches have been obtained.

•Advantages:

–The branches are well distributed, allowing plenty of sunshine to reach the interior of the tree.

–The trees isstructurally strong and not prone to limb breakage.

–Owing to limited height of trees, spraying, pruning and harvesting may be done easily.

Objective: Protected structures and their maintenance

Theory:

Cultivation of Ornamentals in Greenhouses:-

- -Protected cultivation is the technique of providing favorable environmental or growth conditions to the plants.
- -In greenhouses, the growing environment is altered to suit the specific requirements of plants.
- It is rather used to protect plants from the adverse climatic conditions by providing optimum conditions of light, temperature, humidity, CO_2 and air circulation for the best growth of plants to achieve maximum yield and best quality.

Types of Greenhouse:-

1. Ground to ground

2. Gable

3. Quonset

4. Modified quonset

5. Tunnels (Fixed or portable)

6. Lath house/ Seran house

7. Lean to greenhouse

Different types of cladding material:-

1. Glass

2. Fiberglass

3. FRP (Fibre Reinforced Plastic)

4. Polythene (Thermo anti drip)

5. PVC (Poly Vinyl Chloride)

6. Polycarbonates sheets

7. Silpauline sheets

Growing conditions:-

1. Temperature (Cooling, heating and shading)

2. Relative humidity (Misting, fogging and watering)

3. Light (Photoperiod and intensity)

4. Air circulation (ventilation)

5. Carbon dioxide

6. Sanitation

Growing systems:-

1. Ground beds

2. Raised beds

3. Benches

4. Pots

Growing Media Characteristics:-

1. Provide adequate nutrients to the crop

2. Support or anchorage the plants grown

3. Good moisture holding capacity

4. Sufficiently porous

5. Not saline

6. Withstand pasteurization with steam or solarization

7. Free from weed seeds, nematodes

Irrigation:-

In greenhouses mostly micro-irrigation technique is followed, which requires pressure and energy to work properly. The different ways to irrigate in greenhouses are given below:

1. Drip irrigation

2. Sprinkler irrigation

3. Jet irrigation, and

4. Spray irrigation

Fertigation:-

It refers to the simultaneous application of water and fertilizers to the root zone of the plants and it refers only to the drip irrigation system under the micro-irrigation technology.

Objective: Processing of MAP

Theory:

Hydrodistillation

In order to isolate essential oils by hydrodistillation, 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.

Mechanism of Distillation

Hydrodistillation of plant material involves the following main physicochemical processes:

i) Hydrodiffusion

ii) Hydrolysis

iii) Decomposition by heat

Hydrodiffusion

Diffusion of essential oils and hot water through plant membranes is known as hydrodiffusion. In steam distillation, the steam does not actually penetrate the dry cell membranes. Therefore, dry plant material can be exhausted with dry steam only when all the volatile oil has been freed from the oil-bearing cells by first thorough comminution of the plant material. But, when the plant material is soaked with water, exchange of vapors within the tissue is based on their permeability while in swollen condition. Membranes of plant cells are almost impermeable to volatile oils. Therefore, in the actual process, at the temperature of boiling water, a part of volatile oil dissolves in the water present within the glands, and this oil-water solution permeates, by osmosis, the swollen membranes and finally reaches the outer surface, where the oil is vaporized by passing steam.

Another aspect of hydrodiffusion is that the speed of oil vaporization is not influenced by the volatility of the oil components, but by their degree of solubility in water. Therefore, the high-boiling but more water-soluble constituents of oil in plant tissue distill before the low boiling but less water-soluble constituents. Since hydrodiffusion rates are slow, distillation of uncomminuted material takes longer time than comminuted material.

Hydrolysis

Hydrolysis in the present context is defined as a chemical reaction between water and certain constituents of essential oils. Esters are constituents of essential oils and, in the presence of water, especially at high temperatures, they tend to react with water to form acids and alcohols.

Therefore, if the amount of water is large, the amounts of alcohol and acid will also be large, resulting in a decreased yield of essential oil. Furthermore, since this is a time-dependent reaction, the extent to which hydrolysis proceeds depends on the time of contact between oil and water. This is one of the disadvantages of water distillation.

Effect of Heat

Almost all constituents of essential oils are unstable at high temperature. To obtain the best quality oil, distillation must be done at low temperatures. The temperature in steam distillation is determined entirely by the operating pressure, whereas in water distillation and in water and steam distillation the operating pressure is usually atmospheric. All the previously described three effects, i.e. hydrodiffusion, hydrolysis and thermal decomposition, occur simultaneously and affect one another. The rate of diffusion usually increases with temperatures as does the solubility of essential oils in water. The same is true for the rate and extent of hydrolysis. However, it is possible to obtain better yield and quality of oils by: (1) maintaining the temperature as low as possible, (2) using as little water as possible, in the case of steam distillation, and (3) thoroughly comminuting the plant material and packing it uniformly before distillation.

Three Types of Hydrodistillation

Three are three types of hydrodistillation for isolating essential oils from plant materials:

1. Water distillation
2. Water and steam distillation
3. Direct steam distillation

Water Distillation

In this method, the material is completely immersed in water, which is boiled by applying heat by direct fire, steam jacket, closed steam jacket, closed steam coil or open steam coil. The main characteristic of this process is that there is direct contact between boiling water and plant material.

When the still is heated by direct fire, adequate precautions are necessary to prevent the charge from overheating. When a steam jacket or closed steam coil is used, there is less danger of overheating; with open steam coils this danger is avoided. But with open steam, care must be taken to prevent accumulation of condensed water within the still. Therefore, the still should be well insulated. The plant material in the still must be agitated as the water boils, otherwise agglomerations of dense material will settle on the bottom and become thermally degraded.

Certain plant materials like cinnamon bark, which are rich in mucilage, must be powdered so that the charge can readily disperse in the water; as the temperature of the water increases, the mucilage will be leached from the ground cinnamon. This greatly increases the viscosity of the water-charge mixture, thereby allowing it to char. Consequently, before any field distillation is done, a small-scale water distillation in glassware should be performed to observe whether any changes take place during the distillation process. From this laboratory trial, the yield of oil from a known weight of the plant material can be determined. 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.

Traditional Method of Producing Attar Using Hydrodistillation

Floral attars are defined as the distillates obtained by hydrodistillation of flowers (such as saffron, marigold, rose, jasmine, pandanus) in sandal wood oil or other base materials like paraffin. Attar manufacturing takes place in remote places because the flowers must be processed quickly after collection. The apparatus and equipment used to manufacture attar are light, flexible, easy to repair, and have a fair degree of efficiency. Keeping in view these facts, the traditional "deg and bhapka" process has been used for centuries and is used even now with the following traditional equipment.

- Deg (still)
- Bhapka (receiver)
- Chonga (bamboo condenser)

Traditional bhatti (furnace)

- Gachchi (cooling water tank)
- Kuppi (leather bottle)

Disadvantages of Water Distillation

- Oil components like esters are sensitive to hydrolysis while others like acyclic monoterpene hydrocarbons and aldehydes are susceptible to polymerization (since the pH of water is often reduced during distillation, hydrolytic reactions are facilitated).
- Oxygenated components such as phenols have a tendency to dissolve in the still water, so their complete removal by distillation is not possible.
- As water distillation tends to be a small operation (operated by one or two persons), it takes a long time to accumulate much oil, so good quality oil is often mixed with bad quality oil.
- The distillation process is treated as an art by local distillers, who rarely try to optimize both oil yield or quality.
- Water distillation is a slower process than either water and steam distillation or direct steam distillation.

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. It follows that once rural distillers have produced a few batches of oil by water distillation, they realize that the quality of oil is not very good because of its still notes (subdued aroma). As a result, some modifications are made. Using the same still, a perforated grid or plate is fashioned so that the plant material is raised above the water. This reduces the capacity of the still but affords a better quality of oil. If the amount of water is not sufficient to allow the completion of distillation, a cohobation tube is attached and condensate water is added back to the still manually, thereby ensuring that the water, which is being used as the steam source, will never run out. It is also believed that this will, to some extent, control the loss of dissolved oxygenated constituents in the condensate water because the re-used condensate water will allow it to become saturated with dissolved constituents, after which more oil will dissolve in it.

Cohobation

Cohobation is a procedure that can only be used during water distillation or water and steam distillation. It uses the practice of returning the distillate water to the still after the oil has been separated from it so that it can be re-boiled. The principal behind it is to minimize the losses of oxygenated components, particularly phenols which dissolve to some extent in the distillate water. For most oils, this level of oil loss through solution in water is less than 0.2%, whereas for phenol-rich oils the amount of oil dissolved in the distillate water is 0.2%-0.7%. As this material is being constantly re-vaporized, condensed and re-vaporized again, any dissolved oxygenated constituents will promote hydrolysis and degradation of themselves or other oil constituents. Similarly, if an oxygenated component is constantly brought in contact with a direct heat source or side of a still, which is considerably hotter than 100° C, then the chances of degradation are enhanced.

As a result, the practice of cohobation is not recommended unless the temperature to which oxygenated constituents in the distillate are exposed is no higher than 100° C. In steam and water distillation, the plant material cannot be in direct contact with the fire source beneath the still; however, the walls of the still are good conductors of heat so that still notes can also be obtained from the thermal degradation reactions of plant material that is touching the sides of the still. As the steam in the steam and water distillation process is wet, a major drawback of this type of distillation is that it will make the plant material quite wet. This slows down distillation as the steam has to vaporize the water to allow it to condense further up the still. One way to prevent the lower plant material resting on the grid from becoming waterlogged is to use a baffle to prevent the water from boiling too vigorously and coming in direct contact with the plant material.

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 Hydrolytic Maceration Distillation

Certain plant materials require maceration in warm water before they release their essential oils, as their volatile components are glycosidically bound. For example, leaves of wintergreen (*Gaultheria procumbens*) contain the precursor gaultherin and the enzyme primeverosidase; when the leaves are macerated in warm water, the enzyme acts on the gaultherin and liberates free methyl salicylate and primeverose. Other similar examples include brown mustard (sinigrin), bitter almonds (amygdalin) and garlic (alliin).

Modern (Non-traditional) Methods of Extraction of Essential Oils

Traditional methods of extraction of essential oils have been discussed and these are the methods most widely used on commercial scale. However, with technological advancement, new techniques have been developed which may not necessarily be widely used for commercial production of essential oils but are considered valuable in certain situations, such as the production of costly essential oils in a natural state without any alteration of their thermosensitive components or the extraction of essential oils for micro-analysis. These techniques are as follows:

• Headspace trapping techniques
- Static headspace technique
- Vacuum headspace technique
- Dynamic headspace technique

• Solid phase micro-extraction (SPME)
• Supercritical fluid extraction (SFE)
• Phytosol (phytol) extraction
• Protoplast technique
• Simultaneous distillation extraction (SDE)
• Microwave distillation
• Controlled instantaneous decomposition (CID)
• Thermomicrodistillation
• Microdistillation
• Molecular spinning band distillation
• Membrane extraction

Objective: Intercultural operations in flowers and MAP.

Theory:

Weed Control :

Weeding and hoeing are yield generally done manually as and when required, normally 8-10 times yearly. Crop suffers heavily if timely weeding is not given. Besides, control of weeds the soil is made loose porous to provide aeration.

Pinching :

Pinching refers to the removal of the growing tips of the plant to induce the growth of vegetative laterals. It reduces the plant height, promotes axillary branching, delays flowering and helps in breaking rosetting. Pinching is performed both in suckers and in cuttings. It is normally done with thumb and forefinger. For example, pinching is most essential for small flowered chrysanthemum. First pinching is done when the plants reach a height of 15-20 cm with 3-4 pairs of leaves. A second pinching may be necessary if the plants make straggly and lean growth. Two types of pinching are performed in chrysanthemum. In soft pinching the soft tip of the shoot along with 2-3 open leaves is removed while in hard pinching a longer portion upto hard shoot is removed.

In case of standard chrysanthemum only single bloom on a branch is usually allowed to produce. The pinching is not done if only one central bloom is desired on the main branch. Single pinching is done, if two flowers are desired, whereas double pinching is done for four flowers. In spray chrysanthemum numerous small to medium sized flowers are produced, therefore, two pinchings are required to encourage lateral growth. As a general rule rooted cuttings are pinched 2 weeks after planting or approximately 100 days before full bloom.

Disbudding :

This operation is mostly performed for large flowered and decorative type flowers. Foe example, disbudding method vary according to the type of chrysanthemum grown. Many of the varieties are disbud or standard types, in which the largest terminal bud is retained and all axillary buds are removed. Disbudding of spray varieties is very easy because in this case only the large apical bud is removed and the axillary buds are allowed to develop. There is no specific rule for disbudding of spray varieties; it varies with the type of spray produced. When growers want to develop three blooms per plant or one bloom per plant these operations are most essential. Disbudding operations is an important factor in the maintenance of high-quality product

De- suckering :

During the vegetative growth phase, plants grow upwards. New suckers continue to develop from base of plants. For proper and vigorous growth of plants, suckers are removed from time to time.

Weeding and Hoeing :

The field is kept clean by regular weeding and hoeing. When the area is small, weeding and hoeing is done manually. First weeding is completed within three weeks after sowing while the second weeding is done before application of fertilizer as top dressing.

Earthing Up :

Earthing up is practiced when the soil is heavy and deep planting is not possible. It is done when the plants are 20-30 cm in height. The tall plants are staked. Staking is done after the emergence of spikes but before opening of florets. Plants are loosely fastened at three places with the help of jute cord.

Objective: Planning and layout of Garden

Theory:

Principal areas in a home garden:

(1) Public area

(2) Private area

(3) Utility area

Important components:

- For aesthetic value - lawn, shrubs, etc.,
- For utility - vegetables, fruits, etc.,
- Other garden features - path, rock, etc.,

Suitable plants:

Trees:

Shade, fruit trees (guava, papaya, etc.)

As focal point in the centre of lawn - *Araucaria, Thuja, Callistemon*

Shrubs:

- Screening, dividing portions: Bougainvillea

- For colour and variety: Roses

Other garden features:

- Garden path
- Children play area
- Drying cloths
- Steps
- Compost pit

For round-the-year flowering:

Shrubs:

 Hibiscus rosasinensis

 Nerium oleander

 Tecoma stans

 Thevitia nerifolia

Trees:

 Cordia sebestina

 Callistemon lanceolatus

Making a plan

 Before any actual garden work is undertaken a master plan has to be prepared according to a scale (1: 15 or 1: 20) in which all the features such as house wall, drive-way, paths, flower beds, shrubbery, etc., are plotted.

 A plan prepared on a printed graph paper is of great help.

 If the garden area is sufficiently large, this can be divided into three areas.

o Approach or Public Area

o Work or Service Area

 Private Garden Area or Living Area

 Selection of plants is made based on the soil type, space availability, etc.

 The different features are then drawn on the paper with a pencil so that this can be erased if alterations are to be made.

 The first thing is to select the materials for the basic framework such as background, screens, trees needed for shade, the doorway and the corner of the house.

 To this the features needed for effects and beauty as for example plants for foundation planting, flower beds, specimen shrubs or trees are added.

 After everything is finalized on paper these are put into practice on the ground with the help of split-bamboo stakes and rubber hose. The trees are represented by bamboo stakes, while the beds and borders can be plotted by bending a rubber hose in the desired pattern, Paths, hedge, or screen area can also be marked with stakes.