

Fundamentals of Horticulture

A Laboratory Manual



Horticulture

Flowers

Fruits

Vegetables

Training and
Pruning

Pot mixture

Propagation
methods

Nursery bed
preparation

Prepared by

Dr. Divya Slathia

Dr. Amit Saurabh, Dr. Yogendra Singh & Dr. Shalini Singh



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Sirmour 173101, Himachal Pradesh, India

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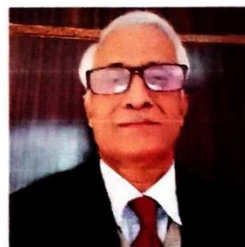
Sirmour 173101, Himachal Pradesh, India

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Foreword

Horticulture is the science and art of growing, manufacturing, selling, and using high-value, intensively grown food and ornamental plants in a sustainable manner. Horticultural crops include annual and perennial species, tasty fruits and vegetables, as well as decorative indoor and landscape plants.

Horticulture's inherent importance and current status reveal the sector's potential and opportunities for development. Fruits, vegetables, and flowers are examples of horticulture crops. Horticulture has evolved into a full-fledged scientific discipline as scientific methods are increasingly applied in the field of agriculture.

The authors' current lab manual on "Fundamentals of Horticulture" is a welcome effort. It's an outstanding up-to-date compendium of various practical techniques from all major and important techniques of Horticulture. The manual covers the basics of horticulture, this will provide relevant information and will be of great benefit to students, teachers, scientists, progressive farmers, and all those involved in Horticulture.

I personally congratulate and admire the efforts of the authors, Dr. Divya Slathia, Dr. Amit Saurabh, Dr. Yogendra Singh, and Dr. Shalini Singh Assistant Professors, Department of Horticulture, Dr. Khem Singh Gill Akal College of Agriculture, Eternal University, Baru Sahib. I am sure that this publication will be very useful to all, who are concerned with Horticulture.


(S. K. Sharma)
Dean

PREFACE

Students would benefit greatly from this practical manual because it contains all of the necessary information in depth, allowing them to devote more time to practical activities. Horticultural practical's are often of great interest because they enable students to apply scientific principles and aesthetics of art to a few horticultural operations such as potting a plant. The students' practical skills would be beneficial to them in their professional careers. The field activities are detailed in the "Practical Manual on Fundamentals of Horticulture" (HORT-101). The exercises in this manual are written in accordance with the revised prescribed syllabus.

It is hoped that “Practical Manual on Fundamental of Horticulture” will be very useful to the under-graduate students as a teaching aid. The information included in this manual is considered to be of utmost value to the students.

For his guidance, motivation, and moral help in the preparation of this manual, I am grateful to Professor Dr. S.K. Sharma, Dean, Dr. Khem Singh Gill Akal College of Agriculture, Eternal University, Baru Sahib, Sirmaur (H.P.).

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Exercise-1

Identification of Garden Tools

Various Operations

Various cultural operations, such as a) pruning, b) training, c) cutting preparation, d) layering, e) grafting, f) budding, g) lawn making, h) fruit harvesting, i) nursery management, are required during the cultivation of horticultural crops and special tools and implements are required to perform these cultural operations.

1. **Rose can / Water can** – This is used for watering the nursery beds. Fine rose can should be used for nursery of small sized seeds, it is a portable container, usually with a handle and a funnel, used to **water** plants by hand



ROSE CAN



CROW BAR

2. **Crow bar** – A long iron bar that is used to dig holes. A crowbar is a single metal bar with a single curved end and flattened edges, often with a small fissure on one or both ends that is used to remove nails or push two objects apart. The iron lever is typically used to open nailed wooden crates.
3. **Garden shears** – Garden shears are used to cut branches and stems up to 34 inch (2 cm.) in diameter and are used to prune hedges and edges. You should avoid using your garden shears on larger branches to avoid damaging the blades.



GARDEN SHEER



SCYTHER

4. **Scythe** – It's a long flat metal with a wooden handle that's 5 cm wide and 45–50 cm long. The metal is slightly bent at the end and has sharp edges. This is mostly used for manually cutting grasses.

5. **Digging fork** – This has 20 cm long prongs attached to a wooden handle. This is used to uproot trees, root cuttings, harvest tubers, and other related activities without causing damage to the root system or tubers.



DIGGING FORK



SHOVEL

6. **Shovel** – This is a curved steel plate with a wooden handle that is used to move dirt, manure, and other materials. A shovel is a method for digging and transferring loose, granular materials (such as dirt, gravel, grain, or snow) from one place to another.

7. **Secateur** – This is used to monitor the growth of small shoots in fruit trees, shrubs, and vines. It is primarily employed in the preparation of cuttings for propagation.



SECATEUR



BUDDING AND GRAFTING KNIFE

8. **Budding and Grafting knife** – This is for budding and grafting purposes. It has two soft blades, one of which has an ivory edge and is used to raise the bark during the budding process.

A straight edge is present on the grafting knife. For opening the bark and inserting the bud, the budding knife has a curved edge and a blunt end. Patch-budding is performed with a double-bladed budding knife.

9. **Hand hoe** – It's used for weeding by hand. A hoe is an agricultural and horticultural hand tool that is used to shape soil, eradicate weeds, clear soil, and harvest root crops. Piling soil around the base of plants (hilling), digging small furrows (drills), and digging shallow trenches for planting seeds or bulbs are all examples of soil shaping.



HAND HOE



SPADE

10. **Spade** – An iron square plate with a 45-degree angle fitted to a wooden handle of 30 – 45 cm in length. This is used for irrigation channel construction and rectification, ridge and furrow formation, earthing up operations, and even weeding operations.

11. **Fruit Harvester** – This has a long handle and a net-like system for storing the fruits that have been picked. The net is usually made of ordinary cotton thread or nylon cord, and the handle is usually made of hollow bamboo.



FRUIT HARVESTER



GARDEN RAKE

12. **Garden rake** – This is used in nurseries to level land and gather weeds. The rake is made up of a crow bar with a long handle and a set of nail-like projections.

13. **Pruning saw** – This is used to prune tree branches that have died. A small saw with slightly curved edges can be used to cut through dense branches and water shoots that secateurs couldn't reach.



PRUNING SAW



TREE PRUNER

14. **Tree pruner** – It comes with a long handle and is used to prune stray branches that are difficult to reach.

15. **Garden fork** – It is used to loosen the soil while harvesting bulb crops like onion and garlic and also in weeding.



GARDEN FORK

16. **Iron pan** – It is used for lifting plants in nursery. It is used to measure the soil, FYM and sand in pot mixture preparation.

17. **Rocker sprayer** – It is used for spraying chemicals in tall trees.



ROCKER SPRAYER



BACKPACK SPRAYER

18. **Backpack sprayer** – Chemicals are sprayed on vegetables and seed spice crops with this device. A backpack sprayer disperses liquid through a hand-held nozzle connected to a pressurised reservoir borne on the operator's back. Knapsack sprayers are ideal for spot treating areas and can be used to apply liquids such as fertilisers, herbicides, and fungicides.

Exercise-2

Preparation of Seed Bed or Nursery Bed

Nursery: A nursery is a location where seedlings, cuttings, and grafts are raised with greater care before being transplanted; it is also a location where plants are propagated and grown to a desired age.



Advantages of raising seedlings in nursery

1. Taking charge of the tender seedlings is a breeze.
2. It's easy to keep the seedlings safe from pests and diseases.
3. Land use quality (duration in the main field is reduced)
4. Without wasting any seeds, valuable and very small seeds can be effectively raised.
5. In main field's uniform crop stand can be maintained by selecting healthy, uniform, and vigorous seedlings in the nursery

Preparation of nursery beds

Selection of site

1. The nursery should be located closer to the water supply.
2. The position should, in general, be partly shaded (i.e., under the trees). If natural shade is not accessible, artificial shade must be given.
3. It should be well protected from animals.
4. Proper drainage facilities should be provided.

Selection of soil

It's best to use a medium-textured loam (or) sandy loam soil. Organic matter should be abundant in the soil. The depth of the soil should be between 15 and 25 cm. Types of nursery beds include the following: (a) Nursery with a flatbed; (b) Nursery with a raised bed (c) Growing a nursery in a jar, such as polybags or pans.

Preparation of raised bed nursery

Work the soil thoroughly to break up the clods. Weeds, stones and stubbles must all be extracted. The height of the raised bed should be 10-15 cm, the width should be 1 m, and the length should be decided by need and convenience. Mix two parts fine red soil, one part sand, and one part FYM into each bed to enhance aeration and fertility. Until preparing the bed, soak the soil in 4 percent formaldehyde or 0.3 percent copper oxychloride to destroy pathogenic spores.

Advantages of raised bed nursery

- The water flow would be constant and any excess water can be drained.
- In most cases, a high percentage of seeds germinate.
- Weed control and plant safety are simple to implement.

Seed treatment

To control seed borne pathogens, seeds should be handled with Captan or Thiram (2 g) or Carbendazim @ 1 g/kg of seeds for 24 hours before sowing. Bio-inoculants such as Azospirillum or Phosphobacteria can be combined with rice Kanji at a ratio of 250 ml/200 g Azospirillum or Phosphobacteria. Before sowing, seeds are treated with bio-inoculants and dried in the shade.

Normally, two packets (400 g) are needed to treat one hectare's worth of seeds. These inoculants help to boost the seedling's vigour.

Sowing of seeds

A fork or a wooden plank can be used to level the bed's surface. Clear lines with a 10 cm spacing and a depth of 1-2 cm are drawn around the bed. Seeds are planted in rows and then coated with sand, fine soil, or powdered FYM. Line sowing seeds makes weeding, drenching, and removing diseased seedlings much easier. The rate of emergence is determined by the depth of sowing. If the depth is too shallow, the seeds will sprout and dry out easily. Seedling emergence is greatly slowed if it is too deep. Sow the seeds 3-4 times the diameter of the seed at a depth of 3-4 times the diameter of the seed.

Season of sowing

Brinjal - December - January and May - June

Tomato - May-June, November - December and February - March

Chillies - June - July and September - October

Bellary onion - May - June and January - February

Cabbage & Cauliflower - January - February, July - August and September - October (hills)
August - November (plains)

To prevent seeds being washed away, the bed is covered with paddy straw and watered with a rose can after the seeds have been sown. The seeds should be watered twice a day before they germinate. Mulches should be removed after germination and watered once a day. The seedlings should be exposed to full sunlight a week before transplanting and the amount of watering should be decreased so that the seedlings do not rot.

Types of nursery

1. Temporary nursery: it is made up of elevated nursery beds. It can be transferred from one location to another as needed.

2. **Permanent nursery:** Side walls with drainage holes are constructed with concrete to a height of 75 cm. Seeds are sown in soil inside the concrete structure. After removal of each batch of seedlings the soil is enriched with manures.

Seed rate per hectare

Tomato - 400 - 500 g

Chillies - 1 kg

Brinjal - 375 - 500 g

Cabbage - 375 - 500 g

Cauliflower - 375 - 500 g

Bellary onion - 8 - 12 kg

Pest and disease management

Pests

There are two types of pests which normally attack the nursery plants

1. **Sucking pests** - Aphids, whiteflies, thrips etc.
2. **Biting (or) chewing pests** - Beetles, grasshoppers, leaf eating caterpillars etc.

Aside from causing damage to seedlings, sucking pests often serve as vectors for viral disease transmission, even in the nursery stage. Chilli mosaic diseases are transmitted by aphids.

1. **Thrips** act as vector for leaf curl virus diseases in chillies and spotted wilt disease in tomato.

Control

- i. Using a hand-operated sprayer, apply systemic insecticides such as methyl demeton or dimethoate @ 1 ml per litre of water.
- ii. Sucking pests in the nursery and early stages of the main field can be managed by applying carbofuran 10 days before pulling seedlings.

Diseases

Damping off (*Pythium* sp., *Phytophthora* sp., *Rhizoctonia* sp.) This disease is particularly harmful to tomato, chilli, brinjal, cabbage, and cauliflower seedlings. Infection is caused by water logging and inadequate drainage. The disease has two effects on seedlings.

1. Seeds that have been affected decay within the soil, resulting in germination failure.
2. The fungi attack the seedlings in the collar region after germination.

The tissues will soften and become more succulent. The seedlings become trapped and decayed as the disease progresses.

Control

1. Raising seedlings in raised beds with good drainage facility reduces infection.
2. The addition of organic matter increases the texture and aeration of the soil.
3. Seeds should not be sown in dense layers in beds.
4. Periodical changing of nursery sites.
5. Before sowing, treat the seeds with Captan, Thiram, or Carbedazim @ 1 g/kg of seeds.
6. Drenching the nursery bed with Bordeaux mixture 1% or copper oxychloride 0.3 percent once or twice will also help to prevent infection.

Nematode

Carbofuran (or) phorate 100 g/cent should be incorporated in the soil and watered periodically before sowing the seeds to prevent root knot and lesion nematodes from affecting nursery seedlings.

Ants: To protect the seeds from ants, apply Lindane 10 percent dust at a rate of 100 g/bed on all sides of the bed.

Exercise-3

Preparation of Pot Mixture, Potting and Repotting

Pot mixture is the medium that provides nutrients to plants that are grown in pots. The composition of the pot mixture varies from plant to plant.

Quality of pot mixture

- 1) Physical and chemical properties should be acceptable.
- 2) It must be able to accommodate enough water and air.
- 3) It must allow for adequate drainage.
- 4) It should provide all of the nutrients necessary for plant development.
- 5) It must be free of weed seeds, soil-borne pathogens, nematodes, and harmful chemicals, as well as being lightweight.

Ingredients for pot mixture preparation

It differs from one crop to the next. The following are some of the most common ingredients used in pot mixtures.

- Red earth
- Sand
- FYM
- Leaf mould
- Charcoal
- Brick stone and dried wooden pieces

Crop Pot mixture composition

Ornamental plants

- 3 parts of soil

2 parts of organic manure

1 part of sand Indoor house plants

(Begonia, Geraniums etc.) - 2 parts of soil 1 part of organic matter 1 part of sand Indoor foliage plants (Dracaena, Dieffenbachia, Philodendron) - 1 part soil

1 part organic matter

1 part sand

Orchids - Half broken bricks compost containing equal parts of fine coconut fibre and fresh sphagnum moss

Anthurium - Leaf mould and cocopeat

Roses Garden loam 4 parts

Cow manure 1 part

Leaf mould 1 part

Wood ash 1 part

Ammonium sulphate 1 handful

A. **Potting:** The process of transferring seedlings or rooted cuttings from bed to pot is called potting. The process of separation of plants from pot to the field is called depotting.

The purpose for which plants are potted are:

- i) Preparing plants for sale such as rooted cuttings of grapes
- ii) Growing plants for decoration like crotons
- iii) Growing plants for experimental studies like pot-culture studies

Steps followed in potting of plants.

1. Wet the seed bed before lifting plants. Lift with a ball of earth with as much of the root system intact as possible. Do not pull out seedlings in the hot sun. Do not allow roots or the soil around the roots to dry.

2. Fill up pots by putting some crocks first, then a layer of sand (5-8 cm) and finally pot mixture (8-10 cm).
3. Place the plant with the ball of earth in the centre upon the layer of pot mixture (Place on one side of pots in case of root-stock plants used in inarching).
4. Put pot mixture around the ball of earth, press as you fill up and level off, and leaving one inch head space at top. Do not press over the ball of earth. It will break and damage the roots.
5. Set the stem of the plant at the same height as it was in the seed bed.
6. Immerse pot with plant in a tub of water gently and keep inside water till air bubbles cease to come out. Remove and place the pot under shade of trees.

Repotting:

When a plant's root system gets matted around the outside of its earth ball, it needs to be repotted. Depending on how quickly your houseplants grow, you will need to repot them. Plants that develop slowly, such as cacti and succulents, do not require regular repotting. Fast-growing plants, such as geraniums and begonias, should be repotted at least once a year. Repotting is usually performed during the rainy season, when it is easier for them to develop themselves and form new roots. In the case of root stocks, the plants should be put in the shade after repotting and watered regularly (morning and evening) to prevent wilting. The pot should be gently watered the day before repotting to make it easier to remove the ball of earth intact from the pot. By placing fingertips over the soil near the plant's base, turning the pot upside down, and tapping the rim on a table lip, you can achieve this. The entire ball of earth would emerge from the pot in one piece. The existence of matted roots indicates that repotting is needed. After extracting a small amount of soil from the ball of earth, place the plant in the centre of a larger pot. The soil should then be placed in the pot to raise the plant to the proper height, and a fresh soil mixture should be placed around the roots. Repotting can be achieved with the same soil mixture as before, firmed with fingertips. A 1cm space underneath the pot rim may be left to allow for water. The plant should then be well watered and kept out of direct sunlight until it has formed itself.

General

1. Wilting is the first reaction after potting and repotting. To assist plants in reviving, the loss of transpiration must be monitored. As a result, keep newly potted plants in the shade and water them regularly.
2. After about ten days in the shade, the plants should be gradually exposed to sunlight by leaving them out in the sun for a few hours and then taking them back into the shade. Every week, the length of exposure can be increased until the plants can be held out in the open.
3. Application of fertilisers, removal of old and dry leaves, and protection from pests and diseases are some of the other tasks involved in maintaining potted plants. The following methods can be used to make liquid manure.

Kinds of liquid manures

Cow dung or horse manure is placed in a gunny bag and submerged in water. The solution can then be diluted and added after a week has passed. Oil cakes, such as groundnut cake and pungam cake, may be broken and soaked in water for one or two days before they have fermented or decomposed, as indicated by the foul odour.

Media for propagation

1. **Soil:** The texture and composition of the soil are crucial. The texture is determined by the proportions of sand, silt, and clay in the mix.
2. **Sand:** Propagation is done with quartz powder, and cuttings are rooted with plastering grade. Before using sand, it should be sterilised.
3. **Peat:** Peat is the partly decomposed remains of aquatic, marsh, bog, or swamp vegetation that has been preserved under water.
4. **Sphagnum moss:** It's the dehydrated remnants of Sphagnum plants from acid bogs. It's sterile, lightweight, and has a large water holding capacity.
5. **Vermiculite:** When heated, it is a micaceous mineral that expands dramatically. Chemically, it's a hydrated magnesium-aluminum-iron-silicate. Insoluble in water, light in weight, and neutral in reaction.

6. **Perlite:** It's a neutral-reacting grey or white volcanic rock mined from lava flows.
7. **Pumice:** It's a volcanic rock that's either grey or white. It allows for sufficient aeration and drainage of the media.
8. **Leaf mould:** In India, it is widely available. Any leaf that is locally accessible can be decomposed and used.
9. **Sawdust:** It's a waste product produced during the processing of wood.
10. **Coco peat or Coco dust:** Cutting and silting coconuts for fibre processing produces a by-product.

Containers:

1. Seed pan and seed boxes

Seed pans are shallow earthen pots with a top diameter of 35cm and a depth of around 10cm. They have one big hole in the middle or three holes that are equidistant from each other for drainage. Wooden seed boxes are 40 cm high, 60 cm long, and 10 cm deep, with 6-8 evenly spaced holes drilled in the bottom. A crock with the concave side down is put against each of the holes. Over it and to the side of this crock are several big pieces of crock. To prevent fine soil from clogging the drainage, two or three handfuls of coarse sand are scattered on the crock bits, creating a thin layer. The requisite soil mixture is then applied on top of this. Cineraria, Begonia Gloxinia, and Petunia are all delicate seed forms.

2. Earthen pots

They're made of burnt porous clay and come in a variety of sizes to give plants the right amount of soil and root space.

They have straight sides and are wider at the top than at the bottom to keep the most compost where the feeding roots are and to make it easier to remove the soil (ball of earth) intact with roots while planting or repotting.

In our country, pots of varying sizes viz., tube pots, $\frac{1}{4}$ size, $\frac{1}{2}$ size, $\frac{3}{4}$ size and 'thali' are used commonly.

Growing Media for Propagation



Sphagnum peat moss



Vermiculite



Leaf mould



Saw dust



Coco peat



Pumice

Exercise-4

Practice of Sexual and Asexual Method of Propagation Including Micropropagation

Reproduction is the process of creating new individuals from pre-existing ones, and the mode of reproduction refers to how they are produced. The genetic constituents of crop plants are determined by the mode of propagation, which determines whether the plant is homozygous or heterozygous.

Sexual method of propagation

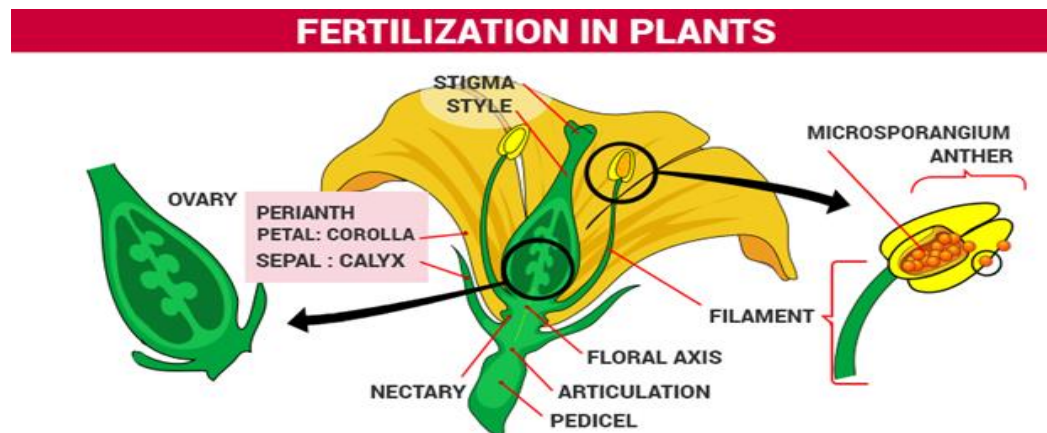
Fertilization is a sexual reproduction process in plants that occurs after pollination and germination.

The fusion of male gametes (pollen) and female gametes (ovum) to form a diploid zygote is known as fertilisation. It is a physicochemical reaction that happens after the carpel has been pollinated. The entire sequence of this process occurs in the zygote as it develops into a seed.

Flowers, as the reproductive structures of angiosperms, play an important role in the fertilisation process (flowering plants). When gametes in haploid conditions fuse to create a diploid zygote, this is the method of fertilisation in plants.

Male gametes are transferred into female reproductive organs by pollinators (honey bees, birds, bats, butterflies, flower beetles) during fertilisation, and the end result is the development of an embryo in a seed.

Fertilization Process



Pollination is the mechanism by which flowering plants are fertilised. Pollen grains from the anther land on the stigma, resulting in pollination. After the carpel is pollinated, the pollen grain germinates and develops into the style, which provides a route for the pollen grain to pass down to the ovary. *Via.*, the micropyle, the pollen tube reaches the ovule and bursts into the embryo sac. Within the ovule, the male nucleus joins with the nucleus of an egg to form a diploid zygote, which then swells and grows into a fruit.

Propagation is the method of multiplying or perpetuating a single or a group of plants that have a particular meaning to humans.

Asexual method of propagation

Many horticultural crops have distinctive vegetative structures that serve as food storage and propagation. The process of naturally detaching these structures from the mother plant is called separation. The process of dividing such structures into parts for propagation is known as 'division.'

Bulb:

It's a segment that's underground. It has a fleshy vertical stem axis with a growing point or flower primordium at the apex that is surrounded by scales. The outside scales are fleshy and contain food materials, while the inside scales are less fleshy and contain less food. Non-tunicate bulbs (such as lily) lack a dry and membranous outer scale, whereas tunicate bulbs (such as onion) do. Tunicate bulbs are protected by outer scale and non-tunicate bulbs are easily damaged.

Corm:

The swollen base of a stem axis is encircled by dried, scale-like leaves. A strong stem structure with distinct nodes and internodes can be seen in the gladiolus corm. Cormels are small corms that appear between the old and new corms. These corms can be divided into parts, each with a bud, and used for planting. e.g. **Elephant foot yam**.

Tuber:

It's a distinct stem system that forms underneath the ground as a result of the swelling of a stem's sub-apical portion and the accumulation of reserve materials that occurs. The shape of a tuber is similar to that of a stem. e.g. **Potato, Jerusalem artichoke**. These tubers are propagated by planting whole tubers or cutting them into pieces with one or more buds. Tubercles (e.g., *Dioscorea bulbifera*) are tubers produced in the axils of leaves that are used for propagation.

Tuberous roots and stem

The adventitious roots of some plants, such as sweet potato and dahlia, thicken and grow external and internal root structures, but they lack nodes and internodes. Tuberous roots are what they're called.

Thickened structures in cyclamen have developed from swollen hypocotyl tissue in plants like begonia. They are vertically arranged and may have stem-like characteristics. Plants with such roots or stems are propagated by slicing them into segments, each with a part of the crown bearing a single short bud.

Rhizome

The main axis of the plant grows horizontally at or just below the ground surface in this stem structure. It is made up of leaf scars on the nodes and internodes. e.g. **Ginger, Turmeric, Ferns** etc. In determinate type of rhizomes each clump ends in a flowering stalk and growth continues only from lateral branches. e.g. **Cardamom**.

Rhizomes of the indeterminate kind do not form a clump, but instead spread widely over a large area and grow continuously from the terminal apex and lateral branches. Cutting the rhizome into pieces and ensuring that each piece has at least one lateral bud or eye allows for rhizome propagation.

Runner:

It is a stem that grows horizontally along the ground from the axis of a leaf at the crown of a plant, ultimately forming a new plant at one of the nodes. e.g. **Strawberry and mint**.

Offset:

It is a type of lateral shoot or branch that grows from the main stem in some plants and is distinguished by a rosette-like shortened thickened stem. Offsets that produce enough roots can be removed and used for propagation by cutting them close to the main stem with a sharp knife. e.g. **Pine apple, date palm**.

Sucker:

A sucker is a shoot which arises on a plant from below ground usually from an adventitious buds on a root, e.g. **Chrysanthemum**.

Division:

It is the most direct way to increase the number of stock plants. During the dormant season, division must be completed. Each division should have around 3 or 4 buds or stems, and

the clump's outer parts should be chosen because they are more vigorous. e.g. **Daisy and Delphinium.**

Stolon:

A stolon is an aerial shoot that hits roots after colliding with the earth. It may be a prostrate or a horizontally rising stem from the crown. *Cyanodon dactylon*, for example. A shoot that has been rooted this way is simply cut from the parent plants and transplanted or potted.

Bulbils:

Some lily varieties, such as *Lilium bulbiferum* and *Lilium tigrinum*, produce aerial stem bulblets, also known as bulbils, in the axils of their leaves. Bulbils bloom early in the season and fall to the ground several weeks after the plant has finished flowering. They are harvested and planted shortly before they fall naturally. When flower buds have grown, disbudding can be used to increase bulbil yield. By pinching out the flower buds of certain lily species that do not naturally form bulbils, they can be induced to do so, e.g. *Lilium candidum*, *L. maculatum*.

Crown:

This is a short stem with closely set, short leaves that extends from the central axis above the fruit. These can be cut and planted to produce a single plant. Pineapple crowns are harvested from the fruit or at the time of harvest for propagation. Crowns will bear fruit in around 22 months, while slips will bear fruit in 12-18 months. e.g. **Pineapple.**

In horticultural terminology, the crown refers to the portion of a plant stem that lies on the ground and produces new shoots. The crown is mainly a point of position near the ground surface in trees or shrubs with a single trunk, defining the general transition zone between stem and root. The crown is the part of the plant from which new shoots emerge in herbaceous perennials. The adventitious roots develop along the base of the new shoots.

Micropropagation

Tissue culture made it possible to grow an entire plant from single cells or tissues, opening up new avenues for plant improvement. It has become a necessary technique for achieving desirable genetics, characteristics, and productivity in plants.

Plant tissue culture methods are most widely used in the cultivation of horticulture crops. Horticulture is a plant agriculture division that focuses on the production of fruits, vegetables, and ornamental plants. The aim of in-vitro ornamental plant development is to grow disease-free and genetically identical plants in large numbers.

Another advantage of tissue culture is that it does not necessitate a large number of stock plants for mass production. Only a few explants are used to create the culture of a specific plant, after which the cultured plants are used in other lines of production. By embryo rescue and somatic hybridization, this technique also allows for the generation of hybrids of incompatible plants.

In order to grow horticulture plants, not all tissue culture techniques have been effective. Some methods, such as embryo culture and axillary bud breaking, have a wide variety of uses, while others are still in the experimental stage of crop production.

ORNAMENTAL CROPS

Tissue culture techniques were used to introduce over 300 ornamentals to the commercial market (worldwide) in 1990. The technique has developed over 500 million plants, with 90 percent of them being ornamentals. Orchids, Gerbera, Spathiphyllum (Spathe or peace Lilies), and Boston fern are only a few of the ornamental plants that use this technique. Some commercial labs can produce up to 200,000 *in vitro* plantlets per week.

The three primary goals of producing ornamentals by tissue culture technique are:

1. Production of disease-free plants
2. Rapid production of a large number of genetically identical plants
3. Introduction of new varieties or genotypes

Micropropagation of ornamentals is accomplished by growing axillary (lateral) bud breaking and adventitious (buds found elsewhere on the plant) bud development.

Axillary bud breaking with shoot tip and single node explants is the best explant/starting material for *in vitro* ornamentals. Bulb scales, base plates of corms and bulbs and the inflorescence are all considered ideal explants in other plants like Lily, Allium, and Irises.

VEGETABLE CROPS

Vegetables are a rich source of vitamins and minerals and they are one of the world's most important crops. However, tissue culture methods have only been used to grow a few vegetables on a wide scale. Tissue culture is used to cultivate vegetables for four key reasons:

1. Production of plantlets of that species in which propagation of plant through seed is a difficult process
2. Production of genetically identical plants on large-scale
3. Production of virus-free plant materials

4. Crop improvement

The three techniques mainly used to produce major vegetable crops of the world include:

1. Somatic embryogenesis
2. Enhanced axillary branching using stem tips and lateral buds
3. Adventitious shoot formation

A somatic embryo develops in two ways: consciously and indirectly (by callus formation). Cauliflower and potato are two crops that follow the direct route. Plants like carrots, asparagus, sweet potatoes, pumpkins, and potatoes, on the other hand, grow by forming callus.

Explants from stem tips and lateral buds are used to improve axillary branching. Explants can be subcultured for several generations with increased shoot formation once they have been formed in labs using this process. Broccoli, cucumber, asparagus, garlic, cabbage, lettuce, tomato, potato, and sweet potato are among the vegetable crops that can be grown using this process. This method is most effective in lowering the genetic abnormalities in the plants.

Asparagus, potato, tomato, broccoli, brussels sprouts, chive, cabbage, carrot, garlic, kale, lettuce, and pepper have all been successfully grown using the adventitious root forming method. The only drawback to this method is that it increases genetic diversity.

FRUIT CROPS

To retain genetic characteristics, most fruit crops are propagated using vegetative techniques. In vitro processing using tissue culture has only been tried on a small number of fruit crops. It was first used for soft fruit crops such as strawberry and raspberry, as well as tree fruit rootstock such as peach, apple, cherry, and apricot.

The tissue culture of fruit crops is followed for mainly five purposes that include:

1. Mass propagation of the desired line of the plants
2. Obtain virus-free plants
3. Rapid mass production of plants for breeding purposes
4. Preserve germplasm
5. Produce haploids for the breeding program

Banana, papaya, passion fruit, fig, mulberry, and jackfruit are the most common fruit crops produced by clonal propagation. Somatic embryogenesis has had limited success in the growth of plants. Citrus spp., mango, banana, and date palm have all been successfully propagated using somatic embryogenesis.

Other uses for tissue culture include the processing of pathogen-free plants, which are primarily used in germplasm conservation (preservation). To feed the world's rapidly growing population, horticulture crops must be propagated in large quantities. Tissue culture is an effective method for improving crop quality and nutrition. As a consequence, it has a more prominent position, and usability can be shortly observed to fulfil the requirements of mankind.

Exercise-5

Training and Pruning of Fruits Tree

Fruits, vegetables, flowers, medicinal components, spices (oleoresins), aromatic (essential oils), and other horticultural plants are grown for their products. As a result, these plants should be handled in such a way that human preferences for growing them in terms of quality and quantity of produce are completely fulfilled. This necessitates the use of various inputs to directly manipulate plant growth or the plant environment. Training and pruning are essential in manipulating plant growth, and our knowledge of plant development and phenology must be complete. In fruit crops, these practices are critical.

Training:

Definition: Training is a collection of physical techniques for controlling the form, size, and direction of plant development. In other words, training is the process of orienting a plant in space using techniques such as binding, fastening, staking, supporting over a trellis or pergola in a specific way, or pruning some bits.

Objectives:

- By having various shapes and ensuring a balanced distribution, you can increase the appearance and utility of your plant/tree.
- Inter-cultivation, plant conservation, and harvesting are among the cultural traditions that have been made easier.
- Planting at a 45-degree angle and horizontally orienting branches increase efficiency. Methods of Training A plant's method of training is decided by its design, environment, growing intent, planting method, mechanisation, and other factors, so making an informed decision is important.

Training in herbaceous annuals and biennials: These plants are typically grown without any effort to alter their growth patterns because, while useful, having a large number in the field is impractical. However, the following styles of training are affected for some of the ornamental value and creeping design.

1. Supporting or staking vine-like plants.
2. Vine fruit plants, as well as indeterminate tomatoes, can be trained on a pergola or trellis.
3. In pot plants like aster, marigold, and chrysanthemum, nipping the apices encourages lateral growth for a bushy or fulsome appearance.

4. De-shooting, or the removal of lateral buds, is used in chrysanthemum and Dahlia to create a single stem for large flowers.

5. In a potted chrysanthemum, staking with bamboo sticks and tying together different shoots.

Training of woody perennials:

Woody perennials are trained to establish a strong foundation for sustainable production of quality produce and ornamental beauty in various shapes. They are widely spaced and remain on a place for a long time (topiary). The following methods of training are used in these plants.

(i) Open centre system (Vase shaped):

- The main stem is permitted to grow to a certain height, then the leader is cut to promote lateral scaffolding near the ground, resulting in a vase-shaped plant. Peaches, apricots, and berries are all examples of this.

(ii) Central leader system (closed centre):

- In this system the central axis of plant is allowed to grow unhindered permitting branches all around.
- This method, also known as the closed centre system, is widely used in the apple, pear, mango, and sapota industries.

(iii) Modified leader system:

- This system is a hybrid of the open centre and central leader systems, in which the central axis is allowed to expand freely for 4-5 years until the central stem is cut back and laterals are allowed.
- It is common in apple, pear, cherry, plum, and guava

(iv) Cordon system:

- This is a device that allows espalier with the aid of wire training.
- This method is used by vines that are unable to stand on their own stems.
- This can be educated in a single or double cordon and is widely used in grape and passion fruit crops.

(v) Training on pergola:

- Pergolas are made up of criss-cross wires supported by RCC/angle iron poles on which vines are trained to support perennial vine crops.

- This is typical of crops such as grapes, passion fruit, small gourds, pointed gourds, and even pumpkins.

Training in different shapes:

- Generally, ornamental bushes are trained into various shapes to enhance the beauty of a place.
- Vase, cone, cylindrical and rectangular box, flat and trapezoid are examples of these shapes.
- These shapes are currently being used in fruit trees for the sake of mechanisation.
- Such shapes are given to adjust the geometry of plantation like hedge row system, box, and unclipped natural in fruits like guava, mango, sapota and citrus.

Details of Training:

1. Height of the head: This is the distance between the field and the first branching or scaffolding. The trees could be divided into three classes based on their height. a) Low head height: 0.7–0.9 m this is a normal phenomenon in windy areas. These plants are simple to care for.

b) **Medium head:** 0.9—1.2 m. This is the most common height which combines both effects, ability to stand against wind and easy management.

c) **High head:** More than 1.2 m. Common in tropics in wind free areas. Operations under the canopy are easy to perform.

2. Number of scaffold branches: It refers to the number of scaffolds allowed on the tree's primary axis, which can range from 2 to 15, but extremes are undesirable. 5 to 8 scaffolds are preferred in fruit trees to make the tree physically solid and open enough for cultural operations.

3. Distribution of scaffolds: Scaffolds should be spaced 45-60 cm apart in all directions to allow strong crotches from large angles of emergence. A well-trained tree is a valuable asset to a farmer, so efforts should be made to properly train trees during their formative years to ensure long-term development. In reality, the process should have started in the nursery.

Different Type of Training System





Pruning

Definition: To strike a balance between vegetative growth and development, plant parts such as bud, shoot, and root are removed. This can also be done to change the tree's fruit load.

Objectives:

1. Maintaining tree growth and vigour, as well as a balance between vegetative vigour and fruitfulness, in order to encourage the production of an optimal crop of the highest quality.
2. To form the tree so that it makes the most of the space between trees while still allowing access.
3. To monitor the size and quality of the fruits by distributing the fruiting area properly.
4. To control crop succession and to provide a crop that can be handled easily and inexpensively.
5. To spread the trees for economic orchard management.
6. To remove the dead, diseased and over aged wood.
7. For effective spraying of pesticides to the crop.

Types of pruning:

Basically there are three types of pruning with definite purposes.

(i) Frame pruning. (ii) Maintenance pruning. (iii) Renewal pruning.

1. Frame pruning: This pruning is done to give a plant shape and form during its formative years so that it develops a solid structure and a shape that is easier to deal with. This procedure begins in the nursery and continues until the fruiting stage is reached. This is done throughout the year, regardless of the season.

2. Maintenance pruning: This pruning is done to preserve the status quo in terms of production and to ensure uniform efficiency. It is an annual feature in some plants (deciduous trees like grapes, apple, pear, peach, etc.) and an uncommon feature in others (evergreen trees like mango, sapota) confining to removal of water sprouts and unproductive growth and opening of the tree.

3. Renewal pruning: This pruning is done in old trees like mangoes which shows decline. In this case severe pruning is required.

Factors to be considered in pruning:

- Pruning is done as a routine feature in bearing trees in some tree species to strike a balance between vegetative growth and development so that farmers can get consistent, high-quality production.

To achieve this one should consider the following factors.

- When buds begin to distinguish in relation to blooming.
- The age of the tree that produces the most fruit buds of the highest quality and quantity.
- Taking these variables into account, we should have a full understanding of the tree/bearing plant's habit.
- Bearing habit refers to a fruit's relative location in relation to a possible bud that will produce a flower or inflorescence in the shoot. This activity differs from one plant to the next.

Principles of pruning:

1. Excessive pruning should be avoided because it stunts the plant's growth and can result in more water suckers, fascinations (the joining of many parts in a flat plane) and thus reduces the plant's bearing capacity.
2. Only the wood that isn't appropriate for the tree should be pruned away.
3. Pruning of larger limbs should be avoided as far as possible.
4. Young trees should be pruned with greater care than yielding trees, since extreme pruning of young trees slows cropping and eliminates much more yield area than is needed.

Exercise-6

Layout and Planting of Orchard

The establishment of an orchard is a long-term investment that requires careful consideration. To ensure optimum yield, the proper position and site, planting method and planting distance, variety selection, and nursery plant selection must all be carefully considered.

Location and site

Proper selection of site is important, Selection may be made based on the following criteria.

1. The position should be in a well-established fruit-growing area so that you can profit from the experience of other growers and sell your produce through co-operative organisations with other fruit growers.
2. There should be a market close to the area.
3. The climate should be suitable to grow the chosen fruit crops.
4. Adequate water supply should be available round the year.

Before a grower selects a site for establishing a new orchard, he must have assessed the following factors:

1. Suitability of soil, its fertility, the nature of subsoil and soil depth.
2. During the rainy season, the site must have adequate drainage and no water stagnation.
3. Water for irrigation must be of good quality.
4. There must be adequate transportation options, whether by road or rail, within easy reach.
7. There should be certain consumer demand for the fruits that will be grown
8. Workforce availability

Planning of an orchard

For the most productive and cost-effective management, the orchard must be meticulously planned. When putting together the strategy, keep the following points in mind.

1. Maximum number of trees per unit area with optimum spacing.
2. In order to ensure adequate supervision, stores and office buildings should be built in the orchard's middle.
3. At a rate of one well per 2 to 4 hectares, wells should be positioned in convenient locations throughout the region.
4. Each fruit type should be allocated to its own block.
8. For the sake of transportation economy, roads can take up the least amount of space possible.

The space between the windbreak and the first row of trees is beneficial to the lane.

9. Short growing trees should be planted in the front, and tall trees should be planted in the back to allow for easier visibility and to enhance the appearance

10. Evergreen trees should be in the foreground, and deciduous trees should be in the background.

11. **Fruits that attract birds and animals** should be planted near the watchman's hut.

12. A **good fence** is necessary. Compared to other types of fences, live fencing is cost-effective. Drought-resistant, easy-to-produce from seed, fast-growing plants with thick foliage that can withstand extreme pruning and thorny plants are perfect for live fencing. *Agave*, *Prosopis juliflora*, *Pithecolobium dulce*, and *Thevetia* would make a good live fence if planted in three rows.

13. **Wind breaks**, rows of tall trees planted close together around the orchard, are essential to resist velocity of wind which cause severe ill-effects particularly moisture evaporation from the soil. Since the wind breaks are very effective in reducing the wind velocity and minimizing the damage to the fruit trees and to other crops, their presence in regions where strong winds prevail is of paramount importance. A wind break ordinarily has its maximum effectiveness for a distance about four times as great as its height but has some effect over twice about that distance. Trees suitable for windbreak should be erect, tall and quick growing, hardy and drought resistant and mechanically strong and dense to offer maximum resistance to wind. The trees which are suitable for growing as wind breaks are *Casuarina equisetifolia*, *Pterospermum acerifolium*, *Polyalthia longifolia*, *Eucalyptus globulus*, *Grevillea robusta*, *Azadirachta indica*.

Laying out of orchards

any method of layout should aim at providing maximum number of trees per hectare, adequate space for proper development of the trees and ensuring convenience in orchard cultural practices. The system of layout can be grouped under two broad categories viz. (a) vertical row planting pattern and (b) alternate row planting pattern. In the former planting pattern (e.g. square system, rectangular system), the trees set in a row is exactly perpendicular to those. Trees set in their adjacent rows. In the later planting pattern (i.e. Hexagonal, Quincunx and Triangular), the trees in the adjacent rows are not exactly vertical instead the trees in the even rows are midway between those in the odd rows.

The various layout systems used are the following:

a) Vertical row planting pattern

1. Square system: In this system, trees are planted on each corner of a square whatever may be the planting distance. This is the most commonly followed system and is very easy to layout.

2. Rectangular system: In this system, trees are planted on each corner of a rectangle. As the distance between any two rows is more than the distance between any two trees in a row, there is no equal distribution of space per tree. The wider spaces available between rows of trees permit easy intercultural operations and even the use of mechanical operations.

b) Alternate row planting pattern

3. Hexagonal System: In this method, the trees are planted in each corner of an equilateral triangle. This way six trees form a hexagon with the seventh tree in the centre. Therefore this system is also called as 'septule' as a seventh tree is accommodated in the centre of hexagon. This system provides equal spacing but it is difficult to layout.

4. Diagonal or quincunx system: This is the square method but with one more plant in the centre of the square. This will accommodate double the number of plants, but does not provide equal spacing. The central (filler) tree chosen may be a short lived one. This system can be followed when the distance between the permanent trees is more than 10m. As there will be competition between permanent and filler trees, the filler trees should be removed after a few years when main trees come to bearing.

5. Triangular system: The trees are planted as in square system but the difference being that those in the even numbered rows are midway between those in the odd rows instead of opposite to them. Triangular system is based on the principle of isolateral triangle. The distance between any two adjacent trees in a row is equal to the perpendicular distance between any two adjacent rows. When compared to square system, each tree occupies more area and hence it accommodates few trees per hectare than the square system.

6. Contour system: It is generally followed on the hills where the plants are planted along the contour across the slope. It particularly suits to land with undulated topography, where there is greater danger of erosion and irrigation of the orchard is difficult. The main purpose of this system is to minimize land erosion and to conserve soil moisture so as to make the slope fit for growing fruits and plantation crops.

Planting distance

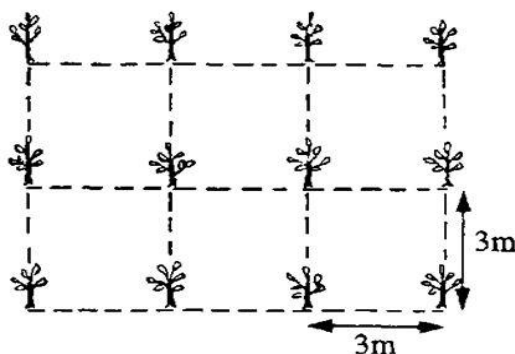
the minimum vertical distance between any two trees or plants is referred as the planting distance and this varies depending upon many factors. The principles in deciding the planting distance are the following.

1. Trees when fully grown, the fringes of trees should touch each other but the branches should not interlock.
2. Trees root will spread over a much larger area than top and there should be proper room for the roots to feed without competition.

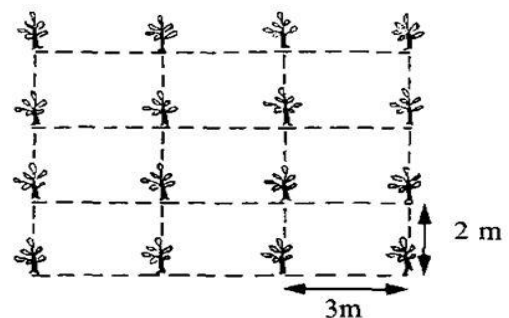
Factors which decide the planting distance are the following.

1. **Kind of fruit trees** - Mangoes are planted at a distance of 10m x 10m, guavas at a distance of 5m x 5m while papayas are planted at a distance of 2m x 2m.
2. **Rainfall** - Wider spacing should be given in low rainfall areas than the high rainfall areas for a kind of tree.
3. **Soil type and soil fertility** - In heavy soils less spacing should be given because the top and root growth are limited.
4. **Rootstocks** - Trees of the same variety grafted on different root stocks will grow to different sizes and as such require different planting distances. e.g. Apple
5. **Pruning and training** - trees trained on head system requires closer spacing than the other type of training system.

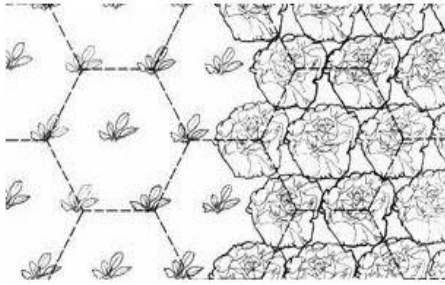
LAYING OUT OF ORCHARD



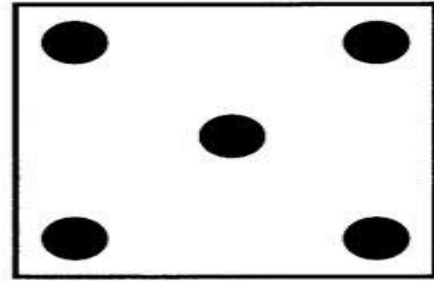
SQUARE SYSTEM OF PLANTING



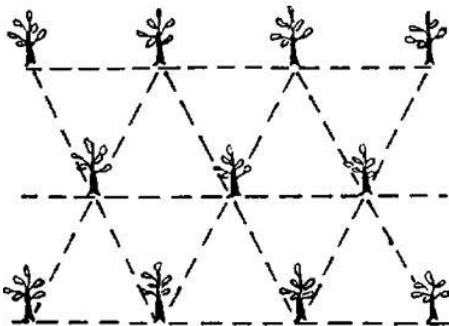
RECTANGULAR SYSTEM OF PLANTING



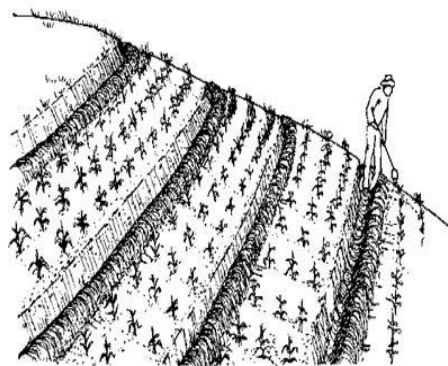
HEXAGONAL SYSTEM OF PLANTING



QUINCUNX SYSTEM OF PLANTING



TRIANGULAR SYSTEM OF PLANTING



CONTOUR SYSTEM OF PLANTING

6. Irrigation system

the total number of trees per hectare for various important horticultural crops under a) square b) hexagonal and c) triangular system of planting are given below:

Crop	Planting distance (in m)	No. of trees per hectare		
		Square system	Hexagonal system	Triangular system
Mango	10 x 10	100	115	89
Sapota	8 x 8	156	118	139
Clove	6 x 6	277	320	248
Acid lime	5 x 5	400	461	357
Coconut	7.5 x 7.5	177	205	159

Exercise-7

Fertilizer Application in Different Crops

The Nutrients are chemical elements which are absorbed by the plants in more or less quantity to transform light energy into chemical energy and to keep up plant metabolism for the synthesis of organic materials.

♣ Feeding of plants with nutrients is termed as nutrition.

♣ Successful growth and production of the plants in general requires a proper supply of the 16 elements. These elements are **regarded as essential to life in higher plants**. Allen and Arnon (1955) laid out following criteria for categorising nutrients essentiality to plants:

1. Complete or partial lack of the element in question must make normal plant growth impossible
2. Deficiency symptoms must be reversed by the addition of the elements in question
3. The element must play specific role in the plant metabolic symptom

They are:

1. Basic elements: Carbon (C), Hydrogen (H) and Oxygen (O) **(03)**

2. Macro elements: The nutrients that are required in relatively large quantity are termed as macro elements.

Nitrogen (N), Phosphorus (P) Potash (K), Calcium (Ca) Magnesium (Mg) and Sulphur(S) **(06)**

3. Micro elements: are those required in relatively less quantity are termed as micro nutrients.

Manganese (Mn), Molybdenum (Mo), Chlorine (Cl), Zinc (Zn), Boron (B), Copper (Cu) and Iron (Fe) **(07)**

Besides some nutrients like Aluminium (Al), Cobalt (Co), Sodium (Na), Silica (Si) and Vanadium (V) are not considered necessary always because either **their essential character has been proved only in some plants or in certain metabolic processes** that are not always necessary.

Types of Fertilizers

Inorganic fertilizers

- Chemical substances manufactured from **inorganic** materials
- Contains higher nutrient than organic manures.
- Nutrient input is lost through leaching, runoff, volatilization, fixation by soil or consumption by weeds etc.

Organic fertilizers

- These are plant and animal wastes that are used as nutrients after decomposition.
- Improves the soil tilth, aeration, water holding capacity and activity of micro-organism.

Where to Apply The Manures?

- In fully grown trees, the manures and fertilizers should be given over the area, where their active roots are spread.
- Fertilizer should be given in restricted area i.e., in the surrounding area of about 1 to 1.5 m away from the trunk of the trees.

Time of Fertilizer Application

- It must be applied when the plants need it.
- Timing depends on the type of fertilizer and climate.
- Fruit trees require more nutrients at the emergence of new flushes and differentiations of floral buds.
- Utilized more during the course of fruit development.
- Nutrients should be available to them in February–March.
- So, it would be better to apply them in October-November to be available to the trees in February to March.

Importance of Fertilizer Application

- Since most of the soils do not provide the requisite nutrient necessary for the growth and health of plant, they have to be fed with fertilizer to overcome the deficiency
- Also, fertilizers are not one time material, which once provide do not have to be resupplied
- In fact every time we harvest plant, they remove some nutrient along with them
- Thus regular supply of fertilizer to plant is a must to ensure their regular growth and yield

Methods of Fertilizer Application:

Broadcasting: • Fertilizer in solid state or granular or dust are spread uniformly over the entire field.

- Leaching loss may be more.

Disadvantages:

- Some of the elements like phosphorous and potash do not readily move in the soil. Therefore, surface application may not be available to the trees especially in drier tracks.
- Leads to accumulation of potassium in surface soil beyond detrimental levels causing injury to plants.
- Surface application always stimulates weed growth.

Band Placement:

- Application of fertilizer on the sides of rows.
- Fertilizer in solid and liquid forms can be applied.
- Quantity of fertilizer may be economised.

Ring Placement:

- Commonly followed in fruit trees.
- Fertilizers are applied in a ring encircling the trunk of the trees extending the entire canopy.
- It is more labour intensive and costly.

Foliar Application

- Fertilizers are applied in liquid form as foliar sprays.
- They are easily absorbed by leaves.
- Fertilizers are applied in a very low concentration tolerable to the leaves.
- Recommended when the nutrients are required in small quantity.

Starter Solution:

- Liquid form of fertilizer application.
- Seedlings and propagules are kept **emerged up to their root system** for varying duration in starter solution.
- The starter solution is prepared either by dissolving concentrated fertilizer mixture at a concentration not exceeding 1%.

Fertigation:

- **Application of fertilizers in irrigation water** in either open or closed systems.
- Nitrogen and sulphur are the principal nutrients applied.
- Phosphorous fertigation is less common because of formation of precipitates takes place with high Ca and Mg containing water.

Advantages:

- Nutrients especially nitrogen can be **applied in several split doses** at the time of **greatest need** of the plant.
- Nutrient is mixed with water and **applied directly near the root zone**, as such higher use efficiency.
- Cost on labour is saved.

Best results of fertigation are noticed when the fertilizer is applied towards the middle of the irrigation period and applied towards the middle of the irrigation period and their application

terminated shortly before completion of irrigation. Use of soluble fertilizer improves use efficiency.

Note: The grower must consider the economics and advantages before deciding for using fertigation.

Fertigation is used extensively in:

- Cut flower production in green houses.
- Fruit crops – Grapes, Papaya, Banana and Pomegranate.
- Vegetables- Tomato and Capsicum under poly/green houses.

Tree Injection:

- Direct injection of essential nutrients into the tree trunk.
- Trees suffering from iron deficiency are injected with iron salt

Feeding Needles:

- Several types of feeding needles or guns are available with these fertilizers either in dry form or in water solution placed in holes.

Factors favouring nutrients absorption and transport:

- High humidity, proper temperature and incident radiation.
- Good CHO supply and vigorous growth.
- Chemical and physical properties of nutrient spray solution.
- Leaf characters like leaf thickness, hairyness and wax coating on the leaf.
- Generally more vigorous plant and young growing leaves have good capacity to absorb nutrients.
- Nitrogen- applied in the form of urea (1%) is readily absorbed.
- Sodium and potassium (KCl) - readily absorbed by leaves and they are among the highly mobile Elements.

Method of Fertilizer Application



BROADCASTING



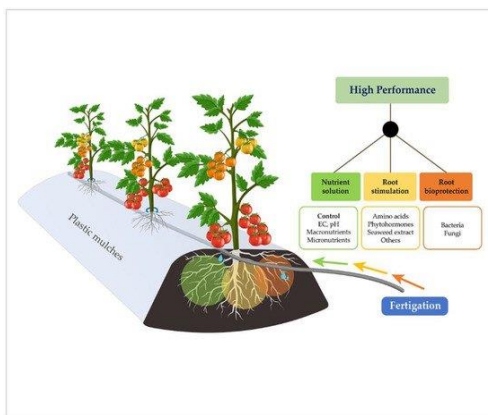
BAND PLACEMENT



RING PLACEMENT



FOLIAR SPRAY



FERTIGATION



TREE INJECTION

Note:

- Foliar application proves to be most effective where problems of nutrient fixation in soil exists. So far the most important use of foliar sprays is in application of micronutrients.
- Foliar sprays should be applied either with pressure sprayer or with specially designed spray guns. The trees should be sprayed until the nutrient solution begins to drip from the leaves.
- Foliar application of urea has been found effective in many fruit crops like citrus, guava, apple, etc.
- Potassium spray (3-5g/lit) - Papaya, Pineapple, Citrus and Guava.

Precaution:

- While applying foliar sprays, care should be taken to ensure correct concentration of spray solution.
- Apply in the morning or evening hours on a clear sky day.

Exercise-8

Identification of Horticultural Crops

Nomenclature and identification of horticultural crops

Nomenclature is a method or scheme for naming plants. Binominal is a universal method in which a plant is assigned a two-word name, one suggesting the genus or group it belongs to and the other separating it from other plants in the group. The plant is classified and named using this two-word or binominal appellation.

Nomenclature of Fruit crops

S.. No.	English Name	Common Name	Botanical Name	Family
1	Aonla	Amla	<i>Phyllanthus officinalis</i> Gaerth	Euphorbiaceae
2.	Almond	Badam	<i>Prunus dulcis</i> Mill	Rosaceae
3.	Apple	Seb	<i>Malus pumila</i> Mill	Rosaceae
4.	Apple Crab apple)	Chhota seb,	<i>Malus baccata</i> Borgen	Rosaceae
5.	Apricot	Khurmani	<i>Prunus armeniaca</i> L.	Rosaceae
6.	Avocado	Avocado	<i>Persea americana</i> Mill.	Lauraceae
7.	Bael	Bil	<i>Aegle marmelos</i> Correa.	Rutaceae
8.	Banana (edible fruit)	Kela	<i>Musa sapientum</i> L.	Musaceae
9.	Banana (cooking type)	Kela	<i>Musa paradisiaca</i> L	Musaceae
10.	Black berry	Brambles	<i>Rubus canadensis</i> L.	Rosaceae
11.	Bardados cherry	Bardados cherry	<i>Malpighia glabra</i> L.	Malpighiaceae
12.	Carambola	Kamrakh	<i>Averrhoa carambola</i> L.	Oxalidaceae
13.	Cashew nut	Kaju	<i>Anacardium occidentale</i> L.	Anacardiaceae
14.	Chinese jujube	Ber	<i>Zizyphus jujube</i> Lamk.	Rhamnaceae
15.	Cherry (Sour)	Sour Cherry	<i>Prunus cerasus</i> L	Rosaceae

16.	Cherry (Sweet)	Cherry (Sweet)	<i>Prunus avium</i> L.	Rosaceae
17.	Chestnut	Chestnut	<i>Castanea sativa</i> Mill.	Fagaceae
18.	Coconut	Khopa or Nariyal	<i>Cocos nucifera</i> L.	Palmaceae
19.	Custard apple	Sita phal	<i>Annona squamosa</i> L	Annonaceae
20.	Date	Khajoor	<i>Phoenix dactylifera</i> L.	Palmaceae
21.	Date (Wild)	Khajoor	<i>Phoenix sylvestris</i> Roxb.	Palmaceae
22.	Fig	Anjeer	<i>Ficus carica</i> L.	Moraceae
23.	Gajanimma	Gajanimma	<i>Citrus pennivesiculata</i> Tanaka.	Rutaceae
24.	Gooseberry	Kiwi fruit	<i>Actinidia deliciosa</i>	Dilleniaceae
25.	Grape (American)	Angoor	<i>Vitis lbrusca</i> Bailey.	Vitaceae
26.	Grape (European)	Angoor	<i>Vitis vinifera</i> L.	Vitaceae
27.	Guava	Amrood	<i>Psidium guajava</i> L.	Myrtaceae
28.	Hazel nut	Bhatia badam	<i>Corylus avellana</i> Mill.	Betulaceae
29.	Indian jujube	Ber	<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
30.	Jackfruit	Katehal	<i>Artocarpus heterophyllus</i> L.	Moraceae
31.	Jambolan	Jamun	<i>Syzygium cuminii</i> Skeels	Myrtaceae
32.	Karonda	Karonda	<i>Carissa carandas</i> L. A	Apocynaceae
33.	Lemon	Baramasi lemon	<i>Citrus limon</i> Burm.	Rutaceae
34.	Lemon	Galgol	<i>Citrus limon</i> Burm.	Rutaceae
35.	Litchi	Litchi	<i>Litchi chinensis</i> Sonn.	Sapindaceae
36.	Mandarin	Sangtra	<i>Citrus reticulata</i> Blanco.	Rutaceae
37.	Mandarin (Satsuma)	Sangtra	<i>Citrus unshiu</i> Marc.	Rutaceae
38.	Loquat	Loquat	<i>Eriobotrya japonica</i> Lindl.	Rosaceae
39.	Mangosteen	Mangosteen	<i>Garcinia mangostana</i> L.	Guttiferae
40.	Quince	Beedana	<i>Cydonia oblonga</i> Mill.	Rosaceae
41.	Peach	Aru	<i>Prunus persica</i> L.	Rosaceae

42.	Persimmon	Japani phal	<i>Diospyros kaki</i> L.	Ebenaceae
43.	Pomegranate	Anar	<i>Punica granatum</i> L.	Punicaceae
44.	Pecan nut	Pecan nut	<i>Carya illinoensis</i> Koch	Juglandaceae
45.	Pistachio nut	Pista	<i>Pistacia vera</i> L.	Anacardiaceae
46.	Pear	Nashpati	<i>Pyrus communis</i> L.	Rosaceae
47.	Plum	Alubokhara	<i>Prunus bokhariensis</i> Schneid.	Rosaceae
48.	Strawberry	Strawberry	<i>Fragaria chiloensis</i> Duch	Rosaceae
49.	Mulberry (Black)	Shehtoot	<i>Morus nigra</i> L.	Moraceae
50.	Mulberry (White)	Shehtoot	<i>Morus alba</i> L.	Moraceae
51.	Olive	Zaitoon	<i>Olea europaea</i> L.	Oleaceae
52.	Papaya	Papita	<i>Carica papaya</i> L.	Caricaceae
53.	Passion fruit	Passion fruit	<i>Passiflora edulis</i> Sims.	Passifloraceae
54.	Phalsa	Phalsa	<i>Grewia asiatica</i> D.C.	Tiliaceae
55.	Pineapple	Arianas	<i>Ananas comosus</i> Merr.	Bromeliaceae
56.	Plum (European)	Alucha	<i>Prunus domestica</i> L.	Rosaceae
57.	Walnut	Akhrot	<i>Juglans regia</i> L.	Juglandaceae
58.	Tamarind	Imli	<i>Tamarindus indica</i> L.	Leguminosae
59.	Sapota	Chiku	<i>Achras sapota</i> L.	Sapotaceae
60.	Raspberry	Rasbhari	<i>Rubus idaeus</i> L.	Rosaceae

Nomenclature of Flower crops

S.. No.	English Name	Common Name	Botanical Name	Family
1	Amaryllis	Belladonna lily	<i>Amaryllis spp.</i>	Amarillidaceae
2.	Begonia	Begonia	<i>Begonia odorata</i>	Begoniaceae
3.	Canna	Indian Shot	<i>Canna indica</i>	Cannaceae

4.	Cyclamen	Florist's cyclamen	<i>Cyclamen persicum</i>	Primulaceae
5.	Freesia	Fressia	<i>Freesia spp.</i>	Iridaceae
6.	Heliconia	Heliconia	<i>Heliconia spp.</i>	Heliconiaceae
7.	Iris	Iris	<i>Iris spp</i>	Iridaceae
8.	Narcissus	Nargis	<i>Narcissus tazetta</i>	Amaryllidaceae
9.	Saffron	Saffron	<i>Crocus sativus</i>	Iridaceae
10.	Spider lily	Spider lily	<i>Hymenocallis littoralis</i>	Amaryllidaceae
11.	Tulip	Tulip	<i>Tulipa gesneriana</i>	Lilaceae
12.	Zantedeschia	Calla lily	<i>Zentedeschia spp.</i>	Araceae
13.	Zephyranthes	Fairy lily	<i>Zephyranthes spp.</i>	Amaryllidaceae
14.	Amaranthus	Love lies bleeding	<i>Amaranthus caudatus</i>	Amaranthaceae
15.	Balsam	Gulmehandi	<i>Impatiens balsamina</i>	Balsamaceae
16.	Cock's comb	Murgkesh	<i>Celosia cristata</i>	Amranthaceae
17.	Gaillardia	Blanket flower	<i>Gaillardia pulchella</i>	Compositae
18.	Gomphrena	Globe amaranth	<i>Gomphrena globosa</i>	Amaranthaceae
19.	Kochia	Bruning brush	<i>Kochia scoparia</i>	Chenopodiaceae
20.	Portulaca	Sun plant	<i>Portulaca grandiflora</i>	Portilaceae
21.	Sunflower	Surajmukhi	<i>Helianthus annus</i>	Compositae
22.	Tithonia	Maxican sunflower	<i>Tithonia speciosa</i>	Compositae
23.	Zinnia	Youth and age	<i>Zinnia elegans</i>	Compositae
24.	Ageratum	Floss flower	<i>Ageratum houstonianum</i>	Compositae
25.	Aster	Ostrich feather	<i>Callistephus chinensis</i>	Compositae
26.	Calendula	Pot marigold	<i>Calendula officinalis</i>	Compositae
27.	Cineraria	Florist's cineraria	<i>Senecio cruentus</i>	Compositae
28.	California poppy	Golden poppy	<i>Eschscholtizia california</i>	Papaveraceae
29.	Candy tuft	Hyacinth flower	<i>Iberis umbellate</i>	Cruciferaceae
30.	Clarkia	Garland flower	<i>Clarkia elegans</i>	Onagraceae
31.	Cliaanthus	Parrot's bill	<i>Cliaanthus dampieri</i>	Leguminoceae
32.	Coreopsis	Tick seed	<i>Coreposis tinctoria</i>	Compositae
33.	Corn flower	Hurt sickle	<i>Centaurea cyanus</i>	Compositae

34.	Cosmos	Maxican aster	<i>Cosmos bipinnatus</i>	Compositae
35.	Dahlia	Dahlia	<i>Dahlia variabilis</i>	Compositae
36.	Daisy	English daisy	<i>Bellis perennis</i>	Compositae
37.	Gazania	Treasure flower	<i>Gazania splendens</i>	Compositae
38.	Gypsophila	Baby's breath	<i>Gypsophila elegans</i>	Caryophyllaceae
39.	Anthurium	Flamingo flower	<i>Anthurium andreanum</i>	Araceae
40.	Bird of paradise	Strelitzia	<i>Strelitzia spp.</i>	Musaceae
41.	Carnation	Carnation	<i>Dianthus caryophyllus</i>	Caryophyllaceae
42.	Chrysanthemum	Guldaudi	<i>Dendranthema grandiflora</i>	Asteraceae
43.	Crossandra	Firecracker flower	<i>Crossandra spp.</i>	Acanthaceae
44.	Dahlia	Dahlia	<i>Dahlia pinnata</i>	Asteraceae
45.	Gerbera	Barberton daisy	<i>Gerbera jamesonii</i>	Asteraceae
46.	Gladiolus	Sword lily	<i>Gladiolus grandifloras</i>	Iridaceae
47.	Jasmine	Chmali	<i>Jasminum spp.</i>	Oleaceae
48.	Lily	lilium	<i>Lilium spp.</i>	Liliaceae
49.	Marigold	Gainda	<i>Tagetes spp.</i>	Compositae
50.	Orchids	Orchids	<i>Dendrobium spp., Vanda spp.</i>	Orchidaceae
51.	Rose	Rose	<i>Rosa spp.</i>	Rosaceae
52.	Tuberose	Rajnigandha	<i>Polianthes tuberosa L.</i>	Amaryllidaceae

Nomenclature of Vegetable crops

S.. No.	English Name	Common Name	Botanical Name	Family
1	Onion	Pyaz	<i>Allium cepa</i>	Amaryllidaceae
2.	Garlic	Lahsun	<i>Alium sativum</i>	Amaryllidaceae
3.	Leek	Leek	<i>Alium porum</i>	Amaryllidaceae
4.	Taro	Arbi	<i>Colocasia esculenta</i>	Araceae
5.	Elephant foot yam	Jimikand	<i>Amorphophyllus sagittifolium</i>	Araceae
6.	Sweet corn	Sweet corn	<i>Zea mays</i>	Graminae

7.	Asparagus	Asparagus	<i>Asparagus officinalis</i>	Lillaceae
8.	Amaranthus	Chaulaee	<i>Amaranthus spp.</i>	Amaranthaceae
9.	Beet root	Chukander	<i>Beat vulgaris</i>	Cheanopodiaceae
10.	Palak	Palak	<i>Beat vulgaris</i> var bengalensis	Cheanopodiaceae
11.	Spinach	Vilayati palak	<i>Spinacea oleracea</i>	Cheanopodiaceae
12.	Lettuce	Lettuce	<i>Lactuca sativa</i>	Compositae
13.	Globe artichoke	Hathiichoke	<i>Cynara scolymus</i>	Compositae
14.	Jerusalem artichok	Girasole	<i>Helianthus tuberosus</i>	Compositae
15.	Sweet potato	Shakarkand	<i>Ipomea batatas</i>	Convolvulaceae
16.	Cabbage	Bandgobi	<i>Brassica oleracea</i> var. capitata	Cruciferae
17.	Cauliflower	Fulgobi	<i>Brassica oleracea</i> var. botrytis	Cruciferae
18.	Brussel's sprout	Mini cabbage	<i>Brassica oleracea</i> var. gemmifera	Cruciferae
19	Sprouting Broccoli	Broccoli	<i>Brassica oleracea</i> var. Italica	Cruciferae
20.	Kno-khol	Kholrabi	<i>Brassica oleracea</i> var. gongylodes	Cruciferae
21.	Kale	Hak sag	<i>Brassica oleracea</i> var. acephala	Cruciferae
22.	Chinese cabbage		<i>Brassica chinensis</i>	Cruciferae
23.	Turnip	Shalgam	<i>Brassica rapa</i>	Cruciferae
24.	Radish	Muli	<i>Raphanus sativus</i>	Cruciferae
25.	Cucumber	Kheera	<i>Cucumis sativus</i>	Cucurbitaceae
26.	Musk Melon	Kharbooj	<i>Cucumis melo</i>	Cucurbitaceae
27.	Gherkin	Gherkin	<i>Cucumis angurai</i>	Cucurbitaceae
28.	Water melon	Tarbooj	<i>Citrullus lanatus</i>	Cucurbitaceae
29.	Round melon	Tinda	<i>Citrullus lanatus</i> var. fistulosus	Cucurbitaceae
30.	Pumpkin	Kaddu	<i>Cucurbita moshchata</i>	Cucurbitaceae
31.	Summer squash	Chappan kaddu	<i>Cucurbita pepo</i>	Cucurbitaceae

32.	Winter squash	Vilayti kaddu	<i>Cucurbita maxima</i>	Cucurbitaceae
33.	Bottle gourd	Lauki	<i>Lagenaria siceraria</i>	Cucurbitaceae
34.	Bitter gourd	Karela	<i>Lagenaria siceraria</i>	Cucurbitaceae
35.	Ridge gourd	Satputia	<i>Luffa acutangula</i>	Cucurbitaceae
36.	Sponge gourd	Tauri	<i>Luffa cylindrica</i>	Cucurbitaceae
37.	Pointed gourd	parwal	<i>Trichosanthes anguina</i>	Cucurbitaceae
38.	Chow-chow	Chayote	<i>Sechium edule</i>	Cucurbitaceae
39.	Cassava	Tapioca	<i>Manihot esculanta</i>	Euphorbiaceae
40.	Peas	Matar	<i>Pisum sativum</i>	Leguminosae
41.	French bean	Kidney bean	<i>Phaseolus vulgaris</i>	Leguminosae
42.	Cluster bean	Guar	<i>Cyamopsis tetragonolobus</i>	Leguminosae
43.	Winged bean	Foxtail bean	<i>Psophocarpus tetragonolobus</i>	Leguminosae
44.	Cow pea	Lobia	<i>Vigna unguiculata</i>	Leguminosae
45.	Fenugreek	Methi	<i>Trigonella foenu graceum</i>	Leguminosae
46.	Okra	Bhindi	<i>Abelmoschus esculantus</i>	Malvaceae
47.	Drum stick	Drum stick	<i>Moringa oleifera</i>	Moringaceae
48.	Potato	Aalu	<i>Solanum tuberosum</i>	Solanaceae
49.	Tomato	Tamatar	<i>Lycopersicon esculentum</i>	Solanaceae
50.	Brinjal	Egg plant	<i>Solanum melongena</i>	Solanaceae
51.	Sweet pepper	Shimla mirch	<i>Capsicum annum</i>	Solanaceae
52.	Chilli	Mirchnu	<i>Capsicum annum</i>	Solanaceae
53.	Carrot	Gajar	<i>Daucus carota</i>	Umbeliferae
54.	Coriander	Dhaniya	<i>Coriandrum sativum</i>	Umbeliferae
55.	Celery	Celery	<i>Apium graveolens</i>	Umbeliferae