

PRACTICALE-MANUAL

Plant Propagation and Nursery Management

(Course No. MSHC-104) Credits: 2(1+1)

[For B. Sc.(Hons.) Horticulture 1st Semester Students]



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Media for propagation of plants in nursery beds, potting and repotting. Preparation of nursery beds and sowing of seeds. Nursery management of fruit crops and raising of rootstock. Seed treatments for breaking dormancy and inducing vigorous seedling growth. Preparation of plant material for potting. Practicing different types of cuttings, layering, grafting and budding etc. Use of mist chamber in propagation and hardening of plants. Preparation of plant growth regulators for seed germination and vegetative propagation. Digging, labeling and packing of nursery fruit plants. Maintenance of nursery records. Use of different types of horticultural tools and implements for general nursery and virus tested plant material in the nursery. Cost of establishment of a mist chamber, greenhouse, glasshouse, polyhouse and their maintenance. Nutrient and plant protection applications during nursery.

Contents

S. No.	Titles	Page No.
1	Media for Propagation of Plants in Nursery bed sand mist Chambers	1-3
2	Preparation of plant material for potting and repotting	4-6
3	Preparation of nursery bed sand sowing of seeds	7-8
	Nursery management of fruit crop sand raising of root stock.	9-14
4	Preparation and application of plant growth regulator solutions For seed germination and vegetative propagation	15-16
5	Use of mist chamber for propagation and hardening of plants	17
6	Seed treatments for breaking seed dormancy and inducing Vigorous seedling growth	18-20
7	Preparation of different	21-24
8	Practicing different types of layering	25-27
9	Practicing of different types apical Grafting	28-31
10	Practicing of different types	32-33
11	Practicing different types of repair Grafting	34-35
12	Practicing different types of budding	36-40
13	To maintenance of nursery records	41-42
14	Identification of horticultural tool sand implements	43
15	To demonstrate application of nutrient sand plant protection Measures in fruits plant nursery.	44-51
16	Application of plant protection chemicals in the nursery	52-54
17	Uprooting/digging, labeling and packing of nursery plants	55
18	Visit to private or hards to diagnose nutrient deficiency and other Maladies	56
19	Annexure-I	57-61
20	Annexure-II	62

Exercise No.-1

Objective: Media for propagation of plants in nursery bed sand mist chambers.

Materials required: Sand, soil, FYM or other formulation of compost, digging and media preparing tools, pots.

Procedure: Media used for propagation of Horticultural plants mainly consists of organic and inorganic components. The components of organic media include peat, sphagnum moss or bark. Sometimes leaf mulch, wheat straw, paddy straw, paddy hulls and saw dust are also used. While using these components some coarse mineral components should be used for increasing aeration such as sand, grit, pumice, vermiculite, perlite etc. The characteristics of different medium used for propagation are as under:-

Soil: The soil texture and structure is the first deciding factor for preparations of soil media. A soil having 40 percent sand, 40 percent silt and 20 percent clay is considered best for seed germination, where as sandy loam soils are excellent for preparation of soil mixtures for container growing plants. The soil p H of 5.5 to 6.5 is generally preferred. On the other hand structure of soil plays vital role in the germination of seed and rooting of cuttings, Heavy soils are avoided, as working with such type of soil is quite difficult.

Sand: Sand contains silica and has almost no mineral in it. Quartz sand, which chiefly contains silica components, is used by nurserymen for propagation. Because sand is the heaviest of all rooting media, it should be used in combinations with some other organic material. Sand should be washed, fumigated or heat treated before use to kill harmful pathogens present in sand.

Vermiculite: It is a micaceous mineral obtained from mica ore after processing the ore at 1090o C. Sterilization of material is done by heating. Heating turn water to steam, popping the layers apart forms small, sponge like kernels. Chemically, it is hydrated magnesium-aluminum- iron silicate. It is neutral in reaction with good buffering property and insoluble in water. It can absorb large quantities of water. It has good cation exchange capacity and can hold nutrients in reserve and release them slowly. It contains enough magnesium and potassium, which is needed for plant growth. Horticultural vermiculite has four grades according to the size of particles:

Name of grade and Particle size(mm)

No1.	5-8
No.2.	2-3
No3.	1-2
No4.	0.75-1

In general No.2 grade is widely used as horticultural grade and No.4 is useful as seed germinating medium. Nursery men should not use non-horticultural grades.

Compost: It is decomposed and rotten material of farm waste. For growing seeds and cuttings it is very common and useful material. Compost is rich in organic matter, nutrients or has higher water holding capacity. It can be used as a medium for propagation but should be mixed with

soil. The whole process of compost making occurs in three steps. Decomposition material should be easily degradable, which is for few days. Cellulose compounds are degraded at a high temperature which takes several months. The micro-organisms recolonize the material. Mostly, compost is prepared using dung which contains fiscal pass out, living seed of weeds and may be infested with soil dwelling pests like beetles, grubs and root-rotting pathogens. Therefore, it should preferably be used after sterilization

Perlite: It is grey-white siliceous material obtained after processing of crude ore which appears, after volcanic eruption.

Perlite is obtained after heating the crushed ore to about 760o C. As a result of heating, the moisture in the particle changes to steam and expand the particles to small, sponge like kernels that are very light. It holds 3-4 times more water to its weight. It is neutral in reaction with a p H of 6.0 to 8.0. It does not contain mineral nutrient.

Peat: Peat consists of the decomposed remains of aquatic, marsh, bog, or swamp vegetation and sediment of water bodies. Peat is of three types:

Moss Peat: It is least decomposed and derived from sphagnum or other mosses. It has high moisture holding capacity about 15 times to its dry weight. It varies in colour ranging from light tan to dark brown. It has highly acidic p H (3.2 to 4.5) and contains little amount of nitrogen. This type of peat is mostly used in horticultural nurseries, the course grade being the best. When peat moss is to be used in mixes as a propagation medium, it must be broken down into pieces and moistened before use. However, its continuous use may be improved by using agents like Agro Grow.

Reed sedge peat: It consists of remains of grasses, reeds sedges and others wamp plants. It holds about 10 times more water to its dry weight and its p H ranges from 4.0 to 7.5.

Peat humus: Peat humus is highly decomposed material. It can originate from hypnum moss or reed sedge peat. It has very low moisture holding capacity and p H ranges from 2.0 to 3.5. It may contain latent seed inoculations of soil dwelling pathogens, so it should be pasteurized while using.

Sphagnum moss: It is a bog grass plant of the genus *Sphagnum* such as *Sphagnum papillosum*, *S. capillaceum* and *S. palustre*. It grows as lithophytes in swampy spheres and is commonly found in hilly tracts of India. Sphagnum is obtained after dehydrating living portion of the grass. Sphagnum moss is relatively sterile, light in weight, having high moisture holding capacity. It has p H of about 3.5 to 4.0. It is widely used for keeping the live material moist for distant transport of seedlings and in air layering (goottee) of plants. It can be used as rooting medium for cuttings. Moss should be shredded either by hand or mechanically before use. It should be moistened with water before use. Sometimes, moss contains a strain of Streptomycin bacteria, which inhibit damping off the seedlings in the nursery.

Saw dust; wood-shaving and shredded bark: Saw dust, wood shavings and shredded bark of different plants like cedar, fir, pines, maple and redwood etc. can be used in mixtures with various propagating medium. Because of low cost, light weight and easy availability, these are mainly used in soil mixes for container grown plants. These mixes usually contain a lower amount of nutrients and hence additional amount of nutrients may be added to the mixes before their use as a growing medium. Being organic in nature, saw dust is ideal for the growth of fungus and hence its use is limited in propagation.

Coco peat: It is also called as coco dust. It is a byproduct of cutting and shifting of coconuts for fiber production. It is becoming very popular propagating and growing medium these days, because it has an excellent pore space (25-30 per cent) and fine structure required for proper growth and development of seedlings. It is a rich source of nutrients and can easily be mixed with other growing media.

Soil mixes: Different soil mixes are used as medium for propagation. Usually, soil mixtures are prepared by mixing sand, loam soil leaf moulds in different proportions. Ideal soil mixtures should be porous and should have good water holding capacity. Soil mixtures are not only used as propagation medium for seed germination or rooting of cuttings but also for filling of containers. The success of these mixes lies in the proportion and thorough mixing of the ingredients

Precautions:

1. The media used for propagation should be free from infections
2. We must use economic source of media preferably locally available

Exercise No.-2

Objective: Preparation of plant material for potting and repotting

Materials and Equipments- Flower pots, crocks (broken pieces of pots), potting mixture, khurpi and watering can (with fine nozzle).

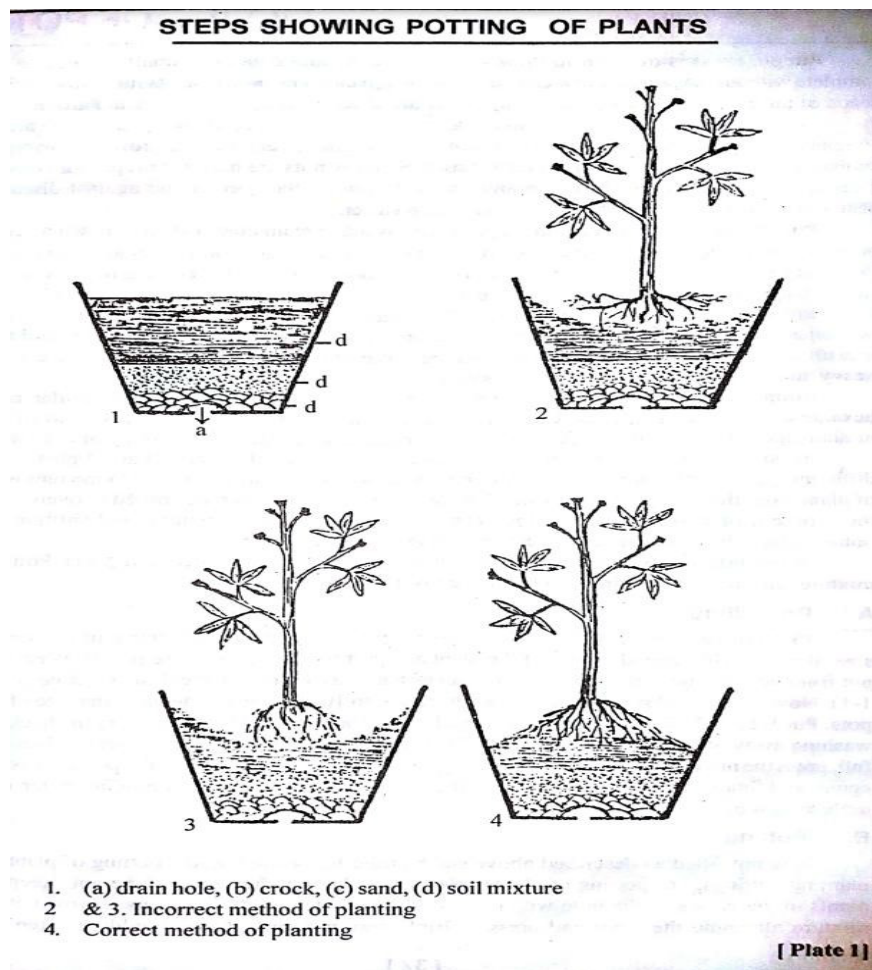
Purpose- Burnt porous layor cement or plastic pots are commonly used for various purposes in horticulture. The pots are used in propagation or plants, cultivation of ornamental plants and flowering annuals. Growing of plants in pots in referred as pot-culture. In pot-culture, operations such as potting, shifting and filling of pots are very important. Patting refers to planting of plants in pots containing soil Du mixture, while shifting means removal of plants from pots and planting them again in the same or different pot. Plants growing for more than one year in the same pot need shifting. The time for potting and shifting of plants is monsoon season (July to Sept.) and during spring (Feb-March).

A. Filling of Pots

Procedure- Select well-baked and sound flower clay pots of the proper size (the size will depend on age of the plant and purpose for which the pots are filled). Wash the pot, both inside and outside, with clean water. Place a large crock on the drainage hole (Plate 1-1). Now put several smaller crocks to a depth of 5 to 10 cm. dependent upon the size of the pot. Put 1.2 to 2.5 cm layer of coarse sand or coconut fiber. This necessary to check the washing away of the fine soil particles. Fill the pot with soil mixture or compost. When half full, press the mixture firmly. Continue filling up to the rim of the pot. Press the potting mixture again, and finally fill and press mixture to a point where a roomof2 to 3 cm. is left for holding water.

B. Potting

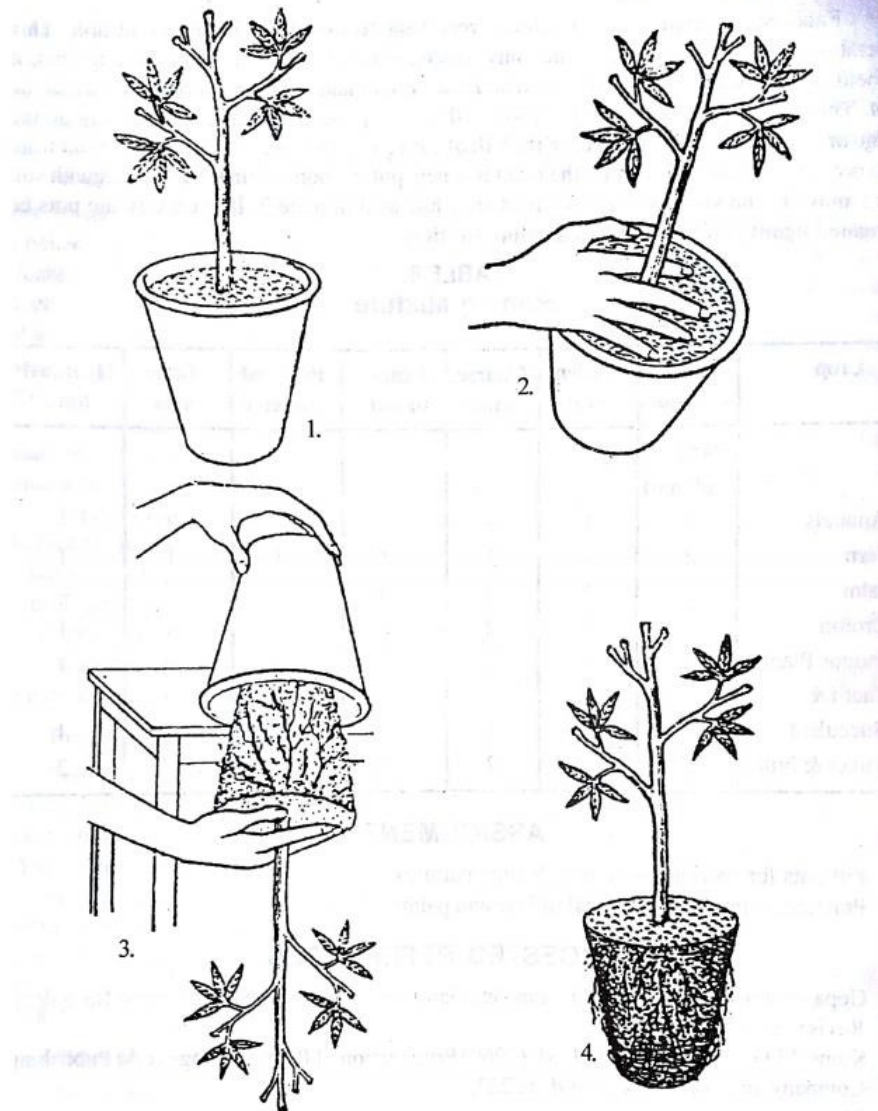
Procedure - The pots filed as described above can be used for sowing seeds, potting of plants or planting cuttings. For potting of plants scoop out a hole in the centre of the field pot. Keep the plant in the centre of the hole with roots well distributed in all directions. Throw potting mixture all round the pant and press it firmly and uniformly. Care should be taken that planting is not done too deep (Plate 1-4). Irrigate the plant with watering can fitted with a fine rose. Place the potted plant in a cool shady place for establishment.



C. Shifting of Plants/Repotting

Procedure - Each potted plant needs shifting every year to avoid pot bound condition. This operation should be done during the rainy season, In order to remove plant from the pot. It is held with right hand second and third finger and the thumb along the side of the pot. The pot is then turned down as shown in plate 2; and then tapped gently on the edge of bench or on a pot to loosen the ball of earth. The ball of earth is then taken cut from the pot carefully, before putting the plant in a new pot the lower fine roots and some soil is removed. The various steps involved are illustrated in Plate-2. If necessary the pots be irrigated lightly three to four hours before shifting

SHIFTING OF POTTED PLANT



1. Plant in Pot
2. Plant held between fingers
3. Pot tapped against bench
4. Ball of earth with plant

[Plate 2]

Exercise No. -3

Objective: Preparation of nursery bed sand sowing of seeds.

Materials required: Digging and hoeing implements, seed, measuring tape, rope and wooden pegs, organic manures (FYM), mulching material.

Procedure: A nursery beds are of three types

- Flat nursery bed
- Raised nursery bed
- Sunken nursery bed

Flat nursery bed: It is prepared during spring-summer when there is no risk of rain and in the areas where the soil is light sandy to sandy loam and has no problem of water stagnation. The area selected for nursery is well prepared till the pulverization of land and well rotten FYM at the rate of 10 kg per square meter area and is thoroughly mixed in the soil. The field is divided into small plots comprising of beds of uniform size depending upon the requirement, with the help of layout rope and measuring tape. Ridges are prepared around each bed, which facilitate the cultural practices. In between two rows of beds, control irrigation channel is prepared through which each bed is connected.

Raised nursery bed: It is especially useful for raising seedlings during rainy season when stagnation of water becomes problematic and causes damping off disease. Raised bed of 10 to 15 cm height from ground level is prepared. All the stumps, stones, pebbles, weeds etc. are removed from the bed and FYM at the rate of 10 kg per square meter is mixed in the soil. In between two rows, a space of 45 to 60 cm is left so as to carry out cultural practices easily. The seeds are sown in lines in the bed.

Sunken nursery bed: This type of bed is useful and prepared during winter season. This type of nursery is prepared 10 to 15 cm downwards from the soil surface. The air blows across the surface of soil and the seedlings in sunken bed is not hit by the cool breeze of the air. Further, covering of sunken bed with polyethylene sheets becomes easy which is required for protecting the seedlings from cool air.

Sowing of seeds: Till the soil to a fine tilth by removing stones, pebbles, crop residues etc. Break the clods and level the land/bed. Mix FYM @ 3 to 4 kg, 250 g ammonium sulphate and 250 g super phosphate per square meter area. The seeds are sown about 2 to 4 cm deep and 8 to 10 cm apart. The depth of the furrow depends upon the size of seeds. Bigger are the seeds, deeper the furrow. After sowing, the seeds should be covered with a mixture of FYM and coarse sand in the ratio of 3:1. Level the bed and sprinkle water after mulching the seed beds, as per requirement. Over watering should be avoided, as excess moisture encourages root rot disease.

In situ sowing: In situ sowing refers to sowing of seeds directly in the field and grafting and budding are performed there it. It is particularly important in some fruits like walnut, pecan nut, jackfruit and ber, which has long tap root system, In situ sowing enables to avoid the damage to tap root at the time of transplanting or uprooting of plants from the nursery. Similarly, for high density planting in Amrapali mango, in situ orchard establishment is recommended.

Precautions:

1. The seed source should be genuine and good quality.
2. The depth of sowing should be decided carefully depending upon the size of seed.
3. Avoid over watering of nursery beds and stress conditions.



Fig. 1-Raised bed and Flat bed



Fig.2-Sunken nursery bed

Objective: Nursery management of fruit crops and raising of root stock.

Nursery- Nursery is a place where seedling, saplings or any other planting materials are raised, propagated, multiplied and sold out for planting. The prerequisites of a successful and remunerative fruit production are the availability of true-to-type, healthy and good quality planting materials. Setting up of a fruit nursery is a long term venture and requires careful planning and expertise, because mistakes committed initially cannot be rectified easily and may adversely affect the return from the investment. Thus, one should pay due attention on every aspects when nursery is to be established.

Classification

Nursery may broadly be grouped into two on the basis of its size:

- 1- Home Nursery: Home nursery is the area where planting materials are specifically grown only to cater the needs of the grower's garden. The area is small and the primary consideration is the raising of quality materials. Costly methods of nursery practices are adopted.
- 2- Commercial Nursery: The commercial nursery is mainly concerned with economic return from the investment and, therefore, very expensive nursery practices are avoided without affecting the quality of the products. This type of nursery can be subdivided into two groups which are as follows:
 - Rural Nursery: Rural nursery is situated in a village near the high road or railway station. In general, the size of rural nursery may be large as the land and labour charges are cheaper. The products are also sold at a cheaper rate.
 - Urban Nursery: The nurseries which are located inside the city or close to it are known as urban nurseries. As the land is very costly and not easily available, the size of this type of nursery is usually small. The labour charges, transport cost etc. are also very high, but these are compensated by the higher price of products and volume of sale. Sometimes they act as middlemen i.e., procure planting materials from rural nursery and resale to the customers.

Factors Affecting the Establishment of A Nursery

1. Location and Site

- a. Topography: The land for the nursery should be as flat as possible with a gradual slope in one direction. This helps in quick draining out the excess water during the heavy down pour. The area should be somewhat elevated than the adjoining area to avoid water logging and congestion.
- b. Climate: It is of prime importance to select only those species and varieties which thrive well in the region.
- c. Reputation of locality for nursery business: The locality where a nursery is intended to be established should have the reputation for the business. This means that the nurseries should be established in the known locality. Since such a place is known to the customers, the fledgling nursery gets the advantage of publicity. Apart from this, skilled lab ours and various inputs are also readily available.
- d. Transport facility: Adequate transport facilities are of prime importance for successful nursery business. An nursery should be located near a metal road, or close to a rail way

station to deliver the plant materials to the customers in a short time. It should be easily accessible to the customers, but totally free from pilferage.

2. Selection of Soil

Type of soil, drainage and soil fertility are the three basic components to be considered while selecting the soil for establishing a nursery. Almost all the fruit crops do well in friable, loamy soil, rich inorganic matter with the soil reaction varying from slightly acidic to near neutral (pH 5.5 to 6.5). However, a clay-loam soil is advantageous as in this type of soil, it is easy to lift the ever green plants with earth balls intact. Shallow soil with hard and compact subsoil's should be avoided as it creates hindrance in proper root growth of mother-plants. A depth of 75.0 cm is sufficient for nursery practices but for the progeny block a soil depth of 1-1.5 m is desired. Presence of calcium carbonate layers affects permeability and aeration, and results stagnation of water which is detrimental to root respiration.

3. Water Supply

Nursery stocks require frequent light irrigation. A regular water supply must be assured in a nursery. The water for irrigation should be free from any dissolved salts and pH should be near neutral. A surface well may be dug or a tube-well maybe installed forth is purpose. In canal-irrigated areas, it is advisable to construct a water reservoir, so that the requirements may be met with the stored water during the dry period.

4. Manures

For nursery work, plenty of organic manures viz. farm yard manure, compost, leaf mould, sludge etc. are required. These should be available in sufficient quantities.

Parts of a Nursery

A nursery should consist of the following parts

1. Building structures: The building structures include office, sale counter, packing shed, potting shed, store, implement shed, bullock shed and residential quarters etc.

- Office-The office is the most important among all the building structures because all the business transactions are done from the office. The size of office depends on the size of business.
- Sale counter-The sale counter should be attached to the office.
- Packing shed-Before delivering the material to the customers they are to be packed and labeled properly. Packing materials like baskets or boxes are kept in this shed. It should be located near the sale counter.
- Potting shed-Pot of varying sizes and shapes and the potting mixture (e.g., loamy soil, leaf mould, well rotten cow dung, fine river silt, sand) are kept in the shed. Potting operations are executed under shade where all the materials are easily available in right condition throughout the year. Only the plants are brought from the nursery beds. Potting under shade also minimise desiccation of plant, saves time and helps to keep other areas of the orchard clean.
- Store-A store is needed to keep the fertilizers, sprayers, insecticides, fungicides etc. This should be located inside the nursery and away from the main office.
- Implement shed-A shed is required for keeping the garden implements.

- Bullock shed-Many bullock drawn implements are generally used in a small nursery. In such case, a shed is necessary and should be located in the rear side of the nursery to maintain the bullock herd of the nursery
- Residential quarters- Sometimes the owner desires to live in the nursery premises with his family. In such case, the house should be constructed according to the choice of the owner. In large enterprises, residential arrangements are also made for the skilled labours and other staff members.
- In general, the placement of structures or quarters should be on the northern border of the nursery which does not obstruct the emission of light and flow of wind inside the nursery. Further movement of workers becomes easy if these are placed on the border

2. Progeny tree block: The correct choice of kind and variety of fruit crops and collection of true-to-type mother plants has strong bearing on the success and goodwill of a nursery industry. Suitable fruit crops should be selected to meet the demand of the customers. There should be a collection of good number of promising varieties of popular crops to make a wide choice. The progeny trees should be healthy, disease free, genetically true-to-type and free from insect-pests attack. The pedigree of these plants should also be known to the nursery man.

3. Propagation structures: The outdoor conditions may not be always congenial for successful multiplication and raising of plants. The freezing cold atmosphere in winter and hot desiccating wind in summer preclude the outdoor cultivation of propagules. Different types of propagation structures greenhouse(glass house), hotbed, cold frame, lath house, net house and mist chamber are in commercial use to create propitious conditions in respect of light, temperature and humidity for facilitating germination of seed, rooting of cutting and also for hardening of young seedling before transplanting them to main field.

The green house and hotbed are structures with temperature control and ample light, and mainly used for seed germination and rooting of cutting. The lath house and cold-frame are structures for hardening the young and tender plantlets before planting them in outdoor conditions.

- Green house-A green house is a structure covered with glass for protection against adverse climatic conditions to cultivate plants. Plants are grown or cuttings are rooted in a green house when the atmospheric condition does not permit for raising them in outdoor condition. Modern green houses are equipped with regulatory mechanism for controlling temperature, light intensity, air flow and humidity. To minimise the high cost of glass, it may be replaced by polyethylene films of various thickness. Polyethylene of 0.10 to 0.15 mm (0.004 to 0.006 inch) thickness, resistant to ultraviolet rays is found most suitable for green house. For controlling the temperature and humidity inside the green house, arrangement should be made for proper air movement. Conservation of heat is essential in the green houses. In general, green houses are heated by steam or hot water passing through pipes fitted suitably from a central boiler. In large green houses, heated air is often blown into large (30 to 60 cm) polyethylene tubes having small (5 to 7.5 cm) holes spaced throughout the length to release the hot air inside, which are hung overhead along the length of green house. The heat loss in green house can be reduced by providing a double layered, sealed polyethylene sheet outside the glass.
- Hotbed- It is a small fixed structure having three components namely, frame, cover and heating unit. It is also used for growing small tender seedling and rooting of cuttings. preferably horse manure and covered with 15-20 cm thick rooting medium. Decomposition of raw dung generate heat and the temperature of the rooting medium is raised. In large size modern nursery, improved heating arrangements like steam piping,

hot water piping, electric cable etc. are used for heating the bed. The frame can be made of wood or any light metal.

- Cold-frame-It is a small and movable structure of glass which encloses a ground bed. It is used for hardening or conditioning of rooted cutting and young seedlings before transferring them out. There is no bottom heating arrangement and heat is tapped from the solar energy. It should, therefore, be located in a sunny place. For assured success, care has to be taken in respect of proper ventilation, shade, watering and winter protection. The sash is removed during day time for quick raising of temperature of growing medium
- Lath house-Lath house is a structure which is made with the object of providing shade and thereby protecting the young tender seedlings or rooted cuttings which are sensitive to strong sunlight and high temperature. The transpiration and evaporation loss of moisture are directly related with temperature. So, in lath house the loss of moisture from leaf as well as from soil surface is greatly reduced, due to low temperature and light intensity, resulting into less water requirements of plants. Seedlings are transferred for hardening from green house or hotbed to lath house. The structure and size of lath house vary widely. Different kinds of shading materials are used (e.g. wood strips, polypropylene fabrics etc.) for the roof.
- Net house-A net house resembles to a green house where the roof as well as sides are made of wire nets fixed on iron or wooden frame. The roof may be covered by polyethylene sheet, leaves or some climbers may be allowed to grow and cover the roof to provide shade.
- Mist propagation chamber- Mist propagation technique has made a break through in the rooting of cuttings of difficult-to-root plants. In this system, an intermittent water mist is provided during day time over the cuttings and to the rooting media which increases the relative humidity surrounding the leaf and lowers the air and leaf surface temperature, thus reduces the rates of transpiration and respiration. The intermittent mist is controlled by an electrically operated timer mechanism, regulating a solenoid valve, spraying water for 5 seconds and then cut-off till the leaves start drying and again turned on. Electronic leaf having two terminals may be placed under the mist along with the cuttings to control the mist. Mist technique is ideal for rooting of leafy cuttings. There may be some losses of minerals by leaching, which can be replenished by adding nutrients to the mist.

4. Nursery beds: A nursery bed should be prepared by repeated ploughing and pulverizing the soils to obtain a fine fifth. Adequate amount of organic manure and compost should be incorporated into the soils. Nitrogen at the rate of 25 kg per hectare may be added for quick growth of seedling at the initial stage. Addition of wood ash makes the soil loose and acts as a source of potassium which is required for better growth.

Raising of Rootstocks

Rootstock is that part of the plant onto which a scion buds or bud stick is placed. It provides the root system to the grafted or budded plant. It is well documented that root stocks have strong influences on the growth, flowering, and precocity of bearing, fruit quality of the grafted or budded plant. They also impart resistance to various pest and diseases and adverse soil and climatic conditions. The desired performance of the scion cultivar depends on the correct choice of the rootstock. The nursery should raise its rootstocks. The information available on the standardization of rootstock of tropical and subtropical fruit crops are scanty, barring citrus and grapes. In general, the rootstocks are raised from seeds. The poly embryonic varieties have been reported to produce uniform nucellar seedlings. The techniques of mound layering may be successfully employed for raising uniform rootstocks in some fruit crops like guava and jackfruit.

The seeds should be collected from the healthy, disease free tree. The seeds are to be washed thoroughly and dried in shade prior to sowing. Some seeds need immediate sowing. The spacing and depth of sowing vary with the size of seeds, viz citrus seeds are sown 2 cm apart in rows at a depth of 1 cm whereas mango stones are placed at a depth of 3 to 6 cm with a spacing of 15 to 20 cm between stone. The germination of seeds normally commences about 3 weeks after sowing. The young seedlings are susceptible to extremes of climate. They should be protected against frost in winter and hot desiccating wind during summer. Light dressing with nitrogenous fertilizers after one month helps in rapid growth of seedling at the initial stage. The beds should be kept free from weeds. Irrigation should be given at an interval of 7-10 days during summer months. Seedlings become ready for grafting or budding at the age of one year when they attain a size of pencil thickness at about 15 to 20 cm above the ground level.

Management of young nursery plants

(a) Irrigation: The young tender seedlings are exacting in their water requirement. Over watering is as harmful as under watering. To maintain the turgor pressure in the cell for maximum photosynthetic activity, light irrigation should be given at an interval of 7 to 10 days during summer and 15 days in winter. Proper care has to be taken to avoid sub soil congestion.

(b) Nutrition: Proper nutrition has profound influence on the growth of nursery plants. Liberal manuring with well decomposed organic matter is a prerequisite for achieving success in nursery business. A light and frequent dose of nitrogenous fertilizer @25 kg per hectare may be applied to obtain quick growth of seedling.

(c) Weed control: Weeds poses severe threat to the young seedlings in the nursery bed. Weeds being wild in nature grow vigorously and get established earlier than the crop plant. Often the seedlings are crowded over by the weeds if they are not controlled initially. The nursery bed should be kept free from weeds by shallow hoeing. This also helps in better aeration of the soils. The roads and irrigation channels also should be made free from weeds to avoid the chances of spread of weed seeds

(d) Plant protection

- Protection against adverse climatic condition: During the daytime in summer season, temperature shoots up in tropical regions resulting into striking rise of transpiration and evaporation rates, If high temperature is accompanied by flow of hot wind, the problem is

further aggravated and the tender seedling soon loses its vitality. The tolerance limit of fruit plants to high temperature varies with species. Seedlings can be protected from scorching sun by providing some shades during day time. Thatches may be erected over the seed bed. Shade crops may also be grown. Windbreaks on the eastern and southern sides of the nursery can reduce the wind velocity, and thereby, minimise the moisture losses from leaf and soil surfaces as well. Recuperation of soils with frequent light irrigation during summer months greatly helps to overcome this problem. The tissues of young seedlings are highly susceptible to frost. Occurrence of early and late frost may affect the plants severely. Generation of smokes by slow burning of dry grasses or plant debris helps to ward off frost from nursery, Irrigation during cold period keeps off the condensation of frost from the nursery, Erection of thatches and planting of wind breaks also provide substantial protection against frost

- Protection against pests and diseases: The reputation of a nursery depends on the supply of genuine, healthy and disease free plants. Once the seedlings are affected by pests and/or diseases, their growth is arrested and they turn pale and weak. The tender seedlings are susceptible to various pests and diseases but the degree of susceptibility varies with species and age of seedlings.

(d) Lifting and packing of seedling: It is desirable to lift the plants with balls of earth intact while the deciduous plants can be lifted bare rooted during dormant condition. Light irrigation should be given, if required, before lifting the seedlings.

The type of packing depends on the size of stock and type of plant. The transplants lifted bare rooted are packed with their roots wrapped in moist sphagnum moss and moist paper. The ball of earth may be wrapped with coconut leaves or rice straw and packed in basket.

(e) Storage: Low temperature (0.5 to 1.50 C) in association with high humidity (80-90%) in the atmosphere of storage reduces the respiration and transpiration rates. The store house should be well ventilated to drive out the carbon dioxide and heat of respiration.

Exercise No.-5

Objective: Preparation and application of plant growth regulator solutions for seed germination and vegetative propagation.

Materials Required: Plant growth regulator(s), measuring cylinder, volumetric flask, beaker(s), electronic balance, distilled water.

Procedure:

Preparation of growth regulator solution: The strength of growth regulators is calculated in ppm (parts per million). One ppm means 1.0mg of chemical dissolved in one litre of water. After weighing the required quantity of growth regulator transfer it to a beaker and dissolve it with the small quantity of solvent. Auxins are soluble in alcohol or 0.1% Na OH. Gibberellins are soluble in absolute alcohol, while, cytokinins can be dissolved in 1-2 ml N/10 HCl. Absciscic acid is highly soluble in Na OH. Shake the beaker till the growth regulator/chemical is fully dissolved. Now transfer it into volumetric flask and make final volume with distilled water to one litre. For every use one should prepare fresh solution. Following formula is used for conversion of hormonal strength.

I) Percent solution = $\text{ppm} / 10,000$

II) Ppm solution = $\% \times 10000$

Preparation of hormonal powder: For preparation of hormonal powder, the required quantity of hormone is weighed precisely with the help of sensitive balance. It is dissolved in ½ litre ethanol, methanol or acetone in a beaker. This material is poured into one kilogram of talc taken in mortar and mixed thoroughly with a glass rod. After mixing, the mixture is kept open in air for few hours. The alcohol will evaporate soon, after which, the dried talc is ground to a fine powder. This fine powder should be kept in air tight containers to avoid moistening and can be used as and when required.

Preparation of hormonal paste: For preparing hormonal pastes, the required quantity of the hormone is weighed accurately and dissolved completely in a few drops of alcohol. The required quantity of lanolin (wool fat, a product similar to grease and is greenish-yellow in colour) is weighed and heated slightly in a beaker under gentle flame. When the lanolin is slightly liquefied the dissolved hormone is poured in it. The mixture is dissolved thoroughly with constant stirring with a glass rod. The mixture is allowed to cool down. The paste is ready for use. Until use, the paste may be kept for few months in a cool dry place but one should prefer to use fresh paste.

Method of application of growth regulators: The effectiveness of growth regulators not only depend the concentration, but also on the method of application. Auxins are most effectively and widely used rooting hormone. Among synthetic auxins IBA and NAA are found to be most effective for inducing rooting. The different methods used for treatment of cuttings and layers are as under:

1. Prolonged soaking method: In this method, the basal end of cuttings is dipped in the dilute solution of the hormone for 24 hours in a cool dry place. The concentration of

hormone or growth regulator usually varies from 20ppm to 200 ppm, depending upon plant species and type of cutting. After treatment cuttings are planted in growing medium. The concentration is usually low in growing medium. The concentration is usually low for easy to root species and vice versa. This method is very useful for difficult to root species, where some materials like vitamins, sugars and nitrogenous compounds are also used along with the growth regulators for facilitating rooting.

2. Quick dip method: In this method, the basal end of cuttings is dipped in the concentrated solution of a hormone for a short time, usually for 5 seconds to 2 minutes depending upon the species to be propagated. Treated cuttings are planted in the rooting medium or field. The concentration of hormone for quick dip method may vary from 500 to 10,000 ppm depending upon the type of cutting and species, but generally a concentration of 3000 to 5000 ppm is used.
3. Powders dip method: In this method also basal ends of cuttings are dipped in the hormonal powder which carries (talc) for some time. After treatment of cuttings, extra amount of powder adhering to the cuttings should be removed by shaking and cuttings are immediately inserted into the rooting medium. For effective rooting, the cut ends of the cuttings should be moistened before the treatment and care should be taken that extra powder adhered to cuttings should be shaken off, otherwise, it may cause adverse effect on the rooting process. Seradix, Rootex or many other formulations are available in the market as powders.
4. Lanolin paste method: As described under preparation of hormonal paste, the paste of growth regulators made in lanolin is applied to the girdled portion of a layer or stool for inducing rooting in them.
5. Spray method: Spraying of growth regulators is sometimes done to mother plants before taking cuttings from them. Spraying of stock plants with 2,4,5-T in concentrations ranging from 25 to 100 ppm is done about 30 to 40 days before taking cuttings from them. Cuttings taken from such plants root better as compared to untreated plants.

Precaution:

1. First of all check the expiry date of the hormone powder.
2. The weight should be taken precisely, preferably on electronic balance.
3. Proper solvent should be used to avoid precipitation.
4. Hormones deteriorate under high temperature, so store in cool and dry place.
5. Hormones are photosensitive; therefore they must be stored in dark or amber colored bottles.
6. Use hormonal solutions for treatment of cuttings and lanolin paste for layers.
7. Solutions should be prepared fresh. If required to store for some time use, refrigerators.
8. The treated cuttings should be planted with the help of some stick to make hole, so as to avoid removal of solution from basal end of cutting.

Exercise No.-6

Objective: Use of mist chamber for propagation and hardening of plants.

Materialsrequired : Mistchamber,cuttings,secateurs,hormone solutionands.

Procedure :Mist propagation units are used for propagation of difficult to root cuttings. The main aim of misting is to maintain continuously a film of water on the leaves by reducing transpiration and keeping the cuttings turgid until rooting takes place. The misting is controlled by time clock, operating a magnetic solenoid valve and is set in a way to turn on the mist for 3-5 seconds to wet the leaves and turn off for some time and by the time leaves are dry, the mist is given turned on.

Generally, mist has five control mechanisms:

Timer: Two types of timers are used in a mist unit one turn on in the morning and off at night and second operates during day hours to produce an intermittent mist, usually 60 seconds 'On' and 90 seconds 'Off'.

Electronic leaf: A plastic with two terminals is placed under the mist along with cuttings, the alternate drying and wetting of the terminal breaks off the current, which in turn controls the solenoid valve.

Thermostat: Controls the temperature of mist.

Screen balance: It consists of a stainless steel screen attached to a lever with mercury switch. When mist is on water is controlled on the screen and when weight is more, it trips the mercury switch.

Photoelectric cell: It is based on the relationship between light intensity and transpiration rate.

Hardening of plants in mist chamber: After rooting in the mist, hardening of the rooted cuttings is important for better field survival. When cuttings are rooted, misting should not cease abruptly because this may lead to drying of young plants as a result of scorching. The weaning off process should be adopted in which misting is continued but the number of sprays are gradually reduced. Lessening the 'On' period and increasing the 'Off' period can do it. Another way is to shift the rooted cuttings to a greenhouse, fog chamber or frames maintained at higher temperature and low relative humidity. Hardening should be done in phased manner so that rooted cuttings are planted at permanent locations.

Precautions:

1. There should be regular supply of water
2. The p H of water should be in the range of 5.5 to 6.5, avoid hard and alkaline water, as it blocks the nozzles.
3. Rooting media should have good aeration
4. Keep mist chamber free from the growth of blue green algae.

Exercise No.-7

Objective: Seed treatments for breaking seed dormancy and inducing vigorous seedling growth.

Materials Required: Seed, sand, box(pit), sand paper, moss, hessian cloth, water, bavistin, labels, and glass containers

Procedure:

Scarification: Scarification is any process of breaking, scratching, mechanically altering or softening the seed covering to make them permeable to water and gases. Three types of treatments are commonly used as scarification treatments.

Mechanical scarification: It is simple and effective if suitable equipment is available. Chipping hard seed coat by rubbing with sand paper, cutting with a file or cracking with a hammer are simple methods useful for small amount of relatively large seeds. For large scale, mechanical scarifiers are used. Seeds can be tumbled in drums lined with sand paper or in concrete mixers containing coarse sand or gravel. The sand gravel should be of different size than the seed to facilitate subsequent separation.

Acid scarification: Dry seeds are placed in containers and covered with concentrated sulfuric acid (H_2SO_4) or HCl in the ratio of one part seed to two parts acid. The amount of seed treated at any time should be restricted to not more than 10kg to avoid uncontrollable heating. The containers should be of glass, earthenware or wood non metal or plastic. The mixture should be stirred cautiously at intervals during the treatment to produce uniform results. The time may vary from 10 minutes to 6 hours depending upon the species. With thick-coated seeds that require long periods, the process of scarification may be judged by drawing out samples at intervals and checking the thickness of the seed coat. When it becomes paper thin, the treatment should be terminated immediately. At the end of the treatment, the acid is poured off and the seeds are washed to remove the acid. The acid treated seeds can either be planted immediately when wet or dried and stored for later planting. Large seeds of most legume species respond to simple sulfuric acid treatment.

Hot water scarification: Drop the seeds into 4-5 times their volume of hot water with temperature ranging from 77 to 100°C. The heat source is immediately removed, and the seeds soaked in the gradually cooking water for 12 to 24 hours. The unswollen seeds may be separated from the swollen seeds by suitable screens. The seed should be sown immediately after hot water treatment.

: is a method of handling dormant seed in which the imbibed seeds are subjected to a period of chilling to after ripen the embryo in alternate layers of sand or soil for a specific period. It is also known as moist chilling. The seeds can be planted immediately after in the field. Seeds with a hard endocarp, such as *Prunus* spp. (the stone fruit including cherry, plum and peaches) show increased germination if planted early enough in the summer or fall to provide one to two months of warm temperature prior to the onset of chilling.

Outdoor stratification: If refrigerated storage facilities are not available, outdoor stratification may be done either by storing seeds in open field conditions in deep pits or in raised beds enclosed on wooden frames. However it is likely that seeds are destroyed in outdoors by excessive rains, freezing, drying, or by rodents. Seeds are placed in alternate layers of sand to provide and low temperature and proper aeration in the stratification pit. The top is covered with Sphagnum moss to maintain moisture level. The pit or tray is irrigated at regular intervals to maintain appropriate moisture status

Refrigerated stratification: An alternative to outdoor field stratification is refrigerated stratification. It is useful for small seed lots or valuable seeds that require special handling. Dry seeds should be fully imbibed with water prior to refrigerated stratification. Twelve to twenty four hours of soaking at warm temperature may be sufficient for seeds without hard seed coats. After soaking, seeds are usually placed in a convenient size box in alternate layers of well washed sand, peat moss or vermiculite. A good medium is a mixture of one part of coarse sand to one part of peat, moistened and allowed to stand for 24 hours before use. Seeds are placed in alternate layers of sand or medium. The usual stratification temperature is 4-7°C. At higher temperature seeds sprout prematurely and low temperature delays sprouting. The medium should be re-moistened. The stratified seed is separated from the medium prior to sowing in nursery beds. The stratification of seeds results in quick and uniform germination and therefore the seed should be subjected to stratification invariably under all conditions.

Table 3.1. Effect of seed stratification period on per cent germination of important temperate fruits

Kind of fruit	Stratification period (days)	%germination
Apple	70-75	70-75
Kainth(Pyrus pashia)	30-35	90-95
Peach	60-70	55-60
Apricot	45-50	75-80
Almond	45-50	85-90
Walnut	95-100	80-85
Pecan	70-75	75-80

Leaching of inhibitors: It is established fact that some inhibitors and phenolic compounds are present in seed covering so many species, which inhibit seed germination. Therefore, soaking of seeds in the running water for 12-24 hours or placing them in water for few hours help in leaching off the inhibitors and phenolic compounds, which help in easy seed germination?

Pre-chilling: In seeds of certain plant species, dormancy can be overcome by pre-chilling treatment. In this treatment, the imbibed or soaked seeds are kept at a temperature of 5-100 C for 5-7 days before sowing. After that seed can be sown in the field immediately.

Pre-drying: This is also a useful practice in some seeds to overcome seed dormancy. In this treatment, the dry seeds are subjected to a temperature of 37-400 C for 5-7 days prior to sowing. After this, seed can be sown in the field.

Seed priming: Seed priming refers to the procedures followed to overcome dormancy in freshly harvested fruits. Most widely used seed priming procedures are osmo- conditioning, in fusion and fluid drilling. In osmo-conditioning, the seeds are placed in shallow layer in a container having 20-30 per cent solution of polyglycol (PEG). The seeds are then incubated at 15-200 C for 7-21 days, depending upon seed size and plant species.

Different hormones and fungicides can also be added to protect the seeds from pathogens. After this, the seeds are washed and dried at 250 C and are stored until use. In infusion, the hormones, fungicides or insecticides and antidotes are infused into dormant seeds through organic solutions. In this process the seeds are placed in acetone or dichloro methane solution containing chemicals to be used for 1-4 hours. Afterwards, the solvent is allowed to evaporate and seeds are dried slowly in vacuum desiccators for 1-2 hours. The seeds absorb the infused chemical directly into the embryo when soaked in water. In fluid drilling, the seeds are suspended in a special type of gel before sowing. Now-a-days different types of gels are available in the market but sodium alginate, guar gum and synthetic clay are most widely used in fluid drilling.

Treatment with chemicals: Some compounds other than hormones are also used to break dormancy but their role is not clear. Thio-urea is one example known to stimulate germination in some kinds of dormant seeds. The seeds are soaked in 0.5–3 percent solution of thiourea for 3-5 minutes. After words seeds are rinsed with water and are sown in the field. Similarly, potassium nitrate and sodium hypochlorite also stimulate seed germination in many plant species.

Exercise No.-8

Objective: Preparation of different .

Materials Required: Cuttings, Secateurs, prepared nursery beds, growth hormone, sensitive balance, alcohol, measuring cylinders, small tub

Procedure(s): On the basis of plant part used and relative position on a plant, cuttings is classified into various groups as:

a.) Stem cuttings: A stem cutting is any cutting taken from the main shoot of a plant or any side shoot growing from the same plant or stem. The shoots with high carbohydrate content usually root better. Broadly, there are four types of stem cuttings, namely hardwood, softwood, semi hardwood and herbaceous cuttings. Hardwood cuttings from mature and lignified stem of shrubs and trees are called as hardwood cuttings. Hardwood cuttings are prepared during dormant season, usually from one year old immature shoots of previous season's growth. The length of cuttings varies from 10 to 45 cm in length and 0.5 to 2.5 cm in diameter, depending upon the species. Usually, the cuttings of 25-30cm length, with pencil thickness are preferred. Each cutting should have at least two buds or more. While preparing the cutting, a straight cut is given at the base of shoot- below the node while a slanting cut, 1 to 2 cm above the bud is given at the top of cutting.

However, in case of hollow pith species such as Kiwifruit top cut should also be close to bud to avoid drying up of top portion. This helps in maintaining the polarity of the shoot and if rain occurs, water does not accumulate on the tip of the cutting, which saves the cutting from fungal infection. A number of deciduous fruit plants like grape, hazelnut, chestnut, fig, quince, pomegranate, mulberry, plum, olive, gooseberry and apple etc. are commercially propagated by hard wood cuttings. The concentration of rooting hormone depends upon the species to be propagated.



Semi-hardwood (greenwood) cuttings: Semi-hardwood cuttings are those made from woody, broad-leaved evergreen species and leafy summer and early fall cuttings of deciduous plants with partially matured wood. This type of cutting are mostly used in evergreen fruit plants like mango, guava, lemon, jackfruit, some shrubs and shrubby plants and ornamental shrubs. The length of the cuttings varies from 7 to 20cm. The cuttings are prepared by trimming the cutting with a straight cut below a node and removing a few lower leaves. However, it is better to retain

two to four leaves on the top of the cuttings. While planting 1/4th of their length should be inserted in the soil. The best time for taking cuttings in summer, when new shoots have emerged and their wood is partially matured. It is necessary that leafy cuttings be rooted under conditions that will keep water loss from the leaves at a minimum. Commercially they are rooted under intermittent mist, fog or under polyethylene sheets laid over the cuttings. The concentration of rooting hormone depends upon the species to be propagated

Softwood cuttings: Cuttings prepared from the soft-succulent and non-lignified shoots, which have not become hard or woody, are called as soft wood cutting. Such are very prone to desiccation. Therefore, proper arrangement for controlling humidity is required. Usually the cutting size is 5-5.7 cm but it varies from species to species. Usually, some leaves should be retained with this type of cuttings. The best time for preparing soft-wood cuttings is late summer. Softwood cuttings generally root easier and quicker than other types, but require more attention and sophisticated equipment. Temperature should be maintained during rooting at 23 to 27°C at the base of cuttings. The concentration of rooting hormone depends upon the species to be propagated

Herbaceous cuttings: Herbaceous cuttings are made from succulent non-woody plants like geranium, chrysanthemums, coleus, carnation and many foliage crops. They are 7-15 cm long with leaves retained at the upper end. They are rooted under the same conditions as softwood cuttings, requiring high relative humidity. Bottom heat is also useful for initiation of rooting process. Herbaceous cuttings of some plants exude a sticky sap (as in geranium, pineapple, cactus etc.) that interferes with root initiation process. In such cases basal ends of cutting should be allowed to dry for few hours before planting. Generally, fruit plants are not propagated by herbaceous cuttings.



Root cuttings: Propagation by means of root cuttings is also a simple and cheap method of vegetative propagation in species which are difficult to propagate by other methods. In general, the plants, which produce suckers freely, are easily propagated by root cuttings. For preparation of root-cuttings, roots which are of 1cm thickness and 10-15cm long are cut into pieces. Best time for taking root cutting is late winter or early spring, when roots are well supplied with stored food material but before the new growth starts. However, temperate fruits, root cuttings are prepared in the month of December and are kept in warm place in moss grass or wet sand for callusing and are then transplanted during February-March in the open beds. Black berry and

raspberry are commercially propagated by this method. However, kiwifruit, breadfruit, fig, rose, mulberry, apple, pear, peach, cherry and persimmon are also propagated by root cuttings.



Leaf cuttings: Propagation through leaf bud cuttings is partially useful in species where leaves develop root system but die because of non-development of shoot system. Leaf bud cuttings are particularly useful when planting material is scarce because the each node in leaf can be used as cutting. Leaf bud cutting should preferably be prepared during growing season because buds if enters into dormancy may be difficult to force to active stage. A leaf bud cutting consists of a leaf blade, petiole and shoot piece of stem with attached a xillary bud of actively growing leaves. In leaf bud cutting, 1-15cm stem portion is used when propagating material is small. It is useful method of propagation in blackberry, raspberry, lemon, camellia etc.

Conclusion

Treated cutting with the growth regulator solution roots earlier than the untreated ones. However, certain species do not root even after the treatment. Treated cutting produce more number of roots. Semi-hard and soft wood cutting perform better than the hard wood culture. Maximum success is obtained during period of active cell division.

Table14- B. Calculation of strength of growth regulators

Percent solution(%)	Milligram1litre(mg/l)	Parts per million (ppm)	Gram/litre*(g/l)
100	1,000,000	1,000,000	100
10	100,000	100,000	10
1	10,000	10,000	1
0.1	1,000	1,000	0.1
0.01	100	100	0.01
0.001	10	10	0.001
0.0001	1	1	0.0001

*(1) 1.0percent =10,000ppm,(ii)ppm=percentagex10,000 (iii)percentage=ppm
10,000

Precautions:

1. Cuttings of appropriate type should be selected and prepared.
2. Concentration of rooting hormone should be prepared accurately.
3. Rooting media should be prepared in accurate proportion.
4. Optimum level of relative humidity should be maintained.

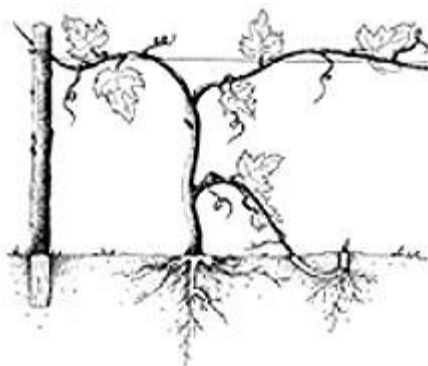
Exercise No.-9

Objective: Practicing different types of layering.

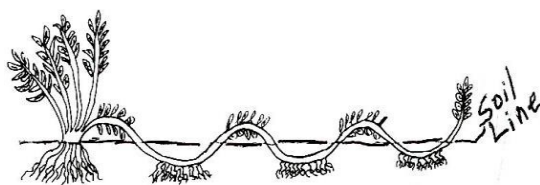
Materials Required: Secateurs, prepared nursery beds, growth hormone, sensitive balance, alcohol, measuring cylinders, small tub, planted mother stool

Procedure(s): The most commercially used methods are mound layering for multiplication of rootstocks and air layering for some tropical fruits.

Simple Layering: Simple layer consists of bending an intact shoot to the ground to cause adventitious root to form. The method can be used to propagate a wide range of plants, in door or outdoor on wood shrubs that produce numerous suckers. Layering is usually done in the early spring using flexible, dormant, one year-old shoot-branches of the plant that can be bent easily to the ground. These shoots are bent and “pegged down” at a location 15 to 20 cm (6-9 inches) from the tip forming a “U”. Bending, twisting, cutting, or girdling at the bottom of the “U” stimulates rooting at that location. The base of the layer is covered, leaving the tip exposed.

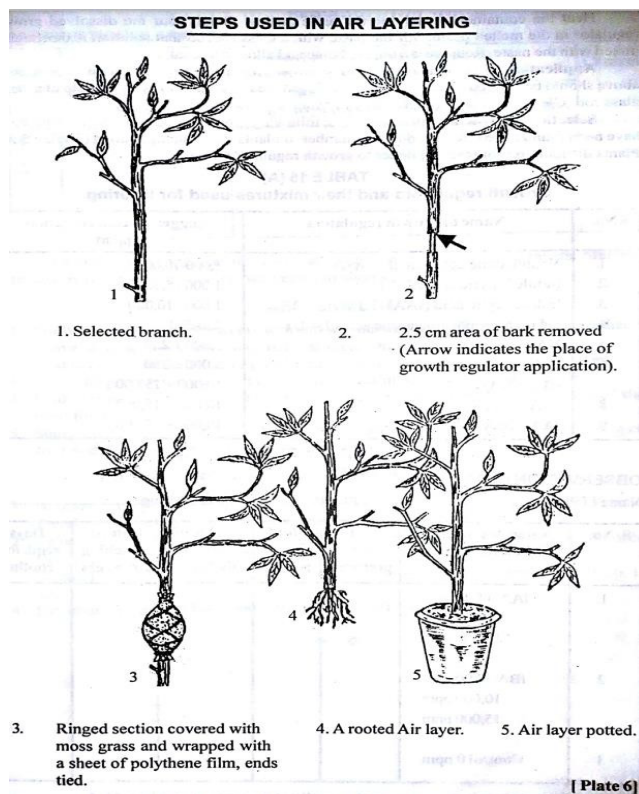


Compound or serpentine layering: It is modification of simple layering in which one year-old branch is alternatively covered and exposed along its length. The stem is girdled at different points in the underground part. However, the exposed portion of the stem should have at least one bud to develop a new shoot. After rooting, the sections are cut and lined out in the field. In this way many new plants can be made from one branch. It is also an easy plant propagation method to perform but is only suitable for plants producing slender, long and flexible shoots. Muscadine grape is commercially propagated by this method.

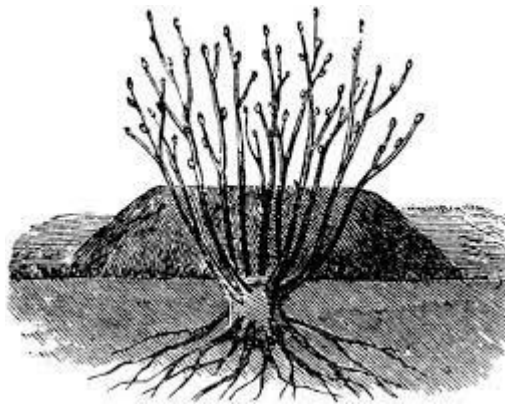


Continuous ortrench layering: It is the most common method of propagation in woody plants, which produce long vines and are difficult to propagate by other methods of propagation. Vigorous roots of apple like M-16, and M-25 and walnut can usually be propagated by trench layering. In this method, it is important to establish a permanent row of plants to be propagated. The mother plants are planted at the base of a trench at an angle of 45° in rows spaced 90 cm apart. The long and flexible stems of these plants are pegged down on the ground to form a continuous line of layered plants. The young shoots that arise from these plants are gradually mounded up to a depth of 15-20 cm in autumn, winter or at the end of the growing season, depending on the species to be propagated

Air layering (Marcottage, Gootee, Pot Layerage): Air layering is an ancient method of layering, originally introduced from China and now commercially used for propagation of a number of tropical and subtropical trees and shrubs including litchi, longan, Persian lime (*Citrus aurantifolia*) , ficus, croton etc. Air layers are made in the spring or summer on stems of the previous season's growth. The presence of active leaves on the layered shoot speeds root formation. Layers are prepared by making an upward cut about 5 cm long at or about the centre of the shoot. The shoot is then girdled by removing a ring of bark about 2 cm wide. The upper part of wound is applied with IBA paste made in lanolin. The wound is covered with moist sphagnum moss in a way to provide complete cover to it. Polyethylene film is wrapped around the moss grass in such a way as to leave no opening, which could allow evaporation of moisture from the moss. Pruning to reduce the top in proportion to the roots is usually advisable. The rooted layers may be severed from mother plant and may be planted in the nursery under shade.



Mound /Stool layering or stooling: The term stooling was first coined by Lynch in 1942. Mound layering is a method where the shoots are cut back to the ground and soil or rooting medium is mounded around them to stimulate roots to develop at their bases. This method is commercially used to propagate apple, pear, quince, currants, gooseberry and other fruit crops. In stooling, the mother plant is headed back to 15 to 20 cm above ground level during dormant season (Fig. 7.1). The new sprouts will arise within 2 months. The sprouts are then girdled near the base and rooting hormones (IBA), made in lanolin paste is applied to the upper portion of the ring, the concentration of IBA depends on species but generally 3000 to 5000 ppm is commonly used. These shoots are left as such for two days for proper absorption of rooting hormone, before they are covered with moist soil. Care should be taken to keep the soil heaps moist all the times. It facilitates rooting in the stools. The roots in shoots may emerge within 30 to 40 days. However, the rooted shoots should be severed from the mother plants only after 60 to 70 days and then planted in the nursery.



Tip layering: It is the simplest form of layering, which often occurs naturally. It is a natural method of propagation for black berries, raspberries etc. The tip of the shoots is bent to the ground and the rooting takes place near the tip of current season shoot. The stem of these plants completes its life in two years. The tips of shoots are buried 5 to 10cm deep in the soil. Rooting in buried shoots takes place within a month. The new plants (layers) may be detached and transplanted in the soil during spring. Currants, gooseberries and rambling roses can also be propagated by tip layering easily.

Precautions:

1. The incisions should be given carefully
2. The earthing – up should be done carefully
3. The detached tools/layers should be lined out properly for hardening and ensuring saleable growth

Exercise No. -10

Objective: Practicing of different types of apical

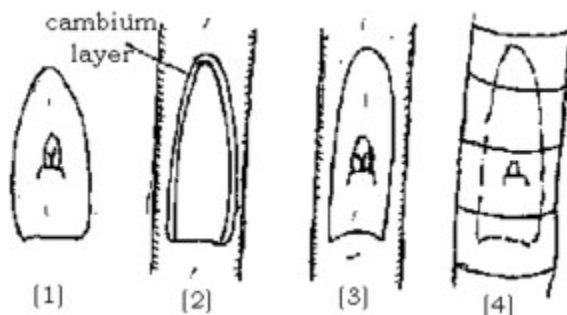
Grafting.

Materials Required: Secateurs, grafting knife, scion wood, rootstock, wrapping material

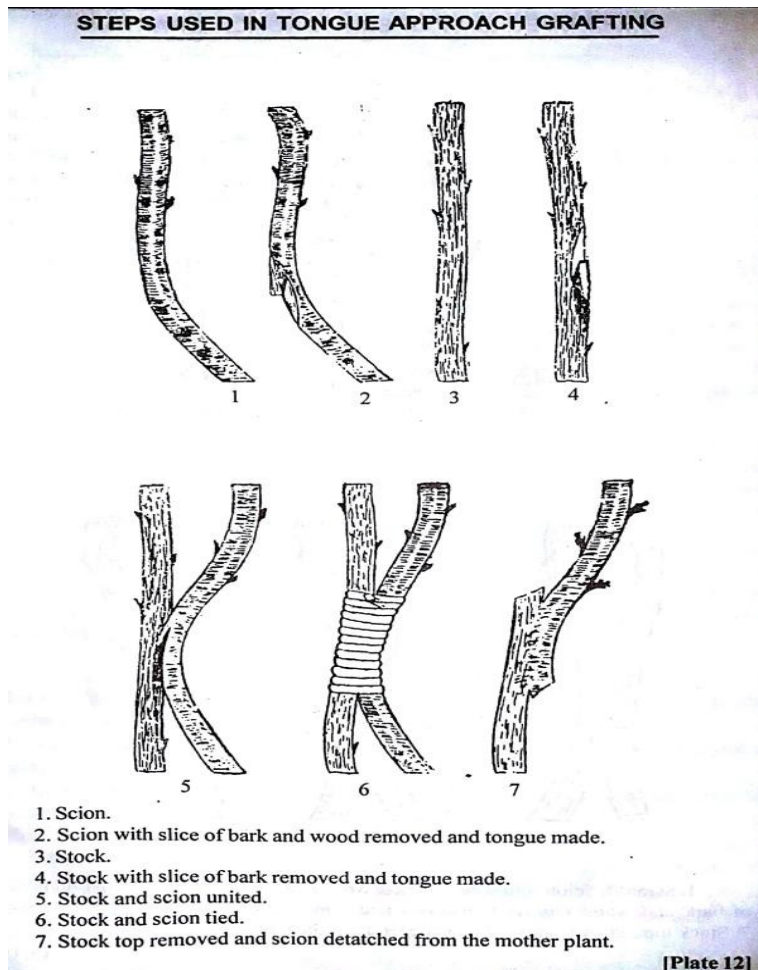
Procedure: Before practicing any grafting method, the selection of optimum size, thickness of root stock and scion is of prime importance. The sequential steps involved in different methods are described as under:

A. Apical Grafting:

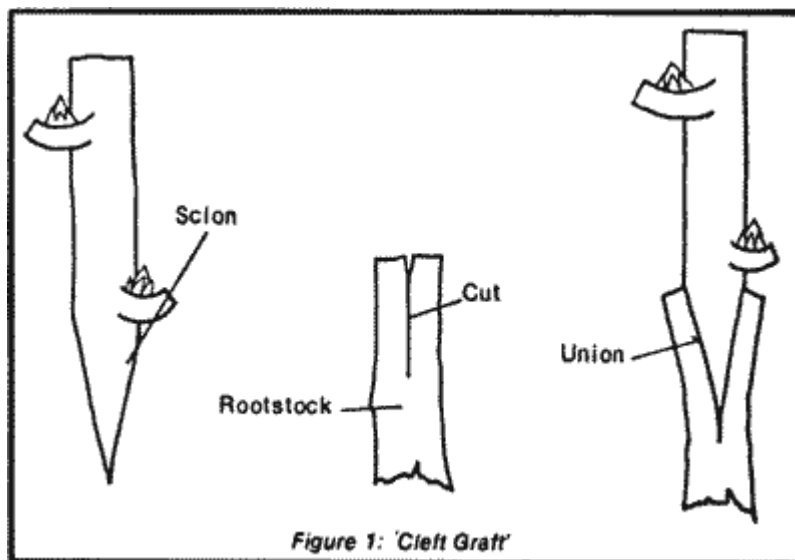
Splice or whip grafting: In this method, it is essential that both the stock and scion should be of equal diameter. For this, about one year old rootstock is headed back at a height of 20-25 cm from the soil and a splice(diagonal) cut 2.5 to 6 cm long) is made at the distal end of the root stock with the help of a sharp knife. A similar slanting cut is made on the proximal end of the scion. The cut should be smooth and the cut surface of both the rootstock and scion are bound together and tied firmly with polythene strip. After the union has taken place, the root stock above the union is lopped off gradually. Sprouts arising below the grafting union must be removed at regular intervals to divert flow of metabolites for the growth of scion only.



Tongue grafting: It is modified form of whip grafting. It differs from whip grafting that a reverse cut is made downward at a point about $\frac{1}{3}$ rd of the distance from the tip and should be about $\frac{1}{2}$ the length of first cut. To obtain a smooth-fitting graft, the cut should not split. The rootstock and scion is then inserted into each other, with the tongues interlocking. It is important that vascular cambium layer match along at least one side, preferably along both sides. A similar slanting cut is made on the proximal end of the scion. The cut should be smooth and the cut surface of both the rootstock and scion are bound together and tied firmly with polythene strip. After the union has taken place, the rootstock above the union is lopped off gradually. Sprouts arising below the grafting union must be removed at regular intervals to divert flow of metabolites for the growth of scion only. The lower tip of scion should not overhang the stock as there is a likely hood of the formation of large callus knots. The use of scions larger than root stock should be avoided. After the scion and rootstock are fitted together they are securely held by tying with budding/grafting tape or polythene. This method gives better success because of better cambial contact between stock and scion due to formation of tongue. Regular de-shooting of sprouts on stock is required to obtain better growth of scion.



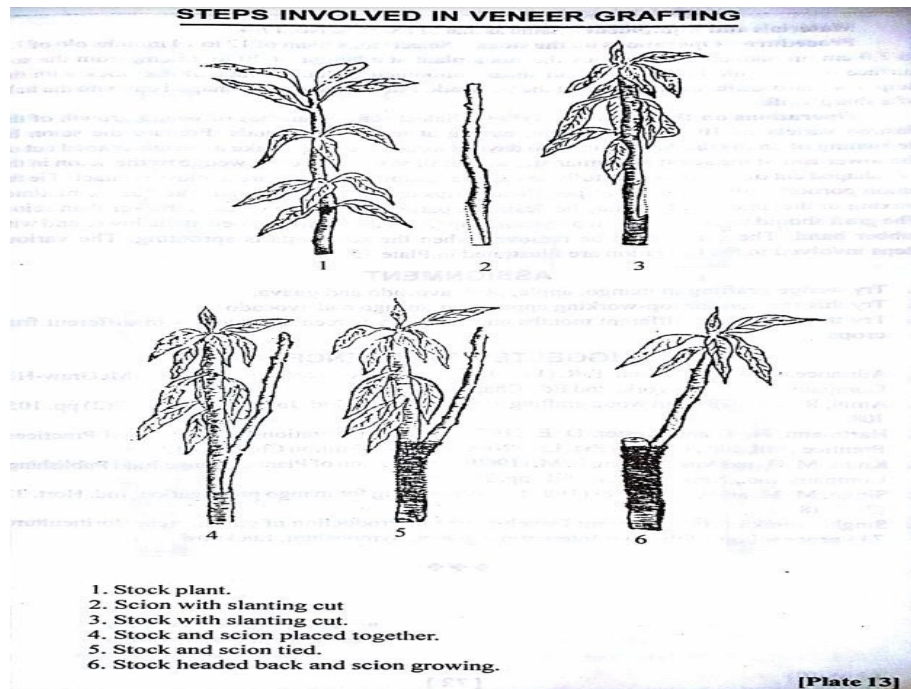
Cleft-grafting (wedge or split-grafting): It is one of the oldest methods of field grafting. It is used to top work trees, either in the trunk of a small tree or in the scaffold branches of a longer tree. In making the cleft-graft, a heavy knife is used to make a vertical split for a distance of 5 to 8 cm down the center of the stub to be grafted. This split is made by pounding the knife in with a hammer. The branch is sawed off in such a way that the end of the stub which is left is smooth and free of knots for at least 15 cm. Two scions are inserted, one at each side of the stock where the vascular cambium layer is located. The scions should be 8 to 10 cm long and 10-15 mm in thickness and should have two or three buds. The side of the wedge which is to go to the outer side of the rootstock should be slightly wider than the inside edge. When the knife is removed, a hard wooden wedge is inserted to keep it open for the subsequent insertion of the scion. The graft should be thoroughly waxed to prevent wilting of the scion. The scion starts growing after 2 to 3 months of grafting. The right time for cleft grafting is the later part of the dormant season or just before the start of active growth. Walnut, hazelnut, pecan nut and grapes are propagated by this method.



Wedge grafting (saw-kerfs grafting): It is performed in late winter or early spring before the bark begins to slip. A sharp, heavy, short bladed knife is used for making a V-wedge in the side of the stub or stock about 5cm long. Two cuts are made, coming together at bottom and as far apart at the top as the width of the scion. These cuts extend about 2 cm deep into the side of the stub. The base of the scion is trimmed to a wedge shape exactly the same size and shape as the opening. With the two vascular cambium layers matching the scion is tapped downward firmly into place and slanting outward slightly at the top so that the vascular cambium layers cross. After all scions are firmly tapped into place, all cut surfaces including the tips of the scion, should be waxed thoroughly. It is called saw-kerfs because the cuts in the side of the rootstock can be made with a saw rather than the sharp knife.

B. Side Grafting Methods:

Side veneer grafting: This method is used for grafting small potted liner plants such as seedling of deciduous trees, shrubs and fruit crops. A shallow downward and inward cut from 1 to 1 1/2 inches long is made. At the base of this cut, a second short inward and downward cut is made, inserting the first cut, so as to remove the piece of wood and bark. The scion is prepared with a long cut along one side and very short one at the base of the scion on the opposite side. These scion cuts should be of the same length and width as those made in the rootstock so that the vascular cambium layers can be matched as closely as possible. After inserting the scion, the graft is tightly wrapped with polythene sheet strips. After the union has healed, the rootstock can be cut back above the scion in gradual steps.



Precautions:

1. Scion wood should have 3-5 buds.
2. Wrapping of grafts should be performed carefully to avoid air entry at the point of grafting.
3. Grafted stock should be irrigated at regular intervals.
4. De-shooting of sprouts below graft union should be done as the sprouts appear. The wrapping material should be removed when it gets tightened.

Exercise No. -11

Objective: Practicing of different types.

Materials Required: Secateurs, grafting knife, scion wood, root stock, wrapping material

Procedure: Before practicing any grafting method, the selection of optimum size, thickness of root stock and scion is of prime importance. The sequential steps involved in different methods are described as under:

Methods:

The characteristic feature of is that two independent, self-sustaining plants are grafted together. After the formation of union, the top of rootstock plant is removed above the graft and the base of the scion plant is removed below the graft. Generally, it is performed with one or both of the plants to be grafted growing in a container. Rootstock plants in containers may also be placed adjoining an established plant which is to furnish the scion part of the new grafted plant. It must be performed in the season when growth is active and rapid healing of the graft- union will take place. The important methods are:

a.) Spliced : In this method both scion and stock should be of same thickness(Fig.9.6.). A splice of 4-5 cm bark and wood is removed both from stock and scion. The cut on both the partners should be of same size and should be smooth too. The cut surfaces of stock and scion are bound together with some suitable tying material and waxed properly. The stock above the union and scion below the union are cut after sometime, when proper union has taken place. It may be necessary to reduce the leaf area of the scion if it is more than the root system of the rootstock can sustain.

b.) Tongue : The tongue approach graft is the same as that of the spliced -except that after the first cut is made in each stem to be joined, a second cut downward on the stock and upward on the scion is made, by providing a thin tongue one a chip piece . By interlocking these tongue slightly, a closely fitted graft union can be obtained.

c.) Inlay : The inlay may be used if the base of the rootstock plant is considerably thicker than that of the scion plant. A narrow slot, 7.5 to 10 cm long is made in the bark of the rootstock plant by making two parallel knife cuts and removing the strip of bark between. This can be done only when the root stock plant is actively growing and the bark slipping. The slot should be exactly as wide as the scion to be inserted. The stem of the scion plant, at the point of union, should be given a long shallow cut along one side, of the same length as the slot in the rootstock plant and deep enough to go through the bark and slightly into the wood. This cut surface of the scion branch should be laid into the slot cut in the rootstock plant and held there by nailing with two or more small, flat headed wire nails. The entire union must then be thoroughly covered with grafting wax. After the union has healed, the root stock can be cut off above the graft and the scion below the graft. tied with waxed string or poly tape to keep them together.

Precautions:

1. Scionwood should have 3-5 buds.
2. Wrapping of grafts should be performed carefully to avoid air entry at the point of grafting
3. Grafted stock should be irrigated at regular intervals
4. De-shooting of sprouts below graft union should be done as the sprouts appear
5. The wrapping material should be removed when it gets tightened

Exercise No. -12

Objective: Practicing different types of repair Grafting.

Materials Required: Secateurs, grafting knife, scion wood, root stock, wrapping material

Procedure: Before practicing any grafting method, the selection of optimum size, thickness of root stock and scion is of prime importance. The sequential steps involved in different methods are described as under:

Repair Grafting:

1. **Inarching:** Inarching is similar to in that both rootstock and scion plants are on their roots at the time of grafting. It differs in that the top of the new rootstock plant usually does not extend above the point of the graft union as it does in Inarching is used to replace roots damaged by cultivation equipments, rodents or diseases. It can be used to very good advantage in saving a valuable trees or improving its root system. Seedlings (or rooted cuttings) planted beside the damaged tree, or suckers arising near its base are grafted into the trunk of the tree to provide a new system to supplement the damaged roots. The seedlings to be inarched into the tree should be spaced about 10-15 cm a part around the circumference of the tree if the damage is extensive. The seeding of compatible species is planted around the tree during dormant season and graft when active growth commences in early spring. Inarching will enhance growth of un injured older trees. A thin slice of bark (6-10 cm in length) at about 20 cm above the ground level is removed from the stock with a sharp knife. A similar cut is made in the scion. Thus, the cambium layers of both stock and scion are exposed. These cut are brought together and tied firmly with the help of polythene strip. After the successful union, stock above and scion below union are lopped off gradually. In low rain fall are as, it should be done with the on set of rains, while in regions of heavy rain fall; it should be done soon after the rainy season is over, provided temperature does not fall below 15°C.
2. **Bridge Grafting:** Bridge grafting is basically not a method of propagation but a form of repair grafting only in plants, which have been damaged either by frost, rodents or insects. It may, however, be kept in mind that bridge grafting is only helpful if the trunk is damaged but the root system of the plant is healthy. In this method first, the damaged portion of the stock is cleaned and the irregular edges of the girdled area are cut evenly. The scion of desired variety is inserted in such a way that it is attached at both upper and lower ends into the living bark. Similarly, it is important that scions be inserted right side up to ensure the polarity. The exposed injured wood must also be covered otherwise; it may serve as an entry channel for decaying organisms.
3. **Bracing:** Bracing is a form of natural branch grafting that is used by fruit growers to strengthen scaffolding limbs of a tree in order to support the load of the fruit crop. In this method two strong, young lateral shoots from the limbs are to be braced. A rope or electrical cord is used to temporarily brace the larger limbs. The weaved smaller shoots, which will naturally graft, are tied with waxed string or poly tape to keep them together.

Precautions:

1. Scionwood should have 3-5 buds.
2. Wrapping of grafts should be performed carefully to avoid air entry at the point of grafting
3. Grafted stock should be irrigated at regular intervals
4. De-shooting of sprouts below graft union should be done as the sprouts appear
5. The wrapping material should be removed when it gets tightened

Exercise No.-13

Objective: Practicing different types of budding

Materials Required: Secateurs, budding/grafting knife, scion wood, rootstock, wrapping material.

Procedure: Methodology followed in different budding techniques is described as under:

:

Chip Budding: Chip budding is done in early spring, summer or autumn. In chip budding a chip of bark and wood is removed from the smooth surface between the nodes of the stock. A chip of similar size and shape is also removed from the bud wood of the desired cultivar. For which a 2-3cm long downward cut is made through the bark and slightly into the wood of the stock. Then a second cut of about 2.5cm is made so that it bisects the first cut at an angle of 30-45° and the chip is removed from the stock. Similarly a chip of bud is removed from the bud-wood, ensuring that the bud is in the middle of chip. The bud chip inserted in the stock in such a way that cambium of the bud chip should have direct contact with the cambium of the stock. It is then tightly wrapped with some wrapping material like polythene strip, leaving the bud uncovered. The bud may sprout after 3-4 weeks and afterwards the wrapping material should be removed. When the bud starts growing, the stock may be cut propagated by this method.

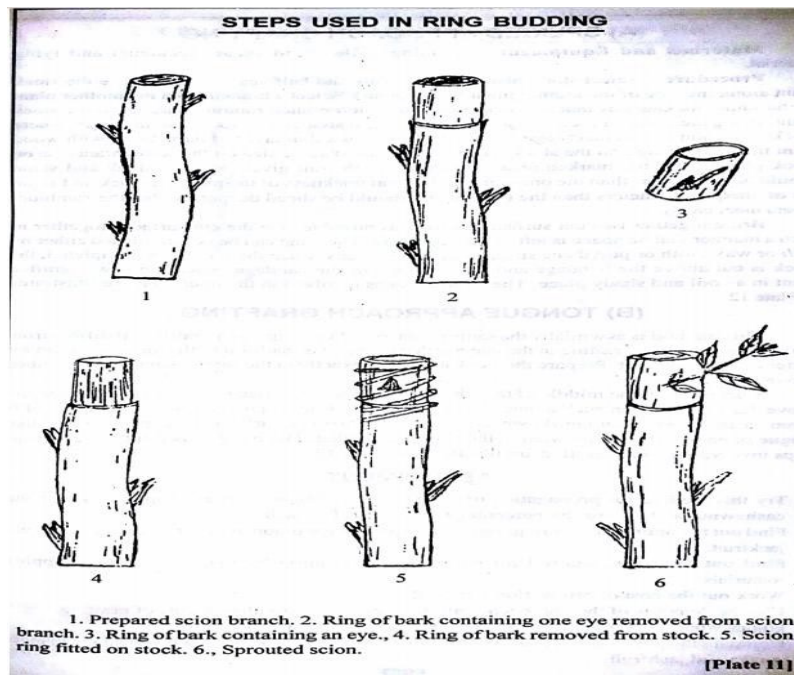
Shield or T-budding: As the name indicates shield is the shape of the bud and 'T' is the shape of cut given on the rootstock. It is the most common method of budding used by nurserymen worldwide. For shield budding one year old rootstock seedlings of 25-35cm height and 2-2.5cm thickness is selected. The bark of seedlings should slip easily. The selected bud of desired cultivar is inserted 15-20cm above the ground level and is tied with a polythene strip. For performing budding operation, a "T" shaped cut is made on the selected portion of the stock with the help of a sharp budding knife. The incision should be given through the bark not the wood. The two flaps of bark are loosened with the help of budding knife. The healthy bud is removed from the bud wood by cutting shallowly about 5-6 mm below and 2-3cm above the bud. This shield piece containing a bud is inserted in the "T" cut made on the rootstock. The shield should be covered by two flaps of the bark, but bud should be exposed. The buds are pressed firmly, fitted into the "T" cut and finally tied with polythene strip. When bud healing process is over, the Bud may attain height of 15-20cm, the remaining portion of the stock is cut to about 10-15cm

above the bud. Plants with thin bark, with sufficient flow of the sap like apple, pear, peach, plum and apricot, cherry, rose and citrus are propagated by this method.

Patch budding: In case of patch budding a rectangular patch of bark is removed completely from the rootstock and replaced with a patch of bark of the same size containing a bud of the cultivar to be propagated. It is slower and difficult to perform than T-budding. It is widely used in thick-barked species, such as walnuts and pecans and rubber tree, where T-budding gives poor results due to poor fit around the margins of the bud-particularly the top and bottom. It is usually done in late summer or early fall, but can be done in spring also. In patch budding, the stock and scion should preferably be of same thickness (20-25mm). First a rectangular piece of bark (25mm long and 10-15cm wide) is removed from the stock and a similar patch, containing a bud is removed from the scion by making two horizontal cuts above and below the bud and then two vertical cuts connecting the horizontal cut. After removing the patch, the bud should fit tightly at the top and bottom. It is then wrapped with polythene strip, keeping the bud uncovered. The

wrapping material should hold the bark tightly and cover all the cut surfaces to prevent free entry of air or water. After the bud starts sprouting, the stock above the bud union may be cut off step by step. In addition to pecan nut and walnut, mango, rubber plant, aonla, jackfruit and jamunare also propagated by this method.

Ring or annular budding: In this type of budding, a complete ring of bark is removed from the stock and it is completely girdled (Fig.11.4). A similar ring of bark containing a bud is removed from the bud stick and is inserted on to the root stock. The thickness of stock and scion should be same size. It has been utilized in ber, peach and mulberry because the newly emerged shoots from the heavily pruned plants are capable of giving such buds for budding, which can be easily separated. In this method since the stock is completely girdled and if the bud fails to heal in, the stock above the ring may eventually die.



Forket budding: In forket budding, the stock is prepared by giving two vertical cuts and a transverse cut above the vertical cuts to join them. The bark is removed carefully along the cuts, so the flap of bark hangs down. The scion is prepared in a fashion similar to patch budding, having the size similar to cuts made on the stock. The scion is then slipped into the exposed portion of the stock and the flap is drawn over the inserted bud patch. It is then tied with a suitable wrapping material. After successful growth of bud, the portion of stock above union is removed carefully.

Flute Budding: In flute budding, the bark patch from the stock is removed in such a way that it almost completely encircles the stock except with an arrow bark connection between the upper

and lower cuts on the stock. A similar patch of bark is removed from bud stick containing a healthy bud. The shield containing the bud is then inserted in the vacant area of the stock; the shield should fit tightly on the stock. It is then wrapped with suitable wrapping material, leaving the bud uncovered. The other procedure is same as in patch budding. Because of presence of a narrow connecting strip of bark on the stock, it remains alive even if the bud fails to sprout.

I-budding: In I-budding the bud patch is cut in the form of a rectangle or square, just as for patch budding. With the same parallel-bladed knife, two transverse cuts are made through the bark of the root stock. These are joined at their centre by a single vertical cut to produce the shape of letter-I. The two flaps of the bark can then be raised to insert the bud patch beneath them. A better fit may occur if the side edges of the bud patch are slanted. In tying the I-bud one should ensure that the bud patch does not buckle outward and leave a space between the rootstock. I- budding is the most appropriate when the bark of the rootstock is much thicker than that of the bud stick. In such cases, if the patch buds are used, considerable paring down of the bark of the rootstock around the patch would be necessary.

Micro-budding: Micro-budding is used successfully for propagating citrus particularly in Australia. It is similar to “T” budding except that the shield (bud piece) utilized is thin and tiny like “T-budding”;the micro budding is also not done under aseptic conditions. The petiole is cut off just above the bud and then bud is removed from the bud stick by a flap cut just underneath the bud. Thus, only the buds are utilized in micro-budding. In stock an inverted “T” cut is made and the tiny shield containing the bud is inserted in it and later tied with a thin plastic tape. The tape may be removed soon (15-20 days) after the healing has taken place.

Precautions:

- (i) The bud to be used as scion should be mature.
- (ii) Wrapping of bud union should be performed carefully to avoid air entry at the point of union.
- (iii) Budded stock should be irrigated at regular intervals
- (iv) De-shooting of sprouts below bud union should be done as the sprouts appear
- (v) The wrapping material should be removed when it gets tightened.
- (vi) In case of chip budding in fall season the bud grafts should be protected from chilly winter
In cold arid conditions.

Exercise No.-14

Objective: To maintenance of nursery records.

Materials required: Registers,chronological operation record,nursery map

Procedure(s):Some records are essential if nurseryman is to plan his nursery for remunerative returns and establish as a reputed enterprise. A nursery planner should know how long it takes to lift saplings or how much seed is required, or how much cuttings he can accommodate in a glasshouse or how much scion wood is required for grafting a particular plot of nursery. There must be specific register for specific selected activities to keep day to day or pedigree or operation records in nursery. These records are required by law to satisfy inspecting authorities, tax calculation, detect or discourage theft in case of big nurseries. The important aspects for which maintenance of record is necessary are as under:

Progeny orchard record: The exact map of progeny orchard is drawn in a register, which depicts the date of plantation, source of mother orchard plants, layout record of different fruit varieties. The addition or deletion of any variety needs to be recorded chronologically. The quantity of scion wood taken from individual mother plant should also be recorded, so as to quantify the volume of cuttings per plant and total strength of mother plants required to be maintained to cater the demand/need of particular nursery or nurseries.

Nursery layout record: The layout plan of nursery plots crop wise, and within crop variety wise, mentioning direction of plots starting or ending. The plots should also be labeled with tags or field plates, if there is no risk of theft. This helps in ensuring the proper record along with date of budding/ grafting, days taken to sprout etc.

Cultural operations record: The record of different operations such as of seeds, date of sowing, date of germination, farm operation such as record of spray dates, date of budding /grafting , fertilizer application and dose applied. Any other foliar spray including insecticides, fungicides, growth regulators and nutrient sprays etc.

Disposal register: The record of salable plants left after thorough inspection is maintained in this register. The record is maintained crop wise, variety wise, which will tell us the expected out come from the nursery and help in accounting purposes.

Advisory/visitor register: The suggestions of experts invited to address specific problem should be recorded in this register, with his own hand. The record of visitors should be maintained with specific remarks and feedback from the field. Some of the valuable remarks of experts and experienced nurserymen can be put in practice.

Precautions:

1. All registers should be issued through Inventory Register, so that record of number of registers maintained is known.
2. The specific information should be recorded.
3. Nursery men should not be bias in recording specific problems.

Exercise No.-15

Objective: To demonstrate application of nutrients and plant protection measures in fruits plant nursery.

Materials required: Specific fertilizer, or nutrient source, hoeing tools, spraying equipments, weighing machine (balance).

Procedures: The choice of method of application of nutrients to the nursery plants depends on the nutrients and their ability to be effectively absorbed effect on soil environment, equipment availability and the relative cost of nutrients. Three important application are:

Surface application: The required quantity of fertilizer is weighed and applied in band along the rows. It is an effective and efficient method for the application of nitrogen, because nitrogen fertilizers move into the root zone with the downward movement of water. However, direct surface application is not advised for the application of phosphorous, potassium and other nutrients because they may get fixed on the exchange complex.

Sub-surface application: Addition of the fertilizers into the soil by surface application is the most effective method of application of nutrients that are fixed (P&K etc) on the exchange complex or are slow to move into the soil solution. The manures/fertilizers are incorporated into the soil prior to planting the nursery.

Foliar application: Nutrients can be applied through foliar application immediately, after the symptoms are observed. For nursery plants, foliar application is more effective because nutrients are absorbed at faster rates and wastage of nutrients can be avoided. The nutrients should be applied in the morning or late evening hours by using some wetting agents like Tween-20, Titron-X-100 etc. in the solution, as these help to absorb the nutrients even more effectively.

Precautions:

1. The nutrient quantities must be calculated and weighed exactly.
2. The basal applied nutrients should be mixed thoroughly.
3. For foliar spray, the nutrient source should be dissolve dproperly.

Exercise No.-16

Objective: To identification of horticultural tools and implements.

1. Sickle: Used for cutting grass, fodder and harvesting crop. Sickle made of steel is better and lasts longer.



2. Khurpi: An useful tool for weeding in vegetable garden and towers teds. It is used for lifting seedlings and plants from the nursery Useful tool tor transplanting and planting plants, The shape and the size determines the nature of work which can be taken with khurpi.



3. Hand Hoe: Effective and efficient tool for weeding in beds and gardens. It can be used for preparing basins, beds and seedbeds. Long wooden handle enables to work without bending. Ideal steel for hoe is high carbon steel.



4. Rake: Ideal tool for leveling land and collecting weed. It can also be used for breaking clods. Rake made up of high carbon steel lasts long. A good rake should have teeth's.



5. Watering Can: Used for irrigating potted plants when fitted with rose, it can be used for irrigating seed beds. They are available various capacities.



6. Trowel: Useful handy tool for lifting young seedling from nursery beds. It helps in lifting seedling without much injury to roots. It is available in market in different shape and size.

7. Pruning Knife: Used for pruning branches and suckers. It can be used for grafting purposes too. The edge of knife remains sharp for a longer period if it is made from high carbon steel.



8. Budding Knife: Used in budding operations. Curved points help making vertical cut on the stock plant. The blade is used for opening bank of rootstock for placing bud. It can be used for making cutting, pruning young shoots and tender branches.



9. Grafting Knife: It is used for separating scion shoot, defoliating scion shoot and making incision on root stock. In grafting operation, also used for pruning and making cuttings. Grafting knives made from high carbon steel are better



10. Secateur: Used for pruning branches of lead pencil thickness. It is used for making cuttings and removing dead flowers and branches.



11. Pruning Saw: Used for cutting thick branches. It is more effective for removing dead and thick branches which over 6cm, in diameter.

12. Lopping shear: Excellent tool for pruning branches thick erthan alead pencil. It is useful tool for hard wood cutting.



13. Hedgesshear: Used for trimming hedges and edges. Also used in making to piary



14. Clipper: Used for clipping soft grass of lawn and edge where lawn mower not cover.



BWG

15. Fork: Used for lifting manures and plant. Useful garden tool in nursery preparation. It is also useful for shifting compost and garden rubbish.



16. Pole shear: Useful for pruning branches of outer periphery of the tree and are 3-4 meter high. The branch is fastened by opening the blade. The blade cuts the branches when rope or chain is pulled.



17. Sprinkler: Useful for irrigating lawn and kitchen garden. Water comes out as spray. There is economy of water as well and it also covers larger area in shorter time.



18. Knap-Sack-Sprayer: It is back mounted. Sprayers are useful for spraying insecticide, fungicide, or herbicides. It is also used for foliar application of fertilizers. It should have a fine nozzle for uniform spray. Sprayers are available in the market in different capacities. They may be foot operated or hand compressed sprayers.



19. Sword: Used for cutting grass or weeds from garden and lawns. It covers a large in small time.



20. Pick Axe. It is made of carbon steel. Pick axe have two edges with provision of axial hole for attachment with handle. One edge of pick axe is pointed and another is broadened. It is used for digging hard, compact and stony soils.



21. Kudali. It can also be said as single pick axe. It is used for digging compact soil.



22. Pronged Hoes, It is having two, three or four arms. It is used for digging of hard stony sol and also for digging tuber crops like potato, tunipete. Besides, it is useful for mixing manure.



23. Spade. It is used for lifting and turning the soil. Also used for digging the pit,preparing channel for irrigation and drainage.



24. Furrow Opener. It is used for opening narrow and shallow furrow after sowing seeds in the nursery.



25. Hand Leveller. It is used in small beds and nursery for levelling land and covering the seeds after sowing. It is also used for evenly distributing the applied manure.



26. Trowel. It is used for uplifting nursery plants and also for transplanting seedlings.



27. Axe. It is used for felling and cutting branches.



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29. Lawnmower-It Is used for cutting lawn grass from ground layer.



Exercise No.-17

Objective: Application of plant protection chemicals in the nursery.

Materials required: Specific pesticide, spraying equipment, sensitive balance and water.

Procedures: The nursery plants being tender in nature are more prone to be infested by insect-pests and disease and may cause considerable loss. Some of major insect-pests include scales, thrips, white flies, beetles, mealy bugs, mites, leaf eating caterpillars, leaf miners, cutworms, snails and slugs. The common diseases are damping off, powdery mildew, leaf spots, blights and dieback etc. Damping off is caused by many fungi but *Pythium*, *Phytophthora*, *Rhizoctonia* and *Botrytis* are major causal fungi. It usually appears shortly after the emergence of seedlings. The main symptoms of this disease are the girdling of the seedling stem near the soil surface. The prevention of these diseases, insect-pests and environmental factors can be made in following ways.

Disinfestations: It is the process of removing organisms from the seed surface. The chemicals used to disinfect the seeds are ethyl alcohol, calcium hypo chloride and mercuric chloride. In general, 50 percent ethyl alcohol, 2 percent calcium chloride and 0.01 percent mercuric chloride concentration are used. The duration of treatment varies from 5 to 30 minutes, depending on size and type of the seed. Prolonged soaking should be avoided as it affects germination. After treatment the seeds are washed with tap water and immediately sown in the nursery.

Disinfection: It is the process to eliminate seed borne diseases. Hot water treatment is most effective disinfection treatment. In this treatment dry seeds are kept in hot water (50 to 55°C) for 10-30 minutes, depending upon the kind of seeds and type of pathogen. Seeds should be stirred continuously and temperature and duration of treatment should be monitored precisely. The seeds are spread in thin layers after the treatment and sun or air drying is followed and sown afterwards. Seeds can also be treated with mercuric chloride and formaldehyde. Nowadays, aerated steam is used commercially. This involves precise control on temperature and vapour flow rate, where injury to seeds is minimum.

Protection: Treatment of seed with different chemicals to protect from pathogens is protection. It includes dry seed treatment and wet seed treatment.

Dry seed treatment: In this method, seeds are thoroughly shaken with chemical in a rotating seed duster for some time, so that chemicals stick properly to the surface. Commonly used chemicals are Brassicol, Captan, Agrosan-G, Ceresan, Thiram and Dithane M-45.

Wet treatment method: In this method seeds are immersed in the liquid suspension of chemical for specific time. Continuous stirring is required so that chemicals do not accumulate at base. After treatment, seeds are dried in sun or shade. For the control of common insect-pest and disease of nursery and their management is listed in the following table:

Common insect-pests and diseases of nursery and their management:

A. Insect pests	Management
Scales	Single spray of Rogor or Metasystox(0.05percent)is quite effective. Repeat it after 15 days interval. Crude oil spray is also useful for controlling the scales.
Thrips	Two sprays of Metasystox or Rogor (0.05 per cent) at fortnightly interval on new growth reduces the population of thrips considerably)
Mealybugs	Collect and destroy the adults. Soil raking in December-January to kill the pupae. Spray Di methoate(0.05per cent)on the crawling insects during February-March Use Ostico sticky bands on the trunks of the mother plants.
White flies	Spray Phosphomidon (0.02percent)or othersystemicinsecticideinthe early stages of infestation.
Mites	Give two sprays of A caricides like Dicofol(0.05percent)and Wettable Sulphur (0.2 per cent) at fortnightly intervals.
Leafeating caterpillars	Spray Sevin/Carbaryl(0.1percent)at the first appearance of the caterpillars. Neem oil (1 per cent) is also effective.
Cutworms	Use light traps for catching the adults. Use poison baits consisting of Malathion (0.1percent),wheat bran and jaggery. Spray Malathionor Quinalphos(0.05percent)before the expected attack of the worms)
Leaf miners	Two sprays of Metasystox or Rogor (0.05 per cent) at fortnightly intervalonnewlyemergedgrowthflushesaresufficient forcontrolling the population of leaf in the nursery.
Snailsand slugs	Hand picking and destruction is the most effective method. Spray of common salt (2percent)is very useful in controlling snails and slugs. Use Metalaldehyde pallets.
B. Diseases	
Damping off	Treat seeds before sowing with ceresin, Thiramor Agrosan@2gper kg seeds. Spray Captanor Bavistin(0.2percent)in the nursery.
Powdery mildew	Give one prophylactic spray of Karathane or Calixin or Wettable Sulphur(0.2percent). Repeat it again if cloudy weather persists for a longer period.

Blights	A single spray of Dithane Z-78 or Bavistin (0.2 per cent) is very effective to check blight disease in the nursery plants
Leaf spot	Give a single spray of Dithane Z-78 or Bavistin (0.2 per cent)
Dieback	Prune the dead portion of plant. Apply Blitox or Bordeaux paste to the cut portion. Spray Benlate (0.2 per cent) as soon as the symptoms become visible.

Precautions:

1. Precise control of time and duration of treatment is necessary.
2. Seed viability may be lost if not done properly.
3. Injury to seed coat or embryos should be avoided.
4. Proper drying is required before storage or sowing.

Exercise No.-18

Objective: Uprooting/digging, labeling and packing of nursery plants.

Materials required: Digging/uprooting tools, labels, sphagnum moss, markers, wrapping material (Hessian cloth)

Procedure(s):

Uprooting/digging of nursery: To avoid the damage to the roots, it is advisable to irrigate nursery, 3-4 days before the actual date of lifting the plants. The lifting of (evergreen spp.) saplings should however be avoided in case if there is heavy rain in the rainy season because earth ball does not form properly if soil is too wet. To achieve high rate of yield survival of ever green tropical or subtropical fruit plants like mango, guava, citrus and litchi etc. these should be uprooted with a ball of earth. In case of deciduous plants like peach, plum, apricot, apple, pear, grapes, walnut, hazelnut, pecan nut, cherry, Kiwifruit and almond etc. can be lifted bare rooted.

Inspection of nursery plants: The uprooted nursery plants should be inspected by the team of experts for thorough check up for parameters like infestation of diseases, attack of insects, healthy root system and other pomological attributes. The unhealthy saplings should be discarded before packing and storage of seedlings.

Labeling of nursery plants: After thoroughly inspection the saplings should be labeled crop wise and variety wise with the help of zinc labels, and plastic labels or wooden labels for proper identification and labeled sale of nursery plants.

Packing of nursery plants: After uprooting and labeling, the saplings should be properly packed. The bare rooted nursery plants of deciduous species should be placed with moist sphagnum moss and wrapped in hessian cloth to avoid drying of roots. The saplings should be wrapped with moist grass or rice straw before putting in polyethylene bags and then kept in baskets. The strawberry runners and vegetable seedlings are first packed in moistened moss grass and kept in hessian cloth bags or in basket for long distant transport.

Packing materials: The different packing materials used for packing of nursery plants are hessian cloth, sacking cloth, paddy straw, dried grasses and plastics etc. The hessian cloth is derived from the best jute, whereas sacking cloth is made from raw grade jute fiber. Different plastic material includes low density polyethylene (LDPE), high density polythene (HDPE), polypropylene (PP) and nylon etc.

Precautions:

1. While uprooting nursery plants, damage to root system should be avoided.
2. Plants offered for sale should be uniform and true to type
3. No negligence in inspection of nursery plants.
4. The packing of nursery plants should be done carefully to avoid drying of root system.

Exercise No.-19

Objective: Visit to private orchards to diagnose nutrient deficiency and other maladies

Annexure-I

List of crops name and their propagation methods of horticultural crops:

Common Name	Commercial propagated methods	Common Name	Commercial propagated methods
Ornamental Plants		Fruit Crops	
Alocasia	Rhizomes	Acidlime	Seed
Amaryllis	Bulbs,bulblets	Cape Gooseberry	Seed
Begonia	Tuberous roots	Coconut	Seed
Belladonnalily	Bulbsandbulblets	Arecanut	Seed
Blood flower	Bulbs	Papaya	Seed
Caladium	Tuberous rhizomes	Passionfruit	Seed
Canna	Tuberous roots	Phalsa	Seed
Caplily	Bulbs	Karonda	Seed,hardwood cutting
Climbing lily	Tubers	Mangosteen	Seed,inarching
Corn lily	Corms	Pummelo	Seed,T-budding
Crocus	Corms	Woodapple	Seed,in situbudding
Crown Imperial	Bulbs	Oilpalm	Seed
Cyclamen	Tubers	Cocoa	Seed
Daffodil	Bulbs	Coffee	Seed
Dahila	Cuttings and tuberous roots	fig	Hardwoodcutting
Day lily	Divisionof roots	Grape	Hardwoodcutting
Fairlily	Bulbs	Pomegranate	Hardwoodcutting
Four O' clock	Tubers	Tea	Softwoodcutting
Freesia	Corms	Lemon	Air,layering,seed
Garland flower	Division of rhizomes	Litchi	Airlayering
Gladiolus	Corns	Avocado	Airlayering
Gloxinia	Rhizomes and stem cuttings	Cherry	Airlayering
Hyacinth	Bulbs	Guava	Stooling
Iris	Rhizomes	Banana	Swardsucker
Lily	Bulbs and offsets	Datepalm	offshoot
Lilyofnile	Offsets and tuberous roots	pineapple	Suckers, slips
Lilyofvalley	Rhizomes	Strawberry	Runners
Magicflower	Tuberoustoots	Almond	T-budding
Oxalis	Bulbs	Aonla	T-budding/patch
Ranunculus	Tubers	Bael	Patch budding
Scentedgladiolus	Corms	Ber	Ring&T-budding
Scilla	Bulbs	Custardapple	T-budding
Snakelily	Tuberous roots	Grape fruit	T-budding
Snakelily	Offsets	Jamun	Shield&patch budding
Tuberose	Tubers	Mandarin	T-budding
Tulip	Bulbs	Sweetorange	T-budding
Water hyacinth	Rhizomes	Peach	T-budding

Wind flower	Tubers	Plum	T-budding
		Olive	T-budding
Aglaonema	Division of basal shoots,nodal cuttings	Pecannut	patch
Anthurium	Seeds	Rubber	Forket budding
Aphelandra	Half re opened wood cuttings	Apple	Tongue grafting
Aralia	Division of crown	pear	Tongue grafting
Araucaria	Seeds	Apricot	Tongue grafting
Asparagus	Division of crown	Cashewnut	Softwood grafting
Aspidistra	Division	Jackfruit	Inarching
Bird of paradise	Seeds	Loquat	Inarching
Calathea	Root cuttings	Sapota	Inarching
Coleus	Herbaceous cutting of slips	Mango	Veneer grafting
Croton	Air layering	Persimmon	Crown grafting
Dieffenbachia	Terminal and nodal cutting	Vegetable Crops	
Draecena	Canepieces	Asparagus	Stemcuttings
Englishivy	Cutting	Basella	Seeds,stemcutting
Indianrubber tree	Air layering	Colocasia	Cormorcormel
Ironplant	Divison of crown	Chow-chow	Whole fruit
Minstera	Air layering	Drimstick	Seedsans stem cuttings
Palms	Offsets	Elephant'sfoot	Offsetsofcorms
Pandaanus	Offsets and division of suckers	Garlic	Clovesand bulbils
Peacockplant	Division of crown	Globeartichoke	Suckers or offshoots
Podocarpus	Shoottip grafting	Horseradish	Root cuttings
Sagopalm	Offsets	Ivygourd	Stem cuttings
Sansevieria	Offsets	Jerusalemartichoke	Sets of tubers roots
Spider Plant	Division of crown	Kakrol	Tuberous roots
Tradescantia	Cutting	Multiplieronion	Bulblets
Yucca	Seeds and offsets	Onion	Seeds and bulbs
Zebrina	Herbaceous cutting	Pointed gourd	Vice cuttings
Acalyapha	hardwood cuttings	Potato	Division of tubers
Allamaanda	Air layering	Rhubarb	Division of crown
Azalia	Hardwood cutting and layering	Sweet potato	Vine cuttings
Bottlebrush	Hardwood cutting and layering	Tapioca	Stemcuttings
Brya	Hardwood cutting and layering	Yam	Division of tubers
Camelia	Hardwood cutting and layering		
Cestrum	Hardwood cutting	Sweetcorn	Seed
Clerodendron	Hardwood cutting	New Zealand	Seed

		spinach	
Clematis	Leaf bud cutting	Cabbage	Seed
Coraltree	Hardwood cutting	Cauliflower	Seed
Hibiscus	Hardwood cutting and layering	Broccoli	Seed
Hydrangea	Softwood and leaf-Bud cutting	Brussel's sprouts	Seed
Ipomea	Hardwood cutting	Knolkhol	Seed
Ixora	Hardwood cutting and layering	Kale/Collard	Seed
Jatropha	Hardwood cutting and layering	Rutabaga	Seed
Juniper	Hardwood cutting	Leaf mustard	Seed
kachnar	Hardwood cutting	Chinese cabbage	Seed
kamini	Hardwood cutting	Horse-radish	Seed
lager stoemaia	Hardwood cutting and layering	Radish	Seed
Lantana	Seed and hardwood cuttings	Rat-tail radish	Seed
Malphigia	Hardwood cutting	Turnip	Seed
Nerium	Cuttings and layering	Cucumber	Seed
Poinciana	Seeds	Muskmelon	Seed
Porlandia	Hardwood cutting	Watermelon	Seed
Russelia	Root cutting	Pumpkin	Seed
Tecoma	Seeds	Summer squash	Seed
Thunbergia	Hardwood cutting	Winters quash	Seed
Woodfordia	Seeds and cuttings	Long melon	Seed
Agasthi	Seeds	Snapmelon	Seed
Amherstia	Seeds and layering	Bitter gourd	Seed
Arjun	Seeds	Bottle gourd	Seed
Auracaria	Seeds, cuttings and layering	Ridge gourd	Seed
Barringtonia	Seeds	Sponge gourd	Seed
Beadtree	Seeds	snakegourd	Seed
Beefwood tree	Freshly harvested seeds	Ash gourd/Wax gourd	Seed
Bottlebrush	Air layering	Teaslegourd/ Kakrol	Seed

Burmeserosewood	Seeds	Chow-Chow	Seed
cammelia	Seeds and cuttings	Tinda/Roundmelon	Seed
Capertree	Seeds and root suckers	Brinjal	Seed
Chalta	Stem cuttings	Tomato	Seed
Champa	Air layering	Chilli	Seed
Covillesglory	Seeds	Pepper	Seed
Colville'sglory	Seeds	Okra/Lady'sfinger	Seed
Deodar	Seeds	Spinachbeet/Palak	Seed
Devil'stree	Seeds	Swisschard	Seed
Divi-divitree	Seeds	Spinach	Seed
Eastertree	Root suckers	Bathua	Seed
Ficus	Seeds	Globeartichoke	Seed
Flameof forest	Seeds	Lettuce	Seed
fameortuliptree	Seeds	Artichoke	Seed
Geigertree	Seeds	Gardenpeas	Seed
Goldenshower (Sondal)	Seeds	Frenchbean	Seed
Greenebony	Stem cutting	Limabean	Seed
Indiancorktree	Hardwood cutting	Broadbean	Seed
Ironwoodtree	Seeds	Cowpea	Seed
jerusalemthorn	Hardwood cuttings	Clusterbean	Seed
Jhau	Seeds	Yardlong bean	Seed
Kadamba	Seeds	Lablabbean	Seed
Kalanj	Seeds	Soybean	Seed
Kanakchampa	Seeds	Wingedbean	Seed
Lilytree	Layering	Methi/fenugreek	Seed
Madtree	Seeds	Kasurimethi	Seed
Madtree	Hardwood cuttings	Carrot	Seed
Magnolia	Air layering	Spices	
Mahogany	Seeds	Allspice	Seeds,budding and approach
Mahua	Seeds	Black pepper	Shoot cutting
Manila Tamarind	Bead tree	Cardamom(large)	Suckers
Milletia	Seeds	Cardamom(small)	Seeds and suckers
Monkey bread tree	Seeds	Cinnamon	Seeds, cuttings or air layering

Mulsari	Seeds	Clove	Seeds
Neem	Seeds	Ginger	Cutting of rhizomes
Palas	Seeds	Peppermint	Suckers
Peacockflower (gulmohar)	Seeds	Saffron	Corms with more than 2.5 cm in diameter
Pines Tree	Seeds	tamarind	Seeds and patch budding
Plumeria	Hardwood cuttings	Turmeric	Rhizomes
Poplar	Seeds	Vanilla	Rooted cutting
Pride of India	Seeds	Basil	Seeds
Purple bauhinia (Kachnar)	Seeds	Common mint	Division of stolens
Raintree	Hardwood cutting	horse radish	Rooted cutting
Rhodoendron	Hardwood cutting	Marjoram	Seeds and stem cuttings
Shisham	Seeds	Oregano	Seeds and stem cuttings
Silk cotton tree (Simbal)	Seeds	Rosemary	Seeds and rooted cuttings
Silver oak	Seeds	Sage	Stem cuttings
Siris	Seeds	Savoy	Seeds
Sterculia	Seeds	Tarragon	Root division and stem cuttings
Thamast tree	Seeds	Thyme	Cuttings
Spices		Belladonna	Seeds and stem cuttings
Poppy	Seeds	Cinchona	Seeds, patch budding And veneer grafting
Rauwolfia	Mostly by seed, stem And cuttings of root	dill	Seeds
Senna	Seeds	Dioscorea	Tuber and its cuttings
Citromellagrass	Rooted slips	Foxglove	Seeds
Eucalyptus	seeds	Ipecac	Seed and stem cuttings
Mehndi	Stem cuttings	Isabgol	Seeds
Kewra	Stem cuttings	Liquorice	Mostly by cuttings And rarely by seeds
Khus	Rooted slips	Peppermint	Stolens
Lemongrass	Seeds	Rose geranium	Stem cuttings
Mint	Stolens	Palm arosagrass	Rooted slips

SUGGESTED READINGS

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