A PRACTICAL MANUAL OF PLANT PROPAGATION AND NURSERY MANAGEMENT

- DR. SHIWANAND PANDEY,
- MR. ROHIT JAISWAL
- MR. MANOJ KUMAR

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About the Author

Dr. Shiwanand Pandey was born in Village and Post Sonkhar Bansi District Siddharh Nagar Uttar Pradesh 272153. He was completed B.Sc. Horticulture in 2015 from Hemvati Nandan Bahuguna Garhwal Central University (UK), M.sc. Horticulture 2017 from Acharya Narendra Deva University of Agriculture and Technology Kumarganj Ayodhya (UP) and Ph.D. from Sardar Vallabhbhai Patel University of Agriculture and Technology Modipurm Meerut (UP). He has published research papers in various International & National Journal and abstract of various International & National seminar He has also qualified NET (National Eligibility Test) in 2020. He is working as Assistant Professor at Baba Farid Group of Institution Suddhowala Dehradun.

Mr. Rohit Jaiswal was born in Village Ranbirpur and Post Sarwan District Mau Uttar Pradesh 275101. He was completed B.Sc. Horticulture in 2015 from Hemvati Nandan Bahuguna Garhwal Central University (UK), M.sc. Agriculture in Extension education 2018 from Acharya Narendra Deva University of Agriculture and Technology Kumarganj Ayodhya (UP). He has published research papers in various Journal. He is working in ICAR-CISH, Rehmankhera, Lucknow as Senior Research Fellow since 2019.

Mr. Manoj Kumar was born in Village and Post Paiga District Bareilly Uttar Pradesh 262407. He was completed B.Sc. (Hons.) Horticulture in 2017 from Banda University of Agriculture and Technology, Banda (U.P), M.Sc. (Ag.) Horticulture 2019 from Sardar Vallabhbhai Patel University of Agriculture and Technology Modipuram Meerut (U.P) and Ph.D. pursuing from Chandra Shekhar Azad University of Agriculture and Technology Kanpur (U.P). He has published research papers in various International & National Journal and abstract of various International & National seminar He has also qualified NET (National Eligibility Test) in 2021.

Preface

The availability of quality seedlings at lower cost offers ample scope for large scale planting. In this juncture, putting efforts on quality seedling production offers scope for sustainable horticulture. Nursery is pre requisite for producing quality seedlings in lesser input and nursery management is a potential tool to execute the activity in successful means. This manual is an attempt for narrating the nursery establishment guidelines, species precise propagation techniques. We assure that "A Practical Manual of Plant Propagation and Nursery Management" will be a valuable field guide for Under Graduate Post Graduate students. We have tried to keep the language as simple and straight forward as possible and consistent with accurate representation of the content. Every effort has been made to present the ideas in very easy and understandable language and the interests of each reader. Finally, I would like to thank one and all who have contributed directly or indirectly in bringing out this manual. Therefore, the definitions or descriptions given here may subsequently be modified. The author, therefore, accepts no responsibility for the legal validity, accuracy, adequacy, or interpretation of the terms given in this manual. The author believes that the reader will get sufficient information concerned with the nursery establishment of horticultural crops. There may, however, be still some short coming in this manual and the author will really grateful to receive suggestion from readers for incorporation in the next edition of the volume.

Dr. Shiwanand Pandey
Mr. Rohit Jaiswal
Mr. Manoj Kumar

Table of Content

Practical No.1

Objective: To study about media preparation for nursery beds, propagation, pot and mist chamber

Aim: Media used for preparation of nursery beds, propagation of horticultural plants mainly consists of organic and inorganic material. The components of organic media include sphagnum moss, peat, or bark. Sometimes wheat straw, paddy straw, leaf mulch, paddy hulls and saw dust are also used. While using these components some coarse mineral components used for increasing aeration such as sand, grit, pumice, vermiculite, perlite etc.

Materials required: Soil, Sand, FYM or Other formulation of compost, Digging and media preparing tools, Pots.

Media: The medium used for germination of seeds or rooting during propagation is called the propagations media. Several media and mixtures of different media used in the propagation of plants. All such media have several properties.

Properties of good propagation media:

It should be free from a high level of acid and salts.

1. The medium must be sufficiently firm and dense to hold the seeds or cuttings or layers in the right position during seed germination or root formation.

2. Its volume must be fairly constant when wet or dry.

3. It should be sufficiently porous the excess water can drain out easily. It provides adequate aeration.

4. It should have the ability to retain and supply an ample amount of moisture for the seeds or propagation plants.

5. The medium must be free from seed of weeds, nematodes and pathogens.

6. The medium should provide an adequate amount of nutrients to the seedlings or propagated plants.

7. It must be capable of being pasteurized with chemicals or steam without any harmful effects.

Criteria for selection of media: These criteria are as follows

1. Always select and use the seed bed and propagation media from locally available materials.

2. The medium should be porous and the pH is about 5.0-6.5.

3. It should be easily mix with other mediums.

Media for nursery beds and propagating plants

1. Soil mixture: This is the most commonly used medium for nursery beds pot plants and propagation. It usually consists of red earth, well decomposed cattle manure, leaf mold, river sand and also charcoal in some cases. A soil having sand 40 percent, silt 40 percent and clay 20 percent is considered best for seed germination, where as sandy loam soils are excellent for preparation of soil mixtures for container growing plants. The soil pH 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.

2. Sand: Consist of small rocks grains 0.05 to 2.0 mm dia, quartz sand is generally used for propagation purposes consisting of chiefly silica complex. The type used in plastering is the grade ordinarily the most satisfactory for rooting cutting e.g cactus.

3. Leaf Molds: It is prepared by placing layers of leaves and soil to which a small amount of nitrogenous compound i.e ammonium sulfate is added. The mixture is

watered to maintain decomposition action. The leaf mold compost is ready in 12-18 months.

4. Sphagnum Moss: Commercial sphagnum moss is the dehydrated remains of acid bog plants (*Sphagnum papillosm*). This is light sterile and having very high water holding capacity. Being able to absorb 10-20 times its weight of water by its cells of stem & leaves. It contains a specific fungistatic substance which accounts for its ability to inhibit damping-off of seedling. This sp. moss is generally used for propagation of plants by air layering pH 3.5**.**

5. Vermiculite: This is a micaceous mineral that expands when heated 1092^0 C. Chemically it is hydrated magnesium aluminum silicate. When expanded, it is very light in weight, neutral in reaction with good buffering properties and insoluble in water absorbs 481.5-641.6 liter/cubic meter.

6. Sawdust: These materials are a byproduct of timber mills can be very well used in soil mixture serving much purpose in propagation. Nitrogen is added in a sufficient amount for the decomposition of sawdust, an additional amount of N used by plants.

7. Peat: Peat consists of remains of amarsh, aquatic, bog or swamp vegetation, composition depends upon vegetation from which it originated state of decomposition, mineral content and degree of acidity classified into following different types.

A. 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 pH (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.

B. Reed sedge peat: It consists of remains of grasses, reeds sedges and other swamp plants. It holds about 10 times more water to its dry weight and its pH ranges from 4.0 to 7.5.

C. 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 pH ranges from 2.0 to 3.5. It may contain latent seed inoculations of soil dwelling pathogens, so it should be pasteurized while using.

8. Perlite: Perlite is grey-white material produced from the lava flow prepared by heating the glassy lava furnace at the temperature of 760°C. Perlite is a sterile medium with a pH of 6.0 to 8.0 hold water 3-4 times by its weight. It does not contain mineral nutrients but is useful in increasing the aeration. Perlite has also different grades but the grade with the particle size of 1.6-3 mm in diameter is mostly use for nursery work. It is an ideal medium for rooting of cuttings, when used in combination with peat moss.

9. Compost: Compost is a mass of rotted organic matter produced from the waste materials. It is produced by the decomposition of organic waste materials like leaves, garden or farm refuses, weed and paddy straw, etc. The mass should be allowed for complete decomposition, which will take about 12-18 months a rich source of minerals nutrients besides having good water holding capacity. It can be used as a medium by mixing with soil. Different microorganisms like fungi, bacteria and nematodes and insects like cutworms, termites and beetles are found in the compost. Therefore the compost should be sterilized before use.

10. **Soil mixture:** Different types of soil mixture are used as a medium for propagation in the nursery prepared by mixing sand, loam soil and leaf mold in different proportions. The ideal soil mixture should be porous and have good water holding capacity used for seed germination, rooting of cuttings and for growing potted plants.
11. **Cocopeat:** It is a byproduct of coconut husk after grinding the husk the cocopeat is ready commercially used in the pot cultivation of vegetables in poly houses. After soaking in water it swells up to 15-18 times more than that of its original weight. It provides good aeration, drainage, and nutrients.
12. **Rockwool:** Rockwool is produced by burning a mixture of coal, basalt, limestone and possibly slog from iron production. The actual composition of Rockwool is 60% basalt, 20% limestone, and 20% coke. Although slightly alkaline, it is not buffered and has negligible CEC.
13. **Polystyrene Foam:** It helps in bringing improved aeration and lightweight to the root substrate. It is neutral and thus does not affect root substrate pH levels and highly resistant to decomposition.
14. **Rice hulls:** These are the by-product of the rice milling industry extremely lightweight and very effective in improving drainage. N depletion is not much serious problem in the media amendment with rice hulls.
15. **Calcined clays:** Calcined clay is formed by heating monomorrillonitic clay minerals to approximately 690^0C. They have relatively high cation exchange capacity as well as water holding capacity.
16. **Bagasse:** It is a waste by-product of the sugar industry to produce a material that can increase the aeration and drainage properties of container media. This decreases the durability and longevity of bagasse and influences nitrogen levels.
17. **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.

Practical No.2

Objective: To study about preparation of nursery beds and sowing of seeds

Aim: In a nursery, plants are nurtured by providing them with optimum growing conditions to ensure germination. Nursery saves considerable time for the raising of the next crop.

Materials required: Kudali, Garden fork, Weeding fork, Crow bar, Shovel, Spade, Furrow opener, Hand leveler, Cultivator, Disc harrow, Rose can, Iron pan, Hose pipe, Measuring tape, Rope, Wooden pegs, Organic manures (FYM), Mulching material.

Nursery: Nursery is a place field where planting material, such as seedlings, saplings, cuttings, etc are raised, propagated and multiplied under favourable conditions for transplanting in prepared beds. The availability of quality and true-to-type and identical planting material is the prerequisite of successful and remunerative ornamental crop production. Setting up of a nursery is a long-term venture, and requires planning and expertise.

Types of nursery: Nurseries are classified on the basis of duration, plants produced and structures used. On the basis of duration

1. Temporary nursery: This type of nursery is developed only to fulfil seasonal requirements or a targeted project. Such a nursery is, usually, small in size and is set up for a short period after which it is abandoned. Temporary nurseries are mostly used for raising seedlings of vegetables and flower crops. Such nurseries are found near the main planting area.

2. Permanent nursery: This type of a nursery, plants are nourished and kept for a longer period of time till they are sold out or planted permanently in a field. The area covered under such a nursery is larger than a temporary nursery and it has all features that are required in a permanent nursery.

On the basis of plants produced:

1. Ornamental nursery: Seedlings, rootstock and scion material of ornamental plants are raised and conserved for further use in such a nursery. It includes mother blocks of ornamental plants, which are used in layering, as well as, producing scion material for budding and grafting.

2. Vegetable nursery: Planting material like seedlings of vegetables, rooted cuttings (Asparagus and Sweet potato), rhizomes (Ginger), tubers (Potato) and bulbs (Onion and Garlic) are raised and conserved in such a nursery.

3. Fruit plant nursery: In this nursery, seedlings and cuttings of rootstocks, budded plants, grafts, layers and cuttings of fruit trees, such as mango, lychee, ber, bael, guava, sapota, etc., are raised and conserved. This nursery has mother blocks of different fruit crops, which are used as scion material.

On the basis of structure used:

1. Open field nursery: Such a nursery is established in open areas without any permanent structure. Usually, raised, flat or sunken seedbeds are prepared. These are vulnerable to natural environmental conditions.

2. Hi-tech nursery: Such a nursery is established under protected structures. The protected structures in which the nursery can be successfully raised are as follows.

3. Thatched roof: In this type of nursery, a thatched roof is constructed over the nursery beds, which protects the seedlings from damage caused by extreme wind, rain, heat, etc.

4. Shade-net: Such a nursery is raised under shade-net houses. To give different amount of shade to plants based on their requirements, shade-nets of different colours and mesh sizes are used as covering material.

5. Poly-tunnel: The nursery is covered with a plastic film or sheet to form a tunnel. It is miniature structure, which produces greenhouse-like effect. Besides not being expensive, it is easy to construct and dismantle. The seedlings are protected from cold, wind, storm, rain and frost. Due to modified conditions, there is better germination and plant growth.

6. Greenhouse or poly-house: It is a framed structure covered by poly-film or shade-net so that the plants can grow under partially or completely modified environment. Such structures are ventilated and may have temperature and humidity controlling devices. The seedlings are raised inside the structure on raised beds or in plug-trays, and also for hardening of tissue cultural plants.

Preparation of the nursery bed: Nursery beds can be prepared in three different ways.

1. 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.

2. 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 10kg per square meter is mixed in the soil. In between two rows, a space of 45 to 60cm is left so as to carry out cultural practices easily. The seeds are sown in lines in the bed.

3. Sunken nursery bed: This type of bed is useful and prepared during winter season. This type of nursery is prepared 10 to 15cm 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 4kg, 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.

Practical No.3

Objective: To study about seed treatments for breaking dormancy and inducing vigorous seedling growth.

Aim: Seeds are central to crop production, human nutrition, and food security. Crop yield and resource use efficiency depend on successful seed germination

establishment in the field, and it is the vigour of seeds that defines their ability to germinate and establish seedlings rapidly. Improving vigour to enhance the critical and yield-defining stage of crop establishment remains a primary aim of the agricultural industry and the seed/breeding companies that support it.

Materials required: Seed, Sand, Stratification box (pit), Sand paper, Moss, Hessian cloth, Hammer, Sulfuric acid (H_2SO_4) or HCl, Water, Bavistin, Labels, and Glass containers.

Methods of Breaking Dormancy:

1. 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.

A. Mechanical scarification: 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.

B. 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. 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.

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

2. Stratification: Stratification 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 stratification 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.

A. 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 mixed with well washed sand, peat moss or vermiculite. A good medium is a mixture of one part coarse sand to one part peat, moistened and allowed to stand 24 hours before use. Seeds are placed in alternate layers of sand or medium. The usual stratification temperature is 0-10^{o}C. At higher temperature seeds sprout prematurely and low temperature delay sprouting. During stratification seeds should be

examined periodically, if they are dry, the medium should be remoistened. 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.

Precautions:

1. Scarification should not proceed to the point at which the seeds are injured and inner parts of seed are exposed.

2. Irrigation during stratification should be given at regular intervals to maintain adequate moisture level.

3. Seed should not sprout during stratification.

4. The sand should be passed through coarse sieve mesh to separate bigger size gravels so as to avoid confusion between seed and gravels at the time of sowing.

Practical No.4

Objective: To study about preparation of plant material for potting

Aim: To get acquaint with different types of pots/ containers used for growing plants prepare pots for planting of plants, prepare soil based and soil-less growing medium, understand the procedure for potting, de-potting and re-potting of plants

Materials required: Containers (Pots), Crocks (broken pieces of pots), Pebbles, Coarse sand, Growing medium, Plant material (seed/ bulb/ seedling/ sapling),

Secateur, Pruning knife, Hand trowel, Dibbler, Khutti, Watering can, Fungicide and Insecticide.

Potting: Potting a process of planting of new seedlings plants in a pot/ container with a suitable growing medium for its establishment. A skill and a person become perfect with experience/ practice and patience growing medium in the containers is restricted and it also leads to restricted growth of plants.

Procedure of potting

1. The different types of containers (earthen, plastic, concrete, brass, glass, metal, pvc, wooden, etc.) for growing plants.
2. Select the appropriate container and ensure that there is a hole at the bottom for proper drainage of excess water.
3. Wash the container both from inside and outside with clean water
4. Place 2-3 crocks on the drainage hole in such a way that it does not block the hole at a later stage.
5. Put smaller pieces of crocks on side and then put 2-3 cm thick layer of coarse sand or dry leaves.
6. Fill the pots with suitable growing medium and when the containers are half way filled then press the growing medium firmly and again fill upto the rim of the container, press the medium and ensure that 2-3 cm unfilled space is left for watering in the container.
7. Use above filled container for sowing of seeds or planting of bulbs or planting of seedlings/ saplings of ornamental plants.
8. With the hand trowel scoop out a hole in the centre of the pot and plant the seedling/ sapling in such a way that its roots are well spread in the container
9. Put growing medium all around and press firmly so that no air pocket s are left.
10. Supply adequate watering.
11. Keep the container in a cool shady place.

Procedure of Repotting:

1. Frequently do watering in the container in which repotting is to be done about 2-3 days prior to repotting.
2. Hold the plant with right hand between fingers and put the thumb alongside the container.
3. Turn the container upside down and tap the edge gently on the ground until the ball of the growing medium along with roots comes out.
4. Do adequate roots and shoots pruning before planting in the container.
5. Clean/ wash the container from inside/ outside and fill the container with fresh growing medium.
6. Do planting of the prepared plant after scooping out the growing medium as described in potting of the plant as above.
7. Do adequate watering and place the container at a cool and shady place for few days.

Precautions:

1. Ensure for drainage hole at the bottom of the container
2. Clean/ wash the container
3. Use clean crocks, pebbles and sand
4. Moisten the growing medium before filling the container
5. Fill the growing medium firmly
6. Use optimum size container depending upon the growth of the plant.
7. Repotting in a cool- shady place and keep them there until establishment

8. After establishing remove the plant from shady area and keep under optimum growing condition depending upon the requirement of different species

Observations to be recorded:

S. No.	Name of the plant	Type of Container	Size and height of top container	Growing Medium type	Remarks
1.					
2.					
3.					

Result:

Conclusion:

Practical No.5

Objective: To study about hardening plants in the nursery

Aim: Encourage root and stem diameter growth, acclimate to the out planting environment to endure stress. Introduce gradual, moderate moisture stress, expose plants to sun equivalent to out planting conditions. Reducing fertilization rates and changing mineral nutrient ratios good airflow and wind exposure for root health and proper shoot-to-root balance.

Hardening of the plants: The term hardening includes any treatment that makes the tissues firm to withstand un-favourable environment like low temperature, high temperature and hot dry wind. Plants accumulate more carbohydrates reserves and

produce additional quiticle on the leaves. The seedlings are given some artificial shocks at least 7-10 days before uprooting and transplanting. These shocks includes:

1. The seedlings/plants are exposure to the full sunlight
2. Removal of all the shedding nets, polythene sheets from nursery/plants
3. The seedling/plants irrigation is stopped slowly and slowly

Methods of hardening: The hardening is done by the following ways

1. The seedlings/ plants irrigation holding by 4-5 days before transplanting
2. Lowering the temperature also retards the growth and adds to the hardening processes
3. Application of 4000 ppm NaCl with irrigation water or by spraying of 2000 ppm of cycocel

Duration and degree of hardening

1. The plants should be hardened according to their kind so that there is an assurance of high percentage of survival and slow growth under the condition to be expected at the time of transplanting.
2. The hardening should be gradual to prevent or check the seedlings growth.
3. Warm season crops like Tomato, Chillies and Brinjal do not favour severe hardening, allowing the soil to become dry for 5-6 days does the hardening.

Effect of hardening: The following effect during the hardening

1. The hardening of seedlings improves the quality and modifies the nature of colloids in the plant cell enabling them to resist the loss of water.
2. The seedlings hardening increases the presence of dry matter and regards in the plants but decrease the percentage of freezable water and transpiration per unit area of leaf.
3. Decreases the rate of growth and developments in the plants
4. The hardened plants can withstand better against un-favourable weather conditions like hot day winds or low temperature.

Practical No. - 6

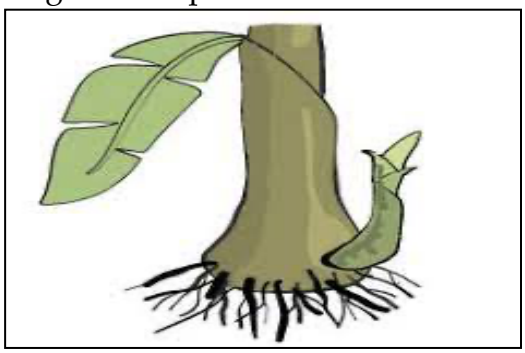
Objective- To study about propagation through vegetative parts special modification of horticultural crops

There are certain plant modifications which are used for vegetative propagation of plants. These modified plant parts may be stem, root, or leaves and are usually specialized for food storage. Two principal methods are used for propagation of plants by using these modifications.

A. Natural modification of layering

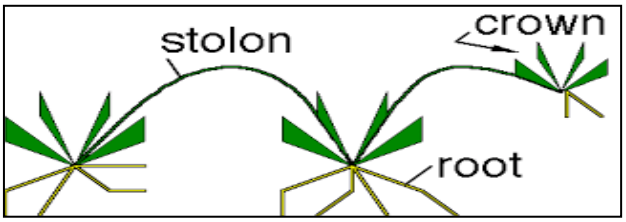
1. Runner: Runner is a thin and long stem which develops from the axil of leaves, grown horizontally along the ground and

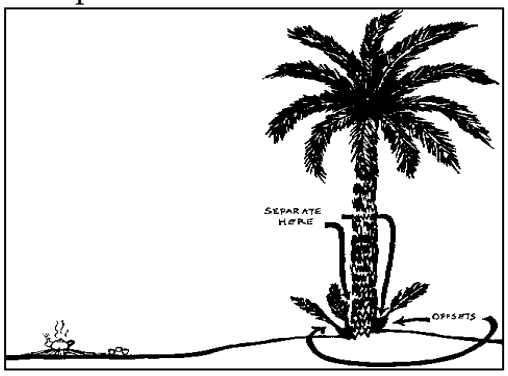
from a new plants at the nodes where is comes in contact of soil. Runner is a mode of propagation in Strawberry, Geranium and Boston fern.
When runner develops sufficient roots, it is dug out and planted in the field.



2. Sucker: Sucker is a shoot that develops from an adventitious bud on a root and grown vertically. The shoot appears from the rootstock below the union of bud or graft is also termed as sucker. Shoot arising from latent bud of stem and vigorous in growth is also a sucker. The sucker originating from the root is dug out and used as a propagation of plants. Raspberry, Blackberry, Pineapple, Date Palm etc are propagated by sucker.

3. Stolon: Stolon is modified stem which grown horizontally to the ground above the surface of the soil. Stolon is common in Mint and Bermunda grass. Stolon after cutting from the parent plants is used to raise new plant.





4. Offsets/ offshoots: The offset is a shoot or thick stem of rosette like appearance arising from the base of the main stem of certain plant such as date palm, pineapple etc., Date palm cultivars are propagated vegetatively by separating away the offshoots and replanting them. However these are girdled and layered for about a year prior to separation, because offshoots do not root easily when directly separated from the mother plant and planted in the field.

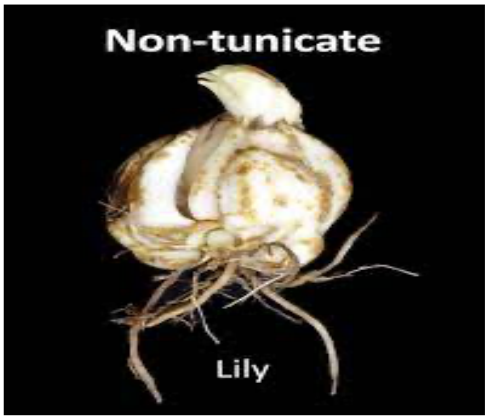
B. Separation and Division:

1. Bulbs: It is specialized underground storage organs
produced by monocotyledonous plants in which the stem is modified for storage and reproduction. Bulb is a specialized underground organ consisting of a short freshly, usually vertical stem axis bearing at tip apex or growing points and enclosed by thick freshly scales.

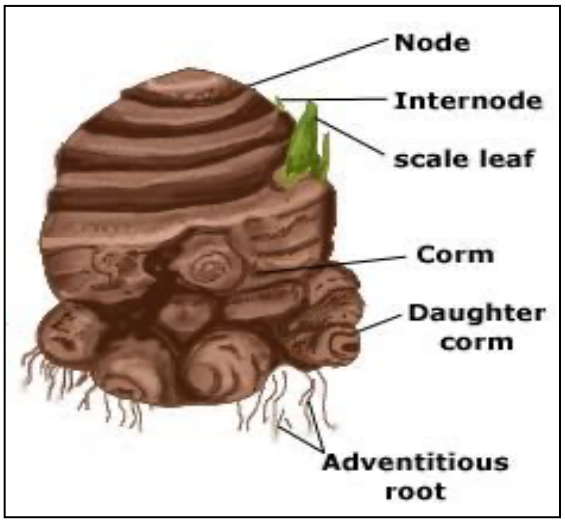
Bulb scales morphologically are the continuous sheathing leaf base. Growing points develop in the axils of these scales to produce miniature bulbs known as bulbets/ daughter bulbs. These daughter bulbs cane separated from the mother plant at the end of growing season and used as propagating material.

Type of bulb:

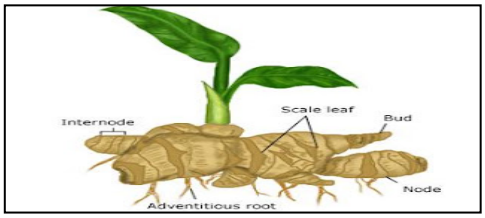
i.Tunicate bulbs: These are the bulbs which remain covered by dry and membraneous scales. The covering or tunic provides protection to the bulb against drying and mechanical injury. Tunicate bulb is very common in Onion, Garlic Daffodil and Tulip.



ii.Non tunicate bulbs: The bulbs do not posses any covering around them these are common in lily.

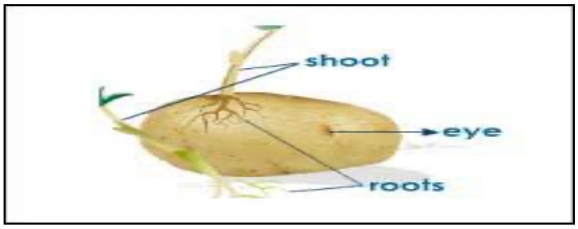


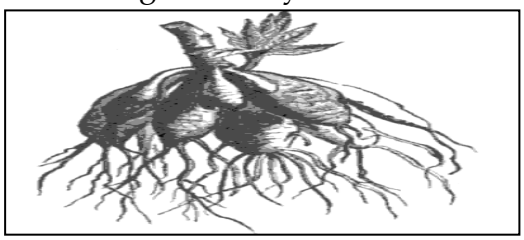
2. Corms: A corm is solid underground base of a stem having nodes and internodes and is enclosed by a dry scale like leaves. After flowering one or more corms may develop just above the old one, which disintegrates. In addition several new corms called caramels develop below each new corm. These may be separated and grown for 1-2 years to reach flowering stage. Eg: Gladiolus.



3. Rhizomes: The horizontal, thick and fleshy or slender and elongated stem growing underground are known as rhizomes. Rhizomes have nodes and internodes and readily produce adventitious roots. The rhizomes are cut into pieces, each containing vegetative bud and transplanted. Eg: Banana, Ginger, Ferns, Turmeric, and Cardamom.

4. Tubers: A tuber is the short terminal portion of an underground stem which has become thickened because of accumulation of preserved food material eg: Potato. Propagation by tuber can be carried out either by planting the whole tuber or by cutting into sections each containing bud or eyes.





5. Tuberous roots: These are thickened tuberous growth that functions as storage organs. Tuberous roots are found in Sweet potato, Dahlia etc.

Practical No.- 7

Objective - To Study about propagation by cutting of horticultural crops

Cutting: Separation of a portion from mother plant and planting it in a medium suitably so that it may constitute a new plant successfully is termed as cutting. This method is commonly used in plants which root easily and readily, thus, multiplication of plant is very quick and cheap.

Aims: Multiplication of plants by cuttings includes stem, root and leaf cuttings. The stem cuttings are of four types i.e., hard, semi hard, soft wood and herbaceous cutting. The success in propagation by cutting depends upon factors such as conditions of mother plant, parts of the tree where cuttings are made, time of year, care while planting and after care.

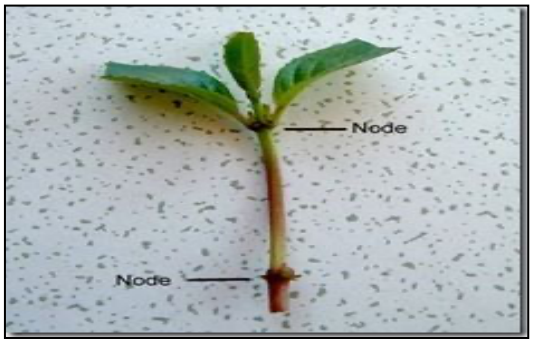
Materials required: Secateur, Poly bag, Rooting media, Nursery bed/pots, Khurpi

1. Stem cutting: A portion of stem is taken for propagation. It is four types.

i. **Hardwood cutting:** Hard wood cuttings are made from the mature and lignified stems of

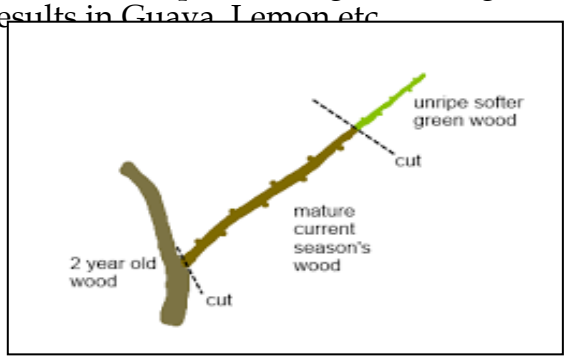
shrubs and trees. Select one year old shoots current year or of previous season's growth about lead pencil thickness from healthy, vigorous and young plants. The length of cuttings varies from 10-25 cm in length depending upon species. Each cutting should have at least two or three buds. While preparing the cutting, a straight cut is given at the base of shoot about 0.3 cm below the node while a slanting cut 1-2 cm above the bud is given at the top.

Remove the leaves from the cuttings. Treating the cutting with 100-5000 ppm IBA before planting gives better results Make holes in the rooting media/ nursery bed and burry the 2/3 basal portion of cutting in the holes at 45 degree angle facing slant portion to sun in the east. Press the soil around cutting firmly. Sprinkle water as and when necessary. Record the data as per technical programme. It is commonly practiced in Grape, Fig, Pomegranate, Mulberry and Phalsa.



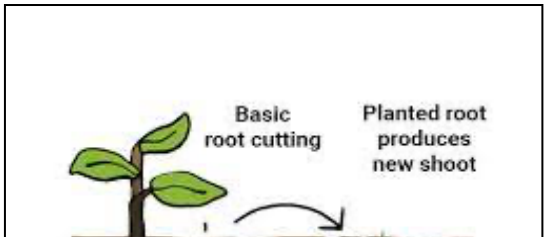
ii.Semi hardwood cutting: Semi hardwood cuttings are prepared from semi matured 6-9 month old, slightly woody shoot. These are succulent and tender in nature and are usually prepared from growing wood of current season's growth. The length of cutting varies from 10-20 cm.

The cuttings are prepared by trimming the cutting with straight cut below a node. However, it is better to retain two to four leaves on the top of cuttings. Treating the cutting with IBA before planting gives better results in Guava, Lemon etc.



iii.Soft wood cutting: Softwood cutting also known as green wood is prepared from soft, succulent and non-lignified 3-6 month old shoots which have not become hard or woody. Usually the cutting size is 5-15 cm but it varies from species to species. Usually few leaves are retained and before planting, treatment with auxin (IBA) is beneficial. This is commonly used for root stocks of Apple, Peach, Plum and Cherry in mist condition.

iv. Herbaceous cutting: The cuttings are prepared from terminal soft, succulent and tender portion of 1-3 month old shoots of current growth under mist condition ensuring warm and humid condition. This is commonly used in ornamental plants like *Alternanthera, Coleus, Pilea, Eupatorium, Iresine* etc.



2. Root cutting: This is commonly used in Apple, Pear, Cherry, Guava, Black berry, Fig, Rasp berry, Wood apple Bael etc. For propagation, roots of 2 to 3 cm thickness are selected. The length of cutting is kept to 10 to 15 cm. in temperate fruits, the fruits, the root cutting are prepared during December. The prepared cutting is placed is sphagnum grass or moist sand medium for callusing which gives better rooting.

The cutting can also be planted in the field directly with necessary hormonal treatment. For subtropical plants, cutting is prepared during rainy season. While preparing cutting, slanting cut is prepared or proximal end and round cutting is prepared at distal end of root. In intact root, proximal end is that nearest to stem-root junction and that farthest to stem root junction is distal end. From adventitious Buds on root cutting shoot emergence and from cambium tissues root emergence out.

3. Leaf/Leaf bud cutting: Leaf cutting should preferably be prepared during growing season because buds if inter in 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 axillary bud of active growing leaves. In this cutting, 1-1.5 cm stem portion is used when propagating material is small. Leaf bud cutting are best made from material having well developed bud and healthy actively growing leaves. High humid condition is essential for better success in leaf cutting.eg. Black berry, Lemon, Rasp berry.

4. Others: Some different kind of cuttings are also used by propagators like Basal cuttings, Heel cuttings, Bud cuttings, Eye cuttings, Inter nodal and nodal cuttings, Irishmam's cuttings and Piping cuttings.

Observation to be recorded:

Date of planting of the cutting:

SI. No.	Type of cutting	Number of cutting planted	Date of sprouting	Number of cutting rooted	Percentage of rooted cutting	Average root length
1.	Hardwood cutting					
2.	Semi hardwood					
3.	Soft wood					
4.	Herbaceous					
5.	Root cutting					
6.	Leaf/Leaf bud					
7.	Others					

Result:

Conclusion:

Practical No.-8

Objective- To study about the propagation by layering in horticultural crops

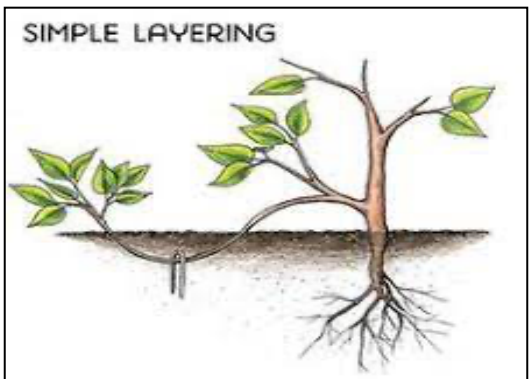
Layering: Layering is a technique of propagation in which a portion of plant is forced to produce adventitious root while it still remains attached to mother plants. In this process, a single portion of plants constitute root and shoot. Upon emergence of roots, the shoots is separated from mother plants, survived in nursery for some time and then planted in field.

Aims: Layering is practiced before many decades and used by nurserymen to propagate many horticultural plants. Plant multiplication through layering includes several forms of ground and aerial layering (Goottie).When branches running parallel to the ground are utilized for propagation, then the method is known as ground layering. When rooting is encouraged on the aerial part of the plant after girdling, then the method is called as air layering or goottie or marcottage.

Materials required: Budding and Grafting knife, Sphagnum Moss, Plastic foil, String, Yoghurt tube, Secateur, Poly bag, Pot, Bowl, Rooting media, Growth regulator.

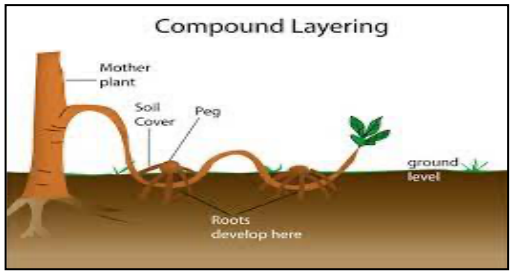
A. Ground layering

1. Simple layering: The flexible shoots of a plant are bent downwards over to ground in early spring or in rainy season. Remove a ring of bark or make a notch at a distance

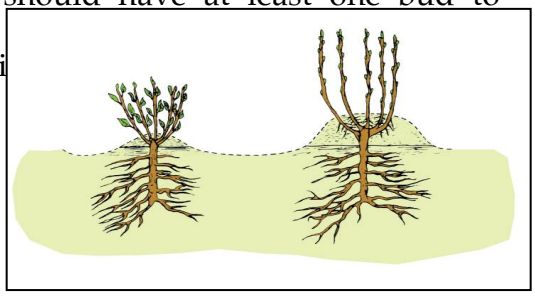


of 20-25 cm away from the tip to encourage rooting. The girdled portion is buried up to 7-10cm depth and covered with soil leaving the terminal end of the branch open. It is necessary to hold the cane/shoot in place with wire or wood stakes.

Keep the soil wet where cane is buried for developing the roots. Rooting in the buried shoots takes place within a month. Eg. Grape, lemon etc.



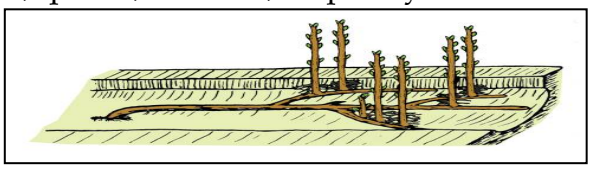
2. Compound or Serpentine layering: It is suitable for those plants which producing long, slender, and flexible shoots. It is modification of simple layering in which one year old branch is alternatively covered and exposed along its length. The stem is girdled 2.5 to 4.0 cm in size at several intervals. Rooting hormones may be applied over it and then it covered with soil. However, the exposed portion of the stem should have at least one bud to develop a new shoot. After rooting, the section
Jasmine, American grapes, Clematis, Smilax, Wi



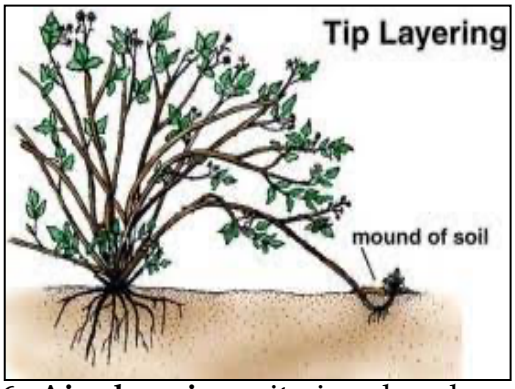
3. Stooling/Mound layering: In this method the mother plants are headed back to 10-15 cm above ground level during dormant season. The new sprout will arise within two months. These sprouts are then girdled and rooting hormone made in lanolin paste is applied to the upper portion of the ring. The concentration of rooting hormones are varies from plant to plant but in general 3000 to 5000 ppm is most commonly used.

These shoots are left for two days for proper absorption of hormone before they are covered with soil. Care must be taken to keep the soil moist all times. The roots from shoots may emerge within 20-30 days depending on species. These rooted stools should be separated from the mother plant only after 60-70 days and then planted in the nursery beds. Eg. Guava, Apple rootstocks, quince, currants, raspberry etc

4. Trench layering: It is used for the propagation of Apple (M16 and M25), Pear, and Cherry. In this method it is important to establish a permanent row of plants to be propagated.

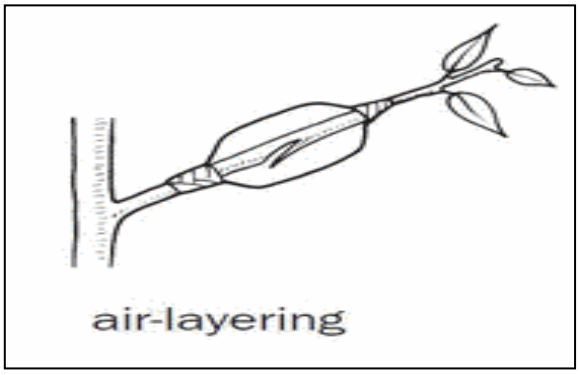


The mother plants are planted at the base of a trench at a angle of 45 ^{0} in rows. The long and flexible stems of these plants are pegged down on the ground. When the shoot develops, the base is covered with 5-10 cm layer of soil. The young shoots that arise from these plants are gradually mounded up to a depth of 15-20 cm in autumn, winter or end of the season, depending upon the species.



5. Tip layering: The tip layering is a natural method of reproduction of Blackberries and Raspberries. The tip of shoots is bending to the ground and the rooting takes place near the tip of current season's shoot. The tips of shoot buried 5-6 cm kept in deep in the soil. Keep the soil wet where cane is buried for developing the roots. Rooting in the buried shoots takes place within a month. The new plants may be detached and transplanted in the nursery during spring.

6. Air layering: it is also known as Chinese layering, Pot layering, Marcottage or Gootte. Generally one to two years old, healthy and vigorous shoots having pencil thickness are used for air layering. First the leaves are removed near the basal-inter nodal portion which is away from 35 to 45 cm from apex of the selected shoots then the stem is given a notch or is girdled by removing a ring of bark about 2.5-3.0 cm wide.



Application of root promoting hormones at the distal end at time of layering helps to get profuse rooting within a short time. Root promoting substances may be applied as powder or in lanolin or as a solution. IBA or a combination of IBA + NAA, both at the rate of 500ppm may be applied for better results. After application of hormones, ringed or girdled portion is covered with moist moss grass or handful of moist clay soil. This ball of earth may be again covered with sphagnum moss and wrapped with a 200 gauge polythene sheet. Air layering should be done either in spring or in monsoon. The rooted layers are either planted in pots or in the nursery beds in a shady place until they are fully established. Litchi, guava and pomegranate, lemon and Lime can be propagated by air layering.

Observation to be recorded:

SI. No.	Type of layering	Number of shoot layered	Number of layers produced roots	Percentage of rooted layers	Ave. root length
1.					
2.					
3.					

Results:

Conclusion:

Practical No.-9

Objective: To study about on the propagation by grafting in horticultural crops

Grafting: The method of vegetative propagation, where two plant parts are joined together in such a manner that they unite and continue their growth as one plant. In this method, the scion twig has more than two buds on it. The upper part of the composite plant is termed as 'scion' and the part which forms the root is termed as 'rootstock'. Sometimes, when scion and rootstocks are not compatible with each other, another piece of wood is used in between the stock and scion, which is compatible with both; this is called as 'interstock'.

Aims: The major aim of grafting is to multiply plants identical (true to type) to the parent plants. Although grafting in fruit tree are used commonly to repair damaged plants or derive certain benefits from root stock. In certain cases, grafting allow to change out dated variety as well as established a new orchard.

Materials required: Root stock, Scion stock, Grafting knife, Light weight hammer, Grafting wax, Rubber bud strips, Wax coated cotton twine, Grafting twine, Grafting tape, wire nails.

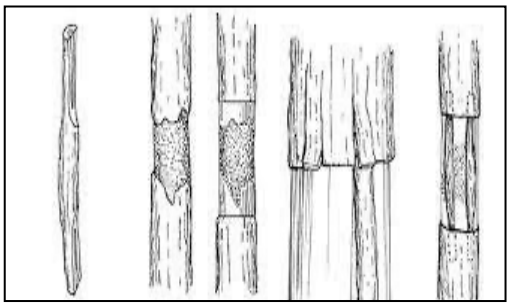
Different methods of grafting-

A. Attached method of grafting:

1. Inarching: It is called as attached methods of grafting in contrast to other method completion of union. This method is practiced in mango, Jackfruit, Sapota, Loquat and Custard apple. It is generally used for repairing or replacing damaged root system and hence also called as repair grafting. Selection of parent tree for taking the

scion is an important factor for its success. The scion plant should be healthy, vigorous, pathogen free and high yielding.

The stock is brought close to the scion. A thin slice of bark (6-8 cm long and about 1/3 inch in thickness at height) 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 cuts are brought together and tied firmly with the help of polythene strip. After successful union, stock above and scion below the graft union are looped of gradually. It is done soon after rainy season July-August provided that temperature of the localities does not fall below the 15^0C.

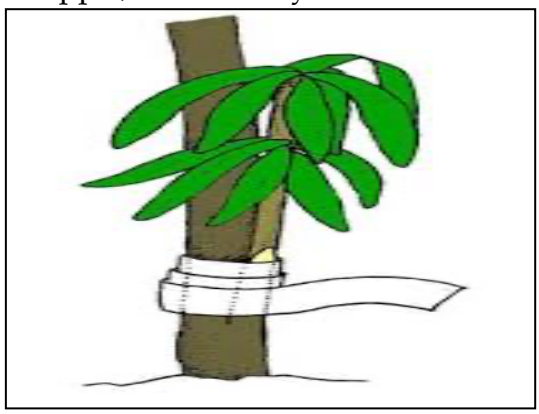


2. Bridge grafting: This method is practiced in plants in which scion is healthy and some portion of rootstock near collar region is damaged. In this technique, the damaged portion of rootstock is scratched. In healthy portion of rootstock, incision is made on top and bottom portion of the stock. The scion portion of suitable length is inserted stick should be removed time to time.

Slowly and slowly, it grows in diameter and covers the damaged portion. The method is useful in repairing damaged wood in Apple, Pear Cherry Walnut etc.

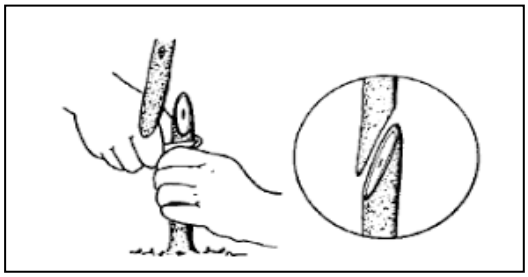
B. Detached method of grafting:

1. Veneer grafting: In this method, one year old rootstock seedlings having a diameter of 1.0-1.5 cm and 3-6 months old scion shoots are a shallow downward cut of about 4 cm long is given on the rootstock at a height of about 15-20 cm from the ground level. At the base of this cut, a second short downward and inward cut is made to join the first cut, so as to remove a piece of wood and bark. The scion is prepared exactly as in side grafting.



The cuts on the rootstock and scion shoot should be of the same length and width so that the cambial layers of both components match each other.Then, the prepared scion is inserted into the rootstock and tied security with polythene strip. After the union is complete the stock is cut back, leaving time for doing veneer grafting.

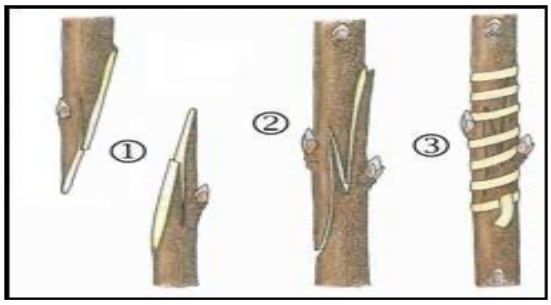
2. Whip grafting: In this method of grafting, it is essential that both stock and scion should be of equal diameter1-1.5 cm. About one year old rootstock is headed back at a height of 20-25 cm from the soil and a diagonal cut is made at the distal end of the rootstock. A similar



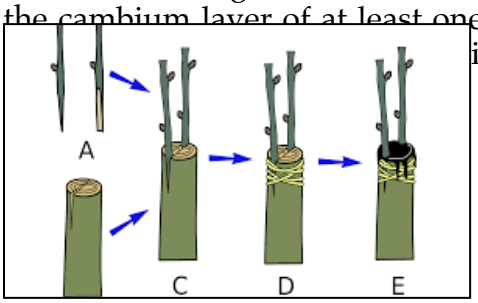
slanting cut of 2-4 cm is made on the proximal end of the scion.

The cut surface of both rootstock and scion are bound together and tied firmly with polythene tape or banana fibre. Many fruit plant are propagated by whip grafting eg. Apple, Pear, Walnut etc.

3. Tongue Grafting: This method is commonly used when the stock and scion are of equal diameter. First, a long, smooth, slanting cut of about 4 to 5 cm long is made on the rootstock. Another downward cut is given starting approximately 1/3rd from the top and about centimeter in length. Similar cuts are made in the scion wood exactly matching the cut given in the rootstock.



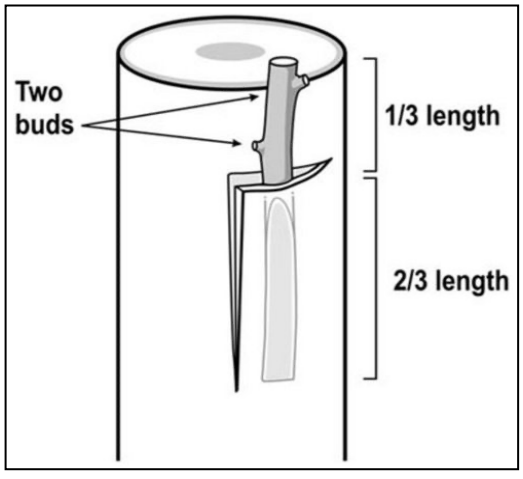
The scion having 2 to 3 buds is then tightly fitted with the rootstock taking care that the cambium layer of at least one side of the stock and scion unites together. This is ip.

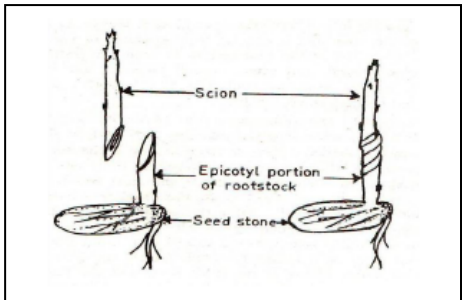


4. Cleft grafting: It is particularly suitable in rootstock having diameter greater than the scion. Rootstock with 5-7 cm or more girth is selected for this purpose. The rootstock is cleft grafted after decapitating the stock 20-40 cm above the ground level. The beheaded rootstock is split to about 5cm deep through the center of stem.

After that a hard wooden wedge is inserted to keep open for the subsequent insertion of scion. The scion of 15-20 cm size is taken from a terminal shoot, which is more than three month old and then it is wedge securely (6-7 cm). The cleft of the scion then slipped into the split of the stock. In thicker rootstock more than one scion should be inserted. The graft should be thoroughly waxed to prevent wilting. eg Avocado, Apple, Mango Pear and Plum.

5. Bark grafting: It should be done in spring when bark of the stock slips easily. It is important that scion used in bark grafting should be dormant. The stock is first sawed off at a point, where bark is smooth. Bark is split downward, about 5 cm from the top. Scion of 10-12 cm long, containing 2- 3 buds are collected from the dormant wood and are preparing by giving slating cut (5cm) downward along one side of the base. The prepared scion then inserted in the center of split between the bark and wood of the stock. The scion is kept firmly by using adhesive tape. eg Many fruit plant.





6. Epicotyl /Stone grafting: It is also known as stone grafting. In this method, the seed of mango are sown in nursery bed and covered with 5 cm to 7

cm thick layer of farm yard manure. While sowing seed preference is given to sand bed which provides easy in uprooting of seedling required at the time of grafting. In about 15 to 20 days, seeds start germination. The germinated seedlings of 7 to 10 days ago, when its leaves remain coppery in colour, are used for grafting.

The seedling is detached at the height of 10 cm from the ground level. A vertical slit of .5 to 4 cm length is given on de-headed portion of rootstock. Scion shoot of 2 to 2 month age having pencil thickness is used. The leaves of scion are defoliated 10 days before grafting to facilitate sprouting. After uniting rootstock and scion, it is wrapped using polythene tape 300 guage. The plants are then maintained in other beds or pots in nursery. This method of grafting practiced during June-July during which the environment remain sufficiently moist.

7. Soft wood grafting: This is very successful technique in *in-situ* grafting. It is commonly practiced in mango. In this method, the seeds of mango are sown at desired distance in the field during rainy season. To ensure germination, 2 to 3 seeds are sown in each pit. When the plant becomes one year old and attains pencil thickness, it is used for grafting. The grafting is done at permanent site of planting in the field itself. The process of grafting is done during rainy season when new growth appears rootstock.

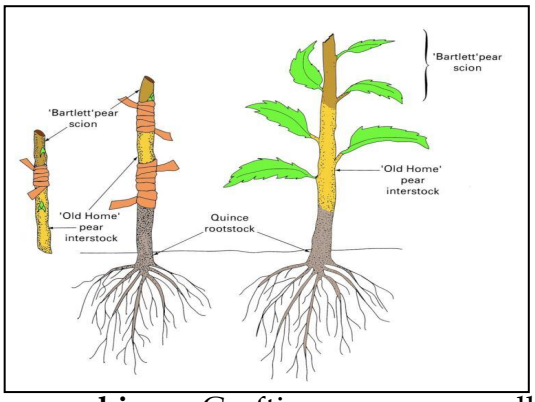
When new growth leaves start turning yellow from canopy colour grafting is performed. Scion shoot of 10 to 15 cm length 3 to 5 month of age and pencil thickness girth is selected. At 15 to 20 cm height from ground level, the rootstock is beheaded. A vertical slit of 2.5 to 4.0 cm length is given on root stock. On scion shoot, similar matching cut is prepared in slanting manner on both surfaces in lower portion. It is inserted in incision on rootstock and wrapped using polythene tape. In about 3 to 4 weeks, sprouting starts and graft start growing. The grafted plants develop at its own root system and shown better survival in the field.

8. Top working: It is the process of converting undesirable plants into desirable type. Usually seedling stand of fruit plants are considered suitable for top working. To begin with process. The plants are headed back within one meter height from ground level during spring. The new shoot appears in response of heading back are selected and vegetative propagation (Budding/Grafting) method is resorted during June-July.

While selecting shoot, it should be taken into account that pencil tick shoots fit well to undertake propagation method. In sub-tropical region, high solar radiation causes, sun-burn injury to the beheaded main stem. It is counter-checked by white washing

the stem. Young plants with a trunk diameter of 2.5-20cm are considered ideal for top working.

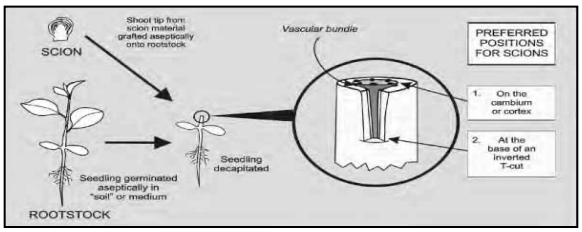
9. Double working: Double working is a specialized technique of grafting in which the composite plant has three different components, the root stock, inter-stock and the scion i.e. the desired variety or cultivar. Thus the double worked plants have graft joints, one between the rootstock and inter-stock and other between the inter-stock and scion. It is employed to overcome the incompatibility between desired cultivar



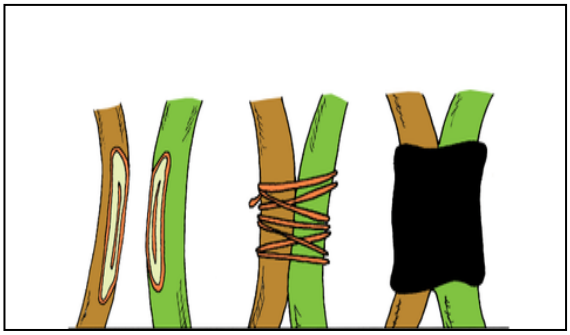
10. Frame working: Grafting many small secondary scaffold branches high on the tree constitutes frame working. It requires insertion of graft throughout the main frame of the tree. A large number of scions are required to replace the small laterals and scaffold branches. Growth coming out of the previous frame of the tree is removed time to time to favour establishment of the scion.

Frame working is resorted using budding/grafting technique. The frame worked plants reward good fruiting. But, the technique being cumbersome and expensive, it is not practiced commercially in orchard.

11. Micrografting: The grafting of tiny plant parts under asceptic and controlled environmental condition is called micrografting. Micrografting has been mostly used in citrus, apple and plum to produce virus free plants.



12. Approach Grafting: This method of grafting is termed approach grafting, as the rootstock is approached to the scion, while it is still attached to the mother plant. Alternatively the mother plants are trained to be low headed and the stock is sown under their canopy. Last week of July or the first week of August is the best period for approach grafting. In this method the diameter of rootstock and scion should be approximately the same.



A slice of bark along with a thin piece of wood about 4 cm long is removed from matching portions of both the stock and the scion. They are then brought together making sure that their cambium layers make contact at least on one side. These grafts are then tied firmly with polythene strip or any other tying material. The

stock and scion plants are watered regularly to hasten the union. The union is complete in about 2 to 3 months.

Incompatibility: It is a condition in which rootstock and scion fail to grow successfully. Generally, distantly related plants are incompatibility and that the closely related ones are compatible. Incompatible combination show yellowing and dropping of foliage, dying of plants, over or undergrowth, splitting of joint at the union, etc it is two types: localized and translocated. In localized incompatibility growth differential in observed at the point of union of rootstock and scion. In case of translocated incompatibility the effect is observed away from the point of union. It is hard to check this type of incompatibility.

Observation to be recorded:

SI. No.	Type of graft	Number of graft made	Number of graft survived	Percentage of survival	Day taken in sprouting of scion

Result:

Conclusion

Practical No.-10

Objective: To study about on the propagation by budding in horticultural crops

Budding: Budding is also a method of grafting, wherein only a single bud with a piece of bark with or without wood is used as a scion material, which develops into plant after successful union of the stock and bud. Budding is generally done when the stock plant is in active growth and more cambial activity.

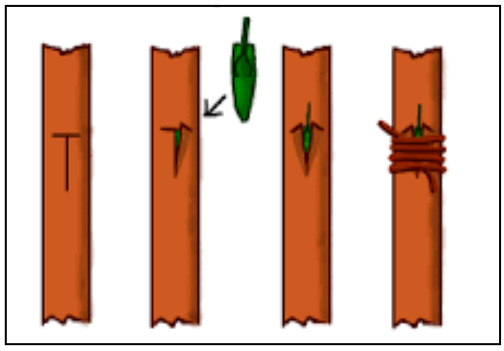
Aims: The major aim of budding is to multiply plant very easy and fast, identical (true to type) to the parent plants saves bud wood as compared to grafting. As soon as the bark start slipping both on the stock and scion, developed plants during spring and rainy season.

Materials required: Root stock, Scion stock, Budding knife, Grafting wax, Rubber bud strips, Wax coated cotton twine, Grafting twine, Grafting tape, wire nails, Raffia, Medifilm.

Bud Union: Like graft union, a series of changes takes place in the formation of successful bud union also. In general, four stages viz. pre- callus, callus, formation of cambial bridge and healing process etc. takes place for the formation of successful bud union.

Types of budding:

1. T-Budding: This is also known as shield budding. A horizontal cut about 1/3rd the distance around the stock is given on the stock 15-20cm above the ground level. Another vertical cut 2-3 cm in length is made down from the middle of the horizontal cut and flaps of the bark are loosened with ivory end of the budding knife to receive the bud. After the 'T' has been made in the stock the bud is removed from the bud stick.



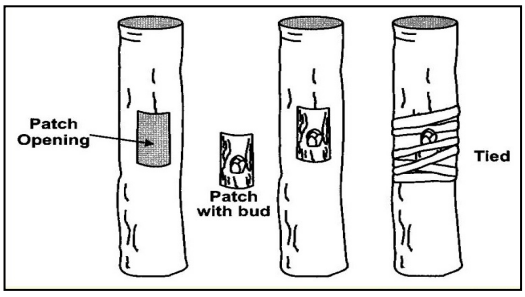
To remove the shield of bark containing the bud, a slicing cut is started at a point on the bud stick about 1.25 cm below the bud, continuing underneath about 2.5 cm above the bud.

A second horizontal cut is then made 1.25 to 2 cm above the bud, thus permitting the removal of the shield piece. The shield is removed along with a very thin slice of wood. The shield is then pushed under the two raised flaps of bark until its upper

horizontal cut matches the same cut on the stock. The shield should fix properly in place, well covered by the two flaps of bark, but the bud itself exposed. The bud union should be wrapped with polythene strip to hold the two components firmly together until the union is completed. T budding can be performed at any time of the year provided cell sap flows freely.

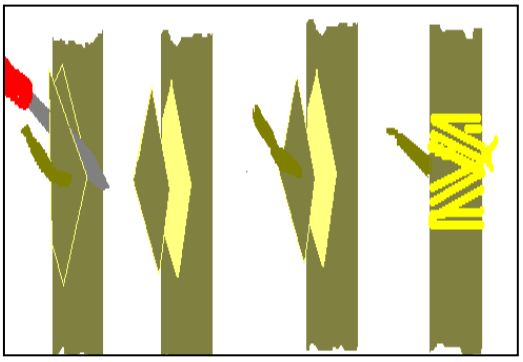
2. Inverted 'T' budding: As the name indicates, the cut is to be given on the root stock is reverse to that of 'T' i.e. inverted 'T' cut is given on the stock. This is widely used in high rainfall areas.

3. Patch Budding: This type of budding is quite successful in guava and it gives 60 to70 percent successes during May and June. Freshly cut angular bud-wood from current season's growth should be used as scion. A rectangular or square patch or piece of bark about 1.0-1.5 cm broad and 2.5 cm long is removed from the rootstock at about 15 to 20 cm from ground level.

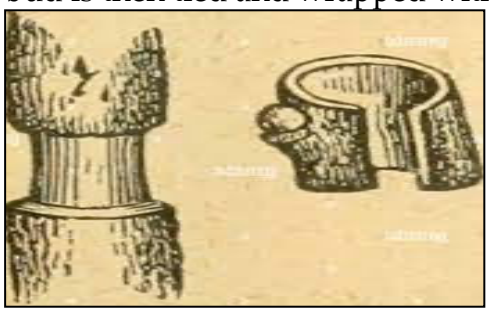


A similar patch with a bud on it is removed from the bud stick taking care not to split the bark beneath the bud. This patch is then transferred to rootstock and fixed smoothly at its new position and tied immediately with polythene strip. To have better success, a patch having two buds is used as scion instead of a single bud. This method is termed as improved patch budding method.

4. Chip Budding: This method is usually employed when the stock and scion are still dormant, that is just before the start of new growth. In this method, one about 2.5 cm long slanting cut is given into the stock followed by another cut at lower end of this first cut, in such a way that a chip of bark is removed from the stock. The bud from the scion wood is removed in the same way so that it matches the cuts given in the rootstock.



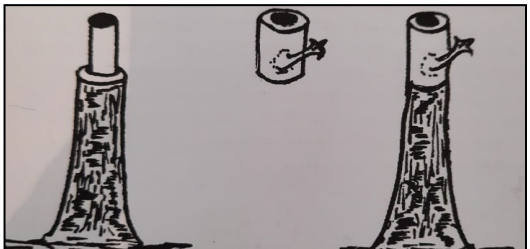
This chip with a bud on it is fitted smoothly into the cut made in the rootstock taking care that the cambium layers of the stock and scion unite at least on one side. The bud is then tied and wrapped with polythene strip, to prevent drying up of the bud.



5. Ring budding: In this method ring shape bark of 2.5 to 3.0 cm length containing a bud is taken out from scion shoot. On terminal end of rootstock, incision similar in size of bud is made. While taking out bud, care is taken that bud is centrally located. The bud wood is made fit on rootstock. For fitting bud, it is slipped downward by rotating it slowly and slowly till it fits tightly.

The bud should fit exactly without any vacant space, no needs of wrapping is required in this method. It is utilized in Peach, Plum, Ber, Mulberry etc.

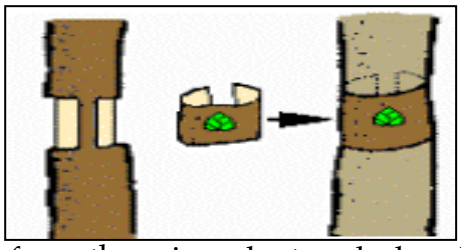
6. Modified ring budding: In modified ring budding, in this method instead of taking



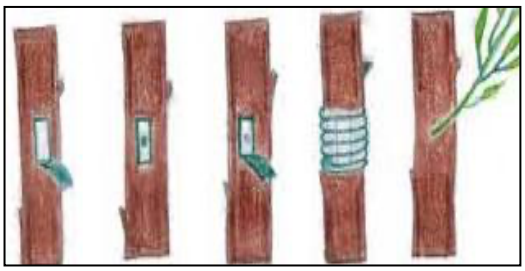
out complete circular ring of bark containing, bud, the bud wood is taken out from scion shoot by giving a vertical slit in bud wood. On suitable portion of rootstock similar size bark is taken out from the rootstock. The scion is fitted on rootstock and wrapped using polythene tape of 300 guage.

This method is successful for propagation Guava, Ber, Walnut and Pecan Nut. When bud sprout, the wrapped polythene is cut and removed. The portion of rootstock above bud is removed. In this method of budding, sometimes due to leaching of rain water through rootstock via slit of scion bud, rooting is noticed. To avoid such type of problem the vertical slit of the bud is sealed using paraffin wax.

7. Flute budding: In flute budding a patch of bark (Flute) encircling the stock is removed leaving a narrow strip thereon.

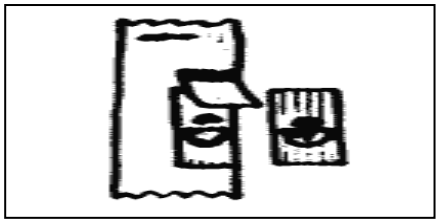


A similar patch of bark containing the bud is taken from the scion plant and placed on the cut surface of the rootstock followed by tying as usual when the bud exhibits the signs of growth, the top of the stock is cut back.



8. Forkert method of budding: It is modified method of patch budding, in which the bark flap of the patch is not removed from the stock plant but used to cover the bud on the stock plant. The bud is inserted in to the flap. It is covered with flap of bark on the stock plant and tied firmly with alkathene strip. Example- Aonla, Ber, Bael and Guava.

9. Modified forkert budding: In modified forkert method, the vertical flap of the bark is covered to base portion of the bud only. Thus the need to remove flap as in forkert method is not required. Rests are similar forkert method.



Observation to be recorded:

SI. No.	Type of budding	Number of stocks budded	Number of bud sprouted	Percentage of sprouting	Day taken for sprouting
1.					
2.					
3.					
4.					

Result:

Conclusion:

Practical No.-11

Objective: To study about on the propagation by micro-propagation in horticultural crops

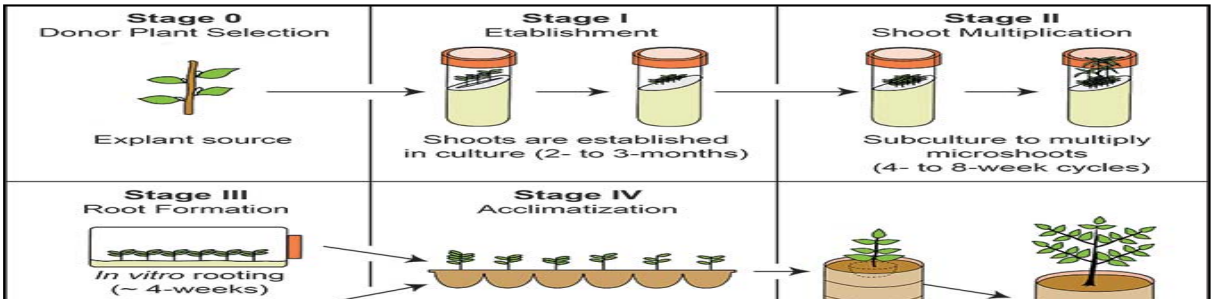
Micro-propagation: Micro propagation refers to the production of plants from very small plant parts, tissue or cells grown aseptically in a test tube or containers under controlled environmental and aseptic conditions. Tissue culture or in vitro culture is two broadly used term for micro propagation. Micro propagation is an advanced vegetative propagation technology for rapidly multiplying a large number of genetically superior and pathogen-free plants or genetically modified plants in a limited time and space throughout year.

Principle: Micro-propagation technique is based on the phenomenon of totipotency of a cell, which is the capacity of a plant cell to regenerate in to a complete plant. German Plant physiologist, Haberlandt (1902) is known as the father of plant tissue culture technique, who for the first time coined the term totipotency.

Stages of micro-propagation-The stages of tissue culture consist of important steps: Callus formation. Shoot initiation, root initiation, shoot and root multiplication, Hardening in green houses and Secondary Hardening in shade houses. Strict adherence to aseptic standards and micro-climatic conditions and care during the hardening process alone can ensure success.

Advantages: Micro propagation has the following advantages over conventional propagation techniques:

1. Year around production of plants irrespective of seasonal constraints.
2. Micro-propagated plants are usually free from viruses
3. Micro propagation is highly beneficial in fruit plant species Date Palm and papaya where large-scale production of female plants is possible.
4. Small space is required to maintain and multiply large number of plants.
5. Small tissue is required as an explant, hence saves the scion wood to a great extent.
6. It is highly beneficial in plants in which vegetative propagation is not possible or the propagation rate is very slow Papaya and Date palm
7. Speedy international exchange of germplasm, requiring minimum quarantine checks is possible.
8. Micro-propagated plants exhibit vigorous growth, and higher yields.
9. It helps in reducing the breeding cycle.
10. Production of homozygous plants is possible under *in vitro* conditions
11. *In vitro* systems have the potential for long-term transportation or shipment of propagation material.



Pathway of Regeneration: There are number of pathways for the regeneration of whole plantlet from excised plant parts. The three main pathways are:

1. Regeneration from existing meristems: This is also known as axillary shoot proliferation. The existing meristems such as shoot tip or nodal bud is cultured on the medium, containing cytokinins. The shoot proliferation depends on the cytokinin used. The commonly used cytokinins are Benzyl aminopurine (BAP), kinetin, 2-isopentanyl adenine (2-ip). The regenerants are considered to be genetically stable, as compared to regeneration from adventitious meristems.

2. Regeneration from adventitious meristems: Shoot multiplication either directly or by callus formation can be obtained by inducing adventitious shoot production on mature plant organs such as leaves, stems and roots. For initiation of adventitious meristems, a proper balance of auxin and cytokinin is needed in culture medium. In general, shoots are formed when a high ratio of cytokinin to auxin is present and reverse is true for root formation. The plants regenerated via this method are not always genetically stable, due to accumulation of aneuploid and polyploid cells with continuous sub-culturing of callus causing mixoploids. The repeated subculture of callus also reduces its morphogenetic potential/regenerative capacity.

3. Regeneration by somatic embryogenesis: The induction of somatic embryos is the best technique for rapid and true to type multiplication of plants. The somatic embryos originate from somatic or vegetative cells, and are bipolar structures, which possess both shoot and root meristem. The induction of embryo requires a high level of auxin in culture medium, followed by low auxin and cytokinin medium. Somatic embryos may arise in culture directly on explants or via callus formation or liquid suspension cultures. The somatic embryos can be encapsulated, thus producing artificial or synthetic seeds, which is an attractive alternative for propagation of plants. Among two methods viz., hydrated or dessicated, for artificial seed production, the production of hydrated seeds is more popular. In this method, the individual somatic embryo is encapsulated in a water based gel (hydragel; such as calcium alginate). Embryos developed through tissue culture technique are mixed with sodium alginate and dropped with pippette into a calcium salt (calcium chloride) solution to form calcium alginate capsules. The capsules are washed in water and then placed on culture medium for germination. Artificial seeds have been produced in Banana, Citrus, Mango, Apple, Olive and Kiwi fruit.

Basic requirements for micro propagation:

1. A well equipped laboratory
2. Aseptic condition
3. Culture Medium (Nutrient media)
4. Controlled culture environment
5. Acclimatization/Hardening chamber

Stages of micro propagation:

A) Stage-1: **Establishment-** It includes selection of an elite mother plant- Explant- Surface sterilization and washing- Inoculation in culture medium.

B) Stage-2: Proliferation- Transfer in proliferation medium-shoot and embryoid formation.

C) Stage-3: Rooting and Hardening- Transfer of shoots to rooting medium and after rooting transfer in artificial medium or sterilized soil by gradual weaning process.

Stages involved in Micro-propagation:

There are several main stages involved in micro-propagation of plants, such as explants establishment, shoot proliferation, rooting of shoots, hardening and transfer to soil/field.

1) Explant establishment: The establishment of explant depends on several factors such as the source of explant/ genotype, type of explant such as leaf, root, stem from mature or immature plants/ seedlings explant sterilization, the in vitro culture conditions such as culture media, composition, temperature, humidity, light etc. The explants showing growth are considered established.

2) Shoot multiplication: The established explants are subcultured after 2-3 weeks, on shoot multiplication medium. The medium is designed in such a way to avoid the formation of callus, which is undesirable for true to type multiplication of plants. Thus the careful use of auxins like NAA, 2,4-D and cytokinins like BAP, Kinetin is done in culture medium. It is well-established fact that cytokinins enhance shoot multiplication.

3) Rooting of shoots: The in vitro regenerated shoots are rooted in the medium containing auxins like NAA, IBA. The rooting can also be induced when in vitro shoots are exposed to stress conditions. The rooting should also be preferably without formation of callus, thus avoiding somaclonal variants.

4) Hardening and transfer to soil/ field: The in vitro plantlets thus obtained are hardened/ aclimatized before transfer to the field. The hardening is necessary as the Tissue culture derived plants grow under high humidity conditions, have open stomata, lower epicuticular wax, thus leading to increased transpiration losses and resulting in mortality of plants.

Micro-propagation Techniques: To produce virus free plants, meristem culture and micro-grafting techniques have been standardized in different fruit plants. The success varies with the plant species, variety and the culture environment.

1. Meristem tip culture: This technique is widely used in horticultural plants like potato, dahlia, carnation and orchids. In this method, the meristem tip consisting of one or two pairs of leaf primordia are cultured in a medium. After a few weeks, the plantlets are re-generated and after hardening of the plantlets, these are transplanted in the soil under natural environmental conditions. Meristem tip cultured plants give rise to polyploid plants instead of diploid plants. Moreover, meristem tip culture is very useful for the elimination of viruses from infected plant material. Rapid multiplication of the plants, which are otherwise not easily propagated by vegetative means, is also possible through meristem culture. Plants produced are free from pathogens and can be stored for longer period and in smaller space.

Problems encountered during Micro-propagation: The success of micro-propagation in several instances is hampered by the following problems.

1) Microbial contamination: Bacterial/fungal contaminations in the cultures do not allow the propagules to grow. This problem can be overcome by growing donor plants in growth chambers, systemic fungicide spray prior to explant removal, effective sterilization of explants, performing inoculations in laminar air flow cabinets fitted with HEPA filters (0.2 μm) and using sterilized surgical instruments. Fumigation of inoculation room using dilute formaldehyde solution also helps to minimize this problem.

2) Browning of cultures: The cultured explants of certain plant species secrete phenolic substances into the medium, which cause browning due to oxidation of phenols and formation of quinones, the toxins which effect the growth of cultured explants. The use of antioxidants such as activated charcoal (1-2%), citric acid or

ascorbic acid (50-100 mg/l) and polyvinylpyrrolidone (PVP), poly vinyl poly pyrrolidone (PVPP) in the culture medium helps to check the browning.

3) Variability in T/C regenerated plants: Variability is highly undesirable in the micropropagated plants. It may occur due to callusing and regeneration of plants from callus instead of direct shoot induction and proliferation. Moreover, the plants regenerated through adventitious meristems as compared to axillary meristem are susceptible to mutations, as it is derived from either a single cell or a small group of cells. Thus leads to variation in regenerated plants. The variation due to callusing, can be overcome by addition of growth substances which inhibit callusing such as triiodobenzoic acid (TIBA), phloroglucinol and phloridzin and also by reduction of inorganic salt concentration in the culture medium.

4) Loss of plants due to transplantation shock: Tissue culture regenerated plants have anormal leaf morphology, poor photosynthetic efficiency, malfunctioning of stomata (open), reduced epicuticular waxes and thus are amenable to transplantation shock. Hardening of such plants is thus must before transplantation under field conditions. Conservation of moisture by creating high humidity around the plants, partial defoliation and application of anti-transpirants are useful for hardening of in vitro raised plants.

Limitations: Micro-propagation has certain limitations also. These are as under:

1. The facilities required are very costly.
2. Technical skill is required to carry out different micro propagation procedures.
3. Pathogens once appeared in the system, they also multiply at a very faster rate in a short time.
4. Plants having high levels of phenols (mango. date palm, coconut etc.), usually do not respond to micro-propagation techniques
5. Establishment of laboratory-raised plants in the field is a very difficult task.

Hardening of Plants: The tissue culture plants need acclimatization or hardening before they are transferred in the field. The acclimatization is necessary because there is vast variation in the environment surrounded by in vitro plants and the field environment. In culture vessels the in vitro plants are exposed to high humidity, hetrotrophic mode of nutrition, high ethylene concentration and constant temperature throughout the year. These conditions lead to the development of plants having low epicuticular wax, low stomatal density and stomatal malfunction, which make these plants more vulnerable to mortality in field conditions. To prevent this mortality, it is must to harden or acclimatize tissue culture plants.

Approaches for Hardening of Plants: To have success in hardening of tissue culture plants, the following approaches are adopted:

1. Balanced proportion of roots and shoots in micro-propagated plantlets.
2. Appropriate rooting media for establishment of plants ex vitro.
3. Balanced nutrition for survival of rooted plantlets.
4. Simultaneous rooting and acclimatization .
5. Cleaning of gelling agents from roots before transfer to rooting media.
6. Moisture content or humidity around transferred plantlets.

Advanced Approaches: The conventional approaches are not sufficient to acclimatize the wide range of plant species, an alternative in vitro and ex vitro approaches can be adopted.

1. Pre hardening of plantlets in culture vessel, before transfer to soil.
2. Alterations in sugar concentration in the culture medium.
3. Concentration of gelling agents.

4. Use of antitranspirants.
5. Control of gas exchange around the plantlets.
6. Use of growth retardants.
7. Autotropic mode of nutrition of in vitro plantlets

Practical No.-12

Objective: To study about use of mist chamber in propagation and hardening of plants

Aim: The aim of mist chamber in propagation is to maintain humidity by a continuous film of water on the leaves, thus reducing transpiration and keeping the cutting turgid until rooting take place. Prevent disease infection in the cuttings by way of washing off fungus spores before they attack the tissues. While the leaves in this process must be kept continuously moist, it is important that only minimum water should be used.

Materials required: Mist chamber, cuttings, secateurs, hormone solution and sand

Mist chamber: The enclosed structure in which artificially mist is generated for the cutting/propagated plants or seedlings. In Mist Chamber, Relative humidity is maintained at high level (85-95 %) with the help of mister's, which spray water under high pressure. Size of mist partials lies between 50 to 100 μm. High relative humidity facilitate better root initiation and cooling effect prevents the cutting from drying out.

Advantages of mist chamber:

1. The mist chamber resulted in faster rooting of the cuttings.
2. The mist chamber creates optimum Micro-climate for better root initiation and development.
3. Higher success rate found in propagation of hard wood cuttings.

Disadvantages of mist chamber:

1. Hardening of rooted cuttings is more difficult and requires careful attention.
2. Selection of right medium is very important.
3. Under mist conditions oxygen deficiency can create problem.

Essential components of mist chamber:

1. **Structure:** Complete Structure will be made by hot galvanised G. I. Pipes (so rust resistant). It with stands strong normal wind load and rains.
2. **Cladding:** Polycarbonate multiwall /DL sheets. This sheet can with stand in heavy rain and hail storm.
3. **Forced Air Cooling System:** Corrugated Cellulose Pad and Axial Flow Flan
4. **Fogging:** Overhead fogging system at the gutter height of mist chamber
5. **Irrigation:** Knapsack sprayer/ Water & Fertilizer applicator boom irrigation system
6. **Alluminate Screen:** To cut off the excess the sunlight in order to maintain the temperature inside the mist chamber

7. Shade Net: Automatically control roof shading system, as per the requirement to reduce heat load inside the facility in peak summer.
8. Root trainer: Made up of high quality polymer with special design. Seedling of the desired species can be grown either through seed or clonal multiplication.
9. Inert Martial: Coco peat, Perlite, Vermiculite.
Optional components:
1. Benching System: Our benching system is in consonance with the International standards with load bearing capacity of 3 tonnes with usable life span of 20 years. By using this benching system we can use 18-21% more area inside the mist chamber as compare to our conventional method. Benches are 100% hot galvanized so rusting will not take place otherwise rusted part of the benches are the favorable point to develop the fungus and other pathogen.
2. Climate Control sensors: All the parameter i.e. Temperature, Humidity and Light are controlled by microprocessor control system. It controls and displays the parameters very accurately.
3. Horticulture Lights: Proper daily light integrals are very important factor for plants. In this facility appropriate light spectrum by photosynthesis lamps is provided to the plant so as to get optimum bio mass production in the plant. The light is 100% evenly distributed in the chamber so that each and every plant get illumination and a result the vegetative growth is very fast. Day length can be increase inside the greenhouse if required.

Practical No.-13

Objective: To study about the preparation of plant growth regulators for seed germination and vegetative propagation

Aim: Plant growth regulators used to modify plant growth such as increasing rooting callusing during cutting and grafting respectively.

Material required: Plant growth regulator(s), Alcohol, Measuring cylinder, Volumetric flask, Beaker(s), Electronic balance, distilled water.

Plant growth regulators (PGRs): Plant growth regulators (PGRs) defined as natural or synthetic compounds that affect developmental or metabolic processes in higher plants, most in low concentration. They do not possess a nutritive value used to regulate the growth of plants and are important measures to ensure agricultural production.

Preparation of growth regulator solution:

1. 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.

2. After weighing the required quantity of growth regulator transfer it to a beaker and dissolve it with the small quantity of solvent.

3. Auxins are soluble in alcohol or 0.1% NaOH. Gibberellins are soluble in absolute alcohol, while, cytokinins can be dissolved in 1-2 ml N/10 HCl.

4. Abscisic acid is highly soluble in NaOH. 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.

5. For every use one should prepare fresh solution. Following formula is used for conversion of hormonal strength.

i. Percent solution = ppm 10,000

ii. ppm solution = % x 10000 = % x 104

- **For liquid PGR**

1 ml=1000ml
1 ml = 1000μl
1 L = 1000000
If 1 μl PGR add in one 1 L solution the solution prepared 1 ppm

- **For solid PGR**

1 kg=1000gm
1gm=1000μg
1kg=1000000μg
If 1 μg PGR add in 1kg solution the solution prepared 1 ppm

Preparation of hormonal powder:

1. For preparation of hormonal powder, the required quantity of hormone is weighed precisely with the help of sensitive balance.

2. 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.

3. 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.

4. 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:

1. For preparing hormonal pastes, the required quantity of the hormone is weighed accurately and dissolved completely in a few drops of alcohol.
2. 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.
3. When the lanolin is slightly liquefied the dissolved hormone is poured in it.
4. The mixture is dissolved thoroughly with constant stirring with a glass rod. The mixture is allowed to cool down.
5. 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.

Prolonged soaking method:

1. This method, the basal end of cuttings is dipped in the dilute solution of the hormone for 24 hours in a cool dry place.
2. The concentration of hormone or growth regulator usually varies from 20ppm to 200 ppm, depending upon plant species and type of cutting.
3. After treatment cuttings are planted in growing medium. The concentration is usually low in growing medium.
4. The concentration is usually low for easy to root species and vice versa.
5. 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.

Quick dip method:

1. 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.
2. 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.

Powders dip method:

1. Basal ends of cuttings are dipped in the hormonal powder which carries (talc) for some time
2. 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.
3. 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.
4. Seradix, Rootex or many other formulations are available in the market as powders.

Lanolin paste method:

1. 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.

Spray method:

1. 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.

Practical No.-14

Objective: To study about demonstrate application of nutrients in fruit nursery

Aim: The 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**.**

Materials required: Specific fertilizer, or Nutrient source, Hoeing tools, Spraying equipments, Weighing machine.

Three important methods of application are:

1. 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.

2. 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 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.

3. 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 dissolved properly.

Practical No.-15

Objective: To study about application of plant protection chemicals in the nursery

Aim: Protect plants or plant products against pests/diseases, before or after harvest. Influence the life processes of plants such as substances influencing their growth, excluding nutrients, preserve plant products, destroy or prevent growth of undesired plants or parts of plants.

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

Procedures:

1. 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 slings.

2. The common diseases are damping off, powdery mildew, leaf spots, blights and dieback etc.

3. Damping off is caused by many fungi but Pythium, Phytophthora, Rhozoctonia and Botrytis are major casual 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.

4. The prevention of these diseases, insect-pests and environmental factors can be made in following ways.

Disinfestations:

1. 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.

2. In general, 50 percent ethyl alcohol, 2 percent calcium chloride and 0.01 percent mercuric chloride concentration are used.

3. 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.

4. After treatment the seeds are washed with tap water and immediately sown in the nursery.

Disinfection:

1. 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^{o}C) for 10-30 minutes, depending upon the kind of seeds and type of pathogen.

2. Seeds should be stirred continuously and temperature and duration of treatment should be monitored precisely.

3. 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.

4. This involves precise control on temperature and vapour flow rate, where injury to seeds is minimum.

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.

Protection:

1. Treatment of seed with different chemicals to protect from pathogens is protection.

2. It includes dry seed treatment and wet seed treatment.

Dry seed treatment:

1. 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.

2. Commonly used chemicals are Brassicol, Captan, Agrosan-G, Ceresan, Thiram and Dithane M-45.

Wet treatment method:

1. In this method seeds are immersed in the liquid suspension of t chemical for specific time.
2. Continuous stirring is required so that chemicals do not accumulate at base.
3. After treatment, seeds are dried in sun or shade.

Practical No.-16

Objective: To study about digging, labelling and packing of plants

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

Procedure(s):

Uprooting/digging of nursery:

1. 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.

2. To achieve high rate of yield survival of evergreen tropical or subtropical fruit plants like mango, guava, citrus and litchi etc. these should be uprooted with a ball of earth.
3. 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 thorough inspection, the saplings should be labeled crop wise and variety wise with the help of zinc/tin labels, 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 fibre. 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.

Practical No.17

Objective: To study about maintenance of nursery records

Aim: The nursery record provides an overview of the all factors that go into starting and operating a native plant nursery. Management includes all aspects of working with plants in all their phases of growth. Crop planning and develop propagation protocols.
Materials required: Registers, Chronological operation record, Nursery map
Procedure:
1. Some records are essential if nurseryman is to plan his nursery for remunerative returns and establish as a reputed enterprise.

2. 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.
3. There must be specific register for specific selected activities to keep day to day or pedigree or operation records in nursery.
4. 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 quantity 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 stratification 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. Nurserymen should not be bias in recording specific problems

ABOUT THE AUTHOR

Dr. Shiwanand Pandey was born in Village and Post Sonkhar Bansi District Siddharh Nagar Uttar Pradesh 272153. He was completed B.Sc. Horticulture in 2015 from Hemvati Nandan Bahuguna Garhwal Central University (UK), M.sc. Horticulture 2017 from Acharya Narendra Deva University of Agriculture and Technology Kumarganj Ayodhya (UP) and Ph.D. from Sardar Vallabhbhai Patel University of Agriculture and Technology Modipurm Meerut (UP). He has published research papers in various International & National Journal and abstract of various International & National seminar He has also qualified NET (National Eligibility Test) in 2020. He is working as Assistant Professor at Baba Farid Group of Institution Suddhowala Dehradun.

Mr. Rohit Jaiswal was born in Village Ranbirpur and Post Sarwan District Mau Uttar Pradesh 275101. He was completed B.Sc. Horticulture in 2015 from Hemvati Nandan Bahuguna Garhwal Central University (UK), M.sc. Agriculture in Extension education 2018 from Acharya Narendra Deva University of Agriculture and Technology Kumarganj Ayodhya (UP). He has published research papers in various Journal. He is working in ICAR-CISH, Rehmankhera, Lucknow as Senior Research Fellow since 2019

Mr. Manoj Kumar was born in Village and Post Paiga District Bareilly Uttar Pradesh 262407. He was completed B.Sc. (Hons.) Horticulture in 2017 from Banda University of Agriculture and Technology, Banda (U.P), M.Sc. (Ag.) Horticulture 2019 from Sardar Vallabhbhai Patel University of Agriculture and Technology Modipuram Meerut (U.P) and Ph.D. pursuing from Chandra Shekhar Azad University of Agriculture and Technology Kanpur (U.P). He has published research papers in various International & National Journal and abstract of various International & National seminar He has also qualified NET (National Eligibility Test) in 2021.

DR. SHIWANAND PANDEY

MR. ROHIT JAISWAL

MR. MANOJ KUMAR

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