Horticultural Crops Production Level-IV

Based on March 2019, Version 2 Occupational standards

Module Title: - Planning a propagation program

LG Code: AGR HCP4 M2 LO (1-3) LG (30-32)

TTLM Code: AGR HCP4 TTLM 1220v1

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GREEN FLOWER FOUNDATION

Table of contents

LG #30	LO #1- Carrying out preliminary planning activities for a plant propagation program

Instruction sheet: 1

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Confirming and understanding management and marketing requirements
- Evaluating space requirements for propagation program
- Determining propagation techniques
- Determining environmental parameters that impact on propagation
- Negotiating budget for the propagation program
- Identifying OHS hazards associated with the propagation program
- Assessing risks and implementing controls

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Confirm and understand management and marketing requirements
- Evaluate space requirements for propagation program
- Determine propagation techniques
- Determine environmental parameters that impact on propagation
- Negotiation budget for the propagation program
- Identify OHS hazards associated with the propagation program
- Assess risks and implementing controls

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

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Information Sheet-1 Confirming and understanding Management and marketing requirements

1.1 Confirming and understanding management and marketing requirements

Plant Propagation: - is an art and science of establishing plant life and increasing the number of plants that are used in daily life. It is a method of multiplication of a plant species in such a way that it perpetuates its characters from one generation to another.

Propagation techniques: - it is a method used to perform plant propagation activities. Propagation techniques are classified generally into two groups: sexual propagation and asexual propagation.

Sexual propagation: - is also called seeding reproduction. Sexual or seed propagation is reproducing plants by the use of seed. This seeds are resulted from fertilization of ovules and often an exchange of genetic material through self or cross-pollination

Asexual propagation: - is also called vegetative reproduction. it is a method by which plants reproduce asexually that is, without the union of cells or nuclei of cells—thus producing individuals that are genetically identical to the parent.

It is the duplication of a whole plant from any living cell tissue or organ or a part of that plant by different methods like cuttings, layering, growing on tissue cultured plants, division or splitting, budding, grafting, spores and cloning.

Plan: - a set of procedure to do something.

A scion: - The upper part of the graft combination which is taken from the desired plant to be multiplied

Rootstock: - The lower part of the grafted plant which provides the root system is known as the rootstock or under stock or sometimes simple the stock.

What are management and marketing requirements?

Confirming and understanding management and marketing requirements are the basic part of developing propagation plan. To undertake propagation operation successfully, there is a need of developing plan which includes all the basic requirements.

These basic requirements may include:-

- Propagation technique depending on the type of crop to be propagated.
- Controlling the growing environment
- Plant species
- Growth habits and cultural requirements
- The purpose or intended use of the propagated plants
- Maintenance services for propagation after-care
- Quality specifications and timelines for the program
- Budget limitations and infrastructures
- Basic tools, equipments and materials required to undertake the task.
- Understanding major factors affecting propagation success.

Self-check-1	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Define the following words.(10 pts)
   - 1.1. Propagation
   - 1.2. Plan
   - 1.3. Propagation techniques
   - 1.4. Sexual and asexual propagation
   - 1.5. Scion and rootstock

I. <u>Choose the best answer for the following question (2pts each)</u>

1. Which one of the following is a combination of two parental systems to produce new generation? **(2pts)**

A. Asexual propagation
B. Propagation
C. Sexual propagation
D. Vegetative propagation

2. Which one of the following is a new generation to come from one parent system **(2pts)**

A. Asexual propagation
B. Propagation
C. Sexual propagation
D. propagation by seed

3._____ is the process of multiplication of plant material. :-**(2pts)**

A. Maturity
B. Propagation
C. Harvesting
D. seedling

Note: **Satisfactory rating – 16 and above points** **Unsatisfactory - below 16 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____

Date: _____

Choose

1. ____
2. ____
3.____

Information sheet 2 Evaluating space requirements for propagation program

1.2 Evaluating space requirements for propagation program

Plant propagation operation may be takes placed on the field, in controlled environments or laboratories depending on the type of crop to be propagated, the nature of the plant, the aim of propagation, materials availability and on the time required to complete the propagation program.

Therefore, evaluating space requirements for propagation program is important part of crop propagation activity in which it needs critical skill, knowledge, budget and available space depending on the aim and type of plant to be propagated.

What are the basic requirements when evaluating space requirements for propagation program?

- Available land, laboratories or tissue culture media depending on the crop type to be propagated.
- Suitable climatic factors (rain fall, temperature, soil type, altitude…etc) depending on the crop type to be propagated must be considered
- Different factors that affect the growth and development of the crop (like disease, insect pests, and different stresses) must be considered.
- Availability of infrastructures that aids in the propagation program.

Self-check-2	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the basic requirements when evaluating space requirements for propagation program?(3pts)
2. What are the evaluating space requirements for propagation program needs critical activity(3pts)

I . Write true If the statements is correct or false statement is incorrect (2pts each)

1. All ways roots of smaller plants may be more damaging than of larger plants. **(2pts)**

2. Density of foliage is more likely to impact upon light levels and ventilation. **(2pts)**

3. The wrong tree or shrub can result in broken drains or damaged foundations. **(2pts)**

Note: **Satisfactory rating – 10 and above points** **Unsatisfactory - below 10 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Choose

1. ____
2. ____
3. ___

Information sheet 3 Determining Propagation techniques.

1.3. Determining propagation techniques according to species

As you know propagation technique is a method used to perform plant propagation activities you can use either of the methods depending on the type and nature of crop to be propagated. Basically, there are two types of propagation techniques: **Sexual and asexual** propagation.

Sexual propagation

Definition – sexual or seed propagation is reproducing plants by the use of seed. This seeds are resulted from fertilization of ovules and often an exchange of genetic material through self or cross-pollination.

Plant species which are reproduced by seed are not identical to their parents or they are genetically variable. For most fruit species propagation by seed is not advisable. However, passion fruit, papaya can be reproduced well from seed. Sexual propagation most commonly used for growing rootstock and for breeding purpose.

The plant selected as mother plant for seed propagation should have the following characteristics.

- Plants of good quality and high yielder
- High adaptability to local climate and soil conditions.
- Grow strong/vigorous healthy plants ,which have desirable characteristics
- Free from diseases
- comparability, timing,
- Disease and insect resistance, drought, tolerance, and hardiness.

The indicators of seed quality are: Highest germination percentage, uniform germination, vigorous seedling growth, purity and normal appearance.

Advantage of seed propagation

- Cheaper and easier method
- Result in plants with new genotype
- Provide a method for starting ‘disease free
- ’ plants Needs less skill for propagation
- Offspring’s are often robust, with deep rooting syst.

Disadvantage

- Genetic variability
- Require long time to maturity

Asexual propagation

Vegetative Reproduction, method by which plants reproduce asexually that is, without the union of cells or nuclei of cells thus producing individuals that are genetically identical to the parent. Vegetative reproduction takes place either by fragmentation or by special asexual structures. Asexual structures in plants include some spores, tubers, bulbs, stolons (runners), suckers and rootstocks

Advantage of vegetative propagation

- Some species propagate more easily vegetative than from seed.
- Offspring’s are identical to parents. This means large genetic advance can be made in a single stem.
- Useful for woody fruit trees, whose reproductive cycles are slow.
- Combination of more than one genotype into a single plant.(by budding or grafting)

- Shortening the time of maturity and fruit bearing

Disadvantage

- Disease transmission
- Require skill for budding and grafting
- May require specialized equipment

The types of **vegetative propagation** carried out in fruit plants include: Layering, Grafting, Budding, Cutting (stem, leave, and root), and Division.

What is a cutting? A cutting is detached vegetative part of the plant, which on separation and planting is able to regenerate the missing parts and develop itself into a new plant.

Importance of cutting in the vegetative propagation of plants:-

- It is an inexpensive and quick method of propagation.
- A Large number of uniform plants can be produced using just a few parent plants.
- It does not involve special skills.

Types of cutting **-Leaf cutting**

-Stem cutting

-Root cutting

Types of Leaf cutting **_leaf bud**

-leaf petiole

- Leaf blade

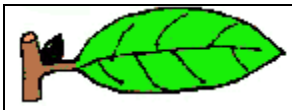
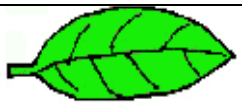
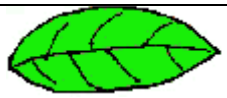
 **Leaf bud**	 **Leaf petiole**	 **Leaf blade**

Figure: 1. 1. **Leaf cutting**

Types of stem cuttings

Based on the age and maturity of shoots detached for vegetative propagation, stem cuttings are classified as follows:

- Herbaceous or softwood cuttings
- Semi-hardwood cuttings
- Hardwood cuttings.

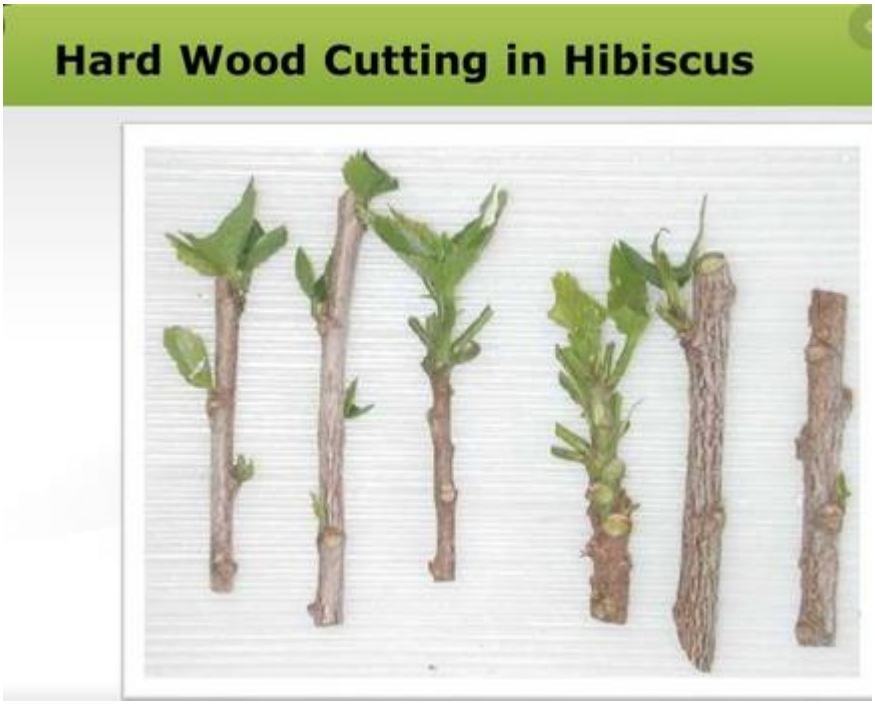


Figure: 1.2.stem cutting

Root cuttings are just that, pieces of **roots** that form new shoots. These are often made in winter or early spring before plants begin growing. **Roots** should be the thickness of a thick wire. **Cut** into one to two inch lengths, place on a moist **rooting** medium, cover, and keep moist but not wet.

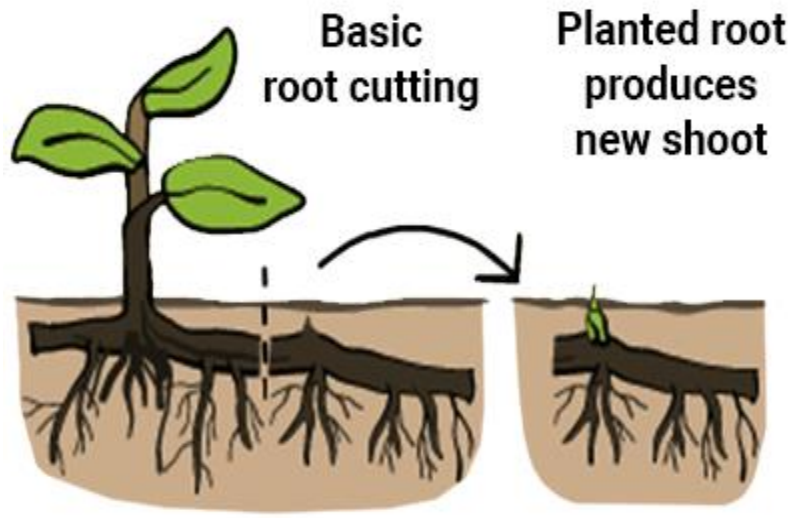


Figure: 1. 3 Root Cutting

What is layering? Layering is the process of development of roots on a stem while it is still attached to the parent plant. The rooted stem is then detached to become a new plant growing on its own roots. Such a rooted stem is known as a **layer**.

How do roots regenerate on the stem?

Root formation during layering is stimulated by various stem treatments, which cause an interruption in the downward translocation of organic materials (carbohydrates, auxins and other growth factors) from the leaves and shoot tips. These materials accumulate near the point of treatment and rooting occurs at the point of interruption.

Advantages of layering

- Most methods of layering are relative simple and can be practiced out of doors or in the nursery.
- Layering can give a high degree of success with comparatively less skill.

Limitations of layering

- Layering is comparatively an expensive method of propagation since it requires considerable labor and does not lend itself to mechanization.
- Layered plants require individual attention.
- Number of saleable plants from a given number of stock plants is limited.

Method of layering:

Mound or stool layering: in this method a plant is cut back to ground level during the dormant season, the soil is heaped around the base of the newly developing shoots. After allowing sufficient time for root development, individual rooted layers are separated from the mother plant and planted. This method is practiced to propagate and multiply **apple** rootstock and also plants like **guava.**

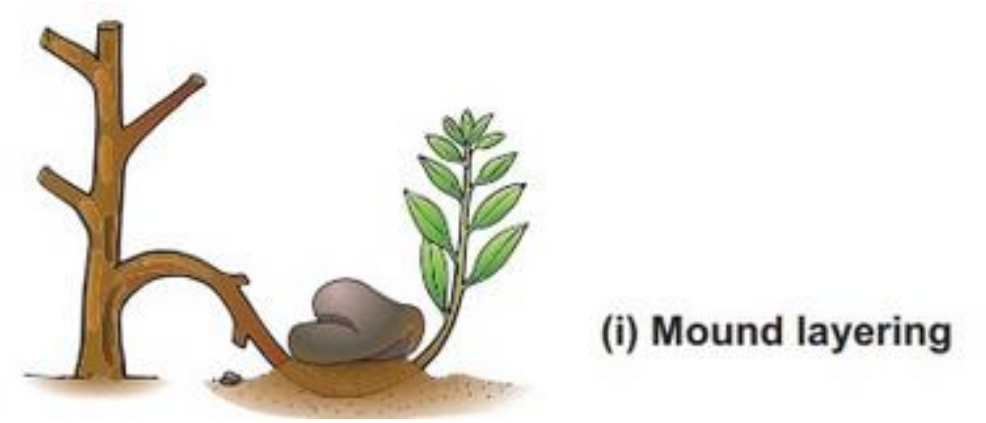


Figure: 1.4 Mound Layering

Trench layering: it is a modification of mound layering, a tree or vine of a desirable cultivar is headed low and allowed to grown vigorously the first season. Long branches are girdled, 5 to 8 cm apart, with each girdled segment having one or two buds. The girdled portion may be treated with IBA before burying the branch in a shallow trench and covering the horizontal portion but leaving the shoot tip exposed.

In the spring, the buried buds develop into shoots, and roots are initiated on the stem segments between girdles. The rooted pieces are separated from each other during the dormant season. Plants with long canes, for example, trailing blackberry, are multiplied in this manner.

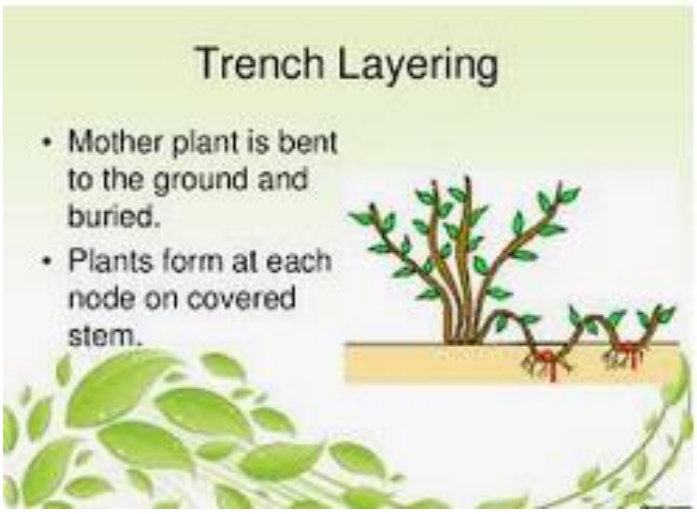


Figure:1.5 Trench Layering

Tip layering: Brambles are commonly propagated by burying tips of canes during their growing season. If the soil is kept moist, the shoot continues to grow while roots are initiated below the soil surface. These newly rooted shoot tips are severed from the parent plant and transplanted. Grapevines may be propagated in this fashion to fill in an adjacent missing vine

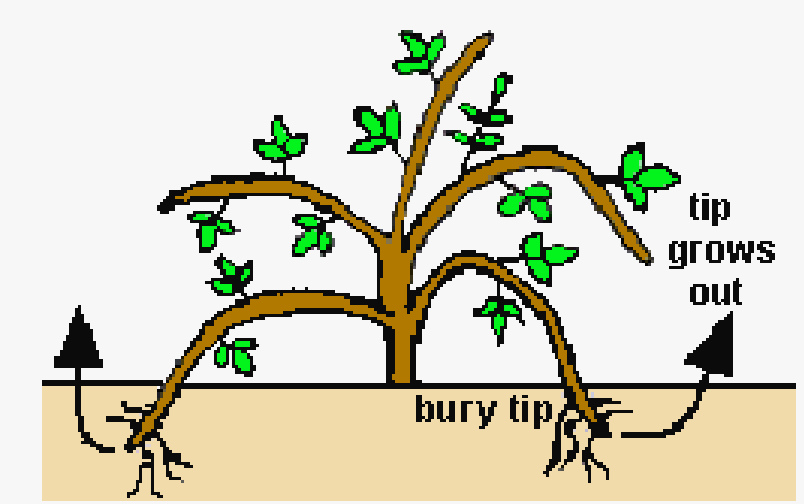


Figure: 1.6 Tip Layering

Air layering: In air layering, roots develop on aerial shoot where the stem has been girdled. The stem is usually stripped of lateral branches and leaves in the springs, and a girdle is made at the base of the cleared region. For getting root initiation, the girdled portion is treated with IBA and covered with a plastic band or a sheet of aluminum foil, which is filled with moist sphagnum moss which is the best rooting medium for air layering as it holds large amount of water till root initiation and their development.

When sufficient roots develop, the rooted stem is severed from the mother plant below the girdle and transplanted into soil. Some species require two growing seasons to form a good root system. This method is not commonly used for fruit trees because it is time-consuming, but it may be the only way to propagate some cultivars that do not readily form root initials by other techniques.

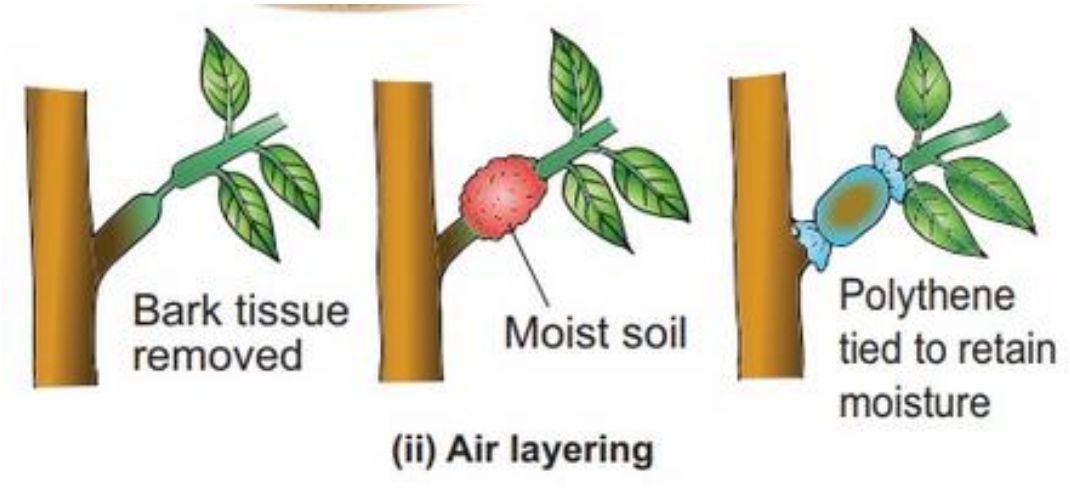


Figure: 1.7 Air layering

3. **What is grafting**? Grafting is the art of connecting two pieces of living tissue in such they unit and grow as one plant. The method of joining parts of two plants together in such a manner that they unite and function as one plant is known as grafting.

What is a scion? The upper part of the graft combination which is taken from the desired plant to be multiplied is known as the scion. It determine the quality productivity and resistance pest and disease

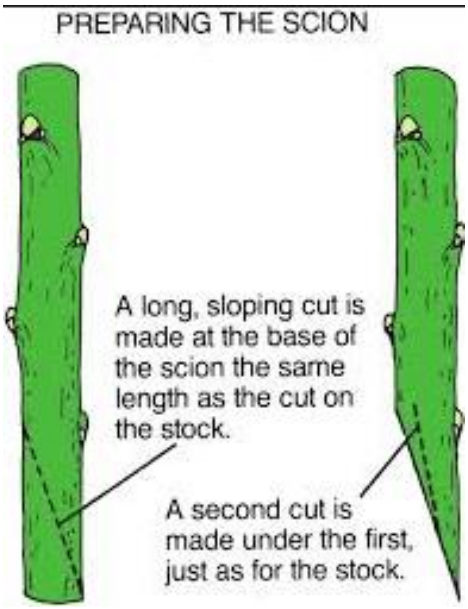


Figure: 1.8. Scion

What is a rootstock? The lower part of the grafted plant which provides the root system is known as the rootstock or under stock or sometimes simple the stock. It determines the vigor of the plant, resistance to root disease and pest.

Figure: 1.9 root stock plant propagation

The purpose of grafting

- For multiplying good or desired clones and cultivars which cannot be propagated easily in large numbers by other methods of plant propagation, such as seeds, cuttings, layers, etc.
- For imparting the beneficial effects of rootstocks and inters tocks, such as dwarfing effect, as in apple; hardinessing respect of unfavorable soil and environmental conditions, as in citrus and peach ; for improving the edible quality of fruit .as in various citrus species;

- For controlling insects affecting the lower portion of stem, as for phylloxera in grapes.
- As an aid in rejuvenation of old and seedling plants by top working (adopting various grafting methods) .
- Repairing the damage in the stem portion of the fruit trees caused by rodents or diseases, by bridge grafting.
- Virus indexing, as grafting makes it possible to test the presence and transmission of virus in plant showing little or no symptoms.
- To bring about early fruiting by reducing vegetative phase in hybrid seedlings or other seedling selections as in **apple** or **mango**.

Disadvantages of grafting

- Only closely related species grow together
- Disease can transmit easily

Incompatibility

Most of the related plants which when grafted together unite satisfactorily and function as one plant, are termed as compatible. Unrelated or distantly related plants grafted together, do not unite and the scion portion mostly dies. This phenomenon is known as incompatibility. Sometimes the union takes place and plants grow for a few years and then die due to poor union. This is termed as delayed incompatibility. Symptoms of incompatibility include: Leaf yellowing and abscission, overgrowth or swelling below, above or at the graft union, marked differences in the growth rate of stock and scion.

The compatibility of graft/bud will affected by:

- The kind of plant: the scion and rootstock must be capable of uniting

- Growth activities of stock plant: some grafting and budding depends on bark slipping which means the bark should be easily peel-off
- Growth activity and quality of scion/bud wood materials: the scion materials or bud wood is normally one year old or less.
- Propagation method used: different method suited to different species. The best method should be selected.
- cambial contact: the cambial regions of the scion must be placed intimate contact with that of rootstock
- Virus contamination, insect and disease: infection of graft union can cause difficulties with union
- Equipment: proper tools and accessories should be used

Four conditions must be met for grafting to be successful:

- The scion and rootstock must be compatible
- Each must be at the proper physiological stage;
- The cambial layers of the scion and stock must meet; and
- The graft union must be kept moist until the wound has healed.

How is a graft union formed?

The most important part of grafting is the formation of a successful graft union; it is an intricate process and depends on several variables and conditions for its success. The first step in the healing of the graft consists of aligning the freshly cut scion and stock tissue to fit tightly. It is necessary when grafting that the cambium layer of the scion and the stock be in contact so that callus cells from cambium tissues may intermingle.

The outer layers of cells in the cambium of the stock and scion produce parenchyma cells which soon interlock, forming the callus tissue. Cells of the new callus tissue begin to differentiate into new cambium cells along the lines of the two intact cambiums between the stock and the scion.

These cambium cells produce vascular tissue, consisting of xylem to the inside and phloem to the outside, which establishes a continuity between the cambiums of the scion and the stock. As a result of formation and joining of the new vascular tissue, the water and nutrients are transported from stock to scion and from scion to stock.

Methods of grafting:

There are essentially two general forms of grafting: detached scion and approach. The first is the most commonly used; roots are present only on the rootstock and the scion is detached from the donor plant. The second method involves the grafting of two plants, both of which are self-sustaining. After the union is formed, the scion is severed from the donor plant. This method is employed with plants that difficult to graft.

Stem grafting: A rootstock can be grafted or top worked with a desirable scion cultivar in several ways, depending on stock diameter, the time of year, and the species. Each method has its advantages and disadvantages. Stem grafting is divided into two types. One is mature cutting, which is usually used in spring before bud germination. Another is shoot cutting, which is used in growth season. The main methods of stem grafting

1. **Cleft Grafting:** This method is useful for grafting older pants with thick stem. The stock is sawed at an appropriate height. A vertical split 7-9 cm down the center of the stock is made. This straight vertical split is kept open with the help of a wedge placed in the center of the stub, Scions 8 to 9cm long and having 2 to 3 buds are selected and made into a tapering wedge

Two such scions are inserted in the sides of the vertical split so that cambium layer of the stock matches with that of the scion, and secured tightly with waxed cloth or plastic strips. Two advantages of this method are that it is easy and that it can be done in late winter when the bark is not yet slipping. The main disadvantage is that the cleft leaves a large wound, which may allow infection by wood-rotting organisms.

Figure: 1 .10 Cleft Grafting

2. Cut-grafting: If stock is thick, cut grafting is used. Cut scion into two sections. The longer section is about 2.5 centimeter. The shorter section, the reverse side, is about 1 centimeter, cutting vertical at the side of xylem of the rootstock, cut width and length is fit for the section of grafting bud, inserting grafting bud, enabling the cambium of longer section of grafting bud to align with cambium of stock. Then tying them tightly.

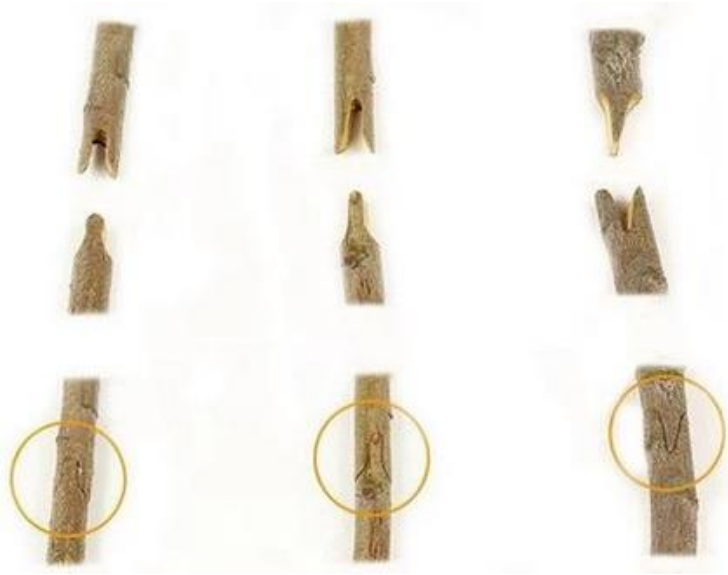


Figure:1.11 Cut Grafting

3. Bark Grafting: Scions are prepared for bark grafting by making a long beveled cut on one side and a short one on the opposite side. The scions held against the stock, and a band of bark of equal width to the stock is cut; the uppermost 5 to 8 mm portion of the bark is then removed.

The scion is slid behind the bark and nailed in place with three wire brads, 2 to 3 cm in length. The main advantage of this method is easy and rapid. Its disadvantage is that it cannot be used until the bark begins to slip in the spring.

Figure: 1.12 Bark Grafting

4. Whip grafting: This is a good method for young stock plants up to 1.0-1.5 cm in diameter. In this a 2 to 5 cm long cut at the top of the stock and a corresponding cut at the bottom of the scion are made .It is better to make the cut in one single stroke of the knife so that the cuter surface is very smooth.

On each of these cut surface reverse cuts are made, which when stock and scion are joined fit into each other, giving a large area for coming together of cambium layers of stock and scion. After joining the stock and scion, they should be tied securely with plastic tape or banana fiber.

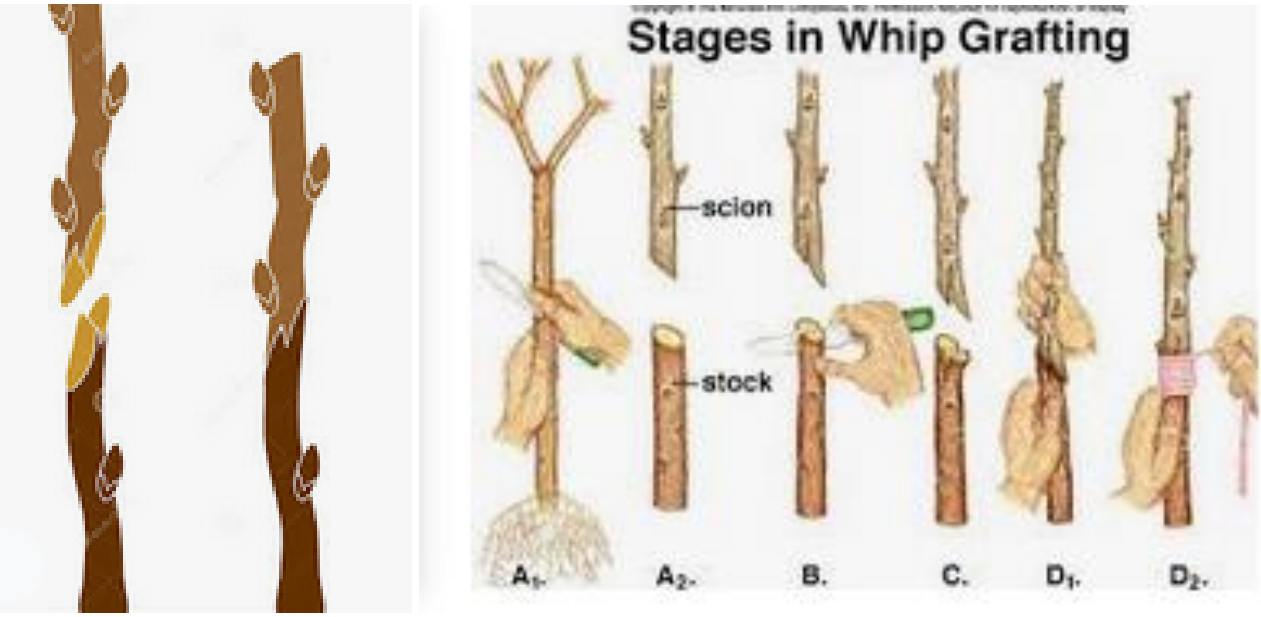


Figure:1.13 4 Whip Grafting

5. Inarching: Inarching is also known as 'approach grafting' or 'scion attached' method of grafting. It is done in evergreen plants which are generally unsuccessful when using other methods of grafting. e.g. Mango, sapota, litchi.

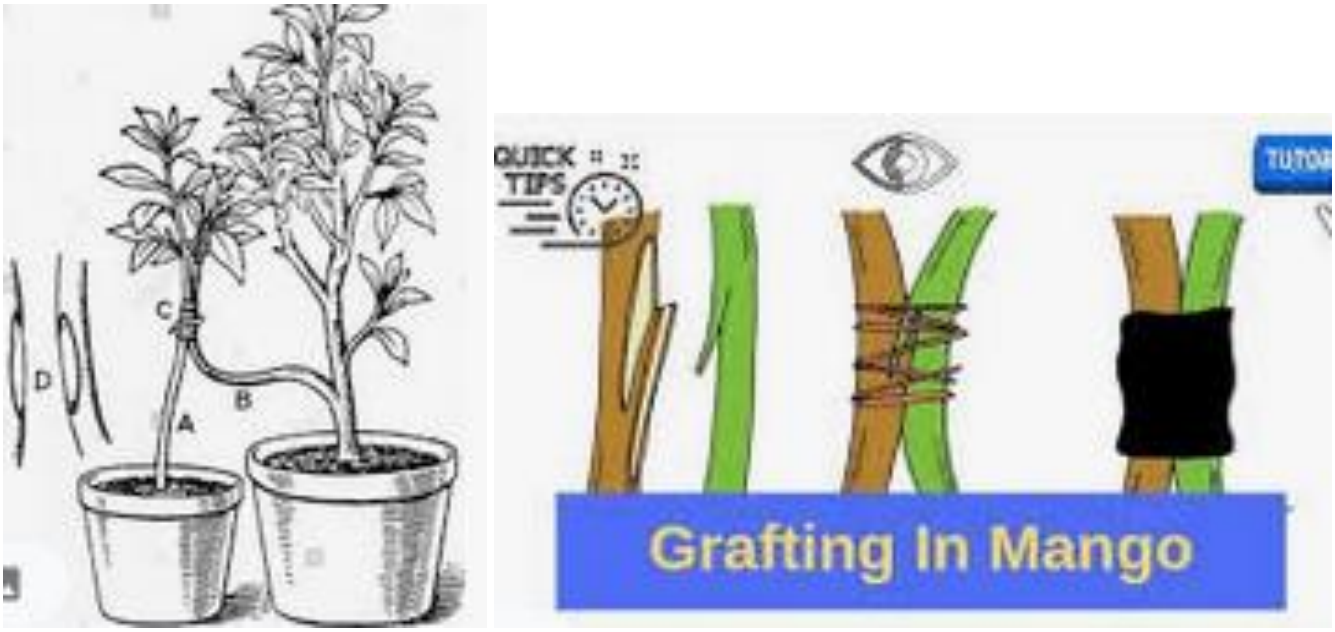


Figure:1.14 Inarching Grafting

4. What is budding? Budding is a special aspect of grafting in which the scion is a small piece of bark or wood with single bud. The bud develops into a plant after successful union with the rootstock.

What is the purpose of budding?

The purpose of budding are:

- To perpetuate the clone that cannot readily reproduced by other methods of propagation.
- To obtain the benefits of certain rootstocks (for cold hardiness, disease resistance, salt tolerance. etc.) and
- For changing the cultivar of established plants by top working.
- To induce precocity of bearing.
- For virus indexing.

What are the limitations of budding?

Since one of the requirements for a successful bud union is the close matching of the callus producing tissue (cambium layers), budding is generally confined to the dicotyledons and cone-bearing plants. Both have a vascular cambium layer existing as a continuous tissue between the xylem and the phloem.

When is budding done? Budding is done when the stock plant is in active growth and the cambium cells are actively dividing so that the bark separates readily from the wood. It is also necessary that well-developed buds of the desired cultivars are available at the same time.

Methods of budding:

1) **T—shape bud grafting (shield budding):**

Steps in T-budding

- A vertical cut about 3cm is made in the stock

- A 2cm long horizontal cut is made at the top of the vertical cut
- Remove the bud from the scion –beginning 1cm above the bud a slicing down ward cut is made to 2cm bellow the bud : horizontal cut is made to remove the at the base.
- The bud is inserted by pushing down ward
- The bud union is tied with a water proof materials but the bud left Showing.
- After the bud healed, the top of the stock is cut off just above the bud

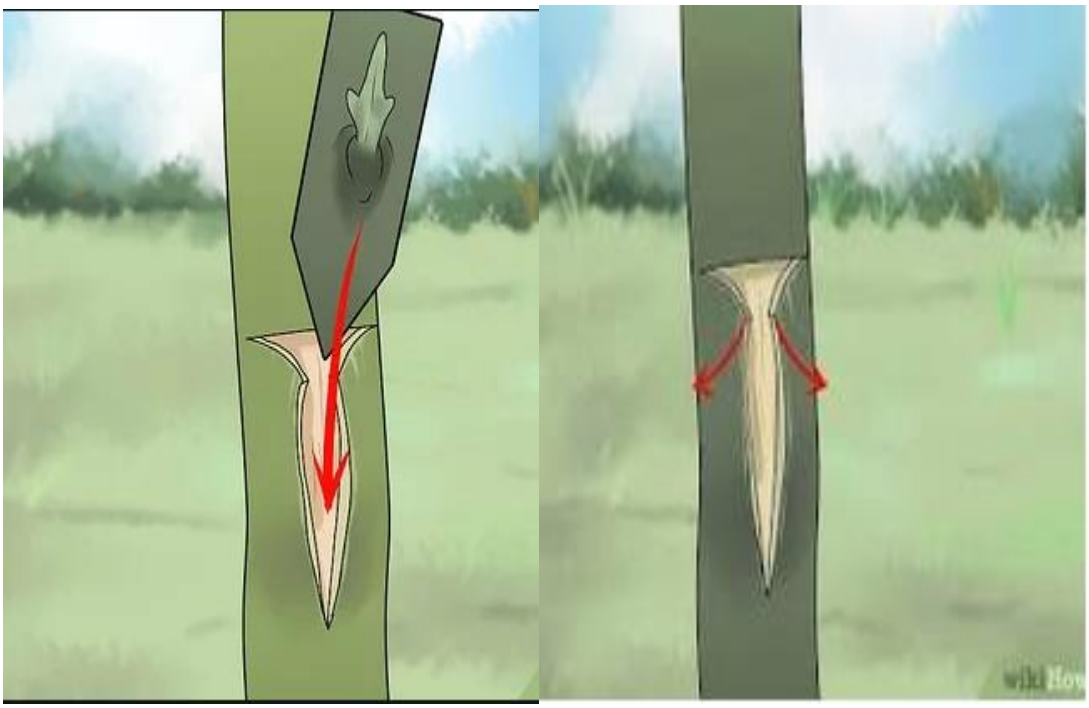


Figure: **1.15 T-shape budding**

2) Embed bud grafting or chip budding

Steps in chip budding

- A 45 degree angle down ward cut is made in scion just above the bud

- A second cut is made going in ward until it meets the first cut and remove a chip of wood containing the bud.
- Identical cut is made on the stock the chip is inserted.
- The bud area is then wrapped with bud left exposed.

Figure: 1.16 Chips Budding

3) **Flute budding**: In this method, a rectangular patch of bark removed from the stock almost completely encircles it. Leaving only a narrow connection of about 1/8 th of its circumference, between the upper and lower parts of the stocks, and replaced with a patch of bark of the same size containing a bud. The bark of both stock and bud stick should be slipping easily.

Figure:1.17 Flute Budding

4) **Ring budding:** In this method, a complete ring of bark from the stock and a complete ring with a bud from the bud stick are removed. In order that the two match, the size of the stock and that of the bud stick should be about the same.

The complete ring with a bud should be properly replacing the position of the stock bark.

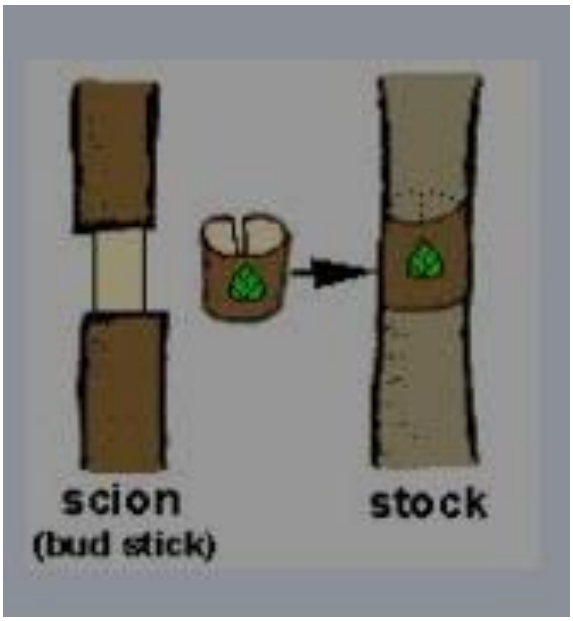


Figure: 1.18 Rings Budding

Other vegetative propagation

1. Crown Division: Separating the daughter plants from the mother propagates species that form suckers or tillers at the crown, such as raspberry and strawberry. Usually dormant plants are dug up, and the crown is divided so that each subdivision has a bud and some roots.

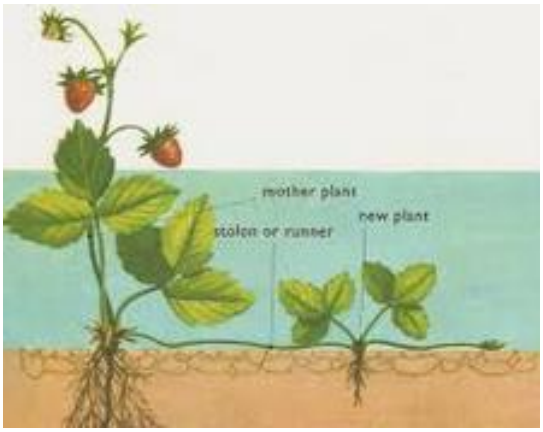


Figure: 1 .19 Crown Division

2. Rooted Suckers: Suckers that arise at the base or at some distance from the trunk, as in banana, may be excavated and transplanted. Spraying or dipping the roots of suckers in an IBA solution produced a better stand of plants than if they are untreated.

Figure:1.20 Root Sucker

3)**Tissue culture propagation :**Tissue, organ, and cell of plant by axenic operation was inoculated in artificial culture medium, under certain temperature, light, developing full plant,

such as this propagation ,we call tissue culture or culture in vitro.

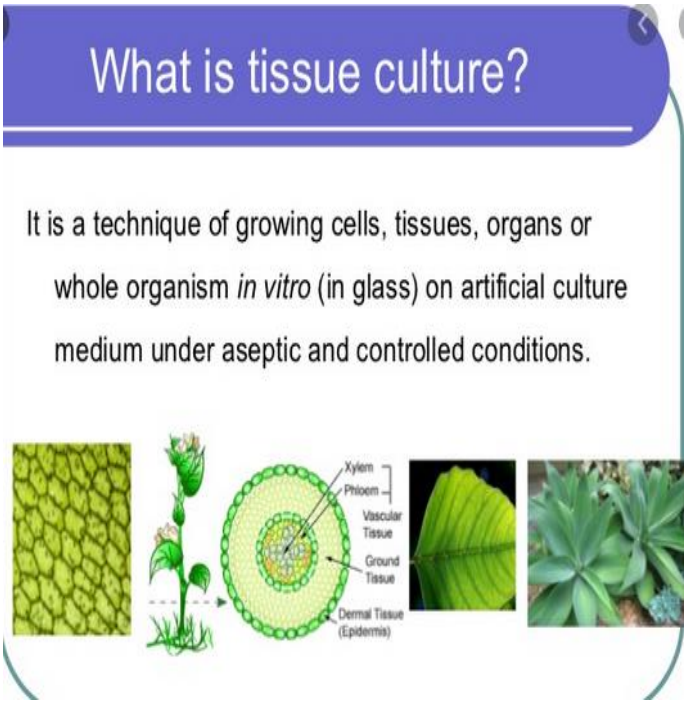


Figure: 1.21 Tissue culture

Name important methods of vegetative propagation for mango, guava, citrus and apple?

- Mango can be propagated by veneer grafting, stone grafting, softwood grafting;
- Guava can be by softwood grafting, air layering, ground layering;
- Citrus by side bark grafting, T-budding, cut-grafting, chip-budding;
- Apple by chip-grafting, approach grafting, T-budding, tongue grafting and air layering.

4. Runners are stems that grow horizontally above the ground. They have nodes where buds are formed. These buds grow into a new plant.

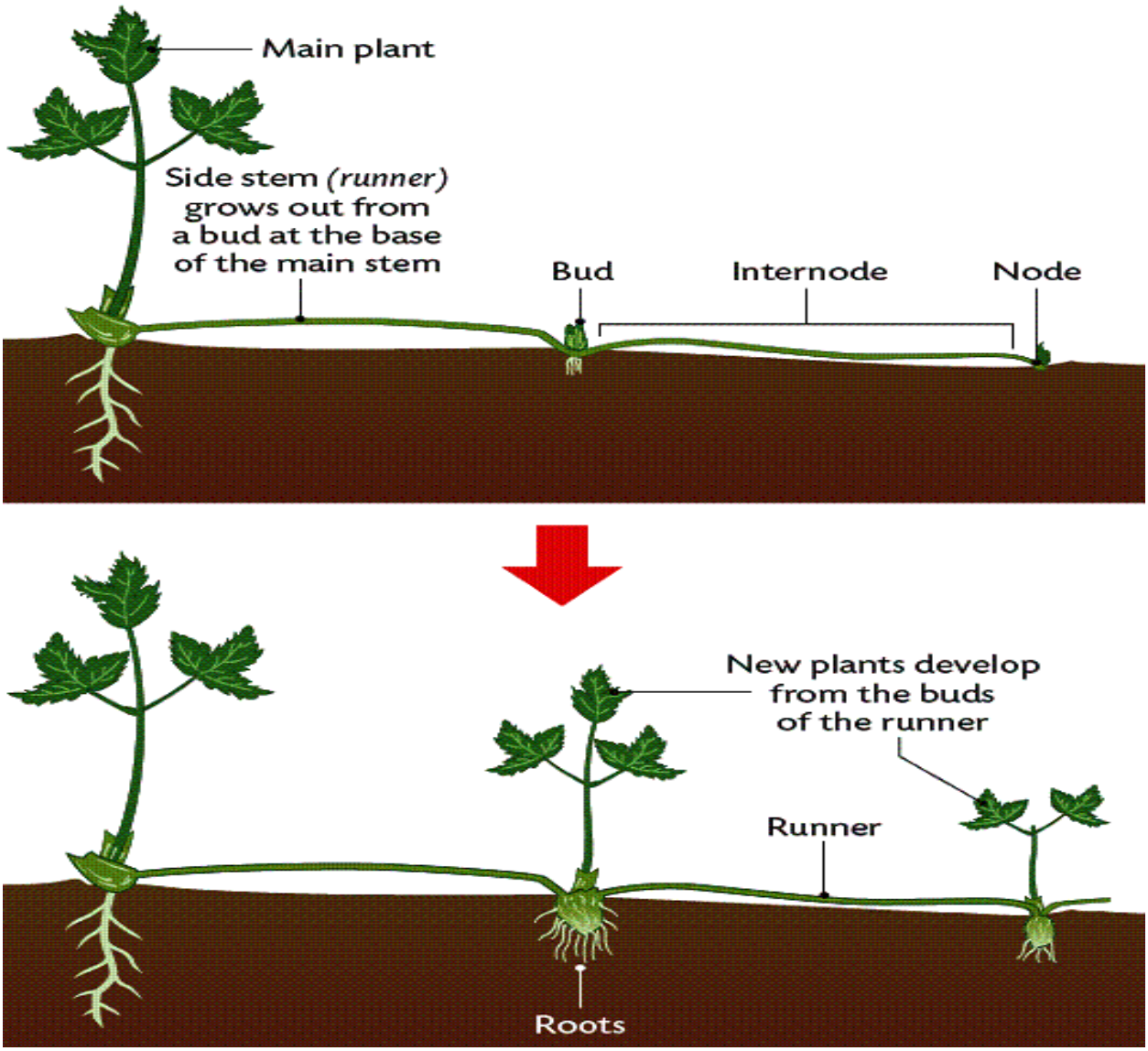


Figure:1.22 propagate by runners

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Self-check-3	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page: 1. Define the following words (10 pts)

1.1. Grafting discus on methods

1.2. Budding discus on methods

1.3. Cutting discus on methods

1.4. Layering discus on methods

1.5. Tissue culturing discus on methods

I. <u>Write true if the statement is correct or false the statement is incorrect(2pts each)</u>

1. Cleft grafting is useful in the rootstock is quite thicker than scion. (2pts)

2. Toung grafting is useful in the root stock is equal to scion.(2pts)

3. Asexual propagation is the combination of two parental system.:-(2pts)

II. <u>Choose the best answer for the following question (2pts each)</u>

1. Which one of the following is types of cutting methods?

A. stems cutting C. tip layer

B. cleft grafting D. All of the above

2. Which one of the following is types of grafting methods?

A. side grafting C. veneer grafting

B. Cleft grafting D. All of the above

Note: **Satisfactory rating – 20 and above points** **Unsatisfactory - below 20**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Choose

1. ____
2. ____
3. ____

Information sheet 4 **Determining environmental parameters that impact on propagation.**

1.4 **Environmental parameters for success of plant propagation**

The success or failure of plant propagation is highly dependent on careful plan, the method of propagation and the major environmental factors. To undertake successful propagation program, highest attention must be given to the major environmental factors affecting the success of plant propagation.

Therefore, before starting the crop propagation program, determining and adjusting all the environmental parameters (factors) affecting the operation depending on the crop type is an important step in plant propagation. Some of environmental parameters that may apply to a field nursery or environmentally controlled structure may include Temperature, wind, light, humidity and frost.

Too high or low amount of these parameters leads to the failure of propagation operation. Since each crop has its own optimum amount these environmental factors, it is utmost important to determine these factors depending on the crop type to be propagated.

Environmental Requirements for Propagation

Newly propagated plants or seedlings must be healthy and adhere specified standards.

To achieve this, the following factors are monitored closely:

- Humidity
- Aeration
- Light quality and quantity
- Temperature
- Moisture

1. Humidity

Humidity, also referred to as relative humidity, is the amount of water vapour in the air at a given temperature, and is expressed as a percentage. This means that at 20% relative humidity, 20% of any given volume of air will consist of suspended water molecules.

Humidity levels are especially important in allowing the plant to carry on with its metabolic processes at desired rates.

The ideal relative humidity for propagation ranges between 80% and 95% for seeds and cuttings, and in the region of 60% outdoors for budding, grafting and seedbed methods. Seed germination is faster at higher humidity levels, as is the case in cuttings.

In warm and dry areas, the level of humidity often falls below 55% on hot summer days, making budding and grafting more delicate and requiring close monitoring.

2. Light

All green plants require light for growth to take place. Some plants (most species) prefer growing in direct sunlight, while others prefer growing in the shade where they are subjected to indirect sunlight. Light is essential for photosynthesis, while light quality, which is determined by the wavelength of the light, also influences germination and flowering.

Plants in grown under protection such as greenhouses and shade-houses, require adequate light for the process of photosynthesis. If the plant does not receive enough light, which may be due to shading or over-crowding, it displays symptoms of retarded growth.

5. Temperature

If heat and light, which cause an increase in temperature, is not controlled properly, plants may suffer from heat injury. The ideal temperature for propagation is 29°C, and it must be monitored closely. In propagation chambers the temperature can often be maintained at this ideal level by heating and cooling systems. The heat is also used for increasing the humidity in the chambers, by drenching the trays and dampening the floor.

6. Moisture

Moisture is essential for germination and healthy plant growth.

Too much water suffocates the plant roots, and can cause diseases such as root rot, damping off, and collar rot. The other extreme is insufficient water supply, or drought, and is detrimental to all plants, but even more so to cuttings and young seedlings. A uniform and constant water supply is required for seed germination to produce healthy and vigorous seedlings, and for seedlings to grow into healthy plants.

In all propagation methods, the properties of the growth-medium determine the quality and quantity of water that will be available for uptake by the plant. A good medium is one that has a low salinity level, a water holding capacity, being the amount of water that the medium retains, of between 55% and 60%, make it available easily, and the ability to allow lateral water movement.

In the case of germination, the seed, and the later seedling stage, has to be kept in media wetted to field capacity, being the maximum amount of water that a particular soil can hold.

Self-check-4	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Discuss on the advantages and disadvantages of sexual and asexual propagation? (5 pts)
2. List all the environmental factors affecting plant propagation? (5 pts)

I. <u>Choose the best answer for the following question (2pts each)</u>

1. Which one of the following is when green plants uptake CO2 & use energy from light to produce food? **(2pts)**

A. photosynthesis C. Light

B. Respiration D. Dormancy

2. Which one of the following is Requirements for success Propagation :-**(2pts)**

A. Light C. Humidity

B. Aeration D .all of the above

3. Which one of the following is the ideal relative humidity ranges for seed & cutting propagation.:-**(2pts)**

A. Between 60%-75% C. Between 80%-95%

B. Between 85%-95% D. Below 55%

Note: **Satisfactory rating – 16 and above points Unsatisfactory - below 16points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Choose

1. ____
2. ____
3. ___

Information sheet 5 Negotiating Budget for the propagation program with management**.**

1.5. Negotiating Budget for the propagation program with management

Plant propagation is an operation which requires a great deal of budget, available materials and skilled man power. Most crop propagating materials are very expensive and needs excess budget to perform the propagation program successfully.

Moreover, some of the propagation activities depending on the type of crop take more time to accomplish the task and this consumes a great budget and resources.

Therefore, negotiating budget for the propagation program is important to:-

- Successfully finish the propagation without fluctuation within scheduled time
- Buy and use advanced and available propagating materials, tools and equipments based on the crop type
- Fulfill necessary infrastructures regarding the operation
- Perform the operation in large scale basis.

Self-check-5	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

II. Choose the best answer for the following question (2pts each)

1. Cutting materials all ways needed sharp and clean. Why? **(2pts)**

A. Sharp & Clean cuts heal faster

B. Clean tools transfer less disease.

C. Sharp tools cut cleanly don't tear Or crush the plant tissue.

D. all of the above

2. Which one of the following is needed around roots and shoots to stop disease and rotting? **(2pts)**

A. Temperature

B. Humidity

C. Air circulation

D. all of the above

3. Which one of the following are suitable environmental conditions for propagation?**(2pts)**

A. Ideal air available.

B. light levels available.

C. soil temperature available.

D. all of the above

Note: **Satisfactory rating – 6 and above points** **Unsatisfactory - below 6 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Choose

1____

2____

3____

Information sheet 6 Identifying OHS hazards

1.6. Identifying OHS hazards associated with the propagation program, assessing risks and implementing controls

Identifying of different OHS hazards associated with the propagation program is appropriate to take the corresponding care. Poor handling propagation operation and different propagating materials, tools and equipment's will leads to:

- Loss of propagation compatibility
- Failure of the propagation program
- Technical errors which leads to the development of undesirable characters.
- Contamination with disease and it highly affects the worker in different ways.

Therefore, strict care has to be given for workers and propagation activities when operating different propagation activities based on the crop type and propagation techniques.

Some of the OHS hazards associated with the propagation program may include air- and soil-borne micro-organisms, chemicals and hazardous substances, sharp hand tools and equipment, manual handling, solar radiation, dust, noise, machinery and machinery parts, slippery and uneven surfaces.

1.6.1. Types of hazards

Hazards can be grouped into several types:

1. Physical hazards: These include noise, radiation (ionizing, electromagnetic or non-ionizing), heat, cold, vibration and pressure.

2. Chemical hazards: Through a variety of actions, chemicals can cause damage to health and property. Some of these actions are explosiveness, flammability, corrosion, oxidation, poisoning, toxicity, carcinogenicity.

3. Biological hazards: Mainly from infection or allergic reaction. Biological hazards include viruses, bacteria, fungi, and other organisms. Some biological hazards are potentially life threatening.

4. Ergonomic hazards: These are hazards from poor work design, layout or activity. Examples of ergonomic problems include manual handling, workplace layout and task design.

5. Psychological hazards: Stress, violence at work, long working hours, lack of control in decision making about work can all contribute to poor work performance.

1.6.2. Assessing the Risks

Risk is the likelihood that harm or injury from a hazard will occur to specific individuals or groups exposed to a hazard.

For the risk to be real:

- the threat must exist;
- there is likely to be a magnitude of effect;
- There is the potential for occurrence.

1.6.3. Effects of hazards

1. on the Individual:

- Death
- Disease
- Injury
- Disability

2. Effects on the Workplace:

- Building damage
- Equipment Damage
- Loss

3. Effects on the Environment:

- Property damage
- Loss of resources
- Degradation
- Pollution

1.6.4. Hazard control

The term ‘’hazardous’’ refers to any chemical which can affect an employee’s health. Effects can range from mildly irritating to potentially highly carcinogenic.

The recommended hierarchies of control measures for managing hazards are:

1. *Elimination*

Whenever possible, remove the hazard completely through elimination.

For example, when a task is automated and performed by a machine, the hazards associated with manually performing this task are eliminated.

2. *Substitution*

Where the hazard cannot be eliminated, consider alternatives to the substances, processes, machines and equipment currently being used.

Could any of these be replaced with a less hazardous substitute? Always realize, of course, that although a substitute may be considered “safer”, that does not necessarily mean it is completely safe or hazard-free.

Substitution reduces the risk of injury or illness to an acceptable level.

3. *Engineering Controls*

Engineering controls involve the design of the workplace and it’s related processes. These controls include such factors as ventilation, isolation, containment and process control. Exhaust ventilation employed during welding operations can be considered an example of an engineering control. Other good examples would be the enclosing of noisy machinery or the isolation of a worker from excessive noise by providing a noise-insulated work booth.

4. *Administrative Controls*

Where the hazard cannot be eliminated and where substitution and engineering controls do not adequately manage the hazard, administrative controls are frequently introduced to lessen the risk.

These measures may include changing work procedures, developing and implementing new policies and requiring personal protective equipment to be used. A typical example of an administrative control is the provision that suitable hearing protection be properly worn in areas where noise cannot be reduced to acceptable levels through elimination, substitution or by engineering controls.

Depending on the nature of the activity or task, it is not always possible or practical to eliminate all hazards. Nevertheless, all potential hazards must be identified and the risks controlled by the use of appropriate procedures or devices. Additionally, some tasks may have specific hazards that are beyond the scope or experience of local management.

Examples would be workstation design, specialty chemicals, radioactive materials, etc. In these cases managers must seek appropriate expertise to assist with the assessment and development of hazard controls.

When it is determined that administrative controls (i.e. Personal Protective Equipment) must be used to control a hazard, the documentation must be specific and include the selection criteria, instructions for proper use, care and maintenance, and employee training.

If employees may be potentially exposed to hazardous chemicals, the employer is required to develop a written hazard communication program that includes the following:

1. A MSDS (Material Safety Data Sheets) for each known hazardous chemicals used in the farm or business, along with container labeling or other forms of warning.
2. A written plan which outline the method that will be used inform employees, workers, and outside contractors of hazardous chemical to which they may be exposed while working on the site.
3. A program, which explain the dangers of hazardous chemicals in the work area at initial work assignment and provides information about any new hazard introduced work area.

Self-check-6	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List all the OHS hazards that may occur in plant propagation program? (4 pts)

I. Correctly match under column A with Column B (2pts each)

A column	**B column**
1. Psychological hazards	A) Noise
2. Biological hazards	B) Stress
3. Physical hazards	C) viruses
	D) Chemical
	E) Poor work design

Note: **Satisfactory rating – 10 and above points** **Unsatisfactory - below 10 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Choose

1.____

2.____

3.____

Information 7: **Assessing risks and implementing controls**

Definitions

Hazard: Anything (e .g. condition, situation, practice, behavior) that has the potential to cause harm, including injury, disease, death, environmental, property and equipment damage. A hazard can be a thing or a situation.

Hazard Identification: This is the process of examining each work area and work task for the purpose of identifying all the hazard s which is “inherent in the job”. Work areas include but are not limited to machine workshops, laboratories, office areas, agricultural and horticultural environments, store s and transport, maintenance and grounds, reprographics, and lecture theatres and teaching spaces.

Tasks can include (but may not be limited to) using screen based equipment, audio and visual equipment, industrial equipment, hazardous substances and/or teaching/dealing with people, driving a vehicle, dealing with emergency situations, construction. This process is about finding what could cause harm in work task or area.

Risk: The likelihood, or possibility, that harm (in jury ,illness, death, damage etc) may occur from exposure to a hazard.

Risk Assessment: Is defined as the process of assessing the risks associated with each of the hazards identified so the nature of the risk can be understood. This includes the nature of the harm that may result from the hazard, the severity of that harm and the likelihood of this occurring.

Risk Control: Taking actions to eliminate health and safety risks so far as is reasonably practicable. Where risks cannot be eliminated, then implementation of control measures is required, to minimize risks so far as is reasonably practicable. A hierarchy of controls has been developed and is described below to assist in selection of the most appropriate risk control measure/s

Monitoring and Review: This involves ongoing monitoring of the hazards identified, risks assessed and risk control processes and reviewing them to make sure they are working effectively.

Responsibilities

Effective risk management requires the commitment to WHS from managers and Officer as well as the input and involvement of workers.

It is the responsibility of all managers and supervisors to ensure that this policy is fully implemented in their area(s) of control and to consult with workers as part of undertaking the hazard identification, risk assessment and control process. It is the responsibility of workers to cooperate and comply with this policy.

This includes providing effective and constructive information and feedback to aid the risk management process.

Officers have a responsibility to ensure that the areas under their control are complying with legislative requirements. This includes the Officer understanding the hazards and risks associated with their operations and ensuring that appropriate resources and processes are in place to eliminate or minimize these risks. WHS

Risk Assessment Procedure

The risk assessment procedure can best be illustrated in the following way.

Figure:1.23 Risk assessment process

Step 1: Identify Hazards

WHS legislation in New South Wales require s that PCBUs, in consultation with workers identify all potentially hazardous things or situations that may cause harm.

In genera l, hazards are likely to be found in the following;

- Physical work environment,
- Equipment, materials or substances used,
- Work tasks and how they are performed,
- Work design and management

In order to identify hazards the following are recommended:

- Past incidents/accidents are examined to see what happened and whether the incident/accident could occur again.

- Employees be consulted to find out what they consider are safety issues,I.e .ask workers about hazards near misses they have encountered as part of their work . Sometimes a survey or questionnaire can assist workers to provide information about work place hazards.
- Work areas or work sites be inspected or examined to find out what is happening now. Identified hazards should be documented to allow further action. The work environment, tool and equipment as well as tasks and procedures should be examined for risks to WHS.
- Information about equipment (e.g. plant, operating instructions) and Material Safety Data Sheets bereviewed to determine relevant safety precautions.
- Welcome creative thinking about what could go wrong takes place, i.e. what hazardous event could take place here?

At the University, any hazard which is identified by this process should be recorded on the Risk Assessment and Control Sheet (see Attachment 1 to this document) and further action taken to assess and then control the risks from this hazard.

Step 2: Assess Risks

Risk assessment involves considering the possible results of someone being exposed to a hazard and the likelihood of this occurring.

A risk assessment assists in determining:

- How severe a risk is
- Whether existing control measures are effective
- What action should be taken to control a risk
- How urgently action needs to be taken.

A risk assessment should include:

- Identify factors that may be contributing to the risk,
- Review health and safety information that is reasonably available fro m an authoritative source and is relevant to the particular hazard,
- Evaluation of how severe the harm could be. This includes looking at the types of injuries/illnesses/harm/damage that can result from the hazard, the number of people exposed, possible chain effects from exposure to this hazard.
- Evaluation of how a hazard may cause harm. This includes examining how work is completed, whether existing control measures are in place and whether they control the harm, looking at infrequent/abnormal situations as well as standard operating situations. A chain of events related to a risk may need to be considered.
- Determining the likelihood of harm occurring. The level of risk will increase as the likelihood of harm and its severity increases. The likelihood of harm occurring may be affected by how often the task is completed, in what conditions, how many people are exposed to the hazard and for what duration.
- Identify the actions necessary to eliminate or control the risk; and
- Identify records that it is necessary to keep to ensure that the risks are eliminated or controlled.

Other risk factors should also be identified as they may contribute to the risk: including

- The work premises and the working environment, including their layout and condition,
- The capability, skill, experience and age of people ordinarily undertaking work,
- The systems of work being used; and

- The range of reasonably foreseeable conditions.

Step 3: Controlling Risks

Once a risk rating is determined, each hazard must have its existing risk control measures evaluated using the Evaluation of Control Effectiveness Table.

This allows for determination of any additional requirement necessary.

Evaluation of Control Effectiveness Table

Well Designed Control ?		Effectively Implemented ?	
3	Needs Improvement	3	Deficient (D)
2	Adequate	2	Marginal
1	Strong	1	Effective

Step 4: Implement additional risk controls

Having identified the hazard s in your work place, assessed their risks and reviewed the existing controls, all hazards must be managed before people are hurt, become ill or there is damage to plant, property or the environment.

The management of risks in the work place requires eliminating risks so far as reasonably practicable in the first instance. Where elimination is not possible, then risks should be minimized, so far as reasonably practicable

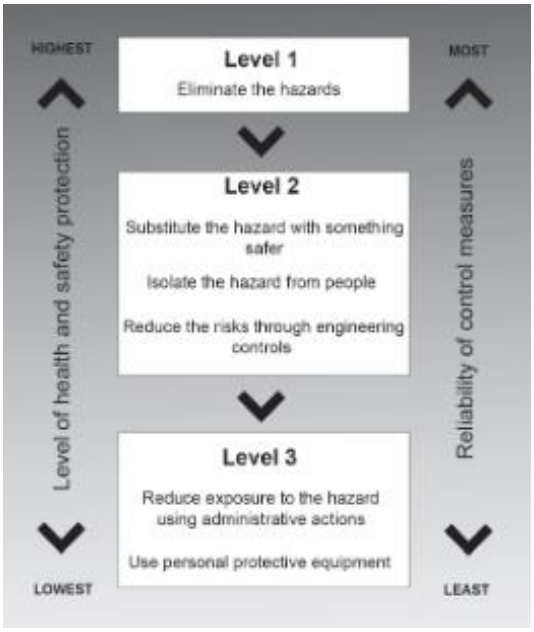

Figure:1.24 risk control level

Step 5: Monitor and Review

Hazard identification, risk assessment and control is an on-going process. Therefore, regularly review the effectiveness of your hazard assessment and control measures at least every 3 years. Make sure that you undertake a hazard and risk assessment when there is a change to the workplace including when work systems, tools, machinery or equipment change.

Provide additional supervision when new employees with reduced skill levels or knowledge are introduced to the workplace. The effectiveness of control measures can be checked through regular reviews as well as consultation with workers.

Figure: 1.25 risk review

Self-check 7	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Define the following words (10 pts)

   1.1. Hazard

   1.2. Risk

   1.3. Risk Assessment

   1.4. Hazard Identification

2. Write the Procedure of risk assessment (3pts)

3. What is the Risk assessment assists in determining? (3pts)

4. List all the OHS hazards that may occur in plant propagation program? (4 pts)

Note: **Satisfactory rating – 20 and above points Unsatisfactory - below 20s points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

1. ____
2. ____
3. ____

Operation sheet -1 Techniques of performing propagation

Objective: To know how to apply different techniques of propagation

Materials required:

- Plastic containers and trays, scalpel,
- Autoclave and alcohol,
- Wheelbarrow, Shovel, water sprays container, dibblers and rubbish bins.
- Plant material
- Container (Tray, pots, sleeves)
- Rooting hormone
- Measuring tape
- Budding knife
- Grafting knife
- A fine-tooth saw for cleft grafting
- Pruning shears
- Dormant scions (cultivar labeled)
- Tying material such as grafting tape, adhesive tape, rubber strips
- Asphalt water emulsion compound for covering grafts
- A light hammer for bridge grafting

1. Procedure of stem cutting

1. Select suitable PPE and wear
2. To take your cuttings, select healthy and vigours growth that's 7.5 to 15cm long
3. Then, cut off a section of stem
4. Remove the lower leaves
5. Clip off the leaves on the lower half of the shoot so you have a bare stem to insert into your potting mix.
6. Pot up your cutting

2. Cleft Graft Procedure

1. Select suitable PPE and wear
2. Then, take scion from mother plant selected
3. Slice scion in both side by sharp knives
4. After that the root stock is cut off squarely and
5. Split vertically with a knife to a depth of about 5 to 7.5cm
6. Keep the knife in position or insert a chisel to keep the split open and insert the scions
7. Wax, Wrap and secure wound part or joining point

3. Inarch Grafts Procedure

1. Select suitable PPE and wear
2. Then, take scion from mother plant selected
3. Slice scion in side by sharp knives
4. Prepare rootstock by trimming the edges of the girdled section back to sound bark
5. Place the scion along the trunk so that the beveled edges rest on sound bark
6. Mark and remove the bark rectangles.
7. The stem piece to be inserted should be slightly longer than needed to ensure a homely fit.
8. Insert the scion and then secure with two number 16 or 18 wire nails at each end

4. Bark Graft Procedure

8. Select suitable PPE and wear
9. Then, take scion from mother plant selected
10. Slice scion in both side by sharp knives
11. After that the root stock is cut off squarely and
12. Split vertically with a knife to a depth of about 5 to 7.5cm
13. Keep the knife in position or insert a chisel to keep the split open and insert the scions
14. Wax, Wrap and secure wound part or joining point

5. T-budding Procedure

1. Select suitable PPE and wear
2. Cut a T shape through the bark of the rootstock tree that selected
3. Open the flaps of the side of the T
4. Collect a bud from a bud wood stick by inserting the knife at the base of the bud & carefully cut out the bud including a sliver of wood
5. Make a horizontal cut just above the bud to sever it and the sliver of wood from the bud wood stick
6. Insert the bud, right side up, into the opening of the T cut
7. Slide it tightly into the cut and secure it with a rubber banding strip
8. Wrap the banding strip above and below the bud, stretching the banding strip to make a tight wrap that will prevent moisture loss

6. Chip budding Procedure

1. Select suitable PPE and wear
2. Cut a T shape through the bark of the rootstock tree that selected
3. Open the flaps of the side of the T
4. Collect a bud from a bud wood stick by inserting the knife at the base of the bud & carefully cut out the bud including a sliver of wood

5. Make a horizontal cut just above the bud to sever it and the sliver of wood from the bud wood stick
6. Insert the bud, right side up, into the opening of the T cut
7. Slide it tightly into the cut and secure it with a rubber banding strip
8. Wrap the banding strip above and below the bud, stretching the banding strip to make a tight wrap that will prevent moisture loss

7. Tip layering Procedure

1. Select suitable PPE and wear
2. Dig a hole 7.5 to 10 cm deep
3. Insert the shoot tip and cover it with soil
4. Then, the tip grows downward first
5. Then bends sharply and grows upward
6. Roots form at the bend, and the recurved tip becomes a new plant.
7. Remove the tip layer and plant it in the early spring or late fall.

8. Air layering Procedure

1. Select suitable PPE and wear
2. Select stems of pencil size diameter or larger are best
3. Choose an area just below a node and remove leaves and twigs on the stem 7.5 to 10cm above and below this point. This is done on a stem about 30cm from the tip.
4. The cut is held open with a toothpick or wooden match stick.
5. Surround the wound with moist, unmilled sphagnum moss (about a handful) that has been soaked in water and squeezed to remove excess moisture.
6. Wrap and cover with plastic and hold in place with twist ties or electrician's tape.
7. Fasten each end of the plastic securely, to retain moisture and to prevent water from entering
8. After the rooting medium is filled with roots, sever the stem below the medium and pot the layer. The new plant will usually require some pampering until the root system becomes more developed. Provide shade and adequate moisture until the plant is well established.

LAP Test 1 Demonstration techniques of performing propagation

Name_____ Date_____

Starting time_____ Ending_____

Instructions: You are required to perform any of the following tasks:

Task1. Perform stem Cutting activities

Task2. Perform Cleft grafting activities

Task3. Perform inarch grafting activities

Task4. Perform bark grafting activities

Task5. Perform T-budding activities

Task6. Perform chip budding activities

Task7. Perform Tip layering activities

Task8. Perform Air layering activities

LG #31	LO #02. : Develop the propagation plan

Instruction sheet: 2

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying labour, materials, equipment and machinery needs
- Determining propagation media requirements
- Determining strategies to modify environmental conditions
- Identifying type of plant and propagation method
- Identifying selection criteria for propagation material
- Determining selection criteria for the propagation material
- Determining hygiene requirements
- Communicating propagation plan and schedule of activities

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify labour, materials, equipment and machinery needs
- Determine propagation media requirements
- Determine strategies to modify environmental conditions
- Identify type of plant and propagation method
- Identify selection criteria for propagation material
- Determine selection criteria for the propagation material
- Determine hygiene requirements
- Communicate propagation plan and schedule of activities

Learning Instructions:

1. Read the specific objectives of this Learning Guide. 2. Follow the instructions described below. 3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them. 4. Accomplish the “Self-checks” which are placed following all information sheets. 5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks). 6.If you earned a satisfactory evaluation proceed to “Operation sheets 7.Perform “the Learning activity performance test” which is placed following “Operation sheets” , 8.If your performance is satisfactory proceed to the next learning guide, 9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information sheet 1 **Identifying Labor, materials, equipment and machinery needs.**

1.1 Labour, materials, equipment and machinery needs

Our propagation plan must consider the identification of all the requirements including labor, materials, equipments and machinery depending on the aim of plant propagation and type of crop propagated. This accounts for the success of our plant propagation operation.

Materials, equipment and machinery required to accomplish the propagation operation may include shade cloth, plastic fencing, tape, support structures, labels, irrigation equipment, heaters, coolers, fans, vents, fogging/misting systems, screens; secateurs, propagation knives, razor blades and other cutting instruments; sharpening stone, strop, linear measure, grafting machine, plastic containers and trays, vermiculite boxes, wheelbarrow, trolley, mechanical trolley, shovel, water spray container, dibblers and rubbish bins.

Basic considerations during the identification of labor, materials, equipment and machinery for propagation operation are:-

- Number of laborers and skilled man power required to perform the task
- Available budget based on the total number of workers, scheduled time, propagation method and crop type to be propagated.

- All the necessary materials, equipment and machinery required to accomplish the propagation operation with available maintenance cost.

Tools For Propagating and Growing Gardening Plants Successfully “Secateurs are one of your must have tools for taking cuttings of semi-ripe and ripe plants"
As with any hand-tools, care should be taken with their use. Be Safe!

Now you don't need lots of expensive tools to propagate and grow gardening plants successfully, but as with any job, having the right ones makes the job a lot easier, and more enjoyable.
Most that you will require can be found in most garden centers, DIY stores and hardware shops at very reasonable prices.

A good source for cheap, but good quality, tools are boot sales and yard sales where they can be found for pennies.
Another good source is on line, there are losts of online suppliers that cater for gardeners. So, which ones do you need, then? Besides general gardening tools, spades and forks for general digging, lifting and dividing plants, rakes for leveling off and preparing seedbeds and hoes for making seed drills you will need others to propagate your plants:

Collecting and adjusting all materials requiring for propagation

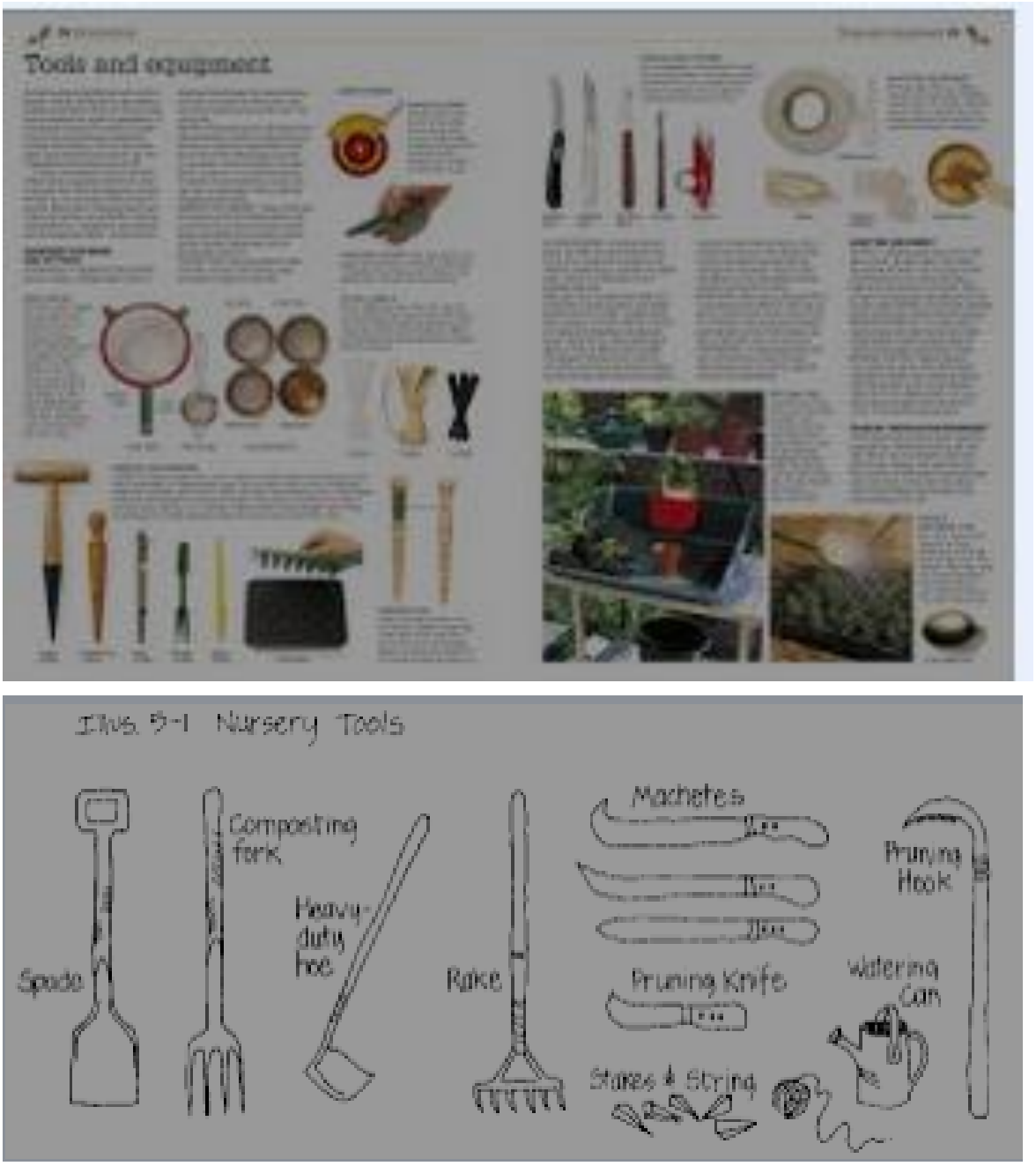

Figure:2.1 propagation tools

Scissors are essential when taking and preparing cuttings. Small stainless steel nail scissors are ideal. But keep them clean at all times to prevent the spread of diseases.

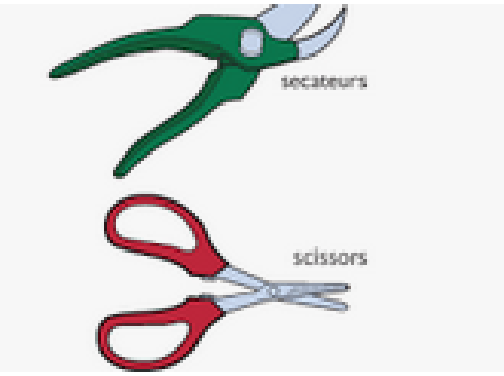

Figure:2.2 propagation scissor

The following tools are used in the propagation methods described above.

1. Grafting knives-This has to be a sharp knife, which should be sterilized before use

Figure:2.3. Different types of grafting/budding Knifes Stainless Steel

2. Grafting wax-After the graft is made, some covering must be used to keep it drying out. Either hand wax or brush wax may be used.

Hand wax is most commonly used for home grafting. It is softened by the heat of the hand and can be easily applied.

Figure:2.4 Grafting wax

3. Grafting tape-This is a special tape with a cloth backing that decomposes before girding can occur. Electrical and masking tapes are also used. Masking tape is suitable where little pressure is required e.g. in the whip graft. Other materials used are polythene strips so long as they are sterilized. One can sterilize using domestic detergent such as jik.

Figure:2.5 Poly Budding Tape

4. Budding strips-Budding strips are elastic bands and look like a wide rubber band that has been cut open. Budding strips secure several types of grafts with small stocks and scions.

Figure:2.6 Rubber Budding and Grafting Strips

5. Nails-Veneer and bridge grafts require long, thin nails. Half-inch nails are long enough for most grafts, except for bridge grafting, which may require ¾ inches nails. These help to hold the graft in place.

6. Chain saw- The chain saw is used to do top working of big trees.

7. Temporary shade-This is used to prevent newly grafted scions from rainwater and wind. This could be shade nets, or rafters or loose thatch. This is also to protect the grafted seedlings from intensive sunshine.

8. Budding Knife – A razor sharp knife used to make cuts on the seedlings and to cut off the bud-eye. The knife must always be sharp and in a good working condition to prevent tissue damage to the plant when cutting through it. If tissue damage occurs, the graft will most likely fail.

8. Budding Tape – Clear polyethylene strips, used to maximize contact between the bud and the rootstock until the union and the healing is complete. It also prevents drying and excess water from getting in and rotting the bud.

9. Pruning Shears – Bud-wood is cut using pruning shears. Pruning shears are also used where cuttings are used for propagation.

10. **Sharpening Stone** – All blades become blunt with use and require periodic sharpening. A sharpening stone, or wet stone, and honing oil are required.

11. **Sterilization Liquid** – Knives and shears must be periodically cleaned and sterilized properly with a solution of 10% bleach (Jik).

12. **Perfect Cut Grafting Tool** :- Makes perfect grafting cuts every time for more consistent grafts and healthier growth. With three different blades, an omega shaped blade, a "V" shaped blade and a budding cut.

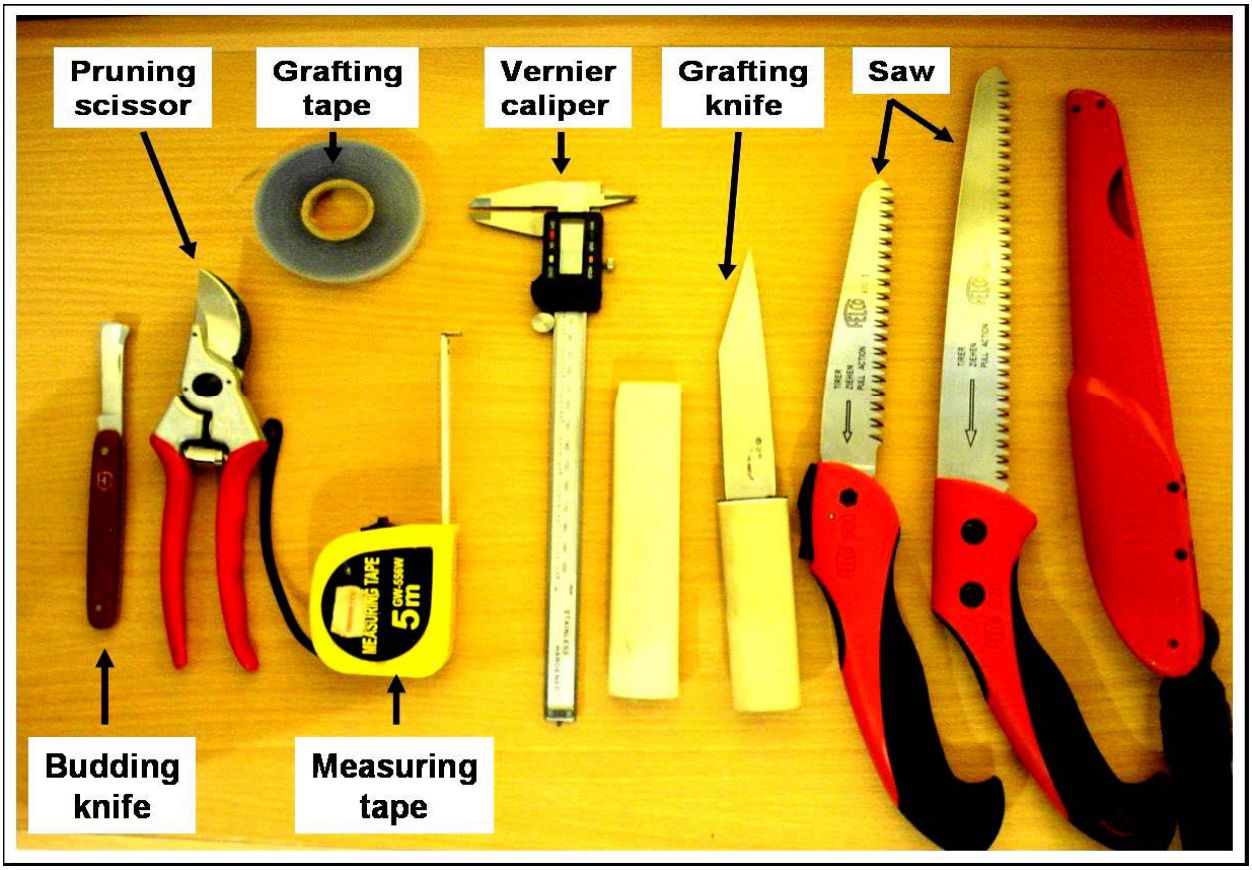

Figure:2.7 some of propagation tools

Self-check-1	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

I. Choose the best answer for the following question (2pts each)

1. Which one of the following is using for prevent newly grafted scions from rainwater and wind? **(2pts)**

A. Pruning
B. Budding
C. shading
D. Grafting

2. Which one of the following is using for covering after grafting made to keep it drying out? **(2pts)**

A. Grafting wax
B. Grafting knives
C. Pruning Shears
D. budding strips

3. Which tools or equipments are using for plant watering.:-**(2pts)**

A. Grafting wax
B. Budding Tape
C. water cane
D. Budding knife

Note: **Satisfactory rating – 6 and above points Unsatisfactory - below 6 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Choose

1____
2____
3____

Information sheet 2 **Determining propagation media requirements**

2.1 Propagation media requirements

Propagation program can be takes placed on varieties of growth media depending on the plant species, aim of propagation and availability of materials. Mostly the operation can be takes placed on soil, in controlled environment, laboratories and culture media.

Types of propagation media may include sand, potting mix, gravel, scoria, rock wool, sawdust, pine bark, perlite, vermiculite, water (hydroponics) and conditioners/additives.

Propagation media requirements will be specific to the species and method of propagation, and may need to be determined:-

- using recognized testing procedures for pH,
- drainage and aeration,
- salinity, nitrate levels and water repellence to ensure that it meets the needs of the propagation plan

Therefore, propagation media requirement is determined depending on plant species to be propagated and propagation method used.

There are many methods of vegetative propagation that is used. The choice depends on the propagator and his goals . An understanding of all factors influencing plant growth in a nursery environment is needed for the successful growth and production of high-quality container plants.

Propagation medium is a substance in which plant parts are placed for propagation. It provides initial support and favorable conditions for Plant Propagation. A good propagation medium is made up of components that provide optimum aeration, drainage and moisture holding characteristics. These are usually made up from combinations of peat moss, perlite, vermiculite, sand or similar materials. The primary role of a propagation medium is to provide support and moisture while the plant is developing.

Maximum Yield explains Growing Media Growing media have three major functions:

- Physically support plant growth
- Allow for maximum root growth
- Supply roots with necessities such as water, air, and nutrients

Media for plant growth and seed germination has great significance in nursery business. The material for rooting and growing media may be used either alone or Incorporated with one or more products in combination.

To prepare growing media use the following ratio

- For heavy (clayey) soils 1:2:2
- For medium (loamy) soils 1: 1:1
- For light (sandy) soils 1: 0:1

Most commonly this ratio is applicable 3(topsoil).1(sand), 2(compost).

For good results, the following characteristics of the medium are required :

- The medium must be sufficiently firm and dense to hold the cuttings or seeds in place during rooting or germination. Its volume must be fairly constant when either wet or dry; excessive shrinkage after drying is undesirable.
- It should be highly decomposed and stable (preferably with a 20C:1N ratio) to prevent N immobilization and excessive shrinkage during production.
- It must be easy to wet (not too hydrophobic) and retain enough moisture to reduce frequent watering.
- It must be sufficiently porous so that excess water drains away, permitting adequate penetration of oxygen to the roots all containers produce a perched water table that creates a zone of saturated growing medium at the bottom of the container.
- It must be free from pests: weed seeds, nematodes, and various pathogens.
- It must have a low salinity level.
- It should be capable of being steam-pasteurized or chemically treated without harmful effects.
- It should have a high cation exchange capacity (CEC) for retention of nutrients that may be applied pre incorporated and/or in a supplementary soluble and/or controlled-release fertilizer program.
- It should be of consistent quality from batch to batch, and reproducible.
- It should be readily available, and economical.

Examples of propagation media are

- Soil- sand, silt, and clay

- Sand – decomposed quartz particles 0.05 to 2.0 mm in diameter.
- Peat Moss – decomposed bog vegetation used to hold water in soil mixes
- Vermiculite – a hydrated magnesium-aluminum-iron silicate mica mineral that expands when heated
- Perlite - a gray-white volcanic silica material. Size range is from 1.6 to 3 mm in diameter
- Pumice – Volcanic rock used in mixes to increase aeration and drainage.
- Shredded Bark - wood products made from redwood, cedar, fir, pine, hemlock, or various hardwood bark species as a component in growing and propagating mixes
- Farm Yard Manure(FYM)

figure 2.8 Coco Peat: Soil-less medium used in Nursery

2.2 Preparing Soilless Growing Media

Although amendment combinations may vary, basic objectives in the preparation of a growing media are alike. An effective program should produce a growing media that is:

- Porus and well drained, yet retentive of sufficient moisture to meet the water requirements of plants between irrigations;
- Relatively low in soluble salts, but with an adequate exchange capacity to retain and supply the elements necessary for plant growth;
- Standardized and uniform with each batch to permit the use of standardized fertilization and irrigation programs for each successive crop;
- Free from harmful soil pests; pathogenic organisms, soil insects, nematodes and weed seeds
- Biologically and chemically stable following pasteurization; primarily free from organic matter that releases ammonia when it is subjected to heat or chemical treatments.

Since innumerable amendment combinations can produce a growing medium with these characteristics, it is important to consider both the economic as well as cultural optimums. Factors that determine the cost of a growing medium include: transportation, labor, equipment, materials and handling. In many cases the cost of mixing a “custom” growing medium exceeds that of the commercially prepared materials. These factors should be studied carefully before making a decision.

2.3. Properties of soil growing media Properties of soil growing media.

The material or combination of materials that you use as a propagation media should have the following properties:

1. Physical Properties

- The media should provide good physical support to the plants
- The media should be reasonably light, easy to handle and easy to stick cuttings into. Sharp-edged materials, such as scoria, may be a problem with germinating seedlings. The materials used should not readily degrade or break down once in use.
- The media should have good aeration. This will aid water penetration and drainage, give adequate provision for the exchange of gases (i.e. root absorption of oxygen and release of CO^2), and provide space for roots to grow.
- A mixture of particles ranging in size from around 1mm to 5mm, with the addition of very fine particles from materials such as peat or pine bark generally provides a suitable mix.
- Once a medium is watered the volume of pore space containing air is reduced. A propagation medium should have an air space of at least 27% evenly spread throughout its volume, although this figure will vary according to the plant you are cultivating.
- The provision of misting will also generally require an increase in the air space of the medium. The upper limit should be no more than about 35 - 40%.

2. Chemical Properties

Propagation media should have the following chemical properties:

- It should be chemically stable during use.

- For most plants it should have a pH in the range of 4-6 (some plants will grow better at a higher pH). The pH can be increased by the addition of lime and decreased by increasing the percentage of materials with low pH such as peat moss and pine bark.
- It should be low in salts and other harmful chemicals.

3. Biological Properties

The propagation media should be as free as possible of harmful organisms such as weed seeds, spores, and insects.

To have success with plant propagation the following biological conditions should be provided:

- Buds must be present on each section of plant material used for propagation.
- Plant material from younger parent plants should be used as this is more likely to produce new roots and shoots.
- Current year's growth should be used because it will produce roots faster from cuttings and layering than older plant material.
- Healthy good looking stock/parent plants free from virus diseases.
- Parent plants that have had good nutrition and water in the months before the cuttings are taken or the layering or division is carried out.
- Plant material used for propagation must be large enough to contain enough stored energy to sustain it while new roots and shoots grow.
- Plant hormones can be used to encourage root formation.

Self-check-2	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

I. Choose the best answer for the following question (2pts each)

1. Which one of the following is an Atmospheric factor? **(2pts)**

A. light C. humidity

B. temperature D. all of the above

2. Which one of the following is a chemical property of propagation media growing :-**(2pts)**

A. PH Values C. Texture

B. Structure D. all of the above

3. Which one of the following is using to promote root formation.:-**(2pts)**

A. Rooting hormones C. Rooting Hair:

B. Rooting Zones D. all of the above

Note: **Satisfactory rating – 4 and above points Unsatisfactory - below 4 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Choose

1. ____
2. ____
3. ___

Information sheet 3 **Determining strategies to modify environmental conditions**

Determining strategies to modify environmental conditions according to the type of plant and propagation method used have a vital role on the success of plant propagation.

Strategies that may be employed to modify the growing environment include:-

- Hooling by manual or automatic processes such as the use of vents, exhaust fans, evaporative coolers, wetting walls;
- Heating by manual or automatic processes such as the use of wall heaters, ducts, heating lines or under-bed heating systems;
- Controlling air circulation to maintain uniform temperatures and relative humidity, such as ventilation or wind breaks;
- Use of artificial light; carbon dioxide enrichment, and irrigation.

Strategies to modify environmental conditions

A good nursery manager knows how to “think like a plant,”and create a propagation environment that modifies all physical and biological factors that may be limiting to plant growth.

Newly propagated plants or seedlings must be healthy and adhere to specified standards.

To achieve this, the following factors are monitored closely:

- Humidity
- Aeration
- Light quality and quantity

- Temperature
- Moisture

To have success with asexual plant propagation the following environmental conditions should be provided.

Table: 2.1 environmental conditions to favourable asexual plant propagation

Environmental condition	Reason provided
A controlled (warm and humid) environment	Prevents water loss from transpiration, especially for softwood and leaf cuttings.
Air circulation	Air is needed around developing roots and shoots to stop disease and rotting.
Time of year has suitable environmental conditions for the type of propagation	Ideal air and soil temperature and light levels available.
Hygienic conditions including clean containers, tools and growing media	To prevent disease. Fungicides and insecticides are used only if needed.
Media used: • is free from pests, diseases, weed seed • will hold water but excess water drains out	A balance of air and water around the developing roots so respiration can take place and the cutting doesn't dry out. Clean media prevents disease. Well-drained media prevents rotting. Water should be available for developing roots
Warm temperatures near the base of cuttings	Warm temperatures increase the rate of plant processes, therefore there is faster development of roots.
Light	Leaves on cuttings need light to carry out photosynthesis. This will give the cutting sugars that can be used for developing

	new roots and shoots. Developing shoots need light to carry out photosynthesis.
Hardening off newly propagated plants	Weaning the plant material from a protected environment and hardening it off once new roots and shoots have developed so it becomes a self-supporting plant.

Key conditions required for successful asexual plant propagation

Plant material	Method of propagation	Key conditions
Root tubers, stem tubers, corms, bulbs	Division	•Healthy young plant material used. •Each piece of plant material will have a healthy bud. •Each piece of plant material should be large enough to have a food store to support the development of new roots and shoots. • The cut surface of the plant pieces should be left to dry in a warm airy place to seal the cut surface from diseases. • Cut pieces should be placed in clean, friable, well-drained loam or growing media that is kept moist (field capacity). • Plant the new plant in a hole twice the depth of the size of the piece of plant material. • Light is required once the shoots

		appear so the shoots can carry out photosynthesis. • Protect developing shoots from adverse environmental conditions, e.g. frost. • Time of year –propagate in early spring when plant material is still dormant but just before it is about to grow shoots.
Rhizomes (e.g. Bearded iris), fibrous crowns (e.g. herbaceous perennials such as Chrysanthemum)	Division	• Healthy young plant material used. • Each piece of plant material must have a healthy bud. • Cut back leaf material to reduce water loss. • Remove old plant material. • Replant plant material at the same depth as the parent plant. If planted too deep, rhizome may rot or shoots may struggle to reach the soil surface. • Keep media moist and protect from adverse weather. • Time of year – propagate after flowering or when dormant.
Root or stem tuber or fibrous crown e.g. Chrysanthemum	Softwood cuttings	• Healthy young plant shoots used. • Shoots 7–10 cm long. • Cut straight under a node – a node is more resistant to fungal rots than other parts of the stem. Cells at the node will divide and produce roots faster than in other parts of the stem.

		• Placed shoots in well-aerated media. Media is well-aerated to prevent rotting of the cutting and the media will be warmer. • Media used for the plant material should be friable, aerated, well drained, moist and warm (if appropriate). The higher the temperature around the plant material forming roots, the faster the chemical reactions and therefore the faster the root formation. • Provide cutting with high humidity to prevent water loss. • Provide warm temperatures at the base of the cutting to speed up root development in a disease free controlled environment (bottom heat 21°C). • Good light levels needed so the cutting can carry out photosynthesis. • Time of year – take cuttings late spring after the buds have started to shoot.
Offsets and runners	Division	•Replant healthy young offsets or rooted runners in a clean, friable, well-drained loam or growing media that is kept moist (field capacity). •Place offsets in a warm sheltered area. •Offsets from succulents need to be in a non-humid environment or they will rot.

		•Time of year – late spring, early summer.
Evergreen flowering shrubs	Semi hardwood stem cuttings or layering Remember: •cuttings take less space than layering •cuttings produce more plants than layering •when layering the plant material is still provided with energy for growth from the parent plant therefore more likely to form roots successfully	•Use young vigorous non-flowering shoots. •Use young parent material where possible. •Shoots 7–10 cm long. •Cut large leaves in half to prevent water loss. •Cut straight under a node – a node is more resistant to fungal rots than other parts of the stem. Cells at the node will divide and produce roots faster than in other parts of the stem. •Media used for the plant material should be friable, aerated, well drained, moist and warm (if appropriate). The higher the temperature around the plant material forming roots the faster the chemical reactions and therefore the faster the root formation. •Rooting takes place during the growing season when layering. •Prevent the cuttings or parent plant drying out when layering. •Encourage fast rooting so it has taken place before the food supply in the stem is all used up. •Prevent drying out and water loss. •Light is needed for photosynthesis.

		•Use rooting hormone. •Time of year – late spring, early summer or just after flowering.
Shrubs and trees and conifers	Hardwood cuttings	•Wound the stem to stimulate root production. •Use plant rooting hormone. •Keep a cool environment for the tip to keep shoot growth to a minimum and prevent water loss and to stop energy

Self-check-3	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

I. Choose the best answer for the following question (2pts each)

1. Which one of the following is using the activity of self-supporting plants? **(2pts)**

A. Pruning
B. Thinning
C. Hardening off
D. all of the above

2. Which one of the following is play important role of light? :-**(2pts)**

A. Faster root development
B. Photosynthesis
C. Newly developed shoot & Root
D. all of the above

3. Which one of the following is Hygienic conditions.:-**(2pts)**

A. growing media
B. Clean tools
C. clean containers
D. all of the above

Note: **Satisfactory rating – 6 and above points** **Unsatisfactory - below 6 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Choose

1. ____
2. ____
3____

Information sheet 4 Identifying type of plant and propagation method

3.1. Introduction

Plants are the most fundamentally important things given to life exist on this world by providing the basic and immediate needs of humans for food and shelter as well as acting as an essential component of the biosphere for maintaining life on the planet that evolved to survive, thrive, and grow by adapting to ever-changing conditions

3.2. Some horticultural crops and their propagation methods

1. Propagation of potato (Solanum tuberosum L.) by tuber: Potato is propagated by vegetative propagation '**division**' of tubers. Tubers are divided into sections each containing one or more eyes. Tubers are thickened underground stems that often develop at the tip of stolon's or rhizomes and serve as storage organs.

Potato can be planted directly as whole or divided to smaller parts of tuber which have a bud at the node for shoot development

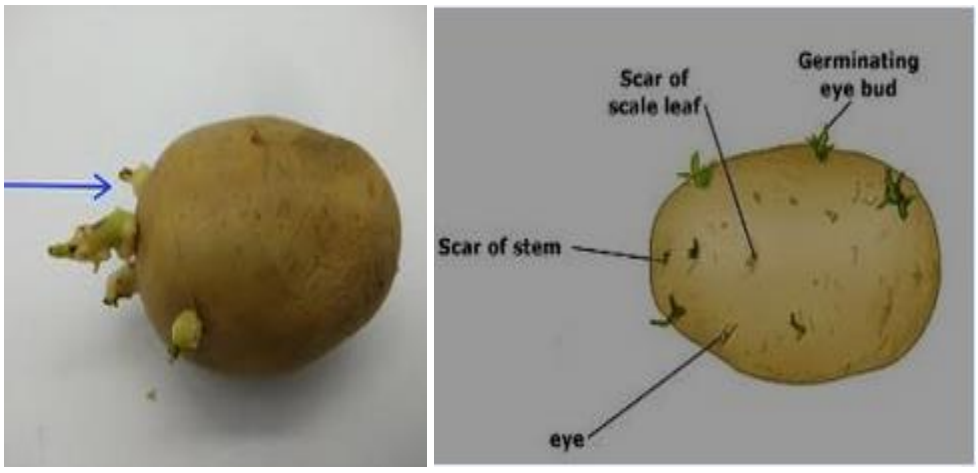

Figure:2.9 propagation of potato

2. Propagation of sweet potato (Ipomoea batatas L.): The sweet potato is modified root called tuberous root is perennial which grown as annual. It is an important traditional crop which is grown extensively in tropical countries for its nutritional and economic benefits.

The sweet potato crop can be planted either for food and/or for animal feed depending on the purpose and season of production. The propagation sweet potato can be done by **two methods viz**. by stem cuttings and by its **sprout**s (slips).

The sprout (slips) propagation is very important to produce virus free plant and to produce vigorous tuber.

Figure: 2.10 propagation of sweet potato

3. Propagation of ginger (Zingiber officinale) by rhizome: Ginger is herbaceous perennial plant that is grown as an annual in commercial production which is widely used as a spice crop plant.

It is a subterranean stem (rhizome) modified for the vegetative propagation and storage of food materials. A rhizome is a swollen modified stem that runs horizontally under the ground that has contained vegetative buds which can be used for propagation by cutting into sections that each has at least one bud.

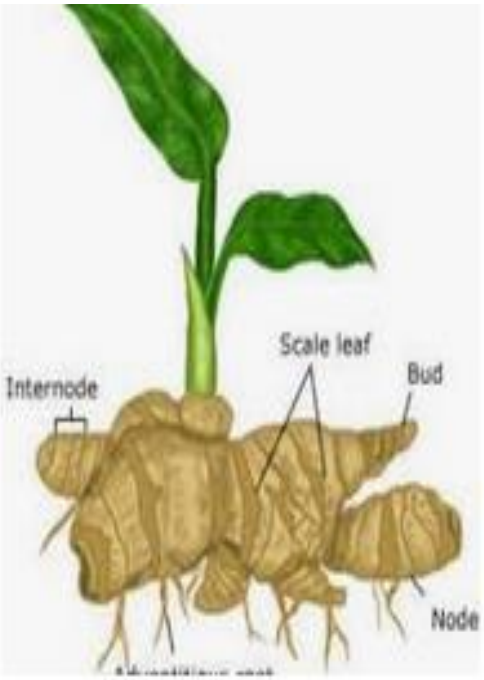

Figure:2.11 propagation of ginger

4. Propagation of onion (Allium cepa L.) by bulbs: Onion (Allium cepa L.) is an important vegetable crop that is grown worldwide. It is propagated either by seed or bulb

There are two kinds of bulbs; tunicate and non-tunicate bulbs. The **Tunicate** bulbs have outer modified leaves, which are dry and paper thin. **Non-tunicate** or scaly bulbs lack this protective (papery) covering and are more easily damaged.

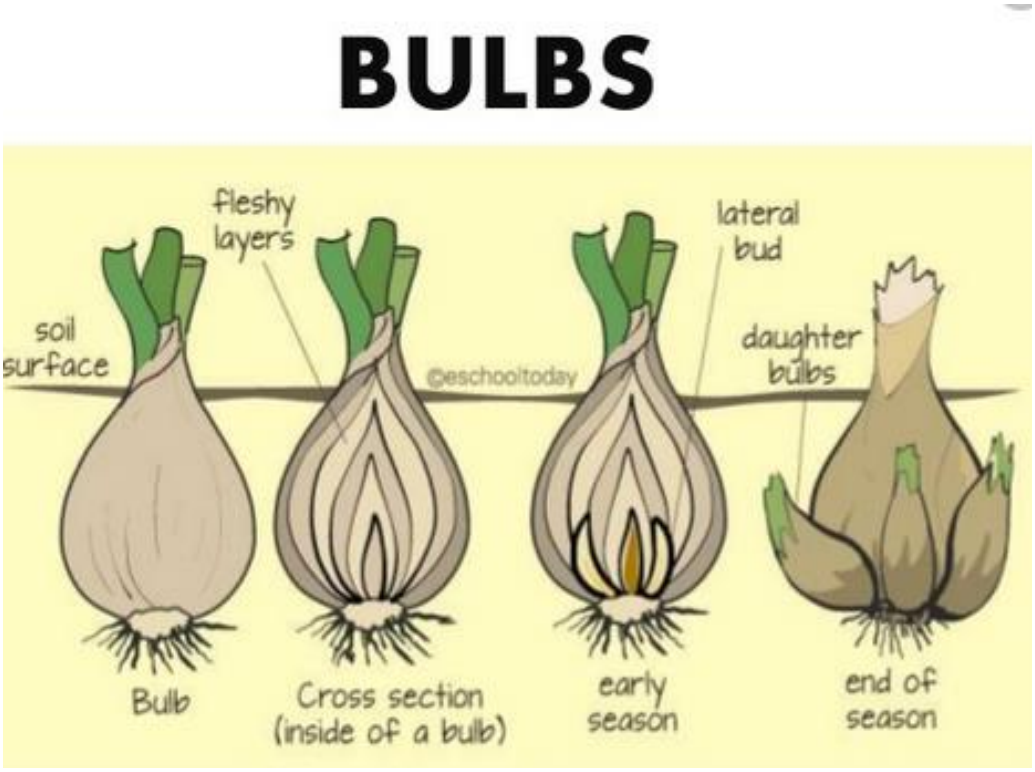

Figure: 2.12 propagation of Onion

5. **Propagation of strawberry** (Fragaria × ananassa) by runner: Strawberry is one of the most important fruit crops which produced by specialized stems called runner that develops from the axial of a leaf at the crown of a plant which grows horizontally along

the ground and forms a new plant at one of the nodes. One plant may have several runners and one runner may grow several nodes.

Figure: 2.13 Propagation of strawberry

6. Propagation of banana (Musa spp.) by sucker: Banana is one of the most important fruit crops which have produced by sucker separation. Asuckeris a lateral shoot that develops from the rhizome and usually emerges close to the mother plant. Sucker is the primary and major source of propagation material in banana

Propagation by sucker follows digging the sucker, separating from the mother plant, and growing as individual plants. The number of suckers produced varies with the type of cultivars

Figure:2.14 Banana propagation

7. Propagation of pineapple (Anana cosmos L.) by sucker: Pine apple is an important tropical fruit crop which is propagated by crowns, suckers and slips. The production of pineapple plants is mostly carried out by means of crowns propagation.

Figure: 2.15 Pineapple propagation

8. Propagation of enset (Ensete ventricosum (welw.) Cheesman) by corm: Enset (Ensete Ventricosum (Welw.) Cheesman) is a perennial herbaceous and monocotyledonous crop which is propagated by its corms. The corm is a short, solid and thickened underground modified stem with basal plate.

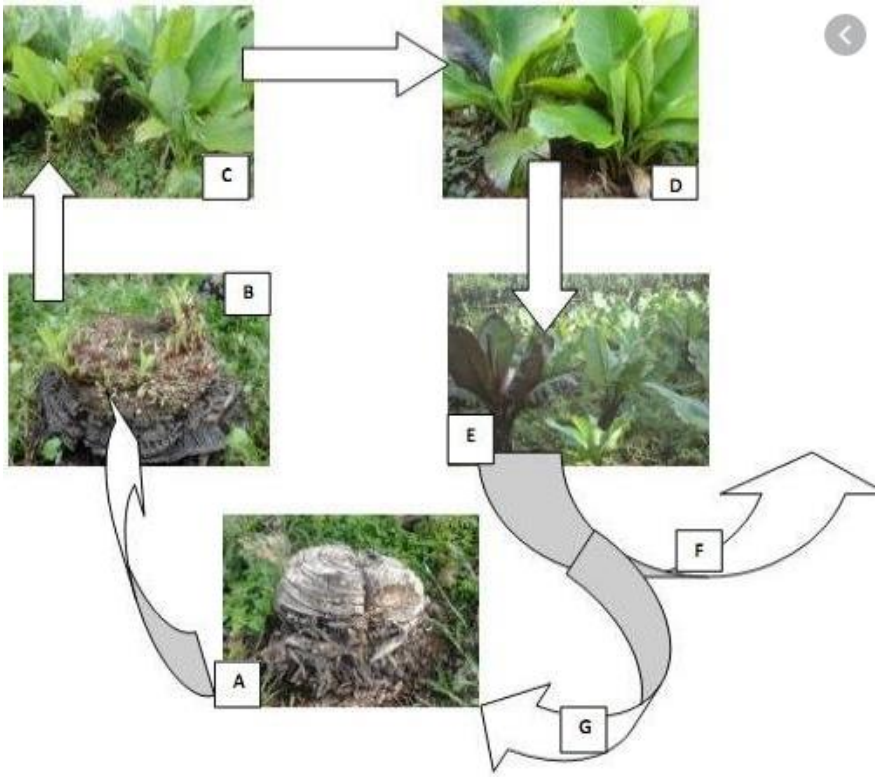

Figure:2.16 Inset propagation

9. Propagation by Corm: this consists of one or more internodes with at least one growing point. Examples of plants with corms include banana, arrowhead and cocoyam

Figure: 2.17 Corm propagation

Self-check-4	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is the difference between of them?4pts)

1.1. Tunicate

1. 2.**Non-tunicate**

I. <u>Choose the best answer for the following question (2pts each)</u>

1. Which one of the following crops are propagated by sucker? **(2pts)**

A. Ginger C. Strawberry

B. Banana D. all of the above

2. Which one of the following crops are propagated by Rhizomes?:-**(2pts)**

A. Sweet potato. C. Garlic

B. Ginger. D. Corm

3. Which one of the following crops are propagated by Bulb?.:-**(2pts)**

A. Onion. C. Garlic

B. Ginger. D. Corm

Note: **Satisfactory rating – 10 and above points** **Unsatisfactory - below 10 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Choose

1____

2____

3__

Information sheet 5 Identifying and Determining selection criteria for the propagation material.

4.1. Determining selection criteria for the propagation material according to the type of plant and propagation method

Selection criteria for propagation material may include company specifications and quality standards; the use of certified parent stock; ensuring parent stock is well nourished and healthy, free from disease, pest, frost or mechanical damage; results from recognized testing procedures, such as leaf tissue analysis; and the season.

Generally, the plant selected as mother plant for propagation purpose should have the following characteristics (criteria).

- Plants of good quality and high yielder
- High adaptability to local climate and soil conditions.
- Grow strong/vigorous healthy plants
- have desirable characteristics
- Free from diseases
- comparability, timing,
- Disease and insect resistance, drought, tolerance, and hardiness
- Actively growing portion

4.1.1. Selection of Elite Mother Trees

1. It should be of known identity

2. It should have production potential

3 It should have commercial acceptance

4 It should be free from pests and pathogens

4.1.2. Selection of Scion Wood, Rootstock and Inter stocks

The selection of scion wood, rootstock and inters tock (the stock between scion and rootstock) should be done carefully. The selection criteria vary in each case depends on company specifications and quality standards; the use of certified parent stock; ensuring parent stock is well nourished and healthy, free from disease, pest, frost or mechanical damage; results from recognized testing procedures, such as leaf tissue analysis; and the season.

4.1.3. Selection of Scion Wood

1. The scion should be from mature shoot i.e. at least one year old.

2. A scion wood of diameter 0.6-1.2 cm is satisfactory for better bud wood.

3. The scion shoot should have healthy, well-developed round and plump buds.

4. Scion should be selected from elite trees known for quality production of fruits.

5. Scion wood should be free from any bacterial, fungal and viral diseases.

6. The scion should be dormant, while selected for grafting on rootstock.

7. The best scion wood can be obtained from the central portion or from the basal Portion of shoot. The terminal sections, which are generally succulent, pithy and low in store of carbohydrate (CHO), should be discarded.

4.1.4. Collection and Storage of Bud Wood: The best quality scion wood usually comes from shoots grown in the previous season. Scions should be severed with sharp, clean shears or knives and placed immediately in moistened plastic bags. It is good practice during the harvesting of scions and the making of grafts to clean the cutting tools regularly. Flaming or immersing them in a sterilizing solution may do this.

Isopropyl alcohol also works well as a sterilant, although it evaporates quite readily. An alternative sterilizing solution may be prepared by mixing one part household bleach with nine parts water (by volume) However, this bleach solution can be highly corrosive to certain metals. For best results, harvest only as much scion wood as can be used for grafting during the same day.

If large quantities of scion wood must to be harvested at one time, follow these steps:

- Cut all scions to a uniform length, keep their basal ends together, and tie them in bundles of known quantity (for example, 50 scions per bundle).
- Label them, recording the cultivar, date of harvest, and location of stock plant.
- Wrap the base of the bundles in moistened burlap or sphagnum, place them in polyethylene or waterproof paper bags, and seal the bags.
- Store the bundles for short periods, if necessary, either iced down in insulated coolers or in a commercial storage unit at 32° to 34°F.
- Never store scions in refrigerated units where fruits or vegetables are currently kept or have been stored recently.
- Keep the scions free from freezing during storage.

4.1.5. Selection of Rootstock

1. Rootstock should have a proper vigour and growth habits.

2. Rootstock should be resistant to soil born diseases and other pests.

3. Rootstock should be tolerant/ resistant to toxic salts like Na, Mg, and Ca etc.

4. It should have wide range of edaphic adaptability (all soil and climatic factors).

5. Should have wide range of graft compatibility.

6. Should be easy to propagate.

7. It should not go under any mutation.

8. Its age should be one to one and half years and not more than 2years.

9. Its diameter should be greater than 1 cm (pencil thickness).

4.1.6. Selection of Inter stock: Inter stock is a piece of stem inserted by means of two graft unions between the stock and scion. It is used to

1. Avoid incompatibility between the stock and scion.

2. Make use of winter hardy trunk.

3. Take advantage of dwarfing rootstock. E.g. Apple: to restrict tree size and improve rooting.

4.1.7. Bud Wood Certification: *The commercialization of different fruit plants and with the urge to produce superior quality cultivars, there is uncontrolled importation of varieties within the country and across the countries. Such movement of bud wood across the globe results in spread of viral diseases from one region to the other, which needs to be controlled. Bud wood certification has a prominent role in this direction, provided if done in each and every case of germplasm movements within and across the countries.*

4.1.8. Bud Wood Packaging: The bud wood should not be allowed to dry out and be kept in polythene bags containing damp sawdust/wrapped in moist pieces of gunny bags/polythene bags Although, essential requirements are to keep the wood moist and viable, but not so wet as to rot, and maintaining a cool enough temperature to prevent premature bud swelling and protecting against freeze damage. For temperate fruits store scions in tightly sealed plastic bags with some moisture in refrigeration until ready to use.

4.1.9. Bud Wood Labeling: Clearly labeled outside packaging where there is no regulatory guidance, the label may include:

1. Type of material
2. Plant species with cultivar
3. Date of harvest
4. Permit Number (where applicable)
5. Permit Number for import and / or Phytosanitary Certification (where applicable).
6. Amount of material shipped
7. Location of the stock plant
8. Genetically modified or not

Self-check-5	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

II. Choose the best answer for the following question (2pts each)

1. Which one of the following is a Selection of Elite Mother Trees? **(2pts)**

A. It should be of known identity C. It should have commercial acceptance

B. It should have production potential D. all of the above

2. Which one of the following is Selection of Rootstock :-**(2pts)**

A. should have a proper vigour and growth habits. C. should be tolerant/ resistant to toxic salts

B. should be resistant to soil born diseases and other pests. D. all of the above

3. Which one of the following is Selection of Scion.:-**(2pts)**

A. from mature shoots C. Free from any diseases

B. Wood diameter 0.6- 1.2cm D. all of the above

Note: **Satisfactory rating – 6 and above points Unsatisfactory - below 6 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Choose

1____

2____

3____

Information sheet 6 **Determining hygiene requirements for propagation activities.**

5 .1. Hygiene requirements for propagation activities

Propagation operation requires careful and strict handling with available hygiene requirements. This contributes to the success of propagation operation.

Hygiene requirements may involve:-

- hand washing,
- removing all media and organic matter from production surfaces, tools and equipment;
- disinfecting production surfaces, tools and equipment;
- disinfecting/sterilizing propagation media;
- disinfestations and removal of plant and media waste, footbaths;
- access restrictions and handling practices which minimize cross contamination, including enterprise quarantine policies and legislation

Poor handling and less hygiene in plant propagation may result in:-

- Contamination of materials with virus, insect, disease and other dangerous microorganisms.
- Causing difficulties with union of scion and rootstock.
- Developments of undesirable characters after propagation
- Wastage of time, money and other resources.

Self-check-6	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

I. Choose the best answer for the following question (2pts each)

1. Which one of the following are hygiene protocols during propagation? **(2pts)**

A. Cutting material and seed collection
C. Hardening off
B. Propagating
D. all of the above

II. Write True **If the statements is correct or False the statement is incorrect (2pts each)**

2. Seed treatment reduces the possibility of infections of pest, weed & any diseases :-**(2pts)**

3. Poor hygienic standard propagation a results of sufficient & healthy plant growth.:- **(2pts)**

Note: **Satisfactory rating – 6 and above points** **Unsatisfactory - below 6 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Choose

1. ____
2. ____
3. ____

Information sheet 7 communicating clearly propagation plan and schedule of activities to staff

After preparing all the necessary pre-conditions to undertake propagation program, it is important to make discussion and communication concerning the propagation plan and schedules of activities to concerning bodies.

Discussion and communication may include:-

- When, where and by whom the propagation plan will be done.
- The supply of available materials and resources

The way in which risk, hazard, and environmental factors will be managed etc…
Communication does not "just happen." Effective communication requires effective strategy - a coherent plan of action.

To be effective, strategy must take three factors into account simultaneously:

- Your goals and objectives;
- Operational constraints and imperatives - things you must do and things you cannot do;
- Pertinent conditions in the environment.

Implementing effective communication strategies to ensure personnel safety and smooth flow of operations plays a great role in:-

- Solving different problems associated with harvesting operation
- Creating safe working environment
- Minimizing OHS hazards and using the corresponding care
- Facilitating the workers etc…

When your objectives involve communicating with others (when do they not?), the most pertinent environmental conditions consist of the **ideas** that your publics have about you and your objectives. It is sometimes said that **"perception is reality."** More to the point: Your publics' perception is your reality.

Our communications approach to research is based on four premises:

- People respond not to the world as you see it, but to the world as they see it. They frame your issue in their mental pictures of the situation.
- Effective communication starts with hearing and understanding rather than talking and trying to convince. We know in our personal lives that the more we know about someone, the more effective we can be in communicating with him/her. This is no less true in a public setting, but it is more difficult.
- Communication is what the receiver does. Until and unless your "message" is heard and understood by the persons you are trying to reach, it is just noise.

Self-check-7	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

II. Choose the best answer for the following question (2pts each)

1. Which one of the following is an Effective communication requires? **(2pts)**

A. effective strategy

C. coherent plan of action

B. Effective production

D. all of the above

2. Which one of the following is an effective strategy factors into account simultaneously :-**(2pts)**

A. Your goals and objectives

C. Pertinent conditions

B. Operational constraints

D. all of the above

3. Which one of the following is Our communications approach to research is based on.:-(2pts)

A. communication starts with hearing and understanding rather than talking

B. Communication is what the receiver does

C. People respond not to the world as you see it

D. all of the above

Note: **Satisfactory rating – 6 and above points** **Unsatisfactory - below 6 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Choose

1____

2____

3____

Operation sheet -2 Soil growing media for plant propagation

Objective: To know how to prepare of soil growing media

Basically, developing a careful plan for plant propagation is very crucial point to undertake crop propagation operation. Therefore, to develop the propagation plan strictly follow the following steps one by one.

1. Understand the main purpose of propagation program and select a soil type (clay, sand and silt)
2. Fix and schedule appropriate time for the media growing preparation program depending on the aim and plant species to be propagated.
3. Allocate the budget depending on your purpose of media preparation and scheduled time to accomplish the task with contingency.
4. Select all the necessary materials, facilities and infrastructures depending on your objectives of media growing.
5. Carefully evaluate space requirements for media growing preparation program depending on your objectives of program, the nature of plant species, availability of materials and the techniques.
6. Strictly determine the ratio of soil growing media techniques according to the plant species you have selected and availability of materials, tools and equipment's and labor force you have.
    6.1. Most commonly this ratio is applicable
    - 3(topsoil).
    - 1(sand),
    - 2(compost).
7. Carefully, determine environmental parameters that affect the program during the preparation and establish suitable controlling measures
8. Depending on the identified environmental factor.
9. Identify OHS hazards associated with the prepare appropriate protection techniques.

10. Discuss and communicate with concerning bodies other personnel about the preparation.
11. Finally start your Media growing prparation on your schedule.

LAP Test 2 soil growing media preparation

Name_____ Date_____

Time started_____ Time finished_____

Instructions:

1. You are required to perform any of the following

1.1 Perform soil growing media

LG#32	LO #03: Monitor success of propagation activities

Instruction sheet: 3

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying and recording variances
- Assessing propagated plants
- planning remedial procedures arranging fire prevention and control

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify and recording variances
- Assess propagated plants
- plan remedial procedures arranging fire prevention and control

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information sheet 1 Identifying and recording variances from plan and scheduled activities.

3.1 Identifying and recording Variances from plan and scheduled activities

3.1.1. Indicators of Successful Propagation

1. **Trueness-to-Name** – Different cultivars of crops have different traits. These traits must be retained in the propagated plant material. The correct cultivar with few deviations from the original stock is expected at the end of the production chain.

2. **Trueness-to-Type** – The external traits of the plant, such as fruit-shape and – size, must be identical to those of the mother-plant in a given environment.

3. **Freedom from Pathogens** – Viruses and bacteria are a threat to the survival of the crops and must not be present in propagated plant material.

- Once a plant has been infected, the pathogen may become part of the plant.
- Only propagating clean plant material will ensure success.

The source of propagated plant material has the responsibility of ensuring that plant material complies with all of the above indicators.

3.1.2. Indicators of Unsuccessful Propagation

Failure to produce plants that meet set standards is a potential source of conflict between the propagator and the farmer, who may suffer financial loss as a result.

- Dead buds

- diseased plants
- mixed cultivars
- And inferior plants are the main indicators of unsuccessful propagation.

Unsuccessful propagation indicators are not to be viewed from a completely negative perspective. Cultivar development and improvement programs around the world have made use of some of these deviations to produce new cultivars.

The known source of Bennie Valencia orange is a case in point. Standing in the middle of a late Valencia orchard, these trees expressed traits that are different to the rest. Fruits had a rounder shape, a sweeter taste, a thicker rind, were bigger in size and juicier, and matured earlier. Subsequently, a new variety was developed.

Self-check-1	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

I. Correctly match under column A with Column B (2pts each

1. Indicators of Successful Propagation	A) Failure & diseased
2. Indicators of Unsuccessful Propagation	B) Non any diseases
3. **Freedom from Pathogens**	C) free from pathogen
	D) Green coloring
	E) Good Flowering

Note: **Satisfactory rating – 6 and above points** **Unsatisfactory - below 6 point**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Choose

1._____

2._____

3.___

Information sheet 2 **Assessing propagated plants for health, quality and viability**

3.2. Assessing propagated plants for health, quality and viability according quality standards

After the propagation operation has been completed, there is a need of careful management, observation and assessing the propagated plants regarding their health, viability, remedial and quality.

Assessment will involve Inspection, recognized analytical procedures, and recording and interpreting production statistics.

Importance of assessing propagated plants after propagation operation has been completed is:-

- To provide available management care to the propagated plant
- To analyze the changes that occurred after propagation
- To protect from some infections, diseases and other factors that affecting the operation
- To assess the health, quality and viability after propagation.
- To record and interpret production statistics and so on.

Propagated plants provide high quality pathological and genetic testing to the vegetable seed, fruit tree, grapevine, and strawberry industries by approved or in-house improved methods at competitive prices.

1. Seed health: Seed Health Lab offers pathogen testing for various seeds (vegetables, field crop, flower seeds, etc). We use standard or improved methods.

2. Plant health: Plant Health Lab provides fast and accurate diagnosis of plant diseases to help farm and nursery managers take the correct steps on a timely basis.

3. Genetic: genetics lab provides variety identification, resistance screening, and hybrid purity tests. We also offer non-GMO testing for several crops!

4. **Remedia**l: provided or intended for children with learning difficulties.

5. **Viabilit**y: ability to work successfully.

:-ability to survive or live successfully

The environmental conditions listed below must be maintained to ensure successful propagations of healthy, disease-free, and true-to-type plants.

Temperature

Light

Aeration

Humidity

Self-check-2	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is the importance of assessing propagated plants after propagation? (4 pts)
2. What are the major points to be included in assessment of propagated plants? (4 pts)

I Choose the best answer for the following question (2pts each)

1. Which one of the following is ensure successful propagations of healthy, disease-free, and true-to-type plants? **(2pts)**

A. Light monitored
C. Humidity monitored
B. Aeration monitored
D. all of the above

2. What the mean of plant health? **(2pts)**

A. Free from diseases
C. Viability
B. True to type
D. all of the above

3. Which one of the following is chief important of propagation plants (**3pts)**

A. Temperature
C. humidity
B. light
D. all of the above

Note: **Satisfactory rating – 15 and above points** **Unsatisfactory - below 15 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Choose

1._____

2._____

3._____

Information sheet 3 **planning remedial procedures**

3.1. Remedial procedures are planned to meet marketing Objectives and business imperative

Remedial procedures may be required in response to damage or loss, pest and disease problems, and marketing requirements.

Remedial procedures may include:-

- Quarantine/isolation procedures,
- Schedule amended,
- Integrated pest management,
- Cultural intervention such as fertilizing, misting, tip/root pruning,
- Spraying growth hormones,
- Light manipulation, temperature changes, increased/decreased humidity,
- Tying, staking, taping; removing and disposing of damaged plant material, and irrigation.

3.2. ECONOMIC AND PROCUREMENT CONSIDERATIONS

In most cases, propagation by seed is the most labor and cost effective method of Reproducing plants, given that genetic variability, such as germination requirements, can be managed within acceptable limits.

Seed may be gathered by commercial collectors on a contractual basis or by the restoration staff directly. Raw fruit requires proper storage prior to cleaning, processing

to some clean product level, inventorying, and proper storage prior to sowing. Large amounts of seed can be planted outdoors in woody production beds with relatively simple machinery.

For a given species in which seed is readily available, viability high, dormancy requirements known and minimal, and cultural techniques established; sexual propagation represents a low cost, labor and facility efficient method of multiplying plants.

As the conditions for the collecting, sowing, and culturing of seed become less than ideal, asexual propagation by cutting becomes an increasingly viable production option. As noted earlier, seed availability may be low, available seed expensive, or a lengthy or difficult dormancy mechanism involved. Although seed may be in abundant supply, its viability may be low--a condition that may be a regular or periodic phenomena.

Once acceptable collection sites have been identified and the propagules collected, verification of origin and the maintenance of the sampled genetics is necessary throughout all stages of production. It may even be necessary to isolate seed or cuttings by individual parent plant, depending on the restoration strategy.

For this reason, the purchase of bulked lots or propagules of questionable origin may not be an acceptable option for National Park and Forest projects.
Managers need to recognize the additional expense associated with site specific propagate collection and the cost of verification and maintenance of these sources. Other factors may increase the cost of production as well.

A lack of commercial incentive has resulted in less propagation research being conducted on the native woody species in comparison to ornamental selections that have been through breeding or selection programs. Project-specific wild land collections are often small and irregular in amount and viability, preventing economies of scale from being reached.

These factors in combination will increase the cost of production. Procurement specifications need to reflect these needs and resources allocated accordingly. One option may be to reimburse commercial growers in two stages, one for attempting to produce a difficult-to-grow species and the second on a “per plant” basis for the actual product grown.

Given some level of success, the sum of the two contracts might approximately equal the per plant cost of producing some relatively easy-to-grow species

Self-check-3	Written test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. .What do mean by planning remedial requirements? (4 pts)
2. What will be included in the remedial plan of plant propagation? (4 pts)
3. Develop remedial plan for plant propagation? (4pts)
4. What are the Remedial Procedures?(2pts)

I. <u>If the statements is correct says true or the statement is incorrect says false(2pts each)</u>

1. Propagation by seed is the most labor and cost effective requirement system? **(2pts)**

2. Asexual propagation by cutting becomes an increasingly viable production option? **(2pts)**

3. Asexual propagation represents a low cost, labor and facility than sexual method of multiplying plants.
2pts)

Note: **Satisfactory rating – 20 and above points** **Unsatisfactory - below 20points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Choose

1.____
2.____
3.___

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