Unit 3

Plant Propagation

Introduction

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Plant propagation, in simple words, may be defined as multiplication or reproduction of plants. Commercialisation of crops leads to the development of various techniques and procedures of plant propagation. Each technique has its own merits and demerits.

Each plant responds differently to different methods of propagation. Various techniques of propagation have been developed with the objective to have uniformity in crops, early bearing, increased production, resistance against pests and diseases, and introduce certain characters in new generation. These objectives have made plant propagation interesting and challenging.

Propagation of plant is the involvement of science and art in a skillful way. Basic knowledge and skill of it can be a better source of income through commercial nurseries. It helps in maintaining the plant stock and preserving endangered (extinct) species.

Plants can be propagated by sexual and asexual means. Sexual means includes propagation by seeds,

while asexual propagation is based on the utilisation of vegetative parts of plants for raising new ones. Vegetative parts of plants like shoots, leaves, roots, stem, buds and underground parts are used in different ways for reproducing new plants. The most common asexual propagation methods include cutting, layering, grafting and budding, which need specialised skill and are done differently in different plants.

Growing of tissues in controlled conditions is an advance and recent method of vegetative propagation. It is known as 'tissue culture'. It is a highly specialised technique of propagation. By using this technique, a large number of true-to-type virus-free saplings can be produced in a short span.

What is a seed?

A seed is a ripened ovule developed after fertilisation. It consists of an 'embryo' and stored food material, both of which are enclosed in a special covering known as 'seed coat'. Plants germinate from seeds when they are provided with favourable growing conditions.

TYPES OF PROPAGATION

Sexual propagation

Propagation or multiplication of plants by seeds is known as 'sexual propagation'. Seeds are formed as a result of successful fertilisation and combination of parental gametes. It is an old and easy method and is widely used for the propagation of crops like ornamental annuals, vegetables, medicinal and fruit plants, such as papaya.

Merits of sexual propagation

- Plants propagated by seeds live longer, are vigorous and more resistant to biotic (insect-pests and diseases) and abiotic stresses (environmental conditions).
- It is an easy, simple and convenient method of plant propagation.

- Some plants like papaya, marigold, chilli, capsicum, tomato, etc., cannot be propagated by asexual method.
- It is the only means of creating genetic diversity of plants.
- New varieties and cultivars of ornamental and vegetable crops can be developed only by this method.
- A large number of rootstocks for budding and grafting purpose is also raised by this method.
- Seeds can be transported easily and stored for a longer time using this method.

Demerits of sexual propagation

- Sexually propagated plants show variations and are not genetically true-to-type to the mother plants.
- Plants that are propagated through seeds have long gestation period, which results in delayed flowering and fruiting.
- Plants grow vigorously and cause obstruction in intercultural practices like harvesting and spraying.
- Advantages offered by rootstocks and scion as in asexual propagation cannot be exploited through sexual method.
- Crop species, which do not produce seeds like pineapple, banana, strawberry, fig, jasmine, hibiscus, bougainvillea, etc., cannot multiply by this method.

Asexual propagation

It is also called 'vegetative propagation'. The vegetative parts of a plant like leaf, stem, root or their modified forms are used for propagation. Most of the horticultural crops are commercially propagated by vegetative or asexual method of propagation.

Merits of asexual propagation

- Many fruit and ornamental plants that do not produce seeds are multiplied by this method.

- Plants propagated by asexual propagation are true-to-type genetically.
- By top working (using budding and grafting), old and economically low productive fruit plants can be converted into superior ones.
- Advantages offered by rootstocks and scion can be exploited through asexual method.
- Maturity is uniform and the plant gives quality yield.
- Plants propagated by asexual method are small in size, so spraying of chemicals and harvesting are easy.
- This method enables noble plant production, e.g., different colours of flowers in a single rose plant and different types of mangoes in one mango plant can be produced through asexual method only.

Demerits of asexual propagation

- By vegetative propagation, new varieties cannot be developed.
- It requires specialised skills, so it is an expensive method of propagation.
- The life span of asexually propagated plants is short as compared to sexually propagated ones.
- These plants are more prone to biotic and abiotic stresses.

SESSION 1: PLANT PROPAGATION BY CUTTING

Cutting

Cutting is a detached vegetative part of a plant, which on separation and planting is able to regenerate the missing parts and develop itself into a new plant. It is an inexpensive and quick method of propagation. A large number of uniform plants can be produced using few parent plants. It does not involve specialised skills. The method is named after the part of plant used for cutting, e.g., stem, root and leaf.

Stem cutting

Based on the age and maturity of shoots detached for vegetative propagation, stem cuttings is of four types.

(i) Hardwood cutting
(ii) Semi-hardwood cutting
(iii) Softwood cutting
(iv) Herbaceous cutting

Hardwood cutting

Such a cutting is taken from woody plants. Mostly, deciduous plants are propagated by this method. One-year old mature branch is cut into pieces of suitable sizes and planted in the rooting medium, e.g., rose, grapes, fig, pomegranate, bougainvillea, *tabernaemontana, lagerstroemia*, *jasminum,* hibiscus, etc.

Fig. 3.1: Hardwood cuttings

Procedure

- Select branches of one-year old healthy plants, having pencil thickness. Cut the branches into 10–15 cm long cuttings.
- Long cuttings are used to raise rootstocks for fruit trees. Each cutting must have at least 4–5 dormant vegetative buds. Leaves and thorns, if present, are completely removed. This checks transpiration loss.
- A slanting cut is given at the base of the cuttings just below the node and a straight upper cut is given away from the top bud.
- The cut portion will help identify the planting position. Slanting cut at the base is given so that a large area of the cuttings is in contact with the rooting medium for inducing roots.
- The secretion of hormones at the bud near the cut portion induces rooting. Straight cut at upper end reduces transpiration loss, which can be inhibited by the application of wax.
- The cuttings are planted slant-wise in a nursery bed or small poly bags for growing plants. Callus tissues form the cambium layer and rooting takes place in this region. The best season for planting the cuttings is monsoon for evergreen plants and November–February for deciduous plants. Cuttings can be planted in greenhouse or poly-house for better results.

Fig. 3.2: Semi-hardwood cuttings

Semi-hardwood cutting

A semi-hardwood cutting is taken from 4 to 9-month old shoots of current season woody plants. Most ornamental foliage plants like croton, *acalyphas, aralias, diffenbachia, russelia, cestrum, nerium,* etc., are propagated by semi-hardwood cuttings.

Procedure

Semi-hardwood cuttings are prepared from branches having pencil thickness. The length of these cuttings varies from 7.5 to 15 cm. The cuttings must have at least 4–5 dormant vegetative buds. Some leaves are retained as they help in preparing food by photosynthesis. Large leaves are reduced in size by cutting. A slant basal cut is given just near the vegetative bud and a straight top cut must be given away from the bud. The slant cut helps to expose more area of the cambium layer, which helps in more water absorption and callus formation. The upper straight cut minimises exposure to the atmosphere, which reduces transpiration loss from the cuttings. It is useful to dip the top of the cuttings in wax to check transpiration and infections. Dipping the base of the cuttings before planting in IBA @ 5000 ppm induces early rooting. The cuttings are planted in slanting position so that their maximum base is in contact with the rooting medium. The planting season for semi-hardwood cuttings is monsoon. Commercially, such cuttings are rooted under mist spray or fog.

Fig. 3.3: Softwood cuttings

Softwood cutting

Such a cutting is taken from herbaceous or succulent plants. Shoots of 2 to 3-month old plants are selected for softwood cuttings. Examples are *alternanthera*, *coleus*, *duranta*, *clerodendrum*, etc.

Procedure

Softwood cuttings are prepared from tender but mature branches. The length of these cuttings varies from 10–12 cm. Tender shoots do not have sufficient food material. Hence, all leaves present on the shoots are retained for photosynthesis. The cutting material are gathered early in the morning and must be kept moist by keeping them in a wet cloth. Sandy loam medium is the best for planting softwood cuttings.

Herbaceous cutting

Such a cutting is taken from herbaceous plants. Shoots of 1 to 2-month old plants are selected for herbaceous cuttings. Examples are chrysanthemum, *iresine*, *pilea*, dahlia, petunia, carnation, marigold, etc.

Procedure

Herbaceous cuttings are made from tender succulents, especially the leafy part of the stems of herbaceous plants. Terminal, measuring 8–12 cm, of a healthy shoot is cut and the basal leaves are removed, leaving the upper leaves undisturbed. The cuttings once detached must not desiccate at the cut and are rooted well under mist. The application of auxins promotes the regeneration of adventitious roots. Sandy loam medium is the best for planting herbaceous cuttings.

Fig. 3.4: Herbaceous cuttings

Leaf cutting

Selection of cutting

Plants with thick fleshy leaves having buds are propagated by leaf cutting. Vegetative buds are present in the notches of leaf margin (*bryophyllum*) or on the vein (*begonia rex*). Leaf blade or pieces of it with bud are put on the rooting medium under favourable conditions. In case of black raspberry, the leaf blade, along with petiole and a short piece of the stem with

Fig. 3.5: Propagation through leaf (bryophyllum)

attached axillary buds, are kept in the medium for rooting. Plants like snake plant (*senseveria*), blackberry, *rhododendron and bryophyllum* are propagated by this method.

Practical Exercise

Activity

Prepare hardwood cutting.

Material required: Branch of bougainvillea, secateurs or sharp cutter, rooting hormone IBA, nursery bed

Procedure

- Select a healthy bougainvillea plant.
- Now, select a matured branch of last season growth of bougainvillea and separate it from the plant.
- Remove the leaves over it without damaging the buds.
- Leave one or two petioles at 5–10 cm distance on the branch.
- Cut the branch into cuttings of 10–15 cm length with at least 3–4 buds on each cutting.
- Make a slanting sharp cut at the bottom just below the node and avoid crushing the stem.
- Dip the basal portion in rooting hormone like IBA of requisite concentration.
- Plant the stem cutting upright or in slanting position in rows in the sand bed at a distance of 10 cm between rows, as well as, within the rows.
- Keep the newly planted cuttings in partial shade until new shoots sprout from the buds.
- Keep the cuttings moist at all times by providing them with adequate air circulation and sunlight.
- After sufficient rooting, transfer the cuttings into a polythene bag or pot.

Check Your Progress

A. Fill in the Blanks

1. Multiplication or reproduction of plants is called _____.
2. Plants that do not produce seeds are propagated by _____.
3. Growing of tissues in controlled conditions is known as _____.
4. The process of reproduction of plants by seeds is called _____ propagation.
5. Plants propagated by _____ live longer.

6. Sexually propagated plants show _____.
7. Plants propagated through seeds have _____ juvenile phase.
8. Vegetative propagation is also called _____ propagation.
9. Bougainvillea is propagated by _____.

B. Multiple Choice Questions

1. *Bryophyllum* is propagated by _____.
   (a) root cutting (b) stem cutting
   (c) leaf cutting (d) seeds
2. Jasminum is propagated by _____.
   (a) root (b) stem
   (c) leaf (d) seed
3. Asexually propagated plants _____.
   (a) are true-to-type (b) bears late fruit
   (c) live longer (d) have large canopy
4. Hardwood cutting is, generally, used in _____ branch.
   (a) one-year old (b) two-year old
   (c) three-year old (d) four-year old

C. Subjective Questions

1. Differentiate between sexual and asexual propagation.
2. Write the advantages and disadvantages of sexual propagation.

D. Match the Columns

A	B
1. Cutting	(a) *Coleus*
2. Seed	(b) Leaf cutting
3. Softwood cutting	(c) Detached vegetative part of plant
4. *Bryophyllum*	(d) Sexual propagation

NOTES

Session 2: Plant Propagation by Layering

Layering

It is an attached method of propagation. In this method, roots are allowed to develop on the covered portion of the stem while still being attached to the mother plant. After the emergence and development of the roots, this portion is separated from the mother plant and allowed to grow as a new plant on its own root stem. Such root stem is known as 'layer'.

Types of layering

(i) Simple layering
(ii) Compound or serpentine layering
(iii) Trench layering
(iv) Mound layering or stooling
(v) Air layering

Simple layering

In simple layering, a partial tongue-like cut is given on a branch. The branch is then bent to the ground and the treated portion is covered with soil, keeping the top or terminal portion exposed. The layered branches produce roots in weeks and are ready for transplanting in a nursery after detaching them carefully. Examples are jasmine, *ixora*, *clerodendron*, *pyrostegia*, etc.

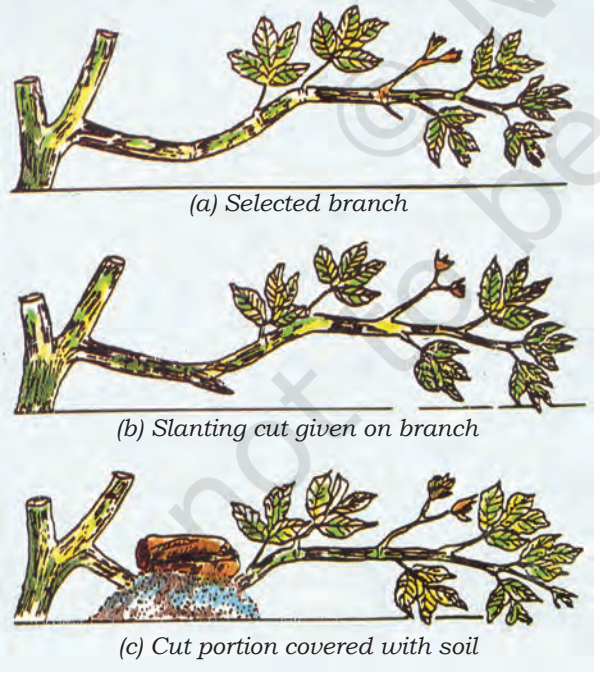


Fig. 3.6 (a–c): Simple layering

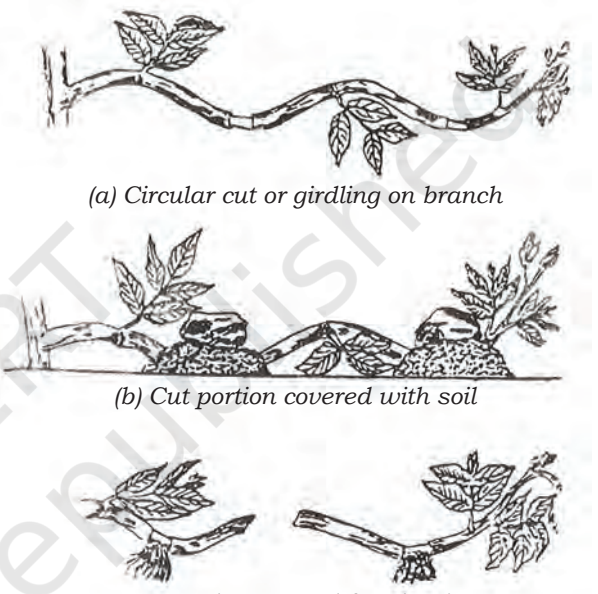
Procedure

Select one-year old healthy, flexible, long un-branched shoot near the ground level. Remove leaves of the selected shoot, retaining some at the top. The retained leaves prepare food through photosynthesis. Bend down the shoot so that some part of it touches the ground. At that portion, generally, 15–30 cm away from the terminal end, a sharp slanting inward cut of 2–3 cm is given. A small matchstick is inserted in the cut to keep the slit open. Bend down the branch and cover the cut part with soil. Keep some weight or stone over the buried part so that it is not pulled upward, and remains

in the same position. A stake is fixed near the layered branch and the branch operated upon is tied with it. Water the layered portion regularly. After 3–4 weeks, rooting starts at the operated portion and this can be indicated by sprouting buds on the shoot. After this, the layer is separated from the mother plant and planted in a new place.

Compound or serpentine layering

Compound layering is similar to simple layering, except the branches are alternately covered and exposed along their length. The branches must be longer so that they can be layered at several places. This method is followed in plants like bougainvillea, jasmine, clematis, muscadine grape and wisteria.



(a) Circular cut or girdling on branch

(b) Cut portion covered with soil

(c) Branch prepared for planting

Fig. 3.7 (a–c): Compound or serpentine layering

Procedure

One-year old healthy and flexible long shoot near the ground is selected for compound layering. The selected stem is placed in soil in a way that the nodes at certain distance are covered under the soil and the intermediate internodes are exposed. Remove leaves from the selected branch but retain few leaves at the top. Give two circular cut around the bark about 2.5–4 cm wide. Remove the bark of the operated portion (girdling). Apply rooting hormone to the girdled portion and cover it with soil. The same branch is operated at 3–4 places at certain distance in the same way. The growing shoots, which emerge from the covered portion of the branch, are separated from the mother plant for planting in a nursery.

Trench layering

Trench layering is primarily used in fruit plants. Covering the shoots with soil results in etiolation, so it is also known as 'etiolation layering'. New shoots arise from the length of the burried branches. After rooting, individual shoots are separated from the mother plant. This method is followed in apple, cherry, pear, jasmine and rhododendron.

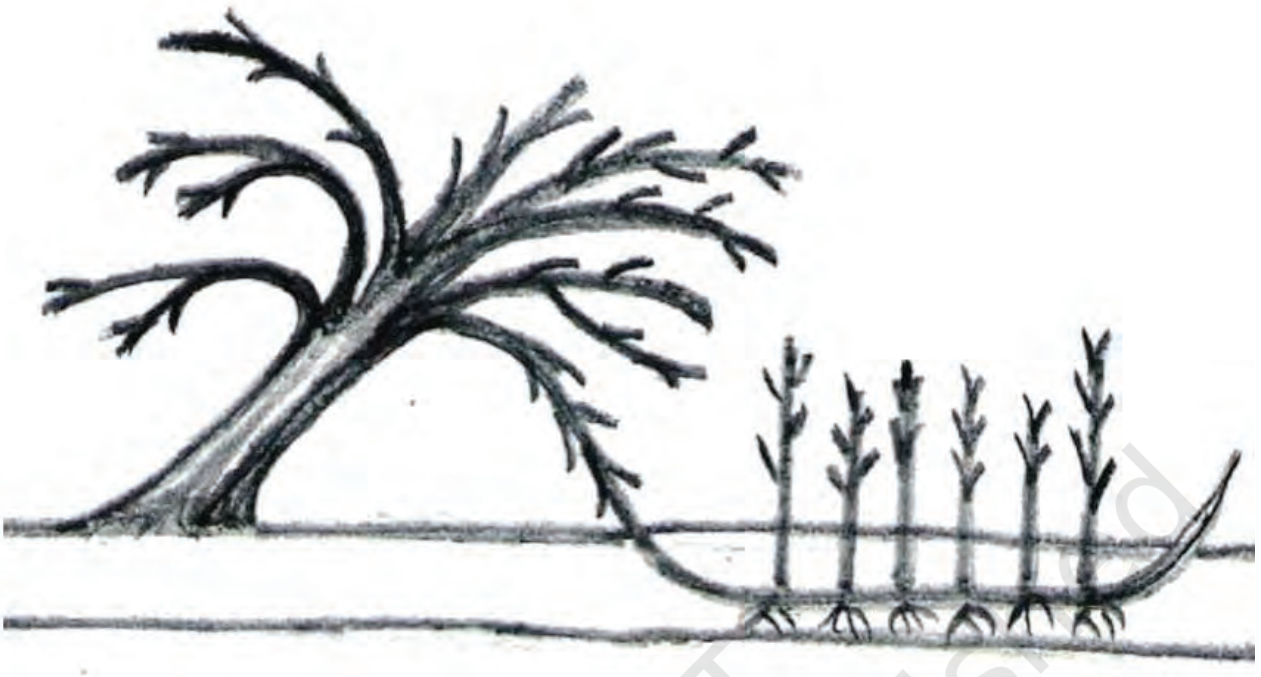


Fig. 3.8: Trench layering

Procedure

One-year old healthy and flexible long shoot near the ground is selected. The selected stem is placed in a shallow trench in a way that the middle portion of it is buried. Remove leaves from the branch but retain few leaves at the top. Cover the whole branch with moist soil 5–10 cm deep. The terminal portion is left exposed to manufacture food and hormones for the developing plants. After some weeks, shoots arise from the nodes, which are covered by soil. The covering of the shoots with soil results in etiolation of the shoots and helps in rooting. Individual shoots with roots (layers) are separated from the mother plant and planted in a nursery.

Mound layering or stooling

This method is followed in plants whose branches are firm and difficult to bend. The selected plant must be at dormant stage at the time of layering.

Procedure

Cut back the upper portion of the plant 2.5 cm above the ground level. After few days, new shoots will emerge. When the shoots grow to a height of 7–15 cm and

become little sturdy, place loose soil around them so that they are half buried. When the shoots attain a height of 20–25 cm, again add soil around them so that they are half buried. Water the heaped soil regularly. It will take 3–4 months to get the layers. Cut the rooted layers close to the base from the mother plant and plant it in a nursery. Examples are apple, guava, currant, gooseberry, pear, etc.

Fig. 3.9 (a–e): Mound layering or stooling

Air layering

It is also known as 'gootee'. Examples are *Ficus elastica*, *Callistemon*, croton, monstera, citrus fruits, lychee, philodendron, pomegranate, etc.

Procedure

Select healthy, vigorously growing aerial branch having pencil-size thickness. The selected branch must be of the past growing season. Girdle the selected branch up to 2–3.5 cm wide just below the node 15–30 cm back from the tip of the shoot. A strip of the bark from the girdled portion is removed. Scrap the girdled portion, which helps in the removal of phloem tissues and prevents formation of bark at the girdled portion. Excessive moisture from sphagnum moss is squeezed out before placing it over the cut portion. A piece of polyethylene film is carefully wrapped around the branch so that the sphagnum moss is completely covered. Both the ends of the polyethylene film are made airtight by tying

them with strings. The layer is removed from the parent plant when roots are observed through the transparent polyethylene film. It takes 2–3 months for rooting. Rainy season is the best for air layering.

Practical Exercise

Activity

Demonstrate simple layering.

Material required: Sharp knife, stone pieces or hooks or pegs, polythene bags, secateurs and matchstick

Procedure

- Select one-year old healthy and flexible long un-branched shoots near the ground level.
- At a distance of 15–30 cm back from the tip, make a sharp slanting inward cut and insert a matchstick.
- Bend the shoot gently to the ground so that the cut part can be inserted into the soil.
- Cover the rooting region with soil.
- Keep a stone on the part covered with soil in order to retain the layer in place.
- Drive a vertical stake to the soil by the side of the layered branch.
- Tie the branch to the stake with a gunny thread.
- Water the layered portion regularly till rooting starts.

Check Your Progress

A. Fill in the Blanks

1. In _____ layering, a partial tongue-like cut is given on a branch.
2. Layering is an _____ method of propagation.
3. Vigorously growing _____ branch is used for air layering.
4. In mound layering, cut back the plant at _____ cm above the ground level.

B. Multiple Choice Questions

1. Plant propagated through air layering is _____.
   (a) croton (b) gaillardia
   (c) jasmine (d) rose
2. Air layering is also known as _____.
   (a) gootee (b) simple layering
   (c) compound layering (d) None of the above

3. In trench layering, the whole branch buried in soil is up to _____cm deep.
   (a) 1–2 (b) 3–4
   (c) 5–10 (d) 12–15
4. The same branch is operated at 3–4 places at certain distance in _____ layering.
   (a) trench (b) simple
   (c) air (d) compound

C. Subjective Questions

1. Write the procedure of compound layering.
2. Discuss in detail the process of air layering.

D. Match the Columns

A	B
1. Air layering	(a) Plant must be at dormant stage
2. Circular removal of bark	(b) Apple
3. Mound layering	(c) Girdling
4. Trench layering	(d) Serpentine layering
5. Compound layering	(e) Gootee

SESSION 3: PLANT PROPAGATION BY GRAFTING

Grafting

The method of joining parts of two plants in a manner that they form a unit and function as one plant is known as 'grafting'.

Advantages of grafting

- Plants propagated by grafting are true-to-type, and bear flowers and fruits early.
- The plants can be multiplied and preserved by grafting.
- Local variety of older plants can be improved to superior variety by top working.
- Wounded or damaged tree trunks can be repaired by special grafting methods.
- Rootstock has an influence on resistance, vigour and quality of grafted plants.

- Certain rootstocks, which are tolerant to saline and alkaline soils and other adverse conditions, can be used for grafting.

Disadvantages of grafting

- It requires specialised skill.
- It is an expensive method of propagation.
- New varieties cannot be developed by grafting.
- Plants produced through grafting are short lived as compared to plants propagated by seeds.
- When contaminated tools or propagation material are used in grafting, newly propagated plants may also get infected.

Rootstock

The part of the graft that provides root system to the grafted plant is known as 'rootstock'. It is, normally, raised by seeds in the seedbed, and then, transplanted in the nursery bed for budding and grafting. Rootstocks are also raised in pots and polythene bags.

Characteristics of rootstock

- Adaptable to local climatic conditions
- Resistant to adverse climatic and soil conditions
- Resistant or tolerant to pests and diseases
- Propagates easily
- Compatible with scion
- Promotes early healing and formation of cambium layer

Raising of rootstock

Generally, rootstocks are raised by seeds (mango and citrus fruits), or sometimes, by cuttings (rose). Seeds are sown or cuttings are planted on raised beds or in poly bags for raising rootstocks. After the germination of seeds or rootings of cuttings, the seedling rootstocks are transplanted in poly bags or nursery beds. Once they reach the stage of growth, they are used as rootstocks for grafting or budding. Sometimes, the rootstocks are not of the same species, e.g., for grapes (*Vitis vinifera*), the rootstock used is a related species *Vitis berlandieri.*

Scion

The upper portion of graft combination taken from the desired plant to be multiplied is known as 'scion'.

Characteristics of scion

- Scion wood must be of the previous season but not from more than one-year old plant.
- Flowering shoots or shoots from where the harvesting is recently done must be avoided.
- Healthy and well-developed vegetative buds must be selected.
- The scion or bud sticks must be selected from known performing orchard trees.

Selection of scion

- The mother plant must be vigorous, high yielding, true-to-type and free from undesirable bud mutation and viral diseases.
- It is advisable to collect scion from grown-up trees.
- It must be preconditioned by defoliating the branch before it is used for budding or grafting. Defoliating helps the buds to swell.

Methods of grafting

Grafting methods can be grouped into the following.

Scion attached method

In this method, the scion shoot is not detached from the mother plant until the union takes place. After the successful union of the scion and rootstock, the scion is separated in gradual cut from the mother plant. For making the grafting handy, the rootstock is grown in a container or polythene bag. This method is followed in plants, in which successful graft unions are difficult to obtain. 'Approach grafting' is a type of scion attached method. It is classified into two types.

- Sliced approach grafting
- Tongue grafting

Approach grafting

Approach grafting is also known as 'inarching'. The main feature of approach grafting is that two

independent self-sustaining plants are grafted together. After the successful union of the graft, the scion plant is detached below the graft union from the mother plant and the top of the rootstock plant is removed above the graft. This method is useful for plants, in which successful graft unions are difficult to obtain. This method is, usually, performed for plants growing in a container, as well as, big trees. In the latter case, the rootstock seedling is brought near the scion branch by erecting a platform.

Selection of grafting material

Approach grafting can be done in two ways, and accordingly, their names are given as 'sliced approach grafting' and 'tongue approach grafting'. In both the methods, the success of grafting depends on the thickness of the scion and rootstock. Both must be compatible and comfortable at the union. The rootstock and scion must be of almost the same thickness. Select the scion branch on the mother plant of desired characteristics.

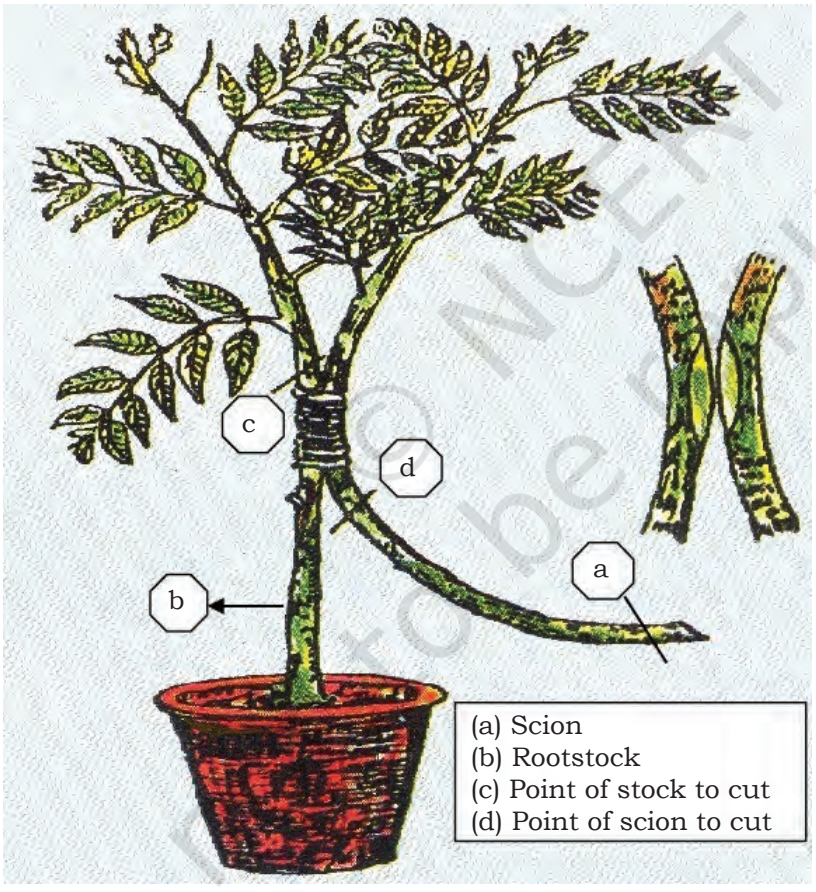


Fig. 3.10: Approach grafting (inarching)

Sliced approach grafting

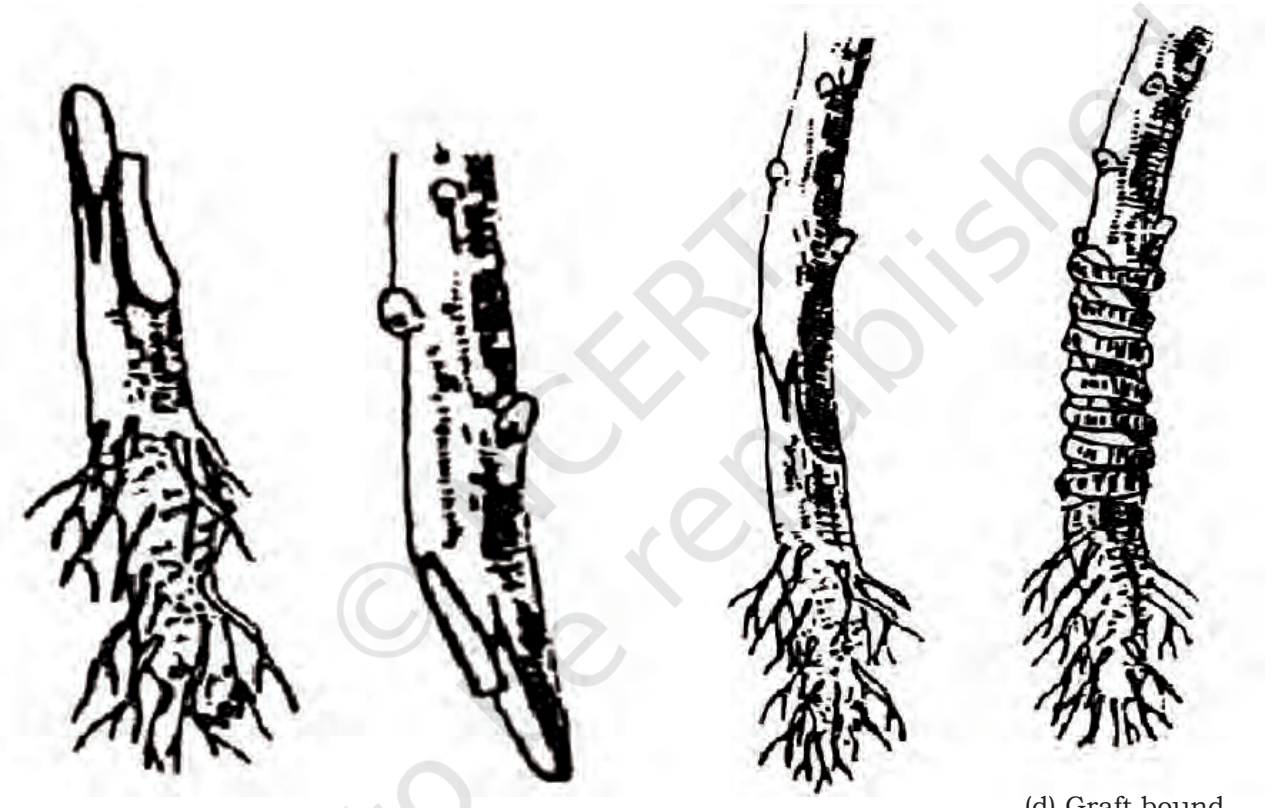
Procedure

- Bring the selected rootstock and scion close together.
- Find out the most comfortable point of contact.
- At the point of contact, a thin slice of wood along with a 2.5 to 5-cm long bark from the rootstock and the scion is removed.
- The operated size must be uniform on both the stems of the rootstock and the scion.

- The cut surfaces are then brought together so that they cover each other completely by overlapping. Press them firmly together and tie them with a waxed string or polythene tape, so that water does not enter.
- After successful union, head back the rootstock above the union and cut the scion below the union, e.g., mango, guava, sapota, etc.

Tongue grafting

This method differs from the former as cuts are given on both the scion and rootstock.



(a) Root portion (b) Prepared portion (c) Fitted graft (d) Graft bound with tape

Fig. 3.11 (a–d): Tongue grafting

Procedure

- Bring the selected rootstock and scion close together.
- Find out the most comfortable point of contact.
- Remove a slice of wood along with a 2.5 to 5-cm long bark from the rootstock and scion.

- A second slanting partial cut downward on the stock and upward on the scion is made, producing a thin tongue-like structure of the same size on the stem of the stock and the scion.
- Insert the scion in the stock so that these tongue cuts interlock.
- All operated portions must be in contact with each other.
- Tie the operated portions.

Scion detached method

This method is a more popular method of grafting and comparatively easier to perform. Besides, the rate of success of plant propagation is more in this case. In this method, the scion is first detached from the mother plant, and then, inserted or tied on the rootstock. The types of scion detached method are:

- Veneer grafting
- Side grafting
- Wedge or cleft grafting
- Stone or epicotyl grafting
- Whip or splice grafting
- Bark grafting

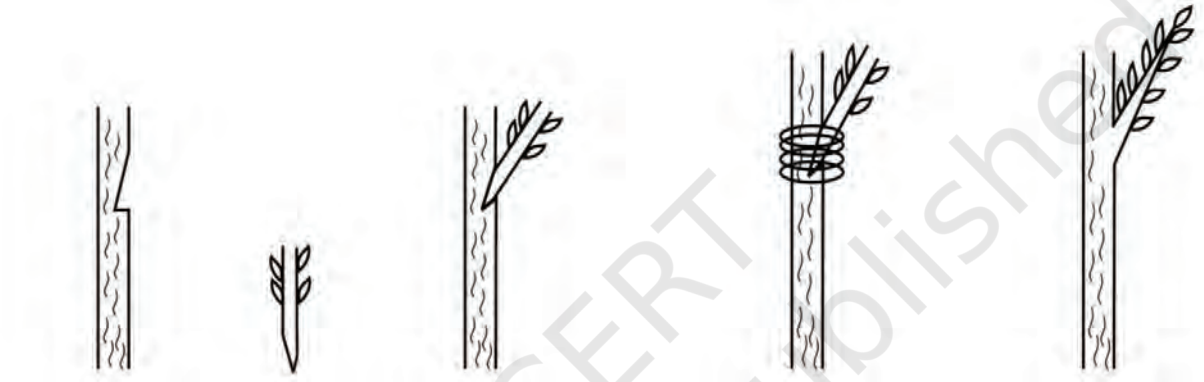
Veneer grafting

It is a simple and economical method of grafting. It the most ideal method for establishing in situ orchards and top working of old unproductive orchards. The best time in north India for veneer grafting is March–April and July–August. Mango, cashew and peach are commercially propagated by this technique. Veneer grafting differs from side grafting. In this, the vertical flap of the stock is completely removed and a slanting cut is given on one side of the scion.

Procedure

- A shallow 3 to 5-cm long downward cut is made on the selected rootstock.
- At the base of the first cut, a short inward and downward cut is made that intersects the first cut.
- In between both the cuts, remove the piece of wood along with the bark by making a small notch in the rootstock.

- The scion is operated with a matching long cut on one side and a short cut on the opposite side is given at the base.
- Insert the scion and fix it in the rootstock. Care must be taken to ensure that the cambium layer matches at least one side of the cut surface.
- Wrap and tie the scion and rootstock firmly.
- Cut back the rootstock above the union after successful union.
- This method is used for grafting conifers, deciduous trees and shrubs.



(a) Prepared stock (b) Prepared scion (c) The scion is inserted in the stock (d) Wrapped scoin and stock (e) Prepared plant

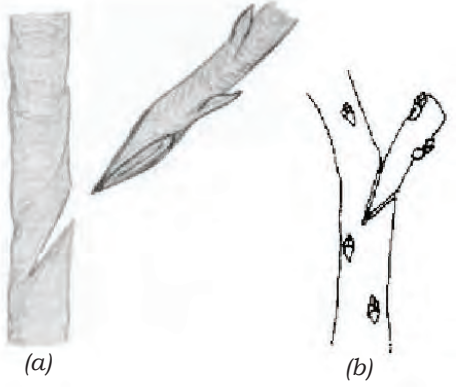
Fig. 3.12 (a–e): Veneer grafting

Side grafting

In this method, the operated scion is inserted into the side of the established rootstock, which has more girth than the scion, e.g., hibiscus.

Selection of material

- A rootstock of 2.5 cm diameter is selected.
- The scion needs to have 3–5 buds and must be about 7.5 cm long.
- The scion must be comparatively thinner than the rootstock.



(a) (b)

Fig. 3.13 (a–b): Side grafting

Procedure

- Use a sharp knife for cutting the scion.
- On the stem of the rootstock, a slanting downward and inward cut of about 2.5–5 cm deep is made.

- A wedge of the same size (2.5–5 cm) of the scion is prepared by two slanting cuts oppositely towards the base.
- The scion is then inserted into the operated rootstock.
- Pour wax and make the operated portion waterproof.
- Wrap and tie the grafted portion to keep it intact.
- After the graft is complete, cut the stock above the union.

Cleft grafting

It is comparatively a simple and an easy method of grafting, which is widely used in fruit trees, e.g., mango, jackfruit, *bael*, *amla*, etc.

Selection of material

- The scion must be a terminal shoot with 3–5 buds.
- It must be of the current season and in active growth.
- The scion shoot is defoliated about two weeks ahead of being separated from the mother plant.
- This will help accumulate food in the shoots. As a result, the buds on the shoots become swollen.
- As compared to the rootstock, the thickness (diameter) of the scion may be the same or less.

Procedure

- The rootstocks of required plant species are raised in poly bags.
- The seedling of the suitable rootstock, which is 4 to 5–month old is selected.
- Head back the rootstock.
- A sharp vertical downward cut of 3–5 cm is made in the centre of the stem.
- Two slanting cuts of the same length (3–5 cm) as in the rootstock are given on the sides towards the base on the scion shoot.
- This will give a wedge-shaped appearance to the scion stick.
- The wedge-shaped scion is inserted in the split of the rootstock.
- Insert the scion in a way that it matches the cambium layer at least on one side with the stock.

- Tie the grafted portion firmly in position with a polythene tape.
- After successful union, the terminal buds of the scion begin to sprout.
- Loosen or remove the polythene tape to allow the shoot to grow normally.
- It is better to stake the newly grafted plant.

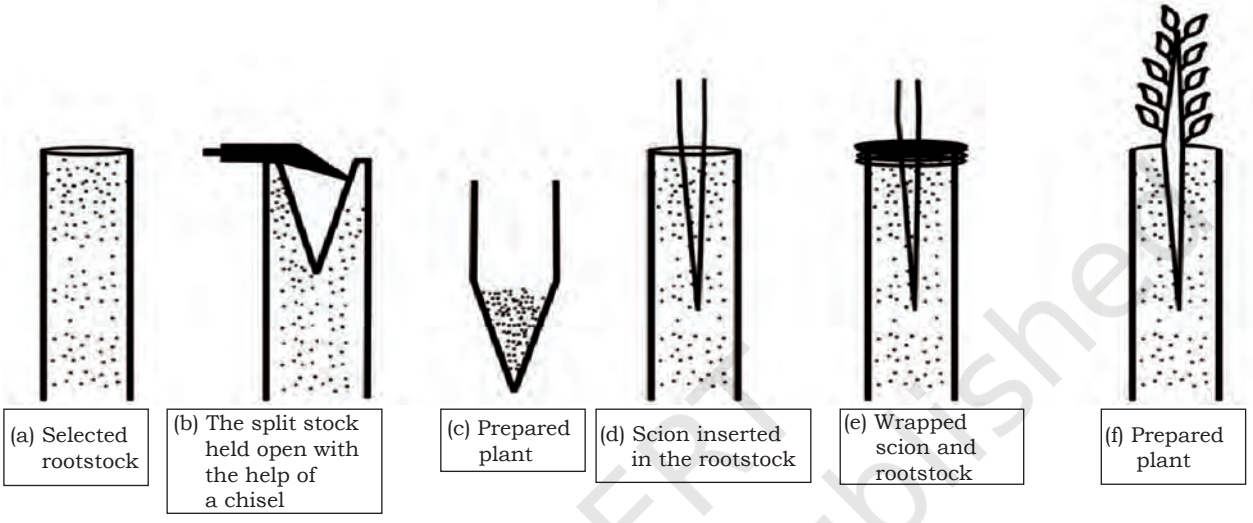


Fig. 3.14 (a–f): Cleft grafting

Stone or epicotyl grafting

This method is commonly adopted for the rapid multiplication of mango plants. In this method, stones (seeds) are sown in polythene bags or moist sand bed and covered with 5 to 7-cm layer of leaf mould for germination. When the seedlings are about 15 days old, they are taken out and grafted indoor.

Selection of material

- Young mango seedlings with copper coloured leaves (15 days old) are used as rootstocks.
- Young (current season growth) 3 to 4-month old shoot with pencil thickness is selected as the scion on the mother plant.
- The scion must have 4–5 terminal (apical) buds.
- Defoliate the selected shoot 15 days prior to grafting.
- Defoliation makes the buds swollen and induces early sprouting.

Procedure

- A wedge in the scion is made at the base by giving two slanting cuts of 5 cm.
- Head back the stock by giving a straight horizontal cut.
- From the centre of the stock, give a 5-cm long vertical cut downward.
- Insert the wedge-shaped scion in the split portion of the stock so that the operated portion is in full contact.
- Tie the graft firmly with a polythene strip. The successful graft sprouts and new shoots emerge. Such grafts are ready for planting within one year, e.g., mango.

Whip or splice grafting

It is the oldest method of grafting. This method is used in fruit trees like apple, pear, walnut, etc.

Selection of material

Select one-year old rootstock. The rootstock and scion must be of uniform thickness. The scion must be 10 to 15 cm long having 4–5 swollen buds. The rootstock must be in active growth phase and sap-flowing condition. It is mostly performed in early spring season.

Procedure

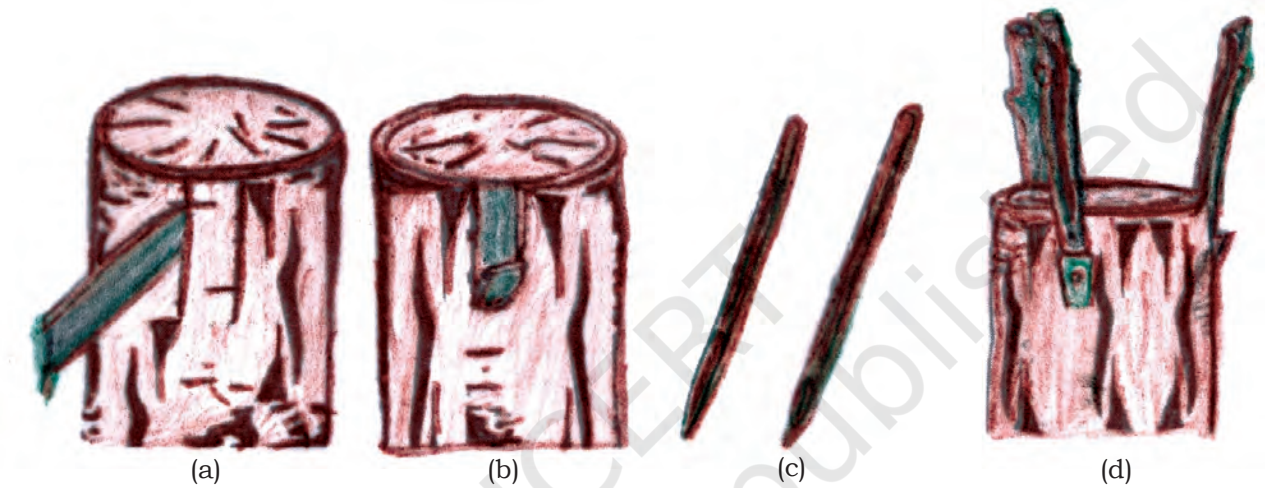
- Head back the rootstock terminally.
- Give a slanting cut of 2.5–5 cm downwards from the top.
- Operate similarly but reversely on the scion.
- On the scion, a slanting cut of the same size is given from the base upward.
- The cuts on both the stock and scion need to be smooth.
- Put the operated portions on each other so that they form a single stem.
- Wrap the union with a polythene tape or a special nursery tape.
- The tape must be removed after the graft has healed, else the growth is restricted around the union, and such plants break due to the force of wind.

Bark grafting

A plant graft made by slitting the bark of the stock and inserting the scion beneath it is called 'bark grafting'. It is commonly used in top working.

Selection of material

- The bark of the rootstock must be in sap-flowing condition.
- The scion must be in dormant condition.
- The scion must be 10–13 cm long and have 3–5 dormant buds.



(a) Remove the bark

(b) Flap of the bark opened to receive scion

(c) Prepared scion

(d) Insert the scion into the rootstock

Fig. 3.15 (a–d): Bark grafting

Procedure

First method

- A vertical cut of 3–5 cm is made in the bark of the stub of the rootstock.
- To prepare wedge shape of the scion, a 3 to 5-cm long cut is made at the end of the scion, followed by another cut on the opposite side of the first cut.
- Slightly lift the bark of the rootstock of the cut portion.
- Insert the wedge-shaped scion into the rootstock and cover it with the bark of the rootstock.
- After grafting, the exposed cut surfaces of the stub and scion are covered with wax.
- Several scions may be used for grafting on a single stock, according to the width of the stub.

Second method

- Two cuts of 5 cm are made on the bark of the stub and the bark is lifted.
- At the base of the scion, a 5-cm long slanting cut is given.
- On the opposite side of the first cut, a slanting cut of 1.5 cm is made so as to form a wedge.
- The operated scion is inserted in the loose bark of the rootstock.
- Care must be taken to have a long cut of the scion towards the wood of stem and wedge at the base.
- After grafting, the exposed portion must be waxed.

Grafting for special purposes

Grafting for special purposes is done for quality improvement and repair. Grafting is done on established plants to improve their quality, e.g., side grafting and top working. It is also done to rejuvenate old or injured trees, for example bridge grafting.

Bridge grafting

This method is used for repairing wounds in trees made by implements, frost, rodents or diseases. In this grafting, the bark of a tree is damaged, resulting into girdling. A completely girdled tree will die. Bridge grafting repairs girdling.

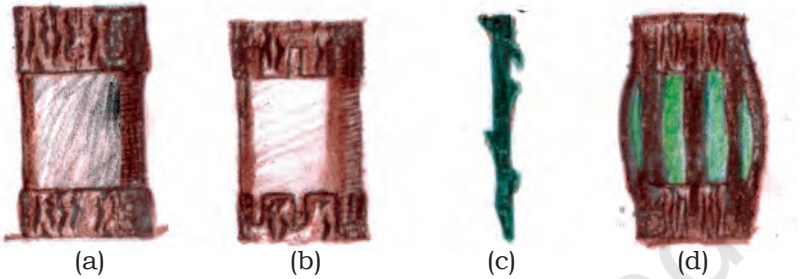
Selection of material

- The rootstock must be in sap-flowing condition.
- The scion comprises one-year old dormant shoots of 6–12 mm in diameter.
- The number of scion sticks depends upon the size of the wound to be repaired.
- The selected scion may be of the same or a compatible plant.

Procedure

- Trim the wounded area by removing the dead bark.
- The cuts are made in the bark at the top and bottom of the wound at 5 to 7.5 cm distance.
- Long slanting cuts are given on the scion at the top, as well as, bottom.

- Both the cuts must be on the same side.
- A sharp wedge of scion is made by an additional short, slanting cut opposite to the first.
- Prepare the required number of scions in the same way.
- Buds on the scion(s) are removed.
- The operated portion of the scion is inserted in each slot of the bark on the rootstock in a way that the wedge remains under the flap of the bark at each end.
- The scions must be put in upright position. The graft unions at top to bottom are waxed.



(a) Remove the bark from the rootstock | (b) Prepared rootstock | (c) Prepared scion | (d) Insert the scion into the prepared rootstock

Fig. 3.16 (a–d): Bridge grafting

Top working

Top working is a method of grafting by which inferior or older plants are rejuvenated into superior or new ones. Top working is, generally, adopted in plants with long leaves. It is suitable for plants like apple, avocado, citrus fruits and vegetable, mango and shrubs or vines. Top working can be done by top grafting or top budding. For top working, cleft, whip, wedge or side grafting methods can be used, according to the suitability of a plant. Top working is, usually, done during spring.

Selection of material

- Prepare the rootstock and scion by any of the above suitable method.
- Usually, 3–5 scaffold branches must be used for rejuvenation in top working.
- In frame working, the secondary scaffold branches are used for grafting.
- The branches to be worked with must be well-distributed around the trunk.
- The branches must be 3–10 cm in thickness.
- Scion sticks of the desired cultivar with 7–10 dormant buds are selected.

Precautions

- Observe the progress of the branches of a top worked tree every 3–5 days.
- Cracks developed in the wax coating must be re-waxed.
- Whitewash the trunk to avoid sunburn.
- The scion must also be protected from the Sun by keeping the graft in shade.
- New shoots developing from scions are tied to stakes to avoid breaking off due to winds.
- New growth on older branches and trunk must be removed from time-to-time.
- The top worked trees must be regularly irrigated and manured.

Practical Exercises

Activity 1

Demonstrate veneer grafting.

Material required: Rootstock and scion of mango plant, grafting knife and grafting tape

Procedure

- Select a one-year old healthy rootstock of a mango plant.
- Select the scion of desired variety having 3–5 buds and about 7.5 cm in length.
- Make 2.5 to 5-cm long shallow cut on the rootstock downwards, and at the base of the first cut, a short inward cut is made. Then, remove the bark and wood.
- Make a cut of the same size on the scion and a very short cut at the base of the scion opposite to the long cut.
- Insert the scion and fix it into the stock.
- Wrap and tie the grafted portion with a polythene tape to keep the union intact.
- After the graft is completed, cut the stock above the union.

Activity 2

Demonstrate cleft grafting.

Material required: Rootstock, scion, grafting knife, grafting tape, etc.

Selection of material

- The scion must be taken from the terminal shoot of current season growth with 3–5 buds.

- The scion shoot is defoliated about two weeks ahead of separation from the mother plant.

Procedure

- Raise the rootstock of the required plant in a poly bag.
- Select 4 to 5-month old suitable rootstock and cut the terminal portion (head back).
- A sharp vertical straight downward cut of 3–5 cm is given at the centre of the stem.
- Two slanting cuts of the same length (3–5 cm), as in the rootstock, are given on the scion shoot at the opposite side towards the base.
- Insert the scion in a way that it matches the cambium layer at least on one side with the stock.
- Tie the grafted portion firmly with a polythene tape.
- After successful union, the terminal buds of the scion begin to sprout.
- Loosen or remove the polythene tape to allow the shoot to grow normally.
- Stake the newly grafted plant.

Check Your Progress

A. Fill in the Blanks

1. Rooted plant on which scion is grafted is called _____.
2. Desirable plant containing dormant buds is called _____.
3. Joining parts of two plants together so as to enable them to function as one plant is known as _____.
4. In _____ grafting, two independent self-sustaining plants are grafted together.
5. In _____ grafting, two cuts are given on both the scion and rootstock.

B. Multiple Choice Questions

1. Veneer grafting is appropriate for_____.
   (a) mango (b) guava
   (c) lemon (d) pomegranate
2. Older and inferior plant can be rejuvenated through _____.
   (a) hardwood cutting (b) approach grafting
   (c) veneer grafting (d) top working

3. Rootstock and scion are required in _____.
   (a) layering (b) grafting
   (c) cutting (d) gootee
4. Epicotyl grafting is also called _____ grafting.
   (a) stone (b) cleft
   (c) wedge (d) whip grafting
5. Top working can be done by _____.
   (a) top grafting (b) stone grafting
   (c) veneer grafting (d) tongue grafting

C. Subjective Questions

1. Describe cleft grafting.
2. How does the union of rootstock and scion take place?
3. What is top working?
4. What is approach grafting?
5. Enlist the characteristics of rootstock.
6. Write the procedure of stone grafting.

D. Match the Columns

A	B
1. Scion detached method	(a) Approach grafting
2. Epicotyl grafting	(b) Raised by seeds
3. Scion attached method	(c) Bark grafting
4. Rootstock	(d) Mango

SESSION 4: PLANT PROPAGATION BY BUDDING

Budding

Budding is the process of inserting a single mature scion bud into the stem (rootstock) in a way that results into a union and continues to grow as a new plant. It is also a type of grafting.

Types of budding

There are many methods or techniques of inserting bud into the rootstock. Some of the common methods are as follows.

T–budding

Since a 'T'-shaped incision is made for bud insertion on the rootstock, it is called T–budding. T–budding is also called 'shield budding' as the bud used for insertion is in the shape of a 'shield'. It is widely used for propagating fruit trees and ornamental plants. In this method, the rootstocks of compatible plants are raised in beds or poly bags.

One-year old rootstock of a healthy and vigorous growth is selected. A T-shaped cut is made at a height of 15–25 cm from the ground level on the rootstock with the help of a sharp knife. Also, a vertical cut, extending up to 2.5–3.75 cm is given on the bark in the internodes. At the top of this vertical cut, another horizontal cut is given in such a way that the two cuts resemble the shape of 'T'. Now, the bark of the cut portion is loosened. The bud from the desirable plant is selected. The shield-shaped bud along with the woody chip is removed from the scion stick. The bud is inserted in the T-shaped cut in the stock. After the insertion of the bud with the help of a budding knife, the bud and stock are firmly wrapped with a polyethylene strip, exposing the bud. The bud sprouts within a month. Examples are rose, apple, pear, peach, apricot, cherry, sweet orange, etc.

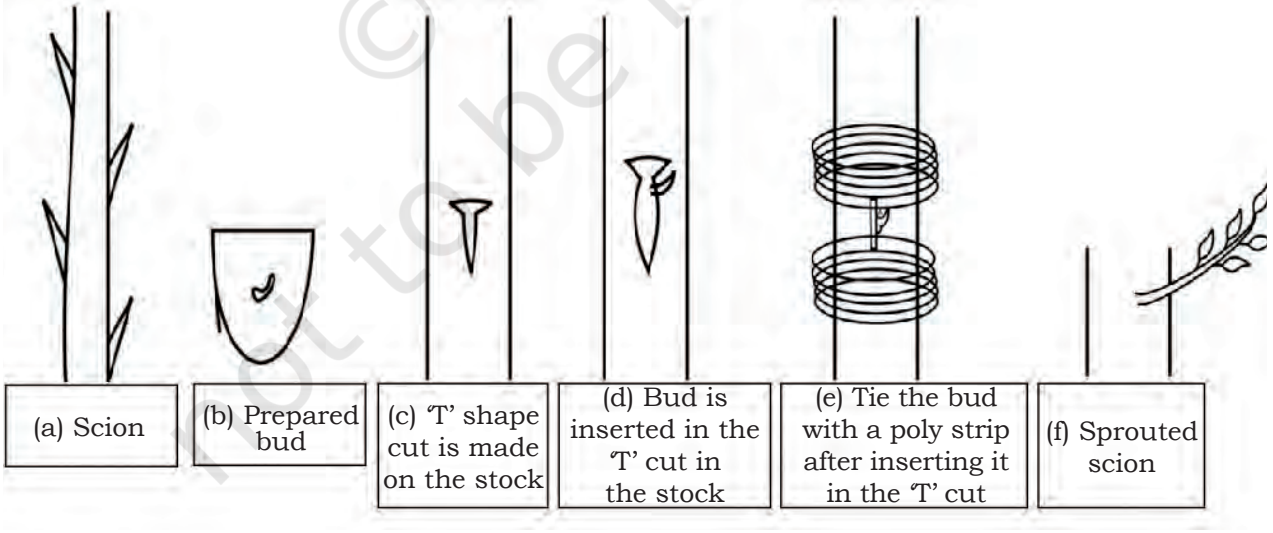


Fig. 3.17 (a–f): T–budding or shield budding

Patch budding

A rectangular patch of bark, measuring 2.4×1.5 cm (length and width), is completely removed from the internodes of the stock plant. A similar patch of bark with a healthy bud is removed from the scion bud stick. This patch is placed on the cut portion of the stock and wrapped with a polyethylene strip, keeping the bud exposed. This type of budding is useful for the propagation of plants having a thick bark. Examples are *amla*, mango, *jamun*, rubber, etc.

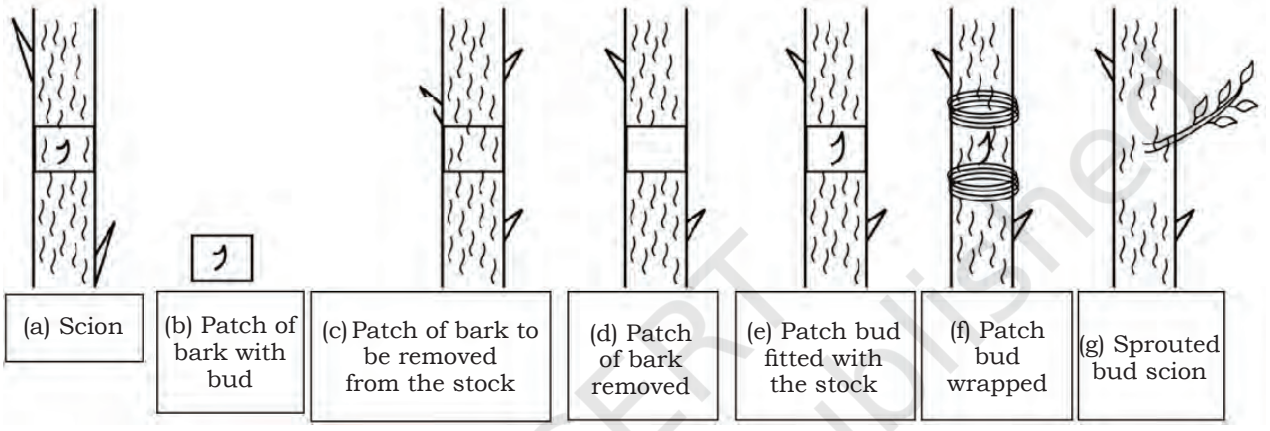


Fig. 3.18 (a–g): Patch budding

Ring budding

In this method, a bark of approximately 3–6 cm wide in ring form is removed from the stock. The same dimension of bark with a healthy bud is removed from the scion bud stick and placed on the stalk. After placing the ring in position, tie it with a polythene strip, keeping the bud exposed, e.g., *ber* and cherry.

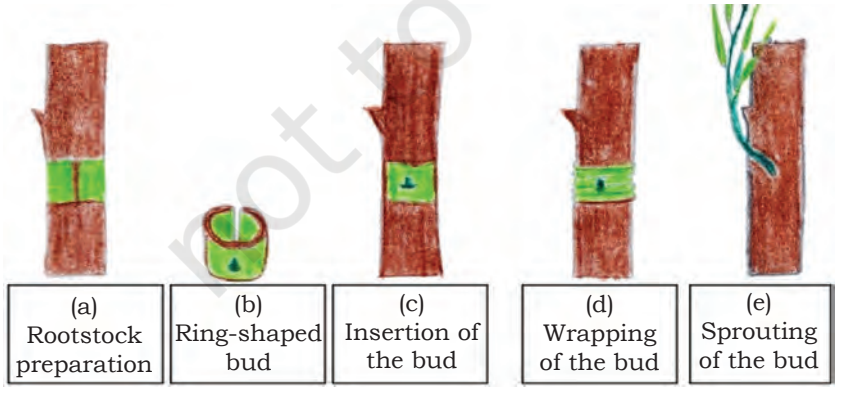


Fig. 3.19 (a–e): Ring budding

Flute budding

This is a slight modification of ring budding. Instead of removing the complete ring, a narrow portion of the bark about 1/8 of its circumference is left on the stock. A similar

portion of the scion is removed along with the bud and is fitted on the cut portion of the stock. The bark of the stock and bud are tied with a polyethylene strip, exposing the growing point e.g., *ber*.

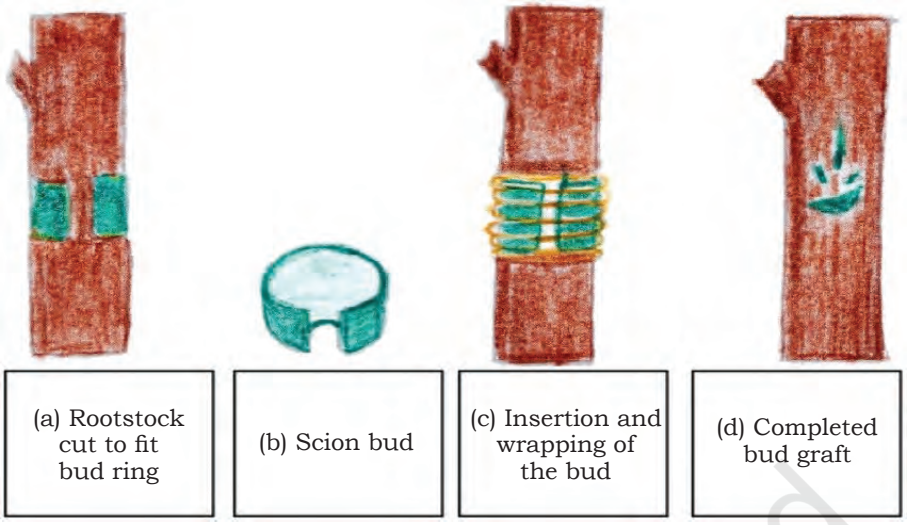


Fig. 3.20 (a–d): Flute budding

Forkert budding

In forkert method, a horizontal cut at the internodes of the selected rootstock is given at a distance of 20–25 cm above the ground level. Two vertical cuts from either ends of the horizontal cut, extending downwards, are taken and a flap of the bark is pulled out, exposing a rectangular woody portion of about 2.5×5 cm on the rootstock. A rectangular piece of bark of the same size along with a matured bud is removed from the bud stick with the help of a budding knife. This piece of bark is then shifted over the exposed

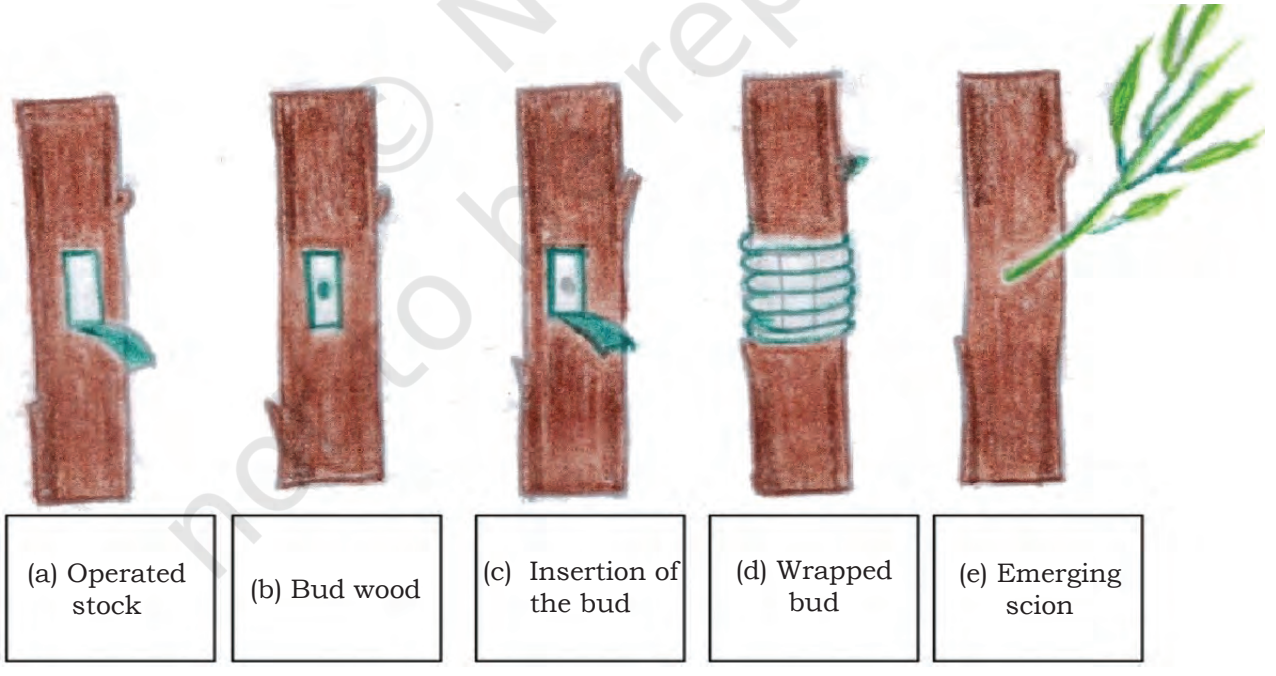


Fig. 3.21 (a–e): Forkert budding

portion on the rootstock. The flap of the bark is loosened and tied to its original position, covering the scion bud fitted inside. After three weeks, the polyethylene strip is removed and the flap of the bark is pulled out for observation. If the bud shows sprouting signs, the flap is removed by giving a horizontal cut on the downside. Then, the polyethylene strip is wrapped, keeping the growing point exposed. The bud sprouts within 3–5 weeks of budding operation. Examples are cashew nut, jackfruit, mango, etc.

Chip budding

This method is followed when the bark is thin and cannot be removed easily. In this method, a piece of thin bark, along with some wood piece, is removed between two nodes of the rootstock, and the same size of chip, which is similar in shape and is collected from the scion, is placed on the rootstock. This is mostly practised in February–March. Fruits like apple, grapes and pear can be propagated through this technique.

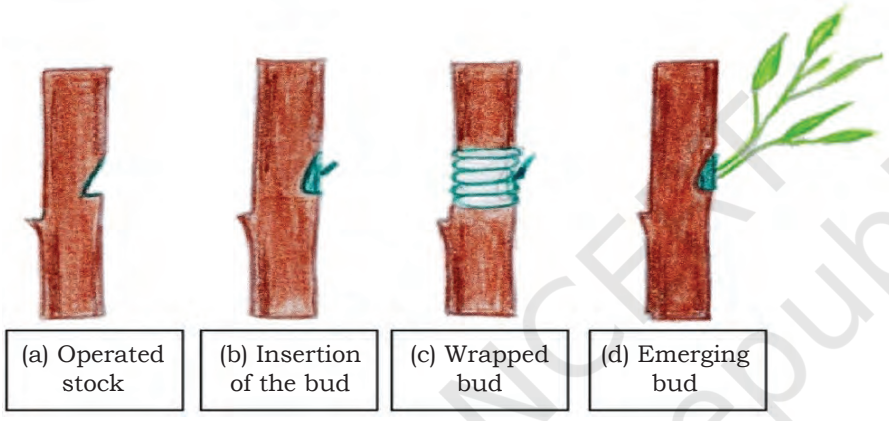


Fig. 3.22 (a–d): Chip budding

Tissue culture

It is a technique for growing plant tissues isolated from the parent plant in an artificial medium and controlled environment over a prolonged period under aseptic conditions. It is used on commercial scale in gerbera, orchid, banana, carnation, anthurium, etc. It is based on the phenomenon of 'totipotency' of a cell, which denotes the capacity of a plant cell to regenerate into a full-fledged plant having different organs.

Callus is produced on explant *in vitro* due to wounding and growth substances, either endogenous or supplied exogenous in the medium. For the collection of explants, plant parts, such as stem, root or leaves

can be used. After disinfestation, they are induced to form 'callus'. Examples are banana, papaya, gerbera, carnation, rose, orchid, etc.

Plant propagation by specialised organs

Specialised organs are modified stems or roots, developing above the ground surface or underground, which may be used for multiplication of plants. In horticulture, bulbous ornamentals include bulbs, corms, tubers, tuberous roots and rhizomes.

Bulb

Bulb is a specialised underground structure having a flat basal stem and surrounded by fleshy scales, e.g., onion, tuberose, amaryllis. Structurally, bulbs are tunicated and non-tunicated. In tunicated bulbs, the outer layer of scales is converted into dry membranous covering, which gives protection, e.g., onion, tuberose, amaryllus, tulip, etc. Non-tunicated bulbs do not possess the enveloping dry covering and are represented by lilium.

Corm

Corm is an underground modified solid or compressed stem oriented vertically in the side having nodes and buds, e.g., gladiolus, crocus, etc.

Tuber

It is an underground storage organ having special swollen modified stem or roots, e.g., root tuber like dahlia, caladium, dioscorea, Jerusalem artichoke, etc; and stem tuber like begonia, potato, etc.

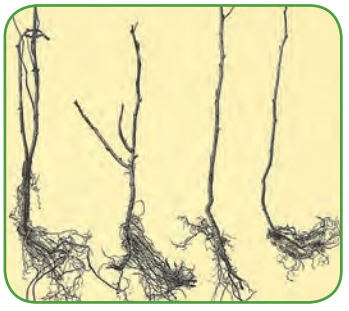
Rhizome

A modified stem of some plant growing horizontally just below the ground surface, e.g., *canna*, ferns, ginger, iris, etc.

Runner

It is a modified stalk, which is creeping in nature, produced in the leaf axil and grows out from the parent plant. It grows horizontally along the ground, where roots are produced at the nodes, which can be used

(a) Runner (chlorophytum)



(b) Sucker

(c) Rhizome (canna)

(d) Corm (gladiolus)

(e) Bulb (tuberose)

(f) Root tuber (dahlia)

Fig. 3.23 (a–f): Plant propagation by specialised organs

to produce new plants, e.g., *doob* grass, strawberry, *chlorophytum,* etc.

Sucker

It is a special shoot arising from the root or stem portion of a plant below the ground level, e.g., chrysanthemum (stem), *Clerodendron splendens* (root suckers), anthurium, etc.

Tuberous root

It refers to a swollen tuberous growth that functions as a storage organ. Examples are *satavar*, dahlia, *chlorophytum*, etc.

Practical Exercise

Activity

Demonstrate T–budding.

Material required: Secateurs, budding knife, rose rootstock, scion and budding tape

Procedure

- Select and prepare a rootstock with the help of secateurs.
- Make a 'T' shape cut with the help of a budding knife.
- Gently open the bark of the rootstock with the help of a bud opener.
- Prepare the bud with the help of a budding knife.
- Insert a shield bud into the 'T' cut.
- Wrap this portion with a polythene strip.

Check Your Progress

A. Fill in the Blanks

1. The art of inserting a scion bud into rootstock is known as _____.
2. T–budding is also known as _____ budding.
3. Lilium is propagated by _____.
4. Dahlia and caladium are propagated by _____.
5. A slight modification of ring budding is known as _____ budding.

B. Multiple Choice Questions

1. Chlorophytum is propagated by _____.
   (a) runners (b) suckers
   (c) rhizomes (d) tuberous roots
2. T-budding is mostly practised in _____.
   (a) cherry (b) lilium
   (c) sweet potato (d) rose
3. In general, the age of a rootstock must be _____ old.
   (a) one-year (b) two years
   (c) three years (d) four years
4. Chip budding is applicable when the bark of a plant is _____.
   (a) thick (b) thin
   (c) rough (d) smooth

5. Multiplication of a plant in controlled environment under aseptic condition is known as _____.

(a) tissue culture (b) protected culture

(c) hydroponic (d) soilless culture

C. Subjective Questions

1. What is budding?
2. Describe the procedure of T-budding

D. Match the Columns

A	B
1. Ring budding	(a) *Doob* grass
2. Sucker	(b) Tulip
3. Tunicated bulb	(c) Lilium
4. Runner	(d) Chrysanthemum
5. Non-tunicated bulb	(e) *Ber*