HORT-243 PRACTICAL MANUAL

EXERCISE NO. 1 22/01/2020

PROPAGATION BY SEED

Propagation of plants may be defined as the controlled reproduction of plants by man to perpetuate selected individual of groups of individual plants which have specific value to him.

The reproduction can be done by two methods –

i. By using seed which is known a 'sexual reproduction'

ii. By use of plant part itself, which is known as a sexual of 'vegetative propagation'.

Sexual method of propagation:

Raising plants by means of seeds is called sexual propagation. Plant to develop from a seed is known as a seedling. Seed is a ripened usually fertilized ovule containing the embryonic plant. Many plants are propagated through the seeds in which other methods of propagation are not useful. In order to secure good germination, the seeds are to be placed in favourable conditions for germination.

Propagation by seed is common in angiosperms, most annuals, biennials and perennials. Some seeds may germinate after passing a 'rest period' to shake off their dormancy. Some need pre germination treatments like scarification while others germinate immediately when placed in proper environment.

Plants propagated by seeds for three basic reasons-

1. For production of commercial crops.
2. In order to develop new variety.
3. For raising of rootstock useful for budding and grafting.

Advantages of sexual propagation:

1. Cheaper and simple way of obtaining of large number of plants.
2. Seedling plants have better root system and provide better anchorage.
3. Seedling trees are hardier and long lived.
4. Plants which are difficult to propagate e.g. papaya, phalsa and mangosteen by vegetative methods can only be propagated by seed.
5. In breeding for evolution of new varieties the hybrids are first raised from the seed and it is, therefore, essential to employ this method in such cases.
6. Sexual propagation may sometimes lead to production of chance seedlings, which are sometimes superior than parent plant.
7. Seedlings are usually hardy and can tolerate wiggeries of adverse climatic conditions in a better way.
8. Seedling plants are comparatively resistant to insect-pest and diseases
9. Seeds can be stored for longer time and can be transported easily to distant places.
10. No special technical skill is required for raising plants through seeds.

11. Most viruses not transmitted through seeds. Hence, it's useful in producing virus free plants.
12. Mangosteen (*Garcinia mangostana*) fruit is developed through parthenogenesis. Seedlings obtained from such fruits are identical to their parent plant and thus propagated commercially through seed.
13. Polyembryony is rule of some of the varieties of citrus and mango. More than one seedling is obtained from a seed. So it's most favourite method of propagation in polyembryonic varieties.
14. The root stocks on which the fruit varieties are budded or grafted are usually obtained by means of sexual propagation.

Disadvantages of sexual propagation:

1. Seedling plants are highly heterozygous in nature. Owing to segregation, seedling trees are not uniform in their growth, yielding capacity and fruit quality as compared to those propagated vegetatively.
2. Seedlings have long juvenile phase in seedlings. Hence, seedlings take more time to bear the first crop.
3. Seeds in most of fruit plants loose viability very fast after extraction from fruit. Thus very low germination rate and percentage.
4. Beneficial effects of rootstock couldn't utilize in sexual reproduction.
5. Some fruit plants *viz.*, banana, pineapple doesn't produce viable seed and only propagated by vegetative mean.
6. Seed borne viruses exist in a number of fruit plants *viz.*, psorosis in citrus and mosaic in peach, cherry and almond. Multiplication of these fruit plants by seed is not feasible.

Seeds vary in shape, sizes ranging from minute (microscopic seed of orchids) to massive (18 kg seeds of double coconut).

Five natural groups of seeds- dust like seeds (begonias), hard coated seeds, fleshy seeds, oily seeds and winged seeds or plumed seeds. form, colour and composition.

Assignment:

1. Collect seed of horticultural plants and note down their observation.
2. Sow seeds of acid lime and observe Polyembryony.

***

EXERCISE NO. 2
PRE-SOWING SEED TREATMENTS FOR BREAKING DOWN SEED DORMNCY

Germination: It refers to the resumption of metabolic activities and growth, of an embryo resulting in the rupture of seed coat and emergence of plantlets.

The treatments which are given just before sowing of seed for getting uniform germination are known as 'pre-sowing seed treatments'.

Pre-requisites for good germination:

1. Seed must be viable
2. It must be non-dormant
3. It must be quiescent
4. It must be placed in favourable conditions for germination

Factors affecting the seed germination:

A) External factors:

1. **Water:** After imbibition of water in seed, it becomes physiologically active and resumes germination. The rate of germination varies with amount of water absorbed by the seed.
2. **Temperature:** The temperature requirement for germination varies from species to species. In general, optimum temperature required for seed germination is 25^0 to 30°C. Higher temperature accelerates the germination up to certain limit while decrease with fall in temperature.
3. **Oxygen:** The demand of oxygen increases rapidly during early phase of seed germination. The requirement of oxygen for germination varies from species to species. For rapid germination, the adequate supply of oxygen is essential.
4. **Light:** in some crop species seed germination is affected by light and some are insensitive to light. Depending upon the response to light, seeds are grouped into
   1. Positively photoblastic seeds: The seeds in which germination is accelerated by presence of light e.g. Strawberry seeds
   2. Negatively photoblastic seeds: The seeds in which germination is retarded by the light e.g. Onion seeds.

B) Internal factors:

1. **Hard seed coat**: The seed coat of some crop species are impermeable to water and oxygen which prevent the germination of seed e.g. Almond, Charoli.
2. **Immature seeds:** When seed having immature embryo, they fail to germinate.
3. **Need for after ripening period:** In some crop species, the seeds require some period for germination after ripening e.g. Bitter gourd, Red pumpkin
4. **High amount of inhibitors:** When the seed contains high amount of germination inhibitors which prevents the germination e.g. ABA

For good germination of seeds, different seed treatments are given to the seeds. The success of seed propagation depends upon the seed germination. The seed germination is hampered due to various types of dormancies.

Seed Dormancy: Failure of seed to germinate even though place in favourable conditions for germination are called as seed dormancy.

Types of seed dormancy:

1. **Dormancy due to rudimentary embryo**: Some plants shed their fruits before the seed has matured enough to germinate, such seeds do not germinate because of immature embryos.
2. **Seed coat dormancy:** The seeds fail to germinate due to presence of hard seed coat which is impermeable to water and air.
3. **Dormancy due to physiologically dormant embryo or physiological dormancy:** It is common in the seeds of certain woody plants. The germination is regulated by inner tissue of seeds such as embryo endosperm.
4. **Double dormancy:** Some seeds have both seed coat dormancy and embryo dormancy, such seeds requires both scarification as well as stratification to overcome the dormancy.
5. **Secondary dormancy:** Failure of seeds to germinate due to exposure to some unfavourable conditions, such as high temperatures or high moisture after stratification.

Pre-sowing seed treatments:

The treatments which are given just before sowing of seed for getting uniform germination are known as pre-sowing seed treatments. Following treatments are used for breaking the seed dormancy.

1. **Scarification:**

a. **Mechanical scarification:** It means breaking or injuring the seed coat to promote the absorption of water and improve the germination. Due to hard coat some seeds are difficult to germinate and therefore rupturing of seed coat by sand paper is essential e.g. Ber, Charoli, Almond, Peach, Plum. Mechanical scarification includes rotating the seeds in drum lined with hard cloth. The extent of germination varies with the nature of seed coat.

b. **Acid scarification:** Soaking of seeds in concentrated sulphuric acid or nitric acid for 15 minutes to 3 hours depending upon the seed coat e.g. Teak and Ber. The acid scarification is used for small seed coats. The acids are washed in running water after seed treatment. Due care to be taken during the handling of sulphuric acid.

2. **Soaking of seeds in hot/cold water:** Seeds are often soaked in water before sowing to modify hard seed coat and to remove germination inhibitors. The hot water treatment for 12 to 24 hours improves the seed germination. Dipping of seeds in

hot water (77 to 100° C) for an hour and again soaked in cold water for 12 to 48 hours improve seed germination e.g. Custard apple, Bael, Wood apple.

3. **Stratification:** The moist chilling temperature treatment is given for hastening uniform germination is known as stratification. It consists of placing the seeds in moist sandy peat or loam soils and holding at a temperature slightly above the freezing temperature (0 to 5°C) for one to six months depending upon the species. During stratification period growth promoters like GA and cytokinin content in the seed increases while the content of growth inhibitors decreases. There are two types

a. **Cold stratification:** Keeping the seeds in moist media at 0° C for three months e.g.Cherry, Plum.

b. **Warm stratification:** The seeds are placed in moist conditions and holding at temperature above 5°C for longer period to inhibit the growth of micro-organisms.

4. **Treatments with chemicals:** Pre- sowing treatments of potassium nitrate @ 0.2 and GA_3 @ 200 to 500 ppm or Thiourea @ 0.5% improves germination of different kinds of seeds. Potassium nitrate used in freshly extracted seeds. Thoiurea used for seeds sown in darkness.

5. **Seed priming:** It refers to procedures followed to overcome dormancy in freshly harvested seeds. Most widely used seed priming procedures are –

   a. **Osmo-conditioning:** seeds are placed in a shallow layer in a container with 20-30 per cent solution of polyethylglycol (PEG). The seeds are then incubated at 15-20 ^{0}C for 7-21 days. Different harmones and fungicides can be added in polyethylglycol solution to protect seeds from pathogens. Afterwards seeds are washed and dried at 25 ^{0}C and stored until further use.

   b. **Infusion:** Hormones, fungicides/insecticides and antidotes are infused into dormant seeds through organic solutions. In this process, seeds are placed in acetone or dichloromethane solution containing chemical to be infused for one to four hours. Afterwards, the solvent is allowed to evaporate and seeds are dried slowly in vacuum desiccators for 1-2 hours. These seeds absorbed the infused chemical directly in to embryo when soaked in water. Treated seeds may be directly sown in their permanent locations.

   c. **Fluid drilling:** In this method, seeds are suspended in a special gel before sowing. Different types of gel are available. However, sodium alginate, guar gum and synthetic clay are most widely used gels.

Assignment:

1. Collect seeds of Ber, Charoli, Custard apple, Bael, Wood apple and give different pre germination treatments.
2. Sow treated seeds of Ber, Charoli, Custard apple, Bael, Wood apple and observe days required to germinate and germination percentage.

EXERCISE NO. 3

PROPAGATION METHODS FOR FRUIT CROPS INCLUDING MICRO-PROPAGATION

Fruit crops are propagated either by sexual or asexual method. When fruit crops propagated by using seed is called as sexual reproduction. However, fruit crops when propagated by using plant part itself are known as asexual or vegetative propagation.

Most of the fruit crops are propagated vegetatively.

Asexual or vegetative method of propagation:

A sexual propagation is reproduction by means of vegetative parts of the plant, such as root, shoots or leaves, buds, etc.

Following are the advantages of asexual method of propagation.

1. As there is no change in the genetic make up of the plant propagated by this method the fruit plants propagated vegetatively are true to type and as a result it is possible to get uniformity in growth yield and quality of fruit, which makes harvesting and marketing easy.
2. Some fruits such as banana, pine apple and some guava being seedless the only way of their propagation is vegetative method.
3. Vegetatively propagated fruit trees come into bearing earlier.
4. Methods like bridge grafting or buttressing can be used for healing of the wounds caused by rodents.
5. By top working the inferior quality fruit trees can be converted into superior quality fruit trees.
6. As a fancy, it is possible to grow two or three varieties on the same plant. e.g. one can get 3 to 4 varieties of roses on the various branches of the stock plants.
7. Certain varieties of fruit plants are susceptible to certain diseases. By budding of grafting them into a resistant rootstock, these varieties can be grown without pest or disease incidence.
8. Hardiness to cold and other unfavourable conditions as drought etc. can be secured e.g. oranges do well on trifoliate stock in areas where frost occurrence is frequent.
9. Trees can be considerably dwarfed by using proper rootstock e.g. the apple trees can be dwarfed by using Malling -IX as the rootstock.

Disadvantages of asexual propagation:

1. The vegetatively propagated plants are generally not so vigorous and long lived as seedlings.
2. No new varieties can be evolved by vegetative propagation.

Methods of asexual propagation:

There are two methods of asexual propagation. These are –

i) Methods based on their own roots (common origin).

ii) Methods based on roots of other plants (separate originm).

These methods can be further subdivided into various specific methods based on particular technique or specific plant part to be utilized for propagation. These methods are given as below:

1) Methods based on plants on own roots:

Parts not detached before rooting- Suckers, Runners, Stolons, Layering.

i) **Parts generally detached before rooting-** Separation (Bulbs, corms) & Division (Rhizomes, crown, offsets, tubers)

A. **Parts always detached before rooting-** Root cutting, Leaf cutting & Stem cuttings (Hard wood, semi hard wood, soft wood)

2) Methods based on roots of other plants

A. Grafting:

a. Scion attached methods-

i. Inarch or simple approach grafting ii. Tongue grafting

iii. Saddle grafting

b. Scion detached methods-

i. Saddle grafting ii. Wedge grafting

iii. Whip grafting iv. Tongue grafting v. Veneer grafting

c. Renovation methods (conservation of superior variety) -

i. Top working ii. Side grafting iii. Crown grafting

d. Rejuvenation or repair methods-Cleft grafting

i. Bridge grafting ii. Buttress grafting

B. Budding:

a. Shield budding b. Patch budding c. Forker budding

d. Ring budding e. Flute budding f. Chip budding

Details of these methods are given below:

1) Methods based on plants on own roots

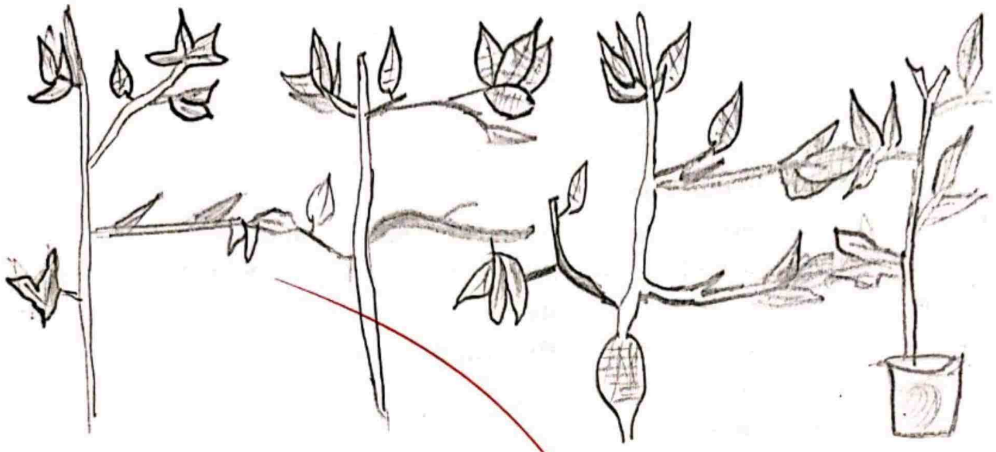
i. **Parts not detached before rooting-** This method includes use of the following plants parts.

a. **Suckers:** These arise from the base of the mother plant. These are cut neatly with attached roots and planted directly in the field e.g. Pineapple.

b. **Runners:** Runners are parts of mother plants each of which is capable of producing roots in contact with soil while connected with the mother plant e.g. strawberry.

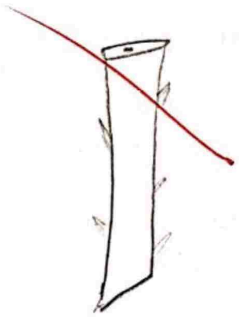
c. **Stolons:** e.g. Hariyali (Bermuda grass).

d. **Layering:** Layering is 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.



Air layering

Stem cuttings :-



1> Hard wood cutting

The diff
layering, mour
(serpentine) lay
Air layering:
Air laye
with sphagnum
to facilitate the
developed the s
Persian lime.
Advantages of
1. This is a rathe
2. Some plants
propagated w
3. The cuttings
alive until ro
parent plant.
4. By using a lar
Disadvantages
1. Slow and cum
2. Interference w
3. Limited numb
4. Requires more
ii) **Parts gene**
Separatio
Division:
iii) **Parts alwa**
Cuttings:
part whic
conditions
Advantage
i. Large
ii. It is in
iii. There
Stem cuttings:
There are furth
a) **Hard woo**
medium si
completely
45⁰ angles
way from t

The different methods of layering are Tip layering, simple layering, Trench layering, mound layering, air layering (marcottage or gooty layer) and compound (serpentine) layering.

Air layering:

Air layering consists in surrounding stems of the previous season's growth with sphagnum moss held in place by sheet of plastic film, usually the stem is girdled to facilitate the production of roots just above the griddle when the root are well developed the stem is separated from the parent plant e.g. Pomegranate, Ficus, Litchi, Persian lime.

Advantages of air layering-

1. This is a rather certain method of inducing rooting
2. Some plants that cannot be satisfactory started from cuttings e.g. guava, can be propagated with relative case from layers.
3. The cuttings which have been detached from the mother plant often not remain alive until roots are formed. But a layer on the other hand is supported by the parent plant.
4. By using a large branch a much larger plant can be obtained in the first instance.

Disadvantages of air layering:

1. Slow and cumbersome process.
2. Interference with cultivation.
3. Limited number of plants can be propagated.
4. Requires more individual attention.

ii) **Parts generally detached before rooting:**

Separation: e.g. bulb of onion or garlic.

Division: e.g. Crown (Pineapple), rhizomes, tubers, etc.

iii) **Parts always detached before rooting:**

Cuttings: Cutting is the process of propagating plant by the use of vegetative part which when detached from mother plant and placed under suitable conditions will develop into complete plants.

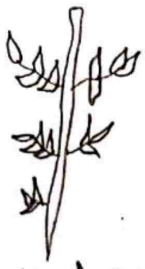
Advantages:

i. Large number of plants can be prepared from a few plants.
ii. It is inexpensive quick, simple and does not require any special technique.
iii. There is no problem of compatibility with rootstocks.

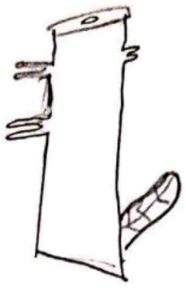
Stem cuttings:

There are further classified as a. Hard wood, b. Soft wood, c. Semi hard wood.

a) **Hard wood cutting:** Hard wood of past seasons growth is used, usually, medium sized wood from 15-25 cm long is used. The leaves are removed completely to avoid loss of moisture from the cuttings. The basal cut is taken 45^0 angles slantwise near the lowest bud and upper cut is taken horizontally way from the top most bud. e.g. Grape, fig, pomegranate, rose.

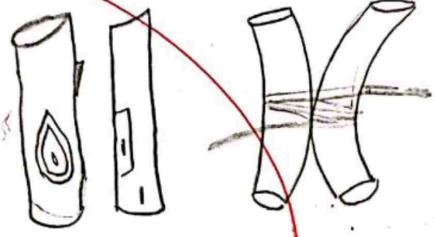


2] Soft Wood cutting.

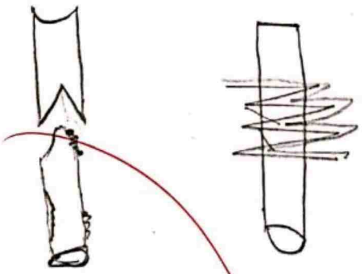


3] Semi hardwooding cutting

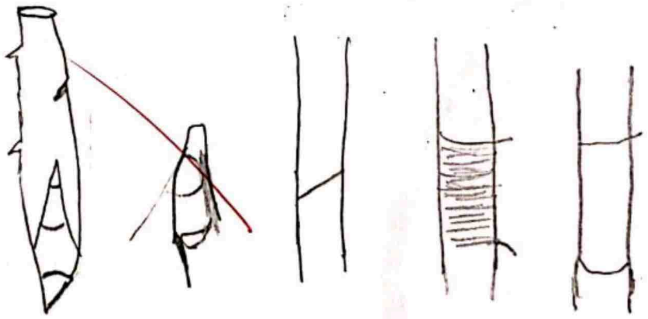
Grafting



Gnarch Grafting



Saddle grafting



Whip grafting

b) **Soft wood cutt**
leaves intact ar
c) **Semi-hardwoo**
cm length of cu
attempted und
growth regulat

Methods based on ro

These methods inv
Scion is that part o
the further tree.

I) Graftage:

Graftage is the p
that union will takes p
normal plant. The diff

I) Scion attached met

a) Simple approach o

Select one year
thickness as that of st
established stock. Th
about proper union.
keep on *Mandav*. Hol
placed. Remove a thi
breadth and 0.2 cm
branches. The cut thu
cut varies with the
pressure face to face
with banana leaf shea
air proof by pasting i
required. The union
scion from the paren
above the graft joint
where it is properly r
prior to its final planti

b) Saddle grafting : e

This method is
inarching. As usual, c

II) Scion detached m

1) Whip grafting : e.g

This method o
inch in diameter. This

b) **Soft wood cutting:** These are easy to root. Cuttings of 7-12 cm length with the leaves intact are used for rooting e.g. coleus, pilea, top cutting of duranta.

c) **Semi-hardwood cutting:** Terminal end of the shoots may be used. About 7-15 cm length of cutting is taken with only the upper leaves, intact and rooting is attempted under condition of high humidity, freedom from chill with the aid of growth regulators. e.g. Aralia, panax, acalypha.

Methods based on roots of other plants:

These methods involve the union of two plants, the stock or rootstock and scion. Scion is that part of mother plant which is used in grafting and budding to develop the further tree.

I) Graftage:

Graftage is the process of inserting a part of plant into another in such a way that union will takes place and two parts joined together would continue growth as normal plant. The different methods of grafting are as follows-

I) Scion attached methods:

a) Simple approach or inarch Grafting: e.g. Mango , Sapota, Guava

Select one year old terminal twig of about 45 to 60 cm length having the same thickness as that of stock from the scion tree of desired variety. Select a healthy well established stock. The stock and scion should be of same thickness, so as to bring about proper union. Carry the selected, potted seedling (stock) to the scion tree and keep on *Mandav*. Hold the scion branch and mark the position where it can tightly be placed. Remove a thin slice of bark along with wood, about 5 cm long and 1 to 2 cm in breadth and 0.2 cm deep with a sharp grafting knife from both stock and scion branches. The cut thus made should absolutely be flat, clean, even and smooth. Size of cut varies with the thickness of shoot used. Bring the cut surfaces together with pressure face to face without leaving any hallow inter space between them. Tie them with banana leaf sheath and then with *Sutali*. The bandage is made water proof and air proof by pasting it with grafting wax or cow dung. Water the rootstock plants as required. The union is completed within two to three months. Cut away gradually scion from the parent tree after union is completed. The original top of stock plant above the graft joint is headed off after about a week. Transfer the graft to a shade where it is properly nourished, hardened and cared for a period of about 3-6 months prior to its final planting.

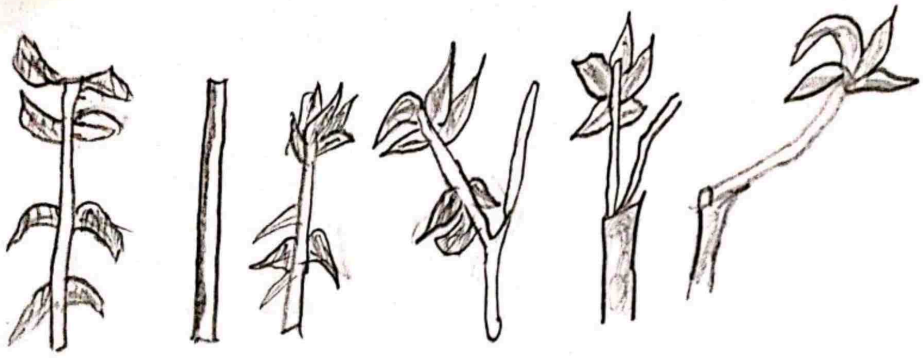
b) Saddle grafting : e.g. Mango

This method is sometime followed in mango though it is not so popular as inarching. As usual, care is taken to select the stock and scion of equal thickness.

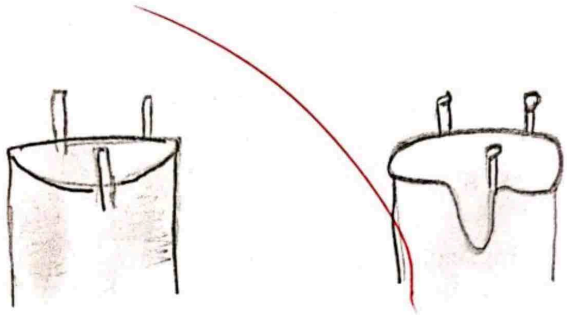
II) Scion detached methods:

1) Whip grafting : e.g. Apple

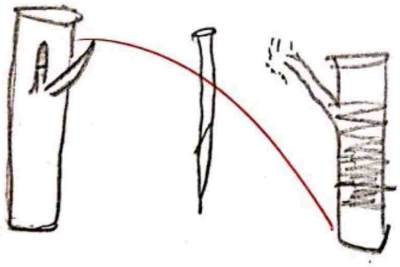
This method of grafting is used to join the plant parts together which are one inch in diameter. This method is not commonly followed.



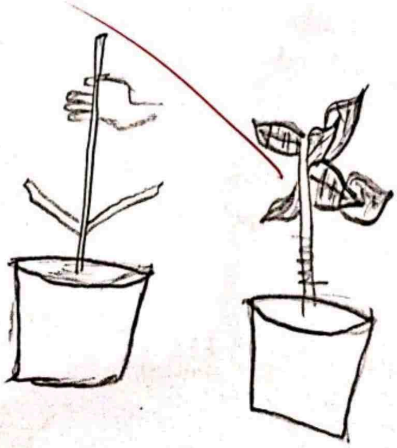
Vinier grafting



Crown grafting



Side grafting



2) Veneer grafting

Veneer graft
scion terminal shoo
Terminal shoots wi
are considered an i

3) Crown grafting:

This method
old and of inferior
with a saw. On the
chisel. The bark is
operation is from A

One year old
the lower end is ma
by cutting the bott
defoliated and inse
been cut back. Fou
thickness of tree. A
immediately closed
This helps to keep
conditions, a big
grafted portion wi
working'.

4) Side grafting:

This is anoth
are used. The scion
separation. Then t
side of stock seedli

5) Buttress graftin

This is a we
trees of sentiment
grown in close pro
tree by inarching m

6) Stone grafting:

Steps in stone

a. Collectio
b. Raising o
c. Selection
d Grafting

a) Collection and s

Country ma
fruits from vigorou

2) Veneer grafting : e.g. Mango

Veneer grafting is commonly practiced in West Bengal. In this method, the scion terminal shoots of 10 to 15 cm length of pencil size thickness are used as scion. Terminal shoots with plumpy and swollen buds that are about to sprout in a fortnight are considered an ideal. Success of this method is ranged between 75 to 80 per cent.

3) Crown grafting: e.g. Mango.

This method is employed for renovating old trees. The tree which is generally old and of inferior variety is cut back to a height of 60 to 90 cm from the ground level with a saw. On the back, longitudinal cuts of 5 to 8 cm are made from the top with chisel. The bark is exposed in strips all round the circular stem. The best time for this operation is from August to October.

One year old terminal shoots with swollen buds 9" to 12" long are selected and the lower end is made into a wedge by using sharp grafting knife. The wedge is made by cutting the bottom of shoot slanting from two opposite sides. These shoots are defoliated and inserted in slits between the bark and wood on old trees which have been cut back. Four to five scions are inserted on the main trunk depending on the thickness of tree. After inserting these shoots all openings in the bark of the stock are immediately closed by mixture of sealing wax, resin and tallow in 1:2:1 proportion. This helps to keep the joint waterproof and air proof. In order maintaining the humid conditions, a big earthen pot with a hole in its bottom is kept inverted over the grafted portion without touching the plant. This method is also known as 'top-working'.

4) Side grafting:

This is another method of grafting in which the terminal shoots of scion plants are used. The scion shoot is first defoliated up to 10 to 12 cm length, a week before its separation. Then these shoots are cut away from the parent tree and grafted to the side of stock seedling of same thickness.

5) Buttress grafting:

This is a well known method used to rejuvenate old or ancient historic trees or trees of sentimental values. In this method, young seedlings of the same age are grown in close proximity of the tree are combined with the disease free trunk of old tree by inarching method.

6) Stone grafting:

Steps in stone grafting:

a. Collection and selection/ mango stones for raising rootstock.
b. Raising of mango seedlings (rootstock).
c. Selection and preparation of scion bud wood.
d Grafting procedure.

a) Collection and selection of mango stones for raising rootstock:

Country mango seedlings are used as a rootstock for mangoes. For this, the fruits from vigorous, disease free and high yielding trees of seedling mangoes are

collected during May-June. The Fresh stones are sown, soon after it is removed from ripe fruit after thorough washing as they lose their viability very quickly.

Before sowing, the stones should be immersed in water and only those stones should be sown which sink in water are considered to be viable. The stones which will float on the surface of water should be rejected. Thoroughly washed stones are immersed in 5% blitox solution for 10 minutes and sown in a bed or polythene bags.

b) Raising of mango seedlings (root stock):

The stones are sown in properly manured raised bed at the spacing of 22 x 45 cm. during May- June at the depth of 5 cm. and beds are irrigated immediately after sowing and subsequent irrigation is given to keep the soil moist. After germination of stones they are transferred in a polythene bag of 15 x 22 cm for grafting.

The stones can also be sown directly in the polythene bag of 15 x 22 cm size. Stones germinate within a period of 1 month. When seedlings attend the age of 8-10 days and produce bronze colour leaves indicate that the seedlings are ready for grafting.

c) Selection and preparation of scion bud wood.

The branch of 3 to 6 month old terminal but wood having 4 to 6 mm thickness and 10-20 cm length is selected from a desired variety which is free from pest and diseases and vigorous in growth. All the leaves are removed from such selected branch keeping 5 to 10 cm petiole attached to it. This branch should be allowed to remain as such on tree at least 8 to 10 days prior to grafting.

i) Dropping of these petioles and swelling of terminal buds is a good judgment of preparation of scion wood.

ii) The usable life of scion bud wood is 2 to 3 days when packed in a wet cloth placed in polythene bag.

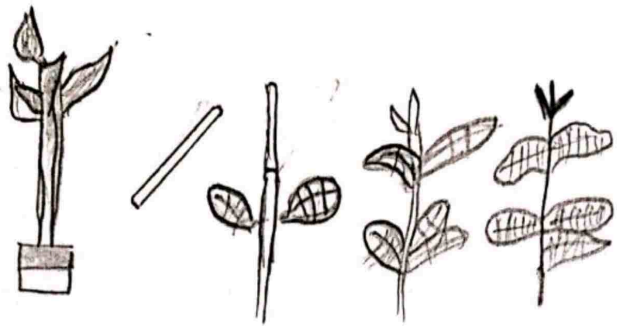
d) Grafting procedure:

Grafting is done by cleft or wedge method. New bronze colour leaves and stem of rootstock is deheaded to half of its length i.e. 7 to 8 cm vertical cut of 3 to 4 cm is given on the stock and 3 to 4 cm slanting cut is given on both the side of scion shoot, so that it will fit properly on the stock causing a good cambium contact of stock and scion. This operated portion is firmly tied with polythene tape of 200-250 gauge of 1.5 cm width.

Within 3 to 4 weeks, bud will sprout and new growth of shoot will start within 1 to 1.5 months. The grafted plants are then kept in a shade before final transfer to field. Presence of stored food material in stones and high meristematic activity help in proper healing and subsequent growth of scion plant. The best season for mango stone grafting is July to August.

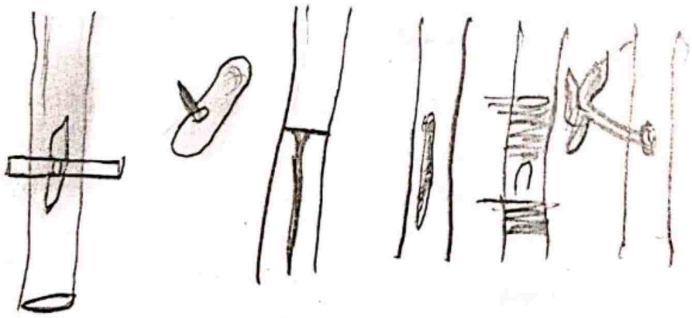
Advantages :

1. Requires less time and less expenditure as compared to other methods of grafting.



Softwood grafting

Budding



Sheild budding

2. Quick metho
3. Success is 70
4. No irrigation
5. Most suitable

Disadvantages:

1. Stone graftin
2. With advan considerably
3. The survival stock to su Secondly hi moisture.

7) Softwood grafti

All the step seedlings, selectio stone grafting exe carried out on a rc for in-situ grafting

Observations to plants, Date of ina

II) Budding

Budding is a fo is inserted in the s

Budding is cla stock is prepared

1. Shield "T"or "I"
4. Flute budding

1. Shield "T" or "I

Select well ma buds on scion pl rootstock having condition to ensu ground level. Mal right angle with a stick. Take out th the flap of bark downwards bene keeping the bud e 5 weeks when the

2. Quick method of mango multiplication.
3. Success is 70 to 80%.
4. No irrigation or watering is required as grafting is carried out in rainy season.
5. Most suitable for coastal region.

Disadvantages:

1. Stone grafting is carried out when age of rootstock is 8 - 10 days only.
2. With advancement in age of stock, percentage of success is reduced considerably.
3. The survival percentage of stone graft is very poor, probably due to inability of stock to support the growing scion after exhaustion of reserves in stones. Secondly high temperature and low humidity may cause excessive loss of moisture.

7) **Softwood grafting:**

All the steps i.e. collection and selection of mango stones raising of rootstock seedlings, selection & preparation of bud wood and grafting procedure are similar to stone grafting except the age of rootstock. In softwood grafting, the operation is carried out on a rootstock of 1 year old seedlings and such method is usually followed for in-situ grafting.

Observations to be recorded on: Name of Plant, Root stock used, Date of raising plants, Date of inarching, Date of detachment of the graft, Time required for grafting.

II) Budding

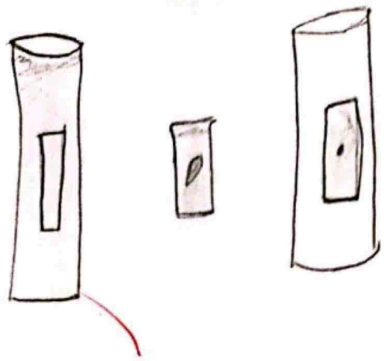
Budding is a form of grafting in which a scion having only one single mature bud is inserted in the stock plant in such a way that proper union will takes place.

Budding is classified in to various kinds according to the manner in which bark of stock is prepared to receive the bud and shape of bud.

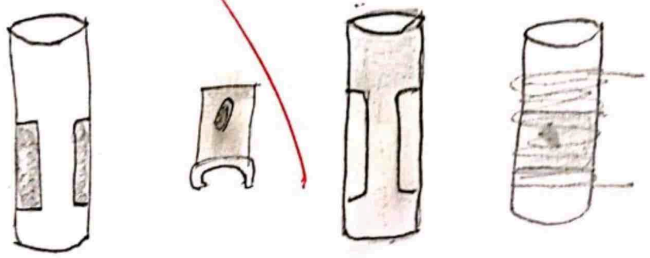
1. Shield "T"or "I" Budding. 2. Patch budding 3. Ring budding
4. Flute budding 5. Chip budding 6. Forkert budding.

1. Shield "T" or "I" Budding : e.g. Pear, Apricot, Peach

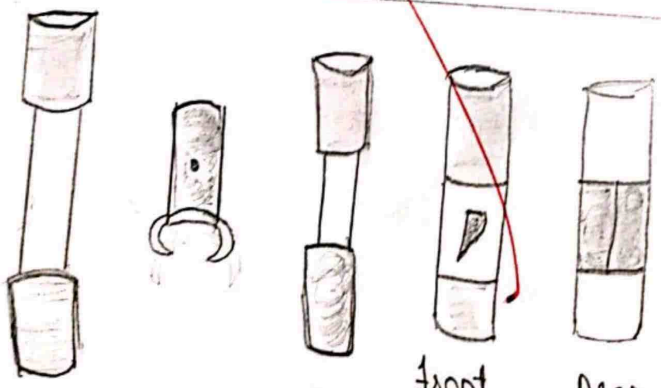
Select well matured pencil size thick branch of past season growth having plumpy buds on scion plant. Select healthy vigorous, erect growing pencil size thickness rootstock having 45 to 60 cm height. Rootstock seedling should be in sap flowing condition to ensure proper union. Perform the budding operation at 25 -30 cm from ground level. Make 2 to 3 cm long vertical cut followed by horizontal cut across top at right angle with a sharp budding knife. Remove a plumpy bud from the selected bud stick. Take out the bud carefully with wood and remove the wood from bud. Loosen the flap of bark on stock plant with the help knife. Insert the bud by pushing it downwards beneath the bark and hold it in position. Tie the bud with polythene strip keeping the bud exposed. Cut off the top portion above the bud union after about 4 to 5 weeks when the union is completed.



2] Patch Budding



3] Flute Budding



2) Patch budding : e.g. Aonla, Jam

Patch budding consists of sm
over a thick rootstock seedling of
from the stem of the rootstock se
removed .from a desired variety
banana fiber is tied to protect th
inserted bud in gradual stages.
method has been adopted on a la

3) Ring budding : e.g. Ber, Peach

This method is useful for sm
This is more or less an extensior
injured and is replaced by ring
plant parts are in sap flowing co

4) Flute budding: e.g. Ber, Cash

This method makes the u
barked trees thinner than 2.5
budded by this method.

MICRO PROPAGATION

Micro propagation (tissue cu
plants, in aseptic condition an
meristem tip, callus, embryos a
to type and disease free entire
plant in aseptic condition in art

Merits of micro propagation:

1. Tissue culture helps in rapi
   year.
2. A new plant can be reg
   conventional methods a sho
3. Large number of plants ca
   uniform growth and proc
   nursery.
4. Plants raised by tissue cultu
5. Tissue culture coupled wit
   fusion of two protoplasts
   cultivars in a short time.
6. Micro propagation facilitat
   long term storage of clonal

2) Patch budding : e.g. Aonla, Jamun, Jackfruit

Patch budding consists of small bud with a patch of bark about 0.5 to 1 cm wide over a thick rootstock seedling of over a year old. At first, a patch of bark is removed from the stem of the rootstock seedling. Then, a patch bud of exactly the same size is removed .from a desired variety and fitted into the exposed area. Polythene film or banana fiber is tied to protect this bud and the stock seedling is deheaded above the inserted bud in gradual stages. This stimulates the sprouting of inserted bud. This method has been adopted on a large scale by nurseryman in India.

3) Ring budding : e.g. Ber, Peach

This method is useful for small stocks of not more than 1.5 to 2.5 cm in diameter. This is more or less an extension of flute method of budding. The stock is completely injured and is replaced by ring containing the bud of scion. Budding is done when plant parts are in sap flowing condition.

4) Flute budding: e.g. Ber, Cashewapple

This method makes the use of ring of tissues adjoining the bud, relatively thick barked trees thinner than 2.5 cm and in the active stage of growth is commonly budded by this method.

MICRO PROPAGATION

Micro propagation (tissue culture or invitro culture) refers to the multiplication of plants, in aseptic condition and in artificial growth medium from plant parts like meristem tip, callus, embryos anthers, axillary buds etc. It is a method by which a true to type and disease free entire plant can be regenerated from a miniature piece of plant in aseptic condition in artificial growing medium rapidly throughout the year.

Merits of micro propagation:

1. Tissue culture helps in rapid multiplication of true to type plants throughout the year.
2. A new plant can be regenerated from a miniature plant part, whereas, in conventional methods a shoot of considerable length is required.
3. Large number of plants can be produced in culture tubes in small space with uniform growth and productivity instead of growing them in large areas in nursery.
4. Plants raised by tissue culture are free from diseases.
5. Tissue culture coupled with somatic hybridization (production of hybrid cells by fusion of two protoplasts with different genetic makeup.)helps in evolving new cultivars in a short time.
6. Micro propagation facilitates long distance transport of propagation materials and long term storage of clonal materials.

7. Tissue culture methods are particularly effective in plants that don't breed true from seeds, seeds are not viable (male sterile) or not available (banana) and in plant where propagation by conventional methods are expensive (Orchids)

Demerits of Micro propagation:

1. The cost involved in setting up and maintenance of a laboratory is very high and may not justify their use in all the horticultural plants ordinarily.
2. Tissue culture techniques require skilled manpower.
3. Slight infection may damage the entire lot of plants.
4. Some genetic modification (mutation) of the plant may develop with some varieties and culture systems, which may alter the quality of the produce.
5. The seedlings grown under artificial condition may not survive when placed under normal environmental condition.

Methods of Micro propagation:

1. Meristem culture:

In meristem culture, the meristem dome and a few leaf primordia are placed into a suitable growing medium. An elongated rooted plantlet is produced after some weeks which is transferred to soil when it has attained a considerable height. A disease free plant can be produced by this method even from an infected plant.

2. Callus culture:

A callus is a mass of undifferentiated parenchymatous cells. When a living plant tissue is placed in an artificial growing medium, with other conditions favourable, callus is formed. The growth of callus varies with the endogenous levels of auxin and cytokinin and can be manipulated by exogenous supply of these growth regulators in the culture medium. The callus growth and its organogenesis or embryogenesis can be classified into three different stages.

- Rapid production of callus after placing the explant in culture medium.
- The callus is transferred to other medium containing growth regulators for the induction of adventitious organs.
- The new plantlet is then exposed gradually to the environmental conditions.

3. Cell culture:

A cell suspension culture refers to cells and or groups of cells dispersed and growing in an aerated liquid culture medium. A piece of soft tissue is placed is a liquid medium and shaken vigorously so as to obtain a suspension of cells. The culture medium includes a complete range of ingredients like inorganic salts, sucrose, vitamins and balanced dose of hormones.

4. Embryo culture:

In embryo culture, the embryo is excised and placed into a culture medium with proper nutrient in aseptic condition. To obtain a quick and optimum growth of the embryo, the culture medium is changed 2 to 3 times. When the embryo has grown

into a plantlet, it is transferred to soil. It is particularly important for the production of interspecific and intergeneric hybrids and to overcome the embryo abortion.

5. **Protoplast culture:**

Protoplast of plant cell can be isolated with the help of cell will degrading enzymes and grown in a suitable culture medium in a controlled condition for regeneration of plantlets. Under suitable conditions the protoplasts develop a cell wall followed by an increase in cell division and differentiation and grow into a new plant. The protoplasts are first cultured in liquid medium at 25 to 28° C with a light intensity of 100 to 500 lux or in dark and after undergoing substantial cell division; they are transferred into solid medium congenial for morphogenesis. Many horticultural crops respond well to protoplast culture.

Invitro: Latin for **"in glass".** Reactions, responses or experiments in an artificial environment in isolation from the whole organism.

In vivo: Latin for **"in living"**. Biological processes that occur within the whole living organism.

Assignment

1. Enlist various rootstocks used while budding and grafting of above listed fruit crops with their distinct features..
2. Draw well labeled diagrammes of various methods of asexual methods of propagation in different fruit crops.
3. Practice propagation methods and mention difficulties occurred along with solution.

***

EXERCISE NO. 4
PROPAGATION METHODS FOR PLANTATION CROPS INCLUDING MICRO-PROPAGATION

Coconut:

Selection of Mother Palms in coconut-

Coconut is a propagated by seed nuts. Seeds should receive utmost attention since the performance of their progeny/palms can be judged only after several years of planting when the yield stabilizes.

Points considered while selecting mother palm for raising coconut seedlings:

1. Selection of mother palm is very important aspect. Mother palm should be selected from the coconut orchard having consistent good yield performances, high proportion of heavy bearers, regular bearer, firmly bearer, free from serious insect, pest and diseases, free from any abnormalities like fruit drop, barren nuts plantation should be of desirable variety true to type.
2. Crown should be spherical or semispherical. Drooping or erect crown should be avoided.
3. Mother palm should be healthy, vigorous, growing, true to type, other characters like copra content, size, etc.
4. Pedigree record should be maintained and the plants showing good performance in respect of yield, quality are selected as mother palm.
5. Usually medium age palm is selected as mother palm about 25-50 years old. Too old or young palm should not be selected as mother palm.
6. Mother palm should have more no. of leaves, about 30-40 fully opened leaves and 12-15 bunches with a high setting of female flowers, with short and stout petiole so that heavy bunch can be rest on that. Long and thin petioles liable to weak and may easily bend or break under pressure.
7. Each leaf axil should have one inflorescence with a large number of spikes and one or two female flowers per spike to ensure high fruit set and stability in yield. The inflorescence stalk should be short, stout and strong and should not have tendency to drop down or buckle.
8. Mother palm should have medium to large sized nuts with more copra content, having good quality copra and more oil content. The palms with irregular shape are not selected.
9. The palm situated at compost pit, water resource, should not be selected though the yield is higher.

Selection of seed nut:

1. Seed nut should be strictly collected from selected mother palm.
2. Seed nut should be completely matured and started drying with palm itself is good. Such matured seed nuts give high germination percentage.

3. The age of seed nut should be 11-12 months.
4. The seed nut should be of medium to large size and selected from middle of the bunch. It should contain thin husk.
5. Mature bunches are lowered down carefully from the palm with rope.
6. Generally, seed nut matures during February-April or May they are very suitable for raising seedlings.
7. Seed nut should contain enough water inside and high kernel content as it is positively correlated with early germination and vigour of seedlings. . Dried seed nut usually do not germinate.
8. The copra content per nut should be around 150g. Nuts from selected mother palms when attain full maturity (11 to 12 months) are harvested along with the bunches.
9. The nuts prior to sowing are stored in shade for 60 days. While storing, nuts are arranged with their stalk ends up on the floor of shed over a layer of about 8 cm dry sand and completely covered with sand till the planting time to prevent drying of nut water.

Selection of seedlings:

Selection of seedlings is an important criteria for obtaining quality planting material. An early germinated nut having a faster rate of leaf production is correlated with early flowering and high nut production.

1. Those seed nuts which germinate within 3 months after sowing are suitable for planting and it is advisable to reject all the sprouts which appear 5 months after sowing.
2. The seedlings should have short stem with good girth at collar.
3. They should have tendency to produce large number of leaves.
4. Leaves should be dark green coloured and there should be early splitting of the leaves.

These are the characteristics of quality seedlings which subsequently result in high-yielding palms.

Areca nut:

Selection of seed nut:

1. Seednuts should be collected from high yielding palm which commence to early bearer.
2. Mother palm which give more than 50% fruit set.
3. Fully ripe nuts are alone selected from mother palms.
4. Don't collect undersized and malformed nuts from mother palms.
5. Heavier seed nuts (above 35 g) within a bunch are alone selected as they give higher germination percentage of germination and produce seedlings of better vigour than lighter seednuts.

Sowing of seednuts:

1. Selected seed nuts are sown immediately after harvest 5 cm apart in sand beds under partial shade with their stalk ends pointing upward.
2. Spread sand over seed nuts just cover them.
3. Beds may be watered daily.
4. Germination commences in about 40 days after sowing.
5. Sprouts can be transplanted in secondary when they are about three month age and might have produces two to three leaves at this stage at the distance of 30x 30 cm with onset of *mansoon*.
6. In secondary nursery during summer, provision of partial has been made.
7. Irrigate during dry months and drain water during *mansoon*.
8. Weeding and mulching should be done periodically.
9. Seed nuts can also be sown in polythene bags (25x15 cm with 150 guage) with 7 parts loam or top soil, 3 parts of FYM and 2 parts of sand.
10. Seedlings of 12-18 months age with 5 or more than five leaves are ready for transplanting.
11. Shorter seedlings with maximum number of leaves are removed with ball of earth for transplanting.

Cashew nut:

Seed: Highly cross pollinated crop, planting of seedling is not recommended. However, seed propagation is used to raise rootstock. Seeds should be collected during March to May. Heavy seed nuts which sink in water are alone are selected and mixed with 2 parts of fine sand for germination. Germination observed after 15-20 days after sowing.

Air layering: Air layers are suited in cyclone prone area as they do not have a tap root which providing less anchorage to soil.

Recently epicotyls grafting and soft wood grafting are recommended for commercial propagation.

Epicotyl grafting:

1. Tender seedling with 15 cm height is selected as root stock.
2. 'V' shape cut made on seedling after beheading it at a height of 4-6 cm from cotyledons connective.
3. The procured scion is collected and a wedge made at the base of it, so as to exactly fit in the cut made at the base, so as to exactly fit in the cut made in the stock plant.
4. The scion is exactly fitted in the stock and tied with polythene strip.
5. The success of epicotyl grafting varies from 50-60 per cent and depends upon high humidity, temperature, freedom from fungal disease, number of rainy days and rate of cambial growth.
6. When the above method is adopted in 30-40 days old seedling, it is known as "Soft wood grafting".

Rubber:

Rubber is propagated by seed and by budding.

Seed: Propagation through seed is useful for raising of seedling as rootstock or to raise polyclonal seedling progenies. Seed normally ripen July-September. Viability is very short (8 weeks), they are sown immediately on raised beds in a single layer touching one another and pressed firmly with surface of the seed just visible above. Regular watering is done. Seed start germinating within 6-10 days. Sprouted seeds may be picked up and planted in the nursery at 30x30 cm to raise seedling stump ot at 60x90 cm or 60x120 cm to raise bud wood nursery or stumped budding. Otherwise, sprouted seeds can be directly planted in the field.

Budding: Scion of particular clone is maintained in bud wood nursery by planting the budded stumps or by budding the clone on the seedlings *in situ* nursery. Budded stump often refers to the budded plant whose scion shoot is cut very close to the budding zone leaving few dormant buds in the scion shoot. On the other hand, if the root stock is cut as a stump and budding is done, usually green budding at four to five months stage, then it is known as stumped budding.

Modified forkert budding: followed during April-May. When the weather is not dry or wet. Two types of budding techniques are practiced. Brown budding is done by using buds taken from bud wood of one year growth on to a stock plant of ten months old. Green budding involves young green bud wood and stock. Bud wood of 6-8weeks old is used on stock seedlings of 2-6 months old.

Poly bag method: Poly bag plants are raised as such plants reach tapping stage quickly. Black polythene bags of 60x30 cm with 400 guage are filled with top soil alone along with 25 g rock phosphate. Green budded stumps are planted in these polybags and scions are allowed to develop 2-3 whorls of leaves.

Tea:

Tea can be propagated by seed and cutting. Seeds collected from fruits of seed berries are soaked in water and only heavy seeds which sink are alone used for sowing in beds. Germination observed within 20-30 days at that stage they are carefully lifted and transplanted in polythene sleeves. They will be ready for planting in nine months.

Cutting:

1. Cuttings for rooting are collected from mother bushes which are well maintained near the nursery area.
2. Such mother bushes are pruned well in advance to induce juvenile shoots.
3. These juvenile shoots are collected in the morning hours and 3 cm long cutting each with a healthy mother leaf and an active axillary bus is prepared.
4. Cuttings from top tender and bottom brown wood should be avoided.

5. These cuttings are planted in polythene sleeves (30 cm x 10 cm x150 guage) at the centre in such a fashion petiole should not touch the soil and then they are watered.
6. Polythene sleeves are covered with polythene sheets over GI wires arches to preserve moisture content.
7. Callusing starts in 4-6 weeks and rooting occurs in 10-12 weeks.
8. When 80% of cuttings have rooted, the tents are opened in stages and the overhead is gradually reduced to harden the plants.

Cleft Grafting: Cleft grafting of single nodal cuttings of two varieties in the nursery and callusing them in the nursery to develop a composite plant has been followed to take advantage of drought tolerant clones as stocks and high yielding and quality clones as scions.

Coffee:

Coffee is propagated by using seed. Healthy and matured fruits of normal size and appearance, three quarters to fully ripe are harvested from specially selected and marked coffee plants for use as seed bearers. Floating seeds are discarded. Sound fruits are pulped, the beans drained and sieved to remove defective beans. The beans are then mixed with sieved wood ash, evenly spread out to a thickness of about 5 cm and allowed to dry to facilitate uniform drying. Excess ash is rubbed off after five days of drying.

Seeds should be sown with flat side facing soil at a distance of 1.5-2.5 cm from one another in rows. Covered with soil of thin layer. Beds covered paddy straw of 5 cm thick. Watering is done regularly and protected from direct sunlight. Seeds germinate in about 45 days. Seedlings transplanted to secondary nursery beds or raising polybags plants (23 cm x 5 cm x 150 guage) in February to March. They are at button or topee stage. Slightly nip the tap roots of seedlings at the time of transplanting. Transplanting done early in the morning or late in afternoon.

Seedling may be manure once in two months with urea (20 g urea in 4.5 liters of water for $1m^2$).

Assignment

1. Observe difference of coconut fruit development.
2. Perform epicotyl/soft wood grafting of cashew nut and record success percentage provided availability of rootstock.
3. Collect beans of coffee from coffee plants. Study test weight, germination percentage and number of days to saleable stage of seedling.
4. Draw well labeled diagrammes of various methods of asexual methods of propagation in different plantation crops.

***