Practical Manual

On

Production Technology for Fruit and Plantation crops

BSAC-405

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Experiment-1

STUDY AND IDENTIFICATION OF DIFFERENT FRUITS CROPS

Objective: Identification of different fruits crops.

Introduction:

A fruit is mature ovary. As the ovules develop into seeds, the ovary begins to ripen and the ovary wall, the pericarp, may become fleshy (as in berries or drupes), or form a hard outer covering (as in nuts). In some multi-seeded fruits, the extent to which the flesh develops is proportional to the number of fertilized ovules.

Based on temperature requirements and response to different climatic conditions, fruit crops have been classified in to three main groups and these are- tropical, subtropical, temperate.

Table-1: Common name, scientific name, family, chromosome number, centre of origin of different tropical fruit plants

Sl. No.	Common Name	Scientific Name	Family	Chromosome number (2n)	Origin
1	Pineaaple	*Ananas comosus*	Bromiliaceae	50	Brazil
2	Banana	*Musa bulbiciana*	Musaceae	22,33,44	Indo- Malayan
3	Guava	*Psidium guajava*	Myrtaceae	22	Tropical America
4	Mango	*Mangifera indica*	Anacardiceae	40	Indo-burma
5	Custard apple	*Annona squamosa*	Annonaceae		West indies
6	Papaya	*Carica papaya*	Caricaceae	18	Tropical America
7	Sapota	*Achras zapota*	Sapotaceae	26	Tropical America
8	Citrus	*Citrus limon (lemon)*	Rutaceae	18	East Asia
		Citrus aurantifolia (lime)	Rutaceae	18	India
		Citrus reticulata (mandarin)	Rutaceae	18	China
		Citrus sinensis (sweet orange)	Rutaceae	18	China
9	Persimmon	*Diospyros kaki*	Ebenaceae	90	China
10	Jack fruit	*Artocarpus heterophylla*	Moraceae	56	India
11	Bread fruit	*Artocarpus altilis*	Moraceae	56	Indo-malayan
12	Rose apple	*Syzygium jambose*	Myrtaceae	28	East Indies
13	Carambola	*Averrhoa carambola*	Oxalidaceae	24	Sri lanka

Common name, scientific name, family, chromosome number, centre of origin of different sub-tropical Fruit plants

Sl. No	Common Name	Scientific Name	Family	Chromosome number (2n)	Origin
1	Litchi	*Litchi chinensis*	Sapindaceae	30	South china
2	Rambutan	*Nephelium lappaceum*	Sapindaceae	22	Malayan region
3	Passion fruit	*Passiflora edulis*	Passifloraceae	18	Brazil
4	Loquat	*Eriobotrya japonica*	Rosaceae	34	Central east china
5	Avocado	*Persia americana*	Lauraceae	24	Central America
6	Mangosteen	*Garcina mangostana*	Guttiferae	56	Malay archipelago

Common name, scientific name, family, chromosome number, centre of origin of different temperate Fruit plants

Sl. No	Common Name	Scientific Name	Family	Chromosome number (2n)	Origin
1	Apple	*Malus domestica*	Rosaceae	34	South west asia
2	Peach	*Prunus Persia*	Rosaceae	16	China
3	Pear	*Pyrus communis*	Rosaceae	34	Western china
4	Plum	*Prunus domestica*	Rosaceae	16,48	China
5	Apricot	*Prunus americana*	Rosaceae	16	North eastern china
6	Cherry	*Prunus avium*	Rosaceae	16	Asia minor
7	Strawberry	*Fragaria ananasa*	Rosaceae	56	France
6	Quince	*Cydonia oblonga*	Rosaceae	34	Caucasus regia
7	Almond	*Prunus amygdelus*	Rosaceae	16	Central Asia
8	Walnut	*Juglans regia*	Juglandaceae	32	Central Asia

Experiment- 2

STUDY AND IDENTIFICATION OF DIFFERENT PLANTATION CROPS

Objective: Identification of different plantation crops

Plantation crops:

The term plantation or estate is used synonymously. Plantation crops are those crops, that are grown in an extensive scale in large contiguous areas and the produce can be utilized only after processing like tea, coffee and rubber.

Plantation crop meaning "A group of commercial crops of perennial nature, cultivated extensively in tropical and subtropical situations which need employment of labour throughout the year and the producers of which are usually consumed after processing."

Common name, scientific name, family, chromosome number, centre of origin of different plantation crops.

Sl. No	Common Name	Scientific Name	Family	Chromosome number (2n)	Origin
1	Coconut	*Cocos nucifera*	Arecaceae	32	Southeast asia
2	Arecanut	*Areca catechu*	Arecaceae	32	Indonesia
3	Tea	*Camellia sinensis*	Theaceae	30	China
4	Coffee	*Coffea spp*	Rubiaceae	22	Ethiopia
5	Rubber	*Hevea brasiliensis*	Euphorbiaceae	36	Brazil
6	Cashew nut	*Anacardium occidentale*	Anacardiaceae	42	Brazil
7	Cocoa	*Theobroma cocoa*	Sterculaceae	20	South America
6	Oil plum	*Elaeis guineensis*	Areceae	32	West Africa

Experiment No: - 3

STUDY ABOUT THE SEED PROPAGATION OF FRUITS AND PLANTATION CROPS

Objective- To study about the seed propagation of fruits and plantation crops.

Introduction-

Propagation of plants involves the formation and development of new individuals, which are used in establishment of new plantings. It is simply the reproduction or multiplication of a plant from a source that is often referred to as a mother plant.

Types of propagation:

Depending upon the size of plant propagating material, plant propagation is divided into two types

1. **Macro-propagation:** - It involves propagation of plants by seeds, cuttings, grafting, budding or any other plant parts which is clearly visible and can be handled easily.
2. **Micro-propagation:** - Micro-propagation is the rapid vegetative propagation of plants under in vitro conditions of high light intensity, controlled temperature and a defined nutrient medium. The technique has been applied to a substantial number of commercial vegetatively propagated plant species. Multiplication of genetically identical copies of a cultivar by asexual reproduction is called clonal propagation. The in- vivo clonal propagation is often difficult, expensive and even unsuccessful. Tissue culture method (in-vitro propagation) offers an alternative way of clonal propagation which is popularly known as micro-propagation. Propagation of some plants by this method is gaining popularity. Eg: Banana, papaya etc.

Depending upon the involvement of pollination and fertilization, plant propagation is divided into two types:

1. Sexual propagation
2. Asexual propagation

Sexual method of propagation:

In this method the plants are raised from seeds. Sexual propagation involves the union of the pollen (male part) with the egg (female part) to produce a seed. The seed is made up of three parts: the outer **seed coat**, which protects the seed; the **endosperm**, which is a food reserve; and the **embryo**, which is the young plant itself. When a seed is mature and put in a favorable environment, it germinates and gives rise to a new plant.

Advantages:

- It is the only possible method of propagation of some fruit plants like papaya, most annuals, biennials and forest trees, which cannot be conveniently and economically raised by vegetative methods.
- Seedlings are comparatively cheap and can more easily raised than vegetative methods. Seed propagated rootstocks are hardy and develop better root system.
- For evolution of new varieties through breeding, the hybrids are raised from seed.
- Viruses don't transmit through seeds, thus mostly the seedlings are free from virus diseases.
- Occurrence of Polyembrony (more than one embryo in seed) in citrus and mango leads to the development of uniform seedlings as in asexual method.

 Rootstocks on which desired scion variety is budded or grafted are raised from seeds.
 Seed propagation sometimes results in the production of „chance seedlings", with superior characters, which may be of great benefit to the horticultural industry.

Disadvantages:
 Seedlings have a long juvenile period and come into bearing later as compared to asexually raised plants.
 Due to segregation of characters, the progeny is not true-to-type.
 It is not economical to handle larger trees, as less number of trees can be accommodated per unit area and the cultural operations are difficult.






Experiment No: - 4

Study about different types of cutting methods in fruit and plantation crops by cutting.

Aim of the Experiment:
To Study about different types of cutting methods in fruit and plantation crops by cutting.

Asexual Method of Propagation:

In this method of propagation the plants are obtained from a vegetative portion of the mother plant like stem, root, leaves, etc. instead of seeds.

Advantages

- In some fruit plants like banana, which do not bear seeds, this is the only method of propagation.
- The plants are generally true-to-type, uniform in growth, yielding capacity and fruit quality.
- Have short juvenile phase, thus come into bearing earlier than seedling plants.
- The advantages of rootstocks can be obtained by budding or grafting susceptible varieties on resistant/ tolerant rootstocks.
- Plants have restricted growth, thus cultural practices and harvesting are easy.

Disadvantages

- New variety cannot be evolved by this method.
- Plants are not so vigorous and long-lived as the seedling trees. Lack of tap root system results in poor anchorage in soil. Consequently, such plants are easily uprooted in storms or other such severe conditions.
- Germplasm conservation requires lot of space and is expensive as compared to storage of seeds.
- It is a special job and requires special training and knowledge on the part of the plant propagator.

Propagation through cutting:
Cutting is a method of asexual propagation in which plant part such as stem, root or leaf is cut from the parent plant and placed under favourable condition to from roots and shoots thus producing a new independent plant. It is of three types

1. Root cutting
2. Leaf cutting
3. Stem cutting

Types of cutting:

Root cutting:
Root cuttings are generally made in early or late winter or early spring, when the roots are well supplied with ample reserve carbohydrates. The plants capable of producing sucker are good for root cutting. For example- apple, pear, guava and bael. Propagation by means of root cutting is simple and can be practiced in species that are difficult to propagate by other methods of cutting. In root cuttings new shoots are developed from adventitious buds mostly at the proximal end.

Leaf Cutting:

It is successful in ornamental plants. Mostly succulent plants having thick and leathery leaves are propagated through leaf cutting. Bryophyllum, Begonia, sansavieria, zade plant, etc. are

propagated through leaf cutting. The leaf is separated from mother plant and planted in suitable medium where it gives out roots and generates a complete plant.

Stem Cutting: A portion of stem is cut from mother plant and planted in rooted media for easy rooting. After successful root formation rooted stem is planted as new plant. According to age and hardiness of stem used for propagation stem cutting are of four types.

1. Hard wood cutting
2. Semi hardwood cutting
3. Softwood cutting
4. Herbaceous cutting

Hardwood cutting:

This type of cutting is taken during November to February before commencement of sprouting. This type of cutting is suitable for Grape, fig, pomegranate, rose, etc. In this method one year old and mature shoots are selected for the purpose of propagation. The selected shoots should be healthy and should not be too vigorously growing. The length of cutting is kept to 10 to 45cm. The cutting must possess at least 2 to 3 buds. The lower cut is made round just below the node and the uppercut given about 1 to 2cm above the upper node in slanting manner. The base part of stem is quick dipped in IBA (Indole-3 butyric acid) solution @ 500- 1500 ppm or commercially available root powder for better rooting in rooting medium.

Semi-hardwood cutting:

This type of cutting is usually practiced during rainy season preventing drying of cutting. Mostly practiced in evergreen plants like mango, guava, jackfruit, lemon, aonla, etc. In this type 4 to 9 month old shoot of semi-hard nature is used for raising new plants. Shoots of 7 to 20cm length are used for propagation. Basal leaves from the shoots are removed. Terminal 2 to 4 leaves are left intact with root.

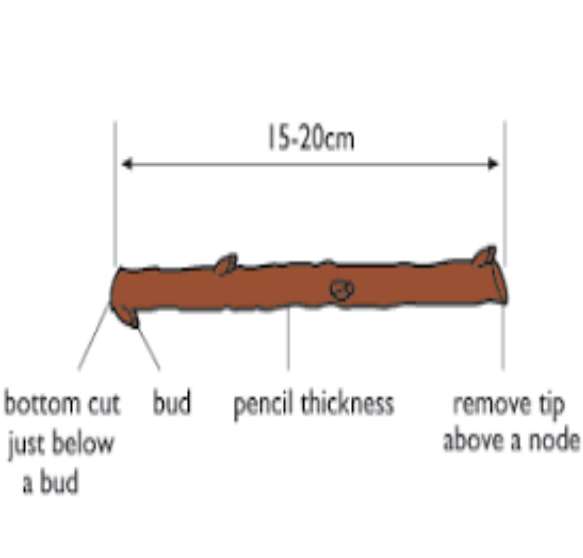
Softwood cutting:

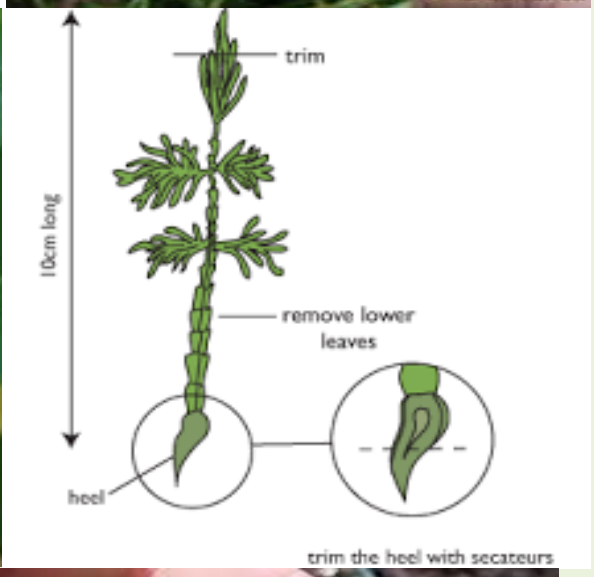
Length of cutting is kept 10 to 15cm and age of shoot is 2 to 3 month. E.g. Apple, peach, guava and ornamental plants. This type of cutting is not practiced for fruits. Humidity requirement is too high; it is not possible to practice in open condition.

Herbaceous cutting:

Mostly ornamental plants are planted through herbaceous cutting. Shoots of 1 to 2 month old are selected for cutting. Duranta, Alternathera, Coleus, creeping jenny, etc. Are propagated by herbaceous cutting.

Different types of cuttings





Experiment no.-5

Objective: Study about different types of Layering of fruits and

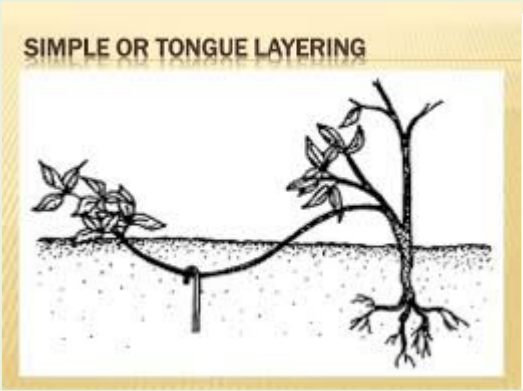
Introduction- It is a technique of propagation in which plant is forced to produce adventitious root while it still remains attached to mother plant. In this process, a single portion of plant constitutes root and shoot system. After emergence of roots the shoot is detached from the mother plant and planted separately.

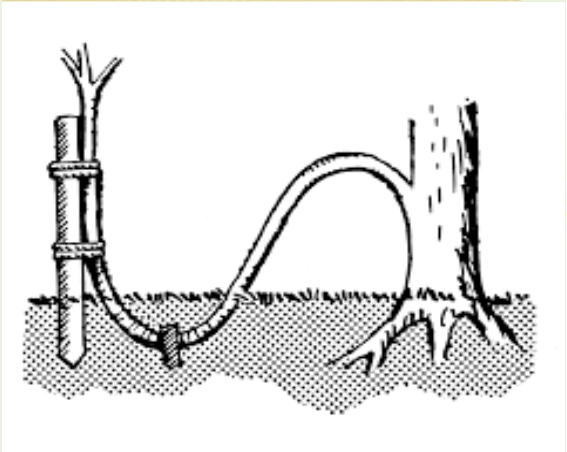
Types of Layering:

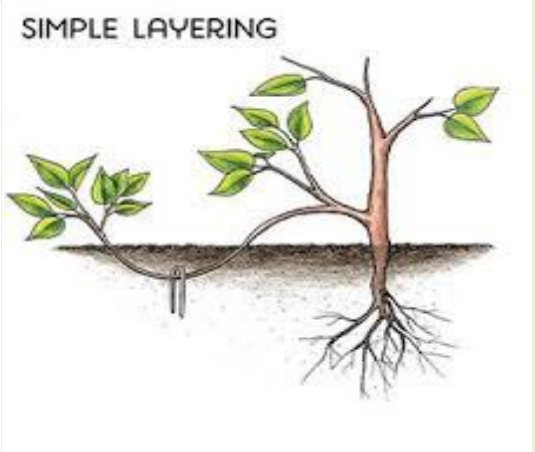
1. **Simple Layering:** In this method one year old shoot is used for layering. The shoot is bent downward in the soil using peg or nail and tied with the help of rope to make it stayed in the position. The ground touching portion is wounded. In about 4 to 5 months, roots emerged out. E.g. Guava, bougainvillea, hibiscus, jasmine, Hazelnut, etc.
2. **Serpentine or Compound Layering:** Covering the branches of the plant at their nodes with soil throughout its length by alternate exposing of intermodal length of shoots is termed as compound layering. It is practiced in plants like Clematis, Smilax, Wisteria and Muscadine Grape. Girdling of intermodal spaces also gives better result. Rooting hormone may be applied.
3. **Mound Layering or Stooling:** This type of layering is practiced in which the branches are very firm and bending is difficult. For mound layering the plant is pruned severely at 2.5cm above ground level before the start of new growth. As a result many shoots emerged out from the base of the plant. When the shoot become little sturdy, it is girdled at the base, rooting hormone is applied if needed and it is covered with soil to a height of about 15 to 20cm. Depending upon case of rooting, roots emerged out in about 3 to 4 month. After rooting the shoots are separated from mother plant and planted separately. It is practiced in Guava, Apple, Pear, Quince, Currant and Gooseberry for clonal propagation.
4. **Trench Layering:** It is useful for the propagation of apple, pear and cherry. In this method, the branch of the plant is bent downward in a horizontal position in a shallow trench. When the shoot develops the base is covered with 5 to 10 cm layer of soil. Covering the shoots with soil gives etiolation effect and helps in rooting. The rooted layers are separated from mother plants and planted in nursery. Trench layering is successful in woody species which are not propagated through stooling.
5. **Tip Layering:** Tip layering is a natural method of reproduction of blackberries and raspberries. In these plants rooting takes place near the tip of current season growth. The shoot tip re-curve upward to produce bend in the stem from which roots develop. The top of the plant is layered by making a hole 2 to 5cm below the soil. The tip roots out produce shoot. The rooted tip is separated from plant along with old shoot. Old shoot act as handle also for handling new rooted tip.
6. **Air Layering:** It is also known as Chinese layering. Pot layering, Marcottage or Gootee. For the purpose of air layering, one year old or previous season shoot of pencil thickness is selected. About 5 to 7 cm away from the base of selected shoot, a girdle of 2.5 to 3.0 cm size, by removing the bark, is prepared. The girdled Portion of the shoot is scrapped using gunny bag or rear side of the blade. This process helps in removal of phloem and ultimately prevents the formation of bark at the girdled portion. The girdled portion is then covered using moist sphagnum moss grass. Covering with moss grass retains better moisture at the point of air layering. The girdled portion is now wrapped using transparent polyethylene tape and both the ends of tape are tied air-tightly. Depending

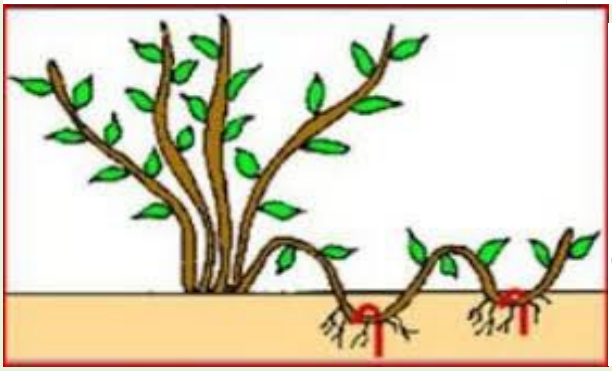
Upon ease of success, rooting appears in about 2-3 months. When root emergence is there and it becomes visible from the transparent wrapped tape, the layered shoot is separated from mother plant giving 2-3 cuts in instalments. The layered plants are planted in nursery under partial shade where frequent watering is provided and high humidity is maintained. Usually, air layering is practiced in the month of July-August. Air layering is practiced in litchi, lime, jackfruit, cashew nut, guava, etc.

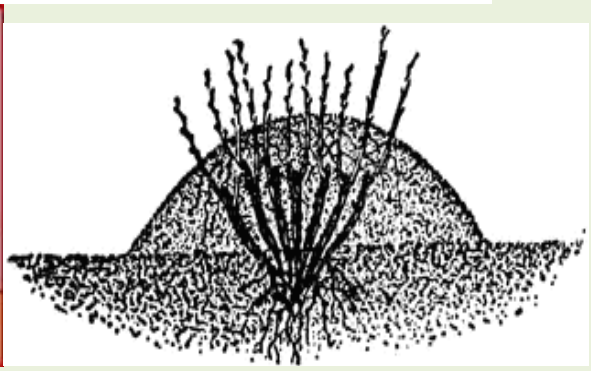
Different types of layering











Experiment no-6

Study about different types of grafting techniques used in propagation of fruits and plantation crops

Aim- To Study about different types of grafting techniques used in propagation of fruits and plantation crops

THEORY: Grafting is a technique of propagation in which scion stick and rootstock is connected in a manner such that they may unite and subsequently grow and develop as a successful plant. Thus, it is clear that grafting utilizes rootstock and scion which ultimately constitutes as plant. The rootstock of 1-2 year age having pencil thickness and desired attributes is selected for grafting. On rootstock, the scion of desirable variety is grafted. Generally, the scion shoot of matching thickness as of rootstock is selected. To get success in union of grafting, the cambium of both the rootstock and scion should unite properly.

Types of grafting:

1. Veneer grafting. This method is used for propagating mango. In this method, a terminal shoot of 10-15 cm length having pencil thickness is used as a scion. The swollen shoot is used as scion. About 10 days before grafting, the scion-shoot is defoliated to facilitate swelling of bud. Shallow, downward and inward cut ensuring V-shape incision in lower portion of rootstock is prepared. Similar matching cut is given in slanting manner is prepared on lower portion of scion. Both rootstock and scion are fastened together using 300 gauge polyethylene tape of 0.5 cm width. During May and September this system is quite successful and good result is obtained. In about 3-4 weeks, union is completed. When scion sprouts completely, the upper portion of rootstock above graft union is removed in 2-3 instalments.

2. Whip grafting. This is very simple technique of grafting. Generally, rootstocks are used and scions of matching thickness are used. Both rootstock and scion are united and tied using polyethylene tape. When union is completed, the polyethylene tape is cut otherwise it restricts the growth at the point of union and such plants break due to wind. It is used for propagating walnut, apple and pear.

3. Tongue grafting. This is modification of whip grafting. In this method, a slanting cut similar to whip grafting is prepared on rootstock and scion. A second cut is also given in reverse direction on previous cut in rootstock and scion. The second cut is started down war at about one third distance from tip and should continue to about 1/2 the length of first cut The stock and scion are inserted which interlock each other. While matching, it is seen that cambium layer of rootstock and scion must match with both cut surfaces. If not so, due to unmatching thickness of rootstock and scion, it must match along one side. After uniting rootstock and scion, both are fastened using polyethylene tape. This method secures contact with six layers of wood, hence the chances of union increase and there is quick healing in grafting. This method is used for propagating apple, pear and walnut.

4. Cleft grafting- It is one of the oldest techniques of top working trees. It is also useful for propagating small trees. Mango, hazelnut, pecan nut, grape etc. are propagated through cleft grafting. In case of top working tree, the use of this technique should be limited to branches of about 2.5 to 10 cm diameter. The plant species which has straight grained wood and splits evenly, are considered ideal for cleft grafting. On the stub to beg rafted, a downward vertical split of 5 to 8 cm length is prepared. The vertical incision is made on two sides of stock. The scion shoot of 8 to 10 cm length and pencil thickness is used. Matching incision is prepared

on lower portion of scion. The scion is inserted in vertical slits of rootstock. The completed graft is thoroughly waxed. In case of grafting small plants, rootstock of one year old and pencil thickness is selected. It is cut back in terminal region. Vertical slits of 2.5 to 3.0 cm length is prepared on rootstock. Scion shoot matching to thickness of rootstock is selected. On lower portion of scion matching incision is given. The scion is inserted in incision made on rootstock. It is wrapped using polythene tape. The sprouting starts after 3-4 weeks. After that the wrapping is removed.

5. Wedge grafting- This method is also used for top working old tree. V-wedge shape incision of about 5 cm length is prepared on the stub of the plant. Shallow and downward matching incision is prepared on lower portion of scion. The scion is inserted in rootstock firmly. The incised portion of rootstock is waxed property.

6. Bridge grafting- This method is practiced in plants in which scion is healthy and some portion of rootstock near collar region is damaged. In this technique, the damaged portion of rootstock is scratched. In healthy portion of rootstock incision is made on top and bottom portion of the stock. The scion portion of suitable length is inserted into incision. It is fixed using nail and then sealed using wax. The sprouted bud from inserted stick should be removed time to time. Slowly and slowly, it grows in diameter and cover the damaged portion. This method is useful in repairing damaged wood in apple, pear, cherry, walnut etc.

7. Epicotyl grafting- It is also known as stone grafting. In this method, the seeds of Mango are sown in nursery bed and covered with 5 cm to 7 cm thick layer of farm yard manure. While sowing seed, preference is given to sand bed which provides ease in uprooting of seedlings required at the time of grafting. In about 15 to 20 days, seeds start germination. The germinated seedlings of 7 to 10 days age when its leaves remain coppery in colour, is used for grafting. The seedling is beheaded at a height of 10 cm from ground level. A vertical slit of 2.5 to 4 cm length is given on beheaded portion of rootstock. Scion shoot of 2 to 3 months age having pencil thickness is used. The leaves of scion is defoliated 10 days before grafting to facilitate sprouting. After uniting rootstock and scion, it is wrapped using polyethylene tap.

8. Soft wood grafting- This is very successful technique of grafting. It is commonly practiced in mango. In this method, the seeds of mango are sown at desired distance in the field during rainy season. To ensure germination, 2 to 3 seeds are sown in each pit. When the plant becomes one year old and attains pencil thickness, it is used for grafting. The grafting is done at permanent site of planting in the field itself. The process of grafting is done during rainy season when new growth appears on rootstock. When new growth leaves start turning yellow from coppery colour grafting is performed. Scion shoot of 10 to 15 cm length, 3 to 5 months of age and pencil thickness girth is selected. At 15 to 20 cm height from ground level, the rootstock is beheaded. A vertical slit of 2.5 to 4.0 cm length is given on rootstock. On scion shoot, similar matching cut is prepared in slanting manner on both the surfaces in lower portion. It is inserted in incision on rootstock and wrapped using polyethylene tape. In about 3 to 4 weeks, sprouting starts and graft starts growing. The grafted plant develops at its own root system and shows better survival in the field.

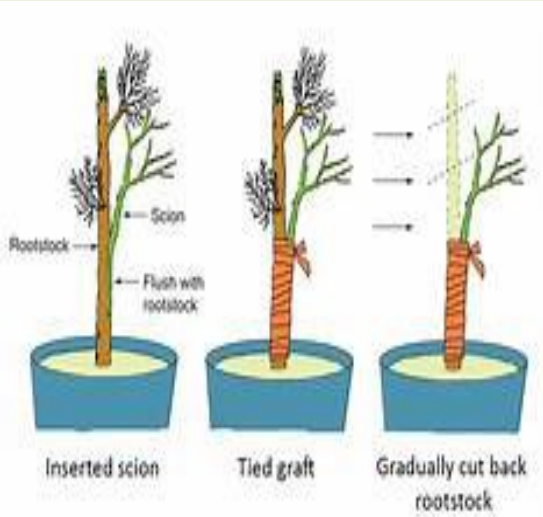
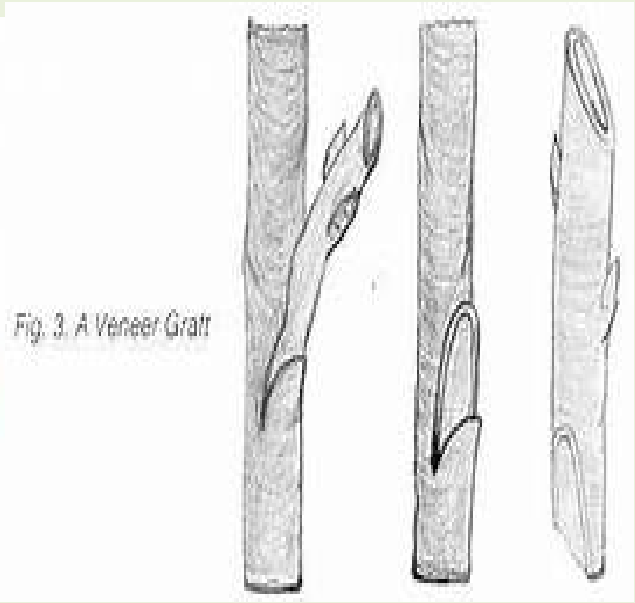


Fig. 3. A Veneer Graft



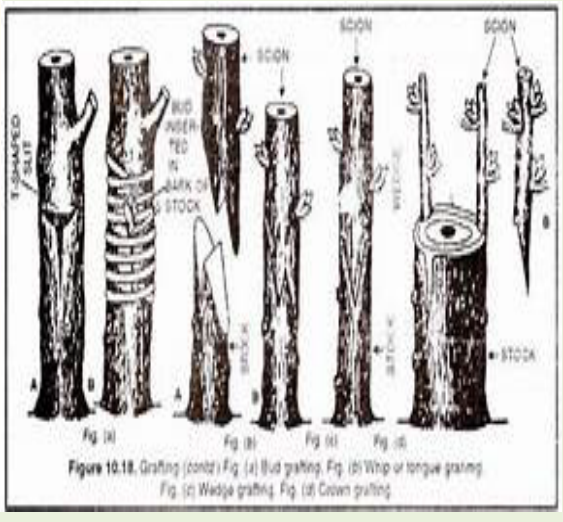


Figure 10.18. Grafting (contd.) Fig. (a) Bud grafting, Fig. (b) Whip or tongue grafting Fig. (c) Wedge grafting, Fig. (d) Crown grafting


Bridge Grafting is similar to Bark Grafting
Mice damage
Seal over grafted area when finished

Experiment no-7

Study about different types of budding techniques used in propagation of fruits and plantation crops

Aim- to Study about different types of budding techniques used in propagation of fruits and plantation crops

Theory- The process of connecting scion, which is a bud, and rootstock in a manner such that they may unite and grow successfully as one plant is termed as budding. Budding is practiced during the period when active sap flow is going on and the plant is growing successfully. During this period, taking out bud from scion stick becomes easy and also due to continued division of cambial cell, the chance of union of bud with rootstock increases. Spring, summer and rainy season, accordingly, March-April, May-June and July-September are considered suitable for budding. Rootstock of 1 to 2 year age having pencil thickness is selected for the purpose of budding.

Types of budding:

1. **Shield budding-** In this method, boat shaped bud of 2.5 to 3.0 cm length is used for budding. If the bud is inserted by making vertical incision on rootstock, it is termed as shield budding. If T-shape incision is made for inserting bud on rootstock, it is termed as T-budding. Sometimes inverted T-shape incision is made to insert bud. It is termed as inverted T-budding. The budding is made at 10 to 25 cm height on rootstock. After inserting bud in incision on rootstock, it is wrapped air-tightly using 300 guage polyethylene tape leaving the bud exposed. This method is very successful for propagating apple, pear, peaches, apricot, cherry, sweet oranges etc. Shield budding is successful in thin skinned type plants.

2. **Patch budding-** This method is very successful for propagating plants having comparatively thick bark. Fruit plants like jackfruit, aonla, mango, jamun, chestnut etc. propagated by patch budding. In this method, square or rectangular shape bud is taken out from scion shoot. Similar size incision is made on rootstock. The bud is placed on rootstock. For placing bud, an incision of 2-3 cm size is prepared. Polyethylene tape is wrapped on bud leaving the sprouting portion exposed. Wrapping prevents desiccation of bud and thus favors sprouting.

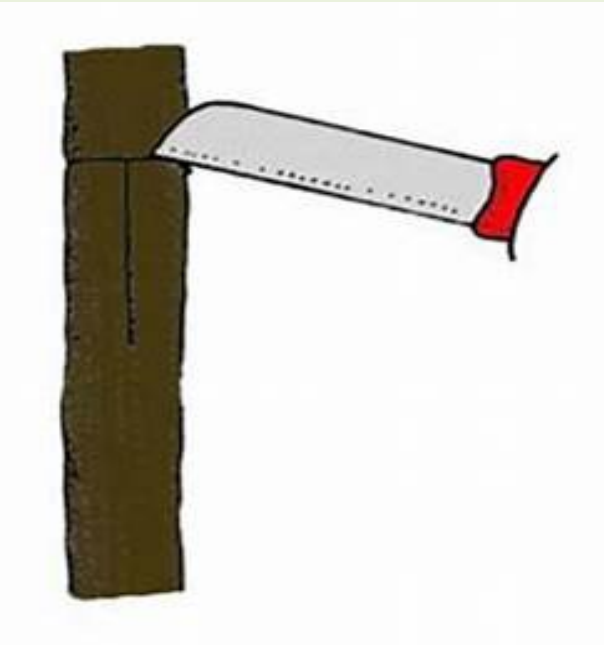
3. **Chip budding-** This method is practiced during the period when there is lack of sap flow and bud does not slip out easily from the bark. Against *Phylloxera* insect, grape varieties are propagated during dormant season using chip budding. During February-March apple, pear and grapes can be propagated through this technique. The bud is taken out from scion shoot along with wood. Similar size incision is made on the rootstock. The bud is placed on rootstock and it is wrapped with polyethylene tape.

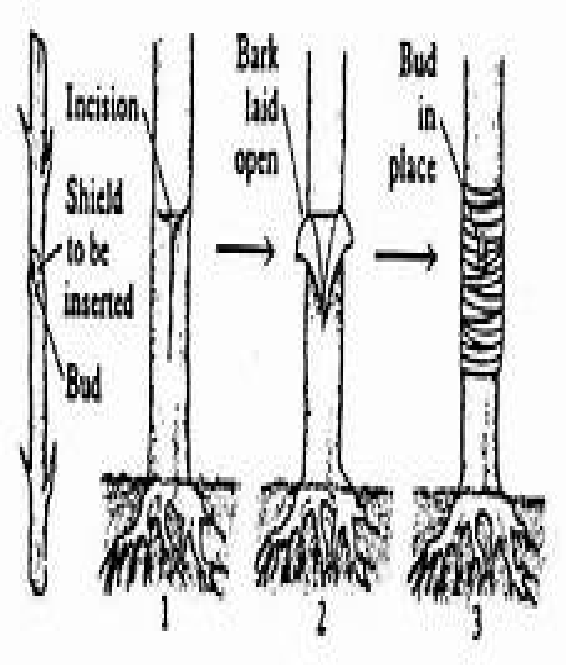
4. **Ring budding-** Ber, peach and mulberry can be propagated using this method. In this method ring shape bark containing a bud and 2.5 to 3.0 cm length is taken out from scion shoot. On terminal end of rootstock, incision similar in size of bud is made. While taking out bud, care is taken that bud is centrally located. The bud wood is made fit on rootstock. For fitting bud, it is downward by rotating it slowly and slowly till it fits tightly. The bud should fit without any vacant space. No wrapping is required in this method.

5. **Modified ring budding-** In this method, instead of taking out complete circular of bark containing bud, the bud wood is taken out from scion shoot by giving a vertical bud wood. On suitable portion of rootstock similar size bark is taken out from the roots. The scion is fitted on rootstock and wrapped using polyethylene tape of 300 guage. This method is successful for propagating guava, ber, walnut and pecan nut. When bud sprouts, the wrapped polyethylene is cut and removed. The portion of rootstock above is removed. In this method of budding, sometimes due to leaching of rain water through rootstock via slit of scion bud, rotting is noticed. To avoid such type of problem the vertical slit of the bud is sealed using paraffin wax.

6. **Forkert budding-** Patch shape bud of 2-3 cm length and 0.5-1.0 cm width is taken from scion shoot. Similar size incision is made on rootstock a height of 10 cm by making incision, the vertical flap of the bark is left intact with lower portion of the rootstock. The patch of bark containing the bud is fitted in the incision made on the rootstock. The bud is covered with flap of the bark and then wrapped using polyethylene tape. After about 15 to 20 days, the union is completed and the wrapped polyethylene is removed. The flap of bark of rootstock is removed. The upper portion of the rootstock is removed in 2-3 instalments. In sub-tropical climate, where excessive temperature prevails, covering the bud through flap of the bark helps in maintaining moisture condition and keeps temperature favorable range. Thus, the chances of union enhance. This method is useful for propagation of mango, jackfruit, cashew nut etc.

7. **Modified forkert budding-** In modified forkert method, the vertical flap of the bark is covered to base portion of the bud only. Thus, the need to remove flap as in forkert method is not required. Rest all is similar to forkert method.

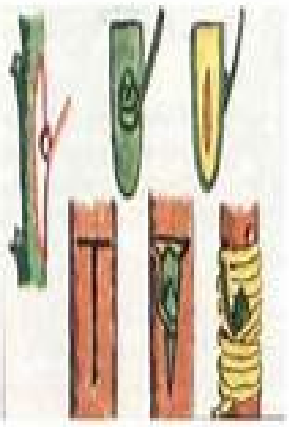





Double working
Scion
Interstock
Root stock

Chip budding:

This budding method can be used when the bark is not slipping. Slice downward into the rootstock at a 45° angle through 1/4" of the wood. Make a second cut about 1 inch long upward from the first cut. Remove a bud and attending chip of bark and wood from the scion, shaped so that it fits the rootstock wound. Fit the bud chip to the stock and wrap the union.



Experiment no-8

Study about seed Scarification and Stratification fruits and plantation crops

Objective: To Study about seed Scarification and Stratification of fruits and plantation crops.

There have several methods to use for breaking seed dormancy of fruits and plantation crops.

These are briefly described hereunder:

1. **Softening seed coat and other seed coverings:** This helps in better absorption of water and gases, which ultimately leads to better germination of the seeds. This can be achieved byscarification.

a) Scarification: Scarification is the process of breaking, scratching, mechanically altering or softening the seed covering to make it permeable to water and gases. Three types of treatments are commonly used as scarification treatments. These include mechanical, chemical and hot watertreatments.

i) Mechanical scarification

- It is simple and effective if suitable equipment isavailable.
- Chipping hard seed coat by rubbing with sand paper, cutting with a file or cracking with a hammer are simple methods useful for small amount of relatively large seed.
- For large scale, mechanical scarifiers are used. Seeds can be tumbled in drums lined with sand paper or in concrete mixers containing coarse sand or gravel. The sand gravel should be of a different size than the seed to facilitate subsequent separation.
- Scarification should not proceed to the point at which the seeds are injured and inner parts of seed are exposed.

i) Acid scarification

ii) The amount of seed treated at any time should be restricted to not more than 10kg to avoid uncontrollable heating.

iii) The containers should be of glass, earthenware or wood, non- metal or plastic. The mixture should be stirred cautiously at intervals during the treatment to produce uniform results.

iv) The time may vary from 10 minutes to 6 hours depending upon the species.

v) With thick-coated seeds that require long periods, the process of scarification may be judged by drawing out samples at intervals and checking the thickness of the seed coat. When it becomes paper thin, the treatment should be terminated immediately.

ii) Hot water scarification

- Drop the seeds into 4-5 times their volume of hot water with temperature ranging from 77 to100ºC.
- The heat source is immediately removed, and the seeds soaked in the gradually cooking water for 12 to 24 hours. Following this the unswollen seeds may be separated from the swollen seeds by suitablescreens.
- The seed should be sown immediately after hot watertreatment.

iii) Warm moist scarification

- The seeds are placed in moist warm medium for many months to soften the seed coat and other seed coverings through microbial activity. This treatment is highly beneficial in seeds having double seeddormancy.
- The hard seeds are planted in summer or early fall when the soil temperature is still higher, that usually facilitatesgermination.
- For instance the stone fruit including cherry, plum ,apricot and peaches) show increased germination if planted early enough in the summer or fall to provide one to two months of warm temperature prior to the onset ofchilling.

Stratification

- The seeds can be sown after fruit drop. The seeds can be sown immediately after stratification in thefield.
- Seeds with a hard endocarp, such as *Prunus* spp. (the stone fruit including cherry, plum, apricot and peaches) show increased germination if planted early in the summer or fall to provide one to two months of warm temperature prior to the onset ofchilling.

i) Outdoor stratification

- If refrigerated storage facilities are not available, outdoor stratification may be done either by storing seeds in open field conditions in deep pits or in raised beds enclosed on wooden frames.

ii) Refrigerated stratification

- An alternative to outdoor field stratification is refrigeratedstratification.
- It is useful for small seed lots or valuable seeds that require specialhandling.
- Dry seeds should be fully imbibed with water prior to refrigerated stratification. Twelve to twenty four hours of soaking at warm temperature may be sufficient for seeds without hard seedcoats.
- After soaking, seeds are usually placed in a convenient size box in alternate layers of well washed sand, peat moss or vermiculite.
- A good medium is a mixture of one part of coarse sand to one part of peat, moistened

and allowed to stand for 24 hours before use. Seeds are placed in alternate layers of sand or medium.

- The usual stratification temperature is 4-7ºC. At higher temperature seeds sprout prematurity and low temperature delays sprouting.








Experiment- 9

STUDY ABOUT THE PREPARATION OF GROWTH REGULATORS AND ITS APPLICATION IN FRUITS AND PLANTATION CROPS

Introduction

A growth regulator is an organic compound synthesized in one part of the plant and translocate to another part which are active at low concentrations in promoting, inhibiting or modifying growth and development of a plant.

- Growth regulators are other than nutrients and vitamins.
- Growth regulators may be synthesized naturally within the plant or artificially in lab.
- If the compound is produced **within the plan**t it is called a **plant hormone or phytohormones** (e.g. Auxins, Gibberellins, Cytokinins, Abscisic acid and Ethylene.). The word "Hormone" is derived from Greek word "hormao" which means to stimulate.
- Artificial growth regulators are prepared in lab (e.g. 2, 4-D, IBA, CCC).
- **Both internal plant hormones and lab created hormones are called plant growth regulators.**
- Substances applied externally also can bring about modifications such as improved rooting of cuttings, increased rate of ripening, easier separation of fruit from the stem, etc. A large number of chemicals tend to increase the yield of certain plants such as corn and sugarcane.
- Hormones usually move within plant from a site of production to site of
- action. PGR are used in different forms like liquid, powder, paste etc.

Class of plant growth regulators

1. Auxins: IAA, NAA
2. Gibberellins: GA_3
3. Ethylene: Ethereal
4. Abscissic acid: Dormins, Phaseic
5. Flowering hormones: Florigin, Anthesin, Vernalin
6. Natural substances: Vitamins, Phytochrome, Tranmatic
7. Synthetic substances: Synthetic Auxins (IBA, 2-4D, 4-CPA), Synthetic Cytokinins
8. Growth inhibitors: AMO-1618, Phosphon-D, Cycosel, B-999.

Different functions of growth regulators in plants

Auxins: Apical dominance, root induction, control fruits drops, regulation of flowering, parthenocarpy, phototropism, geotropism, herbicides, inhibit abscission, sex determination, xylem differentiation, nucleic acid activity.

Gibberellins: It was first isolated from the soil borne fungus *Gibberella fujikuroi*. Stimulate cell division and elongation, stimulate germination of seeds Stimulates bolting/ flowering in response to long days, prevention of genetic dwarfism, increase flower and fruit size, dormancy, induces maleness in dioecious flowers, extending self life

Cytokinins: these are substances composed of hydrophilic group of higher specificity (adenine) and one lipophilic group without specificity. The cytokinins form a group of plant hormones having similar effects as those of GAs. Promotes cell division, cell enlargement and cell differentiation, stimulate bud initiation and root growth, translocation of nutrients, prolong storage life of flowers and vegetables, prevent chlorophyll degradation, morphogenesis, lateral bud development, delay of senescence.

Absecisic acid (ABA): ABA is a naturally occurring sesquiterpene which regulate plant growth and metabolism in various ways and have been detected in nearly all plants. Act as plant stress hormone, dormancy induction of buds and seeds, induces seeds to synthesize storage proteins, dormancy, seed development and germination, stomata closing.

Ethylene: it is the only gaseous hydrocarbon hormone which plays an important role in the ripening of fruits, inhibition of root growth, abscission and senescence of leaf.

Formulation of growth regulators

1. Solution form

The solution form is normally used for rooting of cuttings. There are two main ways of solution application: the dilute solution method and the concentrated solution method.

(a) Dilute solution or prolong dip method

This method depends upon the slow uptake of comparatively dilute water solutions over periods varying from 8-24 hours. In practice, it is convenient to place the cuttings in the solution at the end of the day work and to plant them next morning, some 16 hr later. The cuttings are allowed to stand in the solution with about 2.5 cm of their based immersed. Basal leaves, are first removed. It should be ensured that all cuttings remain in the solution throughout the treatment period. After that, they are rinsed in plain water and planted. Low concentrations is used for easy to root plants while higher concentration for difficult to root species. Prolong dip method is used in combination with hormones, vitamins, sugars and nitrogenous compounds for encouraging adventitious rooting in difficult to root species.

(b) Concentrated solution method or quick dip method

The customary procedure is to momentarily dip the basal 0.5-1.0 cm portion in growth regulator solution and plant the cuttings immediately. Dipping for a short time (say 5 seconds) in a suitably high concentration is probably the most convenient practical way of treating large number of cuttings. For this purpose, generally hormonal concentration varying from 500 to 10,000 ppm is used. After treating the cuttings it should be immediately planted in rooting media. This method can be employed for treating large number of cuttings in small quantity of solution

2. Paste Form

Lanonin is a wool fat, semi solid, greenish yellow in colour, which can be made into liquid form, just by gentle heating. Lanolin paste is particularly convenient for use in air layering though it is widely used for cuttings.

3. Dust form

Certain growth regulators and their commercial formulations are available in powder or talc form e.g. Seradix A and Seradix B, which may directly be used for treating the cuttings dust so that the lower 2.5 cm or less base is covered. If the dust does not adhere to the cutting, the bases of the cuttings may be wetted with water, before dipping into the dust. It is better

to place a suitable quantity of the dust in a shallow dish sufficient only for the task on hand. Once used, the surplus material should not be returned to the stock. After dipping the cuttings into the dust, they should be lightly tapped on the side of the vessel so that the excess powder falls back immediately. They should not be pushed into the medium, as this removes most of the dust, but should be placed in a small trench or dibbled hole.

4. Aerosol form

Growth regulators are used in aerosols form in the greenhouses for rooting in soft wood and herabaceous cuttings. Mother plants may also be sprayed with hormonal solution prior to obtaining the cuttings. The concentration of 25 to 100 ppm may be kept for such sprays which are performed 30 to 40 days prior to taking cuttings from such plants. This process enhance the rooting in cuttings.

Example: For making a solution of 5,000 ppm IBA in 500 ml volumetric flask

Normally growth regulators are expressed in ppm, which means parts per million. This is equivalent to 1mg/litre or 1µg/ml or 1mg/kg. For making the solution following formula may be used.

Ppm = [Plant growth regulator (mg) x 100 or] / Required volume (ml)

Plant growth regulator (mg) = [Required volume (ml) x desired concentration (ppm)] / 1000

Therefore, for making 5,000 ppm in 500 ml water, the following quantity of growth hormone will be required:

Plant growth regulator (mg) = [5000 x5000] / 1000

=2,500 mg IBA

Hence, the 2,500 mg IBA will be first dissoloved in 50 ml ethyl alcohol. Then it will be poured drop by drop in 450 ml of water and mixed by shaking. If some precipitations are seen in the solution, adding few drops of sodium hydroxide or potassium hydroxide will make a clear solution. The solution is ready for use. This solution can be stored in refrigerator (4°C) for 7-10 days until use.

Experiment No 10:

STUDY ABOUT THE PHYSIOLOGICAL DISORDERS IN FRUITS AND PLANTATION CROPS

Objective: To study about the physiological disorders in fruits and plantation crops.

The green plant is a biochemical factory. Certain raw materials are used, either directly or indirectly, in making all important foods, fibers, enzymes, hormones and vitamins. These raw materials meet at least two requirements:

1	Grapes	Hen and chicken disease	Boron deficiency	Spray borax @0.2%
		Millerandage	Boron deficiency	Spray borax @0.2%
		Pink berry formation	High temperature	-
2	Litchi	Fruit cracking	Moisture stress, high temperature, low humidity	Frequent Irrigations, Spray Boric Acid @ 0.2%
3	Pineapple	Fasciation	Due to the genetic factor	-
4	Apple	Bitter pit	Calcium deficiency	Apply a calcium
5				spray to control bitter pit
6		Scald	Storage at high temperature	Proper storage (Ultra Low Oxygen Storage)
7	Rubber	Tapping panel dryness	Excess harvesting of latex.	Proper tapping rest
8	Coconut	Crown chocking	Boron deficiency	Apply in basin Borax @ 50 g/tree twice at monthly.
9	Mango	Black tip	This condition is caused by the fumes (CO_2, SO_2, acetylene, fluorine) of brick kilns located near the mango orchard	Allowing brick klins only at a distance. Spray borax (0.6%) and caustic soda (0.8%) at before flowering,
		Spongy tissue	Un-hydrolised starch due to inactivation of ripening enzyme because of high temperature, convective heat, exposing to sunlight after harvest	Harvesting of fruits at ¾ stage of maturity. Sod culture and mulching
		Alternate bearing	Climatological factors, Infestation of diseases and pests, Age and size of the shoots, *Hormonal balance*	Proper upkeep and maintenance of orchards. Deblossoming. Smudging.
10	Banana	Improper bunch filling	Potassium deficiency	Foliar spray of potassium sulphate

				@1% on leaves.
11	Citrus	Granulation	Due to the high temperature, high RH, age and vigour of trees.	Application of 2, 4-D @ 12 ppm.
12	Guava	Bronzing	Zinc deficiency	Spray zinc sulphate.

Experiment No 11:

STUDY ABOUT THE DIFFERENT DISEASES OF FRUITS AND PLANTATION CROPS

Objective: To study about the different diseases in fruits and plantation crops.

Introduction:
The Horticulture (fruits including nuts, plantation crops) has become a key drivers for economic development in many of the states in the country and it contributes 30.4 per cent to GDP of agriculture, which calls for knowledge and technical backstopping.

Sl no	Name of fruits	Name of diseases
1	**Mangoes**	*a)* Anthracnose: it is caused by *Colletotrichum gloeosporioides* *b)* Sooty mould : it is caused by *Capnodium mangiferae* *c)* Powdery mildew : it is caused by *Oidium mangiferae* *d)* Bacterial canker : it is caused by *Botryosphaeria ribis*
2	**Banana**	a. Panama wilt : Caused by Fusarium oxysporium, F.spcubens. It is the most severe and important disease of banana. b. Leaf spot/Sigatoka: It is a fungal disease, initially presence of light yellowish spots on the leaves under severs condition formation of brown spots and later dies, turning light grey surrounded by a brown ring. c. Banana bunchy top virus (BBTV): Transmitted by aphid vector, Pentalonia nigronervosa.
3	**Guava**	**a. Guava Wilt*:*** it is a fungal disease and pathogens associated with this disease are *Gliocladium roseum, Fusarium oxysporium* f. sp. *psidii, F. solani, Macrophomina phaseolina, Rhizoctonia bataticola, Cephalosporium* sp. First symptom of guava wilt is the appearance of yellow colouration with slight curling of the leaves on terminal branches, after that drying of leaves and twigs from the tip and premature shedding of leaves occurs. **b. Anthracnose** *(Colletotrichum gloeosporioides, Pestalotiopsis psidii):* many small, shallow, water soaked lesions on fruit surface, which later on coalesce. It causes dark brown spots on leaves and affected fruits rot in storage. **c. Styler End Rot** *(Phomopsis psidii and P. destructum):* circular water soaked lesions occur at the styler end.

		4Fruit Canker *(Pestalotia psidii):* small to medium sized raised dark brown cankerous spots on fruit surfaces. Cracking occurs in young infested fruits.
4	**Litchi**	**a) Red Rust (*Cephaleuros parasiticus*):** algal parasite; small lesions of velvety white growth appear on the lower surface, on the upper surface, just opposite the lesions, chlorotic patches occur. **b) Storage Rots (*Geotrichum candidum, Aspergillus restrictus*):** during storage many pathogens have been found on rotting fruits.
5	**Sapota**	a) Leaf spot (*Phaeophleospora indica*) b) Sooty mould (*Capnodium* sp.) c) Flattening of branches (*Botryodiplodia theobromae*)
6	**Jackfruits**	i) **Die Back** (*Botryodiplodia theobromae*): discolouration and blackening of barks in twigs and small branches. Leaf become yellow and drop off. ii) **Fruit Rot** (*Rhizopus artocarpi*): most common disease of jackfruit. Pre mature fall of young fruits due to rotting and may result in heavy loss in yield under high humid condition. iii) **Leaf Spot** (*Colletotrichum gloeosporioides*): reddish or brown spots on leaf surface. iv) **Pink Disease** (*Botryodiplodia salmonicolor*): pinkish powdery coating on the surface of the branches. Leaves become yellow and drop shortly, whole shoot dry. v) **Inflorescences Rot (***Rhizopus artocarpi/Aspergillus niger***):** rotting of male inflorescences.
7	**Pineapple**	**a. Heart rot: *Phytophthora parasitica*** : Heart rot of stem can be controlled by good soil drainage and dipping the planting materials in 0.4% Difolatan before planting. **b. Soft rot, storage rot and fruit rot: C.O.- *Ceratostomella paradoxa* :** paint cut end of stems with in 5 hrs of harvest with 10% solution of Benzoic acid in alcohol.

8	**Pomegranate**	***a. Fruit Spot (Dreschlora rostrata):*** Fruits at all stages are attacked, numerous small black spots appear scattered all over the fruit. Spots may gradually enlarge and coalesce to form brown dark spots. *Control:* Dithane M-45@ 2g/lit of water ***b. Fruit Rot (Aspergillus foetidus, Glomerella cingulata, Phomopsis sp):*** discolouration of fruits of fruits starting from lower parts or sometimes from the sides and fruit show rotting within a week. *Control:* Dithane M-45 @ 2g/lit of water. ***c. Leaf spot (Colletitrichum gloeosporioides, Xanthomonus punicae):*** *Control:* Dithane M-45 @ 0.2% + Paushamycin 500 ppm.
9	**Apple**	2. **Apple Scab** (*Venturia inaequalis*) ✓ Affects leaves and fruits, first appear below leaves and fruit-spurs. Velvety brown to olive green powdery lesions which turn black appear on the leaves. Later develop on fruit results misshapen and knotty fruits. ✓ Spraying of Captafol (300g/100l water), Carbendazim (50g/100l water), Captan 50wp (300g/100l water) at different stages from petal fall to pre-harvest stage. 3. **Fire blight**: (*Erwinia amlylovora*) ✓ First symptom: blossom blight and spread later to shoots. In shoots, wilting of shoot tips which droop without browning. The leaves and shoots gradually turn brown. Fruit-necrotic spots and oozing lesions on the fruit surface. 4. **Powdery mildew** (*Podospaera leucotricha*) ✓ Whitish powdery growth develops on both sides of leaves and twigs. Affected leaves – distorted in shape, smaller, leaf fall. 5. In severe case- fruit drop and russeting spraying of pyrazophos (0.021%), sulphur (0.48%), triforine (0.024%).
10	**Peach**	*i) Peach Leaf Curl (Taphrina deformans)*: *ii) Bacterial Spot (Xanthomonas pruni)*: *iii) Powdery Mildew (Sphaerotheca pannosa)*:
11	**Coconut**	*1.* BASAL STEM-END ROT: *Ganoderma lucidem and Ganoderma applanatum.* *2.* BUD ROT: *Phytophthora palmivora.* *3.* **LEAF BLIGHT** (LB): *Lasiodiplodia theobromae.* *4.* LEAF ROT DISEASE: ***Colletotrichum gloeosporioides****, Exserohilum rostratum and Fusarium spp.*
12	**Tea**	1. Phloem necrosis: Phloem necrosis virus (*Camellia Virus 1*) *2.* Phyllosticta leaf spot: *Phyllosticta erratica, Phyllosticta theae* *3.* Pink disease: *Corticium salmonicolor* *4.* Poria **root rot** and stem **canker:** *Poria hypobrunnea*

Experiment No 12:

STUDY ABOUT THE DIFFERENT PESTS OF FRUITS AND PLANTATION CROPS

Objective: To study about the different pests in fruits and plantation crops.

Introduction:

The Horticulture production has become a key driver for economic development in many of the states in the country and it contributes 30.4 per cent to GDP of agriculture. India is globally, second largest producer of fruits. Country is the largest producer of mango.

Sl no	Name of fruits	Name of pests
1	**Mangoes**	a) Mango hopper (*Amritodus atkinsoni, Idioscopus niveosparsus, I. cleypalis*): b) Mealy bug (*Drosicha mangiferae*): c) Stem borer (*Batocera rufomaculata*) d) Bark eating caterpillar (*Inderbela tetraonis, I. quadrinotata*) e) Leaf cutting weevil (*Deporaus marginatus*) f) Fruit fly (*Bactrocera* sp) g) Fruit borer (*Deanolis albizonalis*) h) Stone weevil (*Cryptorrhynchus mangiferae*)
	Banana	a) Pseudostem borer- b) Rhizome weevil - c) Banana aphid
	Guava	***a)*** *Oriental Fruit Fly (Daucas dorsalis, D. zonatus):* ***b)*** *Bark Eating Caterpillar (Inderbela quadrinotata, I. tetraonis):* ***c)*** *Mealy bug (Drosicha mangiferae)*
	Litchi	**a)** Erinose Mite (*Aceria litchi*): **b)** Bark Eating Caterpillar (*Inderbela tetraonis, I. quadrinotata*): **c)** Fruit Borer & Leaf Eating Caterpillar (*Acrocercops cramerella syn. Conopomorpha cramerella*): ***d)*** Leaf Roller *(Platypelus aprobola)*
	Sapota	a) Stem borer (*Inderbela tetraonis*) b) Bud borer (*Anarsia achrasella*) c) Fruit borer (*Virachola isocrates*) d) Chiku moth (*Nephoteryx eugraphella*) e) Fruit sucking moth (important pest for West Bengal)

	Jackfruits	a) Pink Caterpillar (*Margaronia ceasalis*): b) Stem Borer (*Batocera rufomaculata*) : c) Bark Eating Caterpillar (*Inderbela tetraonis*):
	Pineapple	a) Mealy bug: *Dysmi brevipes* :
	Pomegranate	*a) Pomegranate Butterfly/Anaar Butterfly/Fruit Borer (Virachloa isocrates):* *b) Bark Eating Caterpillar (Inderbela tetraonis, I. quadrinotata):* *c) Stem Borer (Olemecampetus bilobus):*
	Apple	1. **Codling moth** (*Cydia pomonella*) 2. **Apple clearwing moth** (*Synanthedon myopaeformis*)
	Coconut	1. Coconut bug: *Pseudotheraptus wayi.* 2. Coconut leafroller: *Omiodes blackburni* 3. Coconut rhinoceros beetle: *Oryctes rhinoceros.* 4. Coconut scale: *Aspidiotus destructor.* 5. Mealybugs: *Dysmicoccus brevipes. Ferrisia virgata. Planococcus lilacinus.*
	Tea	1. Mealy bug: *Nipaecoccus viridis, N. vastator* 2. Thrips: *Scirtothrips bispinosus, S. dorsalis, Heliothrips haemorrhoidalis,* 3. Aphid: *Toxoptera aurantii*