Your full article (between 500 to 5000 words) - - Do check for grammatical errors or spelling mistakes

Method of propagation in fruit crops

Authors: A.K. Goswami, R.R. Sharma, M. Srivastav, A. Nagaraja and Jai Prakash

Plant propagation

Definition

Plant propagation can also refer to the artificial or natural dispersal of plants. Plant propagation is the process of creating new plants from a variety of sources: seeds, cuttings, bulbs and other plant parts. Basically all plants in this universe multiply themselves both by sexual (seeds) or asexual (vegetative) means. However man has now developed some more techniques for speedy and better multiplication of these plants.

Plant propagation methods

The first and foremost objective of a propagation method should be to produce individuals that are identical to mother or original plant. Thus a successful propagation method is one which transmits all desirable characters of a mother plants to the offspring's.

1. **Sexual Propagation**

   The plants which multiply through seeds as a mode of perpetuation. Example: Most annuals, biennials and many perennial fruit plants; vegetable crops; plantation, aromatic and medicinal plants; ornamental flowering and shade providing shrubs and trees etc. In general the self-pollinated plants which are considered homozygous are propagated by seeds. In sexual method of propagation, the sex organs of flower are involved in process like pollination and fertilization leads to the formation of seeds. Seeds are typically produced from sexual reproduction within a species may have different characteristics from its parents.

   Example: Papaya, *phalsa*, *mangosteen*, rootstocks plants of many fruit crops raised through sexual method of propagation.

2. **Asexual /Vegetative Propagation**

   Propagation by apomictic seedlings: Apomictic seedlings are identical to their mother plants, and similar through the plants raised through other vegetative means, as it has the same genetic makeup as that of the mother plants.

Example: Citrus, mango, apple etc.

Propagation by vegetative structure: It is also called as vegetative propagation as it involves only vegetative parts without any sexual plant parts. The plant parts like leaf, stem, root and other root producing plant organs are used. The new individual propagated through this method is true to type. The commercially important fruit crops are propagated by vegetative method.

Types of Plant propagation

1. Propagation by Cuttings

A cutting is a piece of vegetative tissue (stem, root or leaf) that, when placed under suitable environmental conditions, will regenerate the missing parts and produce a self-sustaining plant. In this method of propagating fruit plants, a plant (generally stem) having at least few buds, when detached from parent plant and placed under favourable conditions develop into a complete plant resembling in all characteristics to the parent from which it was taken. This method is commonly used in plants, which root easily and readily, thus multiplication of plants is very quick and cheap. The fruit plants like *Phalsa*, pomegranate, lemon and grapes etc. are commercially propagated by cuttings. However this method of propagation has certain disadvantages like

- Some plants do not root easily.
- The desired benefit of rootstock of rootstock on a desired variety cannot be exploited.

Cuttings are prepared from vegetative portion of the plants such as stem, root, leaf and are classified according to the plant part used and are described below:

a. Stem Cutting

A stem cutting is any cutting taken from the main shoot of a plant or any side shoot growing from the same plant or stem. Propagation by stem cuttings is the most commonly used method to propagate many woody plants. There are several types of stem cuttings.

i) Hardwood cutting

Hardwood cuttings are prepared during dormant season, usually from one year old immature shoots of previous season's growth. In case of deciduous plants, the cuttings are made after pruning. Generally the cuttings of 15-20 cm length and having 3-5 buds are preferred depending upon species. While preparing the cutting, a straight cut is given at the base of shoot below the node while a slanting cut 1-2 cm above the bud is given at the top, e.g. grape, fig,

pomegranate, mulberry, kiwifruit, olive, quince, hazel nut, chest nut, plum, gooseberry and apple.

ii) Semi Hardwood Cutting

Semi hardwood cuttings are prepared from partial matured, slightly woody shoot. These are succulent and tender in nature and are usually prepared from growing wood of current season's growth. The length of cutting varies from 7-20 cm. The cuttings are prepared by trimming the cutting with straight cut below a node and removing a few lower leaves. However, it is better to retain two to four leaves on the top of cuttings. Treating the cutting with 5000 ppm IBA (an rooting hormone) before planting gives better result. The best time of taking cutting is summer when new shoots is emerged and their wood is partially matured. Ex. Mango, Guava, Jackfruit, Lemon etc.

iii) Soft-Wood Cutting

Softwood cutting is the name given to any cuttings prepared from soft, succulent and non-lignified shoots which have not become hard or woody. Softwood cuttings are taken from new growth of the current season. They are still flexible and non-woody. Softwood cuttings are generally the easiest to root and don't require special handling. e.g. lime and lemon.

b) Leaf bud cutting

There are relatively few plants which can be reproduced by using a leaf or the portions of a leaf to produce a new plant. The reason for this is that leaf cuttings must regenerate both new root and bud tissues. Not many plants have this capacity. Most of the plants propagated by leaf-cuttings are house plants with thick, fleshy leaves. Depending on the plant to be propagated, the leaf cutting may involve the leaf blade only, or a leaf with petiole, or merely portions of a leaf. Leaf-bud cuttings are unlike leaf cuttings in that it contains a portion of stem tissue and most importantly, a bud. The bud, located at the junction of the leaf petiole and the stem, is a pre-formed growing point. Leaf cutting should preferably be prepared during growing season because buds if inter in dormancy may be difficult to force to active stage. Plant material selected for leaf cuttings should be healthy, actively growing and free of insect or disease problems. e.g. Blackberry, lemon, raspberry etc.

c) Root cutting

Root cuttings can be used to propagate a range of herbaceous perennials in late autumn or early winter when the plants are dormant. Root cuttings are used to propagate plants that

naturally produce suckers (new shoots) from their roots. Root cuttings require no special aftercare needed for aerial cuttings as well as large numbers of new plants can be generated from each parent plant and the plants derived from root cuttings are relatively large and vigorous. Another advantage of root cuttings is that plants from root cuttings are free of foliar pests and pathogens that might affect their parents, such as stem and leaf nematodes, e.g. blackberry, fig, cherry, raspberry etc.

2. Propagation by Layering

2.1. Air-layering

In this method one-year-old, healthy and straight shoot is selected and ring of bark measuring about 2.5 to 4.0 cm just below a swollen bud is removed. The cut is then surrounded sphagnum moss or any other material which can retain moisture for long period of time, can be used for this purpose and is wrapped with a polyethylene strip (200–400 gauge). Both ends are tied with fine rope or rubber bands to make it practically air-tight and after 30 to 45 days, roots are formed in the aerial part of the plant. The ideal time is February–March and July–August months for air- layering. Litchi, Lime and sweet lime can be propagated by air layering. Application of root promoting hormones at the time of layering helps to get profuse rooting within a short time. Root promoting substances may be applied as powder or in lanolin or as a solution.

2.2 Trench layering

In this method, it is important to establish a permanent row of plants to be propagated. A branch is laid horizontally in a small trench to encourage the development of several new shoots from it. As these shoots grow, soil is filled around them and roots eventually develop. The mother plants are planted at the base of a trench at an angle of 45^{0} in rows. The long and flexible stems of these plants are pegged down on the ground to form a continuous line of layered plants. The young shoots then arise from these plants are gradually mounded up to a depth of 15-20 cm, e.g., Apple rootstocks (M16 and M25), cherry, plum etc.

2.3 Tip layering

In this method of propagation, bending of a plant stem to the ground and covering the tip with soil so that roots and new shoots may develop. In tip layering, the tip of shoots are bend to the ground and the rooting takes place near the tip of current season's shoot.

2.4 Serpentine/compound layering

Serpentine layering, also known as compound layering is similar to simple layering, except that multiple sections of the stem are buried, resulting in multiple plants from one stem. With this technique, a long, vine-like stem is ideal. It is modification of simple layering in which one year old branch is alternatively covered and exposed along its length. e.g. American grape.

2.5 Mound layering /Stooling

In this method, plants are headed back to 15-20 cm above the ground level during dormant season. The new shoots come out within two months after heading back. These sprouts are then girdled near base and rooting hormone (IBA), made in lanolin paste is applied to the upper portion of cut with moist soil. The rooting of shoots is observed within 25–35 days. The stooling is used in the commercial production of clonal rootstocks of temperate fruit crops like apple, pear etc. and sometimes in guava also.

3. Propagation by Grafting

Grafting is another method of vegetative propagation, where two plant parts are joined together in such a manner that they unite and continue their growth as one plant i.e. the stock and scion are placed in close contact with each other and held together firmly, until they unite to form a composite plant. The different methods of grafting are tongue grafting, cleft grafting, approach grafting, side grafting and veneer grafting etc.

3.1. Tongue grafting (Splice/Whip grafting)

It is the simple and popular propagation method used in apples and widely used in pear. This method is commonly used when the stock and scion are of equal diameter. Each scion sticks should contain at least two to three sets of buds. Identical cuts are made at the top of the rootstock and bottom of the scion, so the two pieces fit together nicely. About one-year-old rootstock is headed back at a height of 23-25 cm from the soil and a diagonal cut is made at the distal end of the rootstock. A similar slanting cut is made on the proximal end of the scion. Try to make this cut with one stroke of the knife. The cut surface of both rootstock and scion are bound together and tied firmly. The scion having 2 to 3 buds is then tightly fitted with the rootstock taking care that the cambium layer of at least one side of the stock and scion unites together. This is then wrapped with polyethylene strip. Tongue grafting is done in March–April in high hills and dry temperate zone while February-March in lower elevation. Many fruit plant are propagated by whip grafting.

3. 2. Cleft grafting

This is also known as wedge grafting. Wedge grafting is a relatively easy method of propagation. In this technique, proper selection and preparation of scion sticks is very important for obtaining higher success of graft. This method is useful in the nursery where the rootstock is quite thicker than scion and tongue grafting cannot be employed successfully. Rootstock up to 8 cm girth is selected for this purpose. The rootstock is cleft grafted after decapitating the stock 45 cm above the ground level. The beheaded rootstock is split to about 5cm deep through the center of stem. After that a hard wooden wedge is inserted to keep open for the subsequent insertion of scion. The scion of 15-20 cm size is taken from a terminal shoot, which is more than three month old and then it is wedge securely (6-7 cm). The cleft of the scion then slipped into the split of the stock. In thicker rootstock more than one scion should be inserted. Care must be exercised to match the cambium layer of the stock and scion along with full length of each component. This technology has overcome seasonal barriers and planting materials could be raised throughout the year either in greenhouse or under open field conditions. Polyethylene cap facilitates early sprouting and ensures good success rate of grafts, e.g. avocado, apple, pear, plum, mango etc.

3.3. Side grafting

In this method of grafting, a three sided rectangular cut about 4.0 x 1.25 cm is given on the rootstock at a height of about 15-18 cm and the bark of the demarcated portion is detached from the rootstock. A similar cut is also given on the base of the scion stick to expose cambium. The scion should be prepared well in advance before the actual grafting. The healthy scion shoots of previously mature flush are selected. The selected scion shoots should have plump terminal buds. After the selection of the scion shoots, remove the leaf blades, leaving petioles attached to the scion. In about 8 to 10 days, the attached petioles drop automatically and terminal buds become swollen. Now the scion stick should be detached from the mother tree and grafted on the stock. The prepared scion is inserted under the bark flap of the rootstock after given a slanting cut so that the exposed cambium of the two components is in close contact with each other. The bark flap of the rootstock is resorted in its position. The graft union is then tied firmly with polythene strip. After the successful completion of the grafting operation, a part of the top of rootstock is removed to encourage growth of the scion. When the scion has shown emergence of leaves, the root stock portion above the graft union should be removed. Side grafting can be carried out successfully from March to October but success during the May and October is rather

low. This method of propagation is commonly used in mango.

3.4. Inarching or Approach grafting

The method of inarching or approach grafting is quite cumbersome and time consuming, but it is still the leading method for commercial propagation of many fruit plants. It is generally used for repairing or replacing damaged root system and hence also called as repair grafting. This method of grafting is termed approach grafting, as the rootstock is approached to the scion, while it is still attached to the mother plant. Selection of parent tree for taking the scion is an important factor for its success. The scion plant should be healthy, vigorous and high yielding. The stock is brought close to the scion. In this method the diameter of rootstock and scion should be approximately the same. A slice of bark along with a thin piece of wood about 6-8 cm long and about 1/3 inch in thickness at height is removed from matching portions of both the stock and the scion. They are then brought together making sure that their cambium layers make contact with each other. These grafts are then tied firmly with polythene strip or any other tying material. The stock and scion plants are watered regularly to hasten the union. The union is complete in about 2 to 3 months. After successful union, stock above and scion below the graft union are looped of gradually. Last week of July or the first week of August is the best period for approach grafting, e.g. mango, sapota, guava, litchi etc.

3.5. Veneer grafting

This method of propagation possesses promise for mass scale commercial propagation. It is simple method of propagation. However, several factors affecting the success like age and diameter of scion, season of grafting and defoliation period of scion stick etc. About one year old rootstock is suitable for this method. However, if the stock attains suitable thickness (about 1to 1.5 cm dia) earlier than a year, can be utilized for rootstock purpose. Better success is obtained with a scion stick of 3-6 months of age with lust green leaves are selected. The scion sticks are pre-defoliated 5-10 days prior the grafting leaving the petiole attached for making the auxiliary and apical buds active. Usually, the terminal and next to terminal shoots are most ideal. For conducting this grafting operation, a downward and inward 25–35 mm long cut is made in the stock at a height of about 15-20 cm. At the base of cut, a small shorter cut is given to intersect the first so asto remove the piece of wood and bark. The scion stick is given a long slanting cut

on one side and a small shortcut on another side to match the cuts with the rootstock. Now the scion is inserted in the stock so that the cambium layers come in contact from the longer side. The graft union is then tied with polyethylene strip. After the scion remains green for more than 10 days, the rootstock should be clipped in stages. When scion growth begins, the shoot of rootstock is removed above the graft union. eg Mango

3.6. Softwood grafting

In this case, as the name indicates grafting is done on newly emerged rootstock of 40-60 day-old. This is easy and simple method and can be practiced throughout the year raised with 60-90% success. This method is useful for in situ grafting while establishing new orchards with already established rootstocks in the field. In this method, remove the leaves of the selected seedling using sharp knife, retaining one or two pairs of bottom leaves. Give a transverse cut on the top soft portion of the seedling. Make a cleft of 3-4 cm deep in the middle of the decapitated stem of the seedling by giving a longitudinal cut. A little wood is removed from the inner side of the cleft at the top. The scion is prepares by mend the cut end of the scion into wedge shape of 3-4cm in length by chopping off the bark and little wood from the two opposite sides, taking care to retain some bark on remaining two sides. Insert the wedge of the scion into the cleft of the seedling taking care that cambium layers of stock and scion come in perfect contact with each other. Secure the joint firmly with polythene strip (30 cm long, 2 cm broad and 150 gauge). Cover the scion with polythene cap (15 cm x 10 cm, 100 gauge) and tie it at the bottom to maintain humidity and to protect the apical bud from drying. The cap should not touch the terminal bud. July and August months with high humidity and moderate temperature are the best for the success of softwood grafting. This is very famous and successful propagation method in cashew nut, mango, sapota etc.

4. Propagation by Budding

Budding is a method of propagation in which only one bud of desired scion is inserted in the rootstock. The ideal condition of budding is when the bark starts slipping both on the stock and scion. It indicates that the cambium is active. Important method of budding are shield or t-budding, patch budding, chip budding, ring budding etc.

4.1. Shield or T- budding

'T' budding or shield budding is a special grafting technique in which the scion piece is reduced to a single bud. A small branch with several buds suitable for T budding on it is often called a

bud stick. Successful T budding requires that the scion material have fully-formed, mature, dormant buds, and that the rootstock be in a condition of active growth such that the bark is slipping indicating the vascular cambium is actively growing, and the bark can be peeled easily from the stock piece with little damage. Bud sticks having plump, healthy buds are suitable as scions. Leaf blades are clipped from the budsticks, leaving the petiole intact. Budding knives should be kept very sharp, so that as little damage as possible is done to the bud. The bud and a small sliver of the wood underneath it are cut from the bud stick using an upward slicing motion. The cut should begin about 1/2 to 3/4 inch below the bud, and should go deep enough into the wood so that when the cut is finished about 1/2 to 3/4 above the bud, the bark and a small sliver of wood are cut off. A perpendicular cut across the top of the upward cut will separate it from the bud stick. Buds must be cut from the bud stick just prior to grafting, otherwise they will dry out. The bark is carefully slipped from the stem of the rootstock exposing a "pocket" into which the bud shield can be placed. Care should be taken not to tear the flaps of bark in the process of spreading them. If the bark does not slip easily, this indicates that the stock is not in active growth and the process should be conducted later when active growth has resumed. The bark flaps are held tightly against the bud as they are wrapped with a budding rubber, grafting tape or other suitable closure. This closure must be removed in 2 to 3 weeks after the union has healed. If the material does not break down, it will girdle the rootstock, e.g. Citrus, plum, peach, cherry, *ber*, rose etc.

4.2. Patch budding

A rectangular patch of bark is removed completely from the stock and replace with a similar patch of bark containing a bud of desired variety. Normally done during the growing season when the bark separates readily from the wood along the cambial layer. It is successfully used in species having thick bark such as walnut, pecan nut.

4.3. Chip budding

Chip budding is successful method of budding when the bark of the stock does not slip easily. A chip of bark and wood is removed from the smooth surface between the nodes of the stock. A chip of similar shape and size is then removed from the bud wood of desired cultivar. For which, a 2-3 cm long down ward cut is made through the bark and slightly in to the wood of the stock. Then a second cut of about 2.5 cm is made so that it bisects the first cut at an angle of 30-45 ^{0}C in this way the chip of wood is removed from the stock. The bud chip then slipped in the place

of rootstock from where chip has been removed, e.g. mango, grape etc.

4.4. Ring budding

In ring budding, a complete ring of bark is removed from the stock and it is completely girdled. A similar ring of bark containing a bud is removed from the bud stick and is inserted on to the rootstock. In this budding both scion and stock should be of same size. It is utilized in peach, plum, *ber*, mulberry etc.

5. Tissue Culture/Micropropagation: The principles of tissue culture can be successfully employed in horticultural crops. Quite a large number of ornamental plants are reported to respond to propagation by tissue culture method. Few such plants are gladiolus, carnation, lily, rose, gerbera, anthurium, magnolia, fern, cacti, etc. Propagation of ornamental plants by this method is gaining popularity. Among fruit crops, tissue cultured plants are commercially produced in banana, strawberry etc.. The supply of tissue cultured plants of Grand Nain variety of banana has revolutionised the banana industry.

Advantages of vegetative propagation

- The horticultural crops which do not produce viable seeds are propagated by vegetative method.
- Most of the important fruit crops are cross pollinated and are highly heterozygous. When propagated through seeds, the progenies shows large variation, so vegetative propagation is remedy for these crops.
- The asexual propagation method gives true to type plants.
- The vegetative way propagated plants bear fruits early.
- In case of fruit crops where root stocks are used, the root stocks impart insect or disease resistance to the plant.
- Vegetative propagation helps to alter the size of the plant. i.e. dwarfing effect. This helps for spraying, intercropping & harvesting of crops easy and economical.
- By grafting method different variety of fruit crop can be grown & harvested.
- Inferior quality fruit plants can be converted into good quality plants.
- By means of bridge grafting a repairing of injured plants can be done.

Disadvantages of the vegetative propagation:

- By vegetative propagation new variety cannot be developed.
- It is an expensive method of propagation and required specialized skill.
- The life span of vegetatively propagated plants is short as compared to sexually propagated plants.
- As all the plants are homozygous the whole plantation may get attacked by a particular pest or disease.
- Viral diseases could be transferred through vegetative parts.

Table 1. Recommended Propagation Techniques for Fruit Crops

Fruit crop	Commercial propagation method
Almond	T-budding and wedge grafting
Aonla	Patch budding and wedge grafting
Apple	T-budding/tongue and wedge grafting
Apricot	T-budding and wedge grafting
Avocado	T-budding and wedge grafting
Bael	Wedge grafting
Banana	Suckers/corm
Cashew	Soft wood grafting
Cherry	Tongue and wedge grafting
Custard apple	Wedge grafting
Date palm	Sucker/off shoot
Fig	Hard wood/semi-hard wood cutting
Grape	Hard wood cutting and wedge grafting
Guava	Wedge grafting
Gooseberry	Hardwood/semi-hard wood cutting
Jackfruit	Patch budding and soft wood grafting
Jamun	Soft wood grafting
Kiwi fruit	Hard/semi hard wood cutting
Lemon/lime	Cutting and budding
Litch	Air layering and wedge
Mandarin	T-budding and wedge grafting
Mango	Soft wood, wedge and veneer grafting
Peach	T-budding, wedge and tongue grafting
Pear	T-budding, wedge and tongue grafting
Pecan nut	Patch budding and wedge grafting
Pineapple	Slip/sucker
Plum	T-budding, tongue and wedge grafting
Pomegranate	Wedge grafting/air layering, Hard wood cutting

Raspberry, Blackberry	Sucker
Sapota	Wedge grafting
Strawberry	Runner
Sweet Orange	T-budding/wedge grafting
Walnut	Walnut Patch budding and wedge grafting

References (if any)

1. Hartmann , H.T. , Kester, D.E. and Davies, F.T. (1993) . Plant Propagation. Prentice Hall of
2. India Pvt. Ltd. New Delhi
3. Mukherjee, S.K. and Majumder, P.K. (1986) . Propagation of tropical and subtropical fruit
4. crops. ICAR, New Delhi.
5. www.sas.upenn.edu/~dailey/VegetativePropagationTechniques.pdf
6. wizznotes.com › Biology › Reproduction in Plants
7. sciencelearn.org.nz/Innovation/...Stories/.../Vegetative-plant-propagation

Terms - Do not remove or change this section (It should be emailed back to us as is)

- This form is for genuine submissions related to biotechnology topics only.
- You should be the legal owner and author of this article and all its contents.
- If we find that your article is already present online or even containing sections of copied content then we treat as duplicate content - such submissions are quietly rejected.
- If your article is not published within 3-4 days of emailing, then we have not accepted your submission. Our decision is final therefore do not email us enquiring why your article was not published. We will not reply. We reserve all rights on this website.
- Do not violate copyright of others, you will be solely responsible if anyone raises a dispute regarding it.
- Similar to paper based magazines, we do not allow editing of articles once they are published. Therefore please revise and re-revise your article before sending it to us.
- Too short and too long articles are not accepted. Your article must be between 500 and 5000 words.
- We do not charge or pay for any submissions. We do not publish marketing only articles or inappropriate submissions.
- Full submission guidelines are located here: http://www.biotecharticles.com/submitguide.php
- Full Website terms of service are located here: http://www.biotecharticles.com/privacy.php

As I send my article to be published on BiotechArticles.com, I fully agree to all these terms and conditions.