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Vegetative Techniques of Propagation in Fruit Crops

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SUMMARY

Perennial plants can be propagated in two ways either by vegetatively or generatively. Fruit and nut trees are typically grown vegetatively by grafting techniques. There are two sorts of grafting methods for this: budding and grafting. Both are used for the same thing: to create a new plant by fusing a suitable rootstock with an aerial section of another plant of the desired kind, known as a scion. And other fruits are propagated by their own cuttings of stem, root and runner. Plants can reproduce asexually by combining parts of two or more plants or by combining portions of the same plant. Graftage is used in the first example, and rooting is used in the second.

INTRODUCTION

Fruit plants are a crucial component of the development of the fruit industry. The lengthy gestation time of fruit crops, however, necessitates extreme caution in the choice of planting material and the adoption of appropriate technologies for its mass replication, as any errors made during the early construction of an orchard could cause significant financial loss down the road. High-quality, consistent, and true-to-type planting material is essential for commercial fruit production. When propagated from seeds, the majority of fruit plants do not yield true to type progeny. Fruit crops are cross pollinated; therefore the offspring created from seeds are not exactly like their parents. As a result, fruit plants are typically multiplied vegetative using techniques including cutting, budding, grafting, and unique vegetative structures. The plants are housed in a designated location known as the nursery before being planted in the field. Fruit plants are therefore fostered in fruit plant nurseries during their formative stages until they are robust enough to be planted in orchards. The act of producing new plants from seeds, cuttings, bulbs, and other plant parts is known as propagation. The artificial or natural dispersal of plants is sometimes referred to as plant propagation. In essence, all plants in this cosmos reproduce either sexually (via seeds) or asexually (by vegetative growth). However, more methods for the quicker and more effective multiplication of these plants have now been devised by man.

Asexual/Vegetative Propagation

Propagation by vegetative structure:

Because only vegetative plant components are used and no sexual plant parts, it is also known as vegetative propagation. These include the plant's leaf, stem, root, and other organs that produce roots. The new person created using this technique fits their type. The vegetative approach is used to propagate fruit crops that are significant commercially.

Vegetative propagation

Types of Vegetative propagation:

Natural vegetative propagation:

It occurs when plants grow and develop spontaneously without the intervention of humans. The growth of adventitious roots can facilitate natural vegetative propagation. As a result, new plants can sprout from the stem, roots, leaves and bulbs:

Artificial vegetative propagation:

Humans carry out this type of vegetative reproduction in the fields and laboratory. Cutting, grafting, layering, and tissue culture are the most frequent types of artificial vegetative reproduction.

Table 1. Commercial 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
Litchi	: 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	: Patch budding and wedge grafting

Types of Artificial Vegetative propagation of fruit crops:

Propagation by Cuttings

A cutting is a segment of vegetative tissue (such as a stem, root, or leaf) that, when placed in the right environment, will grow new components and become a self-supporting plant. In this method of fruit plant propagation, a plant (often a stem) with at least a few buds is separated from the parent plant and placed in favourable conditions where it develops into a full plant that is identical to the parent in every way. This technique is frequently utilised with plants that root rapidly and easily, making plant multiplication swift and affordable. Commercial cuttings are used to propagate fruit trees like phalsa, pomegranate, lemon, and grapes. However, this form of propagation has some drawbacks, such as some plants are difficult to get to root, and some varieties cannot benefit from rootstock in the desired way. Cuttings are made from a plant's vegetative portion, such as a stem, root, or leaf, and are categorised based on the plant part that will be used. They are explained below:

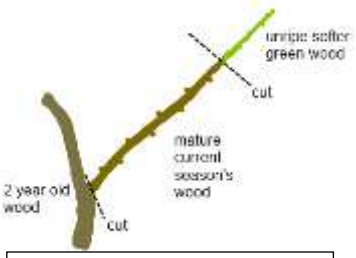
Stem cutting

Any cutting made from the main shoot of a plant or any side shoots that originate from the same plant or stem is referred to as a stem cutting. The most frequent way for multiplying many woody plants is stem cuttings. Stem cuttings come in a variety of forms.

Stem cutting

Hardwood cutting

Hardwood cuttings are made during the dormant season, typically from immature shoots from the previous season's development that are one year old. Cuttings are made from deciduous plants following pruning. Depending on the species, cuttings between 15-20 cm long and with three to five buds are generally recommended. A straight cut is made at the base of the shoot, below the node, when preparing the cutting, and a slanting cut is made at the top, 1-2 cm above the bud, for fruits and vegetables such grape, fig, pomegranate, mulberry, kiwifruit, olive, quince, hazelnut, chestnut, plum, gooseberry and apple.



Hardwood cutting

Semi-hardwood cuttings

Semi-hardwood cuttings are made from somewhat woody, partially mature shoots. These are often made from growing wood from the current growing season and are succulent and delicate in character. Cutting lengths range from 7 to 20 cm. Trimming the cuttings with a straight cut below a node and removing a few lower leaves prepares the cuttings. The top two to four leaves of cuttings should be kept, nevertheless. Better results are obtained by treating the cutting with 5000 ppm IBA (a rooting hormone) before planting. Summer is the finest season for cutting since new shoots are emerging and their timber is nearly mature. For instance, lemon, jackfruit, mango, and guava.

Softwood cutting

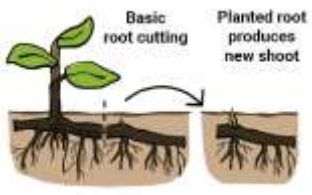
Any cutting made from soft, succulent, non-lignified shoots that have not yet turned hard or woody is referred to as a "softwood cutting." Softwood cuttings are obtained from the current season's fresh growth. They aren't woody and remain flexible. Cuttings from softwood are typically the simplest to root and don't need particular care. like lemon and lime.

Leaf bud cutting

A leaf or a piece of a leaf can be used to create a new plant in a relatively small number of plants. This is due to the fact that leaf cuttings need to develop fresh bud and root tissues. This capability is rare in plants. The majority of plants that are reproduced using leaf cuttings are houseplants with large, fleshy leaves. The leaf cutting may just involve the leaf blade, a leaf with a petiole, or just a piece of a leaf, depending on the plant being propagated. Leaf-bud cuttings differ from leaf cuttings in that they include a bud and a piece of the stem tissue. The bud is a prefabricated growth point that can be found where the leaf petiole meets the stem. In order to force buds that are in hibernation to become active, it is best to plan leaf cutting during the growing season. The plant material chosen for leaf cuttings should be robust, growing, and unaffected by insects or diseases. For instance, raspberry, lemon, and blackberry.

Root Cutting

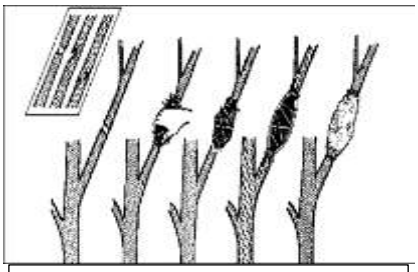
Various herbaceous perennials can be propagated using root cuttings in late fall or early winter while the plants are dormant. Plants that naturally produce suckers (new shoots) from their roots are propagated using root cuttings. Root cuttings can produce many more new plants from a single parent plant than aerial cuttings can, and the resulting plants are typically larger and more vigorous than aerial cuttings. Another benefit of root cuttings is that they are free of foliar pathogens and pests that could harm their parents, such as stem and leaf nematodes, which can impact plants like blackberry, fig, cherry, and raspberry.



Propagation by Layering

Air Layering

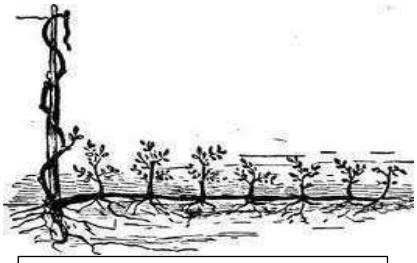
In this technique, a one-year-old, healthy, straight shoot is chosen, and a 2.5 to 4.0 cm ring of bark is removed just below a swollen bud. The cut is then surrounded by sphagnum moss or any other material that can retain moisture for a prolonged period of time, can be used for this purpose, and is wrapped with a polyethylene strip (200-400 gauge). After 30 to 45 days, roots are formed. The ideal time is February–March and July–August months for air-layering. Air layering can be used to grow litchi, lime, and sweet lime. Application of root-promoting hormones during layering aids in obtaining profuse rooting quickly. Application methods for root-promoting chemicals include lanolin, powder, and solution.



Air layering

Trench layering

Establishing a persistent row of plants to be propagated is crucial in this procedure. To promote the growth of numerous new shoots from a branch, it is set horizontally in a tiny trench. These shoots eventually form roots when the earth surrounding them fills in as they expand. Rows of the mother plants are positioned at a 45-degree angle at the bottom of a trench. These plants grow in a continuous line of stacked plants thanks to their long, flexible branches that are nailed to the ground. Once these plants start to produce young shoots, they are gradually mounded up to a depth of 15-20 cm, for example, apple rootstocks (M16 and M25), cherry, plum, etc.



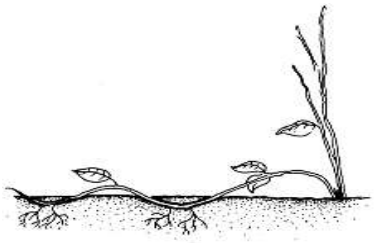
Trench layering

Tip layering

A plant stem is bent to the ground and covered with dirt in this method of propagation so that roots and new shoots can grow. In tip layering, the tips of the shoots are bent towards the ground, and the roots are positioned close to the tips of the shoots from the current season.

Serpentine/Compound layering

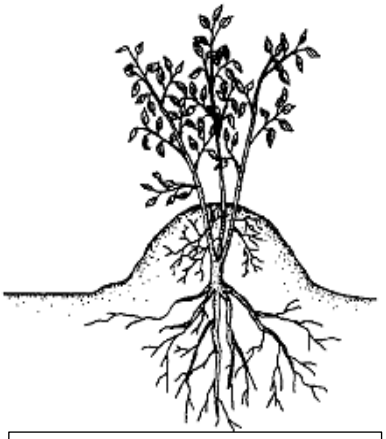
Serpentine layering, often referred to as complex layering, is comparable to simple layering except that different parts of the stem are buried, producing many plants from a single stem. This method works well with a long, vine-like stem. The branch, which is one year old, is alternately covered and left exposed along its length in this version of simple layering. such as American grape.



Serpentine layering

Mound layering /Stooling

In this procedure, during the dormant season, plants are lowered to a height of 15-20 cm above the ground. Within two months of returning, the fresh shoots appear. Following girdling near the base, rooting hormone (IBA), a substance consisting of lanolin paste, is applied to the upper area of the cut with moist soil. Within 25 to 35 days, the roots of the shoots are visible. In the commercial development of clonal rootstocks of temperate fruit crops like apple, pear, etc. and occasionally in guava as well, stooling is used.

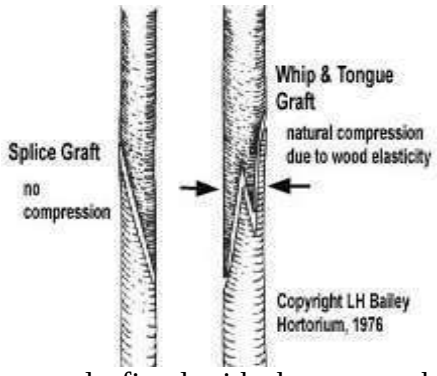


Mound layering

Propagation by Grafting

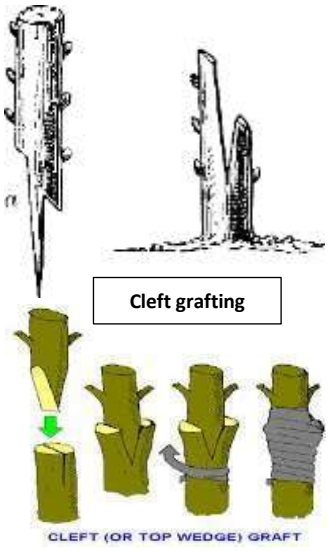
In grafting, two plant parts are joined together so that they combine and continue to grow as a single plant. To do this, the stock and scion are placed in close proximity to one another and are firmly held together until they combine to form a composite plant. The various grafting techniques include veneer grafting, cleft grafting, approach grafting, side grafting, and tongue grafting, among others.

Tongue grafting (Splice/Whip grafting)



It is a common and straightforward method of apple and pear propagation. When the stock and scion have identical diameters, this technique is frequently employed. There should be at least two or three sets of buds on each scion stick. The top of the rootstock and the bottom of the scion both have identical incisions, ensuring a good fit between the two parts. A 23–25 cm headback is performed on a rootstock that is about a year old, and the distal end of the rootstock is cut diagonally. On the proximal end of the scion, a similar slanting cut is performed. Try to complete this cut with a single knife motion. Both the cut surface of the rootstock and the scion are tightly linked together. Then, with care to ensure that the cambium layer of at least one side of the stock and scion fuse together, the scion, which has two to three buds, is snugly fitted with the rootstock. Then a strip of polyethylene is used to wrap it. In high hills and dry temperate zones, tongue grafting is carried out in March–April; in lower elevations, it is carried out in February–March. Whip grafting is a common method of fruit plant propagation.

Cleft Grafting



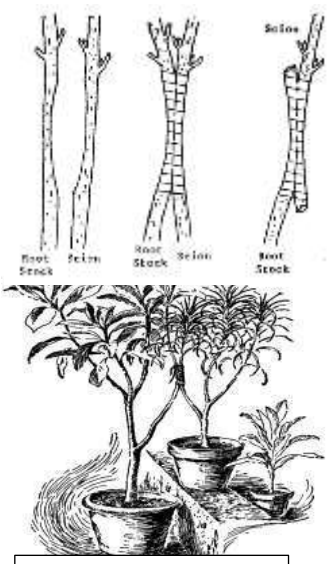
This procedure is sometimes called wedge grafting. A comparatively simple form of propagation is wedge grafting. For a higher graft success rate using this procedure, adequate scion stick selection and preparation are crucial. This technique is helpful in nurseries when tongue grafting cannot be properly used because the rootstock is much thicker than the scion. For this, rootstock with a girth of up to 8 cm is chosen. After the stock has been severed 45 cm above the ground, the rootstock is cleft grafted. The beheaded rootstock is separated through the stem's centre at a depth of roughly 5 cm. A firm wooden wedge is then inserted to maintain the opening open for the scion to be inserted later. From a terminal shoot that is older than three months, a scion of 15-20 cm size is cut, and it is then wedged firmly (6-7 cm). The split of the stock then contained the scion's cleft. More than one scion should be put into thicker rootstock. The cambium layer of the stock and scion, as well as the entire length of each component, must match. Due to advancements in technology, planting materials can now be grown all year long in greenhouses or outside in open fields. Avocado, apple, pear, plum, mango, and other grafts have a higher success rate because to the polyethylene cap's ability to promote early sprouting.

Side Grafting


Side grafting

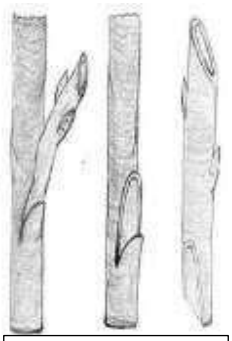
At a height of approximately 15–18 cm, a three-sided rectangular cut measuring approximately 4.0 x 1.25 cm is made on the rootstock, and the bark of the delimited section is separated from the rootstock. The base of the scion stick also receives a similar incision to reveal the cambium. The scion needs to be ready long before the actual grafting. Scion shoots of previously mature flushes that are in good health are chosen. The scion shoots that are chosen should have dense terminal buds. Remove the leaf blades after choosing the scion shoots, but leave the petioles on the scion. The linked petioles naturally fall off after 8 to 10 days, and the terminal buds swell. It is now time to cut the scion stick free from the mother tree and graft it onto the stock. After receiving a slanting cut, the prepared scion is put beneath the bark flap of the rootstock so that the exposed cambium of the two parts is in close contact with one another. The rootstock's bark flap is repositioned in its original location. After that, a polythene strip is used to firmly tie the graft union. A portion of the top of the rootstock is cut off once the grafting procedure is successfully completed to promote the growth of the scion. The root stock part above the graft union should be cut off once the scion has begun to show signs of leaf emergence. From March to October, side grafting can be done effectively, but between May and October, success rates are fairly poor. Mangoes frequently propagate using this technique.

Inarching/Approach grafting


Approach grafting

Although the inarching or approach grafting technique is laborious and time-consuming, it continues to be the most popular technique for the commercial production of many fruit trees. It is also known as repair grafting since it is frequently employed to replace or repair damaged root systems. Approach grafting is the name given to this technique of grafting because the scion is approached by the rootstock while it is still attached to the mother plant. A key element in its success is the choice of parent tree for the scion. The scion plant ought to be strong, robust, and high producing. The scion and stock are brought together. The diameter of the rootstock and scion in this procedure should be about the same. From matching parts of both the stock and the scion, a slice of bark and a thin piece of wood, 6-8 cm long and about 1/3 inch thick at the height, are cut away. After that, they are brought together while being careful to ensure that their cambium layers touch. Then, these grafts are firmly tied with polythene strip or another type of tie-down material. To speed up the union, the stock and scion plants receive regular irrigation. In roughly two to three months, the union is complete. Stock above and scion below the graft union are gradually looped off following a successful union. The optimal time for approach grafting is during the last week of July or the first week of August, for example, on mango, sapota, guava, litchi, etc.

Veneer grafting


Vaneer grafting

This technique of propagation has potential for widespread commercial propagation. The propagation mechanism is straightforward. However, there are a number of variables that affect the outcome, such as the scion's age and diameter, the grafting season, the scion stick's defoliation period, etc. For this procedure, rootstock that is about a year old is appropriate. However, if the stock reaches the necessary thickness (about 1 to 1.5 cm dia) before a year, it can be used as a rootstock. A scion stick of 3 to 6 months old with lush green foliage is preferred for better results. Prior to grafting, the scion sticks are pre-defoliated 5–10 days in advance, leaving the petiole in place to activate the auxiliary and apical buds. The terminal and next to terminal shoots are typically the best. A downward and inward cut of 25 to 35 mm long is made in the stock at a height of around 15-20 cm to perform this grafting operation. To remove the piece of wood and bark, a smaller, more precise cut is made at the base of the larger cut. To match the cuts with the rootstock, the scion stick is given a long, slanting cut on one side and a short, straight cut on the other. The scion is now placed in the stock so that the longer side of the cambium layers contacts the stock. Then, a polyethylene strip is used to tie the graft union. The rootstock should be cut gradually once the scion has been green for more than 10 days. When scion growth starts, the rootstock shoot above the graft union is cut off. Eg. mango

Softwood grafting


Softwood grafting

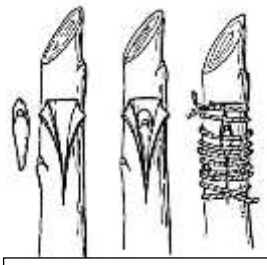
As the name suggests, grafting is carried out in this instance on just emerging rootstock that is 40–60 days old. This is an easy and straightforward procedure that may be used all year long with 60–90% success. When developing new orchards in the field with existing rootstocks, this technique is helpful for in situ grafting. Using a sharp knife, cut off the leaves of the chosen seedling while saving one or two pairs of bottom leaves. On the seedling's soft top, make a transverse cut. Make a longitudinal cut that is 3–4 cm deep in the middle of the seedling's severed stem. On the inside of the cleft at the top, some wood is removed. The scion is prepared by trimming the cut end of the scion into a wedge shape that is 3–4 cm long. Care must be taken to leave some bark on the remaining two sides as you chop off the bark and a small amount of wood from the two opposing sides. Make sure that the cambium layers of the stock and scion are perfectly in contact with one another before inserting the scion's wedge into the seedling's cleft. With polythene strip (30 cm long, 2 cm wide, and 150 gauge), tightly fasten the joint. To keep the scion moist and

prevent the apical bud from drying out, wrap a polythene cap (15 cm × 10 cm, 100 gauge) around it and tie it at the bottom. The terminal bud must be kept free from the cap. The optimum months for softwood grafting success are July and August because of the high humidity and mild temperatures. This is a highly well-known and effective way for growing cashew nuts, mangoes, sapotas, and other fruits.

Propagation by Budding

Budding is a method of propagation in which only one bud of desired scion is inserted in the rootstock. When the bark begins to slide off of the stock and scion, this is the perfect stage of budding. It shows that the cambium is functioning. Shield or tbudding, patch, chip, and ring budding are all significant budding techniques.

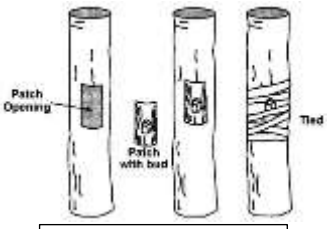
Shield or T- budding



Shield or T budding

A unique grafting method called "T" or "shield" budding reduces the scion component to a single bud. A bud stick is a short branch with multiple T-bodding-suitable buds on it. The rootstock must be in an active growth stage where the bark is slipping, indicating that the vascular cambium is actively growing, and the bark can be peeled easily from the stock piece with minimal damage in order for T budding to be successful. The best bud sticks to use as scions are those with full, healthy buds. The petiole is unaffected by the removal of leaf blades from the budsticks. Knives for budding plants should be kept highly sharp to prevent any harm from being done to the bud. From the bud stick, a little piece of wood and the bud are separated by an upward slicing motion. The cut should start between 1/2 and 3/4 of an inch below the bud and should extend far enough into the wood so, when it is finished, the bark and a thin piece of wood are removed. It can be separated from the bud stick by making a perpendicular incision across the top of the upward cut. Just before grafting, the buds must be removed off the bud stick because otherwise they will dry out. The rootstock's bark is carefully peeled away from the stem, revealing a "pocket" that the bud shield can fit into. When spreading the bark flaps, caution should be used to avoid tearing them. If the bark is difficult to remove, the stock is not actively growing, and the operation should be repeated once active growth has restarted. When the bark flaps are wrapped with grafting tape, budding rubber, or another appropriate closure, they are kept firmly against the bud. After the union has healed, this closure needs to be removed in two to three weeks. If the material does not break down, it will girdle the rootstock, e.g. Citrus, plum, peach, cherry, *ber*, rose etc.

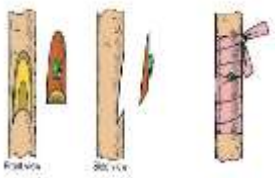
Patch budding



Patch budding

A rectangular portion of bark is totally removed from the stock and replaced with a patch of bark that is comparable to the original but has a bud of the desired variety. Typically, this is done during the growing season when the cambial layer of the bark easily separates from the wood. It works well on species with thick bark, including walnut and pecan nuts.

Chip Budding



Chip budding

When the stock's bark does not slip easily, the budding technique known as chip budding is effective. The smooth stock surface in between the nodes is chipped of bark and wood. The targeted cultivar's bud wood is then scraped clean of a chip of comparable size and form. In order to do this, a downward cut that is 2-3 cm long is made through the bark and just into the stock's wood. Then, a 2.5 cm second incision is made that bisects the initial cut at a 30-45 0C angle.In this manner, the wood chip is taken out of the stock. The bud chip then slipped in the place of rootstock from where chip has been removed, e.g. mango, grape etc.

Ring budding

Ring budding

Ring budding involves totally girdling the stock and removing a ring of bark from it. The rootstock is attached to the bud stick using a similar ring of bark that contains a bud. Both the scion and the stock in this budding should be the same size. It is used in fruits such as peach, plum, ber, and mulberry.

Advantages of Vegetative propagation

- Horticultural crops are propagated vegetatively if they do not generate viable seeds.
- The majority of significant fruit harvests are highly heterozygous and cross-pollinated. Vegetative propagation is a solution for these crops because when they are propagated through seeds, the offspring exhibit a great deal of variety.
- Asexual propagation produces plants that are true to type.
- Early fruit bearing plants are propagated vegetatively.
- In the case of fruit crops, where root stocks are employed, the root stocks give the plant resistance to insects or diseases.
- Vegetative propagation aids in changing the plant's size. Dwarfing effect, etc. This makes it easier and more cost-effective to spray crops, intercrop, and harvest them.
- Different types of fruit crops can be grown and harvested using the grafting procedure.
- Fruit plants of lower quality can be transformed into superior plants.
- Bridge grafting is a technique that can be used to mend damaged plants.

Disadvantages of the vegetative propagation:

- It is impossible to create new varieties through vegetative propagation.
- It is a pricy way of dissemination and necessitates specialised knowledge.
- Compared to sexually propagated plants, vegetatively propagated plants have a shorter lifespan.
- Due to the homozygous nature of all plants, a specific pest or disease may affect the entire plantation.
- Vegetative portions could be used to spread viral infections.

CONCLUSION

With all of these propagation methods now known, one can select the best ones for a specific fruit crop. In order to grow a variety of crops in high quality and quantity and boost a nation's economy, vegetative propagation is a crucial and practical farming technique. However, these also have an impact on the ecosystem, making certain plant kinds more vulnerable to viruses that might wipe out all the harvests. In India, most fruit plants were until recently budded or grafted onto seedlings grown from seeds gathered from various sources. However, due to a shift in experts' perception, certain rootstocks with particular traits are now being used from sources that have been identified. To address issues with adaptation, clonal rootstocks are frequently utilised today. These parent rootstock clones are identical in every way genetically. These rootstocks are unique because they possess some beneficial qualities, such as resistance to winter cold or high temperatures, poorly drained soils, heavy clay soils or salty soils, extremely dry soils, pests and diseases, etc.

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