Unit V: Plant Propagation

Lesson 1: Sexual Propagation

The two lessons in this unit investigate sexual and asexual methods for propagating plants. Lesson 1 examines sexual propagation: legal issues, its environmental conditions, dormancy period, and stages of germination. In addition, this lesson discusses procedures for planting seeds, distinguishes between the germination of monocots and dicots, and describes when and how to transplant seedlings. Caring for seedlings after germination and transplanting is also described.

Sexual Propagation

Sexual propagation uses seeds to produce new plants. In order for germination to occur, environmental conditions must be ideal. These conditions are discussed below.

For sexual propagation to be successful, it is important to select high-quality seeds that are free of disease and insects, broken seeds, weeds, or other seeds. Hybrid seeds are expensive but they offer significant advantages: greater resistance to disease, generally more vigorous plants, and higher yields. To store seeds, keep them dry and cool. Put them in paper packets inside sealed, clean, dry glass jars.

Direct seeding means that the seeds are planted outdoors; no transplanting is involved. The seeds are placed in the same container that will be used for sales. Inside seeding is planting the seeds in the greenhouse and later transplanting the developed plant, either to a larger container or outside. The growing media should be clean, free of debris and disease, loose, and finely textured.

Environmental Conditions for Seed Germination

Four principal environmental conditions play key roles in germination. Adequate amounts of moisture allow the seeds to absorb water. After the seeds are sown, the best way to moisten the growing medium is to apply a fine spray and cover the medium to retain moisture.

Temperature requirements vary among warm weather and cool-weather crops. The general range is 68-86^{o}F. It is important that the medium's temperature remains constant. If the medium is too cool, use supplemental heating.

Light requirements vary. For seeds that need light to germinate, sow them shallowly and do not cover them (e.g., lettuce). Most ornamental bedding plants (e.g., begonias and petunias) depend on light for germination. For some seeds, light may inhibit germination, so no light is required. Sow these seeds more deeply and place them in a dark area (e.g., geraniums).

Air (oxygen) is essential because germination is an aerobic process. Dormant seeds do not require much oxygen, but as the plant develops, the need for oxygen increases. A deficit of oxygen hinders respiration. The growing medium must have good porosity to ensure proper aeration.

Sexual propagation involves legal considerations. In an effort to encourage biotechnological development, the U.S. government passed the Plant Variety Protection Act. This law gives scientists or breeders of new varieties exclusive marketing rights to their seeds for 18 years. This law and subsequent amendments restrict the actions of the buyers of these more resilient seeds, namely, a grower cannot sell surplus seeds. For

more information, contact the Commissioner, Plant Variety Protection Office, Agricultural Marketing Service, National Agricultural Library Bldg., Room 0, 10301, Baltimore Blvd., Beltsville, MD 20705-2351.

In addition to federal regulations, a greenhouse operator must follow state laws. In the state of Missouri, all who handle nursery stock, even if they give it away, must be inspected and certified. The inspector is looking for signs of insect and disease infestation. Fees for this service are based on the size of the greenhouse as measured in square feet under glass. For more information, contact State Entomologist, Missouri Department of Agriculture, P.O. Box 630, Jefferson City, MO 65102-0630 - Phone: (573) 751-5507; Fax: (573) 751-0005.

Dormancy

Dormancy is the resting stage for seeds that prevents them from germinating until specific environmental conditions are favorable for growth. For example, the dormancy period for annual seeds that bloom in the fall lasts until spring. Otherwise, if the seeds germinate too soon, the frost would kill the emerging plants. Seeds of many greenhouse-grown plants do not have a dormancy period and can be planted at any time. However, some plants, such as geraniums, have a hard, protective seed coat that prevents immediate germination. To offset the effects of dormancy, the seed coat undergoes scarification. This is a process in which the seeds are scraped or scratched to increase water absorption. A manual method for scarifying is to rub the seed coat with sandpaper or to nick a portion of it. A chemical approach is to soak the seeds in sulfuric acid to soften the seed coat.

Some seeds require a different technique: stratification. Seeds are planted in a moist growing medium at 32-50^{o}F for several weeks. Conversely, to induce germination for other types of plants, exposure to heat is required to weaken the seed coating so water absorption is possible.

Germination Process

As soon as seeds absorb water through the growing medium, the germination process begins. When the water penetrates into the seed, a growth hormone develops that eventually moves into cellular layers. This triggers the production of enzymes that stimulate various chemical reactions within the cells. New cells and tissues are produced. The radicle is the first to appear from the seed. Next is the plumule (coleoptile), the emerging plant's first shoot. With the appearance of leaves on the seedling, photosynthesis begins and the plant supplies its own food.

Steps for Planting Seeds

The first step for planting seeds is to fill the container 3/4 inch from the top with moistened germination mixture. Be sure the pot has drainage holes. Level off the medium and tap to settle. Make shallow holes or rows according to directions on the seed packet. Place seeds in the holes or rows. Label the pot or flat with the plant type, variety, and date of sowing. Cover seeds with a dry medium, generally twice as much as the seeds' diameter. Plastic, multicell packs are frequently used for planting seeds.

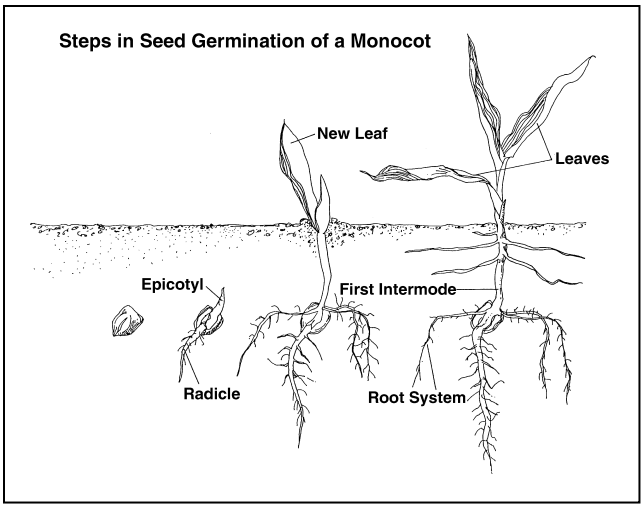
Provide seeds with a fine mist of water and keep them warm. Cover the container with clear plastic or glass in order to retain the moisture. Observe daily for signs of too much or too little moisture and for excess heat. Watch for germination.

Differences in Germinating Monocots and Dicots

Monocots undergo hypogeous germination (cotyledon remains underground). First the seed swells as moisture is absorbed. Finally, the seed coat ruptures. The radicle grows down and the first internode and epicotyl grow up. After the

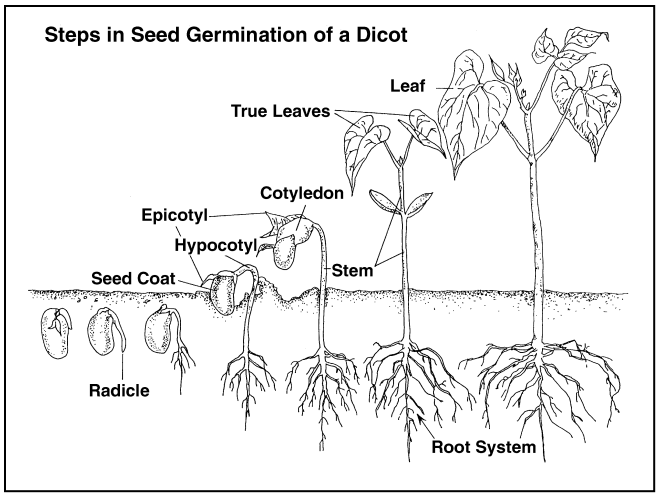
epicotyl emerges, new leaves form and food production starts. The new root system grows just beneath the medium above the first internode. Figure 5.1 illustrates this process.

Figure 5.1 - Steps in Seed Germination of a Monocot



Dicots undergo epigeous germination (cotyledon emerges aboveground). As with monocots, the seed swells as moisture is absorbed. The seed coat splits and the radicle emerges and grows down. The hypocotyl elongates, forms an arch, and pulls the cotyledon upward. When the hypocotyl reaches light, elongation ceases and the hypcotyl straightens up and pulls the cotyledon out of the medium. The cotyledon opens, turns green, and provides food until the true leaves develop. The first true leaves unfold from the epicotyl, exposing the growth bud. The cotyledon dies, dries up, and falls off. See Figure 5.2.

Figure 5.2 - Steps in Seed Germination of a Dicot



Caring for Seedlings After Germination

Once the seedlings begin to emerge, remove the plastic or glass covering. Move the plant to a brightly lit area. The growing temperature should be 10^{o}F cooler than the temperature for the germination period. Monitor the amount of water the plant receives and keep the growing medium moist but not soggy. Be sure to allow the medium to dry completely between waterings and ensure that seedlings do not wilt at any time.

Promptly fertilize plants that were grown in soilless media. Apply a water-soluble fertilizer in a 20-20-20 formulation (1/4 of the recommended strength) a few days after germination. Twice a week thereafter, apply the appropriate amount of nitrogen for each crop in a diluted solution**.** Always observe the plant's reaction to the fertilizer; too much is harmful.

The emerging plant needs protection from diseases. The best preventative steps are to use a soilless mix or pasteurized field soil and to sterilize containers. Always provide ample air circulation and permit the medium to dry out between waterings.

Despite precautions, diseases may develop and endanger the growing plants. Fungi cause damping-off, a disease that rots stems at the base

of the medium. If the infection is limited, the best approach is to get rid of the plants and medium. If the infection is widespread, drench the entire area with a fungicide.

Transplanting Seedlings

The best time to transplant seedlings is after the first set of true leaves develops. If transplanting is delayed, the seedlings become overcrowded and spindly and the plant's health suffers. Because transplanting traumatizes the seedling, the plant must be prepared. This is accomplished through hardening-off. The seedling is put in a cooler environment and watered less frequently for a period of time. The length of the hardening-off period varies with each plant.

After the hardening-off period, the seedling is watered and carefully lifted out of its present container with a small trowel, fork, or knife. Some of the medium should be kept around the roots, and the roots must never dry out. After the container is filled with a moist growing medium, dig a hole in the middle to receive the seedling. This hole should be slightly larger than in the other pot. The extra depth in the new pot gives the seedling room to grow. Add growing medium and gently pat around the base of the seedling. Give the transplanted seedling a final watering to prevent wilting.

Throughout the transplanting process, it is extremely important to be gentle when handling seedlings because they are fragile. As the plant is inserted into the growing medium, carefully hold the seedling by its leaves, not stem.

Caring for Seedlings After Transplanting

After seedlings are transplanted, they need special care. Direct light and intense heat are harmful, so it is important to keep seedlings in the shade or under fluorescent lighting for a few days and also to keep them away from heat.

Summary

Sexual propagation is the development of new plants from seeds. These seeds must be nurtured under specific environmental conditions. The dormancy period that several seeds undergo can be overcome by manual or chemical methods in order to enhance water absorption in the seed coat. Monocots and dicots undergo different stages during germination. Carefully nurturing seedlings after germination, during transplanting, and after transplanting ensures healthy crops.

Credits

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Lee, Jasper S., Series Editor. *Introduction to Horticulture*, 3rd ed. Danville, IL: Interstate Publishers, Inc., 2000.

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Unit V: Plant Propagation

Lesson 2: Asexual Propagation

The greenhouse owner can increase the amount of plants available for sale by using different methods of asexual propagation. This lesson compares the principles and techniques of budding, cutting, division, grafting, layering, and tissue cultures.

Asexual Propagation

In asexual (vegetative) propagation, a new plant is created from the buds, leaves, stems, or roots of a parent plant. It is a popular means of reproduction because it is a faster process than sexual (seed) propagation and it produces identical characteristics of the original plant. Frequently, plants grown from seeds cannot produce viable seeds. Asexual propagation is a less expensive method than sexual propagation. The reason asexual propagation works is that each plant cell contains all the genetic information needed to divide and reproduce itself.

General Considerations for Asexual Propagation

To ensure successful propagation, the greenhouse owner needs adequate supplies and equipment, a suitable growing environment, and an effective tracking system. Tools include sharp knives to cut parts from plants, divide plants, and make wounds in plant materials. Dibbles (sticks) are used to dig holes in the growing medium; puffer dusters and spray bottles are used to apply the rooting compound. Keeping propagation benches above the floor helps prevent exposure to pathogens.

Within the greenhouse environment, sanitation is mandatory. All tools and knives must be sterile and disinfected before use and after each cutting. Cuttings should be put in a sterile container until they are ready for planting. After each use, it is important to sterilize rooting solutions. To ensure further cleanliness, discard any excess plant debris. To help plants flourish, use a soilless growing medium composed of vermiculite and perlite. This pathogen-free medium promotes drainage and aeration while retaining sufficient amounts of nutrients and water. Lighting for the cuttings is an important factor. During winter, for example, more light is required than during the heat of the summer. When too much light floods the greenhouse, the cuttings need shade. Cuttings also need balanced temperature (see below). The bottom temperature is generated from heating pipes or electric cables and is placed below the propagation benches. It generally should be 5-10^{o}F higher than air temperature.

In order to keep track of the increase in plants, the greenhouse owner should maintain careful records. By labeling each plant accurately, the greenhouse owner can identify the plant's name and variety, date of propagation, and any special treatment received.

Asexually reproduced plants, except tubers, are federally protected. The Plant Patent Law of 1930 is similar to the Plant Variety Protection Act, passed in 1970, which regulates sexually propagated plants and tubers. A plant patent gives breeders the right to sell their plants and it controls who may propagate and sell subsequent plants and plant parts. This is referred to as a licensing agreement. A plant patent lasts 20 years. In 1998, the Plant Patent Act was amended. The revised Act explicitly protects the owner of a plant patent against unauthorized sale of plant parts that could be used to propagate the plant. It also expands protections on par with those for sexually propagated plants as covered by the Plant Variety Protection Act. For further information,

contact the Assistant Commissioner for Patents, Washington, DC 20231.

In the state of Missouri, those who sell, transport, or give away nursery stock (perennials, woody stem plants, perennials, bulbs, roots, crowns, corms, rhizomes, and tubers) must be licensed. Twice a year, a state entomologist examines the nursery stock for infestations from pests and diseases. Fees for this service are based on the size of the greenhouse as measured in square feet under glass. For further information, contact the State Entomologist, Missouri Department of Agriculture, P.O. Box 630, Jefferson City, MO 65102-0630 - Phone: (573) 751-5507; Fax: (573) 751-0005.

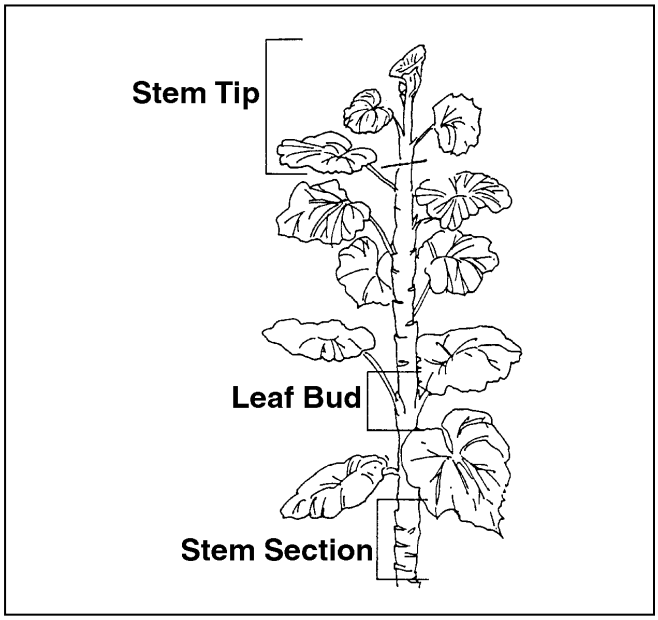
Methods of Asexual Propagation

Six basic methods of asexual propagation are described below: budding, cutting, division, grafting, layering, and tissue culture.

Budding is similar to grafting (explained below) and is used most often to produce roses. A single bud from one plant (used as the scion) is inserted into the bark of another variety. But most greenhouse owners sell rose bushes that plant propagators have already grafted through bud grafting.

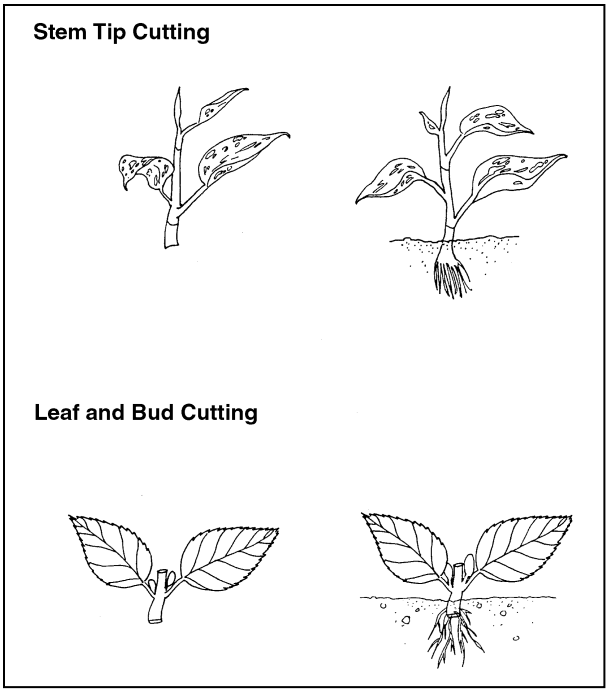
Cuttings, used predominantly with floriculture crops, are sections from the parent plant that are rooted in the growing medium to form a new plant. As illustrated in Figure 5.3, cuttings may be taken from three parts of the plant: stem tip, leaf bud, and stem section

Figure 5.3 - Cutting Locations



Stem tip cuttings are taken from a section or tip of the stem. This method of propagation is suited to herbaceous greenhouse plants such as carnations and chrysanthemums and various soft wood, hardwood, and semihardwood plants. Leaf cuttings are taken from a piece of the leaf or from the entire leaf, including the leaf vein or leaf bud. Leaf bud cuttings are taken from the leaf blade, petiole (stem of the leaf), and axillary bud (found in the angle between the leaf and the main stem). The cut from a stem section includes a bud and its attached leaf. Although this technique takes longer than stem tip cuttings, it produces many cuttings even with only a limited number of plants. See Figure 5.4.

Figure 5.4 - Cuttings



Before proceeding, the first step is to assemble clean tools, containers, and a suitable growing medium. The cutting sites, as illustrated in Figure 5.3, determine where the cut is made. For example, stem tip cuts are made with a sharp knife that removes a 2-4-inch section at the top of the plant, just below a node. The leaves are removed from the lower third to half of the cutting.

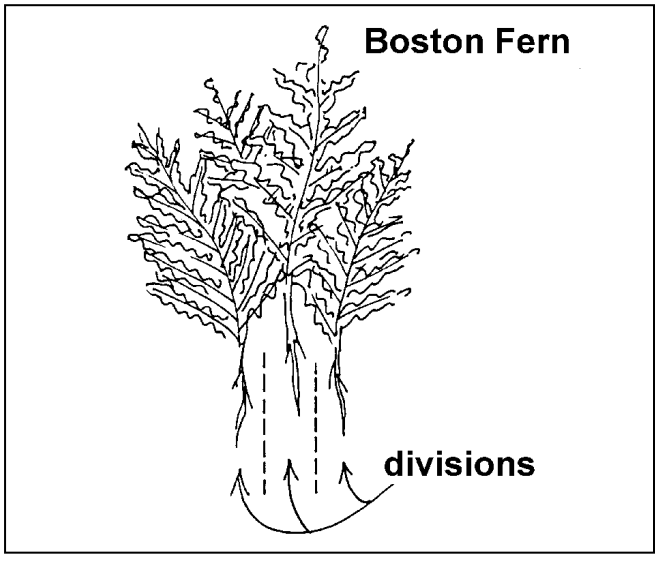
Treating the base of the cuttings with a rooting hormone enhances growth. The cuttings should be planted in a moist, soilless growing medium and placed in a high-humidity environment to reduce moisture loss. Cuttings thrive in temperatures between 65 and 75^{o}F (18-23^{o}C) and with a bottom heat of 75-85^{o}F (23-29^{o}C).

By stimulating vigorous root growth, rooting hormones increase the percentage of successfully propagated cuttings. These synthetic hormones help plants root more quickly and uniformly. They are formulated as powders and solutions. A puffer duster sprays the hormone powder on the stem. Dusting is preferred over solutions because it enables the greenhouse owner to apply precise amounts to the base of the stem. Excessive quantities of rooting powder can rot the stem and prevent root development. In rooting hormones formulated as solutions, the base of the cutting is dipped into the hormone mix for a short period of time.

These routes for administering rooting hormones could pose a threat to the plant under certain circumstances. Pathogenic organisms can spread from diseased cuttings to healthy cuttings through the powder or solution. When applying powders, use of the puffer duster prevents infection from spreading. When rooting hormones are applied via solutions, it is wise to use only fresh ingredients and to discard all leftovers. Spraying cuttings with the solution is a safer method than dipping them.

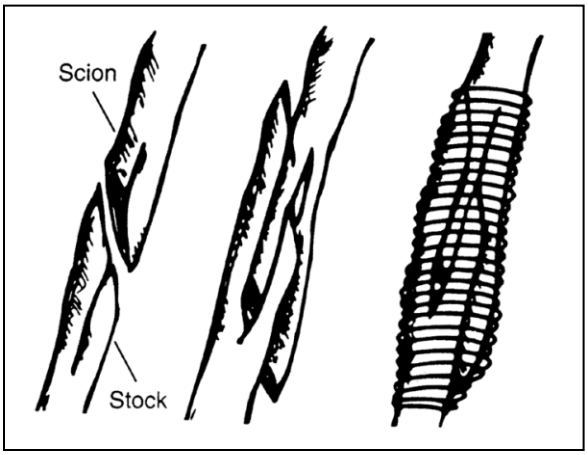
Plant division is another method of asexual propagation. Clumps of a plant are separated into small groups. Each group has its own roots, stems, buds, and leaves or the potential to develop these parts. For plants that produce multiple crowns (e.g., Boston ferns) or offshoots, division is the easiest method of propagation. Examples of plants that naturally propagate through division are tulips, daffodils, and gladioli. See Figure 5.5.

Figure 5.5 - Division



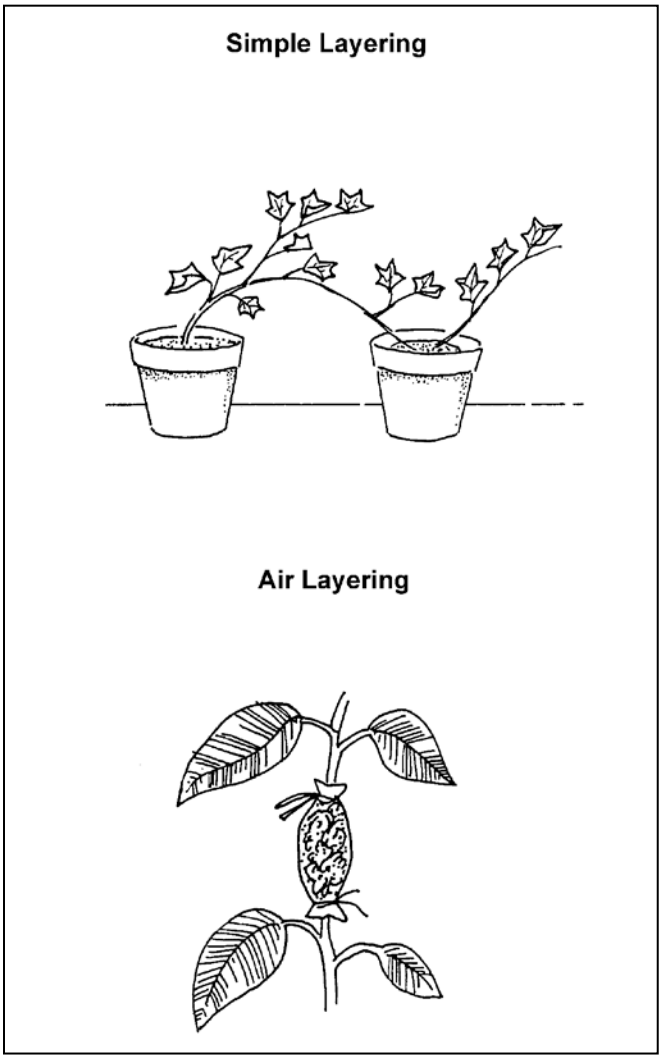
Grafting is a propagation method in which buds, twigs, or shoots (the scion) are taken from one plant and inserted into the stems or roots of a similar plant (the rootstock), matching the cambiums in the process. Whip (or tongue) grafts join scion rootstock, whereas cleft and bark grafts join small scions to large rootstocks. This propagation technique is not prevalent in most greenhouse operations; it is used most often for developing trees. However, some flowers are grafted, such as lilacs, camellias, and azaleas. Refer to Figure 5.6.

Figure 5.6 - Grafting



Layering is a method for propagating plants in which new roots are established while the stem stays attached to the parent plant. As the root system develops, it derives support from the parent plant until it is self-sufficient. Many houseplants are easily propagated by this method. There are several kinds of layering. Of all the types described here, the only ones commonly used in a greenhouse are simple layering and air layering (see Figure 5.7).

Figure 5.7 - Layering



In *simple layering*, a superficial cut is made to a portion of the stem to stimulate new root growth. The wounded stem is then buried, but the tip of the stem is left exposed. Foliage plants (e.g., English ivy and rhododendrons) are commonly propagated by this method.

Air layering is also used to propagate foliage plants, such as ficus. This technique requires cutting around the stem. The wound is dusted with a hormone to induce rooting and is covered with some moist sphagnum moss, which is covered with clear plastic and then secured in place.

Tip and simple layering are similar. The terminal (end) tip is wounded, treated, and buried. However, the terminal tip is buried in the growing medium. As the tips develop, they first grow downward and eventually move upward, creating a bend. New roots develop at this juncture and the emerging tips appear above the growing medium. Raspberries, blackberries, and blueberries, which have flexible stems, are crops that are propagated by tip layering.

In *serpentine (compound) layering*, sections of the stem are alternately buried in the growing medium and exposed to the surface. This creates multiple sites for rooting. The buried portion of the stem is slightly wounded and treated with a rooting hormone.

Woody plants, such as fruit trees and roses, are propagated through *mound layering*. This involves cutting back the stem and burying the stem while it is dormant. Trench layering is also designed for propagating woody plants. After the stem has been wounded and treated with a rooting hormone, the entire plant is bent and buried in the growing medium. Only the tip is left above ground.

Tissue culture, also referred to as micropropagation, is a highly technical method in which one or more cells from the tissue of a plant are used to produce a new plant. Tiny pieces of the plant are grown in artificial media under sterile conditions. Plant development is carefully controlled through selected chemicals and growth regulators. This allows mass production of plants in a short period of time. Compared to other asexual methods of propagation used to produce a large number of crops, tissue culture is especially cost-effective and efficient.

Summary

Asexual propagation is an effective technique for increasing crop production in the greenhouse. Adequate supplies, a suitable growing environment, and an effective labeling system are essential. Each propagation method - budding, cutting, division, grafting, layering, and tissue cultures - offers unique features that can boost the greenhouse owner's inventory. Foliage and ornamental plants are propagated by herbaceous cuttings, division, and simple and air layering. The greenhouse owner can promote successful, healthy plant development by applying correct amounts of rooting hormones.

Credits

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