

# Plant Propagation for Central America

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## INTRODUCTION

Plant propagation is one of the most important aspects of horticulture. An adequate supply of high-quality plants which may produce delicious fruits or beautiful blossoms cannot be available to the public unless there is efficient, large-scale multiplication of the very best varieties in every locality in this vast area. Because horticultural improvement depends upon vegetative reproduction to perpetuate superior fruits and prized blossoms, it is imperative that horticulturists increase plants by one of the several methods of non-sexual propagation described herein. Close attention to all details in each of the numerous steps along the way is always requisite to success. Only through such careful attention is it possible to meet the ever increasing demand for superior trees, shrubs, palms, and vines. To-day there are all too few nurseries providing well grown plants of the best horticultural varieties in tropical America.

It is the purpose of this work to provide horticultural students, nurserymen, and home-owners with authentic information based upon sound research as well as tried-and-true practices that have been handed down through the years.

## GROWING NURSERY PLANTS FROM SEEDS

For sowing seeds of most trees and shrubs it is suggested that, whenever possible, you use flats rather than sowing the seeds directly in the open ground. A flat is a box of any convenient size, four or five inches deep, that has plenty of drainage — holes or cracks in the bottom to allow excess water to pass quickly out of the compost. Thorough drainage is very important in soils where tender seedlings are grown, as a sour, water-logged medium is fatal to most young horticultural plants. In the bottom of the flat place a layer of coarse material so the soil will not sift or wash through the drainage holes.

The soil used in seed flats should be a fertile mixture that has a fair amount of well-rotted organic matter such as cow manure, leaves or other organic matter. If a compost pile can be laid up with alternating layers of fertile soil and one or more of the materials listed above, an excellent compost should result.

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Pasteurization of soil for seedling flats is highly recommended. Moist soil cooked at about 160 degrees for a couple of hours should be free of the organisms which cause damping-off, root-knot and weeds. Small quantities of soil can be baked in an oven, larger amounts are efficiently sterilized by steam. If steam is not available, formalin or a proprietary soil fumigant can be used. Vapam or MC-2, when used exactly according to directions, give excellent results.

Fill treated soil to within a half-inch of the top of a flat, firm with a block of wood and flood with water. After the liquid has drained through, sift the seeds, if very small ones onto the wet surface. Some growers broadcast the seeds, others like to drill them in neat rows. Cover lightly by sifting sand or sandy loam through a screen over the seeds. Covering too deeply is a common error, and, generally speaking, if the seeds be just barely hidden, good results may be expected. The final operation is to cover the flat with a sheet of plastic or a moist newspaper.

The latter is preferred by many growers because water flooded in on top of the paper will seep through gently and evenly to soak all of the soil in the flat, yet the seeds cannot be washed out. Remove the covering as soon as the seeds commence to germinate. Place the flats on boxes or benches that are protected from ants.

Sphagnum moss is popular as a germinating medium because of its high waterholding capacity, excellent aeration and freedom from damping-off. The usual soil mixture is filled into about half the depth of the flat; over this is screened a one-inch blanket of sphagnum moss. After this is soaked, the seeds are sown and then they are covered with a quarter-to a half-inch of sphagnum moss rubbed through a sieve of hard ware cloth. Finish the job by a gentle sprinkling and then cover with a sheet of plastic or a newspaper. As soon as germination commences, remove this covering. With the sphagnum method, feeding is recommended. Stir a teaspoon of a high analysis fertilizer into a gallon of water and apply with a sprinkling can at intervals of about ten days.

Certain classes of nursery plants may be handled by sowing the seeds directly in nursery rows in the same manner as many vegetables are planted. This method is used only with robust species, as it is difficult to control the environment and pests, and to avoid adverse growing conditions. Sowing in flats is always to be preferred for small-seeded species. Coconuts and many other large fruits such as palms, mangos and avocados should be planted in seedbeds rather than flats. These beds should be made up of enriched soil and should be protected from direct rays of the sun. Seeds of some species are very slow to germinate and may require careful attention for many months before they will sprout, even under the best of conditions.

When seedlings are large enough to handle they may be transplanted to plant bands, plastic bags, pots or cans. Plant bands are little bottomless cells of thin wood veneer or asphalt-treated paper that are useful temporary containers when large numbers of seedlings are to be transplanted. Each type of band has its staunch advocates, so it remains for every grower to try various kinds so that he may settle

upon one that best suits his requirements. For a week or so the banded plants must be protected from the sun, then the amount of light is gradually increased. Transplanting to nursery rows should be completed while the larger part of the root system is still within the bands. In this manner most of the feeding roots are transported with the plants that are being removed. If, on the other hand, the plants become too large, a great many roots are left behind, to the detriment of the seedling.

Some growers leave the bands intact, just barely hiding the top edges below the surface of the earth; others laboriously remove each plant cell. This, also, is a matter that must be worked out by each individual.

Choose a cool, cloudy afternoon for transplanting if it is at all possible, and water well to eliminate air pockets.

Larger containers may be made from roofing paper or purchased under proprietary names. As the asphalt-impregnated paper deteriorates rapidly in soil, roots will soon penetrate the sides of these pots. For this reason they are recommended for temporary use only. Roses, papayas and avocados are frequently offered for sale in pots that hold about a gallon of soil. Bags of black plastic are popular containers for growing nursery plants.

#### STRATIFICATION

Stratification, as used in horticulture, is the preserving of seeds by spreading in layers alternating with sand. For seeds with extra hard coats and those which need after-ripening this method provides suitable temperatures, moisture and air, and safety from pests as well. While stratification is used frequently in temperate regions, it may be used as an aid in germinating seeds of certain species of the family Rosaceae in the Tropics.

While the word stratification implies that the seeds are placed in layers, research has demonstrated that a jumbled mixture with sand that is agitated by shifting about every few weeks may give better results.

A box with large drainage holes can be used; better, a basket of quarter-inch hardware cloth can be made to the desired size. Place an inch of sand in the bottom and then build up layers of seeds and the medium, or a jumbled mixture, until the container is nearly full. A final blanket of sand is spread across the top and screen wire is secured across the opening as protection against rodents. The container of stratified seeds may be buried on the shaded side of a building, under a tree or in a lath house, provided the area is well drained. In no case should seeds be stratified in poorly-drained soil. While the stratifying medium may be allowed to fluctuate in moisture content, if it dries out completely mortality of the seeds will be high.

After 90 to 100 days, when inspection shows that the seed coats have begun to crack, pot the seeds or line them out in nursery rows.

In tropical America, where temperatures are always mild, such a box of stratified seeds may be placed in humid cold storage at 35 to 45 degrees F. for several months.

## MANAGEMENT OF GROWING PLANTS

When the young plants, show an abundance of well-developed roots an inch in length they should be potted.

Potting soil should be loose in texture, high in fertility, rich in organic matter, free of toxic substances and, slightly acid in reaction.

An alkaline reaction of the potting soil, caused by the presence of such materials as mortar, bits of builders' lime, limerock or shell, is unsuitable.

Compost makes good potting soil. The compost pile should be located in a well-shaded spot so that decomposition of the organic matter through exposure to the sun will not be excessive. Satisfactory ingredients are cow manure, leaves and field soil. These components should be piled in alternating layers, sprinkling each layer lightly with balanced commercial fertilizer that contains minor nutritional elements. The top of the pile should not be peaked or pointed but should form a basin that will hold water that may seep through the compost. It is important that the pile be kept constantly moist. In two or three months the soil should be sliced down with a shovel, thoroughly re-mixed and repiled. Aging improves the quality of compost, so it should be allowed to stand for 6 to 12 months if possible. Weeds must be kept off lest they devitalize the compost by their heavy feeding. Finally, when the compost is needed for potting or for seed flats, run it through a soil shredder or turn it through a screen of half-inch hardware cloth to assure proper pulverizing and mixing. Add sufficient water as necessary. When a handful of the compost is squeezed, then released, the soil should show the mold of the fingers and should crack slightly. In no case should the potting soil be so wet that it will retain the mold of the fingers without cracking, nor should it be possible to squeeze water from the soil at potting time. Just before using this potting soil it should be made free of weed seeds and harmful organisms by cooling, treating with MC-2 or Vapam.

## FERTILIZING

Nursery plants must be fertilized so that they will make good growth, assume beautiful form, and be clothed in pleasing foliage.

There is variation among plant species in requirements for nutrients and trials with different fertilizers will reveal the ones best suited to a grower's particular need. However, a general mixture, such as 6-6-6 or 8-8-8, will suffice in most cases.

Fertilizers may be applied shortly before plants produce new growth and at intervals of a month or two thereafter during the growing season.

It must be remembered that commercial fertilizers will burn tender foliage or roots when they come in direct contact, consequently it is best to water the fertilizers well at time of application.

The cost per unit of nutrient element, and not the cost per bag, must be borne in mind when shopping for fertilizer. High analysis fertilizers are popular today not only because they are efficient and easy to apply, but because the cost per unit may actually be less per pound than in mixtures with lower analysis.

Now that containers are so widely used for growing nursery stock, liquid fertilization assumes a place of importance.

Complete soluble high-analysis fertilizers under various trade names can be bought in 25—, 50—, or 100-pound drums and dissolved at rates indicated upon the labels.

### LAYERING

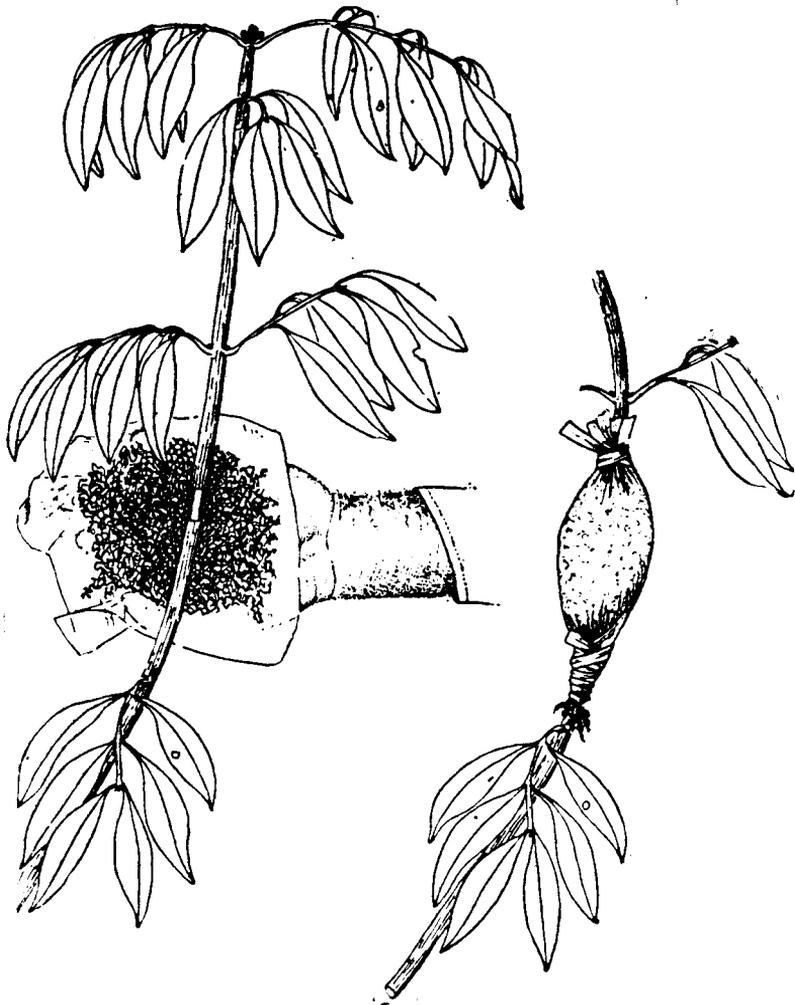
One of the surest ways to increase plants is by layering. In this method, a stem is induced to root while it is still attached to the plant. Mounding moist, sandy soil about growing shoots during the rainy season supplies an environment conducive to the production of roots. Shoots to be layered are young growths that will separate from the old plants without damage. If the stock plant to be increased by layerage does not have an abundance of small, pliable canes it should be cut off just above the ground and then willowy sprouts will be ready for mounding within a year's time.

It is usually advisable to wound stems to be covered with soil. This mutilation inhibits the free movement of food materials and helps to induce root formation. The bark may be simply broken or scraped for a couple of inches, a ring of bark can be removed completely, or a tongue can be cut and this kept from healing back by inserting a sliver of wood.

Branches must be held in firm contact with the soil, because if the branch is moved about during watering, good contact with the soil will be broken and rooting may not take place at all. Watering must be frequent, as a moist medium is necessary for the formation of satisfactory root systems.

The time necessary to form systems that are adequate to support the new plants will vary with the species, and the moisture content of the soil. This can be carefully removed for inspection of the buried portions every four or five weeks. When there are many roots three or four inches long the shoots should be cut away from the parent plant and potted or lined out as new individuals.

Air layering, or marcottage, is a method used to increase lychees, rare bougainvilleas, new hybrid crotons and hybrid hibiscus; while dracaenas, ficus and other tropical plants that have become "leggy" and have shed their lower leaves are given new root systems by this method. Just below the leaf mass a ring of bark is removed or a cut is made partly through the stem and a splinter is inserted into this incision so that it does not grow shut. A mass of moist sphagnum or other soft moss the size of a baseball is placed around the stem where



**Fig. 1. Air layering is a simple, yet efficient method of vegetative propagation**

the incision is made. Aluminum foil, or polyethylene plastic is used to wrap this type of layer, as illustrated in Figure N<sup>o</sup> 1. In this ball of moist sphagnum moss roots will grow quickly and abundantly. When inspection shows that the ball is well filled with roots, cut the stem through and pot the new plant in fresh soil.

Air layering is best practiced when there is abundant rainfall and high humidity.

#### PROPAGATION BY DIVISION

This easy and rapid way of increasing plants is a method used with ferns, orchids, bamboos, herbaceous perennials and some palms.

The plants, except in the case of the large specimen palms, are dug and shaken free of soil. It will be apparent, then, that the clumps can be divided up into units or small plants, each having roots, stems, buds or leaves. These units are separated and planted as individuals where they are to grow permanently. Plants are best divided after their season of blossoming, and during the rainy season.

With such palms as *Chrysalidocarpus lutescens*, *Caryota mitis* and some *Rhapis* and *Phoenix* species, division is accomplished by carefully separating the small suckers as they become well rooted at the base of the older plants. These separated suckers may be potted up and handled the same as small seedlings. It has been written that it is possible to reproduce any plant from a cutting, and while this statement is somewhat beyond the realm of practicability, the fact remains that most favorites may be so multiplied.

A cutting might be defined as a separated portion of a plant that is induced to form roots in a new environment. The tiny bit of living plant thus rudely removed from its source of water and nutrients is dependent upon the skill of the gardener to carry it through the critical period until a root system, adequate to maintain the new individual, is developed.

The rainy season, characterized by almost continual high humidity, is an excellent time to root cuttings with basic, minimum equipment. As it has been recorded that environmental conditions that are suitable for the growth of mature plants are congenial for the rooting of terminal growths as cuttings so it follows that the period, July-October, is ideal for taking softwood cuttings. These are leafy tips of the last flush of growth that are still immature and non-woody. The season at which cuttings are taken (the age of the cutting wood) is very important, and all propagators arrive at the proper season for taking cuttings of each variety by trial.

Cuttings must be taken from stock plants that are true-to-type and free from pests.

Softwood tips three or four inches long are cut from healthy plants with a sharp tool and are immediately placed in plastic to protect them from the sun and drying winds. Cuttings may be made from below the terminal growth, as well.

The upper two or three leaves are left intact, as cuttings will produce heavy root systems more quickly when a large leaf surface is present to supply food materials, hormones, and vitamins. Investigations have shown that the old nursery practice of removing halves of the upper leaves actually prolongs the time that cuttings must remain in the propagating frame. Terminal leaves that are unusually large, however, must be reduced to economize on space in the cutting frame.

Beginning at the base of the cutting, trim the leaves with a sharp knife or, if the leaves come away readily, considerable time can be saved by stripping rather than laboriously cutting through each individual petiole.

If it is planned to use a root-stimulating powder, now is the time that it will be needed. The basal ends of the cuttings are moistened in water and then dipped one-half inch into the white powder. Excess dust is shaken off by tapping the cuttings against the side of the jar.

In the rooting medium, then, open holes to a depth of about four inches and insert the cuttings at a considerable slant so that the leaves lie directly on the rooting substance. This material is pressed firmly around the cuttings and leveled off, after which the whole batch is gently flooded with water. It is no longer considered good horticultural practice to hammer the rooting medium solid with a brick and then open a furrow with a blunt knife.

After flooding the cuttings in, cover the box with a piece of glass substitute. For reducing the sun's glare, shade should be suspended over the box. The cover must be lifted each day so that the leaves can be sprinkled with a mist-like spray.

#### LEAF-BUD CUTTINGS

Investigations have shown that plant tissues in the region of buds are likely to be rich in food materials and hormones. Therefore, these tissues make good propagation material, even though the amount of wood used may be extremely small as compared with a standard cutting with long internodes. It is understood, of course, that the environment must be wholly congenial if a high percentage of plants is to be obtained.

A one-inch shield of stem tissue with dormant bud and single leaf attached is cut exactly as though it were to be used in shield budding. The cutting is placed in the rooting medium that has been found best adapted for the particular species being increased. The stem tissue and the axillary bud are barely covered and the untrimmed single leaf lies flat on the moist rooting medium. It is important that the area of the leaf attached to the bud not be reduced, yet with very large-leaved plants, such as some crotons, it may be necessary to cut down the leaves to get the best value from the cutting bench.

The time required for a leaf-bud cutting to form a heavy root system depends upon the season, the variety, and the environment into which the cutting is introduced.

An 18-inch cane from a bougainvillea or hibiscus plant might give but four regular cuttings, whereas the same shoot might yield 20

or more leaf-bud cuttings. Generally speaking, it is best to take these cuttings from shoots that are half-hardened and non-woody; they should be neither succulent and sappy nor woody and hard.

If there is a distinctly limited amount of propagating material available, as is often the case with rare plants, the leaf-bud cutting method should be useful. It has given gratifying results with certain varieties of ficus, bougainvilleas, crotons and hibiscus in numerous trials.

#### LEAF CUTTINGS

Although most woody plants must have a vital shield of stem tissue that contains an axillary bud for successful shoot growth, certain herbaceous pot plants, particularly gesneriads such as African-violets and gloxinias, may be increased by placing a leaf with its petiole or leaf-stalk (without chip of stem tissue) in moist sand.

Rex and Lorraine begonias, peperomias, kalanchoes and crassulas are succulent pot plants from various families that will grow from leaves or leaf fragments placed in moist sand and kept humid. Pieces of sansevieria leaves will readily produce small plants. Some bulbous plants, particularly members of the lily and amaryllis families, will form small bulbels when a leaf is inserted base-down in moist sand.

#### HARDWOOD CUTTINGS

This class of propagating material consists of mature branchlets of woody plants from which the leaves have already dropped. Some deciduous fruits, rose understocks and various ornamental shrubs are propagated in this manner.

Cut pencil-sized stems into 12-inch lengths, carefully cut off all but the two uppermost eyes, and set the cuttings directly in nursery rows. Two inches, or one eye, of each cutting is allowed to stand above the surface of the soil. Firming the soil around the cutting, and watering, eliminate air pockets and assure a good contact between the cuttings and the soil.

Frequent irrigation is requisite for success.

#### ROOT CUTTINGS

Root cuttings may be made as follows: Expose carefully some of a plant's larger roots, trace them down until they are about pencil size, lift and, after cutting them into three-inch lengths, set them in a box or bed of sand or sterilized compost. The root fragments may be laid horizontally, at a 45° angle, or set vertically. It is essential that the end nearest the body of the plant be upward, and it may protrude a half inch above the surface.

When root cuttings are made up, cut the tops (nearest the body of the plant) square and the bottoms (which go downward) at a sharp slant, so no mistake will be made at time of insertion. Water root cuttings with care to assure good contact with the soil and cover with

a newspaper to maintain a humid atmosphere. When shoots begin to appear from adventitious buds remove the covering material. Transplant to permanent locations after one growing season.

When a sharp spade is driven deep into the earth about well-established plants of some species, small plants will arise from the cut ends of pencil-sized roots. These new plants may be dug after one season's growth and set out as individuals.

#### PROPAGATING CASES

A simple bed underneath a shade structure or tree, made by placing boards to hold the rooting medium and to support covers, is sufficient for vegetative propagation. Success with leafy cuttings and grafts placed in such a bed during the rainy season should be the general rule.

For ease and efficiency, raised benches may be preferred. The bench bottom must have an abundance of cracks or holes to assure the free passage of excess water out of the rooting medium. Aeration, vital to root growth, is assured when there are many drainage holes or half-inch cracks in the bench bottom.

The case must be at least eight inches deep so that there may be five inches of rooting medium and adequate head room for leafy tips of the cuttings or grafts. The sash that fits over the top of the propagating case may be fitted with glass or covered with polyethylene film.

A water supply must be near at hand so that the cuttings can be sprinkled at least once during each bright day.

Investigations have shown that a temperature suitable for optimum growth of a mature plant is a very acceptable temperature for the rooting of its tip cuttings.

#### ROOTING MEDIA

A congenial medium to hold the cuttings during their period of rooting is of utmost importance. Formation of a waxy protective layer at the wound is essential and to this end oxygen is necessary, as are moisture and a slight acid reaction for most plants. Materials to be used as rooting media must be relatively cheap, easily accessible, retentive of moisture, open in texture and free from toxic substances or rapidly decaying organic matter. Fairly coarse material is preferable to very fine and an open, porous, light, airy condition is desired.

Sand is the most widely used propagating material, yet research has shown repeatedly that it is not necessarily the best substance for rooting cuttings. Other materials, either in combination with sand or alone, are sometimes vastly superior to this traditional cutting-bed material. As the need for more than one medium is seen, beds may be subdivided so that several different mixtures are available.

Cuttings of many types form heavy root systems most quickly in mixtures that contain acid organic matter. In wet, warm weather disease may enter this congenial environment and take a heavy toll of cuttings as it progresses across the bench. A bath of Ferti-am or

Captan, made up at the rate of a tablespoon of the powder to a gallon of water may control disease when it is applied at very first signs. Unless new boards and medium and scrupulous sanitation can be used, propagation in mixtures which include much organic matter should be completed during the coolest weather of the year.

Research has demonstrated that many different products that are coarse, inert, easily accessible, and inexpensive can be used as rooting media. Sawdust can be used for rooting cuttings, and this by-product is widely available at no cost. Coarse, yellow sand is the tried-and-true medium for rooting cuttings either alone, or in mixture with organic materials. Sub-surface sand dug from holes two or three feet deep is an excellent, inert, slightly acid, weed-free medium that may be used alone or in mixture.

### SANITATION

Sanitation is extremely important and sterilization by soil fumigant, such as Dowfume (MC-2) or Vapam, or the frequent renewal of the rooting medium is positively essential in tropical climates. Soil-borne diseases of several kinds are very likely to work into the beds and play havoc with the cuttings unless fresh or sterilized materials are used after each batch of cuttings has been potted. Cost and labor are certainly a great deal less than the value of a batch of rare cuttings. It is essential that the site and all boards be thoroughly sterilized if they are to be used for a second batch of cuttings.

Ferbam and Captan, sterilizing agents referred to earlier, should give reasonably good control of disease when used according to directions printed on the labels. Fungicides actually speed rooting of some species, retard the phenomenon in others, hence their value must be established by trial. Some successful propagators dip all cuttings in a bath of one of these just before sticking them in the rooting medium.

### DOUBLE POT METHOD

When only a few rare cuttings are available for rooting the double pot method can be recommended. Use a seven — or eight — inch clay flower pot and, in the bottom, place a couple of inches of potsherds or coarse gravel. Next, fit a three-inch tightly-stoppered, clay pot in the center and pack the rooting medium between the two. The cuttings are set in the rooting medium in concentric rings and flooded in. The three-inch, tightly-stoppered, flower pot in the center serves as a well from which moisture will move by capillary attraction throughout the rooting medium. Before the medium becomes dry the pot can be refilled. To assure high humidity around the leaves secure a dome of polyethylene plastic stretched over ribs made from heavy wire.

Many cuttings should form heavy root systems within six weeks. When inspection shows that there are several roots an inch or more in length the rooted cuttings may be carefully lifted with a knife or trowel and potted in a fertile, composted mixture. Careful watering and shading are needed to help the new transplants to become established.

## MIST PROPAGATION

In this system of vegetative propagation water vapor is played across leafy cuttings. When water runs continuously, it is called constant mist; if a clock-timer turns the water on and off at stated intervals, it is known as intermittent mist. If no timer is used, the propagator can turn the water on before sunrise, and, on still evenings, he may close the valve about sundown. If the wind is blowing, however, the mist must bathe the cuttings all night, lest they dry out and die.

Mist propagation is based upon an efficient atomizer. Precision instruments, available in several styles and under several brand names (Monarch, Magic Mist, Thompson, and others) are engineered to break water into the fine droplets needed for mist propagation.

A convenient backyard mist propagator can be made easily from a discarded oil drum. Run one-half-inch pipe from your water supply up through a hole in the bottom. Fit some metal or plastic screen wire around this and fill the drum to within six inches of the top with small stones. Next, insert five inches of the medium you have decided upon for the rooting of your cuttings, screw your mist fitting on the end of the water pipe, turn on the water and you are ready to insert greenwood, leafy cuttings.

Under this system the medium and the vessel that holds it do not have to be sterilized, cuttings require no sterile bath and glass structures overhead are eliminated. These savings will offset the cost of equipment and water. One real advantage is that extra large cuttings of many species can be rooted just as easily as small ones.

Various materials can be used as rooting media in the constant mist system. Coarse yellow sand and sterile organic matter, sand and perlite, and sawdust and coarse sand and even a grid of hardware cloth or poultry netting have been used with success. Coarse sand will serve, but fine-grained materials do not drain fast enough and allow for sufficient aeration. In all cases, the rooting stratum must be between four and five inches thick. This will be well aerated, and rooting should take place rapidly.

As soon as cuttings are well rooted, they can be potted and placed around the outside of the oil drum on the ground so that the foliage is moistened occasionally as the air moves the vapor about. Care must be observed, lest the soil in the containers become waterlogged. Gradually move the new plants away from the mist, so that within two or three weeks they are hardened to endure field conditions.

## ROOT-INDUCING SUBSTANCES

Root-inducing substances might be defined as those synthetic chemicals which have hormone-like action upon cuttings in that they may stimulate root formation. True plant hormones are complex orga-

nic substances produced by leaves and are found in the regions of buds. These hormones are transported by the vascular system and may influence the root-ability of cuttings.

Several chemicals, dispersed in talc, and sold under various trade names in garden supply stores, may speed the rooting of cuttings of some species when they are used according to directions. Carefully selected cuttings of the correct age and size, when dipped in one of these powders, can generally be expected to produce heavy root systems more rapidly than untreated cuttings otherwise handled in the same

It must be forcefully stated that these chemical compounds are not substitutes for skill, but rather they may be aids to rapid rooting. The operator must control the environment into which the cuttings are set just as carefully as he would if no stimulant were used. Careful attention must be given to temperature, humidity, moisture and shading so that the environment will approach the optimum as closely as possible.

The season at which cuttings are taken is highly important and many so-called difficult plants may respond well if the propagator arrives at the proper season (in some cases a very narrow period) through trial.

Scientific investigations have shown, and forward-looking propagators agree, that cuttings from young plants (from seed) will root more readily than comparable cuttings from old mature plants. Furthermore, cuttings taken from the lower portion of a shrub or tree, near its root system, will root with less difficulty than those taken from upper regions. It is acknowledged that ease of rooting increases as cuttings are taken nearer root systems, provided, of course, that those cuttings are in an acceptable state of vegetative growth, and that they are carefully handled through each step in propagation. This phenomenon is accounted for by the fact that the root-promoting hormones are thought to accumulate toward roots.

#### PROPAGATION BY BUDDING

The insertion of a shield of stem tissue, with a single axillary bud, in an incision in another plant is known as budding.

Success depends upon intimate contact of the cambium layers of the stock and the scion. This can be assured when the bud shield is cut with a very sharp blade, insertion is carefully done, and the finished work is held snugly with an acceptable, waterproof tying material.

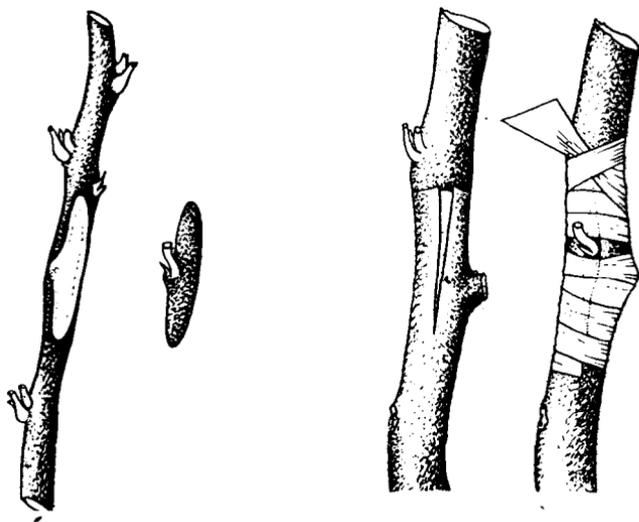
The common shield bud with the incision in the understock in the form of a T, or an inverted T is most popular. The buds are cut

from firm, round twigs, slightly smaller than a pencil in diameter. Carefully cut off the leaves with a sharp instrument, leaving a short piece of each petiole for easy handling. After the budsticks are prepared, carry them in a plastic bag to prevent their drying.

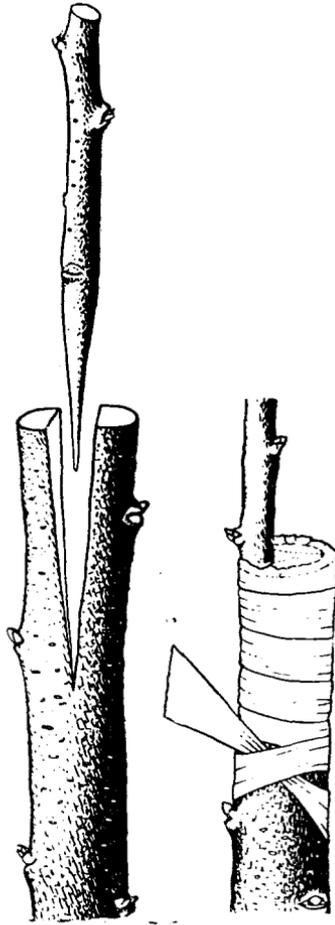
Figure N° 2 clearly demonstrates steps in inserting a shield bud.

Many propagators use budding strips of rubber. These exert an even pressure without cutting the bark of the understock; they do not require as close attention as do other binding materials, and ordinarily they do not have to be cut, as they deteriorate after a short while and fall to the ground. The bands, available at horticultural supply houses, are convenient and inexpensive and can be used very efficiently after a little practice.

Uncolored polyethylene has become very popular for tying buds. Cut into strips one-half inch wide and ten inches long; this plastic is pleasant to handle and it protects the work effectively. Plastic wraps must be cut away after three or four weeks, or buds may be injured.



**Fig. 2. Budding is the most popular method of increasing citrus varieties. It is also practiced with roses and many other horticultural plants**



**Fig. 3. Cleft grafting, a method used more commonly in the tropics, for top-working trees of various sorts than for young plants in the nursery**

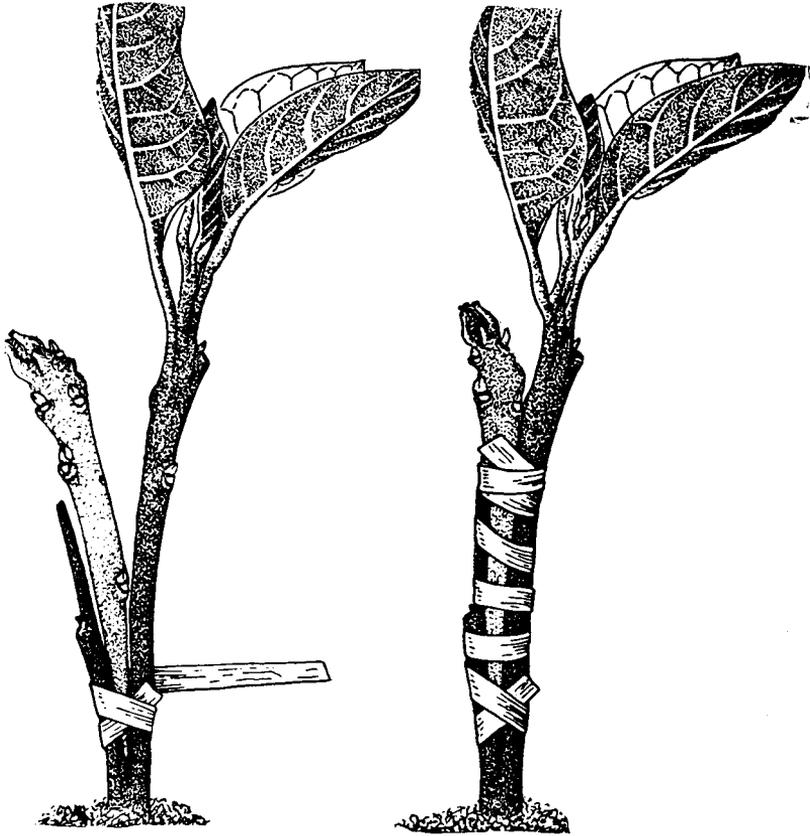
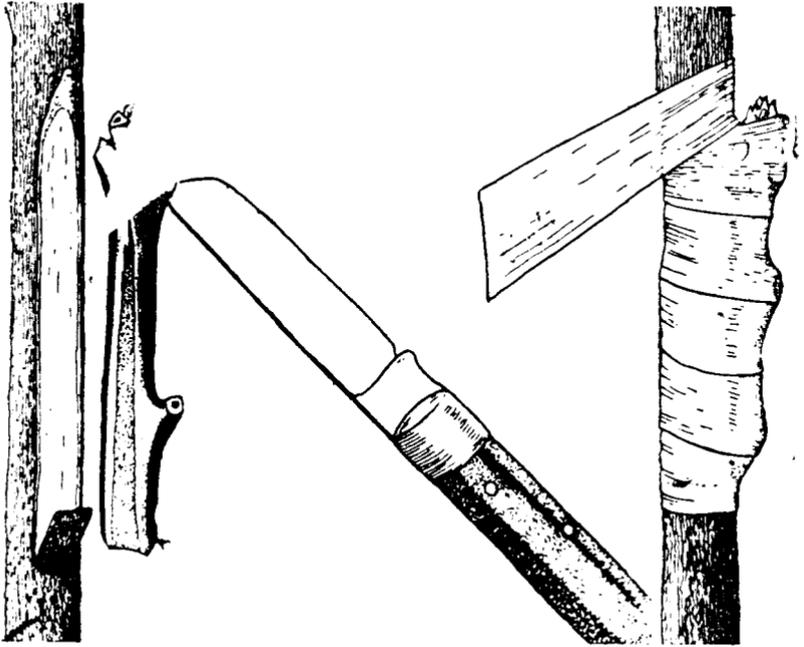


Fig. 4. Side grafting. On the right, the graft is completed and tied with rubber grafting strip



**Fig. 5. Veneer grafting. On the left, scion ready for placing on the stock plant. Note the notch at the lower end of the cut on the stock, useful in holding the scion in place while wrapping proceeds. On the right, the graft has been wrapped with vinyl film, leaving only the tip exposed so that the terminal bud may break into growth**

Roses are budded below the ground line, avocados and mangos one to three inches above the surface. In climates where gumosis is a factor, citrus root-stocks resistant to gumosis disease are budded twelve to eighteen inches above the ground.

The chip bud can be used when bark will not peel or slip. A one-inch slice, with the lower cut sloping inward, is cut in a *small stock*. A chip with one dormant bud toward its thickened base is cut from the variety to be increased, in exactly the same fashion. This is fitted into place with the cambium of the bud aligned with the cambium of the stock on at least one side, and bound with a rubber or plastic budding strip. Mangos and roses are successfully increased by the chip bud method and, because the stock is injured but little, it can be used over again, the same season, in the event of failure.

With citrus, as soon as the bud starts to grow the stock plant is carefully cut off at an angle half an inch above the bud. It is preferable to "lop" certain types of plants, that is, cut the understock part way through several inches above and on the same side as the bud and allow it to lie over ground on the side opposite the bud. In some cases this system will start buds that are lying dormant and will also help to prevent drowning by excessive sap.

Staking is important to prevent the bud from being broken at the point of union and for this purpose a wooden stake must be driven close to each budded plant so that it may be tied securely with soft cord every six or eight inches as the plant grows taller.

#### PROPAGATION BY GRAFTING

Grafting, the method of reproducing plants by inserting a twig with several buds in an incision in a stock plant, is a favored way of increasing hibiscus, gardenias, mangos, avocados and many other fruit trees. Certain kinds of cacti are produced by grafting in specialty nurseries.

Just as in budding, intimate contact between cambiums of stock and scion is requisite to success in grafting.

When rootstock plants are more than an inch in diameter the cleft graft method is favored. The stock is cut off several inches above the ground with a sharp saw or pruning shear, split with a small, sharp heavy knife or machete, then a wedge-shaped scion carefully trimmed to a long sloping cut is inserted into this cleft. Be careful to make sure that the wedge is cut with a single draw so that the surface is smooth. Two edges of the wedge-shaped scion must be in perfect contact with cambium layer of the stock. After binding tightly with a rubber budding strip or polyethylene, the graft is coated with melted paraffin, grafting wax, or tree wound dressing to prevent desiccation.

Cleft grafts may be inserted close to the ground level or in the upper branches of large shrubs and trees, depending upon the need or the desire of the propagator.

In the side-graft method, used with hibiscus, mangos, and avocados, and many other plants, a deep, sloping cut is made into one side of an understock plant. A terminal scion about three inches long

is sharpened to a long sloping wedge that will fit into this slot. Cambiums on one side are carefully aligned, the work is bound with a rubber or plastic strip and then carefully waxed to exclude air and water. When the scion has grown a few inches the top of the understock is carefully pruned away with a sloping cut, just above the successful graft union. Budding strips must be removed at this time, if this has not already been done.

The veneer graft, quite similar to the side graft, is a comparatively simple and easy method successfully used to increase sapodillas, mangos, avocados, hibiscus, gardenias and many other plants. A cut just under the bark is made about two inches long on the plant that is to serve as the understock, with the bottom ending in a V-formed basal notch. A twig of about the same diameter is then taken from the plant to be reproduced. This scion is cut to fit the notch and the edges of the wound on the stock plant. If there is even a slight difference in size, cambiums must be aligned accurately to one edge. The work is held together by binding tightly with a rubber or plastic strip. The completed job should be waxed or covered with tree wound dressing to conserve moisture. When growth commences the top of the stock plant must be cut away and the binding material cut to relieve pressure.

In the splice-graft the entire top of the rootstock is removed with a long sloping cut. A scion is cut similarly and, after cambiums on one side are matched, the work is wrapped with cotton cord. Waxing and carrying the plants in a closed grafting case to assure high humidity is recommended. Cut the cord after three or four weeks so that stunting of the scion may be avoided.

With the whip or tongue-graft method the first step is the same as for the splice graft. A tongue is cut by making an incision across the grain on the slope of both the understock and the scion. The two are fitted together so the tongues interlock and the cambium layers join at least on one side. Binding with cord and waxing finishes the job. This is a somewhat difficult type of graft but it is a favorite method in large propagating nurseries because of its strength.

Cacti can be grafted easily by making a sloping cut with a razor blade in any position upon a selected stock plant. The scion is sharpened to fit into this slot, then held in place with two or three long cactus thorns. Pins or nails will rust and thus cause injury, so failure may be expected if cactus thorns are not at hand. Waxing is not requisite for success in grafting cacti.

## ROOT GRAFTING

Root pieces may serve as cuttings and they make good grafting stocks as well. Use care in tracing out the major roots of a plant until they are about pencil-size. Lift the roots carefully and cut them into three-inch lengths with a square cross-cut to identify the end nearest the body of the plant and a sloping basal cut for the downward-pointing distal end.

Splice grafting is recommended for novices. With a very sharp knife cut the upper, square end of the root piece to a long, sloping diagonal. Cut a two-inch scion in exactly the same fashion, fit together, aligning the cambium layers on one side, bind and dip the scion and matrix in melted paraffin to complete the work. Carefully plant the finished grafts in a propagating case, then flood the sand with a gentle stream of water to eliminate air pockets.

If the cleft graft is preferred, a wedge-pointed scion is fitted into a split in the square-cut, proximal end of a root piece. The work is bound with rubber or plastic strip, and dipped in melted wax before planting.

Union should be well started within a month, after which the binding material can be cut. New roots will form, then shoots in about 60 days. Growing piece-root grafts should be carefully lifted, with ball of the rooting medium clinging to the roots, and placed in containers of fertile, friable compost. Protect the transplants from sun and wind and attend to watering carefully.

## USING SAWDUST

Sawdust may be used as a rooting medium for cuttings, to improve the physical condition of soils, and as a mulch. As a mulch it insulates the soil against wide fluctuations in temperature, discourages weed growth and reduces evaporation of soil moisture. However, there is a difference of opinion as to its merit. Some operators have long used this easy-to-get forest by-product in large quantity with complete success. Others have had unfortunate experience with sawdust and have discarded it as unsuitable to their needs.

Possibly a lack of understanding as to how to handle sawdust has caused some of these failures. When sawdust is incorporated with the soil it requires large quantities of nitrogenous fertilizer if the plants growing in the soil are not to suffer from nitrogen starvation. The organisms in the soil which break down cellulose require appreciable amounts of nitrogen and will use up all available supplies of this element.

It has been estimated that 24 pounds of nitrogen are required per ton of sawdust from some species of pine to bring the nitrogen content up to 1.2 to 1.5 percent, the values needed for decomposition without inducing nitrogen deficiency in plants. This would equal 115 pounds of ammonium sulphate or 72 pounds of ammonium nitrate per ton of sawdust during the period of its decomposition, which may be two or three years. A 4-inch layer of loose dry sawdust over a space 20 x 30 feet weighs a little over a ton. A bushel of sawdust (10 to 15 pounds) requires 0.8 pound of ammonium sulphate or 0.5 pound of ammonium nitrate. When the sawdust is used as a mulch, nitrate fertilization is not required to the extent that it is when the material is incorporated with the soil.