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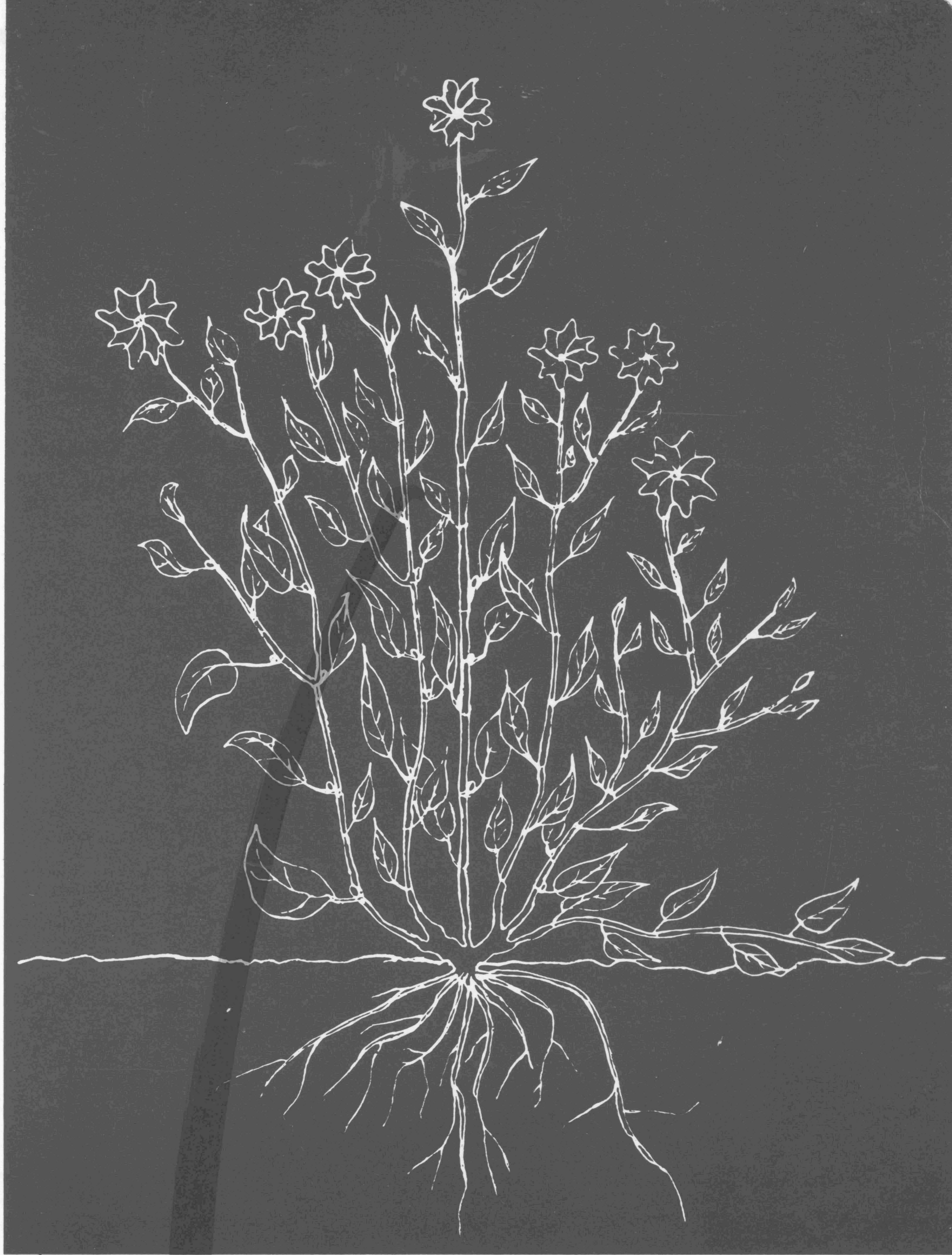
September 1970



The Propagation of Ornamental Plants

Texas A&M University The Texas Agricultural Experiment Station, H. O. Kunkel, Acting Director, College Station

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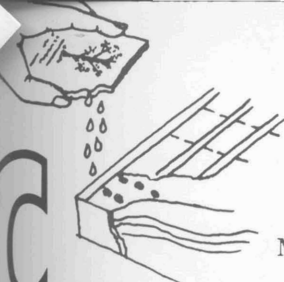
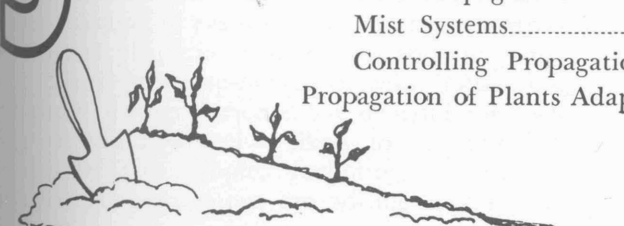


CONTENTS



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The Propagation of Ornamental Plants

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The multiplication of plants has always been of prime importance to the nurseryman and flower grower. As a fascinating aspect of horticulture, it has long been the favorite hobby of gardeners and home owners who like to reproduce plants.

Chinese gardeners were no doubt propagating plants by various methods long before recorded history. Some of the basic techniques employed then may still be in use today, but the methods have improved greatly through the centuries. Success is now the general rule because changes have continually taken place in propagation as well as in all aspects of applied science.

Recent inquiries into the physiology of plant growth have been responsible for dramatic new departures. Old beliefs have been changed by modern methods of scientific investigation and the use of new materials. Due to this increase of knowledge and development of new methods and modern materials, any operator who is careful and follows instructions can, in general, be quite successful in the multiplication of garden and landscape plants.

Plant propagation today is much more than custom and manual dexterity. The amateur as well as the professional plant propagator must keep abreast of the research being done to be assured of continued success.

In Texas and the Southwest the climate offers many varied challenges to the home gardener as well as the professional plantsman. At this time there is an overproduction of easy-to-propagate, rapidly growing species of plants in smaller sizes and the usual scarcity of well grown specimens of oaks, hollies and other plants of rarer varieties. A demand for such garden subjects, however, is likely to continue. A comparatively few people, including professional plantsmen and propagators, are willing to take the time and effort required to produce finished landscape plants of slower growth and usually more desirable quality.

Plant propagation is important to satisfy the present demand of gardeners in the varied climatic regions of Texas from the sub-tropical Gulf Coast and the Rio Grande Valley to the colder winters of the Panhandle; and from the forest areas of East Texas to the arid regions of West Texas.

METHODS OF PLANT PROPAGATION

Sexual Propagation

Propagation by seed is a sexual process; many flowering ornamental plants can be increased rapidly in exceedingly large numbers by this method. A commercial propagator with five marigold seeds of a certain variety can produce several hundred pounds of seed in several successive harvests.

Sexual propagation which is an easy and rapid method of increasing plants that produce seed which germinate readily might well be the only method of plant propagation except for several important reasons.

Some plants, especially hybrid varieties developed by plant breeders, do not produce seed or are sterile. Other hybrid varieties may produce seed abundantly, but the resulting offspring produced by these seeds will not resemble the parent plant. In the language of the horticulturist, these plants do not "come true" from seed. And lastly, in many woody ornamental plants, the seed produced is difficult or almost impossible to germinate without specific and time consuming treatments of various kinds.

Asexual or Vegetative Propagation

Science has shown that every plant, as well as every other living organism, is made up of combinations of living cells. Each individual cell has all the potential of the entire plant of which it is a part.

Except for some of the lowest forms, members of the animal kingdom do not at present have the ability to form a whole animal from a small part. The higher animal forms cannot regenerate any lost part of the living organism. However, any portion of a plant when severed from the parent and placed in the right environment has the potential to regenerate not only lost parts but become a complete new plant exactly like the parent. This capacity for regeneration in the higher plant forms is the basis of asexual plant propagation.

There are many different types of vegetative propagation. Some occur naturally such as bulblets produced at the base of the leaves of certain lilies, on the sides of the mother bulbs on tulips or by runners such as those found on many ferns.

Other types of asexual propagation have been greatly improved or devised by horticulturists. Those most important and most widely used at the present time are: stem cuttings, leaf and leaf bud cuttings, root cuttings, layering, division, separation, grafting and budding.

Vegetative propagation is often both necessary and desirable to perpetuate the hybrid characteristics of the parent plants or to propagate plants that produce seed that is difficult to germinate. In many cases vegetative propagation is used to increase desirable new varieties in a shorter period of time or to produce mature plants more rapidly than they can be produced from seed.

Propagation by Seed

The most universal method of propagating ornamental plants is by seed. All commercial horticulturists or home gardeners at one time or another grow plants by this method. But the techniques employed and results vary greatly. However, scientific research has developed certain simple procedures that, when carefully followed, can insure the successful increase of many kinds of plants from seed.

The types and kinds of ornamental plants usually propagated by seed are annual flowers, herbaceous perennials, many woody trees and shrubs and most palms.

Sources of Seed

Many years ago home gardeners saved seed from the plants in their own gardens. Today this practice is hardly worth the time and effort involved. The greatest number of present day ornamental woody plants, garden annuals and perennials and vegetables are hybrids of mixed ancestry that will not come true from home collected seed. Results from such seed are usually disappointing.

Commercial seed producers grow seed by special techniques that insure they will produce the exact kind of plant desired.

Seed purchased from reputable seedsmen are much more satisfactory and, except for certain rare plants or new varieties, are very reasonably priced.

Seed should be sown when fresh. Most ornamental plant seeds will not stay viable for longer than 1 year—a few kinds remain for even shorter periods of time.

Types of Seed

Annual Flower and Vegetable Seed

When properly sown and placed in the right environment, flower and vegetable seed present few germination problems.

Herbaceous Perennials and Woody Plant Seed

Seed of some woody plants may present germination problems. The simple germination practices used in growing annual flowers and vegetable seed are often unsuccessful for many perennials and woody plant seed. There are various reasons why some of these seed are difficult to germinate. The propagator must understand the factors involved in the creation of these problems so that such seed can be handled in the proper manner.

Seed Dormancy

Environmental factors such as moisture, temperature, oxygen and, in some cases, light have a great influence on seed germination and must be in proper balance for this process to take place in easy-to-germinate seed as well as difficult ones.

Dormancy is a term applied to the inability of a viable seed to germinate readily. The cause may be due to unfavorable environmental conditions or to factors within the seed itself.

Oxygen and water are necessary not only for germination but for all plant growth. These requirements will be discussed later in outlining the requirements for the germination of all types of seed.

Some seed of woody and herbaceous perennial plants have peculiar temperature and light requirements. Most seed will germinate in either light or darkness, but a few require light for germination; others are inhibited by it.

Most seed in this group will germinate over a wide range of temperatures, but others have more specific requirements.

Dormancy caused by internal conditions is often overlooked by plant propagators and may be the cause for failure in growing woody plants from seed.

Perhaps the most common cause for such internal dormancy is the presence of a hard seedcoat. This coat serves as a protective covering, but it may prevent germination by excluding air and water from the seed. In some cases it has prevented the expansion and growth of the embryo plant within the seed. In other seed, the food storage tissue within the seed called the endosperm acts like a hard seedcoat.

In some seed the embryo or immature plant within the seed may not be completely organized at the time the seed is shed from the parent plant. In most cases, there are ways to speed up germination when this condition exists. Seed will germinate only after the embryo has had an opportunity to develop and mature at a favorable humidity and temperature. In some cases this may require 2 years, in others, 3 years.

The above causes of dormancy in seed are the most obvious ones. In other seed however, more complicated conditions may also occur such as *after ripening.* After the seed is ripe, a period of time must transpire before the seed will germinate. The causes of this condition are not fully known. No doubt certain physical and chemical changes must occur for the seed to germinate, and the exact nature of these changes is not yet understood.

Most propagators need not be unduly concerned about this phenomenon since after ripening can be accomplished or accelerated by placing such seed in a cold, moist environment for certain periods of time. This cold treatment is called *stratification.*

An additional cause for dormancy in seed is shoot or epicotyl dormancy. After the seed are sown and placed in a warm temperature, the roots appear; but if the shoot on the plant fails to develop, the seed are then placed in a temperature of about 40° F. for several months.

In some woody plant seed, dormancy may also be caused by a combination of two or more of the factors that inhibit germination. This type of dormancy can be overcome only by submitting the seed to combined treatments.

Treatments for Hard to Germinate Seed

Seedcoats Impermeable to Water

Three methods are commonly used to treat seedcoats that cannot be penetrated by water: Soaking in sulphuric acid; soaking in hot water or dipping for a very short period of time in boiling water; and mechanical scarification or nicking.

All three methods have been found to be effective in trials at Texas A&M University and elsewhere. When knowledge is lacking on any hard-coated seed, any of these methods can be used on a trial basis.

Sulphuric Acid Treatment

Seed to be treated with sulphuric acid is placed in a glass or glazed pottery container; then concentrated acid of commercial grade is poured into the container. The best practice is to use a volume of sulphuric acid equivalent to from three to five times the volume of the seed. The important consideration is to have every seed covered with acid.

Dry seed will tend to float to the surface of the acid, so the seed should be stirred occasionally to get all seed covered equally on all sides.

The time the seed is soaked in the acid varies with the species of seed. But even within the same species there may be a variation in the time required to *thin down* or *burn off* the hard seedcoat.

After the seed has been treated in the acid for the required period, the seed is removed; the excess acid drained off; and the seed plunged into a large volume of cold water. Then the seed should be washed for 15 to 20 minutes in running water to water to remove all traces of acid.

Sulphuric acid treatments are usually made preceding planting. It is always well to let the seed soak overnight in a large volume of water after it is washed and before it is placed in the soil or stratified.

The treated seed will absorb a large quantity of water while soaking and will be ready to germinate immediately after planting.

Hot or Boiling Water Treatment

These treatments have also been found to be very effective in making the seedcoat permeable to water.

One method is to heat the water to between 180 and 200° F.; remove it from the source of heat; and plunge the seed into it. The water and seed are then allowed to cool together. Then the seed is left to soak overnight or until it absorbs enough water to swell. This method is very effective on some seed, but it fails on others.

The use of boiling water on seed is much more effective than this first method, but greater care must be exercised. When improperly handled it is very easy to kill or damage the seed.

The seed to be treated is placed in a cheese cloth or muslin bag and dipped into the boiling water from periods varying from 30 seconds to 2 minutes (rarely any longer than 2 minutes), depending upon the seed to be treated. Since this treatment is very brief, seed must be removed as quickly as possible.

A convenient way of handling this is to tie a long piece of string or twine to the cloth bag so that it can be removed quickly and safely from the boiling water at the end of the specified time.

Mechanical Scarification

This is an inexpensive and often effective way of making the seedcoats of some seed permeable to water. The purpose of such treatment is to wear off or scratch the seedcoat with some mechanical device.

When only small numbers of seed are to be treated this is often done by scratching or nicking each seed with a needle point, knife, 3-cornered file or some similar tool. When large amounts of seed are used, a scarifier of some type may be constructed to save time.

The basic principle of a scarifier is a large, rough surface against which the seed can be thrown, blown or rubbed with sufficient force to scratch the seedcoat well.

Dormancy of the Embryo

Embryo dormancy is the most common cause of a natural delay in seed germination. Seed which has a dormant embryo must complete after ripening before it has the ability to germinate.

SEED PROPAGATION TREATMENTS FOR SOME TEXAS LANDSCAPE PLANTS

Name of plant	Recommended treatment	Remarks
Albizzia julibrissin (Silktree albizzia)	Break seedcoats by any of the following methods: Nick with knife, dip in boiling water for 30 seconds, or soak in full strength commercial sulphuric acid for 15 to 30 minutes.	If sulphuric acid is used, wash in running water for 10 minutes after seed is removed from acid, then soak in fresh water for several hours before sowing. Germination—5 to 10 days.
Cercis canadensis (Redbud)	Soak in full strength commercial sulphuric acid for 20 minutes. Stratify in moist peat at 35° to 40° F. for 60 days.	When seed is removed from acid, wash in running water for 10 minutes. Soak in fresh water for several hours before stratification. Germination—10 days to 3 weeks.
Chilopsis linearis (Desert Willow)	Use freshly gathered seed; soak in water several hours before sowing.	Germination—9 to 30 days.
Diospyros texana (Texas Persimmon)	Fall planting: Soak seed in concentrated sulphuric acid for 30 minutes, wash thoroughly and plant. Spring planting: Keep air-dry at room temperature, until ready for planting.	Stratification of freshly cleaned seed was fatal to this species after 1 month of treatment. Germination—20 to 30 days.
Diospyros virginana (Common Persimmon)	Stratify freshly cleaned seed in moist peat 36° to 41° F. Seeds will be ready for planting in 30 days.	These seed will not germinate at these temperatures and can be left in stratification until spring without damage. Germination—40 to 60 days.
Duranta stenostachya (Brazil Skyflower)	Soak in concentrated sulphuric acid for 15 minutes. Best germination will be with fresh seed.	Stratification of berries or cleaned seed was of no value. Germination—15 to 30 days.
Ligustrum japonicum (Japanese Privet—Commonly called Wax Privet)	Stratify at 41° F for approximately 120 days. These seed germinate at this temperature and must be closely watched.	Seed must be cleaned before stratification. Stratified berries gave no germination. Germination—15 to 30 days.
Magnolia grandiflora (Southern Magnolia)	Stratify cleaned seed 8 to 10 weeks at 41° F. Seedcoats will show splitting when stratified long enough. Seedlings grow slowly. Start in greenhouse in mid-winter, line out in nursery in late spring.	To remove fleshy red pulp on fruits, soak in water for 2 or 3 days. Then wash cleaned seed in fresh water. Empty seed and pulp will float. Good seed will sink to bottom. Germination—20 to 40 days.
Melia azedarach (Chinaberry)	Stratify cleaned stones for 120 days at 41° F. Each stone has about 4 seed. When sown without cracking, germination is not hindered. Seed do not germinate at stratification temperatures.	Stratify clean seed, not berries. Fresh seed will germinate erratically following spring when fall sown. Stratified seed gave 100-percent germination. Germination—10 days to 3 weeks.
Paliurus spina-christi (Christ-thorn)	(See *Albrizzia julibrissin*) Stratification for 30 to 60 days at 41° F is also effective.	Nicking with a knife is preferred. Germination—7 to 20 days.
Pithecellobium flexicaule (Texas Ebony)	Use freshly gathered seed. Soak in water several hours before planting.	Grow in containers. They are extremely difficult to dig because of thorns. Germination—9 to 30 days.
Poinciana gilliesi (Paradise Poinciana)	Use freshly gathered seed. Soak in water until seed swell before planting.	Germination—10 to 30 days.
Prunus caroliniana (Carolina Laurelcherry)	Stratify cleaned seed 120 to 130 days at 45° to 50° F. Seed must be watched closely as stratification period is often shorter with some seed. It will show germination in storage temperatures.	Fresh cleaned seed will sometimes germinate well without stratification in 60 days. Do not sow or stratify berries. Germination—15 to 60 days.
Prunus mexicana (Mexican Plum)	Stratify air-dry seed at 31° to 41° F for 60 days in moist peat and sand before planting.	Seed will germinate at stratification temperatures. They must be watched closely. Germination—15 to 40 days.
Quercus virginiana (Live Oak)	Fall planting: Pick ripe acorns from tree or gather within 10 days after falling. Plant immediately. Spring planting: Store in sealed jars 36° to 41° F until ready for planting.	At warm temperatures, the acorns lost their viability in about 2 weeks after they fell. Germination—30 to 50 days.
Rosa bracteata (Macartney Rose)	Soak cleaned seed in concentrated sulphuric acid for two hours. Then stratify for 60 days at 41° to 45° F.	Seed will germinate at stratification temperatures. They must be closely watched. Stratification without seedcoat treatment is of no value. Germination—10 to 40 days.
Sapindus drummondi (Western Soapberry)	Treat cleaned seed with concentrated sulphuric acid for 3 hours or dip in boiling water for thirty seconds; repeat dip 3 times. Stratify for 120 days at 41° to 45° F.	Stratification without seedcoat treatment is of no value. They have an exceptionally hard seed. Seed germination is very slow. Allow plenty of time. Germination—30 to 60 days.

Name of plant	Recommended treatment	Remarks
Sapium sebiferum (Chinese Tallowtree)	Fall planting: Freeze in ice for 2 weeks before planting. Spring planting: Keep air dry at room temperatures for at least 3 months before planting.	Germination percentages for both treatments were over 80 percent. Germination—30 to 60 days.
Sophora secundiflora (Mescalbean Sophora)	Use fresh seed when possible. Touch seed to emery wheel or soak in concentrated sulphuric acid for 30 minutes or dip in boiling water for 30 seconds.	Soak seed in water for 24 hours after any of these treatments. Retreat any seed that do not swell after this treatment. Germination—7 to 10 days for fresh seed.
Vitex agnus-castus (Lilac Chasetree)	Use fresh seed whenever possible. Soak fresh seed in concentrated sulphuric acid for 30 minutes. Older seed require longer. Wash in running water and soak for several hours before sowing.	Stratification at 41° to 45° F for 90 days is also effective with older seed after treatment. Germination—10 to 50 days.
Zanthoxylum clavaherculis (Herculesclub Pricklyash)	Treat seed for 45 minutes with concentrated sulphuric acid, wash in running water and soak several hours before sowing.	Stratification is not as successful as seed treatments. Seed germinates slowly. Give plenty of time. Germination—20 to 40 days.
Zizyphus jujuba (Common Jujube)	Seed germinate readily after air-dry storage for 3 months at room temperatures. Stratification of hard seed for 60 to 90 days at 41° F is beneficial.	There are two seedlings per stone. Germination—30 to 50 days.

This process takes place in the seed only at the proper temperature and in the presence of abundant supplies of oxygen and moisture. For most native shrubs and trees and others used for landscape purposes in Texas, an average temperature of 41° F. is favorable for after ripening to take place.

In commercial practice the handling of dormant seed during this period of after ripening is done by stratification, which is accomplished by mixing the seed in moist sand, moist peat moss or a mixture of the two.

The use of moist (not wet) peat moss is most desirable, because it has a large water holding capacity that does not interfere with the air supply of the seed.

After the seed is thoroughly mixed with the stratification medium it is placed in flats, pots, jars or any other convenient containers and stored in refrigerated storage where the temperature can be controlled during the after ripening period. Never pack the medium used for stratification. This has a tendency to interfere with good aeration.

The length of any period of stratification varies with the seed stratified. The recommendations for each species is only an approximate or an average period, not an exact or standard period. Seed in stratification should always be watched carefully because of this factor.

Many seed will germinate at these low temperatures when the after ripening process has been completed. Germinated seed is always difficult to handle without injury, so the seed should always be removed previous to germination when possible. This time can only be determined by close observation from time to time.

In some areas of the country, fall planting is a satisfactory substitute for stratification. However, in most areas in Texas where cold weather can seldom be depended upon, stratification in controlled temperatures is the only dependable method of germinating seed which have a dormant embryo.

SEED SOWING PROCEDURES

Sowing Seed Outdoors

Annual, biennial and many of the commonly grown herbaceous perennials can be grown from seed sown outdoors. Under Texas conditions in the warmer sections of the state, annuals can be sown both in the spring and fall. Lists of those to be sown at each season are given in Table 1 and Table 2.

Seed can be sown outdoors in the spring as soon as the woody deciduous plants begin to leaf in the area. Fall sown sorts can be planted from September through October in most sections of the state.

The simplest method of growing plants from seed outdoors is to sow the seed directly in the garden. Spade or till the area and rake the surface until it is completely level.

When the existing soil in the garden location is heavy clay or exceptionally sandy, success in growing plants from seed can be assured by adding liberal amounts of organic matter to the soil. Work this material such as peat moss, well rotted pine bark or other organic materals that are well decomposed into the top 4 inches of soil before leveling the surface.

Seed can be sown either in rows or broadcast. Very small seed should not be handled in this manner and are best started in containers and then transplanted. Sow the seed at a depth equal to twice the size of the seed which will result in the seed being covered at about the depth of the seed. Water the seedbed thoroughly with water applied with a *mist* nozzle so the seed will not be washed out of the soil.

When the seedlings appear, thin them out to the desired distance by eliminating the weak plants or by transplanting some of the stronger seedlings at the proper spacing.

When a specially prepared seedbed in the garden or nursery is used, seed should be sown in rows about 8 inches apart. Space the seed in the rows about one-fourth to one-eighth of an inch apart depending upon the size of the seed.

If the bed has been prepared so the soil is of fine structure, draw it from the sides of the row and cover the seed. If not finely prepared, cover the seed with screened soil or peat moss. Firm the covering over the seed and water it in well with the water applied in mist form.

When the seedlings have reached suitable size, they should be transplanted immediately into permanent locations.

Seed can be started a month or so earlier in the season in the colder areas of Texas by sowing the seed in specially constructed structures such as cold frames or hot beds. These structures are identical except that in hotbeds bottom heat is supplied through the use of soil cables. The frames are constructed about 1 foot high on the front side, 2 to 2½ feet on the other, 6 feet wide and any length in multiples of 3 feet so that a 3 × 6-foot sash can be used for covering. The sash can be either plastic or glass.

The procedure for sowing seed directly in these structures is the same as that used in specially prepared beds outdoors, or when containers are used, they are prepared the same as those used for sowing seed indoors.

When growing seedlings in frames or hotbeds the sash should be raised during midday to provide ventilation and prevent the temperature within the frame from becoming too high. As the season advances the sash can be removed during warm sunny days and replaced at night. Eventually it should be left off entirely. The seedlings should be removed from these structures and transplanted as soon as they are large enough to handle.

TABLE 1. ANNUALS TO BE SOWN IN THE SPRING: FEBRUARY TO APRIL

Common and scientific name	Germination period (days)	Height (inches)	Spacing (inches)
Arctotis			
Arctotis grandis	15-20	24	12-18
Floss Flower			
Ageratum houstonianum	8-12	6-24	6-9
China Aster			
Callistephus chinensis	8-10	24	12
Moonflower			
**Calonyction aculeatum*	5-8	120-240	10
Feather Cockscomb			
Celosia argentea	20-25	24	24
Spiderflower			
Cleome spinosa	10	36	24
Cosmos			
Cosmos bipinnatus	5-15	36-72	24-36
Golden Cosmos			
Cosmos sulphureus	5-15	36-72	24-36
Globeamaranth			
Gomphrena globosa	20-25	12-24	6-8
Sunflower			
Helianthus annuus	15-20	39-36	24
Balsam			
Impatiens balsamina	10-12	18-24	12-18
Sultan Snapweed			
Impatiens sultani	8-12	24-36	18
Morning Glory			
**Impomoea purpurea*	5-8	180	10-12
Summercypress			
Kochia scoparia	15-18	36	12-18
Four O'clock			
Mirabilis jalapa	12-15	18-24	24-30
Petunia			
Petunia hybrida	18-20	12-24	9-12
Portulaca			
Portulaca grandiflora	18-20	6	4
Cypressvine Starglory			
**Quamoclit pinnata*	10-15	180-300	8-12
Castorbean			
Ricinus communis	15-20	36-144	24
Scarlet Sage			
Salvia splendens	15-25	24-36	12-18
Sweet Scabious			
Scabiosa atropurpurea	18-20	24-30	8
Aztec Marigold			
Tagetes erecta	5-8	30	18
French Marigold			
Tagetes patula	5-8	12	18
Blackeyed Clockvine			
**Thunbergia alata*	8-10	72-96	6-8
Blue Torenia			
Torenia fournieri	18-20	8-12	6-8
Verbena			
Verbena hybrida	8-10	12	12
Periwinkle			
Lochnera rosea	30-35	12-24	10-12
Zinnia			
Zinnia elegans	5-8	12-36	12

*Indicates vines.

Sowing Seed Indoors

Sowing seed in pots, flats or other containers indoors in various environments is much preferred to outdoor sowing since weather conditions will not jeopardize the results obtained.

Success in raising seedlings indoors depends upon the availability of optimum cultural requirements.

TABLE 2. ANNUALS TO BE SOWN IN THE FALL: SEPTEMBER TO DECEMBER

Common and scientific name	Germination period (days)	Height (inches)	Spacing (inches)
Bugloss			
Anchusa capensis	15-20	12-18	8-12
Mexican Poppy			
Argemone mexicana	20-25	24-36	6-8
Snapdragon			
Antirrhinum majus	20-25	12-36	12
Swanriver Daisy			
Brachycome iberidifolia	20-25	10	5-6
Browallia			
Browallia speciosa	18-20	18	3-6
Calendula			
Calendula officionalis	10-12	30	12-18
Cornflower			
Centaurea cyanus	5-20	30	6
Sweet Sultan			
Centaurea moschata	5-20	24-36	8-12
Clarkia			
Clarkia elegans	8-10	30	6-10
Leptosyne			
Coreopsis stillmani	8-10	24	10-12
Calliopsis			
Coreopsis tinctoria	10-12	36	12-18
Rocket Larkspur			
Delphinium ajacis	15-20	24	8-12
Pinks			
Dianthus plumarius	5-8	12	8-12
Winter Marigold			
Dimorphotheca aurantiaca	15-20	12	8-10
California Poppy			
Eschscholtzia californica	5-10	12	8
Gaillardia			
Gaillardia pulchella var. *picta*	12-15	18-24	12
Godetia			
Godetia amoena	10-25	12-24	12
Babysbreath			
Gypsophila paniculata	15-20	18-24	8-12
Strawflower			
Helichrysum bracteatum	5-10	24-30	12
Rose Sunray			
Helipterum roseum	8-10	18	6.8
Goldencup			
Hunnemannia fumariaefolia	10-12	24	8-10
Rocket Candytuft			
Iberis amara	5-8	12-18	6-8
Globe Candytuft			
Iberis umbellata	5-8	12-18	6-8
Sweetpea			
**Lathyrus odoratus*	15-20	36-72	3-6
Toadflax			
Linaria bipartita	8-10	12	8-12
Sweet Alyssum			
Lobularia maritima	18-20	8-12	6-8
Lupine			
Lupinus pubescens	25-30	24-36	12
Annual Stock			
Mathiola incana var. *annual*	10-15	12-18	12
Virginia Stock			
Mathiola maritima	10-15	6-8	8
Forget-me-not			
Mysotis sylvatica	15-20	12	6
Baby-blue-eyes			
Nemophila menziesii	6-8	6-12	6
Flowering Tobacco			
Nicotiana alata var. *grandiflora*	20-25	36	24
Love-in-a-Mist			
Nigella damascena	10-15	18	8-12
Evening Primrose			
Oenothera speciosa	10-25	12-24	8-12
Shirley Poppy			
Papaver rhoeas	15-20	24-36	6-8
Petunia			
Petunia hybrida	18-20	8-12	9
Annual Phlox			
Phlox drummondi	20-25	12-18	8
Mignonette			
Resedra odorata	8-10	18	8
Pincushionflower			
Scabiosa atropurpurea	18-20	24-30	8
Butterflyflower			
Schizanthus pinnatus	20-25	24	18
Blue Laceflower			
Trachymene coerulea	8-10	24	12
Nasturtium			
**Tropaeolum majus*	8-15	6-120	12
Pansy			
Viola tricolor	8-10	6	4-6
Verbena			
Verbena hybrida	8-10	12	12

These are easily controlled in a greenhouse, but in other indoor situations the following cultural requirements must be provided for the adequate germination of the seed and the subsequent development of the seedlings. These are a location with sufficient sunlight or light provided by artificial lamps; a temperature of 68° F for germination; and 55 to 60° temperatures for proper seedling development. (Temperatures above 60° or low-light intensities will result in weak, spindly seedlings which will be difficult to handle.)

Facilities must permit frequent and adequate watering.

Propagating Medium

Research with various propagation media during the past 12 years at the Texas Agricultural Experiment Station has shown that a mixture of horticultural grade perlite and sphagnum peat moss, in equal parts by volume, is an excellent medium for germinating seed and growing seedlings.

When properly prepared, this medium holds sufficient moisture with infrequent watering; provides sufficient aeration; is free of weed seed, soil borne insects and diseases; and is light in weight, clean and easy to handle.

In preparing the mixture, be sure the ingredients are measured accurately and are thoroughly mixed so that all constituents are well distributed throughout the entire volume. These materials are practically inert and, for this reason, adequate slowly available nutrient materials must be added.

The home gardener can prepare this propagating medium on a small scale by using the following formula: one-half bushel horticultural grade perlite, one-half bushel coarse sphagnum peat moss, 3 ounces of 20 percent super-phosphate, 6 ounces of dolomitic limestone and 3 ounces of a complete garden fertilizer with a 1-1-1 ratio.

Since the individual ingredients named may be difficult to obtain in small quantities, it may be cheaper and easier for the home gardener to purchase them already mixed. However, he should be certain that the mixture contains like ingredients.

Sowing Seeds

Be certain that the fertilizer materials are distributed evenly during mixing. Then wet the mixture thoroughly. This medium provides excellent drainage, yet it has adequate moisture-holding capacity for good germination and rooting and prevents loss of roots when seedlings or cuttings are removed because of the capacity to cling to the roots. This practically eliminates transplanting losses.

The materials can be sterilized easily by heating in a closed container in the oven until steam rises from it.

Fill the propagating flats or pots level with the top edge with the mixture and firm the material very lightly.

Where very fine seed are to be sown, screen one-sixteenth of an inch of the peat-perlite mixture or screened sphagnum moss on the surface, sow the seed and do not cover them. If larger seed are to be sown, the layer of peat or sphagnum moss is not required. Mark out the rows, sow the seed and cover them with a thin layer of the peat-perlite mixture.

Place the seed flats or pots in a cellophane or polyethylene bag and seal it with a staple or pin. Do not place the covered flat in a sunny location. When the seed has germinated, remove the containers from the bag. Do not water until the surface of the mixture shows real signs of dryness. Then water lightly.

Transplanting Seedlings

When most seedlings begin to grow they produce small *seed leaves* called cotyledons. These are followed in a short time by the first true leaves that have the characteristics of the leaves produced by that particular plant. The best time to transplant seedlings is when these first true leaves are visible.

Transplanting operations cause a temporary check in the growth of the seedling which results in a more compact plant. Seedlings should be lifted from the starting containers a few at a time using a blunt pencil or small flat stick such as a plant label. Then each seedling should be planted into larger containers or into the plant bed or garden.

To avoid damage to the plants in handling, hold them between the thumb and forefinger by the leaf rather than by the stem. The roots of the seedlings should not be exposed to the air any longer than necessary.

The depth at which seedlings are planted is very important and dependent upon the type of seedling being transplanted.

There are two types of seedlings. Type number 1 has an upright stem having the growing point at the tip. Type number 2 forms a rosette with the growing point at the base of a cluster of leaves.

The type number 1 seedlings may be planted as deep as the first leaves since the growing points are at the tops of the stems. This type can be planted deeper than they were growing originally since additional roots will develop along the stem on the portion covered by soil.

Type 2 seedlings must be planted at exactly the same depth they were in the seed container since the growing points are at the center of rosettes of leaves at the soil line. When not planted at the same depth as they were growing originally, the growing points will be buried, and the seedlings may die.

When transplanting the seedling, firm the soil gently but *very firmly* around the roots, and water them in well.

VEGETATIVE PROPAGATION

When a plant is reproduced from the vegetative parts of that plant, the process is referred to as asexual or vegetative propagation. This is possible in the reproduction of plants because in many plants detached vegetative portions have the capacity to regenerate either a new root system, a new shoot system, or both, or are able to unite with another plant part.

One decided advantage of vegetative propagation is that the plant propagated will be identical with the parent plant from which the vegetative portion was removed, while seedlings may vary considerably.

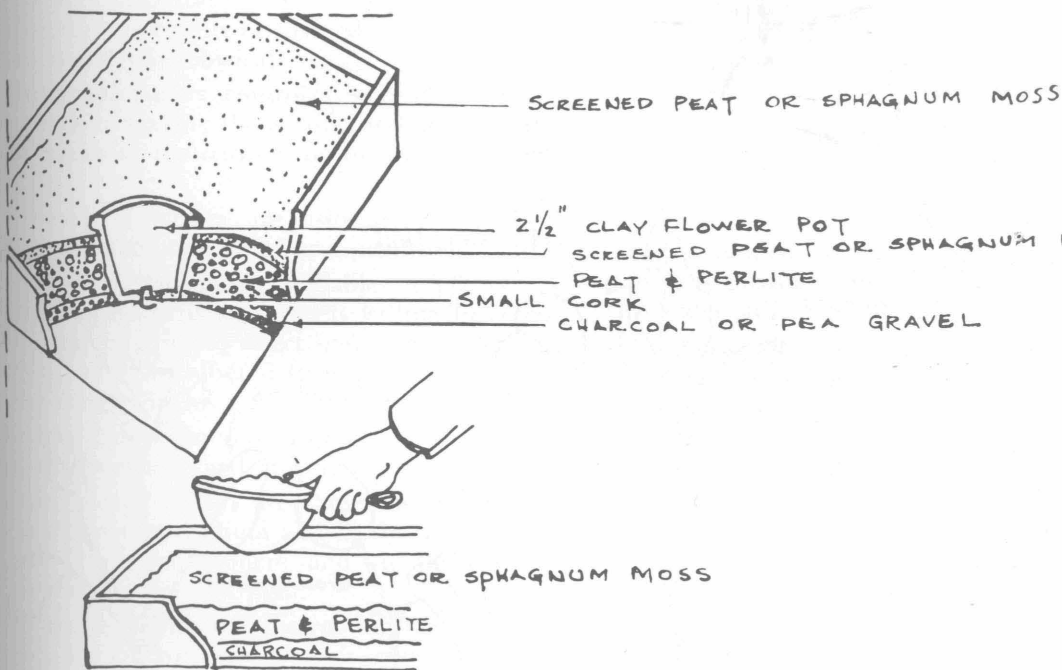
Propagation by Cuttings

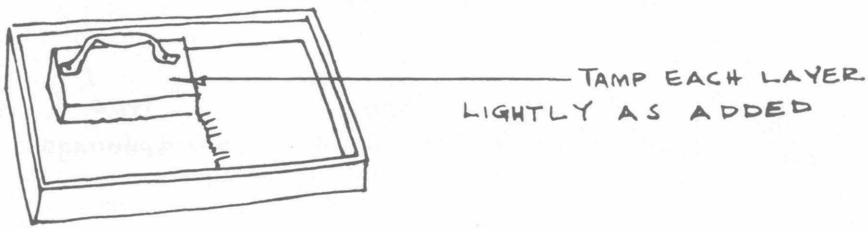
Any severed vegetative portion of a plant is called a cutting. In propagation by stem cuttings, it is only necessary for the cutting to develop a new root system since a bud or potential shoot system is already present. Root cuttings must produce not only an extended new root system but also a new shoot system from an adventitious bud. Leaf cuttings must produce both an entirely new root system and a shoot system as well.

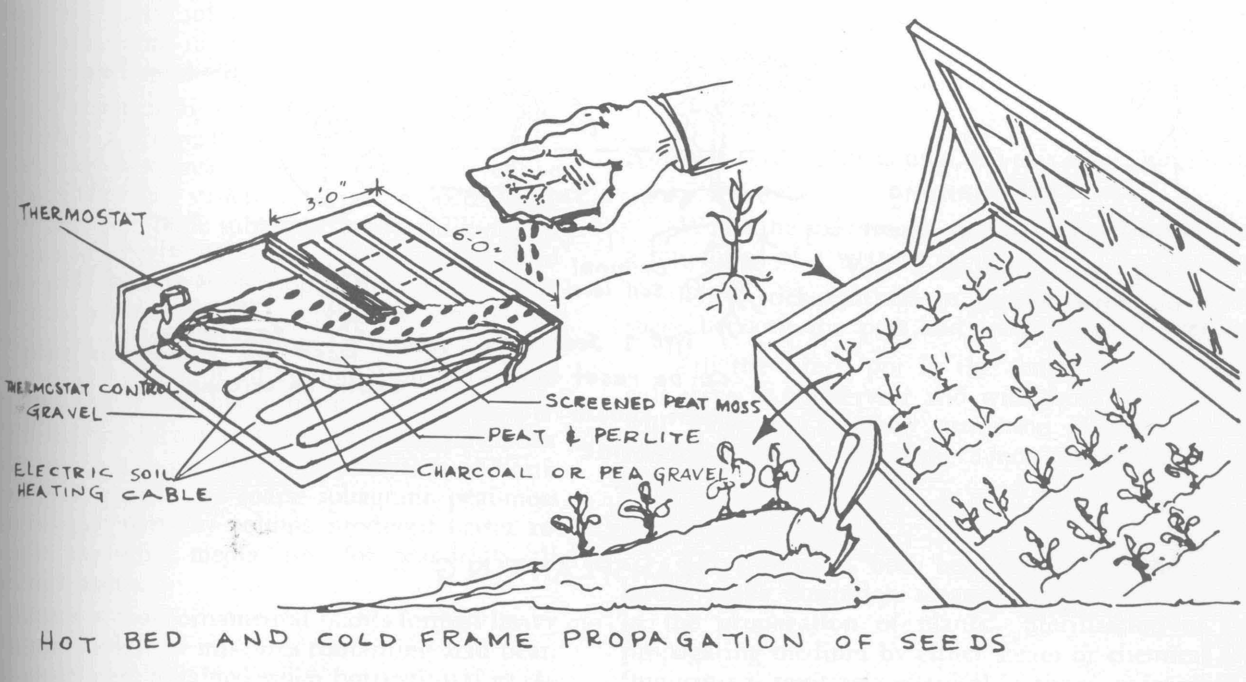
This regeneration of entirely new systems of plant development from vegetative cuttings is possible in green plants because many cells, even some of those found in the mature portions of the plant have the capacity to return to the meristematic or undifferentiated condition and thus produce the necessary root and shoot systems.

Many factors are involved in the successful propagation of plants by cuttings. It has often been said that all plants could be propagated by cuttings, providing the right combination of internal and external factors could be attained.

Since internal factors vary greatly from season to season and from one time of year to another, successful rooting of cuttings is greatly dependent upon careful attention and control of external conditions. They must fit the internal conditions of the cuttings at the time rooting is being carried on.

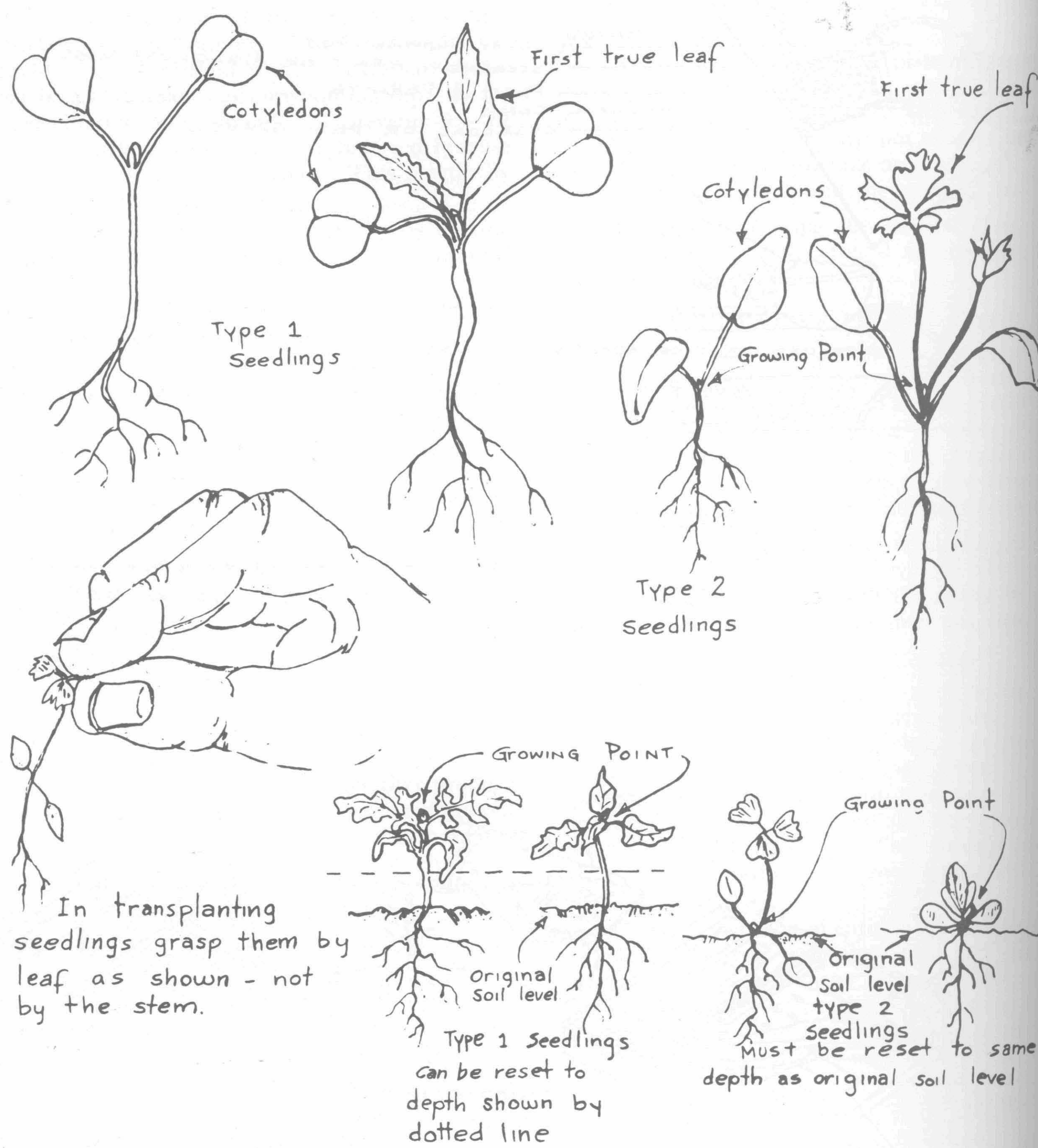






HOT BED AND COLD FRAME PROPAGATION OF SEEDS

Seed Sowing Methods



TRANSPLANTING

The internal factors necessary for successful rooting of cuttings can readily be divided into two groups, anatomical and physiological.

Anatomical factors control the healing of the wound made in making the cutting and the presence of root initials in the cutting, or its ability to form them.

Physiological factors are associated with food supply, auxins and unclassified or unidentified factors.

Both sets of factors are variable in plants. A successful propagator is one who is willing to accept these factors and tries to select and handle cuttings in such a way as to offset deficiencies that exist or that may develop in his particular situation.

External factors are also readily divided into two groups, environmental and cultural.

Environmental factors are those associated with water in the rooting medium and in the atmosphere, the gases in the atmosphere and in the rooting medium, temperature and light.

Cultural factors include the rooting medium, leaf reduction, use of synthetic growth regulating substances and position of the basal cut.

Although these and other cultural factors are important, they are not often limiting factors to successful rooting. In most cases the limiting factors prove to be those of environment.

Rooting Media

A congenial medium for the cuttings during the period of rooting is of utmost importance. A rapid formation of suberin at the wound is essential. This not only makes oxygen necessary, but moisture must also be present in the proper amount at all times. (Suberin is a fatty substance impervious to water and gases, that forms rapidly to cover and protect the surface of the wound or cut.)

On a commercial basis materials used in the preparation of a propagating media have traditionally been relatively inexpensive; easily accessible; retentive of moisture; open in structure to insure good drainage; and free from toxic substances and readily decaying organic matter. For these reasons sharp sand was the most widely used propagating medium for many years; yet research has repeatedly shown that sharp sand is not the best medium for rooting cuttings. Other materials alone or in combination with sand are vastly superior for this purpose.

Research conducted at Texas A&M University for over 10 years has shown that a combination of horticultural grade perlite and coarse sphagnum peat-moss mixed in equal parts by volume produced better results than any other media used for practically all ornamental plants.

Cuttings of most ornamental plants formed heavy root systems rapidly in mixtures containing acid peat. Better results were obtained when horticultural grade perlite was added to the peat in the proportion mentioned.

The research project on propagating media demonstrated that many different products that are inert, coarse and easily accessible may improve sand as a rooting medium.

The perlite and peat mixture holds sufficient moisture without frequent watering and drains well, providing sufficient air at the base of the cuttings. It is important that the medium, regardless of the materials used, be no deeper than 4 to 5 inches. A shallow medium allows for maximum drainage and provides sufficient oxygen to the rooting regions.

Vermiculite, a type of expanded mica ore, is another coarse material now widely used as a propagating medium. It, like perlite, is coarse, friable, inert, sterile, clean, pleasant to handle and easy to obtain. It also is available at any garden supply store under a variety of trade names, but one word of caution must be made in the use of vermiculite as a propagating medium either alone or in mixture with other materials: It *must not be firmed* after the cuttings are stuck, or both drainage and aeration will be impaired.

Other media that can be used for propagation at the discretion of the propagator *if, they are steam sterilized before use are:* ground pecan hulls, pine bark and locally harvested peats or mucks.

A Simple Self-watering Home Propagator

When only a few cuttings are to be propagated or when only a few rare cuttings are available for rooting, a self-watering propagation unit can be employed. This unit can be constructed in the following manner.

Place about 2 inches of coarse gravel in an 8-inch azalea pot. Next fit a cork in the drainage hole of a 3-inch clay pot and then place this pot in the center of the 8-inch pot and pack the rooting medium in between the two pots.

Note: If vermiculite is used, fill this space, but *do not pack it.*

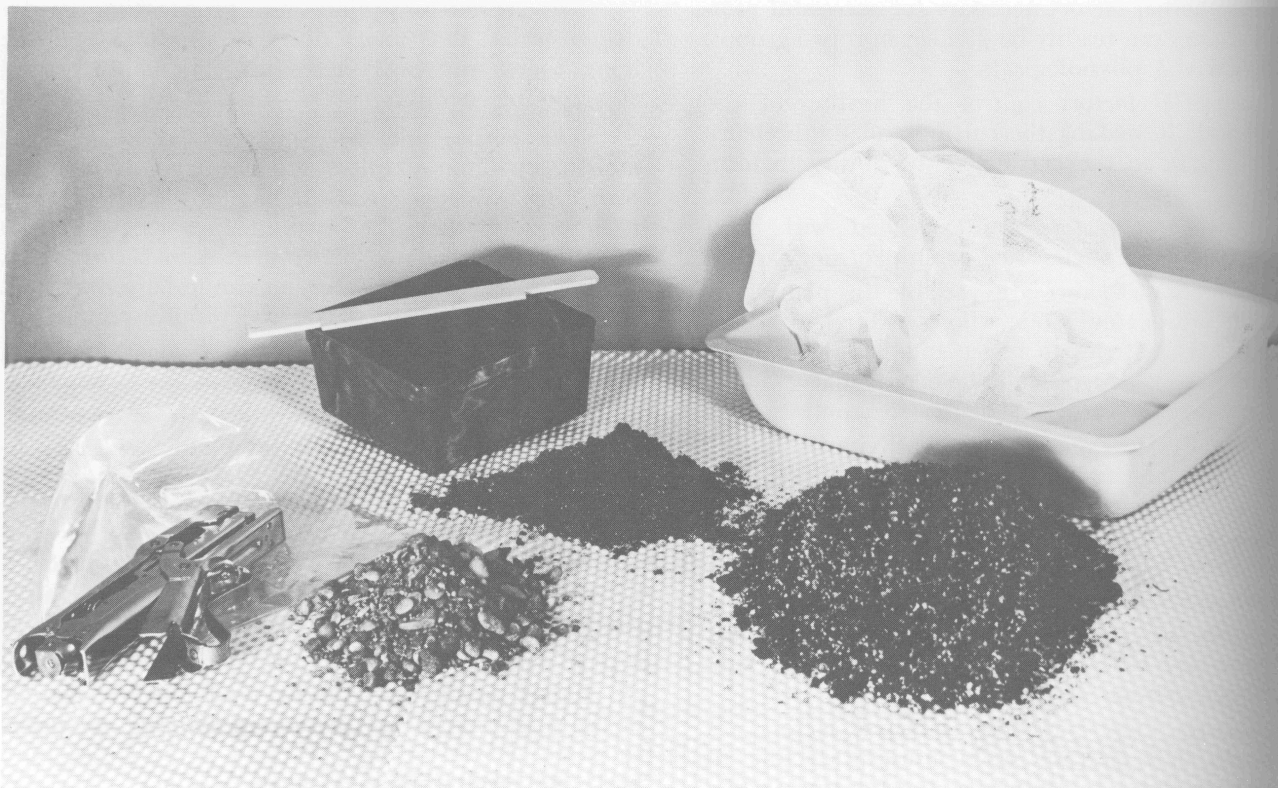
Water the medium in well with water containing a few drops of a wetting agent.

Then stick cuttings in concentric rings in the space between the pots and water them in well.

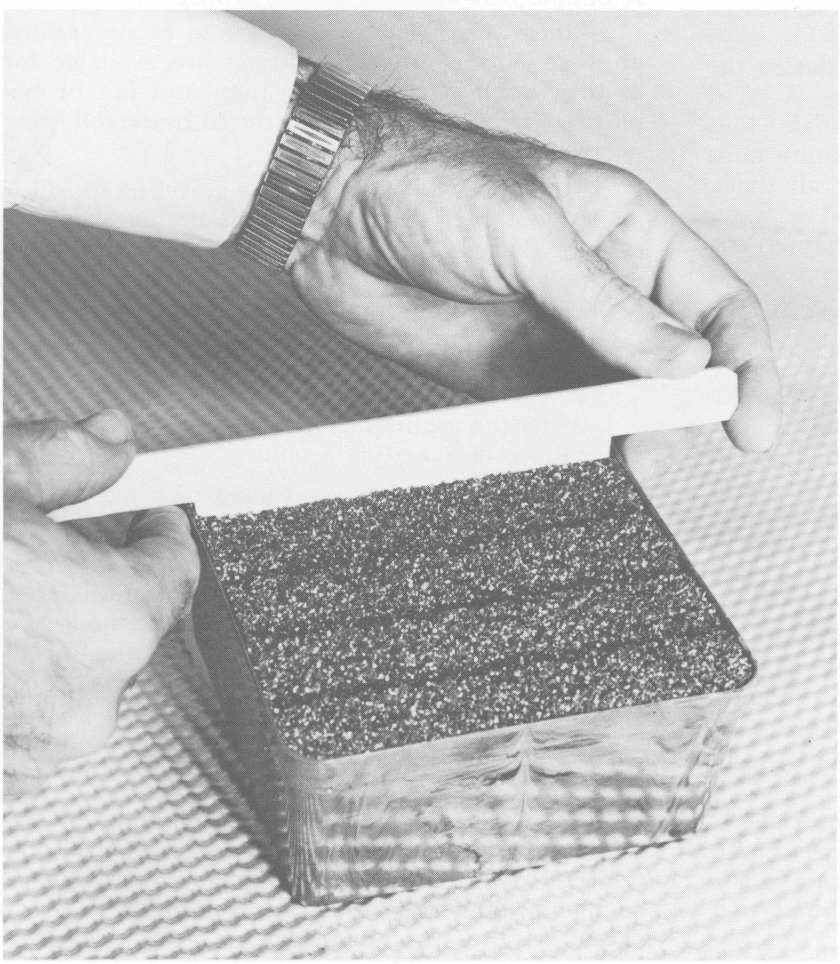
Fill the 3-inch pot in the center with water; it will serve as a reservoir and wick from which water will move by capillary attraction throughout the rooting medium. Keep the 3-inch pot refilled at all times.

Sanitation

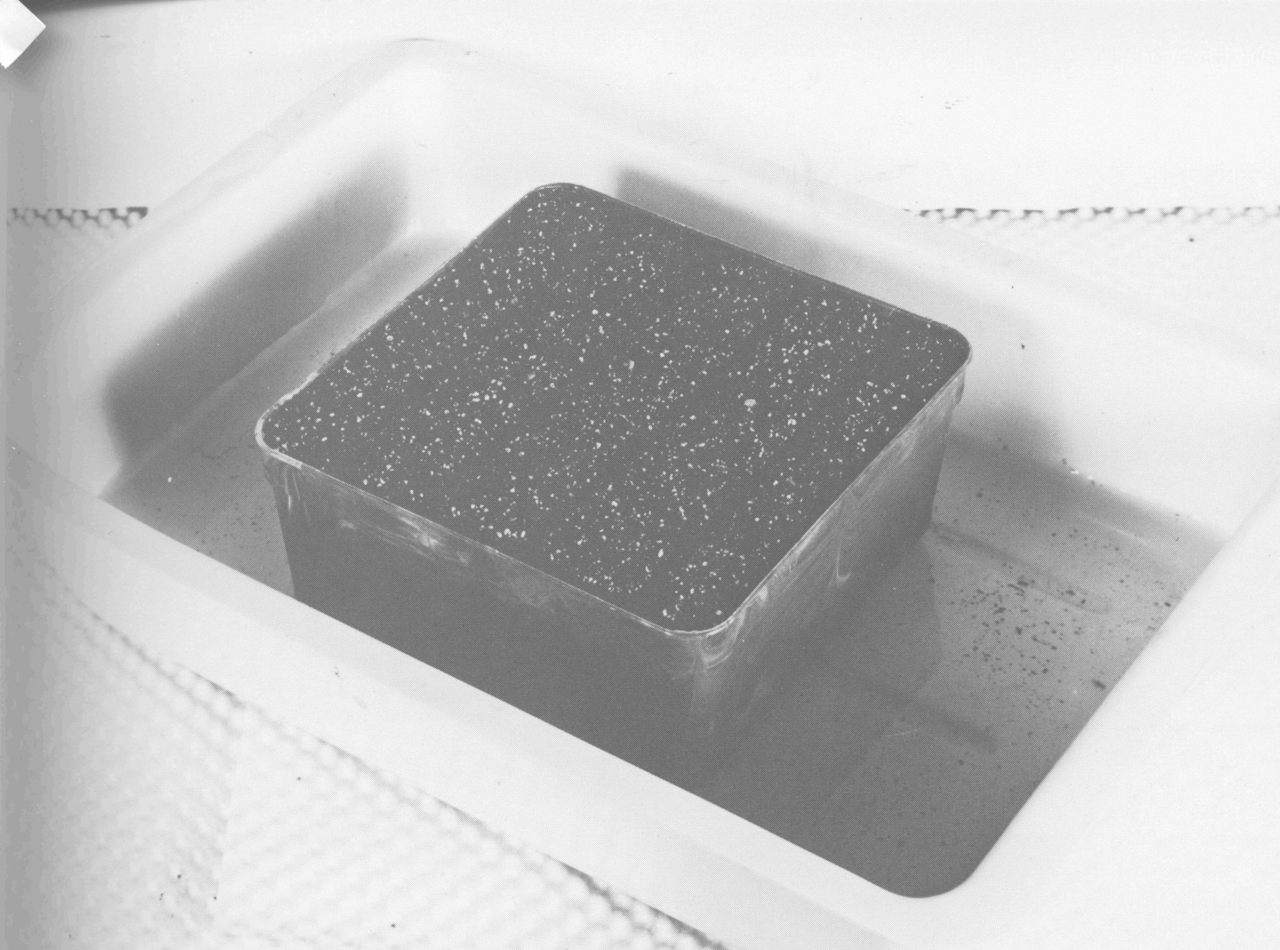
Texas climates, both outdoors and in the greenhouse, make sanitation measures essential to success in the propagation of plants. Sterilization of the propagating medium by either steam or chemical soil fumigants is positively essential in these environments or the medium used must be renewed after every second or third crop of cuttings.

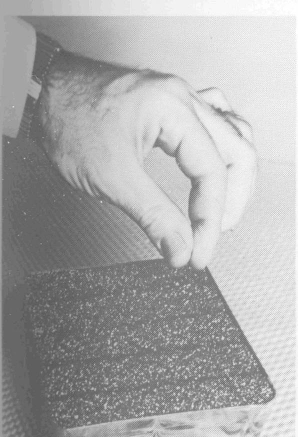


Materials required for seed propagation.



Preparation of seed flat.



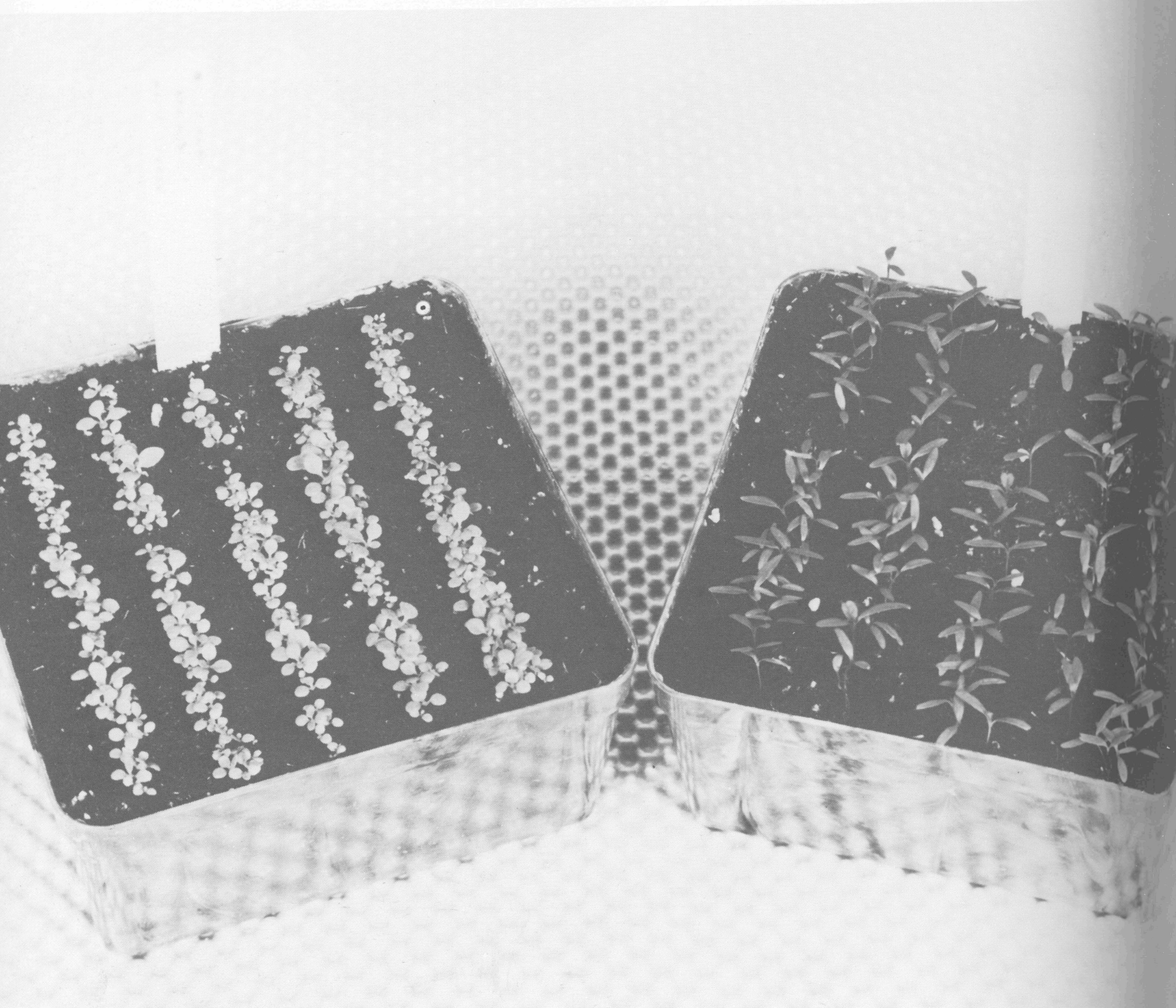


Subirrigate seed flat.

Sow seed in rows.

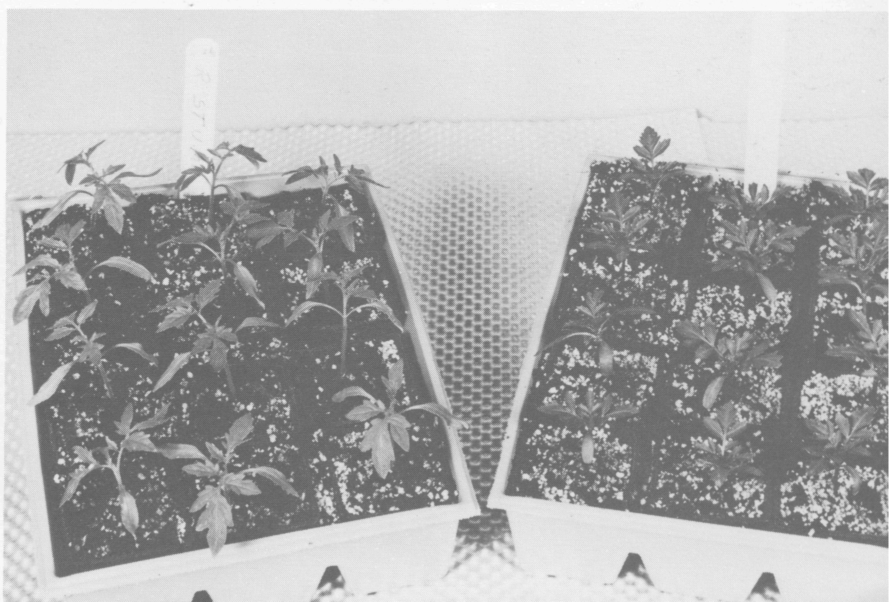
Place planted seed flat
in cellophane bag.
Remove flats from bag as
soon as seed germinates.

Seedlings ready for transplanting.



Allow seedlings to develop one set of leaves.

Plant seedlings into pots or open ground with dibble.



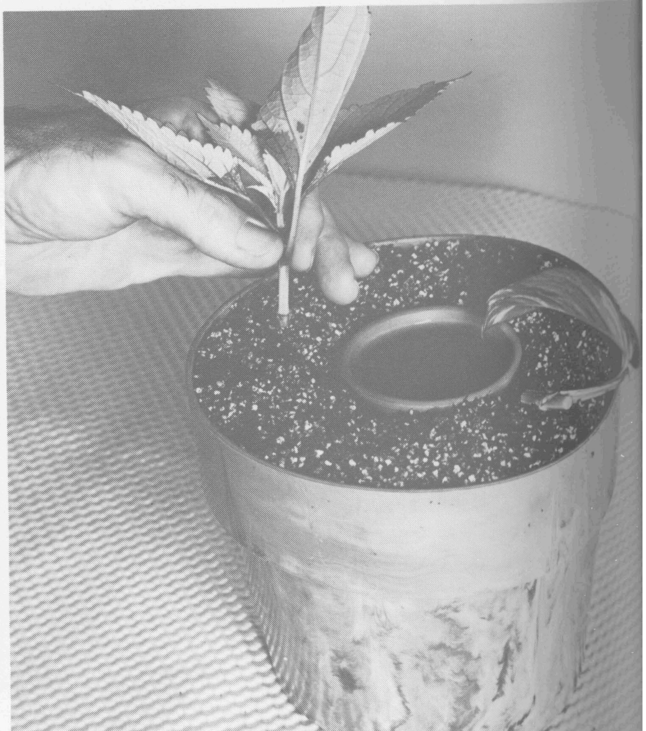
Established potted seedlings ready for planting in permanent location.

Materials required for
self-watering propagator.

Preparation of
self-watering propagator.

Make the cutting.

Insert cutting into
rooting medium.



Completed self-watering propagator filled with cuttings.

Propagation media trials under intermittent mist.

Cuttings rooted in various media under intermittent mist.

Outdoors, soil-borne diseases of several kinds readily work into propagating beds and cause complete loss of cuttings unless clean or fresh materials are insured after each use. The cost of the materials and labor required for sterilization or fumigation are small compared to the loss of a large number of cuttings.

Watering Methods

A convenient supply of water is required for propagation by cuttings so that the cuttings can be misted or fogged at frequent intervals during periods of hot bright weather.

Any type of device that will produce mist or fog can be used for this purpose. A fog nozzle on the end of a hose or any of the small atomizers now used for sprinkling clothes are ideal for this purpose.

Any method will work which can be devised to apply the water in a very fine mist so that the rooting medium does not receive enough of the moisture supplied to become soggy. Recent research in plant propagation has developed a system of rooting cuttings by keeping them moistened intermittently with a fine mist spray of water since an important factor in rooting cuttings is to keep the cuttings moist. This method will be described in detail later.

When this mist is supplied continuously from 8 a.m. until 5 p.m. daily, it is called constant mist. If a clock-timer is used to turn the mist off and on at stated intervals, it is known as intermittent mist. If no timer is used, the amateur gardener can turn his mist on when he leaves for work and cut it off when he returns in the evening, or on bright days he may let it run until sundown. The amount of water saved by the use of a clock-timer, however, will soon pay for the cost of the timer.

There are many advantages in the use of mist by the home gardener. A cutting continues to lose water by transpiration after it is removed from the parent plant. It is impossible for the cutting to take up sufficient water to replace that lost by transpiration until new roots have formed. The mist system prevents excess water loss by the cutting. Maintaining a higher water content in the cutting aids the plant in forming roots and reduces the time required for rooting.

A mist system also reduces the incidence of insect and disease problems in cutting beds, but unfortunately it does not solve all the propagation problems.

Rooting Substances

During the late 1930's, research with several synthetic chemicals showed them to be of value in shortening the rooting time required on cuttings of many ornamental plants. These materials have since been widely available under proprietary names in any garden supply store. They have become known as root-inducing substances; although, this is largely a misnomer. They might be defined as synthetic chemicals which have hormone or auxin like effects upon cuttings since they may stimulate certain rooting factors in cuttings.

True plant hormones are complex organic substances produced by leaves and found in the regions of buds. These hormones are transported by the vascular system and may influence the rooting ability of cuttings. Many successful propagators now use the synthetic chemicals regularly. Carefully selected cuttings of wood of the correct age treated properly with these materials will generally produce heavier root systems in a shorter period of time than untreated cuttings.

These chemical compounds are not substitutes for skill, nor will they induce difficult-to-root cuttings to produce roots, but they may aid in reducing the time required for the cuttings to root.

The propagator must still control the environment into which the cuttings are placed with the same care he would exert if no stimulant were used. Careful attention must be given to temperature, humidity, moisture and light to keep the environment in optimum balance.

The root inducing action of these chemicals is slowed by low temperatures. The temperature of the rooting medium should be maintained between 70° and 80° for best results.

The cut end of the cuttings should be lightly dusted with these materials, and the cuttings should be inserted into the medium carefully to avoid rubbing the dust from the cuttings. The chemical must be in solution and be absorbed by the cutting to be effective.

Types of Cuttings

Greenwood or Softwood Stem Cuttings

Leafy tips of plants that are still immature and non-woody can be used for softwood cuttings for the increase of most nursery and garden plants grown in Texas. The terms softwood or greenwood, semihardwood and hardwood refer to the hardness of the wood or stem at the time the cutting is made.

Usually the half-hardening of growth on a plant after the first flush of growth in the spring produces wood that yields excellent cuttings of the greenwood type. This type of cutting can be taken any time in the spring or early summer during the active growing season. It roots easier and more rapidly than the other two types, and it is probably the best kind for the amateur propagator to begin with.

Softwood cuttings can be used for the propagation of deciduous or evergreen shrubs, trees and climbers and herbaceous perennials.

Semihardwood or evergreen cuttings are taken later in the summer growing season or in the autumn. They should be selected at the point on the stem where the growth is firm enough to snap when the twig is bent sharply. If the wood bends and does not snap readily, it is considered too old to root as a semihardwood cutting.

Other than the hardness of the wood involved, the methods and considerations for both softwood and semihardwood cuttings are the same.

Scientific investigations have shown that cuttings from young plants will root more readily than comparable cuttings from older mature plants. In addition, cuttings taken from the lower portion of a woody plant usually will root more readily than those clipped from upper regions of the plant. It is acknowledged that the ease of rooting increases as cuttings are taken from nearer the root systems, providing those cuttings are in the same state of vegetative growth.

Side branches that have formed after the growing tips of the main stem have been pinched out make good cuttings. In selecting wood for cuttings, avoid abnormal growth, including weak shoots formed on the interior of the plant.

In preparing the cuttings for insertion into the propagating medium, begin at the base of the cutting and trim the bottom leaf or leaves that may touch the rooting medium from the cutting. The upper two or three sets of leaves on the cutting should be left intact to enable the cuttings to produce a heavier root system in a shorter period of time. Research has shown that the time honored practice of removing halves of the upper leaves on cuttings actually prolongs the time of rooting since the supply of food materials, hormones and vitamins present in larger leaf surfaces decrease the rooting period.

In some cases, however, when the tip leaves of some cuttings are extremely large they must be reduced in size somewhat to economize the space in the propagating bench.

The cuttings should then be placed in the medium in an upright position so the lower leaves are just above the propagating medium. Firm them in well unless vermiculite is used. Also, water the cuttings in well to insure that the medium is in close contact with the bottom end of the cutting.

Leaf-bud Cuttings

Scientific investigation has shown that stored food materials and hormones are richest in the plant tissues most closely associated with the buds. These tissues, therefore, present good propagating material even though the amount used may be extremely small when compared with a standard cutting with long internodes. These research findings lead to the development of what is now called the leaf-bud cutting technique.

A bud with a single leaf atttached is cut from the plant exactly as though it were to be used for chip budding. This cutting is then placed in the propagating medium. The cut stem tissue and axillary bud are barely covered, and the untrimmed single leaf can extend above or lie flat on the rooting medium. Similar to stem cutting, the leaf area on leaf-bud cuttings should not be reduced unless this is done to secure the best value from the bench space available.

The time required for leaf-bud cuttings to form a heavy root system and a new shoot will be dependent upon the season, the cultivar and the environment of the propagating area.

An 18-inch piece of stem from a woody plant may yield only four regular stem cuttings, but the same shoot might yield 20 or more leaf-bud cuttings.

In general, it is best to take leaf-bud cuttings in the spring from shoots that are non-woody after the first flush of spring growth. Leaf-buds from woody or hard stems with large amounts of sap do not respond well.

Leaf Cuttings

Most woody plants have a shield of stem tissue that contains an axillary bud at the juncture of the leaf or petiole with the node. Certain herbaceous plants grow from a crown or circular stem at the soil surface. Peperomias and several members of the Gesneriad family such as African violets, episcias, gloxinias and many begonias may be increased by placing the leaf with its petiole in the rooting medium. This differs from a leaf-bud since no stem tissue or bud is included in the cutting.

Several begonia types such as Rex and Lorraine and some other greenhouse plants such as kalanchoe, peperomia, crassula and other succulents can be propagated from leaves or leaf fragments. Pieces of sansevieria leaves can also be used as leaf cuttings. Certain bulbous plants in both the amaryllis and lily family will form small bulblets when a fleshy leaf is placed base down in a rooting medium.

Hardwood Cuttings

Many woody trees and shrubs can be propagated by hardwood cuttings made in the late autumn, winter or early spring. Hardwood cuttings are made of mature branches of deciduous plants when they are dormant and the leaves have fallen. This method of propagation requires more patience than the others since hardwood cuttings root slowly, sometimes requiring 6 months to a year.

Hardwood cuttings can be made of deutzia, forsythia, kolkwitzia, honeysuckle, privet, philadelphus, fig, grape, deciduous fruits, rose understocks and others. Some deciduous plants, however, cannot be propagated satisfactorily by this method and are propagated from seed or by budding and grafting. Some examples are named fruit tree varieties, most nut trees, oaks and maples.

Hardwood cuttings are prepared by cutting the tip of a branch back to a place where the wood is about the size of a lead pencil. Make the cuttings 6 to 9 inches long and include at least two nodes on each cutting. Make the lower cut on a slant just below the node. Tie each kind of cutting into a bundle of from 10 to 25 cuttings with the bases of the cutting even. Then attach a label marked with the name of the plant and the date on each bundle.

Dig a trench in a well-drained garden location. Place the cuttings in the trench and cover them with about 2 inches of soil in frost free areas. In areas where the ground freezes, bury the cuttings at least 6 inches deep. Cuttings stored in this manner will get enough moisture to keep the plant tissues from drying out.

When the weather turns warm in the spring, the cuttings will have formed callus or rooted. Then they can be set out in the open ground. When the cuttings are removed from the trench in the spring, wash them off and untie them. Protect the cuttings with moist burlap or paper towels so they do not dry during the planting period. Place them in a cutting bed or nursery row so that about 2 inches or one node is above the surface of the soil. Firm the soil well around the cuttings and water them in.

Root Cuttings

Root cuttings can be made from the roots of any plant that produces adventitious buds or sprouts from the roots. The roots used as cuttings will not show any visible buds, but they will develop after the cuttings are stuck in the medium.

Expose some of the larger roots of the plant with care and trace them down until they are the sizes of a pencil or smaller, lift these small roots and cut them into pieces about 3 inches long. Fill a box or flat to within 1 inch of the top with the propagating medium recommended for softwood cuttings. Lay the root cuttings horizontally on top of the medium about 2 inches apart. Cover them with about one-half of an inch of the propagating medium and water them in thoroughly.

Plants often propagated by root cuttings are perennial gypsophila, oriental poppy, Japanese anemone, trumpetcreeper, blackberry and raspberry.

Another method of producing plants from root cuttings is to drive a sharp spade deep into the soil around the roots of established plants of coralberry, crapemyrtle, roses, plumbago and yucca. Small plants will then arise from the cut ends of pencil-size roots. These new plants can be dug after the following season's growth and transplanted as new plants.

Propagation by Layering

Ground Layering

One of the most reliable ways to increase shrubs, vines and sometimes small trees is by layering. In this method of vegetative propagation a stem is induced to form roots while still attached to the parent plant.

This is a simple method in which branches are notched and brought into contact with the soil to make them root. When the roots are formed, they can be detached from the parent plant and planted as new individual plants.

The simplest method of ground layering is to mound moist, light soil about the growing shoots of a plant during a favorable season, which supplies an environment conducive to root production. Shoots on a plant that can be readily layered are young growths that bend easily and will separate from the old plants later without damage. If the stock plants to be layered do not have a suitable supply of small pliable stems, they should be cut just above the ground. Then sprouts will be available the following year.

In any of the several methods of ground layering, select a low growing branch that can be bent down to the soil. It is usually advisable to wound the stem where it is to be covered with earth. This wound or notch inhibits the free movement of food materials through the stem and induces root formation.

The bark may be broken or scraped bare for an inch or two; a ring of bark may be removed completely or a tongue can be cut and a wedge opened with a pebble, sliver of wood or a peg. Moist, sandy soil should be heaped over the wounded stem and a peg, brick or some other weight used to hold the branch in firm contact with the soil. The weight or anchoring is extremely important because if the branch is moved about during watering and good contact with the earth is broken, rooting may never take place. Water must be applied often in order to keep the soil moist and insure the formation of a satisfactory root system.

Layering should not be done before late winter or very early spring. Many tender plants killed to the ground by frost may be increased readily by mound layering these old plants. Light sandy soil is mounded up over the crown of the plant. When sufficient moisture is provided, all the shoots should then root abundantly and be ready to separate and transplant as individual plants at the end of the following growing season.

With any type of ground layering the time required for an adequate root system to form will vary with the plant species, the temperature that prevails and the moisture condition of the soil.

Earth can be removed carefully from the layers for inspection of the buried portion every month or two. When many roots about 3 to 4 inches long are present, cut the shoots away from parent plant and place them in containers or transplant them as individual plants.

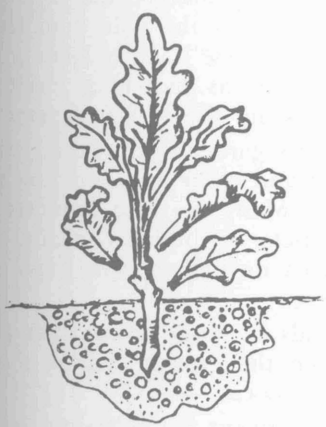
The various kinds of ground layering are shown in the sketches.

Air Layering

Air layering, also referred to as Chinese layering, marcottage, pot layering or *mossing off* is an ancient, highly interesting and well proven propagation technique. It is an excellent method for increasing rare plants, choice trees or shrubs and tropical plants. It is also a method often used on plants that are difficult or impossible to root by other methods.

Many indoor landscape plants such as dieffenbachia, dracaena, ficus and crotons that have lost all the lower leaves can be given new root systems by this method.

SOFTWOOD CUTTINGS



A SOFTWOOD CUTTING PROPERLY TRIMMED AND INSERTED INTO PROPAGATING MEDIUM

HARDWOOD CUTTINGS

A SIMPLE STEM CUTTING

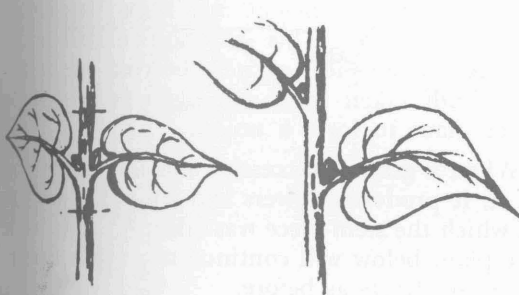
A HEEL CUTTING

A MALLET CUTTING

A SINGLE EYE CUTTING

A LEAF CUTTING

PETIOLE CUTTING



LEAF BUD CUTTINGS

TYPES OF CUTTINGS

Select a branch from the size of a pencil up to an inch in diameter. Make a slanting cut one-third of the way through the stem just below a node. Insert a piece of wooden matchstick or round toothpick in the cut to keep it from closing. Dust the cut lightly with rooting stimulant dust, wrap the stem around and above and below the cut with a mass of moist sphagnum moss about the size of a baseball. Enclose this sphagnum ball completely with polyethylene film and bind it securely above and below the ball with string or plant tie. Kitchen grade aluminum foil can be used in place of polyethylene film, but this will make it more difficult to determine when rooting has taken place.

Roots will form quickly and abundantly in the moist sphagnum moss and roots will appear in a month or two. Then the layer can be removed from the parent plant and planted in fresh soil.

Propagation by Division or Separation

Division is a propagation method widely used with herbaceous perennials, bulbs, tubers, rhizomes, stolons, some shrubs, some palms, bamboos and other grasses.

This is an easy and rapid way of increasing plants, and for many in this group it is essential to keeping them vigorous and healthy over a period of years. Herbaceous perennials in most instances increase in diameter by producing new stems and roots usually around the outer perimeter of the previous year's growth. These older plants are referred to as clumps.

These clumps increase in size gradually until they are too large for the space in the garden allotted to them.

All of the plants that can be propagated in this manner, except in the case of large specimen palms, are dug and shaken free of soil. It will then be apparent that the clumps can be divided into units or small plants each having roots, stems, buds or leaves. These units are readily separated and planted as individuals, where they are to grow permanently.

Plants are best divided after their blooming period, but with care this type of propagation can be done at any time of the year.

Bulbous plants that live from year to year should be left undivided until flower production begins to dwindle. The season after the foliage dies down, the bulbs can be dug, divided or separated and replanted. The same procedure can be followed for plants producing corms, tubers, rhizomes or stolons. These can be handled the same way either annually or every several years.

The cluster palms such as some Phoenix, Chrysalidocarpus and Caryota species can be divided by carefully separating the small clusters as they appear at the base of the older plants. These suckers can be potted and handled in the same manner as small seedlings or rooted cuttings.

Rapid Multiplication of Bulbs and Other Modified Stems

Many types of garden plants are grown from bulbs, corms, rhizomes, tubers and tuberous roots. These include tulips, narcissus, iris, lilies, caladiums, crinums, cannas, hyacinths, anemones ranunculus and several others.

True bulbs and corms, for the most part, are propagated by separating the slabs or offsets at the time they are dug. These small bulblets or cormlets are reset and treated as individual plants. They usually reach blooming size in 2 to 3 years.

In the modern garden such Texas favorites as amaryllis, crinum and other bulbs are now grown as named varieties. Many of these improved hybrids do not form offsets or bulblets readily. Various methods have been devised to make rapid multiplication possible.

These methods of rapid propagation should all be practiced when the growth cycle of the bulb is beginning.

One method is to cut the bulbs into longitudinal sections so that each section contains a fragment of stem tissue. These wedges are then inserted in the propagating medium in pots, flats or boxes which are placed in a warm humid atmosphere. Small bulbils will soon begin to form between the fleshy leaves. They will usually be large enough to pot at the end of the growing season.

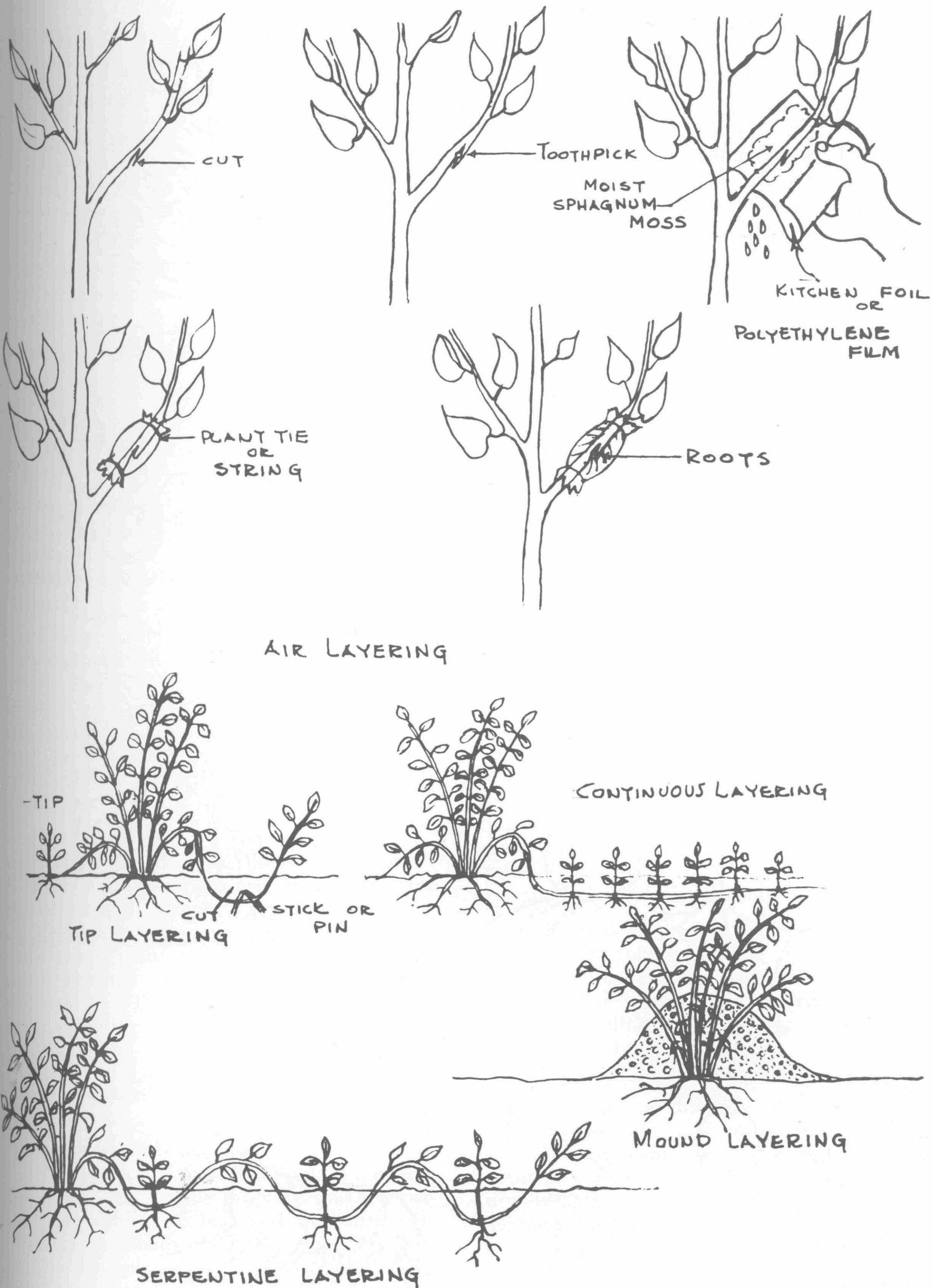
Members of the genus Lilium, the true lilies, produce scaly bulbs that are composed of many loosely attached fleshy scales. These plants can be rapidly increased by placing detached scales in flats of moist propagating medium. Small bulblets will soon form at the base of the scales and produce blooming size plants in 3 or 4 years.

Propagation by Grafting

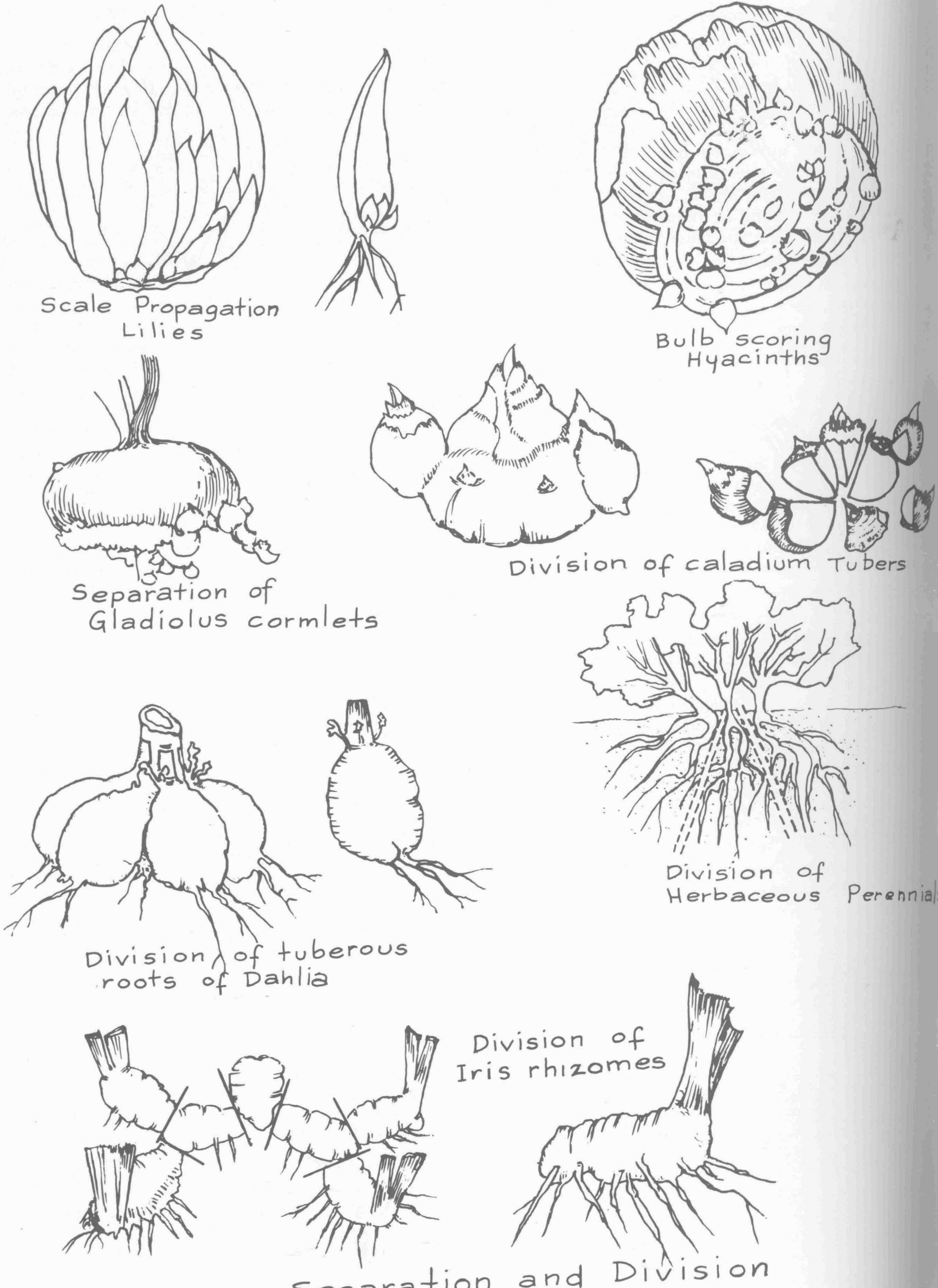
Grafting is an ancient and fascinating form of plant propagation. This is a horticultural practice in which a short piece of stem bearing one or more growth buds taken from one plant is inserted into another plant to form a union.

When a graft is successful and the branch grows from it, it produces flowers and fruits like the plant from which the stem piece was taken. The remainder of the plant below will continue to produce the same flowers and fruits as before.

An individual who becomes interested in grafting must understand well three terms fundamental to the process. These words are: *stock, scion,* and *cambium*. *Stock* is used to indicate the plant upon which the graft is made. *Scion* is the piece of stem containing one or more growth buds that is inserted into the stock. *Cambium* is the soft layer of tissue in a stem that lies between the bark and the wood. Through cell division, this layer has the capacity to produce new bark tissue on the outside and wood tissue on the inside.



Methods of Layering



Separation and Division

The basic principle in grafting is to join a section of the cambium layer of the scion with the cambium layer of the stock as completely as possible and to bind the stock and scion together so that a union takes place between the two cambium layers.

The various types of grafts that can be made are shown in the illustrations. In all grafting methods, the tight union between stock and scion must be sealed off from the air with some type of sealing agent. The best method for the amateur is to use a manufactured water base asphalt emulsion that comes in small cans.

Plants used for stock and scion must have a close botanical relationship, but even some closely related species and varieties are not compatible.

Deciduous trees and shrubs can be grafted any time during the dormant season. In most cases it is most satisfactory if it is done before buds begin to swell in late winter or early spring. Most evergreens can be grafted in early spring before active growth begins.

Grafting is employed to increase camellias, ornamental citrus, hibiscus, gardenias, mangos, avocados, privet, holly, fruit trees and in some nurseries which specialize in the production of cacti. Certain cacti are often grafted.

Cacti can be readily grafted by making a sloping cut in any position upon a selected stock plant. The scion is sharpened to fit into this slot and is then held in place with two or three long cactus spines or plastic toothpicks. Pins or nails will usually result in injury that will produce an unsatisfactory graft. Waxing or sealing the grafts are not required in the cactus since suberin forms quickly and protects the union.

Root grafting can be done also by using pieces of roots made in the same manner as described for making root cuttings, except, the pieces should be made with a straight cut across the root on the end nearest the parent plant and a slanting cut on the end farthest from the parent plant. Cut a scion in the same manner. Then make a splice graft and handle the grafts in the same manner that root cuttings are planted.

Propagation by Budding

Budding is a type of grafting that is performed with a scion that has only one growth bud. The bud from one plant is inserted under the bark of a closely related plant. If this is done properly, and the two plants are compatible, the bud and the stock will unite. Budding is usually done in the summer and early fall with most plants since through the fall and winter the growth bud remains dormant. In the spring when active growth begins in all buds of the plant, the inserted bud also starts to grow, and the branch just above it can be cut off. Then all the growth from this bud will be identical to the plant from which the bud was taken.

While the results of budding are the same as those accomplished by any other type of grafting, it is much easier to accomplish for several reasons.

Buds can be placed in the bottom 3 or 4 inches of a seedling or a rooted cutting. If the bud does not take, the plant is not disfigured as it would be with an unsuccessful graft. An undesirable plant can be converted into a better variety, or another variety could be added to an established plant.

The plant or the section of the plant into which the bud is placed is called the stock. In budding, a branch or a firm round twig with several buds and a diameter slightly smaller than a pencil is cut from the desired plant. The leaves are cut from a portion of branch with a very sharp knife leaving only a short piece of each petiole below each bud for easy handling. This branch from which the buds will be taken before they are inserted is called a *budstick.* The budsticks must be kept fresh and firm. After they are prepared they are usually carried in a small box of moist sphagnum moss to prevent their drying.

When a bud is to be inserted into the upper branches of an older shrub or large tree choose a branch 1 or 2 years old, remove the foliage that might interfere with the budding operation and proceed as shown in the illustration. The illustrated T-bud method is the easiest and the most widely used.

Patch budding is used, however, on plants that have a thick bark such as avocado, walnut or pecan. Double-bladed tools are available that remove about a 1-inch long rectangle of bark. A patch of bark must peel freely if a patch bud is to be made. In using this method, it is essential to work rapidly so that the tissues do not dry out. The newly inserted patch must be held securely in place by rubber strips or waxed cloth, and all cuts must be carefully covered.

The present practice is to use rubber budding strips or soft, rubber budding patches to tie the buds. These materials exert an even pressure without cutting the plant, and they do not require as much attention as other binding materials. In most cases they do not have to be cut, since they deteriorate and fall from the plant in a short time..

The place of insertion of buds of such plants as roses, gardenias and ornamental citrus or other field budded plants is usually dependent upon the plant or upon past horticultural practice. Roses are usually budded slightly below the soil surface, gardenias about 12 inches above the soil surface and ornamental citrus about 2 or 3 inches from the soil.

Transplanting and Care of Growing Plants

When plants have been multiplied from seed, cuttings, grafts or layers and they begin to show a considerable number of well developed roots an inch or more in length, they must be transplanted in their new location or potted in individual containers.

Potting or transplanting soil should have a loose, open structure, high in fertility, rich in organic matter and free of toxic materials. If good clean sterilized soil is not available, the mixture of peat and perlite recommended for germinating seeds has been found to be an excellent potting soil for newly propagated plants.

Today plastic containers, peat pots and pots made of various other materials are rapidly replacing the traditional clay flower pot. Any type of container is satisfactory for growing young plants as long as it is the right size and is managed properly. Soil in plastic pots does not dry out as readily as it does in clay pots, and the soil should be more porous and watered less frequently.

Peat pots are now used extensively for seedlings and rooted cuttings since they can be transplanted into permanent locations later, pot and all. Peat pots are difficult to handle individually after they have been potted. As a general rule, they should be planted in more permanent locations or larger containers sooner than if they are grown in other types of pots.

When seedlings or rooted cuttings are transplanted, be certain the soil is firmed well around the roots and that they are watered in well. Never allow the soil to dry before the roots are well established or placed in permanent locations.

Newly planted plants should be fertilized with a starter solution of complete fertilizer with 2-10-3 ratio at the rate of 1 ounce to 5 gallons of water applied with each watering.

As soon as a good root system is established, the plants can be fertilized at weekly intervals with a soluble fertilizer with a 1-1-1 ratio at the rate of 1 ounce to 2 gallons of water.

Do not allow plants to become pot bound in small containers before they are shifted to larger ones or are planted outdoors in a permanent location.

Mist Propagation

In about 1940 an outstanding advancement in propagation of plants began with the development of techniques for rooting leafy cuttings under mist.

The presence of leaves on cuttings is a strong stimulus to root initiation, but loss of water from the leaves may reduce the water content of the cutting to such a low level that it may cause them to die before root formation can take place.

When a portion of a plant has been severed in making a cutting, the natural water supply to the leaves from the roots has been cut off, but the leaves are still capable of carrying on transpiration. In rapidly rooting species, quick root formation soon permits water uptake to compensate for that removed by the leaves. In more slowly rooting species, the transpiration of the leaves must be reduced to a very low rate to keep the cuttings alive until new roots form.

To reduce the transpiration of the leaves on cuttings to a minimum, the vapor pressure of the water in the atmosphere surrounding the leaves should be maintained as nearly equal as possible to the water pressure in the intercellular spaces within the leaves.

A standard practice for many years in any propagating structure was to sprinkle cuttings, walls and floors frequently to maintain a high relative humidity. Automatically controlled devices which disperse a fog-like mist are also available for use in greenhouses or other closed propagating structures. These methods of humidification give a beneficial effect primarily in increasing the amount of water vapor in the air.

The basis of mist propagation was the use of sprays of water on the foliage of cuttings to maintain a film of water on the leaves. This not only results in high humidity around the cutting, but also lowers the leaf temperature and that of the surrounding air —all of the factors that tend to lower the rate of transpiration.

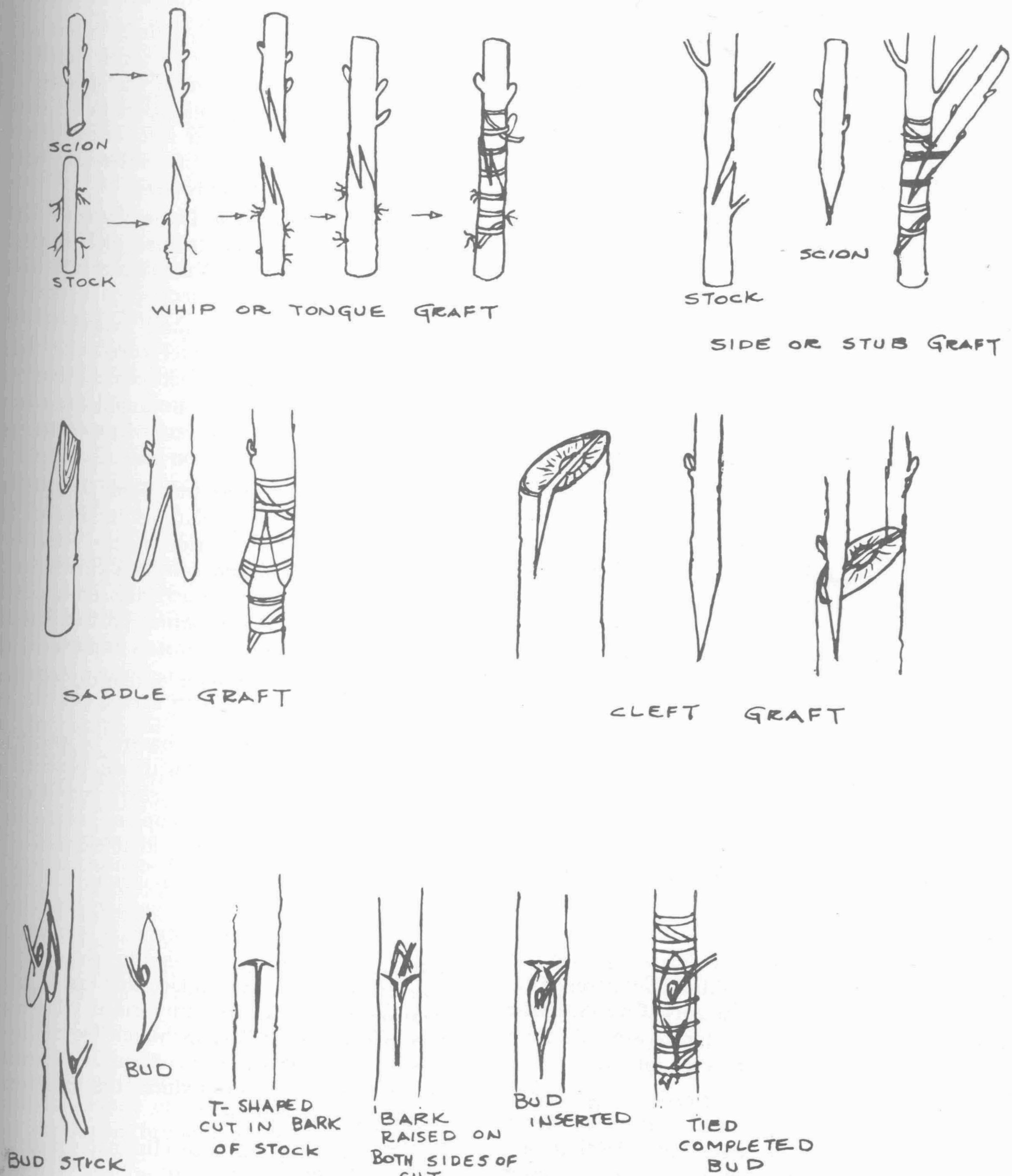
The cooling effects of such water sprays are so effective that propagating beds can be placed outdoors in full sun without an appreciable increase in leaf temperature. This permits a higher rate of photosynthesis in those cuttings placed in the sun than in those placed in shady locations.

To thoroughly understand the advantages of mist propagation, some distinction must be made between humidifying systems and mist systems. Under systems that only increase the relative humidity, the water vapor pressure in the area around the leaves is increased. In mist systems this also occurs, but the leaf is covered with a film of water which provides the additional benefit of reducing the temperature of the leaf which in turn reduces the internal water vapor pressure and consequently the transpiration rate.

Conditions for the growth and rooting of cuttings are ideal under mist. Transpiration is reduced to a low level; the light intensity can be high, promoting a high rate of photosynthesis; and the temperature of the entire cutting is relatively low, thereby reducing the respiration rate. Cuttings under mist can be synthesizing food in excess of that used in respiration. Such nutrients are very important in promoting the initiation and development of new roots.

Mist nozzles should maintain a film of water on the leaves at all times during the daylight hours. The application of additional water as mist does not seem to be an advantage, and in many cases it can be harmful.

The leaves of cuttings of certain species of plants deteriorate to some extent under mist and much more so under constant mist than under intermittent mist.



Methods of Grafting

Various scientific studies have shown that exposing leaves to natural or artificial rains or soaking them in water will remove nutrients, both organic or inorganic, from the leaves.

Considerable variability exists, however, among plant species in regard to susceptibility to loss of minerals by leaching. Apparently there is a difference also between loss of minerals by leaching from young vigorous growing cuttings and cuttings made from more mature growth. In cuttings of older tissues, there is an actual loss of nutrients by leaching; in the younger ones, it is more of a dilution effect due to tissue increase and active growth.

Recent research has indicated that nutrients added to the mist in very low amounts will be helpful at least in some plants where nutrient loss is a problem.

Softwood cuttings may be taken very early in the growing season, if they are to be rooted under mist. This is the stage most favorable for rooting in many cases. When rooted in the conventional manner, these cuttings would be difficult to maintain without wilting.

Mist Systems

One of the chief problems in propagating plants by leafy cuttings is to maintain the cuttings without wilting until the roots are produced.

Intermittent mist sprays over the rooting bed have been found to be very effective in rooting leafy cuttings of many kinds of plants, especially ornamental species.

This technique enables the propagator to root cuttings of plants previously considered very difficult or impossible to root.

Two basic types of mist nozzles are available and widely used along with many modifications of each kind. They are the oil burner or swirling action type and the deflection type.

The characteristics of the oil burner nozzle are that it produces an evenly distributed relatively fine spray and uses relatively small amounts of water. Mist is produced in the nozzle by water passing through small grooves set at an angle to each other.

The characteristics of the deflection type nozzle are that it develops mist by a fine stream of water striking a flat surface; has a larger aperture that prevents clogging but uses more water; covers a larger area than oil burning type, so fewer are required; and operates more effectively at low water pressures than oil burner types.

Intermittent mist that supplies enough water at intervals during the daylight hours to keep a film of water on the leaves gives better results than constant mist. Since it is impractical to turn such systems off and on by hand, electrical controls are used.

Several types of controls are available, and all operate to control a solenoid valve in the water line to the nozzles. "Normally open" solenoid valves should always be used in intermittent mist systems so that if power fails, the valve will remain open, and the cuttings will not accidentally dry out. The more commonly used controls are as follows:

The electrically operated timer system is the best type of control. It uses two timers together: One turns the entire system on in the morning and off at night, and the second one operates the system during the day to produce an intermittent mist at any desired combination of time intervals, such as 10 seconds ON and 90 seconds OFF.

Another control used is the *electronic leaf*. This control system consists of a small piece of plastic containing two terminals placed under the mist along with the cuttings.

Wires from the terminals extend to a control box. When a film of water covers the plastic permitting electrical contact between the two terminals the solenoid valve is activated, and the mist is shut off. When the film of water evaporates from the plastic, the systems turn on etc.

Finally, there are *controls based on light intensity*. These operate on the relationship between light intensity and the evaporation rate. They contain a photoelectric cell which conducts current in proportion to light intensity. It activates a magnetic counter so that after a certain period of time the solenoid valve is opened and the mist is applied.

The higher the light intensity, the more frequently the mist is applied.

Note: There is always a hazard of electrical shock when one works with an electrical control unit in a mist bed *where considerable water is present*. The complete installation should be made by a competent electrician.

There are many advantages in the use of mist by the home gardener. A cutting continues to lose water by transpiration after it is removed from the parent plant. It is impossible for the cuttings to take up sufficient water to replace that lost by rapid transpiration until new roots are formed. The mist system prevents excessive loss of water by cutting. Maintaining this higher water content in the cutting helps the plant to root and reduces the time required for rooting to take place.

The mist system also eliminates most insect and disease problems in the cutting beds. It does not solve all the problems of propagation by cuttings, however.

Originally, this system was called constant mist since it was believed necessary to keep cuttings under the mist during the entire rooting period.

The average home gardener, who wishes to propagate only a few cuttings, should turn the mist on about 8 a.m. and leave it on until 5 p.m.

Since each mist nozzle is designed to cover an area of about 4 square feet, one nozzle usually is sufficient for the needs of the average gardener. Media for cuttings under constant mist should be no deeper than 4 inches.

Controlling Propagation Environment With a Plastic Structure

A plastic structure provides a new technique for rooting leafy cuttings and grafts under adverse environmental conditions. It shows considerable promise for wider use by plant propagators. This technique overcomes some of the disadvantages encountered by the use of intermittent mist.

Research on mist techniques in plant propagation at Texas A&M University presented difficulties because of high soluble salt content in the available water supply—largely because of sodium accumulation on the leaves. This condition resulted in severe marginal burning of the leaves on most cuttings placed in this environment for more than 15 days.

Another well-known propagating technique for cutting and grafts is the use of a closed case covered with glass, plastic films or other translucent materials. In a closed-case system of propagation, the transpiration rate is reduced by humidification rather than mist. Normally, the effect of humidification and mist on the transpiration rate is distinct since the relative humidity around the leaf decreases or increases the water vapor pressure around the leaves.

In this method, the leaves are not usually covered with a film of water that reduces the leaf temperature and in turn decreases water vapor pressure within the leaves. Because of this condition, closed cases used for propagation are usually shaded to reduce temperatures. This reduction in light intensity, however, often makes the rooting environment less desirable.

An ideal environment for rooting and growing many types of cuttings and grafts can be maintained with the use of mist methods, if a satisfactory water source is available. Under these conditions, transpiration is reduced to the lowest level, and high light intensity can be maintained promoting a higher rate of photosynthesis and a lower rate of respiration.

When the conventional closed-case propagation was used and the case shaded and ventilated by laborious and time-consuming methods, cuttings and grafts suffered because of reduced photosynthesis and increased respiration brought about by the shading and high temperature.

The disadvantages encountered with a higher than normal soluble salt content in water used in mist propagation along with attempting to automatically control ideal temperature and humidity relationships in closed-case management prompted the development of a closed-case propagation system with automatic or semi-automatic control. This device has produced excellent results in ornamental plant propagation with cuttings.

The propagating case can be constructed inside a greenhouse; however, this is not necessary. The case could be constructed and maintained as efficiently under lath or field conditions if a suitable water supply with 25 pounds pressure and a source of electricity are available.

This closed-case system with automatic controls was constructed over a conventional concrete greenhouse bench 3 feet wide, 8 inches deep and 33⅓ feet long. The case construction was kept as simple as possible. The supporting members were constructed of ⅝-inch standard steel conduit, such as that used for electrical wiring. The material was formed with a pipe shaper and, when installed over the bench, resembled an inverted "U" with a 2-inch flat area on the top. The pipe supports were erected and held together upright by five wood strips, 1 inch thick and 2 inches wide, that extended the length of the case. One strip was bolted to the apex of the inverted "U" pipe forms when they were set in place on the bench. One strip was bolted to the base of the forms on each side, and one strip was bolted to the forms at the tangent point on the sides of the inverted "U" forms. This frame made up the superstructure of the closed case.

The bottom of the V-bottom concrete propagating bench was filled with pea gravel 2 inches deep. A thermostatically controlled soil heating cable was placed on the gravel and covered with ¼-inch mesh hardware cloth. One inch of the propagating medium was placed on top of the hardware cloth.

The bench was filled with a standardized propagating medium composed of 50 percent horticultural grade perlite and 50 percent sphagnum peat moss with 7 pounds of dolomite and 10 pounds of gypsum thoroughly incorporated into each cubic yard of the mixture. (For acid loving plants, the dolomite could be omitted, and, in areas where sodium salts in the water are not a problem, the gypsum could be omitted.) The medium was well watered in by hand. For grafts in pots or seed planted in flats, the bench was filled nearly full with perlite or fine gravel. The pots or flats were placed on this medium.

About three-fifths of the case (from the upper wood strip on one side to the lowest strip on the other side) was covered with weatherable mylar and stapled to the wood strips. The other side of the case was covered with polyethylene curtains, 9 feet 5 inches long, fastened to the upper wood strip. A wood strip was fastened to the bottom end of the curtains, permitting them to be rolled and unrolled like a window curtain. In this manner, one section of the case could be opened while the rest of the case remained closed.

One end of the case was covered with a 50-mesh brass screen. Two Monarch No. F 110C fog nozzles were installed one-third of the distance from each end of the case and connected to a humidistat and solenoid valve located in the center of the case. A 10-inch exhaust fan similar to those used for greenhouse cooling was installed in the other end of the case. The area around the fan was enclosed with mylar, and the fan was controlled by a thermostat located midway between the two ends of the case.

When the thermostats on the soil cable were set at the desirable temperatures, they automatically controlled the temperature in the propagating medium. When the humidistat was set at the desired relative humidity, a constant percentage of humidity was provided automatically. The automatic control of temperature and relative humidity eliminates the need for shading usually required with closed-case propagation.

Excellent results have been obtained with seed germination and the propagation of cuttings and grafts. Several types and kinds of plants, including several exotic plants difficult to root under mist, have been propagated successfully by this method.

PROPAGATION OF PLANTS ADAPTED TO INDOOR LANDSCAPES

The following plants are not subjects necessarily difficult to root, but they are plants about which there is little recorded propagation information.

Since the trend in propagation in recent years has been toward controlled environments through the use of mist and closed plastic cases or tents, there has been some tendency to disregard the use of open bench propagation methods.

Two methods of propagation were used for rooting cuttings of these plants.

A closed-case system with automatically controlled bottom heat, relative humidity and atmospheric temperature was used in comparison with propagation on an open bench in the same greenhouse in which the bottom heat, atmospheric temperature and relative humidity were also controlled automatically. Both methods were used for various plants, but comparative tests were not made in each case.

The night air temperature was maintained at 70° F, the bottom heat at 80° F and the relative humidity at 80 percent. The same propagating medium was used in both methods. All cuttings were rooted in 2½-inch lightweight plastic pots placed pot to pot on 2 inches of perlite layer that covered the heating cables. All pots were filled wtih a mixture of 50 percent horticultural grade perlite and 50 percent sphagnum peat moss in which 7 pounds of dolomite and 7 pounds of gypsum were thoroughly incorporated into each cubic yard. The gypsum was used in these trials to counteract the sodium accumulation that normally occurs in this location by repeated watering.

The rapidly developing interest in indoor landscaping and gardening in recent years and the increase in apartment type dwellings in urban areas have stimulated an interest in and demand for the propagation and use of lesser known, durable and attractive plants for use in small planters, as well as for large specimens in ornamental containers or in interior planting boxes and beds. The plants included here are some of those that have been selected by previous adaptability trials to be best suited for such use.

An index of the results obtained in these trials is as follows:

Scientific name	Method	Days to root	Percent rooting
Acalypha wilkesiana obovata Ceylon	Open bench	16	100
Achimenes grandiflora	Case	15	100
Achimenes longiflora	Case	15	100
Aeschynanthus grandiflora Black Pagoda	Open bench	16	75
Aeschynanthus bracteata	Case	13	100
Aeschynanthus grandifloras	Case	20	100
Agathis robusta	Open bench	20	86
Aglaonema commutatum	Case	31	100
Aglaonema modestum	Case	30	50
Aglaonema robelini	Open bench	33	89
Aglaonema simplex	Open bench	44	100
Aglaonema treubi	Case	31	100
Anisacanthus thurberi	Open bench	15	100
Anthurium aenulum	Open bench	24	92
Anthurium pictamayo	Open bench	31	97
Asystasia coromandeliana	Open bench	14	100
Begonia coccinea Angel Wing	Open bench	30	96
Begonia feasti	Open bench	15	90
Begonia odorata	Case	15	100
Bougainvillea speciosa variegated	Open bench	32	50
Chirita asperfolia	Case	10	100
Chlorophytum comosum	Case	16	100
Cissus discolor	Open bench	24	97
Columnea banksi	Case	10	100
Columnea gloriosa superba	Case	14	100
Columnea linearis	Case	11	100
Columnea Lois Hammond	Open bench	14	84
Columnea Lois Hammond	Case	7	100
Columnea microphylla	Open bench	14	100
Columnea microphylla	Case	14	90
Columnea V. C. Covert	Open bench	14	86
Cotyledon ladysmithiensis	Open bench	24	94
Cyperus haspan viviparus	Open bench	8	100
Dichorisandra picta	Open bench	15	97
Dracaena sanderiana	Open bench	18	89
Episcia dianthaflora	Case	30	87
Ervatamia coronaria	Open bench	22	76
Euonymous fortunei gracilis	Open bench	15	97
Euonymous japonicus albo-marginata	Open bench	30	96
Euonymous japonicus Goldspot	Case	30	100
Ficus australis variegated	Open bench	20	94
Ficus mallatocarpa	Open bench	20	96
Ficus phillipenensis	Open bench	20	95
Ficus retusa (nitida)	Open bench	20	100
Ficus rubiginosa	Open bench	20	91

Scientific name	Method	Days to root	Percent rooting
Fittonia verschaffelti Pearce	Case	7	100
Graptophyllum pictum	Case	15	100
Graptophyllum pictum roseum	Case	15	100
Hemigraphis colorata	Case	11	100
Hemigraphis exotica	Case	11	100
Homalocladium platycladum	Open bench	16	100
Hoya australis	Case	16	100
Hoya bella	Case	16	100
Hoya keysii	Case	16	95
Hypocyrta numullaria	Mist	30	25
Jacobinia carnea	Case	16	100
Kalanchoe engeleri	Open bench	17	100
Kalanchoe Mace	Open bench	11	100
Kalanchoe Nasa	Open bench	10	100
Kalanchoe pubescens	Open bench	8	100
Kalanchoe Telestar	Open bench	11	100
Kalanchoe Thor	Open bench	10	100
Kalanchoe tricolor	Open bench	11	100
Kalanchoe tsaratanensis	Open bench	10	100
Kleinia repens	Open bench	19	96
Koeleria eriantha	Open bench	14	100
Ligularia kaempferi leopard	Open bench	15	92
Ligularia kaempferi	Open bench	10	82
Ligularia tussilaginea argentea	Open bench	18	70
Nautilocalyx lynchii	Case	15	100

Scientific name	Method	Days to root	Percent rooting
Passiflora edulis	Case	23	86
Pellonia pulchra	Case	10	100
Peristrophe aurantiaca	Case	10	100
Philodendron karstenianum	Case	19	100
Philodendron mandaianum	Case	26	79
Philodendron microstichum	Open bench	15	100
Philodendron tripartitum	Case	30	100
Pseuderanthemum atropurpureum	Case	15	100
Raphidophora celatocaulis	Open bench	35	40
Ruellia amoena	Open bench	12	100
Scindapsus aureus	Case	17	97
Scindapsus pictus argyraeus	Open bench	12	79
Setcreasea purpurea	Case	15	100
Stenandrium lindeni	Open bench	16	100
Stenataphrum secundatum variegated	Case	14	100
Stephanotis floribunda	Case	29	100
Syngonium podophyllum Green Gold	Open bench	26	100
Syngonium hoffmani	Open bench	15	100
Syngonium podophyllum	Open bench	26	97
Syngonium podophyllum monstrose	Open bench	25	89
Syngonium schotti	Open bench	21	95
Tradescantia avicularis	Open bench	10	100
Tradescantia sillamontana	Case	14	100

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