FLORIDA MASTER GARDENER

Plant Propagation

UF | IFAS Extension
UNIVERSITY of FLORIDA

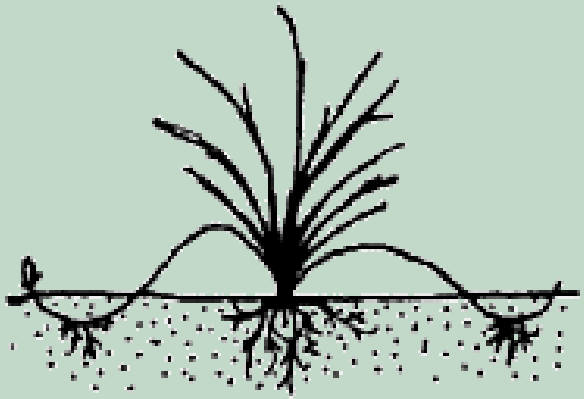
Learning Objectives

- Define sexual and asexual plant propagation.
- Describe various techniques for propagating plants.
- Identify the environmental factors affecting plant propagation.

Plant Propagation …

Plant multiplication

- Sexual: from seed
- Asexual: from vegetative parts



SEXUAL (SEED) PROPAGATION

Sexual Propagation

Advantages:

- Major source of genetic diversity (new or improved cultivars)
- Large numbers of plants can be reproduced easily and inexpensively
- May be only technique for a species (ex: some palms)
- Long-lived seeds are easily stored.

Sexual Propagation

Disadvantages:

- Genetic variability
- Seed may require special treatment to break dormancy
- Some species slow to flower and fruit
- Some diseases are seed-borne

Plant Propagation from Seed

Plant multiplication

- Sexual: from seed (pollination and fertilization with zygote formation)
- Apomixis: asexual seed production (cloning, no meiosis – citrus, mango, daisy, grasses and roses)
- Polyembryony (asparagus, tulip, beets, Swiss chard)

Seed Types

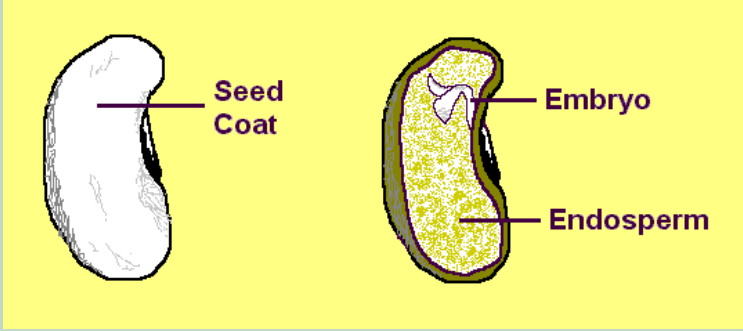
- Orthodox: maturation drying
- Recalcitrant: do not dry (avocado, mango, citrus, lychee, cocoa< 5%)
- Intermediate: share characteristics (non-orthodox: 10% - 15%, e.g *Salix* and *Cuphea*)
- Vivipary: germinate while still attached (Mangroves). Zinnia and tomato seeds can start to grow.

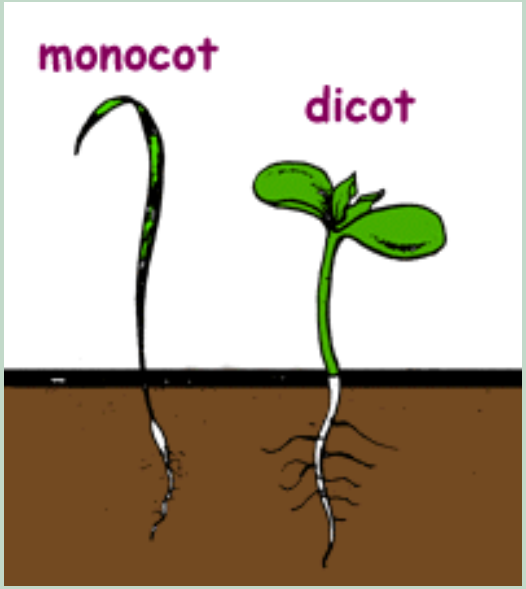
Seed Development

- Histodifferentiation: begins at fertilization and formation of zygote from the two haploid gametes
- Cell expansion (and food reserves)
- Maturation drying: can lose up to 90% plus of water

Parts of a Seed

- Seed coat
- Endosperm: stored nutrients
- Embryo: tiny plant
  - Cotyledons (seed leaves)
    Monocots = 1, Dicots = 2
  - Radicle (embryonic root)
  - Plumule (embryonic shoot)



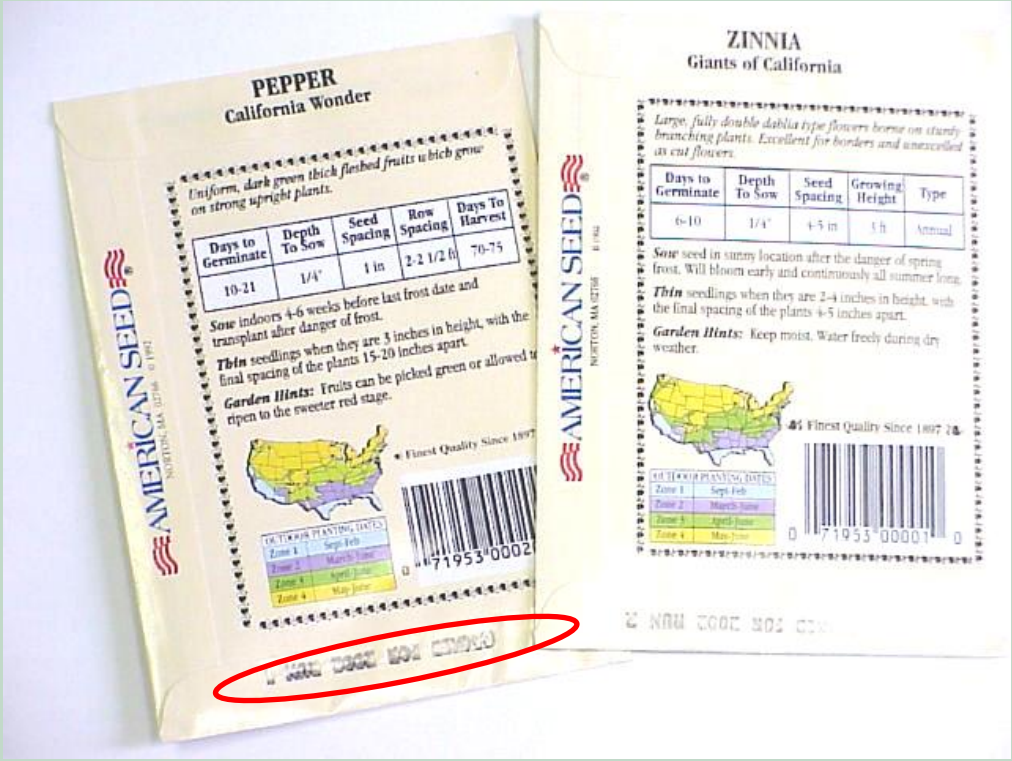


Seedling Emergence

- Epigeous: hypocotyl hook like beans
- Gypogeous: shoot tip emerges first
- Hypogeous: epicotyl emerges and cotyledons remain inside seed coat

Purchasing Seed

- Look for percent germination and packaging date
- Select species adapted to your area
- Follow package info



Purchasing Seed

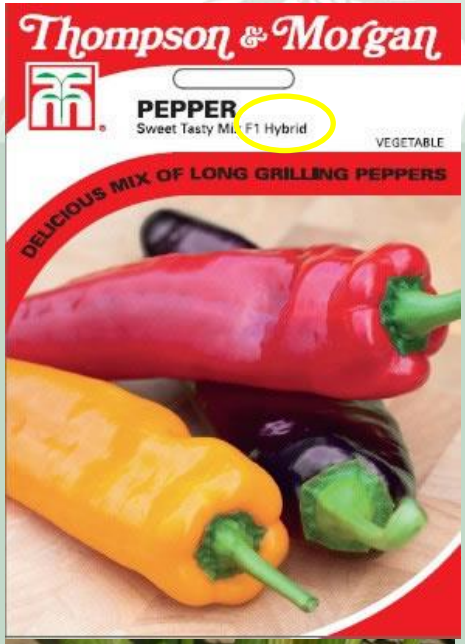
- Purchased seed is often treated with a pesticide
- Wash hands after handling

Collecting Seed

- Collect open-pollinated seeds (true-to-type)
- Determine seed maturity by size, shape, weight, and color
- Viability may be short or long
- Seeds from fleshy fruits should be cleaned

Don’t Collect Seeds from…

- F1 hybrids
- Plants that cross pollinate (ex: squash); next generation of seed will not be “true-to-type”
- Diseased plants



Testing Seed Viability

<u>To check germination</u>

- Rag doll test:
  - Place seeds in a moist paper towel
  - Place in plastic bag
  - Keep warm ~70ºF
  - Check daily for germination

- Float test:
  - Non-viable seeds may float or sink more slowly (Ex: oaks, cycads)

- Many seeds are short-lived (Ex: onion and tropicals)

Credit: Colorado State University

Storing Seed

- Once dry, place seeds in an envelope marked with the name and date
- Store in an airtight container (plastic bag or jar)
- Store at 40-45°F and low relative humidity (~30-35%) (refrigerator)

Direct vs. Indirect Seeding

- Direct – seed sowed in permanent growing area
- Indirect – seed grown in temporary container and transplanted

Direct Seeding

- Easy to grow
- Poor transplant quality
- Must have good environmental conditions
- Right time of year
- Vegetables, flowers, turfgrass
- Seed coatings
- Moisture is critical
- Disease control

Indirect Seeding

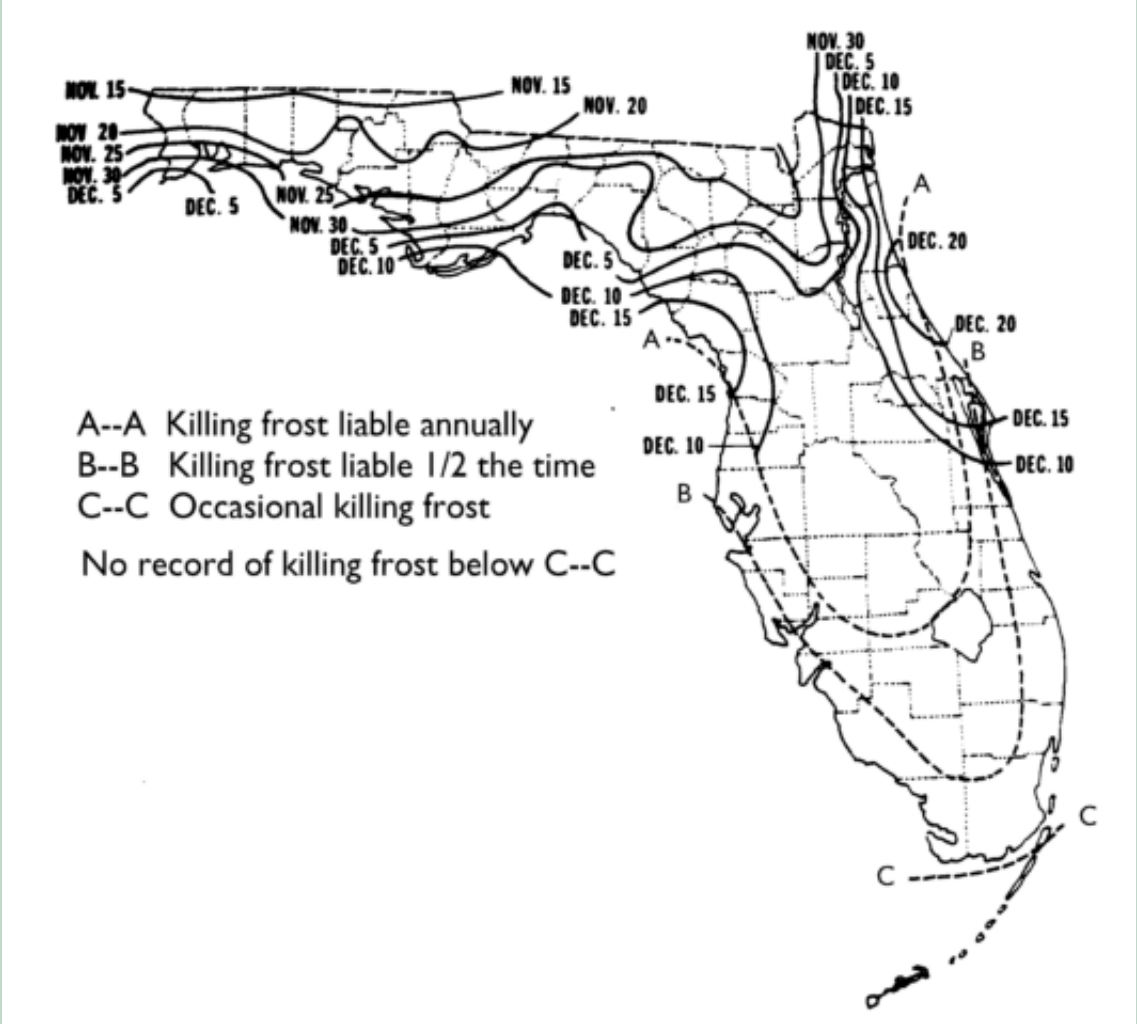
- House vs. greenhouse
- Warm – then cooler w/bright light, overhead not window
- Try to time going outside
- Short, thick stemmed seedlings
- Pasteurized substrate, containers, etc.
- Disease control: damping off (*Pythium*, *Rhizoctonia*, *Botrytis* and *Phytophthora*)

Which Vegetables to Transplant (TP)

TP - easy	TP - okay	TP - difficult
Beet	Carrot	Bean
Broccoli	Celery	Corn
Brussels sprouts	Eggplant	Cucumber
Cabbage	Kale	Cantaloupe
Cauliflower	Kohlrabi	Mustard
Chard	Leek	Peas
Collards	Onion	Squash
Endive	Pepper	Turnips
Lettuce	Salsify	Watermelon
Tomato		

When to Start Transplants

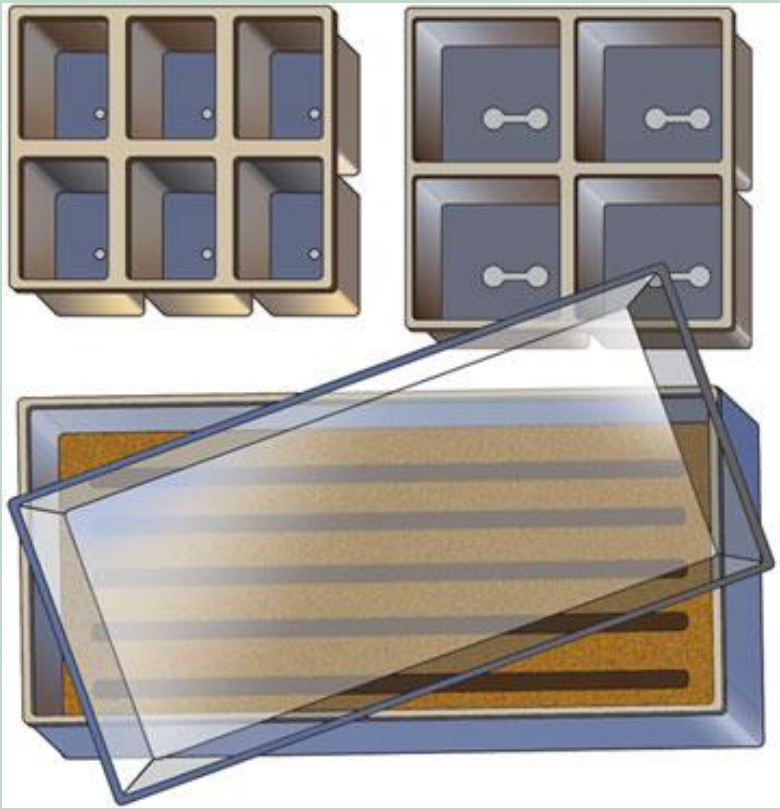
- Count back from last frost date
- Add up days to germinate plus “hardening-off” time



Containers for growing TP

Should be:

- Sterile, well-drained, and 2” to 3½” deep
- Examples: flats, pots (plastic, clay, peat)
- To sterilize: clean with chlorox/water 1:9 dilution

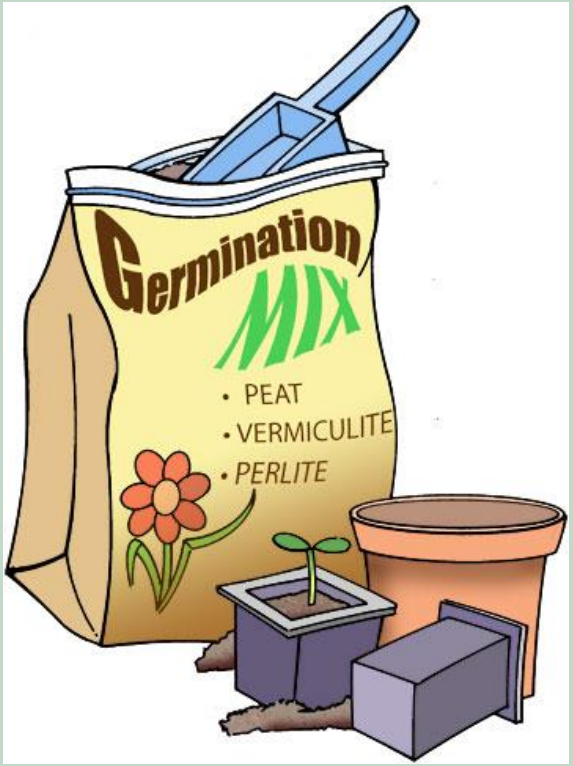


Germination Medium

Any combination of below:

- Builders Sand (porous)
- Peat Moss (holds water)
- Shredded Sphagnum (holds water)
- Vermiculite (light weight material, holds water)
- Perlite (light material for air/drainage)
- Jiffy Mix (sphagnum, peat, vermiculite)

Examples: 50/50 Builders Sand/Peat Moss; or 50/50 peat/perlite

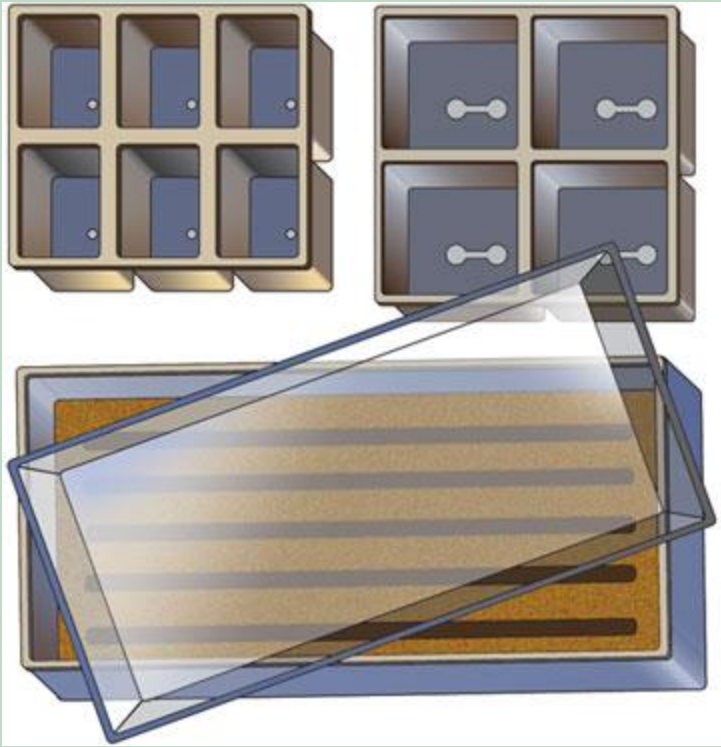


Germination Medium

- Sterile
- Moist, but well-drained (seeds/seedlings need O_2)
- No fertilizer (seed contains nutrients it needs)
- Particle size (fine-textured for small seeds)

Planting Seeds for TP

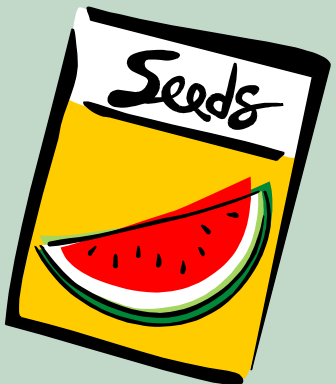
- Fill containers with moist growing medium.
- Gently press seeds onto surface (follow directions on seed package).
- Cover with plastic.
- Keep warm - 75°.



Planting Depth

Determined by Size of Seed (i.e., stored food)

- Small seed – scatter over surface and press into soil
- Medium seed – cover lightly
- Larger seed – 1 to 2 times the seed diameter
- Exception – cycad and coconut – level or just under surface



Germination Stages

Seed Germination Stages:

- Imbibition: two phases of water uptake
- Lag
- Radicle emergence

Stages of Seed Germination

- Activation: Water penetrates seed coat and endosperm swells
- Digestion/Cell Division: Water dissolves nutrients in endosperm for embryo
- Growth: Cell division and elongation

Germination Parameters

- Germination percentage
- Germination rate or speed
- Germination uniformity

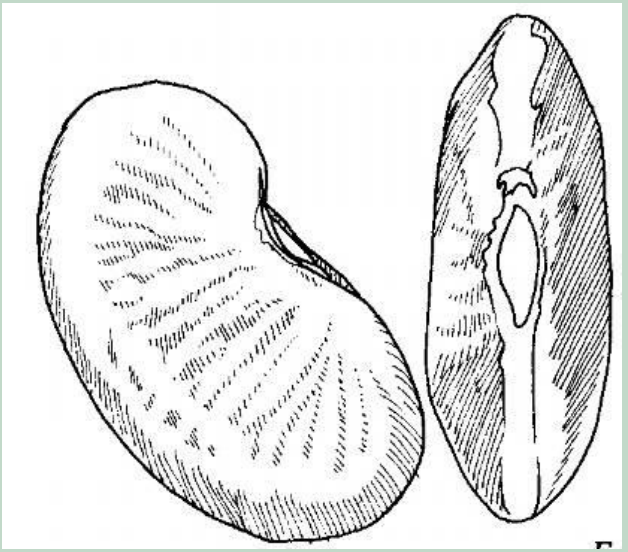
Environmental Factors

- Temperature (soil versus air)
  - Maximum, minimum or optimum
  - Thermoinhibition
- Water
- Gas: exchange between embryo and substrate (oxygen and CO_2 accumulation)
- Light: quality and photoperiod phytochrome Pr to Pfr (poinsettias Pfr to Pr)

Seeds with “Special Needs”

Seed remains dormant due to:

- Impermeable or hard seed coat
- Chemical that inhibits germination
- Immature embryos
- Double dormancy

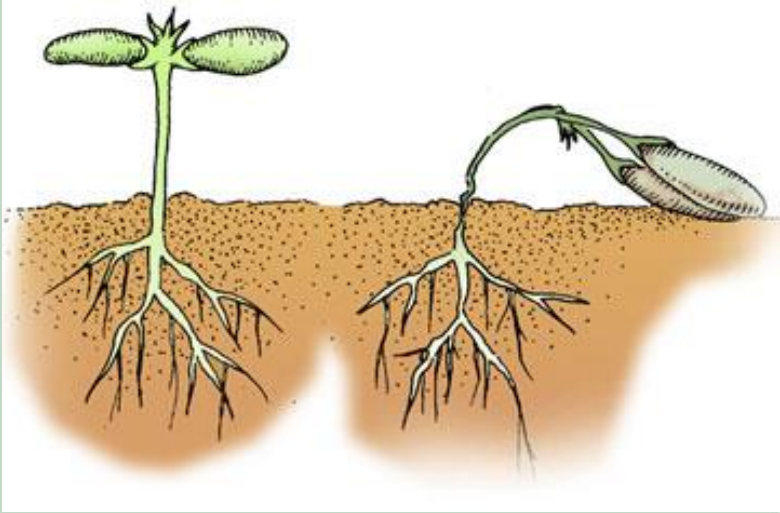


Days to Germinate – Varies with Species

Examples	Days to Germ.
Broccoli	7-10
Cabbage	4-10
Cucumber	6-10
Eggplant	6-10
Lettuce	6-8
Melons	6-8
Onion	7-10
Pepper	9-14
Squash	4-6
Tomato	6-12
begonia	2-3
impatiens	8
coleus	10
vinca	14-21

Care of Transplants

- When seeds sprout, remove cover & place in bright light.
- Water as needed but do not overwater (causes rot and disease).
- Fertilize when 2nd set of “true leaves” appear (use water soluble fertilizer at half-strength; gradually increase over time.



“Harden Off” Seedlings

- Gradually acclimate plants to outdoor conditions.
- Process takes 1 to 2 weeks before putting into garden.
- Set outside for a few hours each day in semi-shade (not below 45˚F).
- Gradually increase time outdoors and sunlight.
- Transplant late afternoon or on a cloudy day, or add protection.

Seeds with “Special Needs”

Treatments:

- *Scarification:* process that weakens or removes the hard seed coat
  - *chemical (acid treatments)
  - *mechanical (file, sand paper, hammer, etc.)
  - *hot water (170-210°F) - softens seed coat
  - *Ex: Zamia, camellia, redbud, peaches

- *Stratification:* imbibed seeds are subjected to prolonged chilling or heat to allow the embryo to develop.
  - *seeds are layered in a moist medium
  - *can be accomplished outdoors or in refrigerator (1-4 months)
  - *Ex: dogwood, holly, magnolia; palms (warm)

- *Double Dormancy:* cold-warm-cold stratifications; scarification followed by stratification, etc. Ex: fringe tree

ASEXUAL (VEGETATIVE) PLANT PROPAGATION

Asexual Propagation

- Advantages:
  - Progeny are identical to parent plant (clones)
  - Uniformity
  - Shorter time to mature (flower/fruit)
  - May be only way to propagate a plant
  - New cultivars can be multiplied quickly
  - Can combine plants (grafting/budding)
- Disadvantages
  - No variation or evolutionary advances
  - More expensive per plant than seeding

Main Methods of Asexual Propagation

- Cuttings
- Layering
- Separation/Division
- Grafting/Budding
- Micro-propagation/Tissue culture

Plant Sale Hints

- PCGC
- Shorten time between harvest and stick
- Correct sized cuttings
- Consistent number of cuttings
- Use correct hormone (IBA auxin)
- Reduce water loss in cutting

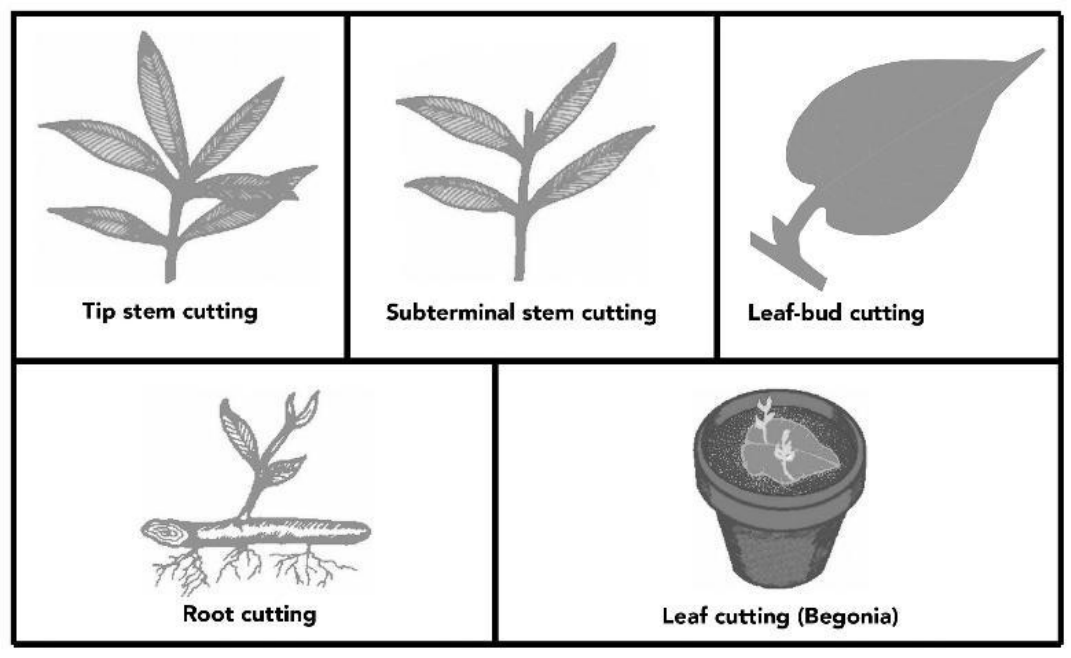
Plant Sale Hints

- Use right size containers, repotting?
- Consistent substrate
- Final appearance at propagation
- Follow headspace line
- Fertilize after rooting until September
- Pinch when appropriate
- Roots, shoots and flowers (pinch flowers early on)

Cuttings – Common Techniques

Part of Plant:

- Stem cuttings
- Leaf-bud cuttings
- Leaf cuttings
- Root cuttings



Stem Cuttings

- No uptake
- Healing
- Balancing act: water management and stored energy
- Time of day
- Photosynthesis
- Polarity: proximal and distal
- Preformed roots vs. de novo roots (competency vs. determinism)

We ask a lot of a cutting!

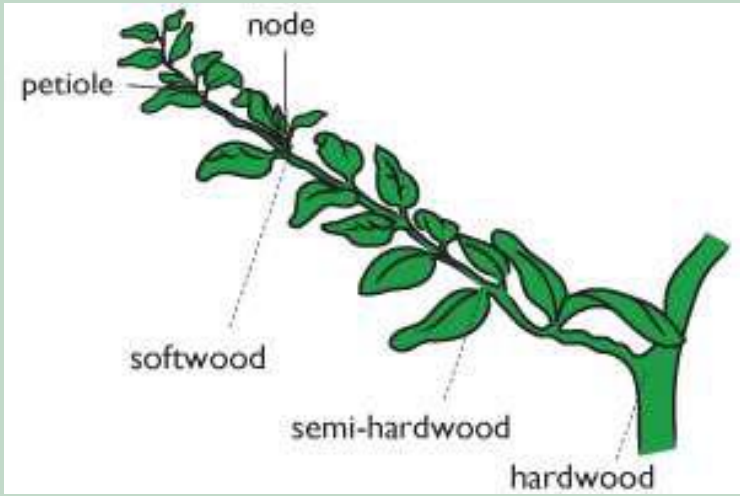
It must regenerate roots under adverse conditions:

- Loss of water supply
- Loss of nutrient supply
- Excessive wounding

Stem Cuttings

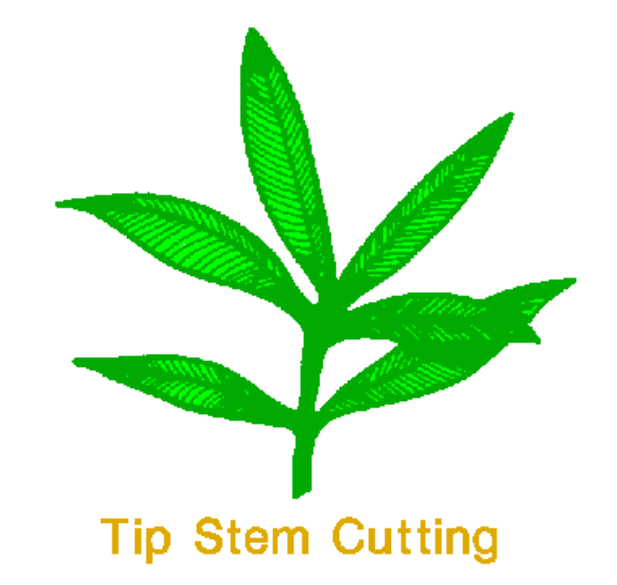
<u>Defined by maturity of plant tissue:</u>

- Softwood and Herbaceous
  - Current season's growth
  - Plant tissue bends easily
  - Taken 3-4 weeks after growth flush
- Semi-Hardwood
  - Current seasons growth
  - Still green, but not woody
  - Plant tissue snaps when bent
- Hardwood
  - Usually last year's growth
  - Springs back when bent
  - Take just before or during dormant season



Softwood/Herbaceous Stem Cuttings

- Cuttings collected from succulent new growth.
- Tip and subterminal cuttings
- Quick to root; < 8 weeks



Semihardwood Stem Cuttings

- Taken late spring to midsummer
- Tissue is mature, but not woody

Hardwood Stem Cuttings

- Taken from last season’s growth
- During or just before dormant season
- Tissue springs back when bent

Stem Cutting Types

- Single node (eye): vines, no polarity
- Double node: polarity, commercial
- Multiple node: polarity and usually contains apical bud
- Stem vs. tip cutting

Cutting Considerations

- Stem cutting angle: slanted vs. straight
- Reduction of leave surface area
- Sanitation[3]

Leaf-bud Cuttings

- Leaf, petiole, and ½”-1”stem
- Mark which end is “up” or cut one end straight and angle the other.

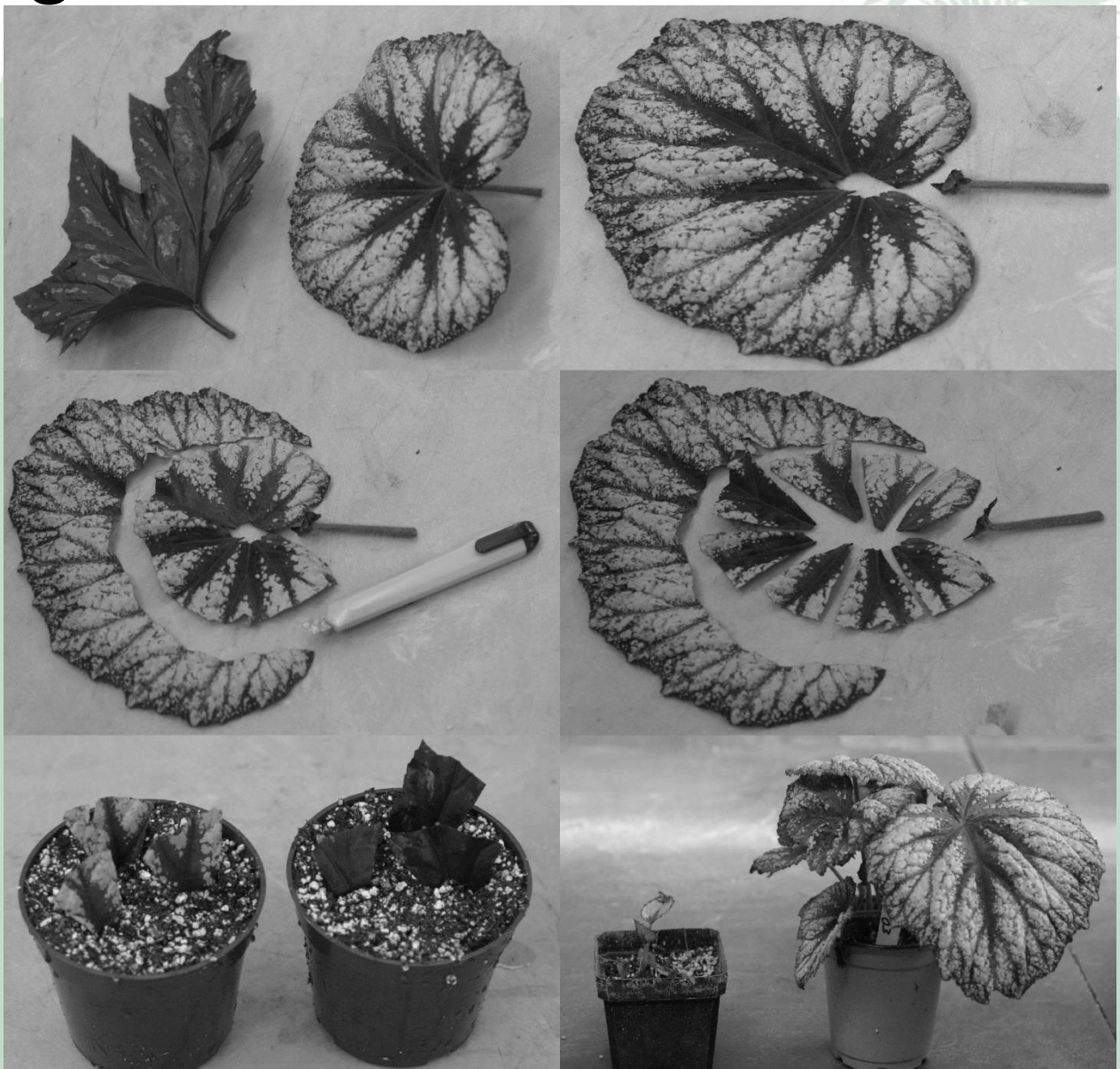
Leaf Cuttings

Leaf Cuttings

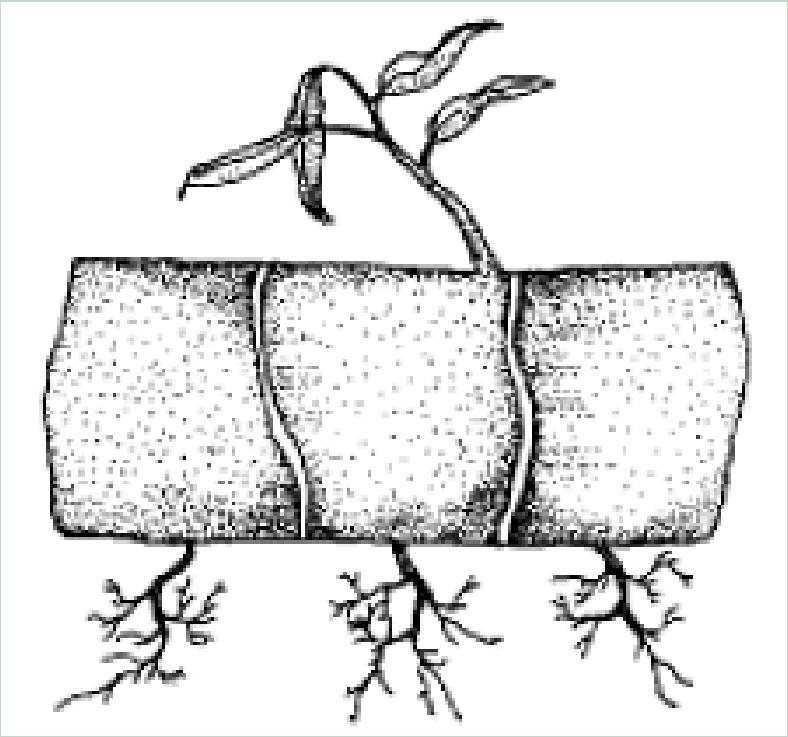
- Snake plant

Leaf Cuttings

- Begonia



Cane Cuttings



Root Cuttings

Adventitious Roots

- Successful cutting propagation relies on the formation of adventitious roots.
- Adventitious roots grow from areas of the plant other than the root zone.
- Root growth is stimulated by interruption of downward movement of carbohydrates, hormones, and other materials.
- Initiate from preformed root initials or a wound.

Adventitious Roots from Preformed Root Initials

- Develop naturally on stems while they are still attached to the parent plant
- May or may not emerge prior to severing the stem
- Plants with preformed root initials generally root rapidly (Ex: Coleus).

Adventitious Roots from Wounds (de novo)

- Develop after the cutting is made.
- Steps:
  - wound seals
  - callus forms
  - adventitious roots are initiated

callus

Harvesting Stem Cuttings

- Select most vigorous and healthy plants.
- Turgid leaves (not wilted)
- Free of insects and diseases
- Take cuttings from higher light area vs. shade.
- Take cuttings in morning and place in moist plastic bag or bucket of water.

Auxins

Auxins (plant hormones-IAA, IBA, NAA) stimulate root initiation and development

- Produced naturally in plants
- Also synthetically produced (NAA, IBA).

NAA

IBA

Propagation Container

- Direct stick vs. indirect stick
- Propagation flat spacing
- Proportion of cutting to salable container
- Bumping up advantages during process (space, materials and substrate moisture)
- Order of desired growth: roots, shoots, and flowers

Rooting: Choose a container

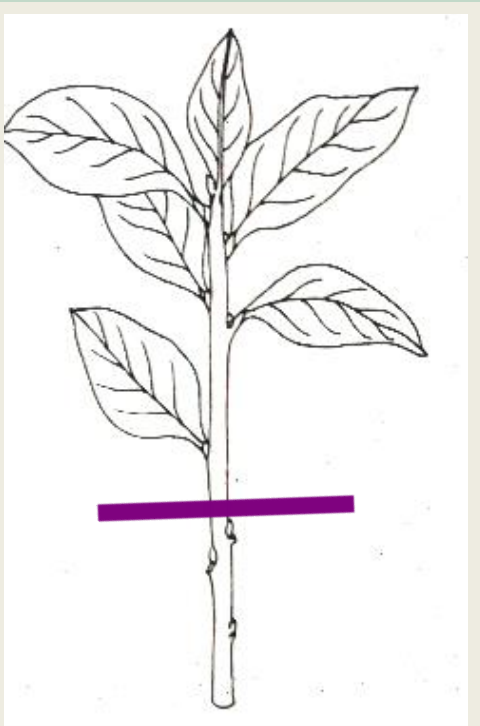
It must be deep enough to keep cuttings out of saturation zone

Rooting: Choose a medium

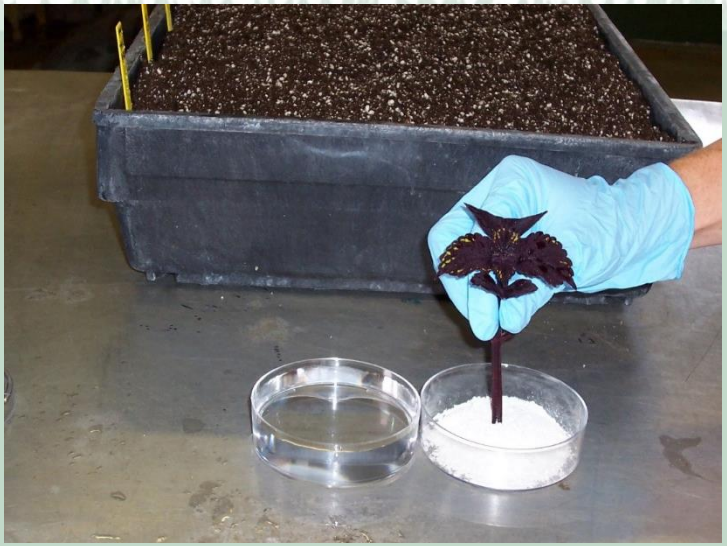
- Use a mix of organic and inorganic materials such as peat & perlite 1:1
- Coarse vermiculite

Prepare the cuttings

- Take cutting 4-6 inches long (or shorter).
- Free of flowers, and fruit
- Remove leaves from lower 1/3.
- Cut just above a bud in most cases.

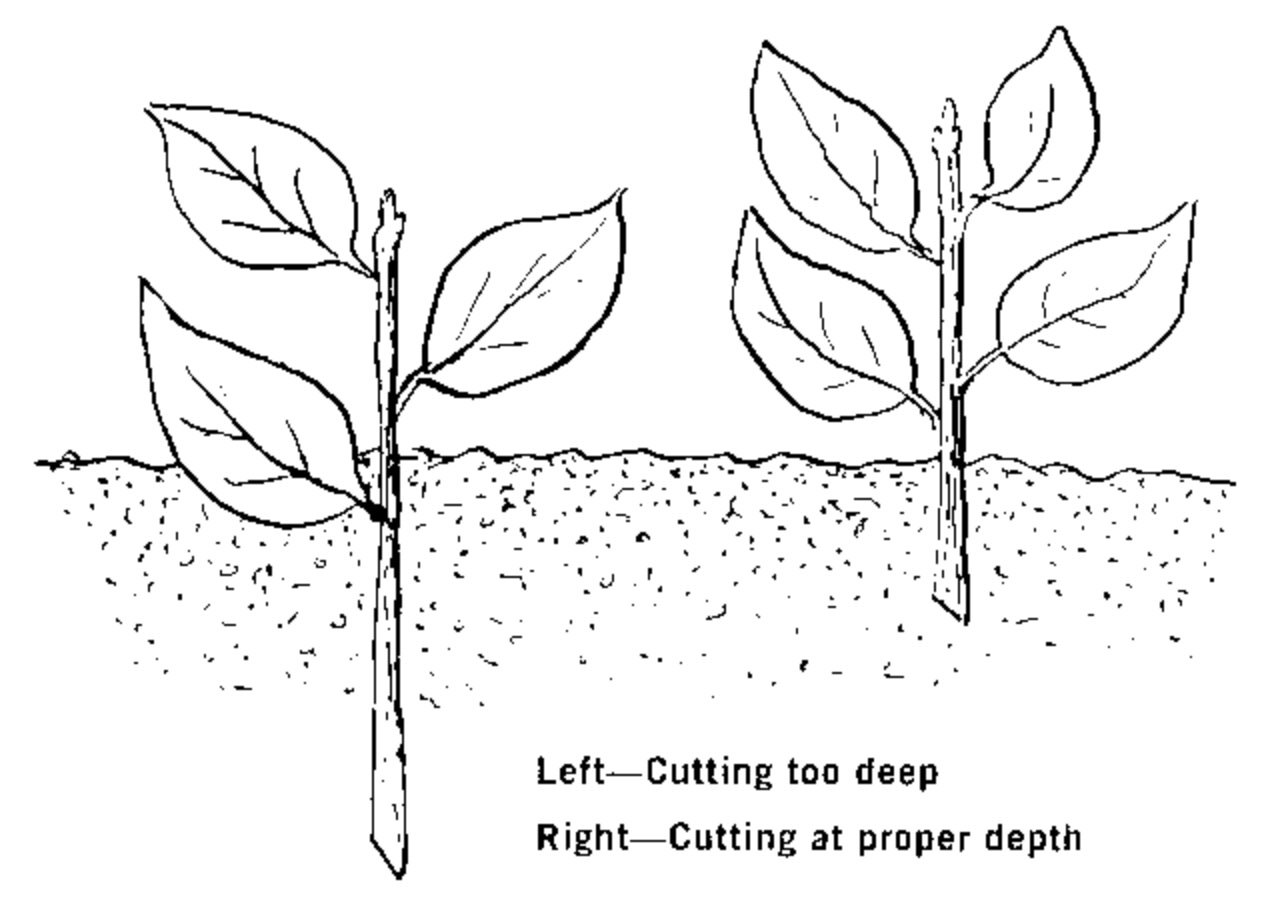


Prepare the cuttings



Transfer a small amount of rooting hormone to another container to avoid contaminating the entire bottle.

Place cuttings in media



Left—Cutting too deep

Right—Cutting at proper depth

Polarity

- Mark which end is “up” or cut one end straight and angle the other

We ask a lot of a cutting!

It must regenerate roots under adverse conditions:

- Loss of water supply
- Loss of nutrient supply
- Excessive wounding

Environmental Conditions

- Substrate
- Sand, perlite, vermiculite, bark, peat-based mixes (not water)
- Well-drained substrate
- Correct-sized container
- Lower light and high humidity
- Warmer substrate temperature and lower air temperature
- Mist tent or bag

Key to Success:
A Favorable Environment

- 100% relative humidity
- 70°-80°F
- Diffused light
- Moist medium

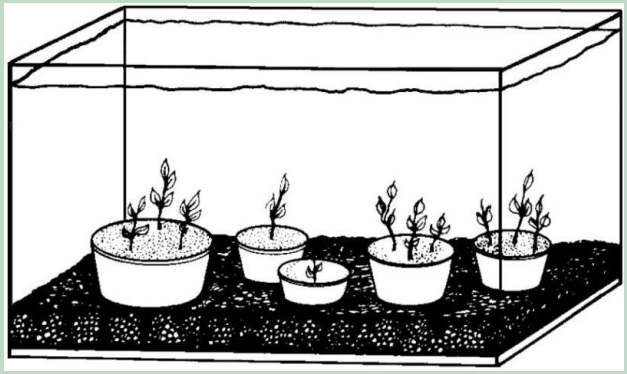
Mist System

See instructions online for building a small mist unit

…or a more elaborate one!

Simple Enclosed Systems

Aluminum pans and plastic covers



Covered aquarium

Pot and a clear plastic bag

Once Roots Develop

- Apply soluble fertilizer – ½ rate
- “Hardening off” cuttings - gradually alter environment
  - Increase light level
  - Reduce mist or RH level

Critical Factors

- Healthy stock plants
- Well-drained substrate (gas exchange)
- Correct-sized container
- Hormones
- Lower light and high humidity
- Warmer substrate temperature and lower air temperature
- Don’t overwater
- Mist tent or bag

Cuttings – in review

Stem cuttings

- Hardwood
  - Deciduous
  - Narrow-leaved evergreen
- Semi-hardwood
- Softwood
- Herbaceous

Leaf-bud cuttings

- Single node stem cuttings

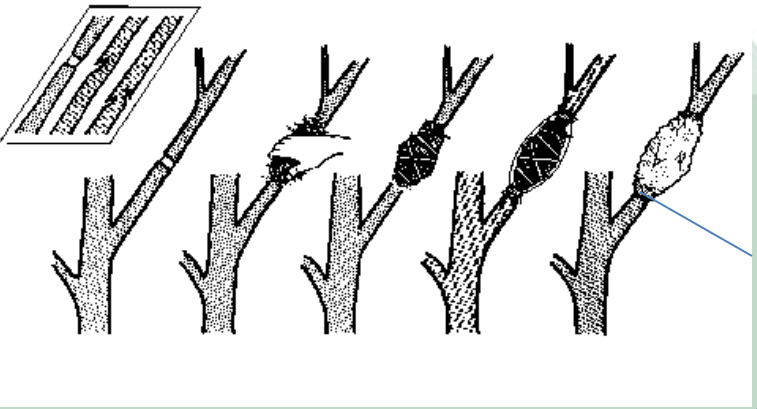
Leaf cuttings

- Leaf
- Leaf & petiole

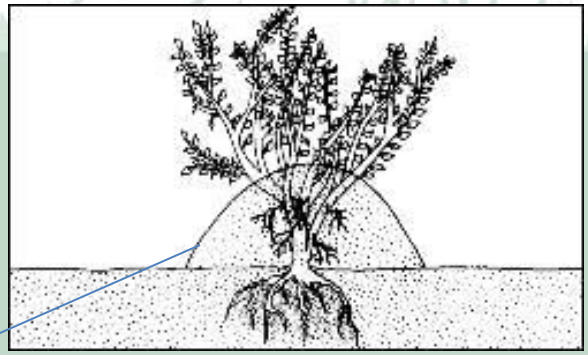
Cane cuttings

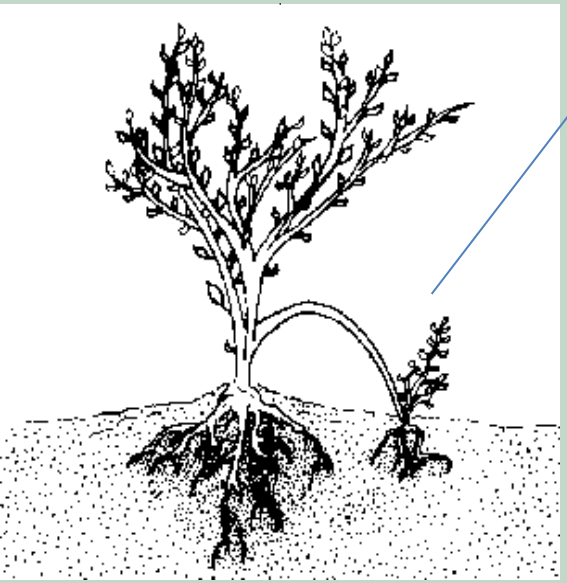
Root cuttings

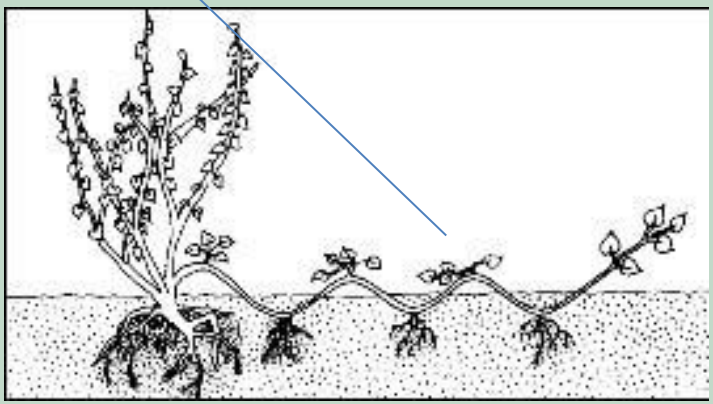
Layering



- Air
- Simple Tip
- Mound
- Serpentine



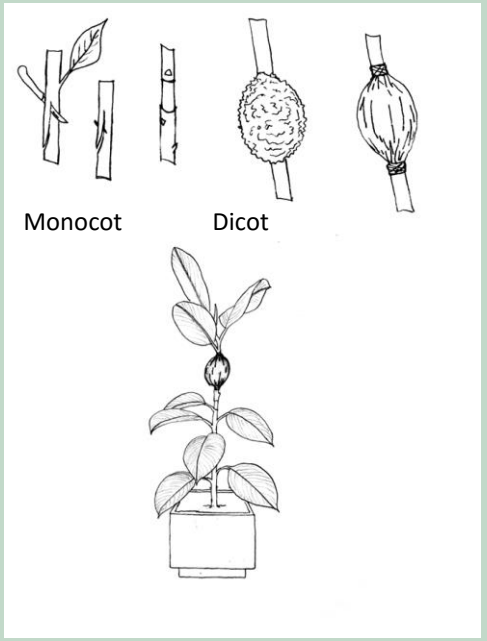




Steps in Air Layering Dicots

Materials needed: moist sphagnum moss, sharp knife, rooting hormone, plastic wrap, 2 twist ties, healthy plant, aluminum foil

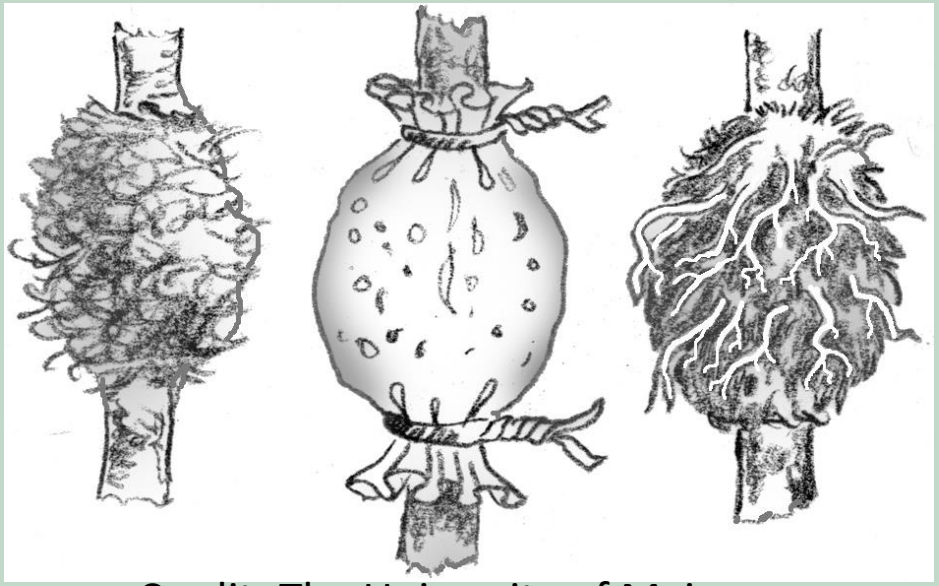
- Remove ½ - 1” ring of bark with knife.
- Use a small paint brush to dust the wound with rooting hormone.
- Wrap wounded area with moist sphagnum moss.
- Cover with plastic and secure with twist ties.
- Wrap with aluminum foil.
- When roots are visible through the plastic, cut the plant stem below the layer and pot in container.
- “Baby” the plant until roots are well established.



Air Layering

Plants that air layer easily (among others):

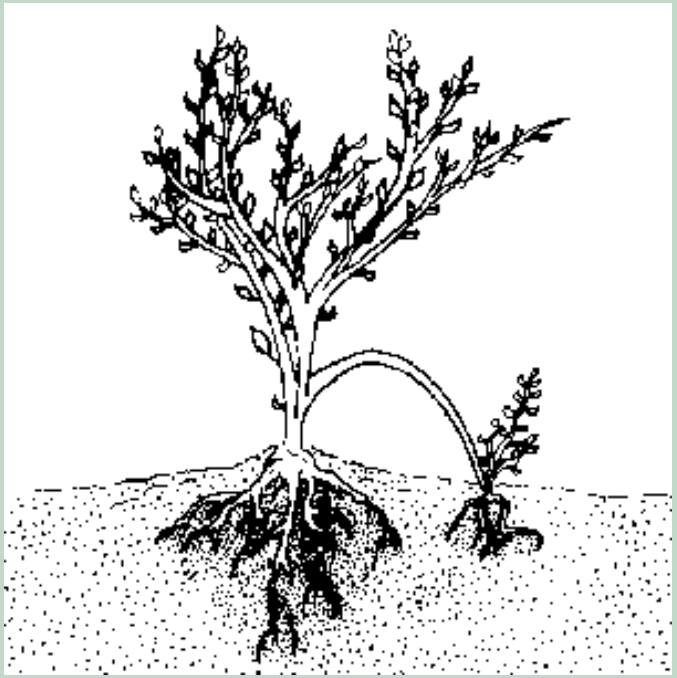
- Fiddle-leaf fig
- Rubber plant
- Croton
- Hibiscus
- Camellia
- Azalea
- Magnolia
- Oleander



Credit: The University of Maine

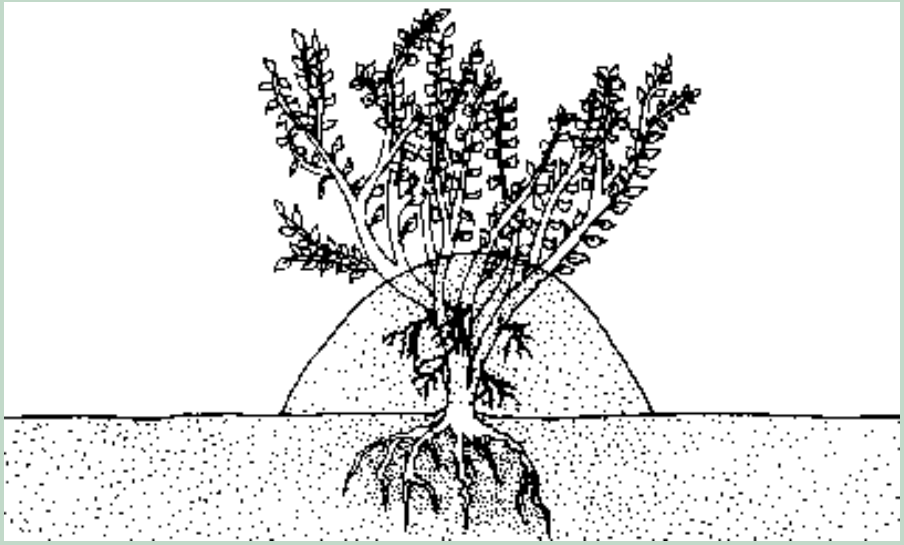
Tip-Layer

- Bend a low stem to the ground.
- Wound the lower side of the stem.
- Cover with soil leaving 6-12 inches exposed.
- Anchor if necessary.
- Best time is spring.
- Ex: climbing roses, jasmine, abelia, pyracantha, oleander, azalea



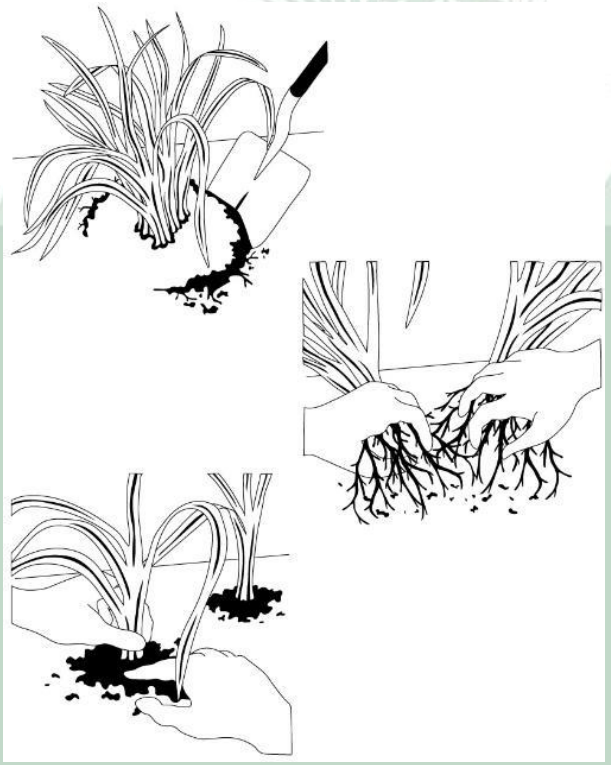
Mound (Stool) Layering

- Cut plant back heavily prior to spring.
- Lightly wound emerging new shoots and mound soil over them.
- Ex: Japanese magnolia, croton, tibouchia

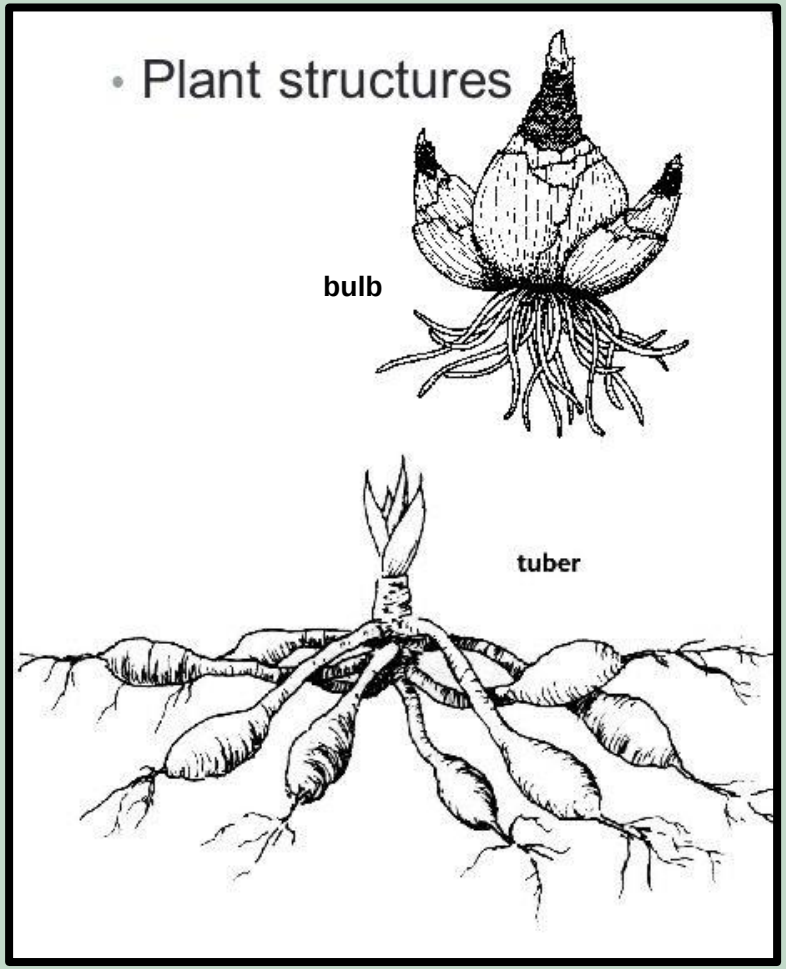


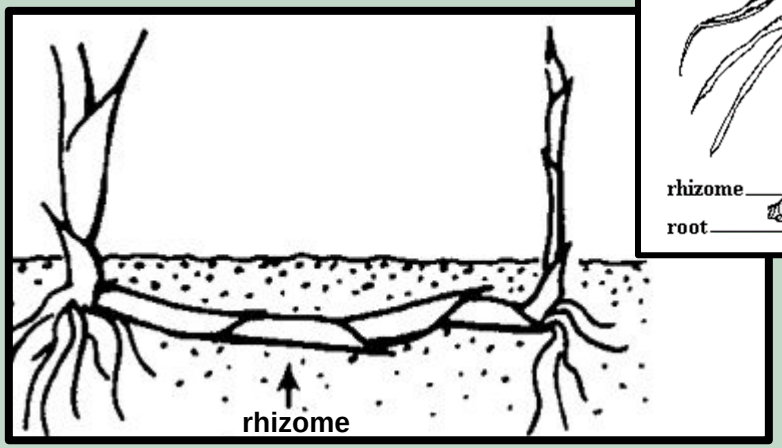
Division/Separation

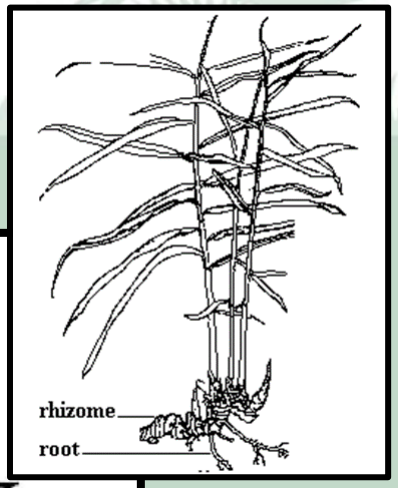
- Useful for clumping plants with more than one crown…
- …or underground storage structures like rhizomes, bulbs, tubers.
- Do not divide when flowering.
- Ex: ferns, orchids, daylilies, liriope, amaryllis

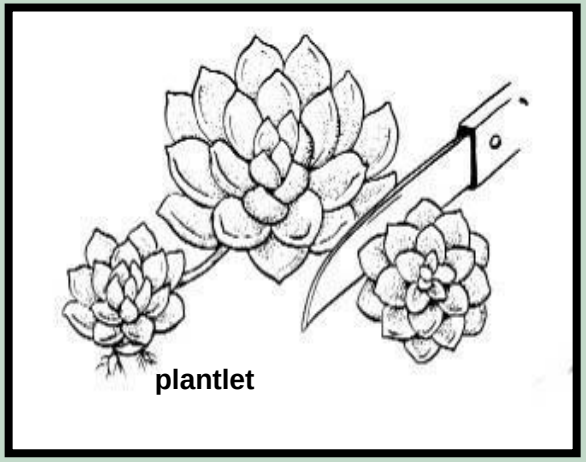


Division/Separation



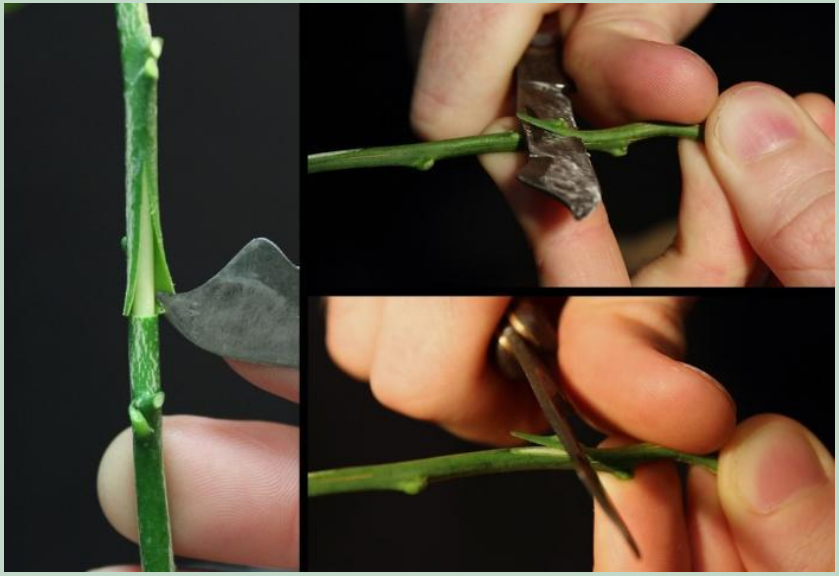






Budding/Grafting

- Joining of 2 or more plant parts as one plant.
- Scion – a piece of shoot with dormant buds that will produce the new stem and branches.
- Rootstock – provides the new plant's root system and lower stem.



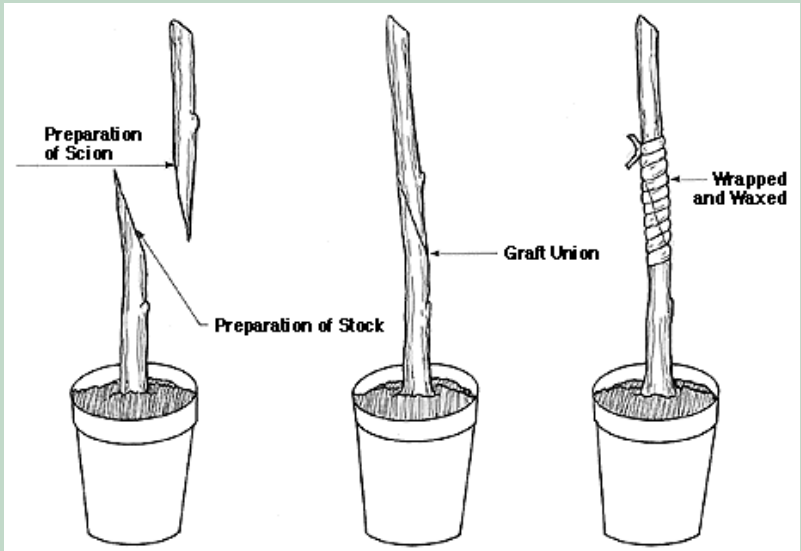
Inverted T cut (left); cutting a bud (right)

Requires Four Conditions:

1. Scion and rootstock must be compatible.
2. Each must be at the proper physiological stage.
3. Cambial layers of each must meet.
4. Union must be kept moist until joined.

Budding/Grafting

- Method used to:
  - reproduce “true” types;
  - decrease time to flowering/fruiting;
  - provide a hardier root system (Ex: cold and nematode tolerance);
  - dwarf plants.
- Requires more skill than most methods.



Tissue Culture / Micropropagation

New-age clonal propagation: Growing tiny plant pieces in test tubes under stringent conditions

For More Propagation Information:

Landscape Plant Propagation Info

http://hort.ifas.ufl.edu/database/lppi/sp185.shtml

Return to **Landscape Plant Propagation**

***Ilex cornuta* 'Burfordii Nana'**

Common name(s): Dwarf Burford Holly

Plant type: evergreen medium shrub
Primary method of propagation: cutting

Propagation by Cuttings

Cutting type: secondary
Time of year to take cuttings: Summer
Cutting maturity: semi-hardwood
Rooting hormone: IBA TALC 3000 PPM
Rooting environment: intermittent mist
Time to rooting: 16-20 weeks

Table 1a. Propagation Methods for Some Common Florida Landscape Plants.

***Botanicall* Common Name**	**Seed**	**Layering**	**Division**	**Cuttings**
Calliandra haematocephala Powderpuff	germinate readily	*air, mound	---	---
Callistemon spp.Bottlebrush	collect seed when mature; pretreat at 40°F for 2 months; much seedling variability	---	---	*semi-hardwood, tip, early summer; hardwood in fall or winter
Camellia spp.	scarification of seed coat necessary	air	---	*semi-hardwood, tip, early summer; grafting and budding
Carissa macrocarpa Natal Plum	clean and sow when ripe; slow to germinate	---	---	*semi-hardwood, tip, early summer

Plant Propagation for the FL Gardener

http://edis.ifas.ufl.edu/mg108

References

- Plant Propagation Techniques for the Florida Gardener http://edis.ifas.ufl.edu/mg108
- Landscape Plant Propagation Information http://hort.ifas.ufl.edu/lppi/
- Nursery Propagation http://edis.ifas.ufl.edu/topic_nursery_propagation
- Plant Propagation – Concepts and Laboratory Exercises by Beyl & Trigiano
- Plant Propagation Principles and Practices by Hartmann and Kester

Acknowledgements

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