Plant Propagation

Casey Sharber
Canadian County
Horticulture Educator
History of Propagation

- Aided in the development of civilization
- Seed propagation began in agriculture crops
- Early Greek & Roman writings describe propagation techniques that are similar to modern day techniques
- Plant explorations & exchanges made propagation a necessity
Modern Propagation Industry

- Large and complex
  - Propagates plants
  - Distributes plants
  - Sells plants
  - Regulates industry
  - Consultants
  - Researchers
  - Teachers
Modern Propagation Industry

- Many groups involved
  - Amateur, hobbyists
  - Not-For-Profits
    - Arboreta, botanical gardens, universities
  - Germ-plasm repositories
  - Commercial wholesale nurseries
    - Ornamental, Bedding, Foliage, Fruit & Nut, Forest
  - Tissue culture laboratories
    - Commercial, public & private research institutions
  - Seed producers
Propagators must know

- **Art of Propagation**
  - Technical skills for manipulation plant growth

- **Science of Propagation**
  - Knowledge and insight into plant growth, development, and morphology as well as physical, chemical, and ecological aspects of the propagation environment

- **Knowledge of Plants**
  - Understanding of which propagation techniques works best for particular types of plants
All living organisms can be described by genotype and phenotype

- Genotype – sum total of all of the genetic characteristics of the organisms controlled by genes
- Phenotypes – overall appearance and performance of the organism

Phenotype results from the interaction of the genotype with the environment within which the organism is growing
Plant propagation deals with the multiplication and production of plants using propagules representing a specific genotype.

**Propagule** – any plant part used to produce a new plant or a population of plants

- Seeds, cuttings, layers, buds, scions, bulbs, corms, and tubers
Propagation Biology

- Meiosis
  - Cell division initiated from male (pollen) and female (egg) gametes

- Mitosis
  - Cell division of vegetative

- Totipotency
  - Biology principle that every living cell has the potential to reproduce an entire organism, since it possesses all the necessary genetic information.
Plant Life Cycles

- Germination, Growth, Flower, Fruit & Seed Development, Death
- Annual – complete life cycle in 1 growing season
- Biennials – complete in 2 growing seasons
- Perennials – live for more than 2 years
- Herbaceous Perennials – Produce shoots during 1 season & die back at the end of season
- Woody Perennials – develop permanent woody stems that continue to grow annually
Fundamental Factors

- Light
- Water
- Temperature
- Gases
- Mineral Nutrients
Light

- Critical for rooting cuttings, germinating seeds, growing seedlings, or shoot multiplication
- Light is manipulated by light duration and quality (wave length)
- Long-day plants – flower when critical photoperiod of light is equal or exceeded
- Short-day plants – flower when photoperiod is not exceeded
- Day-neutral plants – flowering is not triggered by photoperiod
Water – Humidity Control

- Critical for any propagation procedure
- Misting helps reduce plant water loss and reduces heat load on cuttings
- Capillary Mats
  - Allows the plant to draw water up from the bottom
  - Concern about spreading pathogens between plants
  - Reduces leaching and conserves water
Temperature

- Can break seed dormancy
- Effects seed germination and rooting
- Root zone heating hastens the germination of seeds and rooting of cuttings
Temperature

- PROPAGATING BLANKET
  - This specialized blanket is made of electric wires encased in aluminum foil to provide an even spread of heat. In view is the propagator, thermostat, probe to monitor temperature, capillary matting, plastic sheet, electric blanket, insulation pad.
Gas Exchange

- Seed germination is impeded when a hard seed coat restricts gas exchange.
- High respiration rates occur with seed germination and plug development.
- Gas exchange is reduced when cuttings are stuck in highly water-saturated propagation media.
Mineral Nutrition

- Fertigation or slow-release fertilizers are most often used.
- Intermittent mist can severely leach cuttings especially if they have long propagation periods.
Soilless Media

- **Sand**
  - Heaviest of medias
  - Contain no minerals
  - Needs to be fumigated or steam-pasteurized

- **Peat/Sphagnum Moss**
  - Light weight
  - High moisture-holding capacity
  - High acidity (3.2-4.5)
  - Peat moss is the most widely used organic ingredient, however sphagnum is the most desirable but limited by expense
  - Peat moss should be pasteurized, sphagnum moss is relatively pathogen free
Soilless Media

- Vermiculite
  - Mineral that expands when heated
  - Very light weight
  - Absorbs large quantities of water
  - Can hold nutrients
  - Use only horticulture grade

- Perlite
  - Light weight
  - Holds 3-4 times its weight in water
  - Can not hold nutrients
  - Increases aeration
  - Often used with peat as a rooting medium
Hormones - Auxin

- Important hormone that induces adventitious roots on cuttings
- Synthetic – IAA, IBA, NAA
Hormones - Cytokinin

- Involved in cell division
- High auxin/cytokinlin ratio favors rooting
- High cytokinin/auxin ratio favors shoot formation
- High levels of both favor callus development
Additional Hormones

- Gibberellins – germination and dormancy of seeds
- Abscisic acid (ABA) – germination and dormancy of seeds
- Ethylene – induce initiation of adventitious roots, stimulate germination in some seeds, and overcome dormancy
Sanitation

- Three areas of introduction of pathogens and pests
  - Propagation facilities
  - Propagation media
  - Plant material
- Wash equipment with a Clorox solution (1:9)
- Used sterilized media
- Take cuttings from top of plants
- Keep “clean” stock plant & purchase “clean” seeds
Types of Propagation

- Sexual Propagation
  - Seeds

- Asexual Propagation or Vegetative Propagation
  - Cuttings
  - Layering
  - Division
  - Tissue Culture
Pollination

- Self-pollination
  - The pollen fertilizes the egg of the same flower or plant

- Cross-pollination
  - The pollen from one plant fertilizes the egg of a flower on another plant
  - Provides the opportunity of evolutionary adaptation
Seed Storage

- Optimum storage temperature and seed moisture content vary with species, but generally seeds should be stored at 40°F and in an environment with 30-35% relative humidity.

- Household refrigerators usually maintain temperatures suitable for seed storage, but the relative humidity may exceed that optimum for some seeds.

- Seeds can be stored in metal cans, plastic bags, or paper or aluminum foil lined envelopes.
Seed Dormancy

- Nature's way of setting a time clock that allows seeds to initiate the germination process when conditions are suitable for germination and seedling growth
- Can be a physical barrier (hard seed coat) or a chemical barrier
Scarification

- Scarification is the process of penetrating or cracking the seed coat barrier
- Used to break dormancy caused by a hard seed coat
- Acids and hot water treatments are sometimes used in commercial however, mechanical scarification is most suited for the landscape gardener
- Small numbers of seeds can be scarified by rolling them on a cement floor using a brick or board, by rubbing the seeds with sandpaper, or by cutting the seed coat with a knife
- Scarified seeds will not store as well as nonscarified seeds and should be germinated as soon after treatment as possible
Stratification

- Seeds of many temperate-zone plants require a cold period before they will germinate.
- This requirement is met by cold stratification - storing the seeds in a cold, moist environment.
- Seeds are mixed with moist sphagnum peat or vermiculite after a 12- to 24-hour soak in water at room temperature.
- It is also advisable to spray the seeds with a protective fungicide treatment before putting them in refrigerated storage.
Stratification

- The seeds should be stored for 2 to 6 months at 37°F to 40°F. Temperatures in household refrigerators are usually adequate. Suitable containers for stratification are flats, trays, boxes, or cans that provide aeration, prevent drying, and allow drainage.

- Seeds should be planted immediately after removal from refrigeration.
Seed Treatments

- Seed protectants
- Germination enhancers
- Inoculation with nitrogen-fixing bacteria
- Facilitation of sowing
Seed Planting

- Optimum temperatures for germination of most ornamental plant seeds are 75° to 80°F
- The germination medium must hold adequate water yet drain freely
- The medium should be sterile to prevent disease. Damping-off, a common disease of seedlings, is caused primarily by the fungi *Pythium* and *Rhizoctonia*
Seed Planting Depth

- Seed should not be planted deeper than 1 to 2 times their diameter.
- Small seeds should be scattered over the germination medium surface or planted thickly in rows.
- Medium-sized seeds sown on the surface should be covered with a thin layer of shredded sphagnum or peat moss.
- Larger seeds should be planted at a depth less than their diameter since a 2- to 3-inch planting depth is maximum for any species.
- Coconut palm and cycad seeds are exceptions, and should be planted just under or level with the medium surface.
Seedling Establishment

- Seed germination and early seedling development is best accomplished in a moist environment with moderate temperatures (75°F to 80°F).

- Although light is not required for germination of many seeds, high intensity light is necessary to produce stocky, strong seedlings.
  - Low intensity light will result in weak and spindly, pale green seedlings.
Seed Establishment

- Seedlings planted close together soon become crowded, resulting in slow growth and weak, spindly stems.
Vegetative Propagation

- Cuttings
  - Leaf
  - Tip
  - Stem
  - Root
- Layering
- Division
- Tissue Culture
Cuttings

- Most common method of propagation
- Cuttings can be made from stems, roots, leaves, or combinations of plant parts such as stems with leaves
- Cuttings should be taken from healthy plants with desirable characteristics, and placed in a warm, humid environment to hasten root development and prevent them from drying
Leaf Cuttings

- Can be comprised of only the leaf blade or the leaf blade and petiole (leaf stem).
- Leaf cuttings of some plants, i.e. Rex begonia, are wounded by cutting the underside of the main veins before placing the leaf surface flat and in firm contact with the propagation medium. It is helpful to pin these leaves to the moist medium with small stakes or toothpicks.
Leaf Cutting

- Leaf cuttings of many plants can be stuck upright in the propagation medium.
Leaf Cutting

- When subterminal sections of leaves are used, make sure the basal end of the cutting is inserted into the propagation medium. Roots and new shoots will start at the base of the leaf or at points where the veins were cut.
- Cut the basal end straight and the top on a diagonal.
Stem Cuttings

- Stem cuttings can be taken at different stages of vegetative maturity and may consist of just the growing tip or subterminal stem sections.
- Some plants root better from softwood cuttings, while others should be propagated from semi-hardwood or hardwood cuttings. Softwood and semi-hardwood cuttings are from the current season's growth, and hardwood cuttings are from the previous season's growth.
- Softwood cuttings are generally taken from plants in spring or early summer during a growth flush when the tissue is relatively soft and succulent. Semi-hardwood cuttings are taken after a growth flush has matured.
Stem Cuttings

- Stem cuttings are removed using a clean, sharp knife or pruner. Cuttings 4 to 6 inches in length are appropriate for most plants.
- Leaves are removed from the bottom 1-2 inches of stem cuttings.
- Dip ½ inch of the stem end into rooting hormone.
- Insert the cuttings just deep enough—usually 1/2 to 1 inch into the propagation medium to hold them upright.
Stem Cutting

- Herbaceous stem cutting can often easily be rooted in water
- Cut off leaves below water surface.
- Keep water fresh
- Chemicals (i.e. chlorine) may not be suitable for plants
Hardwood Cuttings
Stem Cuttings
Root Cuttings

- Usually taken from young plants in early spring or late winter, before they start growing. Healthy roots have ample food (carbohydrates) stored to support shoot development at this time.

- Root cuttings are typically 2-7 inches in length depending upon root diameter. Large roots can be cut shorter than small roots and still have an adequate food supply for root and shoot initiation and growth. Small, delicate root cuttings (1/8 to 1/4 inch in diameter) should be positioned horizontally in the propagation medium and covered with 1/2 inch of medium. Larger root cuttings (1/4 to 1/2 inches in diameter) can be planted vertically with the end of the cutting originally nearest the plant crown positioned upward.

- 55°F to 65°F is optimum
Root Cuttings

- Separate root cuttings showing two different types of cut to distinguish the two ends.
**TYPES OF CUTTINGS**

**LEAF CUTTINGS** - must form both adventitious shoots and roots (except leaf bud).

- leaf bud
- leaf petiole
- leaf blade
- leaf section

**STEM CUTTINGS** - must form adventitious roots

- hardwood
- semi-hardwood
- soft or greenwood
- herbaceous

- cane
  - leafless stem
- rhizome
  - underground stem

**ROOT CUTTINGS** - must form adventitious shoots

- root section
- tuberous root
Layering

- **Basic principle** - disruption of the downward translocation of photosynthates (sugars) by either girdling, ringing, notching, tying, or bending of stems, but at the same time minimizing any disruption of upward translocation of water, thus allowing the top section to continue normal functioning (photosynthesis, metabolism) during the rooting process.

- **Ideally**, one would like maximum disruption of downward flow in the phloem, while allowing minimum disruption of upward flow in the xylem.
Layering

- Back to Botany

Diagram of woody dicot or gymnosperm and monocot structures, showing layers such as bark, phloem, cambium, xylem, vascular bundle, and phloem.
Air Layering of Dicots

1. 6-12” from the tip of the stem (depending on the plant species) make 2 ringing (girdling) cuts 1/2-1” apart. Connect the 2 cuts with a longitudinal slit and remove the cylinder of bark.

2. Dust the cut area with rooting hormone for more successful results.

3. Wrap the area with moist, but not soggy, coarse unshredded sphagnum peat moss to form a ball approximately 3-4" in diameter.
Air Layering of Dicots

4. Wrap and completely enclose the sphagnum peat moss ball with plastic. Tie-off the ends of the plastic with twist-ties (rubber bands or tape). Make sure no shreds of sphagnum extend from the polyethylene wrapping or it will wick-out all of the water.

5. The layered area may be covered with aluminum foil to decrease light and temperature build-up.

6. When roots are visible through plastic, cut the layer off from the parent plant just below the peat moss ball, and remove the foil and plastic.
Air Layering
Air Layering of Monocots

1. Six to twelve inches (15-30 cm) from the stem tip, depending on the plant, make a diagonal (30-45°) cut or slit through a node and 1/3 the way through the stem. Place a toothpick, match stick or bamboo strip across the slit to hold it open.

2. Dust the cut area with rooting hormone for more successful results.

3. Wrap the area with moist, but not soggy, coarse unshredded sphagnum peat moss to form a ball approximately 7-10 cm (3-4") in diameter.
Air Layering of Monocots

4. Wrap and completely enclose the sphagnum peat moss ball with plastic. Tie-off the ends of the plastic with twist-ties (rubber bands or tape). Make sure no shreds of sphagnum extend from the polyethylene wrapping or it will wick-out all of the water.

5. The layered area may be covered with aluminum foil to decrease light and temperature build-up.

6. When roots are visible through plastic, cut the layer off from the parent plant just below the peat moss ball, and remove the foil and plastic.
Tip Layering

- Most plants with a trailing or viny growth habit can be propagated by this method i.e. climbing roses, jasmine, abelia, oleander, and pyracantha.
- The bark is injured about ½ -1 inch along the stem and 4-5 inches back from the tip, and the injured area is anchored 2-3 inches in the soil.
- Keep the soil moist.
Tip Layering

- Spring is the best time to tip layer, since the injured portion will develop roots during warm summer months.
- Spring layers can be cut from the parent and planted in late fall or left until the following spring.
- Layered portion should be checked for roots before removal from the parent plant.
Tip Layering
Trench & Serpentine Layering

- Trench and serpentine layering methods are similar to tip layering, except that a longer branch is placed in a trench and covered with soil. These methods produce several new plants from each layered branch.

- Trench layering is useful on plants whose buds will break and start to grow under the soil surface i.e. willows, viburnum.

- The entire branch, except the tip, is placed in a trench and covered with soil.

- Serpentine layering involves burying every other bud, leaving the alternate bud above ground. This method requires plants with pliable or vining stems i.e. grapes, trumpet creeper, & confederate jasmine.
Trench Layering
Serpentine Layering
Mound Layering

- Used to propagate heavy-stemmed or closely-branched plants i.e. Japanese magnolia, croton, & flowering quince.

- Cut plant back severely prior to spring growth; new shoots that emerge are wounded and soil is mounded around the base of the plant.

- Soil should be mounded up in several stages to a maximum of about 1 1/2 feet. Adding peat or sphagnum moss to the mounded soil helps when removing the rooted branches.

- It takes about one growing season to produce shoots that have rooted sufficiently for transplanting.
**Division**

- Cutting large clumps into smaller sections
- Each clump must have an adequate amount of stems, leaves, roots and buds to survive transplanting.
- Plants with a multi-stem or clumping growth habit, offshoots, or with underground storage structures such as rhizomes or tubers can be propagated by division (i.e. ferns, orchids, daylilies, bulbous plants, nandina, and liriope).
- Division is an excellent way to increase the area in the landscape covered with plants.
Division

- Each season dig the plants from a portion or all of the ground cover area, divide the clumps, and replant them into a larger area.
- Transplant the separated clumps at the same depth they were growing originally.
- Do not divide plants when they are flowering, but any other time during the growing season is suitable, as long as adequate care is provided after planting.
Tissue Culture

- **Tissue culture (micropropagation)** is a special type of asexual propagation where a very small piece of tissue (shoot apex, leaf section, or even an individual cell) is excised (cut-out) and placed in sterile (aseptic) culture in a test tube, petri dish or tissue culture container containing a special culture medium.
Hardening Off

- Development of plant resistance to environmental stress after rooting has occurred.
- Critical for survival and growth
- Reduction of irrigation and fertilization in seedlings and plugs
- Reduction of light and humidity in tissue culture plantlets to increase photosynthesis rates
Grafting

- Technique of joining two separate plant parts such that a union (intermingling of newly produced cells) is formed between the two parts, after which they continue growth as one plant.

- **Scion** - upper part of the graft or top of the new plant

- **Stock/Rootstock** - the lower part of the graft or bottom of the new plant

- **Interstock** - sometimes inserted between the scion and stock

- Grafting is a natural process in nature, especially root grafts (this is how Dutch elm disease is spread).
Principle of Grafting

- In all methods, the **basic underlying principle** is that the cambium of the scion is aligned and placed in intimate contact with the cambium of the stock, such that a successful graft union can be formed.

- It is for this reason that grafting is restricted to dicots and gymnosperms, since monocots lack a cambium.
Types of Grafting

- A **whip or tongue graft** is used when the scion and stock are approximately equal in diameter.
- A **cleft graft** is used when the scion is considerably smaller than the stock.
- A **T-bud** is used when the bark is slipping (easily peeled).
- A **chip bud** is used when the bark is not slipping (bark is tight and will not peel)
Plant Piracy
Legal Protection - Patents

- Gives exclusive rights to the inventor of a “distinct and new” kind of plant (cultivar) for a 17 year period.
- Plant does not have to have superior merit.
- Only vegetatively propagated cultivars (cutting, grafting, layering, micropropagation) not tuber propagated plants (potato) can be patented.
- A plant found growing wild in nature is not patentable.
Legal Protection – Plant Variety Protection

- Extends plant patents protection to certain seed propagated cultivars and tuber propagated crops
- Plants must be novel, distinctive, uniform, and stable
- A certificate protects these rights for 20 years
- Rights may be sold or licensed
Legal - Trademarks

- Offers protection for a name that indicated the specific origin of a plant.
- The mark is distinct from the cultivar name and both identities should be provided.
- The trademark is any word, symbol, device, logo, or similar distinguishing mark.
- Granted for 10 years but can be renewed indefinitely.
Resources

- University of Florida Extension
  - http://edis.ifas.ufl.edu/mg108

- Texas A&M
  - http://generalhorticulture.tamu.edu/HORT604/WorkshopMex07/PropSoilWaterWorkshop.htm