Propagation of Ornamental Plants

Learning objectives

• Basic principles of sexual plant propagation
• How plants are asexually propagated
• Techniques for stem, leaf and root cutting propagation

Learning objectives

• Basics of seed germination
• Layering, grafting and budding as methods for plant propagation
Seed Propagation

No Two Seeds Are Alike

Seed Collecting

Provenance: A seed’s origin, in terms of climate and geographic location. This can have profound effects on seed germination and plant survival. Example: Hemlocks grown from southern North Carolina seed sources are more heat tolerant than Hemlocks grown from Pennsylvania seed sources.
Seed Collecting

Seeds collected from hybrids rarely look like the parent plant due to the random re-assortment of genetic material, and the random sources of pollen. Native species tend to be more stable, but also have variation between generations.

To get a clone, try vegetative propagation!

Three Types of Seed Sources

- **Fleshy Fruits:** Berries, Figs
- **Dry Fruits:** Grains, Grasses
- **Dry Seeds / Dehiscent Pods:** Cones/Pods

Extraction Methods

- Fermentation
- Flotation
- Blender Separation
- Gravity Separators
- Hand Separation
- Sifting
Fleshy Berry Seed

For many dry seed, simply crush dried material and blow gently, transferring the seed from hand to hand.

Cleaning seed reduces disease and weed seed from growing along with your selection.

Seed Cleaning / Separation

Handling Tiny Seeds

Some seeds can be smaller than the head of a pin. They can also be very expensive. A very careful approach is often needed to be efficient and successful when planting tiny seeds.
Handling Tiny Seeds

Mix Seed with Sand

Ferns

Ripe spores

Enhanced Seed

Park’s Seed
Seed Coatings

- Fungicides / Rhyzobia
- Polycoating
- Pre-germinated

Seed Deterioration

Seeds lose half their storage life for every 1% increase in seed moisture between 5 and 14%.

Seeds lose half their storage life for every 5 degrees C increase in storage temperature between 0°C and 50°C.

SEED STORAGE

Recalcitrant Seed

**Tropical** – Store warm and moist (ASAP)
- Coffee, Cocoa, Mango

**Subtropical** – Store cool and moist (ASAP)
- Maple, Oak, Elm, Poplar
Orthodox Seed

**Short-Lived** – Store dry and cold (Under 1 yr)
Vinca, Pansy, Begonia

**Medium - Lived** – Store dry and cold (2-5 years)
Marigold, Petunia, Coleus

**Long - Lived** – Store dry and cold (5-200 years)
Morning Glory, Zinnia, Hollyhock

Seed Storage

<table>
<thead>
<tr>
<th>1 Year or Less</th>
<th>5 – 10 Years</th>
<th>10-20 Years</th>
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<tr>
<td>Iberis</td>
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<td>Phlox</td>
<td>Dianthus</td>
<td>Robinia</td>
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<td>Delphinium</td>
<td>Calendula</td>
<td>Tilia</td>
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<tr>
<td>Parsley</td>
<td>Petunia</td>
<td>Elacagnus</td>
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<tr>
<td>Onion</td>
<td>Viola</td>
<td>Koelreuteria</td>
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Important Information

- Directions
- Planting Depth
- Expiration Date
- Source
1. Imbibed water stimulates Gibberellin synthesis.

2-3. Gibberellins diffuse to the aleurone layer and stimulate the synthesis of enzymes.

4-5. Enzymes break down the starch and the sugars are transported to the developing embryo.
Seed and Plant Dormancy

Dormancy is the condition in which seeds will not germinate even when most of the environmental conditions are favorable for germination.

There are many types of dormancy!

Terms To Know

Recalcitrant Seed – seeds are able to germinate without desiccating. They lose viability after drying and must be planted quickly. Oak, Maple, Coffee

Orthodox Seed – seeds desiccate after reaching full development to allow the seed to be quiescent or dormant until conditions are right to germinate. Beans

Advantages of Seed Dormancy

- Favors seedling survival
- Creates a seed bank
- Seed dispersal (birds)
- Synchronizes germination with seasons
Types of Dormancy in Seed

**Quiescent** – seeds are able to germinate upon imbibition of water at permissive temperatures.

**Primary Dormancy** – seeds cannot germinate even if immediate conditions are right. This form of dormancy delays germination until season, or other macro-environmental issues are right for survival.

**Secondary Dormancy** – an additional level of protection to prevent germination. Can be induced under very unfavorable conditions such as drought or cold, etc.

Primary Dormancy in Seed

**Exogenous Dormancy** - imposed by factors outside the embryo
- **Seed coat**

**Endogenous Dormancy** - imposed by factors within the embryo
- **Underdeveloped embryo**

**Double (Combinational) Dormancy** – two kinds of dormancy
- **Seed coat and underdeveloped embryo**

Exogenous Dormancy

- **Physical** – Impermeable seed coat:
  - Scarification

- **Mechanical** – Seed covering restricts radicle:
  - Removal

- **Chemical** – Inhibitors in seed coat:
  - Removal / Leaching
Endogenous Dormancy

**Morphological** - Underdeveloped embryo: 
- Warm Stratification

**Physiological**
- **Non-Deep** – After Ripening: Dry storage
  - Photo-dormant: Exposure to red light
- **Intermediate** – Embryo/coat separation:
  - Cold Stratification
- **Deep** – Embryo dormant:
  - Cold Stratification

Double Dormancy

**Morpho-physiological** – Some combination of underdeveloped embryo and physiological dormancy
- Cycles of warm and cold stratification.

**Exo-Endodormancy** – Combination of exogenous and endogenous dormancy conditions
- Sequential combinations of dormancy releasing treatments, e.g. scarification followed by cold stratification.

Secondary Dormancy

- **Thermodormancy** - High temperatures induce dormancy
  - Growth regulators or Cold stratification
- **Conditional** – Change in ability to germinate is related to time of year
  - Chilling or Warm stratification
Photodormancy
Photodormancy: A type of dormancy where the ability of the seed to germinate is controlled by the wavelength and duration of light received by the embryo.

- Lettuce,
- Butterfly weed,
- Tobacco

Photoperiodism:
Response to the duration and timing of day and night

Photodormancy and Photoperiodism Are Under the Control of a Pigment - Phytochrome

What Is Phytochrome?
- Phytochrome is a pigment found in some plant cells that controls plant development. This pigment has two forms or “phases” it can exist in; P-red light sensitive (Pr) and P-far red light sensitive (Pfr) forms.
- If a photoperiodic plant is exposed to light at the 740 nm wavelength, Pfr is converted to Pr.
- If a photoperiodic plant is exposed to light at the 660 nm wavelength, Pfr is converted to Pr.
- The actual plant response is very specific to each species!
Which Wavelengths Are Photoperiodic?

- The length of the night period plays a major role in determining which wavelength will be effective, as the phytochrome pigment tends to revert to Pr during long periods of darkness.

- Thus the length of exposure to light in a building, or if outdoors, the seasonal light changes, affect how long the plant perceives each form of phytochrome.

Bright Sun

Long hours of bright spring sun stimulate formation of Pfr and germination begins.

Far-red light, such as is found under a vegetative canopy, prevents germination. Seeds wait for sun.
Darkness maintains Pr and quiescence. Buried seed won’t germinate until brought to the surface.

Light Requirements for Germination

<table>
<thead>
<tr>
<th>Species</th>
<th>Light/Dark</th>
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<th>Light/Dark</th>
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<tbody>
<tr>
<td>Ageratum</td>
<td>Light</td>
<td>Marigold</td>
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<td>Aster</td>
<td>Either</td>
<td>Nicotiana</td>
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<td>Begonia</td>
<td>Light</td>
<td>Pansy</td>
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<td>Centaurea</td>
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<td>Petunia</td>
<td>Light</td>
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<td>Cosmos</td>
<td>Either</td>
<td>Phlox</td>
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<td>Impatiens</td>
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<td>Vinca</td>
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</tr>
<tr>
<td>Larkspur</td>
<td>Dark</td>
<td>Zinnia</td>
<td>Either</td>
</tr>
</tbody>
</table>

Preconditioning Seeds
(for more uniform germination)

Methods:
- Mechanical Scarification
- Soaking in water
- Acid Scarification
- Moist Chilling / Freezing
Mechanical Scarification

An alternative to scraping the seed coat is to use acid to etch through the coat. There are many reference books that advise which acid and how long to treat.

Tip: use vinegar as a safer alternative to acid.

Acid Scarification

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Hot Water Scarification

Water temperature should be over 110°F

Let soak for a few hours. Stir often.

Do not re-heat the water.

Plant ASAP.
Moist Stratification
Cold or Warm

Vegetative Propagation

Why Vegetative Propagation?
- Maintain specific characteristics (cloning)
  - true-to-type plants
- Cost
  - break-even point for cuttings is 50-60% (90% or higher for grafting)
- Avoid graft/bud incompatibilities
What is a ‘cutting’?

any vegetative portion of the plant

Types of Cuttings

Tip cutting
One-node cutting
Stem cutting

apical bud
stem
node
leaf
axillary buds

herbaceous plants
woody plants

softwood cuttings
taken early in the growing season

semi-hardwood (greenwood) cuttings
taken in the summer (mid-July to early September)

woody plants
taken in the dormant season

hardwood cuttings
Taking & Treating Cuttings

Cut the woody stem at an angle.

Make the angled cut on the side of the closest bud.

Scratch/scrape the stem on the other side.
Remove bottom leaves and/or cut bottom leaves in half to reduce transpiration.

The Science behind…

Wounding induces hormones to form in the cutting at the wound site.

- Callus
- Adventitious roots
Adventitious Roots Are Two Types
Preformed & wound-induced

Plant Growth Substances (Hormones)
- Adventitious root formation involves plant hormones.
- Hormones occur naturally within plants.
- Root-promoting hormones are present in buds.
- Rooting hormones are synthetic chemicals that stimulate adventitious root formation.

Plant Rooting Response to Growth Regulators
Three classes:
1. Plants that have all essential endogenous root substances plus auxins. *Cuttings rapidly form roots.*
2. Plants that have all essential endogenous root substances but no auxins. *When cuttings are treated with auxins they rapidly form roots.*
3. Plants that lack an endogenous root substance(s) and/or lack the sensitivity to respond to this substance(s), even though natural auxins may or may not be present in abundance. *External application of auxins has little or no effect.*
Auxins such as indole-3-acetic acid (IAA), indolebutyric acid (IBA), and naphtaleneacetic acid (NAA) have greatest effect on initiating roots in cuttings.

Not a universal response across plant species:
- difficult-to-root species
- mixtures of root-promoting substances are sometimes more effective than either component alone
- IBA + NAA are better than either one alone

For general use in rooting stem cuttings of the majority of plants, IBA and/or NAA are recommended.

Rooting Hormones Concentrations

Generally
- auxin concentrations of 500 to 1,250 ppm are used to root the majority of softwood and herbaceous cuttings
- auxin concentrations of 1,000 to 3,000 ppm with a maximum of 5,000 ppm are used to root semi-hardwood cuttings
- auxin concentrations of 1,000 to 3,000 ppm with a maximum of 10,000 ppm are used to root hardwood cuttings

Rooting Hormones

Powder Formulations

Liquid Formulations
excessive hormones, only callus formed

Methods of Vegetative Propagation

- Plantlets
- Divisions
- Layering
- Root cuttings
- Shoot cuttings

Strawberry begonia

Saxifraga

Plantlets
Kalanchoe

Yarrow, Achillea

Divisions

Bulbs, Corms, Tubers, Rhizomes, Rootstocks
adventitious buds

Woody Plants

Loropetalum
Soils and Growing Media For Propagation

- Any substance providing air/water relationships (25 to 40% air space)
  - Soil, sand, pumice, bark

Soils

Garden soil (homemade mixes)

- Sterilize before use
- Sieve moist soil through a ¼-inch sieve, place a layer up to 3-inch deep in a baking tray, bake for 30 min @ 400°F
- In a microwave (seal in a pierced roasting bag) heat on high for 10 min

Media components -- Sand

Sharp builders sand (particle diameter 0.5–2 mm)

- Sterilize before use
- No buffering capacity, pH varies with source and can change with the water, no nutrients, no water-holding capacity
- Suitable with peat, perlite, and other components
Media components -- Perlite
Crushed aluminum-silica volcanic rock, heated rapidly to 1800 °F
- Sterile, lightweight & chemically inert
- No nutrients, low water-holding capacity, pH 7-7.5
- Horticultural grade (#2) best

Media components -- Vermiculite
Clay mineral w/ high potassium and magnesium, heated to 1400 °F
- Sterile & lightweight
- High water- and nutrient holding capacity; pH 7-7.5
- Use coarser grades

Media components – Scoria & Pumice
Scoria is a naturally occurring volcanic rock, crushed and screened for size.
Pumice is a white, natural glass.
- Similar qualities to perlite
Media components -- Peat
Sphagnum moss peat, hypnaceous moss, reed and sedge peats, and humus or muck peat

- Relatively sterile & lightweight (when dry)
- High water- and nutrient holding capacity; pH 3-4.5
- Different sizes used (fine seed, shredded form is most common)
- Excellent when mixed with sand and perlite

Media components -- Bark
Hardwood and pine bark

- Milled, w/ 70-80% of the particles in the 1/40 to 3/8-inch size, and 20-30% of the particles less than 1/40-inch size
- High nutrient holding capacity; pH 3.5-4.0
- Alone or mixed with others
  3 Bark: 2 Peat: 2 Perlite

For most plants:

2 coarse perlite: 1 peat (by volume)
Propagation Systems

Mist Systems – Purpose and Components

- Mist keeps the leaves wet to maintain a favorable water status and cools leaves
- The objective is NOT to water the cuttings
- Cutoff valve
- Pressure regulator(s)
- Filter
- Solenoid valve
- Mist nozzles

Mist Control Systems

Timer (install away from mist)
- Simple, malfunctions are obvious
- Use a timer designed for mist systems
- Turn the system off at night (some have a photocell built-in, or you can use a second timer)
Bottom Heat

Why?
- Temperature controls development
- Cool tops, warm roots
  Optimal root zone temperature: 65 - 75 °F
  (depending on species)
  Thermostat placement is crucial!

How?
- Commercially available propagating mats
- Heat tape (soil heat cable) and thermostat
- Warm water pipes (can be buried)
Use Healthy, Pest-Free Plants

Use Healthy, Disease-Free Plants