The Basics of Plant Propagation

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Types of Plant Propagation

1) **Seed** - theoretically possible with all plants

2) **Vegetative**
   - **Cuttings** - work well with most plants
   - **Division** - fibrous-rooted clump formers
   - **Layering** - cultivated woody plants
   - **Grafting** - applies to select species
   - **Tissue Culture** - high tech science
Materials Used in Plant Propagation

- Containers
- Root Maker
Materials Used in Plant Propagation

• Containers

• Soil-less Components
  - Peat Moss
  - Perlite
  - Sand
  - Vermiculite
  - Compost
  - Coir (coconut husk)
  - Composted Peanut Shells
Materials Used in Plant Propagation

- Containers
- Soil-less Components
- Tools & Supplies
  - Pruners
  - Knives
  - Chemicals
Materials Used in Plant Propagation

• Containers
• Soil-less Components
• Tools & Supplies
• Mist System
Mist System
Materials Used in Plant Propagation

- Containers
- Soil-less Components
- Tools & Supplies
- Mist System/Humidity Tent
- Bottom Heat
Bottom Heat
Materials Used in Plant Propagation

- Containers
- Soil-less Components
- Tools & Supplies
- Mist System
- Bottom Heat
- Ebb and Flow Watering System
Ebb and Flow Irrigation System
Materials Used in Plant Propagation

- Containers
- Soil-less Components
- Tools & Supplies
- Mist System/Humidity Tent
- Bottom Heat
- Ebb and Flow Irrigation System
- Greenhouse Environmental Controls
Greenhouse Environmental Controls
Facilities and Equipment

- **Standard Equipment** - Media, Trays, Labels, Tools, other supplies

- **Special Facilities** – Mist, Bottom heat, Supplemental Light, Shading, Ebb and Flow Irrigation, Environmental Controls
Seed Propagation

• **Getting Started** - know the biology of the species
Viburnum berries

Acer samaras

Abies cones

Crataegus drupes
Seed Propagation - Mendelian Genetics

- **alleles**
- **WW, Ww, ww = pairs of genes**
- During sexual reproduction these paired alleles separate to form pollen or eggs. During fertilization, alleles from egg and pollen are rejoined and are found in the seed.
Sexual Reproduction and Fertilization

male flower

WW

W

pollen

W

Ww

seed

female flower

ww

w

eggs

w
Complete Dominance - when the products of one allele completely mask the products of another allele. Example - flower color

Parents  WW x ww

hybrid cross

F1  Ww

100%

self-pollinated

F2  WW  Ww  ww

25%  50%  25%
Incomplete Dominance - when the products of one allele do not mask the products of another allele, but rather the outcome is an intermediate form. Example - flower color

Parents  **WW**  x  **ww**

F1  **Ww**
100%

hybrid cross

F2  **WW**  **Ww**  **ww**
25%  50%  25%

self-pollinated
Seed Propagation

- Getting Started
- **Collecting Seed** - always obtain full, mature seed
Seed Propagation

- Getting Started
- Collecting Seed
- Seed Testing - easy field methods to determine seed viability
Cut test on walnut seed

uncut  good seed  bad seed
Seed Propagation

- Getting Started
- Collecting Seed
- Seed Testing
- **Seed Cleaning** - extract seeds and/or remove fruits which are barriers to germination
Cleaned Seeds of Woody Species

- Walnut
- Persimmon
- Redbud
- Hydrangea
- Trumpet Creeper
Seed Propagation

Seed Depth

Rule of Thumb – Sow the seed at a depth equal to the size of the seed.
Seed Propagation

• Getting Started
• Collecting Seed
• Seed Testing
• Seed Cleaning
• **Seed Storage** - know what is optimum for the species you are working with
  • temperature
  • moisture/humidity
  • longevity
Seed Propagation

• Getting Started - know the biology of the species
• Collecting Seed - always obtain full, mature seed
• Seed Testing - easy field methods to determine seed viability
Seed Propagation

• Seed Cleaning - extract seeds and/or remove fruits which are barriers to germination

• Seed Storage - know what is optimum for the species you are working with
  • temperature
  • moisture/humidity
  • longevity
Requirements for Germination

Viability - embryo is alive

Non-dormant and quiescent embryo - no barriers to germination

Appropriate environment - water, temperature, oxygen and sometimes light
The Germination Process

Phase 1
Imbibition of water

Phase 2
Activation of metabolic processes

Phase 3
Growth of the embryo

Phase 4
Emergence of the radicle
The Germination Process

Phase 1: Imbibition of water

Phase 2: Activation of metabolic processes

Phase 3: Growth of the embryo

Phase 4: Emergence of the radicle

• Hard seed coats prevent water or air uptake - scarify the seeds (acid, mechanical, water soak);

Robinia pseudoacacia, black locust,
Chamaecrista fasciculata, partridge pea,
Lespedeza spp., lespedezas
The Germination Process

Phase 1: Imbibition of water

Phase 2: Activation of metabolic processes

Phase 3: Growth of the embryo

Phase 4: Emergence of the radicle

• Chemicals in the seed
• Immature embryo
• Dormant embryo
• Thermodormancy
• Photodormancy
Metabolic Processes in Phase 2

- Synthesis of enzymes necessary for metabolism and growth processes
- Mobilization of storage products (fats, proteins and carbohydrates) necessary for energy and cell elongation
Overcoming Phase 2 Problems

• Chemicals in the seed may be leached with water (*Atriplex canescens*, 4-wing saltbush)
• Chemicals inhibitors may be removed during stratification
• Chemical promoters may be formed during stratification
Overcoming Phase 2 Problems

• Immature embryos may be after-ripened with warm stratification (*Malus* sp., apples)

• Dormant embryos may be released with cold stratification (many woody species, some grasses)
Overcoming Phase 2 Problems

- **Thermodormancy** - High temperatures may induce dormancy, therefore provide cooler temperatures (*Elymus hystrix*, bottlebrush grass)

- **Photodormancy** - Light is required for the seed to germinate (many ericaceous species)
The Germination Process

- **Phase 1**: Imbibition of water
- **Phase 2**: Activation of metabolic processes
- **Phase 3**: Growth of the embryo (marked as unsuccessful)
- **Phase 4**: Emergence of the radicle

- Seed coat mechanically blocks embryo growth (relatively rare); *Pinus koraiensis*, Korean pine
Overcoming Germination Problems

Often times there is a combination of factors which prevent seed germination.
Factors Affecting the Ability to Germinate

- **Collection location** - northern ecotypes and arid ecotypes may be more dormant

- **Normal genetic variation**

- **Improved materials** - normal occurrences during the plant selection process may favor those seeds which germinate more easily
Practical Methods to Improve and Enhance Germination

- Work With Nature
- Artificial Methods
- Handling Small Seed
- Providing Shade
Stratification

- Old term for layering seed with a moist substrate (sand or peat)
- Moisture Always Required
- Cold - 35 to 45 F
- Warm - 65 to 80 F
- Duration - Depends on Species
- Some species require both cold and warm stratification
Lindera benzoin - second season from seed planted in September

1 month warm, then 3 months cold - natural stratification
Screen bags for artificial stratification

- fiberglass screen
- cut, fold, and staple
Direct sowing of small seeds in flats for artificial stratification
Simple method for shading seed beds

- 3/8” x 2’ rebar
- 1/2” x 5’ CPVC pipe
- 4’ wide fiberglass screen
- 1/2” binder clips
Scarification

Need to break hard seed coats to allow water into the seed

- hot water soak
- file or sandpaper
- acid
INTERMISSION
Cutting Propagation

Types of Cuttings

• **Stem Cuttings**
• **Root Cuttings**
• **Leaf Cuttings**
Adventitious Rooting

• Preformed Roots - adventitious roots which already exist in the plant; *Salix* spp., willows

• Wound Roots - adventitious roots which arise after a cutting is made
Epidermis
Phloem
Cambium
Xylem

Initiation of Roots in this region
When a Cutting is Made...

• A necrotic plate forms to seal the wound and plug the xylem to protect the surface from desiccation
• Living cells behind this plate divide to form callus
• Cells around the vascular cambium and phloem begin to initiate adventitious roots
Anatomical Changes

- Mature cells will dedifferentiate (become meristematic)
- Root initials form from meristematic cells near vascular tissues
- Root initials are organized into root primordia
- Growth and emergence of the root primordia and connection to the vascular tissues of the cutting
Physiological Stages of Rooting

- **Initiation Stage** - root meristems are formed
- Auxin-active stage - about 4 days (auxin is required)
- Auxin-inactive stage - about 4 days (auxin has little effect)
- **Root elongation and growth stage**
Plant Factors Affecting Cutting Propagation

- **Health of Stock Plants** - disease and insect free; is not wilting; vigorous growth
Plant Factors Affecting Cutting Propagation

• Health of Stock Plants
• **Time of Day Cuttings are Taken** - morning is best for taking green cuttings; does not matter for dormant cuttings
Plant Factors Affecting Cutting Propagation

- Health of Stock Plants
- Time of Day Cuttings are Taken
- Juvenility of Stock Plants
Newest growth is usually best
Plant Factors Affecting Cutting Propagation

- Health of Stock Plants
- Time of Day Cuttings are Taken
- Juvenility of Stock Plants
- Size of Cuttings
2 node cuttings of *Sambucus*
Plant Factors Affecting Cutting Propagation

- Health of Stock Plants
- Time of Day Cuttings are Taken
- Juvenility of Stock Plants
- Size of Cuttings
- Time of Year Cuttings are Taken
Plant Factors Affecting Cutting Propagation

- **Health of Stock Plants** - disease and insect free; is not wilting; vigorous growth
- **Time of Day Cuttings are Taken** - morning is best for taking green cuttings; does not matter for dormant cuttings
- **Juvenility of Stock Plants** - one to two year’s growth is best
Plant Factors Affecting Cutting Propagation

- Size of Cuttings - minimum 2 nodes for most species; size depends on the material
- Time of Year Cuttings are Taken - depends on species
Types of Stem Cuttings

- **Hardwood Cuttings**
  - Needle Evergreen - typically Nov-Jan
  - Broad-leaf Evergreen - typically Dec-Mar
  - Deciduous - typically Jan-Mar
Hardwood cutting material
Types of Stem Cuttings

• **Hardwood Cuttings**

• **Softwood Cuttings**

  New season’s growth - typically April-early June
Softwood cutting material
Types of Stem Cuttings

- Hardwood Cuttings
- Softwood Cuttings
- Semi-Hardwood (Greenwood) Cuttings
  New season’s growth - typically mid-June through August
Types of Stem Cuttings

• **Softwood Cuttings**  
  New season’s growth - typically April-early June

• **Semi-Hardwood (Greenwood) Cuttings**  
  New season’s growth - typically mid-June through August
External Factors Affecting Cutting Propagation

- **Medium for Rooting** - moist but well-drained
- **Moisture** - usually keep stems and leaves moist and under high humidity
- **Light** - intensity, day length, light quality
- **Temperature** - moderate, avoid extremes
External Factors Affecting Cutting Propagation

• Rooting Hormones - help with many species, especially woodies and difficult to root species

• Fungicides - help keep cuttings from rotting

• Wounding - promotes site for root initiation
Rooting Hormones

• indoleacetic acid (IAA)
• indolebutyric acid (IBA)
• naphthaleneacetic acid (NAA)
Commercial Preparations

- Hormodin 1, 2 and 3 (powder)
- Rootone F (powder)
- Hormex
- Dip ‘N Grow (liquid)
- Wood’s Liquid Rooting Compound
Commercial Preparations

**Liquids**
- Used as 5-second quick-dips
- Better coverage of the stem
- Absorbed faster
- Generally more effective

**Powders**
- Slower to absorb
- Longer-lasting action
- Harder to regulate the effect
Aftercare of Seedlings and Cuttings

• Regulate Light, Moisture, and Fertilizer

• For most cuttings encourage a flush of growth after rooting

• Start early enough to be able to overwinter new plants under normal conditions
Propagation by Division

Plants Best Suited:
• clump forming perennials
• suckering woody shrubs
Propagation by Division

Basic Principles:

- Divide the root mass
- Each new piece must have at least one growing point
Propagation by Division

Making Divisions:

• time of year - early spring or late fall depending on time of bloom
• dig entire clump or separate in the ground
• replant in amended soil
• keep moist
• provide shade if necessary
Propagation by Layering

Basic Principles:

• typically done with stems while the stems are still attached to the mother plant
• need to establish soil contact at a node
• rooting occurs at nodes
• wounding may help promote rooting
Propagation by Layering

Types of Layering:

- tip layering
- simple layering
- compound (serpentine) layering
- air layering
- mound (stool) layering
- trench layering
Simple layering of coralberry (*Symphoricarpos*) stems
Propagation by Grafting

- A little bit of science and a lot of art
- The Science:
  - ensure that the vascular layers (xylem and phloem) of the stock and scion are lined up with each other
- The Art:
  - obtaining consistent results
Tissue Culture

• Usually expensive to set up
• Requirements:
  • sterile environment & culture
  • media preparation (chemicals)
  • growing area
Questions? Discussion

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