INTRODUCTION

• The goal of vegetative propagation is to select a single source plant of superior characteristics and to reproduce populations of progeny plants with identical genotypes that are its direct descendants.
  
  – This biological process is described as cloning, and the resulting population of plants as clones.

Figure 16–1 (a) Monterey Pine (Pinus radiata) 0-1-rooted layer cuttings after 1 year in stoolbed, and (b) 11-year-old, uniform stand of clonal P. radiata for timber production in New Zealand (see circled individual in photo for scale reference).

Principles and Practices of Clonal Selection

• How Clones become Cultivars
• Chimeras as Clones or Cultivars
• Variation within clones
• Clonal sources used by nurseries
• Clonal selection and pedigree distribution system
Clone

- The vegetative progeny of a single genotype.
  - individual seedling
  - a mutant branch
  - a single plant of a clonal population
  - a recombinant DNA segment

Propagule

- Any plant part used as the starting point of a propagation process.

Clonal Selection

- The process of selecting an individual plant or plant part to create a clone.

Advantages

- Genetic improvement and selections
- Uniformity of populations
- Control of phases of plant development
- Combine more than one genotype into a single plant.

Disadvantages

- Monoculture
- Slow reproduction rate
- Potential for genetic variation
- Potential for systemic pathogens
Traditional Breeding
Seedling Selection

Origins of Clones as Cultivars

Seedling selection
– Grapes ‘Cabernet Sauvignon’ 2K
– Pear ‘Bartlett’ 1770
– Apple ‘Delicious’ 1870
– Nuts
– Roses
– Chrysanthemum

Mutations and “Bud-Sports”

Mutation – permanent genetic change involving some part of the DNA molecule.
1. rearrangement of bases in the DNA structure - Point mutations.
2. rearrangement of parts of the chromosome - Deletions, duplications, translocations and inversions.

3. Addition or subtraction of individual chromosomes - Aneuploidy.
4. Multiplication of entire sets of chromosomes - Polyploidy.

Most mutations are deleterious but occasionally a bud-sport appears that has some horticultural advantage.
Induced Mutations

- The rate of mutation may be increased.
  - Mutagenic agents
    - X-rays, gamma rays, neutrons, and chemicals
  - Mutation breeding
    - Development of new clones with the use of mutagenic agents

Biotechnology

- Cell and tissue culture technologies
- Recombinant DNA technology
  - A gene from one organism is inserted into the genome of another individual.
  - Roundup Ready cotton

Increased Yields

- Improve Nitrogen Assimilation
- Increase Sucrose hydrolysis, Starch biosynthesis
- Increase O₂ availability
- Modify photosynthesis

Chimera

- Distinct genotypes growing side-by-side within the same plant.
  - Periclinal – occupies the outer layer of cells completely.
  - Mericlinal – occupies only a portion of the outer layer of cells.
  - Sectorial – occupies only a section of the stem extending through all cell layers.
PATTERNS OF GENETIC CHIMERAS WITHIN CLONES

**Figure 16–8** Chimeras: the dicot shoot meristem is usually organized into three distinct layers—LI, LII, LIII. Typically, LI gives rise to epidermal cells. LII provides the next inner layer of cells and also the gametes. LIII cells become the innermost cells and the vascular system. Cells in the tunica (L1 and L2) divide anticlinally, whereas cells in the corpus (below L3) divide anticlinally and periclinally.

**Figure 16–9** In anticlinal divisions the new cell wall plates of actively dividing cells form perpendicular to the shoot apex in Layer I, whereas in periclinal division, new cell wall plates form parallel to the shoot apex in cells dividing in Layer III and the corpus. The arrows indicate progressive division and growth of the shoot apex.

**Figure 16–10** Mericlinal, periclinal, and sectorial chimeral development. Only the periclinal chimera is stable and of horticultural importance. A segment of one or more apical layers is genetically different with mericlinal chimeras, while periclinal chimeras have one or more genetically distinct apical layers. In sectorial chimeras a segment of all apical cell layers is genetically distinct.

**Figure 16–18** Chimeral reversion in (a) dogwood and (b) fuchsia from the desirable chimeral variegation back to a nonmutated, green form (arrow), or other mutation. The propagator needs to vigorously rouge-out these "off-types" and be sure to propagate cuttings with the desired chimeral variegation.
What causes phenotypic variations within clones?

• Environment by genotype interactions
• Ontogenetic aging (phase changes)
• Permanent genetic variation
• Infection by systemic pathogens
  – Viruses etc..

Trueness-to-name vs Trueness-to-type

• TTN – implies that the plant conforms to the specific characteristics of the specified cultivar.
• TTT – implies the plants conform to the phenotypic expectations of the specific cultivar.

Trueness to Name
How will you know?

• Visual inspection
• Isozymes – genetic variants of specific enzymes
  – identified by biochemical tests
  – used as genetic markers
• DNA-based marker technology
  – RFLP – restriction fragment length polymorphism
  – RAPD– randomly amplified polymorphic DNA
Trueness-to-type
How will you know?

- Visual Inspection
- Phenotypic Selection – source selection based on phenotypic appearance of the source plant.
- Genotypic Selection – source selection based on phenotypic appearance of the vegetative progeny.
- Vegetative Progeny test - vegetatively propagating progeny to test their ability to reproduce the source plant.

Visual Inspection

‘Fingerprints’
Randomly Amplified Polymorphic DNA
Gel Images

“Fingerprints” Dendogram
Conclusions

• Red leaf selections of Imperata cylindrica may result from more than one source.

Freedom From Pathogens

• Visual Inspection
• Culture Indexing – (fungi and bacteria)
• Virus Indexing
• Serology - ELISA
• Biochemical methods

Elimination of Pathogens?

• Selection of uninfected parts
• Shoot apex culture (micropropagation)
• Heat treatments
  – Hot water soaking, hot air
• Thermotherapy
  – Heat treatment over longer period of time (2 to 4 weeks)
• Growing seedlings

Propagation Source Management

• Commercial Plantings
• Commercial Nursery Crops
• Stock Blocks
• Clonal Selection and Pedigreed Production Programs
• Repositories, Botanical Gardens, and Plant Collections
• Quarantines and Movement of Vegetatively Propagated Material
**Guidelines for selection**

Obtain stock from:
- plants with a known history of production
- Plants that have been inspected

If genetic disorders are common:
- Conduct a vegetative progeny test
- Conduct frequent visual inspections
- Conduct test plantings and inspect for trueness to type

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**Pedigreed Production Programs**

- **Step 1**
  - Identify individual plants within the clone that are genetically true and free of serious pathogens.

- **Step 2**
  - Maintain source plants in a protected Foundation block located to prevent reinfection.

- **Step 3**
  - Multiply source and distribute to the public.

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**NRSP-6 - United States Potato Genebank**

To facilitate improvements in the potato of the future by promoting the use of valuable exotic genes found in wild potato germplasm.

Wild potato species represent a veritable treasure chest of genetic diversity for potentially useful traits that may someday be bred into new varieties.

5-fold approach: Introduction, Classification, Preservation, Evaluation and Distribution of potato germplasm.