Propagation by Grafting
Propagation by Grafting
Grafting
Grafting is a term which covers many propagation techniques
It includes the scion or the above ground part of the plant.
Scion

A piece of detached twig or shoot. The scion usually contains two or three buds, although it may contain more. When the scion is only a single bud, the type of grafting is known as budding.
Cultivar

This is a term now used in place of variety. It means cultivated variety and differentiates a plant from a botanical or natural variety.
The rootstock or lower portion of the grafted plant
The rootstock provides the root system for the new plant.
Rootstock (also stock or understock)

This term means the part of the graft that produces the root system of the grafted plant. It must be related to the scion and often has dwarfing or other desirable characteristics.
Interstem on fruit trees help dwarfing or incompatibility
Interstock (also interstem)

This is a piece of plant (usually to form trunk or a portion of it) grafted between the scion and understock.
Grafting with interstocks is double working

- Interstocks are not normally needed with ornamental plants
Grafting Tools
When grafting, make clean cuts in the tissue of the two pieces.
The cambium tissues must match together
Cambium is the meristematic tissue layer in woody plants.
It is a layer of tissue immediately under the bark in stem and roots.
The botanical limits of grafting
Grafting within species
Grafting of species within the same genus
Grafting of different genera within the same family

- *Pyrus communis* (Pear)
- *Cydonia oblonga* (Quince)
Grafting between families

- Plants of different families cannot be grafted successfully. Reports of relatively short-lived grafts of herbaceous plants of different families have been made but there is no successful commercial or home grafting of different woody plant families.
Reasons for grafting plants
Propagate plants not economically done other ways
Cultivars of ornamental shrubs and trees
To control tree growth and performance
Apple and pear orchards
Malling series and other dwarf rootstocks
Malling 27, 26, 9 and other dwarf rootstocks
To control grape phylloxera, fire blight and other pathogens
To bring fruiting plants into production earlier
Add a pollinator
All fruit crops are commercially grafted
Fruit at 2-3 years
Grafting to obtain special effects in plants
Weeping standards
Multiple cultivars on the same tree
Preserve old cultivars
Grafting as an orchard management technique
Top working of fruit trees to change varieties
Frame working of fruit trees to assist pollination
Successful grafting needs
Time of year

Active growing stock

Dormant scion
Scion material at correct stage of growth
Growing environment

Healthy, growing trees without pest problems
Maintain correct polarity of stock and scion
The proximal scion end is fitted to the stock distal end.
Incompatibility in grafting
Graft compatibility means two closely related plants will graft.
There is no physiological or morphological reason for a union.
Graft incompatibility occurs when

- Morphological or physiological reasons prevent related rootstock/scion combination from forming a strong union
Incompatibility is not common with ornamental plants
Most rootstocks used for grafting are closely related to the scion

<table>
<thead>
<tr>
<th>TREE FRUIT COMPATIBILITY</th>
<th>SCION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ALMOND</td>
</tr>
<tr>
<td>STOCK</td>
<td></td>
</tr>
<tr>
<td>ALMOND</td>
<td>X</td>
</tr>
<tr>
<td>APPLE</td>
<td></td>
</tr>
<tr>
<td>APRICOT</td>
<td>X</td>
</tr>
<tr>
<td>CHERRY, SOUR</td>
<td></td>
</tr>
<tr>
<td>CHERRY, SWEET</td>
<td>X</td>
</tr>
<tr>
<td>PEACH</td>
<td>X</td>
</tr>
<tr>
<td>PEAR</td>
<td></td>
</tr>
<tr>
<td>PLUM, EUROPEAN</td>
<td>X</td>
</tr>
<tr>
<td>PLUM, JAPANESE</td>
<td></td>
</tr>
<tr>
<td>QUINCE</td>
<td></td>
</tr>
</tbody>
</table>

Trees bearing multiple types of fruit can be created by grafting or budding wood from one fruit type, or the scion, onto a tree, or the stock, of another fruit type. The chart above indicates compatibility between fruit types. The symbol * indicates that the combination is possible but may be short-lived or weak.
Vegetative propagation can transmit diseases
There are two basic grafting systems.
Field Grafting – rootstocks are grown and grafted in the field
Selection of suitable rootstocks
Ornamental rootstocks used are closely related species to the scion.
Seeds are easy to propagate and fast growing
The rootstock vigor determine size and vigor of the grafted plant.
This controls the size of fruit trees and shrubs.

DWARF APPLE ROOTSTOCKS

Percent dwarfing of Malling (M) and Malling Merton (MM) apple rootstocks.

- Standard tree
- 30% MM106
- 40% M7
- 50% M26
- 60% M9
- 70-75% M27
Budding is a contraction of BUD

GRAFTING
The scion is a single bud
It uses scarce scion material economically.
Simple to learn
Fast to do
High success rates (95-100% common)
Budding produces a strong union
T-budding
T-budding
T-budding
T-budding
Chip budding
Patch budding
Plants that are budded
Deciduous fruit trees
Nut trees
Citrus
Roses
Roses
Ornamental trees
Top grafting
In top grafting the top is removed from the rootstock
The scion shoot is grafted in to the top end of the rootstock stem.
Used both in the field and in bench grafting
Top grafting is much slower than budding
Many styles are complicated to carry out.
Used in spring when t-budding is not possible
Cleft grafting
Cleft grafting
Cleft grafting
Cleft grafting
Cleft grafting
Cleft grafting
Cleft grafting
Cleft grafting
Cleft Grafting
Cleft Grafting
Bark Grafting
Bark Grafting
Bark Grafting
Bark grafting of walnuts
Bark grafting of walnuts
Bark grafting of walnuts
Bridge grafting
Bridge grafting
Bridge grafting
Bridge grafting
Inarching bridge grafting
Bridge grafting
Examples of top grafted plants
Many species do not respond well to top grafting.
Once the top is removed from the rootstock

- Uptake of water and mineral nutrients is restricted
- This prevents a graft union from forming
Graft the scion onto the side of the rootstock in side grafting
The top stays on the rootstock for moisture and nutrient uptake.
Side grafting is only done on container grown rootstocks
The grafted rootstocks is grown on in a greenhouse.
Collect dormant scion material in winter and cold store until use.
Approach grafting
Approach grafting is an old fashioned horticultural curiosity
Usually considered to be the last resort in grafting
Approach grafting

• In approach grafting the scion remains attached to the mother plant until the graft union forms
It is used to graft tomato varieties onto disease resistant rootstocks
Grafting unrooted cuttings eliminates rootstock production
The unrooted cutting roots develops as the graft union heals.
Grafting machines speed up the grafting process
It also enables the grafting to be carried out by less skilled staff.
Scions and rootstocks must match in diameter
Several materials are used for securing the graft union.
It depends on grafting technique and post-grafting environment
Tie or wax the union is to keep it from drying out
Tying materials for grafting

- Grafting Wax
- Toilet Bowl Wax
- Silicon Seal
- Plastic Roofing Cement
- Others?
With t-budding, use rubber bands that disintegrate
PVC tape is used but must be cut off after the graft forms
Use laboratory “Parafilm”

This thin, stretchable tape keeps the graft union from drying out.

It degrades rapidly so it does not need to be removed.
Reasons for failure

• Stock and scion were not compatible
• The cambiums were not meeting properly
• Scions were upside down
• Grafting was done at the wrong time
Reasons for failure

- Scions were dried out or injured by cold
- Scions were not dormant
- Stock and scion were not compatible
- The scion was displaced by storm, birds or other means
Reasons for failure

- The graft was not properly covered with grafting wax
- The graft was shaded too much by other growth
- The graft was attacked by insects or disease
- The graft union was girdled because tape was not cut or released in time
• ROOTSTOCKS ARE PRODUCED IN SPECIALIZED NURSERIES
• CLONAL ROOTSTOCKS ARE PRODUCED WITH MOUND LAYERAGE
• SEEDLINGS ARE PRODUCED FROM SEED SOWN IN THE NURSERY ROW
Mound layering:

- Strong root systems are developed in rows. The shoots that arise are cut back close to the root each year to force plants. As the plants grow, media is mounded around the shoot base for rooting.
MOUND ESTABLISHMENT
Mound layering:
Layering:

- Tip
- Simple
- Mound
- Air
Mound Layering Media

- Sawdust or sawdust with added ingredients is added several times during the summer to induce ideal rooting conditions at and above the crown of the growing rootstocks.
CLONAL ROOTSTOCKS

- **APPLE**
  - MALLING
  - RUSSIAN
  - POLISH
  - NEW YORK (GENEVA)
  - MICHIGAN

- **PEAR**
  - OREGON
# APPLE ROOTSTOCKS

<table>
<thead>
<tr>
<th>Stock Code</th>
<th>SDLG Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 27</td>
<td>20-25%</td>
</tr>
<tr>
<td>M 9</td>
<td>25%</td>
</tr>
<tr>
<td>M 26</td>
<td>33%</td>
</tr>
<tr>
<td>M106</td>
<td>50%</td>
</tr>
<tr>
<td>M 7</td>
<td>50-60%</td>
</tr>
<tr>
<td>M 111</td>
<td>66%</td>
</tr>
<tr>
<td>EMLA</td>
<td>VIRUS FREE</td>
</tr>
</tbody>
</table>

- Stocks better than those on the left:
  - GENEVA 65
  - BUDAGOVSKI 9
  - GENEVA 26
  - GENEVA 30
  - STOCKS BETTER THAN THOSE ON THE LEFT?
**THE MOST COMMON ROOTSTOCKS AVAILABLE TODAY INCLUDE:**

### Apple

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>M 27</th>
<th>M 9</th>
<th>M 7</th>
<th>M 106</th>
<th>M 111</th>
<th>Seedling (Golden Delicious)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size*</td>
<td>20%</td>
<td>25%</td>
<td>33-50%</td>
<td>50%</td>
<td>70%</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Size relative to seedling or own rootstock

### Pear

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Hawthorne</th>
<th>EM Quince A</th>
<th>Quince C</th>
<th>Bartlett Sdng</th>
<th>Old Home/Sdng</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>40%</td>
<td>50%</td>
<td>75%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

Pears not compatible with Quince = Bartlett, Bosc, Seckel, Clapps Favorite

### Peach

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>P. tomentosa</th>
<th>Marianna</th>
<th>St.Julien A</th>
<th>Nemaguard Lovell, Halford Peach sdng</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>25%</td>
<td>33%</td>
<td>70%</td>
<td></td>
</tr>
</tbody>
</table>

### Apricot

'Real' apricot seedlings

### Cherries

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Stockton-Morello</th>
<th>Mahaleb</th>
<th>Mazzard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>60%</td>
<td>100%</td>
<td>85%**</td>
</tr>
</tbody>
</table>

**Mahaleb is the best rootstock for sweet and tart cherries in Utah. In other states and soils Mazzard may be larger than Mahaleb**

### Plums

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Marianna (heavy soils)</th>
<th>Peach 'Lovell' (light soils)</th>
<th>Myrobalan (heavy soils)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>66%</td>
<td>88%</td>
<td>100%</td>
</tr>
</tbody>
</table>
HARVESTED ROOTSTOCKS
ROOTSTOCKS ARE PLANTED ABOUT 6-10” APART, AND PARTIALLY DEFOLIATED IN AUGUST JUST BEFORE BUDDING IS DONE
Propagation by budding:

- **T-bud**
  - fruit trees,
  - roses

- **Patch bud**
  - Walnut,
  - pecan

- **Chip bud**
  - fruit trees
  - grapes
Budding:

- “T” bud
1 ¼" Vertical cut
¼" Cross cut
6" above soil

Scion:
shield 1" long
¾" below to 1/4" above the bud
CHIP AND PATCH BUDDING

- Chip bud
- Patch bud
NEWLY BUDDED TREES

- Bud in August
- North Side
- Petiole abscises on good buds
- Petiole dries and remains on dead buds
TOP PRUNING

- The rootstock tree top is cut off in the spring
- The cultivar tree grows during the year and is dug in the fall
Harvesting Nursery Trees
Harvested Trees
Harvested Trees

- Roots are broken in harvest operation
- Roots are pruned in the storage shed
- Roots need to be pruned for problems when the trees are planted
Harvested Trees on Wagon
High Density Staked Orchard
TIME-LINE FOR TREES

• LINERS PLANTED SPRING 2002
• BUDDED AUGUST 2002
• CUT ROOTSTOCK OFF SPRING 2003
• GROW CULTIVAR SUMMER 2003
• DIG TREES FALL 2003
• SELL TREES SPRING 2004
• INTERSTEMS – ADD ONE YEAR
Propagation by grafting:

- Whip/bench/tongue graft was used long ago for tree production.
- A piece of root and a scion were joined with an elaborate graft in a root cellar in winter.

- Top grafting: crown of the root, trunk, and on limbs.
- Cleft graft for fruit trees.
- Bark graft for fruit trees, easier but not as strong as cleft graft.
Grafting:

- Whip, bench, piece root, or tongue graft
Graftage:

- When plants are difficult to root or wanted on another root than their own, grafts of the desired scion and a rootstock are made.
- Graft = scion + root
- Bud = root + 1 bud
Graftage:

- Cleft graft: A scion of 4-5 buds is cut to form a double tapering (top to bottom, and out to in) wedge. It is placed in the cleft of the rootstock so that cambium layers line up. The union and tip of the scions are covered with grafting wax.
Cleft Graft:

- Cleft graft:
Healing:
Bark Graft:

- Bark graft: Scions are placed when cambium is slipping. The bark is cut to accommodate the scion and the scion (cut with a sloping cut) is nailed to the stock.
Bark Graft:

- Bark graft:
Top Worked apple tree using bark graft
When to graft? When to bud?

• Graft in the spring
• Collect scions in mid- to late-winter
• Store scions in cool - 2-4 °C, moist conditions
• Graft just as cambium begins to divide!

• Bud in August in cool climates
• Collect scions just before budding
• Store scions in cool - 2-4 °C, moist conditions
• Bud while cambium is still dividing!