PLANT PROPAGATION
BUDDING AND GRAFTING


Terminology: grafting, budding, stock (rootstock, understock), interstock (intermediate stock, interstem), vascular cambium, callus.

Reasons: Perpetuating clones difficult to propagate in other ways, benefits of a certain RS (disease resistance, insect resistance, dwarfing, nutrient efficiencies, soil type preferences, special forms), hastening reproductive maturity of seedling selections, repairing damaged plants, changing the cultivar of an established plant (topworking), and studying virus diseases (*Prunus serrulata* - Shirofugen flowering cherry is used as a tool to detect various viruses).

Advantages of clonal rootstocks - well understood in Europe - reduces variability, adds refinement to adaptation of a clone. Concept of “clean” rootstocks.

Double working - avoids certain kinds of compatibility, refines the degree of dwarfing.

Formation of the graft union: 1) Lining up of the vascular cambiums, 2) wound healing response, 3) Callus bridge formation, 4) Cambium formation, 5) Vascular tissue formation.

Limits: easy to graft within a species, less easy between genera, very difficult between families.

Factors influencing the healing: 1) incompatibility, 2) kind of plant, 3) temperature, moisture and oxygen conditions during and following grafting, 4) growth activity of the stock, 5) propagation techniques, 6) virus contamination, insects and diseases, 7) plant growth regulators in the healing of graft unions.

Polarity: 1) in most cases, proximal end of scion into the distal end of stock), 2) In nurse-root grafting, proximal end of scion goes into proximal end of the rootstock. Think!

Symptoms of incompatibility: poor unions, overgrowths or undergrowths, dies over time, deficiency symptoms, dwarf trees, premature defoliation.

Three types of graft incompatibility: 1) localized, translocated and virus-induced. The first (localized) can be corrected by using a mutually compatible rootstock (interstem). Translocated incompatibility cannot be overcome. Virus-induced is more common than previously thought (Citrus, Pyrus)

Translocated effects. 1) Sometimes the RS will impart characteristics to the scion: size and growth habit, fruiting (precocity, fruit bud formation, fruit set, and yield), size, quality and maturity of fruit, winter-hardiness, disease resistance, and time of fruit maturity). 2) Effects of the Scion cultivar on the rootstock - vigor of rootstock, cold-hardiness of the rootstock.
Mechanisms for these translocated effects are due to nutritional uptake and utilization, translocation of nutrients and water, and alterations in endogenous growth factors.

Translocated or localized incompatibility - use interstem to compensate for this problem.

Translocated effects. Sometimes the RS will impart characteristics to the scion and vice-versa.

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\begin{align*}
A & \quad B = 0K \\
A & \quad C = OK \\
C & \quad = DEAD
\end{align*}
\]

\[
\begin{align*}
A & \\
B & \quad = OK \ (LOCALIZED \ INCOMPATIBILITY) \\
C &
\end{align*}
\]

\[
\begin{align*}
A & \\
B & \quad = dead \ (TRANSLOCATED \ INCOMPATIBILITY) \\
C &
\end{align*}
\]

Timing. Most grafting takes place at the time of bud break. Most budding takes place in June. Roses are June T-budded. Pecans are patch budded or whip grafted in the end of March or first of April. Grafting - collect the wood in winter, store moist and cold (32 degrees F).

Splice, whip and tongue, veneer and side grafts, saddle, cleft, cutting grafts, double working, root grafting, bareroot grafting.

**ROOTSTOCKS FOR ORNAMENTALS PRODUCTION AND USE IN THE SOUTHEASTERN UNITED STATES.**

The following is adapted from a presentation by Dr. J.C. Raulston, NCSU Arboretum, Raleigh, NC, made at the International Plant Propagators Society (IPPS) conference, Charleston, SC, November 8, 1995.

Root survival is perhaps the single most important factor determining adaptation of species to a specific environment. As temperatures rise, respiration rates increase which create a requirement for more oxygen to permit root survival. Sudden flooding of poorly drained soils during maximum temperature periods can create temporary, but quickly fatal, anaerobic conditions for roots at the time of peak oxygen demand. This situation is unique to the southeastern U.S. as soils in southwest and western states are dry (and well aerated) at periods of high temperatures, and central and northeast areas are cooler when rains occur. In addition, modern container production with carefully formulated media of coarse texture and rapid drainage allows simple, successful production of plants with fragile root systems which often
cannot be subsequently grown easily in landscape soils of the production region. Prominent examples include many Ericaceous plants and such native and exotic taxa as *Franklinia alatamaha*, *Gordonia lasianthus*, *Ilex* X meserve (“Blue Hollies”), and *Taxus* X *intermedia*.

Grafting is used to produce plants which combine aerial portions of superior ornamentals with adapted and tolerant root systems suitable for the area of production. The majority of such grafting is used in fruit production where an economic product permits the extra costs of such specialty propagation. Very little research has been conducted on potential rootstocks specifically for ornamental plants in the southeastern U.S. due to the lack of commercial grafting operations in the region, the lack of such specific skills among most academic researchers, and the time and expense to conduct such long-term trials on “minor” crops.

Commercial grafting firms in the Pacific northwest and the northeast are not aware of the potential problem and often use rootstocks which work well in those areas, but are failures when planted in the southeastern U.S. A prime example is the use of *Abies balsamea* or fraseri seedlings for all fir grafting (due to low costs and ready availability as major Christmas tree species). These are the two weakest roots system firs in existence and such grafted plants never survive the first month of wet summer conditions here. In early years after its introduction, *Cornus* X ‘Eddies White Wonder’ was grafted in the Pacific northwest on *C. nuttallii* which cannot be grown in the Southeast, leading early researchers to believe the scion cultivar could not be grown in the east. Many other such examples exist.

The following list contains theoretical proposed graft rootstock:scion combinations for research and production trials. The listing has been formulated from observation of plant behavior at The NCSU Arboretum, in other gardens around the world, and native habitats of many of the species. The plants listed first (before the hyphen) are taxa which have been observed to have more tolerance to hot, wet southeastern U.S. soils than average species of the genera and therefore have potential for understock use. The plants listed following the hyphen are those which have ornamental value, but have been observed to have survival problems in poorly drained situations and therefore would be the scion stock.

In a few cases, bigeneric combinations have been proposed where tolerant species do not exist within the problem genera. Bigeneric grafts are usually less successful than interspecific grafts, but enough successful combinations have been achieved to warrant trial. An asterisk is used after the proposed combination where promising trial grafting work has been conducted at The NCSU Arboretum or observed elsewhere.

*Abies firma* - for other *Abies* taxa*
*Acer japonicum* or *palatum* - *Acer circinatum* and *A. macrophyllum*
*Acer rubrum* - for *Acer pentaphylla* *
*Acer saccharum* - for *Acer griseum* *
*Arbutus unedo* - for *Arbutus arizonica*, mensiesii, and texana.
*Baccharis halimifolia* - for *Baccharis pilularis*
*Betula nigra* - for other *Betula* taxa*
*Calycanthus floridus* - for *Calycanthus occidentalis*
*Ceanothus* X *pallidus* or *americanus* - for west coast or Mexico *Ceanothus* taxa
Cercis canadensis or chinensis - for Cercis griffithii, occidentalis
Chamaecyparis pisifera or thyoides - for Chamaecyparis lawsoniana and nootkatensis cultivars
Chitalpa (Catalpa X Chilopsis hybrids) - for Chilopsis linearis
Cornus florida - for Cornus nuttallii and C. X ‘Eddie’s White Wonder’
Crataegus aestivalis - for other Crataegus taxa
Cupressus bakeri or glabra - for Cupressus sempervirens ‘Swane’s Golden’.
Eleagnus X ebbengii or pungens - for Elaeagnus angustifolia
Fagus grandifolia - for Fagus sylvatica cultivars; trial on Nothofagus spp. ??
Garrya ovata var. lindheimeri - for Garrya elliptica ‘James Roof’.
Photinia X fraseri - for Heteromeles arbutifolia
Ilex X ‘Nellie Stevens’ - for Ilex aquifolium and I. X meserveae (“Blue Hollies”)
Itie chinensis - for Itea ilicifolia
Kalmia latifolia - for Kalmia cuneata and microphylla
Magnolia virginiana - for Magnolia sieboldii and wilsonii
Myrica cerifera - for Myrica californica
Picea abies, omorika, or orientalis - for Picea brewerana
Pieris japonica - for Pieris floribunda
Pinus glabra, pinea, sylvestris, or virginiana - for Pinus edulis, muricata (2 needle pines)
Pinus palustris, serotina, rigida or taeda - for Pinus albicaulis, aristata, flexilis, torreyana (5 needle pines
Playtcladus orientalis - for Microbiota decussata (unlikely bigeneric graft but only possibility for south)
Pseudolarix amabilis - for Larix taxa (unlikely bigeneric graft but only possibility for Larix in south)
Quercus virginiana - for numerous west coast and Mediterranean evergreen Quercus species.
Raphiolepis umbellata - for Raphiolepis indica taxa
Rhododendron chapmanii - for small-leaved evergreen Rhododendron taxa; trial for Kalmiopsis leachiana??
Sorbus alnifolia - for other Sorbus taxa
Spirea sp. - for Holodiscus discolor (unlikely bigeneric graft, understock suckering impractical also).
Stewartia monadelpha, koreana, or pseudocamellia - for Stewartia malacodendron and ovata.
Styrax americanus or japonicus - for Styrax hemsleyana, obassia, officinalis, officinalis californicus, planatifolia, texana, and youngae
Syringa oblata var. dilatata - for Syringa vulgaris cultivars
Taxus chinensis - for Taxus X intermedia cultivars
Tsuga canadensis or sieboldii - for Tsuga caroliniana, heterophylla and mertensiana

Successful combinations from the above potential grafting/rootstock trials would make possible the successful landscape cultivation many new ornamental plants currently impractical or impossible to grow in the humid, warm climate of the south and southeast. There is an industry conception that grafted plants are a commodity of the past with increasingly unavailable skills needed and greater costs than for cutting production of clonal taxa. This statement is generically true for mass market crops, but for a number of plants grafting may be the only feasible way to use certain taxa in this region. Knowledge of graft combination feasibility would create opportunities for development of regional specialty propagation nurseries to fill the
potential consumer market for such connoisseur plants.

Related Literature: