Woody Plant Materials

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Revised for New York State
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Learning Objectives

1. Understand basic wood plant classification for identification of woody plant materials common in the landscape.

2. Understand and be able to apply concepts of landscaping for energy conservation.

3. Understand and be able to apply the basic principles and techniques of foundation planting.

4. Understand and be able to apply the concepts of plant material selection for existing or modified environmental factors.

5. Understand and be able to apply good planting techniques for trees and shrubs.
Woody Plant Materials

Woody plants can be divided into four main groups: trees, shrubs, vines and ground covers. Because of their permanence and because of their potential for four seasons of beauty and interest, they can be used to form the backbone of the landscape.

Consciously or unconsciously people landscape their properties for three main reasons: 1) to make their homes more beautiful, 2) to make their surroundings more climatically favorable, 3) to make their properties more usable. It is beyond the scope of a Master Gardener class to teach concepts of aesthetic beauty. Each individual’s concept of beauty is different. Modification of microclimate with plant materials follows relatively simple guidelines, as does the basic development of exterior spaces. A grasp of these principles is possible. A basic knowledge of 1) plant identification principals, 2) basic planting techniques, 3) environmental factors limiting plant selection and 4) color factors influencing plant selection can be achieved.

Planting Technique

Home and commercial landscapers often plant trees and shrubs using less than ideal technique. Improperly planted trees and shrubs will potentially struggle for years. They might die outright within a few weeks or after years of poor growth. They might also recover and grow normally after growing many new roots.

Most problems can be avoided by planting so that the root system can develop as quickly as possible.

Some helpful tips to successful planting of woody plants:

1. Prepare the planting site by loosening the soil in a wide area. The wider the better. Many experts recommend an area five times wider than the actual planting hole. It is not necessary to dig deeper than the root ball. Often the tree or shrub will sink in the ground too deep as the loosened soil beneath settles. Excessive depth will impede growth or even kill the plant.

2. When planting in heavy soils or disturbed soils after construction, position the plant with the top of the root ball higher than the existing soil line. One third to one half of the root ball above the soil may be needed. Grade the soil out gradually from the root ball to secure the plant and prevent the root ball from drying out.

3. Always remove all inorganic material wrapped around the ball including nylon ropes, wires, preservative treated or plastic burlap.

4. Do not add soil conditions, such as compost or peat moss, into the planting hole.
This practice will cause the planting hole to collect and hold too much water for an extended period of time. Instead use soil conditioners throughout the entire planting bed. Research shows that trees do well without any soil additions.

5. Always cut and spread container grown roots systems. Plants that have grown too long in the same container develop thick, spiraling roots that often fail to grow properly when planted.

6. Do not stake a newly planted tree. Research has proven that the natural movement of the trunk by wind stimulates root growth and promotes increased growth of trunk caliber. Only in extreme conditions can staking be helpful such as with pines in a windy site. Staking should be loose enough to allow for gentle movement of the tree.

7. Apply mulch to conserve moisture, moderate soil temperatures and reduce weed growth. A two-inch layer of bark mulch is sufficient. The mulched area should extend out to the drip line of the tree or shrub. Do not pile the mulch against the trunk or stems. Deep mulch against trunks promotes decay.

8. It is no longer recommended to prune back top growth of trees after planting. The tree needs the top portions to promote root growth. Nursery trees are usually properly pruned and need no additional pruning after planting. Even if a plant is transplanted, it does best if it is not pruned back. Weak branches may occasionally die back on their own but, until then, the tree can use the food stored in the leaves and stems for growth.

9. Thoroughly water newly planted trees and shrubs after planting. It is important to check the moisture content of both the root ball and the surrounding soil. This should be monitored for the first couple of weeks and watered as needed. In moist cases it is not necessary to soak the plant everyday. Many newly planted trees and shrubs are inadvertently killed by over zealous watering.

Another important time to monitor soil moisture is in the late fall and winter. This is especially important for evergreens such as azaleas, rhododendrons, hollies and pines. If these plants go into a dry and cold winter under drought stress, they will suffer winterburn and dieback.

**Plant Material Selection for Existing or Modified Environmental Conditions**

Selection of woody plant material is the most common problem facing Master Gardeners. Plants planted under unfavorable conditions are likely to grow poorly and be subject to numerous environmentally related problems. Weakened plants seem to be a magnet for numerous insect pests. Their feeding activity is likely to have a much
more serious effect on already weakened plants.

Six key environmental factors influence the selection of plant materials:

1. Cold or winter hardiness.
2. Soil drainage and texture.
3. Susceptibility to insects and diseases.
4. Soil pH.
5. Adverse environmental conditions: i.e., urban, seashore.
6. Special needs: i.e. windbreaks; foundations; space consideration; energy conservation and color.

**Cold or Winter Hardiness**

Selecting the right plant materials is easier for Master Gardeners familiar with cold hardiness zone maps and the cold hardiness of common landscape plants. Signs of cold injury such as bark splitting, leaf margin browning, twig and bud death are clues that the chosen plants will not fare well in the landscape.

Protection from the north and west, mulching and watering are a few measures that can be taken, to protect marginally hardy plants. Conditions can be altered and microclimatic site selection can be made so that marginally hardy plants can survive unusually cold winters with less injury.

**Soil Drainage and Texture**

Unfortunately many landscape plants die because they are planted in soil that is too wet or too dry. Low areas where the soil is heavy because of a clay content or fine silt tend to stay wet for extended periods of time. Even a desirable soil such as loam can drain poorly after compaction caused by construction. Once soil has been compacted it can take many years to return to its former structure. Newer homes with the clay subsoil brought to the surface commonly have problems with drainage. The drainage potential of a soil is determined by its porosity. Soils with large macropore spaces such as sandy loams drain more quickly than those with very small macropores such as clay soils. Clay soils are easily compacted especially when wet and can form a "hard pan". This is because individual clay particles are flat plates that easily compact tightly together.

Without proper drainage plant roots gradually die because of decreased oxygen levels in the soil. Plant roots require oxygen to function properly. Oxygen is displaced by water in saturated soils or soils with small pore spaces. Some commonly grown landscape plants particularly susceptible to drainage problems are dogwoods, azaleas, rhododendrons, yews and boxwoods.

Soil drainage and texture can be modified but not without cost and hard work.
However, the results are always worth the effort. To help overcome poorly drained site problems, plants can be planted in raised beds. In extreme situations drainage tiles and ditches can also be constructed to move water away from the planting. Soil structure can be enhanced by the incorporation of liberal amounts of organic matter. Use compost, animal manure, peat moss, leaf mold, old decomposing bark mulch, composted sewage sludge products or shredded leaves. Incorporate these materials throughout the entire bed area to a depth of at least ten inches. The addition of coarse, builders sand is also helpful if used along with organic matter. Many gardeners use gypsum to break up clay soils. Gypsum is effective but works best when used along with organic matter. Gypsum contains calcium sulfate which works to open up clay by bonding tiny clay particles into large particles. The result is larger pore spaces in the soil. The calcium in gypsum is what performs this task so lime can also have the same advantageous effect. However with gypsum, there is no change in soil pH as with lime.

Very dry areas also present problems. Some areas of the state have very sandy soils. There is little water holding capacity in these soils. Pines and junipers fair better than many species on these soils. Large additions of compost or organic matter can greatly improve the tilth of sandy soils. Any type of compost or organic mulch can be used.

Exposure to sun and wind can sometimes dry tender leaves. Some plants thrive in the sun but seldom do well in the shade. Junipers and pines fit into this category. Others grow best in the shade or when protected from strong winds. Dogwoods fit here. Yews tolerate both fairly well.

**Insects and Diseases**

Plants vary tremendously in their attractiveness to insect pests and susceptibility to disease organisms. Before someone buys a landscape plant he should familiarize himself with the plant's environmental needs and tolerance to pests and diseases. A plant's success is often limited by the site and insect and disease pests that comprise the local ecology. Some plant problems are so limiting that the plants should not be considered for most landscapes. Some typical problem landscape plants include: American elm (Dutch Elm disease), White Birch (borers), European Mountain Ash (Fireblight and cankers), and Lombardy Poplar (cankers).

Additional plants with less severe problems include crabapple (scab and rust), black locust (borers and leaf beetles), and Austrian pine (diploodia tip blight). Fortunately, plant selection and breeding have produced some new, very good cultivars with improved resistance to some of these disease and insect problems. Excellent crabapple cultivars resistant to rust and scab are now available. Improved cultivars of birch resistant to the bronze birch borer are also available. Refer to the plant disease and pest selection chart for recommended cultivars. (Table 1)
Adverse Environmental Conditions

Urban Conditions

Urban conditions and seashore salt problems are the two most common environmental situations which necessitate careful selection of plant material. Trees are an invaluable natural resource that reduce the harshness and improve the appearance of an urban environment. They improve the quality of an urban setting by reducing soil erosion problems and filtering dust from the atmosphere. Trees can be used to block wind, provide shade, reduce glare and attenuate noise, thereby improving human comfort in the city. Trees can be planted to direct vehicular and pedestrian traffic and provide a sense of visual orientation and order to the increasingly complex urban environment. They also provide shelter and habitat for urban wildlife.

When trees are planted in an urban environment, they are often expected to grow in conditions that are unfavorable or even hostile to plant growth. Some of the problems encountered in urban situations include compacted soils, soils that are consistently dry, pollutants and high winds, and air and soil temperature extremes. In some urban settings these problems are often the rule rather than the exception. Space for root and crown development is often limited. If trees are to provide aesthetic, functional and environmental value for urban residents, it is important to find species that are tolerant of the city growing conditions.

Findings from the Ohio Shade Tree Project, conducted by horticulturists from the Ohio Agricultural Research and Development Center (OARDC), shed some much needed light on the subject of trees that are suitable for planting in an urban environment. The project was conducted in two phases. Phase I consisted of semiannual evaluations over 10 years of 140 shade tree species planted on the OARDC campus in Wooster, Ohio. Maintenance at the shade tree test site has been minimal in an attempt to simulate the urban environment in which these species are often found. Phase II consisted of 10 annual evaluations of 53 different tree species growing in the cities of Toledo, Cleveland, Columbus, Cincinnati and Wooster, Ohio. Evaluation in both Phase I and Phase II examined foliage density and color, branch and crotch development, disease and insect susceptibility overall growth rate and general tree condition.

Those species receiving highest evaluations from the Ohio Shade Tree Project for use in urban conditions are listed in Table 3.

Foundation Plantings

Sadly, many homeowners believe that a house is landscaped when only some shrubs are planted along the front wall. Foundation plantings have become a tradition in this part of the U.S. When properly planted they can help tie the building to the ground.
Emphasize these guidelines to help homeowners use foundation plants.

1. Allow plenty of space. Shrubs should be no closer than three or four feet to the building wall.
2. Select shrubs and small trees that grow slowly or to a desirable size.
3. Provide uniformity for a background or foreground.
4. Use specialty plants for variety and accent. Do not over use specialty plants.
5. Allow for seasonal change and interest. Use evergreen, deciduous and flowering material as desired.

Homeowners should be advised that, like most things, plants that are the most desirable are also the most expensive. Slow growing, compact plants are desirable for foundation plantings. Because they take longer to grow in the nursery, they cost more to buy.

Plants selected for the foundation planting should be researched. Ultimate size, growth habit, site requirements, soil requirements, common pests, and general management should be understood before planting is done.

**Landscaping for Energy Conservation**

Most of our energy sources are both finite and limited. It is the responsibility of everyone to use energy sparingly and as efficiently as possible. Proper landscape plantings can save up to 40% on winter heating and summer cooling costs.

Before any residential planting is done four factors relative to energy conservation should be considered: 1) Protect the dwelling from the winter wind, 2) Shade the dwelling from the summer sun, 3) Expose the dwelling to winter sun, 4) Open the dwelling to summer breezes. Woody plants grow large and remain part of the landscape for years. Thousands of dollars can be saved if home landscapes are designed with energy saving trees and shrubs.

Landscape planning for energy conservation, site layout and house design should proceed simultaneously. Master Gardeners will probably not be involved in site layout. They may well be called on to help select trees for shade or windbreak plantings and to offer advice where they can best be planted.

**Landscaping For Space Use**

Indoor living space is costly per square foot to build. Outdoor living space should cost only a small percentage of the indoor living space.

There are two main considerations involved in creating outdoor spaces. First enclosure and/or privacy must be provided. Second, some kind of “floor” is needed. The first can be screens of trees or shrubs. Fencing and walls can also be used. Paving, decks, grass
or ground covers fulfill the latter requirement. Think of your property as a series of outdoor spaces, large and small. If it is all one big open room it will not be very interesting. If it is planted helter skelter with trees and shrubs it will be unattractive and unusable.

Fall Color

Fall color in plant material can be a real bonus in the overall landscape design. It's not everywhere in the world that this striking phenomenon occurs, but the Northeastern U.S. is fortunate in having a spectacular display of various reds, yellows and oranges during autumns with suitable weather conditions. Not all years produce good color, and not all plants with color potential are consistent from year to year. Autumn color is very complex. It is actually dependent on a number of factors but the most important ones may be summed up quite briefly.

- The yellow pigments usually present in plants are continually masked by chlorophyll, the green color manufactured by plants when exposed to sufficient light. At a certain stage in the autumn this manufacturing process is stopped, existing chlorophyll is destroyed, and the yellow pigments make themselves evident sometimes quite brilliantly. Some plants turn directly from green to brown, while others are consistently yellow each year regardless of weather conditions. Red maples normally have a good red fall color, but certain individuals may always show only yellow.

- A pigment called anthocyanin is responsible for the brilliant red coloration and results from an accumulation of sugars and tannins in the leaf. Two factors are necessary for this color change to appear. First there must be warm, bright sunny days in the fall, resulting in the manufacturing of a great deal of sugar in the leaves. Secondly, these warm days must be followed by cool nights, under 45 degrees F. With this sequence the sugars and other materials are "trapped" in the leaves rather than being translocated to other parts of the plant. This accumulation results in the manufacture of the red pigment. Certain plants may be so sensitive to this process that one side which is exposed to strong light may be red while the opposite side is still yellow or green.

- Dull autumn colors are usually the result of a warm, cloudy fall with much rain. There is less sugar produced with even less being "trapped" in the leaves.

The best tree selections for fall color are listed in Table 7.
Table 1

Recommended Disease/Insect Plant Chart

Crabapples resistant to scab and rust:

These varieties are recommended for New York home gardens because they are resistant to rust and apple scab, and only moderately susceptible to fire blight and powdery mildew.

Some disease-resistant crabapples for New York:

- Adams
- Candied Apples
- Centarian
- Gibbs Golden Gage
- Henry Kohankie
- *M.sargentii* cv. Tina
- Mount Arbor Special
- Donald Wyman
- Royalty
- Indian Summer
- Professor Sprenger
- Persicifolia

Bronze Birch borer resistant birch for New York:

*Betula nigra* 'Heritage'
Table 2

Desirable Soil pH and Salt Tolerance of Ornamental Plants

Francis R. Gouin

<table>
<thead>
<tr>
<th>Common Plant Name</th>
<th>Desired pH</th>
<th>Relative Salt Tolerance</th>
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<tr>
<td>Abelia</td>
<td>6.0 - 7.0</td>
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<tr>
<td>Alder</td>
<td>6.0 - 7.0</td>
<td>Low</td>
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<td>Almond, Flowering</td>
<td>6.0 - 7.0</td>
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<td>Andromeda</td>
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<td>Apricot</td>
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<td>Arborvitae</td>
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<td>Ash</td>
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<td>Aspen</td>
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<tr>
<td>Azalea</td>
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<td>Barberry</td>
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<td>Bayberry</td>
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<tr>
<td>Beech</td>
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<td>Low-Medium</td>
</tr>
<tr>
<td>Birch</td>
<td>5.0 - 6.0</td>
<td>Low-Medium</td>
</tr>
<tr>
<td>Bottlebrush</td>
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<tr>
<td>Boxwood</td>
<td>6.0 - 7.0</td>
<td>Medium</td>
</tr>
<tr>
<td>Cedar</td>
<td>5.0 - 7.0</td>
<td>Medium</td>
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<tr>
<td>Cherry, Flowering</td>
<td>5.0 - 6.0</td>
<td>Medium</td>
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<tr>
<td>Cotoneaster</td>
<td>6.0 - 7.0</td>
<td>High</td>
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<tr>
<td>Cottonwood</td>
<td></td>
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<td>Crabapple, Flowering</td>
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<tr>
<td>Currant</td>
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<td>Cypress</td>
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<td>Deutzia</td>
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<td>Elm</td>
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<td>Euonymus, Ground Covers</td>
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<td>Euonymus, Winged</td>
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<td>Fir</td>
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<td>Firethorn</td>
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<td>Forsythia</td>
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<td>Ginkgo</td>
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<td>Grape, Oregon</td>
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<td>Hawthorn</td>
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<td>Hazel, Witch</td>
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<td>Damage Rating</td>
<td>Damage Rating</td>
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<td>Hydrangea</td>
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<td>Ilex, American</td>
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<td>Ilex, Japanese</td>
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<td>Ilex, Deciduous</td>
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<td>Ivy</td>
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<td>Juniper</td>
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<td>Laurel (Mountain)</td>
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<td>Magnolias, Evergreen</td>
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<td>Maple, Hard, Box-elder</td>
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<td>Plane, American, London</td>
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<td>Poplar, Italian, Lombardy</td>
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<td>Tamarix</td>
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| Plant            | pH Range | Growth
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<tr>
<td>Willow, Golden</td>
<td>6.0 - 7.0</td>
<td>Medium</td>
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<tr>
<td>Willow, Blue Artic</td>
<td>6.0 - 7.0</td>
<td>Low</td>
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<tr>
<td>Yew</td>
<td>6.0 - 7.0</td>
<td>Medium</td>
</tr>
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*Taken from the Cooperative Extension Service, College of Agriculture and Environmental Science Rutgers University - The State University of New Jersey.*
Table 3

**Trees for Urban Conditions**

Small Trees (30 Feet or Less in Height)

*Acer buergerianum*, Trident Maple - Interesting exfoliating bark, drought tolerant.

*Acer campestre* (tree form), Hedge Maple - Dense, rounded head, drought resistant, leaf-hoppers may be a problem.

*Cornus mas* (tree form), Cornelian Cherry Dogwood - Not widely available, good yellow flowers in early spring.

*Crataegus crusgalli* 'inermis', Thornless Cockspur Hawthorn - Good horizontal branching.

*Crataegus laevigata*, Lavalle Hawthorn - Requires secure staking, for the first 2 years, to avoid wind throw, good foliage and fruit.

*Crataegus phaenopyrum*, Washington Hawthorn - Thorn are hazardous but may aid plant's survival in some situations. Good red fruit, fall colors. Needs a lot of pruning to keep form.

*Crataegus punctata* 'Ohio Pioneer'. Dotted Hawthorn - Thornless, flat habit, silver twigs, limited availability.

*Crataegus viridis* 'Winter King', Winter King Hawthorn - Silvery bark, exfoliating with age, few thorns, good red fruit.

*Eucommia ulmoides*, Hardy Rubber Tree - Extremely drought hardy, shiny green foliage.

*Koelreuteria paniculata*, Golden Rain Tree - Yellow flowers in August. Tolerant to dry alkaline soils.

*Malus* x 'Snowdrift', Snowdrift Crabapple - Uniform rounded head, outstanding spring flower effect, occasional fireblight.

*Morus plantanifolia* 'Sterile', Fruitless Mulberry - Large shiny leaves, other selected types becoming available.
Pyrus calleryana 'Faureri', Faureri Callery Pear - Spring flower effect, foliage character, and fall color all outstanding.

Upright or Fastigiate Trees

Acer platanoides 'Cleveland', Cleveland Norway Maple - Upright oval. Drought resistant. Roots may heave sidewalks when in severely limited area, or may develop girdling roots.

Acer platanoides 'Columnare', Columnar Norwalk Maple - Narrow upright columnar form. Drought resistant. Roots may heave sidewalks when in severely limited area, or may develop girdling roots.

Acer platanoides 'Erectum', Erect Norway Maple - Erratic, narrow, upright. Drought resistant. Roots may heave sidewalks when in severely limited area, or may develop girdling roots.

Acer rubrum 'Armstrong', Armstrong Red Maple - Narrow usually having yellow fall color, pyramidal habit.

Acer rubrum 'Bowhall', Bowhall Red Maple - Upright, pyramidal shape usually having yellow fall color.

Acer rubrum 'Columnare', Columnar Red Maple - Narrow form, slightly smaller and narrower than Armstrong, good red fall color.

Carpinus betulus 'Fastigiata', Upright European Hornbeam - Small, narrow columnar habit having formal upright appearance without pruning.

Ginkgo biloba 'Princeton Sentry', Princeton Sentry Ginkgo - Extremely hardy, pest resistant plant with yellow fall color.

Medium and Large Trees (40 Feet or More in Height)

Acer rubrum 'Autumn Flame', Autumn Flame Red Maple - Outstanding red fall color. 'Autumn Flame' colors approximately 2 weeks earlier than 'Red Sunset'. Does well in urban environment, roots generally do not create a problem.

Acer rubrum 'Red Sunset', Red Sunset Red Maple - Does well in urban environment, roots generally do not create a problem.

Fraxinus americana 'Autumn Applause', Autumn Applause White Ash - Selected for
good purple to red fall color, large trees, fast growing.

*Fraxinus pennsylvanica* subintegerrima 'Marshall Seedless', Marshall Seedless Ash - Large tree, fast growing, yellow fall color, excellent growth in dry soil situations.

*Ginkgo biloba* 'Autumn Gold', Autumn Gold Ginkgo - Selected for good yellow fall color, drought tolerant, resistant to insects and diseases, excellent broad spreading habit.

*Gleditsia triacanthos inermis*, Thornless Honeylocust - Selected fruitless types, filtered shade, spreading habit. Plant bugs and leafhoppers may be a problem.

*Platanus hybrid* 'Bloodgood', Bloodgood London Planetree - Resistant but not immune to Anthracnose, exfoliating bark may be considered messy by some, tough plant.

*Quercus bicolor*, Swamp White Oak - Tolerant of moist wet soils, coarse texture.

*Quercus coccinea*, Scarlet Oak - Excellent fall color, tolerates urban situations well, tap root can make transplanting difficult.

*Quercus macrocarpa*, Bur Oak - Tolerates alkaline and dry conditions, coarse texture.

*Quercus rubra* maximia, Eastern Red Oak - Excellent in most urban situations

*Sophora japonica*, Japanese Pagoda Tree - Does well in most dry situations, striking white flowers effective in late July. Under 2 inches should not be transplanted in the fall. Subject to winter damage in cold climates. Fruiting could be a problem on pavement.

*Tilia cordata* 'Chancellor', Chancellor Littleleaf Linden - Pyramidal shape, drought tolerant.

*Tilia cordata* 'Greenspire', Greenspire Littleleaf Linden - Pyramidal shape, drought tolerant.

*Tilia cordata* 'June Bride', June Bride Littleleaf Linden - Selected for yellow flower effect and glossy foliage.

*Tilia pallida*, Pallinda Common Linden - Tolerant of drought and city conditions, uniform habit, limited availability.
Table 7

**Fall Color**

**Trees with Red Fall Color**

- *Acer ginnala* - Amur maple
- *Acer japonicum* - Fullmoon maple
- *Acer palmatum* - Japanese maple
- *Acer Platanoides* 'Crimson King'
- *Crimson King* - Norway maple
- *Acer rubrum* - Red maple
- *Acer saccharum* - Sugar maple (and yellow)
- *Amelanchier canadensis* - Downy serviceberry
  (orange to red)
- *Amelanchier laevis* - Allegany serviceberry
  (yellow to red)
- *Carpinus caroliniana* - Americana hornbeam
  (orange to red)
- *Carpinus japonica* - Japanese hornbeam
- *Carpinus orientalis* - Oriental hornbeam
- *Cornus florida* - Flowering dogwood
- *Cornus kousa* - Japanese dogwood
- *Cotinus americanus* - American smoke tree
  (scarlet to orange)
- *Crataegus crus-galli* - Cockspur thorn (orange to scarlet)
- *Crataegus lavallei* - Lavalle hawthorn (bronze -red)
- *Crataegus phaenopyrum* - Washington hawthorn
- *Franklinia altamaha* - Franklinia (orange to red)
- *Liquidambar styraciflua* - Sweet-gum (scarlet, purple and yellow)
- *Nyssa sylvatica* - Black Gum (scarlet and orange)
- *Oxydendrum arboreum* - Sourwood
- *Pyrus calleryana* - Callery pear
- *Quercus borealis* - Red oak
- *Quercus coccinea* - Scarlet oak
- *Quercus palustris* - Pin oak
- *Sassafras albidum* - Sassafras (orange - red)
- *Sorbus aucuparia* - European mountain - ash
- *Stewartia koreana* - Korean stewartis (orange to red)
- *Viburnum species* - Virburnum
Trees With Yellow Fall Color

Acer campestre - Hedge maple
Acer platanoides - Norway maple
Betula species - Birch
Carva species - Redbud
Cladrastis lutea - American yellow-wood (orange to yellow)
Fagus grandifolia - American beech (golden bronze)
Fagus sylvatica - European beech (golden bronze)
Fraxinus americana - White ash
Fraxinus pennsylvanica - Green ash
Ginkgo biloba - Ginkgo - (golden yellow)
Liriodendron tulipifera - Tulip tree
Magnolia stellata - Star Magnolia
Quercus phellos - Willow oak
Salix species - willow

Shrubs and Vines With Red Fall Color

Abelia grandiflora - Glossy abelia
Amelanchier species - Serviceberry
Aronia arbutifolia - Red chokeberry
Berberis species - Barberry
Cornus amomus - Silky dogwood
Cornus mas - Cornelian dogwood
Cornus racemosa - Gray dogwood
Cotinus coggygria - Smokebush
Cotoneaster species - Cotoneaster
Enkianthus campanulatus - Red-veined enkianthus
Euonymus alatus - Winged euonymus
Euonymus fortunei 'Coloratus'
Purple leaf winter creeper
Fothergilla species - Fothergilla (red and yellow)
Juniperus horizontalis 'Plumosa' - Andorra juniper (purple)
Leucothoe fontanesiana - Dropping leucothoe
Mahonia aquifolium - Oregon holly-grape
Mahonia bealei - Leatherleaf mahonia
Mahonia repens - Creeping mahonia
Myrica pennsylvanica - Nandina
Parthenocissusquinquefolia - Virginia creeper
Paxistima canbyi - Canby paxistima (bronze)
Photinia serrulata - Chinese photinia
Shrubs and Vines With Yellow Fall Color

*Amelanchier x grandiflora* - Apple serviceberry (yellow to orange)
*Clethra acuminata* - Cinnamon clethra (yellow to orange)
*Clethra alnifolia* - Summersweet (yellow to orange)
*Hamamelis mollis* - Chinese witch-hazel
*Hamamelis vernalis* - Vernal witch-hazel
*Hypericum species* - Hypericum
*Kerria japonica* - Kerria
*Lindera benzoin* - Spice bush
*Poncirus trifoliata* - Hardy - orange
*Wisteria species* - Wisteria
Review Questions:

1. Describe what might be necessary to develop a low, poorly drained area in full sun with clay soil so that azaleas could be grown successfully.

2. What should be done to ensure that the roots of a container grown plant will grow quickly after transplanting?

3. What four basic factors are involved in landscaping to conserve energy?

4. What group of woody plants would ideally be planted first when landscaping a new home?

5. Ask students to make a list of shade trees and another of windbreak trees that might be recommended for a specific property.
What Happens to the Trees when they are Transplanted?

How we select, plant and get newly planted trees established has become as much science as an art form. First, we are questioning the size and shape of root systems. We are also questioning many time honored practices in transplanting, such as adding organic matter and drainage materials to the planting hole, pruning shoots to balance roots, and wrapping tree trunks for protection.

Questions arise out of research that has shown that these may not be the best practices in all cases. Different research reports, however, are often conflicting because conditions under which studies are conducted may differ. Studies are usually conducted with small trees in laboratory conditions. Results from these studies are often not very applicable to landscape-sized trees in an open environment.

Trees are complex organisms. Transplanting success depends in the interactions among the physiological condition of the tree at the time of transplanting, climate, micro-climate, soil conditions and care of the tree after transplanting. Fortunately, trees have a remarkable capability to survive catastrophic stresses such as transplanting.


Literature Cited


Urban Horticulture Institute
20 Plant Science Bldg.
Cornell University
Ithaca NY
What Happens to the Trees when they are Transplanted?

Tree Roots

What do tree roots look like? A tree growing in a moist site has a horizontal root spread 2.5 to 3 times greater than the spread of the top of the tree. Over 60 per cent of the roots are located outside the “drip line” of the tree. More than 95% of the tree roots are located in the top three feet of soil, with most of the fine roots in the top 6 inches of soil. Roots are mostly fibrous, with tap roots being extremely rare.

During transplant, only a small percentage of these roots will be moved. It is estimated that 91-98% of the roots are left at the nursery. Practices at the nursery, such as root pruning, irrigation, fertilization, molding a root-ball, or even how the tree is being grown — all can influence the percentage of roots that are actually moved during transplant.

Removing most of the water-absorbing roots of the plant puts the tree under stress. When transplanted trees fail, it is usually because of this water stress. Irrigation is critical after transplant, but the available reservoir is sharply reduced when the roots are cut. Most of the water absorptive capability within a transplanted root-ball is a result of root hairs and other small roots of the tree. These fragile roots are first to suffer from dessication. Traditional wisdom and most research has shown us that trees with coarse roots do not transplant with as much success as trees with a root-ball containing small, more branched fibrous roots. Root balls with fewer, thicker roots may have equal root mass as more fibrous roots, but the water absorbing capacity is less.

The ability to survive the loss of much of the root system indicates a plant’s ability to endure during the critical period immediately following transplant. Once past this critical period, the tree regenerates roots into the surrounding soil. Factors that make regenerating roots favorable for an individual tree are: the amount of stored carbohydrates, the ability to tolerate or avoid drying out, and it’s physiological ability to function while roots regenerate.

Root tip loss has other effects: (1) it reduces the amount of hormones being made and (2) there is a disruption of photosynthesis after transplanting. Root tips would normally generate a signal to the shoots of the plant to continue photosynthesizing.

What Happens to the Trees when they are Transplanted?

Packaging the Tree at the Nursery

Introduction

Trees are produced in the nursery in different ways. Does that make a difference in how easily they are transplanted and adapted to the new site?

We must choose tree species, size and how the tree was produced in the nursery — ball-and-burlapped (B&B), bare-root, or containerized. The recent introduction of fabric containers and improved shipping makes those choices even more complicated. Landscape-sized trees are now produced in containers throughout the sun belt and many growers are experimenting with fabric containers. Improved shipping ability, aggressive marketing and over-wintering facilities have made trees produced in warmer climates available for planting in other parts of the country.

Above-ground containers (usually plastic)

*Advantages:* The primary advantage of using trees produced in containers is that 100% of the root system is moved with the transplant. This is a real advantage if the tree (with all its roots intact) is planted during the growing season, when the tree is rapidly transpiring. It also extends the season of planting. If it is cared for properly after it is transplanted, the containerized plant undergoes no transplant shock.

Container-grown trees are generally much lighter than balled and burlapped trees because a well-drained, lighter potting mix is used to minimize water collection at the base of the container. Shipping and handling is much easier with containerized trees. A two inch caliper tree produced in a container can be lifted by two people, but a two inch caliper tree, B&B, would require a tractor to move it. Container-grown trees can be loaded and unloaded much more quickly than B&B trees.

*Disadvantages:* Perhaps the principal disadvantage of container-grown trees is the possibility of deformed root systems. Problems arise mostly when the trees have been held for too long a time in the container. This ‘pot-bound’ condition reduces the vigor of the plant in the nursery and has a dwarfing effect on the tree. Dwarfed container trees are no bargain. The existing entangled mass of roots forms a barrier and prevents new roots from regenerating. The tree may develop roots that eventually girdle the tree.

Container-grown trees are often more expensive than B&B trees because it costs more to produce them. Most capital expenses on containerized trees must be invested before the harvest, while capital expenses for the B&B tree come at harvest after the plant is already sold. For this reason, larger sizes are often unavailable in container-grown trees. Since roots are less cold
hardy than shoots, container-grown trees may need winter protection in the north, making them cost even more.

When planting container-grown trees, it is necessary to irrigate more frequently. By planting the container-grown tree (with a fine-textured soil mix) into a planting hole filled back in with surrounding soil (which inevitably is coarser), water from the container soil mix more quickly drains into the surrounding soil. It will need more water than it did in the nursery. Container-grown trees transpire water very quickly after transplant. Since 100% of the root system is planted, the tree transpires at the same rate as it did in the nursery. Non-container-grown trees have many of their roots removed at the nursery, thereby triggering a response to the leaf stomates to close and conserve moisture by reducing transpiration and using soil water reserve less quickly.

Fabric containers
The use of fabrics to control root growth was introduced in 1982 and refined in 1983. The fabric container is placed in the ground, native soil is shoveled in the fabric bag and the area surrounding it, and the tree sapling is planted in the fabric container. The fabric container is removed at transplanting. Roots can penetrate the container, but expansion outward is limited, frequently causing the roots to girdle the tree. This girdling effect causes more root branching inside the container and a general increase in the fibrous nature of the transplanted roots.

Advantages: Speculated advantages of fabric container-grown trees are (1) faster and easier digging, (2) a higher proportion of roots contained in the root-ball, (3) digging and planting season are extended beyond that of traditional B&B, and (4) root-balls are smaller and lighter than B&B. Research to date has shown that the fabric container does produce a more compact root system on many species. However, regeneration of roots after transplanting does not always occur.

Disadvantages: One disadvantage of using trees produced in fabric containers is their relative newness on the market. Growers, landscape contractors and non-professional gardeners alike have little experience handling trees produced by this method and few research results are available to assist them.

Various tree species respond differently to the fabric container-grown method. One study showed that root-balls of laurel oak were unaffected by production in fabric containers, but slash pine and Leyland cypress were.

Note: all three are trees of the southern states.

In another study, Palatka holly was observed after transplanting from fabric containers. More (desirable) small diameter roots were found compared to those grown B&B. Root surface area was about the same in fabric container trees and B&B trees, even though the fabric container-grown root-balls had one-half the volume of B&B grown trees. Fabric container-grown trees were more stressed immediately after transplanting and in a simulated drought experiment. Part of this stress occurred because roots were disturbed while removing the fabric. Another factor may have been the sandy north Florida soils and might not occur in finer textured soils.

Since fabric container-grown trees had smaller volume root-balls than B&B, their water reservoir was depleted faster. Recovery, however, was rapid. At the end of the drought experiment, all trees (B&B and fabric container grown) were irrigated daily for two weeks, and there was no difference in regenerated roots. Fabric container-grown trees may need staking after transplanting due to small root ball.

Balled and Burlapped (B&B)
Advantages: Moving B&B trees is the traditional method of transplanting. Seasoned workers are
used to handling B&B trees, and consumers are used to seeing B&B trees of large caliper planted. In addition, B&B trees are readily available. Large sizes are available, and are limited only by the equipment available to lift and ship them. A major advantage to planting B&B trees as opposed to trees produced by other production methods is that it is possible to match soil types between the nursery and the site. Where soils are matched, there is enhanced water flow to the root system. Where nursery soil differs from the site soil, we call the resulting inhibition of water flow an “interface problem”, because the roots must adjust to the change at the “interface” between the soil around the roots carried from the nursery and the soil at the new site.

Disadvantages: The main disadvantage of field-grown trees moved B&B is that over 95% of the roots are left behind when the tree is dug from the nursery. This may be overcome somewhat by root pruning or by buying relatively small trees which were set out in the nursery from containers (where most of the roots are in a confined area).

Using Palatka holly grown in Florida, scientists found that in trees that were started in containers and then planted out in the nursery, less than half of total root length were left behind seventeen months after the trees had been set out in the nursery. Ideally, trees should be moved B&B during the season when transpiration is low and roots can regenerate rapidly. However, these usually do not coincide, since the most favorable time for root regeneration is probably after the first flush of growth has hardened. By then, transpiration rates are high.

With the much reduced root system, there must be some assurance to the newly transplanted tree that there will be adequate water to sustain it.

B&B trees are heavy. Moving landscape trees requires equipment and skilled personnel to operate it.

Bare-root

Advantages: Advantages to planting trees bare-root are primarily financial. Bare-root trees are much cheaper than trees produced by other production methods because of ease of digging, storing and shipping. Many species respond well to moving bare-root. Longer root lengths are possible since weight is of little concern. Bare-root trees can potentially retain a greater proportion of the original root system. Inspection of the entire root system is possible, and inferior root systems or defects, such as girdling roots, can be detected.

Disadvantages: It is not possible to obtain large size trees bare-rooted, since they would usually not transplant well. A wider range of sizes is available in trees produced by other methods. Many species of trees cannot be moved bare-root. This is primarily due to an intolerance for desiccation (roots drying out). The exposed root system must be protected from drying influences by paying careful attention to handling these vulnerable trees.

Transplanting bare-root trees is more affected by seasonal restraints than other production methods. Trees should be dormant. Short windows of transplanting opportunity in colder climates can be a major restraint when summer comes ‘quickly’ or winter comes ‘early’. Larger bare-root trees usually have to be staked, since a leafy crown without a secure root-ball is more likely to be uprooted or dislodged by spring wind.

What Happens to the Trees when they are Transplanted?

Planting the Tree

Introduction
Once the tree has left the nursery, the process of delivery and planting may play an important role in the future health of the tree.

Size
Smaller trees generally transplant better than larger trees. There are, however, exceptions: research between 1975 and 1977 revealed that larger sized willow, pin oak and red oak transplanted better than smaller sizes. For landscape sized trees, however these are the exception to the norm. Sometimes people want trees with large sized diameter trunks to get an instant effect. However, stresses caused after the transplant, the extra effort and cost increase exponentially with the tree size.

The growth rate of regenerated roots is similar for all sized trees. Trees characteristically maintain a stable balance between the root (underground) and the shoots (above ground). Transplanted trees do not put on significant shoot growth until they have re-established its root to shoot balance. A researcher in 1985 used a growth rate for roots of 18 inches per year to determine that two trees (one with a 4 inch diameter trunk, the other with a 10 inch diameter trunk), planted at the same time, will both be the same size in 13 years! This is because there are more roots to replace in the larger transplanted tree than there are in the smaller tree. So the smaller tree catches up by developing roots systematically while the larger tree is replacing all the roots that it lost in the transplanting process.

The area of living cells on either side of the cambium (inner bark) of a tree with a 5 inch diameter is 40 times more than that of a tree with a one inch diameter trunk! That means that more water and nutrients are required to feed more cells of the larger tree. When the roots that take in the water and nutrients are suddenly cut off for transplanting, the larger tree is put into more stress.

Planting Procedures
We can control the planting process. If we pay close attention during planting, we can enjoy greater satisfaction in the results and the trees will be healthier.

Unloading the Tree
Trees should never be lifted by the trunk. Trees are particularly vulnerable to damage if they are actively growing. Cell walls of the cambium are thin when growth resumes in the spring. At that time, the inner bark (including the phloem and other tissues outside the phloem) is easily
‘slipped’, causing damage. Trees that are moved B&B are particularly susceptible because of the weight of the root-ball.

**The Planting Hole**

Adding organic matter and drainage materials as amendments to the soil surrounding the newly planted tree is a time honored tradition. It is still recommended by some contemporary horticulturists.

Most research, however, reveals that the amendments offer no consistent advantages or may even be harmful. Backfill, the soil we use to fill the hole in a newly planted tree should be, in most cases, the same soil removed from the planting hole. If that soil is of poor quality, it may be better not to plant the tree in that particular spot. If it is necessary to replace the poor quality soil, good quality topsoil may be the best alternative. One exception is where entire beds can be amended with organic matter and drainage material, allowing new root growth to develop for several years.

The most important contribution to backfill is aeration. We can accomplish this by digging a hole that is no deeper than the root-ball and at least three times as wide. Digging a deeper hole creates an opportunity for settling of the root-ball and an increased chance of suffocation! Backfill should be lightly tamped periodically as it is returned to the planting hole to eliminate air pockets. Air pockets make it harder for water to move freely in the soil and use valuable space needed for soil that is available for root regeneration.

**Root-Ball Coverings**

Coverings are necessary to hold the root-ball together. The larger the root-ball, the more types of coverings are available. Burlap should be pulled down from the top of the ball at planting and twine should be removed from around the trunk. Burlap exposed at the surface can act as a wick to dry out the root zone. Synthetic burlap does not break down in the soil and will girdle the roots.

Large trees are generally handled by professional landscape contractors. It is important to know, however, that large root-balls are often covered with wire fencing or specially designed baskets, which hold the balls together during transit. The effect of wire baskets on future health of the trees is a subject of concern and debate. Research in Canada in 1988 and 1992 shows that there is probably no danger for trees with the wire baskets already in place.

Whether or not to remove the wire before planting is still not clear. The concern is that the wire may girdle roots. It appears that specific species are more or less prone to root girdling by wire baskets. Until more research clarifies how the wire affects the tree, it is best to remove wire baskets before planting. An alternative is to place the tree in the planting hole with the wire intact and remove or fold down the upper half of the basket. This will allow the majority of the roots to escape girdling.

Master Gardener Series on Transplanting Trees

What Happens to the Trees when they are Transplanted?
Caring for the Tree after it is Transplanted

Introduction
Once the tree is planted, its need for attention does not end. After-care, or how the tree is cared for after transplanting is critical.

Wrapping
It has become standard procedure over the years to wrap a newly planted tree. The effectiveness of this practice is now being questioned. In theory, tree wraps prevent sun scald and frost cracks, particularly on trees with thin bark, such as birch and maple. In 1983, paper tree wraps were tested for effectiveness in buffering temperatures on the tree trunk. Surprisingly, it was observed that the temperature fluctuations were greater under the tree wrap than where no wrap was used. The most effective material for wrapping is a greenhouse insulation material. A 1992 study in Virginia looked at the effectiveness of other wrapping materials.

A survey of professional tree specialists (arborists) primarily cite physical protection from vandals and equipment as the chief advantage of tree wrapping. They may deter damage from rodents and offer some protection from damage from a lawnmower, automobile or other heavy machinery.

The decision to wrap tree trunks should be made on a tree-by-tree basis and should not be required of all plantings.

Staking and Guying
A common practice to help newly planted trees “anchor” during the first year of planting is tree staking. The younger the tree, the more common the practice. Staking and attaching guy wires to newly transplanted trees is often unnecessary. For instance, professionals agree that staking should never be used to straighten a crooked tree.

It should be noted that prolonged staking and guying prevents the tree from forming a normal taper. Studies have shown that gentle movement in the wind promotes a stronger trunk and ensures that the root system is well enough established to support the tree. It also is liable to cause accidents, particularly if guy wires are not clearly marked. Guy wires that are not removed after one growing season can quickly disfigure and girdle the tree. It is all too common to see tree bark growing over wire supports.

There are situations, however, when staking the tree is advisable. Trees that were grown in the nursery with stakes may require continued staking. Trees in very open and windy sites, particularly in wet conditions, will also require staking.

The decision to stake trees should be made on a tree-by-tree basis and should not be required of all plantings.
Pruning
A standard recommendation for pruning has been to prune back 15 to 40% of the top of the tree, prior to transplanting. The premise is that pruning the top would reduce the amount of new growth during the spring flush. That would mean that water loss should be reduced when there is less leaf surface area transpiring. However, in 1981, a study showed that the degree of pruning did not affect on survival at all. Furthermore, pruning more than 15% of the tops before transplanting reduced the visual quality of the tree.

In a study at Cornell in 1989, it was learned that when cherry trees were pruned 50% before planting, there was a decrease in transpiration, but also a reduction in growth rate of roots and shoots. The benefits of indiscriminate pruning of deciduous trees during the dormant season are doubtful. Pruning should be restricted to corrective pruning to improve form only.

Fertilizing
Recommendations for fertilizing after the tree is transplanted vary considerably. Some researchers report that fertilizing at planting time has no effect. Others report that there is a significant increase in growth when the trees are fertilized at planting. Broadcasting fertilizer evenly upon the soil surface or mixing a slow-release fertilizer into the backfill may promote good tree growth. However, there are no clear advantage to any other form of fertilizer application.

Watering and Mulching
Water is essential to the newly transplanted tree. Be especially diligent about watering at initial transplanting. In the first two weeks following the transplant, soil should be checked regularly to maintain an even moisture around the root ball and the surrounding backfill. It is possible to overwater during this time before new roots begin to develop. Again resume needed watering during any hot or dry spells throughout the rowing season. During the next two years, watering is important, as the tree is forming a significant new root system.

Watering, when it is needed, should be slow and deep. It is reasonable to apply 20 gallons at a time, but it is important to apply it slowly, in order to reduce runoff. The tree should go into each winter, before the ground freezes, with a moist planting bed.

It is recommended to apply a two to three inch mulch to the surface of the planting bed, extending out in a circle about 3 feet in diameter from the trunk, without being in contact with the trunk. The mulch is important to conserve soil moisture around the tree roots and to reduce grasses and other weeds that compete for water and nutrients. The mulch also creates a zone of protection to the tree trunk, reducing damage caused by lawn mowers and string trimmers. Mulch should be replenished, if necessary, each year.

Related Resources

Woody Plant Materials

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<tr>
<th>Title</th>
<th>Item Code</th>
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<tbody>
<tr>
<td>Suggested Practices for Planting and Maintaining Trees and Shrubs</td>
<td>141IB24</td>
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<td>(available as an expanded publication and under a new title in 2005)</td>
<td></td>
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<tr>
<td>Shrubs for Landscape Plantings in New York State</td>
<td>141IB50</td>
</tr>
<tr>
<td>Home-Grounds-Garden: Resistance of Woody Ornamental Plants to Deer</td>
<td>147HGGFS800.00</td>
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<td>Damage</td>
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<td>Know Your Trees</td>
<td>147J85</td>
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<td>Tree ID Guide for Common Urban Trees in NY State &amp; the Northeast</td>
<td>141TIDG</td>
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<td>Recommended Urban Trees: Site Assessment and Tree Selection for Stress</td>
<td>141RUT</td>
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<td>Tolerance</td>
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<tr>
<td>Pruning: An Illustrated Guide to Pruning Ornamental Trees and Shrubs</td>
<td>141IB23</td>
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These titles are available for review and sale at The Resource Center's online bookstore:
www.cce.cornell.edu/store

You may also order titles or a catalog by:
Phone: 607-255-2080
Fax: 607-255-9946
E-Mail: resctr@cornell.edu

Or write:
The Resource Center
Cornell University
PO Box 3884
Ithaca, NY 14852-3884

These titles are also usually available through your local Cooperative Extension association office.
Cornell Website information on **Woody Plants (Trees, Shrubs and Vines)**

All Cornell website information on gardening is accessible through the Cornell Gardening Resources Website [www.gardening.cornell.edu](http://www.gardening.cornell.edu)

The following are specific sections of the Cornell Gardening Resources Website as of Dec. 15, 2004. New web pages are added regularly. Please check [www.gardening.cornell.edu](http://www.gardening.cornell.edu) periodically for updates and new information.

[http://www.gardening.cornell.edu/woodies/index.html](http://www.gardening.cornell.edu/woodies/index.html)


[http://plantclinic.cornell.edu/treeshrub/index.htm](http://plantclinic.cornell.edu/treeshrub/index.htm)

[http://www.hort.cornell.edu/department/faculty/bassuk/uhi/](http://www.hort.cornell.edu/department/faculty/bassuk/uhi/)

[http://www.entomology.cornell.edu/Extension/Woodys/CUGroundCoverSite/GroundcoverMain.html](http://www.entomology.cornell.edu/Extension/Woodys/CUGroundCoverSite/GroundcoverMain.html)

**Cornell Visual Presentation Resources in Woody Plants (Trees, Shrubs, Vines and Ground Covers)**

Master Gardeners may borrow resources from the Department of Horticulture’s Home Grounds and Community Horticulture Resource Library in Ithaca, NY. MG’s should discuss it with their county MG Coordinator and reserve a resource through that staff person. Resources in this library are slides, powerpoint CD-ROM’s and videos. They are generally used by Master Gardeners to make presentations to community groups as part of the county CCE’s educational mission. The number preceding each resource is its library code number in Ithaca.

**TREES, SHRUBS, VINES AND GROUND COVERS**

106. *Selected Landscape Plants* Slide Set (253 slides & script) K. McCann, Ohio State University


151. *Surface Treatments (mulches, geotextiles, turf, groundcover and porous pavements)* Slide Set (51 text and photo slides, with instructor’s outline) Urban Horticulture Institute, Cornell University

152. *Landscape Plant Selection Module* Slide Set (100 text and picture slides with instructor’s outline) Urban Horticulture Institute, Cornell University


CD-6 Climbing Perennial Plants: Gardening in the Fourth Dimension -- CD-powerpoint -- 80 frames (images and/or text) & script, David Chinery, Rensselaer County CCE, 2002

CD-1. Michael A. Dirr’s Photo Library of Woody Landscape Plants (Set of 4 CDs and user’s guide) Plant America. Intended for self-study at the computer. Difficult to use for group instruction.

CD-9 Small Trees for Home Landscapes in Zone 5 or warmer. (CD-powerpoint – 87 frames (images and/or text) C. Mazza, Cornell University, 2003.
149. **Nutrient Management** Slide Set (In the Landscape) (from Soil Modification Module) (42 text and picture slides, with instructor’s outline) Urban Horticulture Institute, Cornell University
Cornell Visual Presentation Resources in Woody Plants (Trees, Shrubs, Vines and Ground Covers) - continued

83. **Pest Management for Urban Trees** Slide Set (62 slides, script & cassette) G. Hudler, Cornell

### Pruning

72. **Pruning Transparencies** (25 Overheads) Apple Tree Pruning
73. **Pruning Evergreens** Slide Set (80 slides, script & cassette) National Arborists Assoc.
97. **Pruning & Training Grapevines** Slide Set (74 slides & script) D. Himelrick
99. **Training & Pruning Apple Trees** Slide Set (38 slides & script) D. David, G. Forshey & W. Smith
119. **Pruning Ornamentals in the Home Landscape** Slide Set (155 slides & script) D. Rakow & R. Weir III, Cornell & CCE/Nassau Co.

V-3. **Pruning Your Own Shrubs and Small Trees** Video, (51 min.) Ag. Communications Center, University of Idaho

V-11. **Elements of Landscape Pruning; an Employee-training Video** (30 min., script) Dr. Alex Shigo, U.S. Forest Service

105. **Suggested Practices for Planting and Maintaining Trees and Shrubs** Slide Set (13 slides & IB#24) A.S. Lieberman & R. Weir III, Cornell & CCE/Nassau Co

### PROPAGATION

94. **Trees and Shrubs from Cuttings** Slide Set (80 slides & script) C. DeWilde, CCE

110. **Etiolation and Banding** Slide Set (23 slides & script) N. Bassuk, Cornell University

URBAN TREES (or STRESS TOLERANT TREES)

83. **Pest Management for Urban Trees** Slide Set (62 slides, script & cassette) G. Hudler, Cornell Univ.

144. **Site Assessment Module** Slide Set (73 text and picture slides, with instructor’s outline) Urban Horticulture Institute, Cornell University

145. **Soil Structure** Slide Set (from Soil Modification Module) (54 text and picture slides, with instructor’s outline) Urban Horticulture Institute, Cornell University

146. **Soil Texture** Slide Set (from Soil Modification Module) (28 text and picture slides, with instructor’s outline) Urban Horticulture Institute, Cornell University

147. **Drainage and Aeration** Slide Set (from Soil Modification Module) (32 text and picture slides, with instructor’s outline) Urban Horticulture Institute, Cornell University

148. **Soil pH** Slide Set (from Soil Modification Module) (11 text slides, with instructor’s outline) Urban Horticulture Institute, Cornell University

149. **Nutrient Management** Slide Set (In the Landscape) (from Soil Modification Module) (42 text and picture slides, with instructor’s outline) Urban Horticulture Institute, Cornell University

150. **Soil Contaminants** Slide Set (from Soil Modification Module) (30 text and picture slides, with instructor’s outline) Urban Horticulture Institute, Cornell University

152. **(Landscape) Plant Selection Module** Slide Set (100 slides, with instructor’s outline & publication on urban trees) Urban Horticulture Institute, Cornell University

153. **Transplanting (Trees) Module** Slide Set, (74 slides, with instructor’s outline & publication on transplanting) Urban Horticulture Institute, Cornell University


V-16. **The Youth Mentors Trees Project** Video, University of Connecticut


V-27. **Creating an Urban Forest – The Bare Root Tree Planting Method** Video (15 min.) and printed guide, Cornell University, 1998

V-36 **Bonsai** Video (22 min.) Brooklyn Botanic Garden


**ECOSOCIAL PERSPECTIVE**


**CD-7 Invasive Plants of New York State.** CD-powerpoint, 79 frames (images and/or text) & script, Community Horticulture Program Work Team, Cornell University, 2004.