

Selecting and Planting Woody Plants

Kentucky Master Gardener Manual Chapter 21

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Woody ornamental plants are key components of a well-designed landscape. Landscape plantings divide and define areas, add aesthetic and psychological benefits, and increase a property’s environmental and economic values.

There are many woody plants available for use in landscaping, so select carefully. Choose plants based on their ability to fulfill your purposes and grow well in your property’s environment.

Install landscape plantings according to a plan, keeping two factors in mind:

- Use the right plants in each area to create your desired design effect.
- Place plants in the right environment with proper sun exposure, temperatures, soil pH, drainage, and water.

Landscape plants last for many years. Making wise decisions for types of plants and giving plants proper growing conditions and care will help ensure that they remain a healthy and aesthetically pleasing part of your landscape.

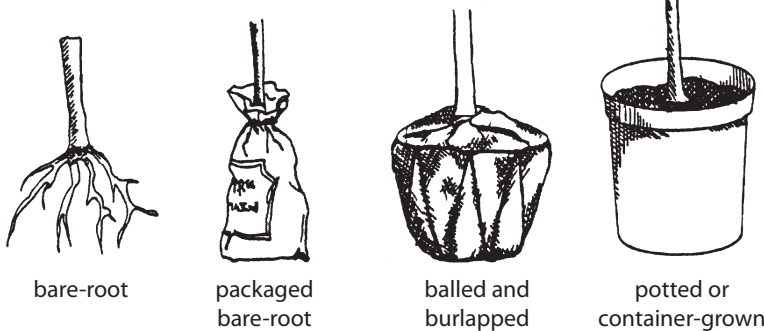
Planting Trees and Shrubs

You can purchase trees and shrubs in a variety of ways (Figure 1):

- Bare-root (BR) plants have little or no soil around the roots. This method is common for deciduous plants and small evergreens shipped by mail during the cooler months.
- Balled and burlapped (B&B) plants are dug with soil around the roots with the root ball enclosed in burlap or a synthetic and are often available year-round.

- Container plants are grown and sold in containers and are also available year-round.
- Field-potted plants are grown in a field and dug with or without soil and potted into containers filled with organic media (substrate), field soil, or a combination of the two.

Figure 1. Types of nursery plants.



Planting

Proper planting procedures are crucial to establishing a healthy plant. Planting procedures depend on which type of plant you choose (e.g., bare-root, balled and burlapped). Instructions for the common types are given below.

Bare-root

- Cut back damaged roots with a clean cut. Then soak the roots in water for 1 to 2 hours.
- Dig a hole wider but not deeper than the root system. The root flare (where roots meet the trunk) should be no deeper than about one inch below grade.
- Put the plant in the hole to the level where it was growing in the nursery (Figure 2). You can put a cone of soil under the plant for support and spread the roots on top of the cone.
- Backfill with native not amended soil. Tamp down the soil to remove air pockets.
- Water thoroughly.

Balled and burlapped

- Dig a hole wider but not deeper than the root ball (Figure 3).
- Remove the burlap or synthetic material from around the ball along with all rope, string, or twine tying materials.
- Place the ball in the planting hole with the top of the ball even with the soil surface or slightly higher.

Figure 2. Planting depth for a bare-root tree or shrub.

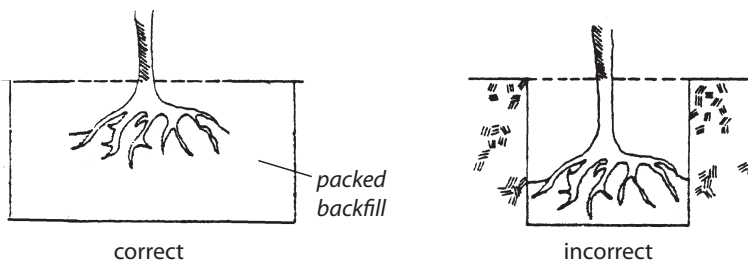


Figure 3. For B&B and container plants, the hole should be a minimum of two or three times as wide as the soil ball.



- Sometimes the digging process results in B & B plants with excess soil at the top of the ball. Excavate to find the top most root and ensure that it will be no deeper than one-inch below grade. If needed, remove some of the soil at the top of the ball.
- Backfill with native, not amended, soil. Tamp down the soil to remove air pockets.
- Water thoroughly.

Container plants

- Dig a hole larger than the spread-out root system.
- Always remove the container, even papier-mâché and peat pots.
- Container plants differ from those grown in native soils. Roots of container-grown plants frequently circle the inside of the container. If this action is not stopped, the plant will fail to become established in the landscape. Roots of container-grown plants are also growing in a substrate (artificial soil containing pine bark, compost or other materials) which has a different texture than soil.
- You must remove enough of the artificial mix to expose several inches of roots. You can do this by working your fingers into the mix resulting in the loose mix falling away from the roots. You do not need to remove all of the mix but you should remove as much as can be easily removed.

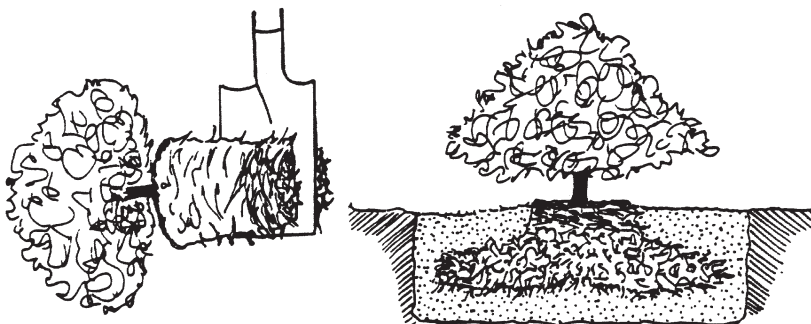
- If the roots have begun to circle the inside of the container, try to unwind them so that they will radiate out away from the trunk.
- If the root mass is so dense that it is impossible to separate the roots, you will have to resort to cutting the roots. Make several vertical slices into the root ball to stop the circling action. This is the least desirable corrective action but is often the only solution for plants that have become extremely pot bound.
- Place the prepared root ball in the planting hole with the surface of the container media level with the soil surface or slightly higher.
- Backfill with native, not amended, soil. Tamp down the soil to remove air pockets.
- Water thoroughly.

Pruning

Contrary to popular opinion, it is not a good idea to prune one-fourth to one-third of a tree or shrub's branches to compensate for root loss when you plant it. However, light pruning may be helpful in correcting problems. Follow these steps:

- Remove dead or injured branches.
- Remove interfering, rubbing, or crossed branches.
- Remove branches forming narrow "V" crotches (multiple or codominant leaders). Leave the other branch to become the leader.

Figure 4. Splitting a root ball.



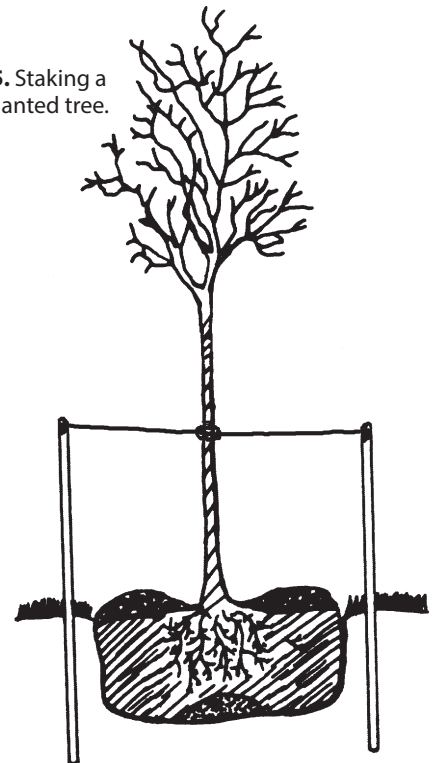
Staking

A plant that is supported by a stake from the time it is small grows differently than an unstaked plant. It will be taller and thinner and have deformed xylem and less root growth. It may not be able to stand by itself.

Bare root trees generally need to be staked because they are tall and do not have the weight of firm soil around their roots to help stabilize them. If staking is not needed, don't do it. If you do need to stake a plant in a windy area, follow these steps (Figure 5):

- Drive two or three stakes into firm ground outside the planting hole. The line formed by the two stakes and the tree trunk should be parallel to the prevailing wind.
- Tie the two stakes to the trunk about 2/3 of the way up the trunk. Use a material that will not chafe or damage the bark.
- Allow some play in the line to allow slight swinging of the trunk. Gentle swaying of the trunk stimulates root growth on newly transplanted trees.
- Remove stakes as soon as possible after the roots are established and the plant is stabilized, typically after one growing season.

Figure 5. Staking a newly planted tree.



Fertilizing

Do not put fertilizer into planting holes and do not apply any fertilizer to the newly transplanted woody plant during the first growing season. Roots that come into contact with fertilizer particles may be damaged (burned). Root stimulating products are also not needed as their effectiveness is questionable.

Watering

A recently transplanted plant needs special attention through its first growing season. The nursery soil around a potted or B&B plant may be radically different from the soil where it is planted and water may not move readily between the two. Therefore, it is important to apply water to both the nursery soil and the surrounding soil during the establishment period. Roots grow only where there is moisture; unless both media are moist, roots may never grow out of the original nursery soil.

Container soils have a bad habit of drying out much faster than the surrounding soil or backfill soil. Moisten both media adequately to prevent new plants from being injured or dying of drought. However, be careful not to over-water. Average rainfall in Kentucky is often adequate for woody plant growth once the plant has been established. However, newly transplanted trees and shrubs are not able to tolerate even brief periods with inadequate rainfall. When the top five inches of soil/medium becomes dry, water the plant thoroughly making sure to wet the container and surrounding media to at least 6 to 9 inches and repeat as often as the soil becomes dry.

Mulching newly established shrubs and trees helps prevent moisture loss. Apply no more than 2 to 3 inches of mulch, and ensure that mulch is pulled away about 4 inches from the base of the trunk.

Transplanting Established Plants

Careful selection and placement of a plant should make transplanting at a later date unnecessary. Occasionally you may need to move a plant. Plants often die after transplanting because of root damage or poor handling. Generally the younger the plant and the more careful you are, the better your chance of success.

Timing

The best time to move evergreens is spring followed by early to mid-autumn. Move deciduous plants while they are dormant (usually from late fall to early spring, anytime the ground is not frozen).

Preparation

If time allows, root prune the plant a year or more before digging it. The fall before you plan to move the plant, divide the circumference of the root area into six segments and prune every other segment by driving a sharp spade into the ground to the full length of its blade. (Make the circle of cuts slightly smaller than the size of the ball you'll eventually dig.) New roots will grow at the cut edges. The following spring, prune the remaining segments. When you dig the plant for transplanting, make the root ball larger than the root-pruned area to retain the maximum number of new roots.

Moving the Plant

It is best to ball and burlap both deciduous and evergreen plants before moving them to minimize damage. Dig a trench around the plant, just beyond the spread of its branches (or just beyond your root-pruning cuts). Cut through woody roots, but leave fibrous roots intact if possible. Use a garden fork to loosen the soil around the outer edge of the root ball to reduce its size and weight.

Next, cut under the ball and tip it to the side so you can work a sheet of plastic or burlap under it. Tip the ball from side to side carefully. Do not use the trunk of the plant as a lever to tip the root ball to prevent

excessive damage. Wrap the ball tightly with plastic or burlap, lift the plant from the hole, and move it to its new location. It is always best to move the plant by lifting the root ball, not by lifting or dragging by the trunk. Unwrap the ball and plant it as you would a B&B plant.

Fertilizing

Woody ornamental plants require moderate soil fertility to thrive. High soil fertility stimulates excessive and possibly undesirable growth. Low fertility is likely to make plants grow poorly and lack vigor. Plants stressed by low fertility are more susceptible to insect pests, diseases, and other problems, such as lack of hardiness.

If plants are growing well in fertile, well-drained soil, they may not require regular fertilization. If plants are growing in areas with a lawn fertilization program, additional fertilization will probably be unnecessary for the woody plants. Fertilizers can be expensive, and many are manufactured using non-renewable fossil fuels. If leaching and erosion occur, they can enter water supplies. Thus, remember these important tips:

- Fertilize woody plants only when needed.
- Apply the correct amount of fertilizer at the right time of the year.
- Place fertilizers where they will be available to the plant's roots.

Determining the Need for Fertilizer

Whether or not you carry out a yearly fertilizer program for landscape plants should depend on the inherent fertility of your soil, how well the plants are growing, and whether you recycle nutrients (e.g., grass clippings or leaves). Very sandy soils, for example, may lack sufficient clay and organic matter to hold nutrients and may be prone to low fertility. This situation is not common in most areas of Kentucky. Landscape plants growing in such soils often exhibit nutrient deficiency symptoms unless they are fertilized regularly. On the

other hand, trees and shrubs in regularly fertilized turf areas may not need supplemental nutrients.

If plants are not doing well, fertilization may be helpful, but only after you determine the cause of the problem. Some possible indicators of a need for fertilization are:

- Smaller than normal leaves
- Light green or yellowish leaves (if the plant's leaves normally are dark green)
- Shorter than normal annual shoot growth
- Dead twigs and branch tips

However, these symptoms also may be caused by environmental, insect, disease, or other cultural problems. It is prudent to rule out any such causes before embarking on a fertilizer program. In Kentucky the most common cause of yellow foliage is not lack of fertilizer but the attempt to grow acid-loving plants on alkaline soils.

Research indicates that nitrogen may be the only nutrient that improves growth of woody landscape plants. In most cases, potassium and phosphorus soil reserves are sufficient for woody plants. Having your soil tested through the county extension office or by a reputable laboratory can help you determine the levels of phosphorus and potassium. Very low readings of these two minerals may indicate the need to add these nutrients to your fertility program. A soil pH imbalance may also affect woody plant growth. For example, hollies become deficient in iron when soils are alkaline. To the untrained eye, the yellow leaves seem nitrogen deficient but the real issue is lack of available iron often caused by incorrect soil pH. A soil test will reveal soil pH.

Fertilization is appropriate in some specific cases. For example, it may help newly planted trees and shrubs reach their potential. Fertilizing also benefits trees and shrubs that have been partly or completely defoliated by insects or disease, those that are stressed by digging or trenching in their root zone or those that may have suffered severe limb damage due to weather. Appropriate fertilizer application also may stimulate recovery from winter injury.

Types of Fertilizer

The three numbers on fertilizer packages refer to the percent of nitrogen (N), phosphorus (as phosphate, P₂O₅), and potassium (as potash, K₂O), always in that order. Many fertilizer formulations are available, but since woody plants generally respond only to nitrogen, it is appropriate to use formulations consisting only of nitrogen or ones in which nitrogen is predominant. Some examples are 16-8-8, 21-7-14, 20-10-5, 21-0-0 (sulfate of ammonia), 33-0-0 (ammonium nitrate or urea), and 45-0-0 (urea). Lawn fertilizers without weed killers are acceptable for fertilizing woody landscape plants.

How Much Fertilizer to Apply

Calculating by area

Deciduous, broadleaf evergreen, and needleleaf trees (conifers) can be fertilized each year with one to three pounds of actual nitrogen per 1,000 square feet. If your soil is very poor or plants are not growing well, consider using the higher amount. If plants are growing well and you know the soil is fairly fertile, use the lower end of the range or none at all.

For flowering trees and shrubs, particularly crabapples, use no more than 2 pounds of actual nitrogen per 1,000 square feet. Too much nitrogen may stimulate shoot growth at the expense of flowers.

Once you know how much actual nitrogen you need, it's easy to calculate the amount of fertilizer to use. To apply 3 pounds of actual nitrogen per 1,000 square feet using a 21-7-14 fertilizer, divide the desired amount of nitrogen (3 pounds per 1,000 square feet) by the percent of nitrogen in the formulation (21 percent, or 0.21). For example, $3 \div 0.21 = 14$ pounds = 3 pounds of nitrogen for a 1,000-square-foot area. See Table 1 for approximate amounts based on other formulations.

Table 1. Approximate amounts of fertilizer needed to provide 1, 2 or 3 lb of actual nitrogen per 1,000 sq ft.

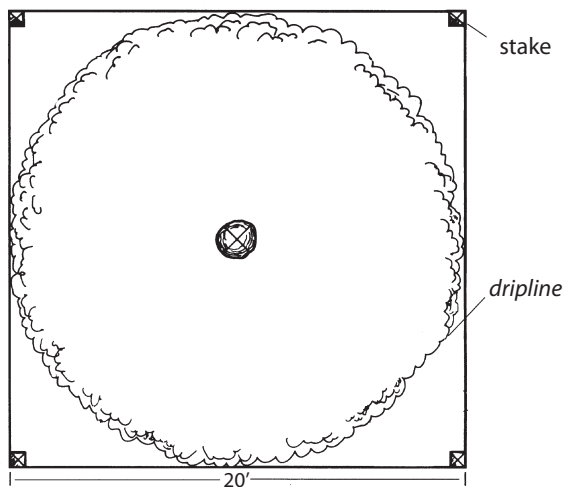
Type of fertilizer*	Amount of fertilizer to apply per 1,000 sq ft		
	1 lb N	2 lb N	3 lb N
10-6-4	10	20	30
12-3-6	8	16	25
16-8-8	6	12	19
21-0-0	5	10	14
21-4-4	5	10	14
24-4-8	4.5	8.3	12.5
33-0-0	3	5	9
46-0-0	2	4	6.5

*These are examples. Availability may vary by location.

The area beneath a tree usually is not exactly 1,000 square feet. To find the area beneath a tree or shrub, put four stakes in the ground to form a square that encloses the dripline or extends beyond it (Figure 6). Measure the distance between the two stakes along one side of the square and multiply this number by itself to get the area in square feet. Divide this number by 1,000, then multiply the answer by the pounds of fertilizer needed per 1,000 square feet. The result is the amount of fertilizer needed for the tree.

Example: If one side of the square is 20 feet, then the area under the tree is 20 feet by 20 feet, or 400 square feet. Four hundred square feet divided by 1,000 square feet equals 0.4. If you need 3 pounds of actual nitrogen per 1,000 square feet, and you want to use a 21-4-4 fertilizer, you need 14 pounds of fertilizer per 1,000 square feet

Figure 6. Finding the area beneath a plant.



(from Table 1). Multiply 14 pounds times 0.4 (400 square feet) to get 5.6 pounds, or roughly 6 pounds of 21-4-4. This is the amount to spread under the tree. The calculations for this example are:

$$\begin{aligned} 20 \text{ ft} \times 20 \text{ ft} &= 400 \text{ sq ft} \\ 400 \text{ sq ft} \div 1,000 \text{ sq ft} &= 0.4 \\ 3 \text{ lb N} \div 0.21 &= 14 \text{ lb (or read from Table 1)} \\ 14 \text{ lb N} \times 0.4 &= 5.6 \text{ lb fertilizer} \end{aligned}$$

Calculating by plant size

You also can determine how much fertilizer to apply based on a plant's trunk size, height, or spread. For example, shade trees with a trunk diameter of less than 6 inches (measured at 54 inches (4.5 feet) above ground) should receive from $\frac{1}{8}$ to $\frac{1}{3}$ pound of nitrogen per inch of trunk diameter. Trees greater than 6 inches in diameter can receive $\frac{1}{3}$ to $\frac{2}{3}$ pound of nitrogen per inch of trunk diameter.

Flowering trees and large shrubs can receive from $\frac{1}{8}$ to $\frac{1}{3}$ pound of nitrogen per inch of stem diameter. Shrubs often are fertilized according to their height or spread. Use $\frac{1}{20}$ to $\frac{1}{10}$ pound (about 1 to 1½ oz) of nitrogen per foot of height or spread.

Figure the amount of fertilizer to apply to an 8-inch diameter shade tree as follows. If you want to apply $\frac{1}{3}$ pound of actual nitrogen per inch of trunk diameter, multiply the pounds of nitrogen needed (0.3) by the diameter of the trunk (8). Divide this number (2.4) by the percent nitrogen expressed as a decimal (0.21 for 21-4-4 fertilizer). Thus:

$$\begin{aligned} \frac{1}{3} (0.33) \text{ lb} \times 8 \text{ in} &= 2.4 \text{ lb actual nitrogen} \\ 2.4 \text{ lb} \div 0.21 &= 11.4 \text{ lb of 21-4-4} \\ &\text{Round off to 11 or 12 lb.} \end{aligned}$$

How to Apply Fertilizer

Apply fertilizer throughout a tree or shrub's drip zone (the area from the trunk to the edge of the canopy in Figure 6). You can broadcast fertilizer over the soil surface and water it in immediately. However, water soluble nitrogen with a high salt index applied to the soil surface may damage turf or other plants growing under the tree, and these plants may use the nitrogen before it

reaches the tree's roots. Placing fertilizer in holes or pounding in spikes is NOT recommended as the fertilizer is placed below many of the roots. On steep slopes, it may be necessary to place fertilizer into the soil to keep it from entering streams.

When to Fertilize

Research indicates the most effective time for established deciduous plants is late fall. For trees or shrubs planted in turf areas, it may be better to split the amount into several applications to avoid burning the grass. If you apply fertilizer during winter when turf is likely to be dormant, it may not be necessary to split the application.

In Kentucky, where most trees and shrubs grow among cool season turf grasses (Kentucky bluegrass and fescue), fall applications are best to avoid excessive growth of turf grass in spring.

Fertilizing landscape plants with high-nitrogen fertilizer after mid-July is not recommended. It may stimulate growth that will not have time to harden off before fall; consequently, the plant may be damaged by winter freezes. Wait until plants are dormant, between Thanksgiving and New Year.

Fertilizing Hints

- Never put any type of herbicide-containing fertilizer (such as weed-and-feed products offered by various companies) into planting holes, on the soil covering plant roots, or into soil near woody plants.
- Fertilizer applications do no good without moisture. If conditions are dry, irrigate soon after applying fertilizer.
- Do not apply dry fertilizer to wet turf.
- Fertilizers containing water-insoluble, organic nitrogen sources may take 3 to 8 weeks to break down to a usable form. Time applications accordingly.
- Do not put fertilizer onto frozen soil. Precipitation and/or snow melt will cause wasteful and environmentally hazardous runoff of the nutrients being applied.

Watering

Watering landscape plants is one of the most misunderstood and challenging tasks facing gardeners. The average Kentucky climate generally supplies enough water for woody plants. However, our summer and fall seasons are often drought prone and windy. Plants may occasionally benefit from supplemental irrigation during extreme droughts. Water-stressed landscape plants may be more susceptible to other problems as insects, diseases, and winter injury.

A good rule of thumb for watering is to fill the entire root zone with water and then allow the soil to dry partially before watering again. How much the soil should dry out between irrigations depends on plant species and size. For large trees and shrubs, allow the top several inches of soil to dry before rewatering. Water small, newly established, or extremely shallow-rooted plants before very much soil drying occurs. Become familiar with how long it takes to completely moisten the root zone of various plants in your landscape and how deeply the soil can dry before plants begin to show signs of stress.

Some situations may require more frequent watering than the rest of your landscape. Check these areas and water them more often. For example:

- Shrubs and groundcovers near house foundations, under eaves, or in hot afternoon exposures may receive little water from natural precipitation or may transpire water rapidly, so they may be stressed during hot summer days.
- Mounds or berms have much more soil surface exposed to evaporation than does the natural soil profile so they dry out more quickly. Runoff is also more rapid.
- Some plants, such as rhododendrons, azaleas, and ferns, demand more moisture or have shallow roots that dry out quickly during warm, sunny weather.

Many native woody plants that are drought tolerant should not be watered during the summer once they are established, and some may be damaged by summer moisture.

How to Water

Water trees and shrubs just under and outside their dripline or outer edge. For foundation or border plantings, water the entire area.

Hoses, soaker hoses, or various kinds of sprinklers are common watering methods. For deep-rooted trees, try a root needle or fertilizer-feeding needle (without the fertilizer) for deep watering. This is a tedious process, but it gets water into areas of the root zone that may take a long time to reach with a sprinkler.

In soils that are slow to accept water, try building a dish-like or berm-enclosed area around the base of newly planted trees or shrubs. Fill this area with water. After the first growing season, remove the basin rims to avoid directing too much water into the root zone.

Watering Container Plants

Plants in containers need special care because both the volume of soil and amount of available water in containers are limited. Water these plants more often than those in the ground. The frequency and amount of water needed depend on the medium, exposure to sun or wind, temperature, humidity, size and type of plant. Plants growing in plastic or ceramic containers need water less often than those in porous fiber or clay pots.

Water when the medium surface feels dry. If a container completely dries out, you may need to soak it to rewet the soil.

A potted plant that uses a lot of water, such as a fuchsia, or one that is pot-bound may need to be watered daily or even several times a day during dry weather. For most container-grown plants, however, a thorough watering every two to three days is sufficient.

Be careful not to keep the root system soaking wet, and do not allow the pot to sit in water. Disease problems occur more often when soil is constantly wet.

Watering Hints

- Remember that most woody plants of native origin to Kentucky will require extra supplemental water as they are established but normal rainfall will usually suffice once plants are established.
- A quick, light watering does not wet the entire root zone properly. Frequent, shallow watering leads to shallow roots. Shallow roots suffer more stress during drought or hot weather and may freeze in very cold weather.
- You can water any time of the day, but it is more efficient to water at night, when evaporation losses are less. However, sprinkled water on surrounding plants may promote disease. Early morning watering is better in this situation.
- Too much water is as bad as or worse than too little. Excess water can run off, leach nutrients, and promote root diseases.
- Do not apply water faster than the soil can absorb it.
- Fertilizer does absolutely no good unless it is dissolved in water. Always water after applying fertilizer if it doesn't rain at least a half inch over the following six hours.
- Conserve water where possible. Clean water is a valuable resource that should not be wasted.
- Trees need water in winter. Winter drought conditions are less common. If water is applied in winter to frozen soil it will just run off.

Woody Landscape Plant Problems

If cared for properly, landscape plants can live a long, healthy life. However, they can suffer damage from a wide variety of causes. Microorganisms cause problems such as root rots and foliage diseases. Insects also cause injury. However, most plant problems are due to adverse weather or cultural conditions that stress the plant. These conditions include freezing, drought, over-watering, and improper use of fertilizers. Tree thinning and construction activities such as grading also contribute to stress

by compacting soil, submerging roots, and injuring plants with equipment.

Symptoms of plant damage resulting from stress sometimes do not show immediately. In fact, they may not be obvious for years. Symptoms may result from the accumulation of several stress conditions. In addition, the older a plant is, the less likely it is to successfully adapt to change or difficult conditions.

Root Problems

The root systems of semi- to fully mature trees and shrubs normally extend far beyond the plant's dripline. The rooting depth normally is fairly shallow—usually only to the depth of good soil. Sometimes roots grow very close to or above the soil surface. This condition may be caused by any of the following:

- A high water table
- A hard soil layer (hardpan) just beneath the surface
- Shallow, frequent watering

Several root problems are discussed below. Keep in mind that the symptoms of these problems may show up in other plant parts, especially leaves.

Trunk girdling (strangling) roots

Symptoms—This problem eventually limits water and nutrient transport up the trunk causing slow deterioration of the plant. The plant is stressed and top growth diminishes.

Causes—Impurities (such as sheetrock or lumber) in the soil; twisting the plant during the planting process and failing to spread roots properly during transplanting.

Remedies—Remove debris and foreign materials from the soil before planting. Prune girdling roots and spread roots when planting.

Circling roots

Symptoms—General decline of plant vigor over a period of time.

Cause—The plant remained in its container too long at some stage of development (not necessarily the last).

Remedy—Spread the roots, butterfly the root ball, or slash and spread the roots when you plant.

Kinked roots, one-sided root system

Symptoms—General decline of plant vigor over a period of time.

Causes—Improper production methods, jamming the plant in the pot or planting hole, dragging with a mechanical planter (J-shaped roots).

Remedy—Cut off kinked roots and carefully spread and straighten the remaining roots when planting.

Root rots

Symptoms—Mushy, brown, partially to totally decayed roots. The plant usually wilts and partially or totally dies.

Causes—Variable depending on susceptibility of the plant to disease organisms, poor soil aeration, amended backfill soil, inadequate drainage, and over-watering.

Remedies—Increase downward and lateral drainage. Plant higher in raised beds. Plant flood tolerant species or resistant varieties. Do not amend backfill when planting. Monitor watering.

Suffocated roots

Symptoms—No buttressing or flaring out of the tree or shrub's trunk at the point where it enters the soil. Leaf and branch growth declines from the top down.

Cause—The addition of fill soil, planting too deep, plants that were grown in the nursery too deep in the soil ball, or paving around the plant's base decreases the air supply to roots and changes water movement patterns. Susceptibility varies with species.

Remedies—Remove the excess soil covering the roots of established plants. Replant newly installed trees and shrubs at the correct depth. Improve the drainage. Consult an arborist about whether an air well around the trunk base of mature, established trees might help.

Cut roots

Symptoms—Death or decline in growth from the top of the plant downward.

Cause—Digging trenches within the plant's root zone.

Remedies—Avoid cutting large roots; tunnel under roots where possible. Cut back damaged roots cleanly. Water the plant. Fertilization is of questionable benefit and often increases decay in cut roots.

Compacted soil

Symptoms—A decline in growth from the top down.

Cause—Soil compaction or root damage from foot or machine traffic after the plant is in the ground. This is especially serious when traffic occurs on wet soils.

Remedy—Buffer the area with a thick (2 to 3 inches) layer of organic mulch. Direct traffic away from plants. Protecting the critical root zone of established plants prior to construction is less expensive and more effective than mitigation of soil compaction after it has occurred.

Plastic bag, synthetic burlap or other materials left on the plant's root system

Symptoms—Wilting, stunted growth and eventual death.

Cause—Not taking the plant out of its pot before planting, allowing synthetic burlap or twine to remain after planting.

Remedy—Take the pot and other materials off the plant before planting.

Stem Problems

Stem maladies usually arise from improper care or stress.

Heart rot

Symptoms—Decay of heartwood or other internal portions of the trunk or branches.

Causes—Improper pruning, broken branches, storm damage, wounded stems, or root damage.

Remedies—Filling cavities and using pruning paint is of NO value and can actually increase the rate of decay. If decay is in advanced stages, remove the tree for safety. Avoid problems by using proper pruning techniques.

Stem wounds, cankers, or girdling of trunk and branches

Symptoms—Bark wounds.

Causes—Rope left on after planting, careless use of lawn mowers or weed trimmers, staking ties or wires left on too long.

Remedies—Remove all ties when planting. Stay away from plant stems and trunks with mowing and weed-cutting equipment. If damage occurs, cut away the loose bark in a rounded ellipse. Painting or spraying the wounded area provides no benefit and may even be detrimental.

Fork pockets, bark inclusions, or narrow crotches that may split

Causes—Two or more branches compete to be the central leader (codominant leaders).

Remedy—Prune out all but one of the leaders if the tree is young. If the tree is old, consider subordinating the weaker branch, cabling, or cabling and bracing the competing limbs. Failure to mitigate the problem may result in branch failure and the potential for damage.

Bark scald, sunscald, or southwest disease

Symptoms—Dead bark, usually on the south or southwest side of the trunk.

Causes—Hot sun, alternate freezing and thawing of bark. Newly transplanted and young trees are very susceptible.

Remedies—Shade the southwest side of the trunk with a loose layer of plastic window screen. Wrapping is of questionable benefit on mature trees, although it may be helpful for newly planted trees. If you do wrap a trunk, use wrap that is a light color (to reflect sunlight) and woven (to allow air passage). If damage occurs, cut loose bark back to firmly attached bark. Remove all wraps after the danger of winter freezes have passed.

Graft failure

Symptoms—Large overgrowths appear above or below a graft union or the plant breaks cleanly at the graft union. Leaves change color early in autumn.

Cause—Incompatibility between the grafted scion and stock.

Remedy—Purchase plants rooted from cuttings (not grafted). Avoid stock–scion combinations with known problems.

Leaf Problems

Symptoms of stem and root maladies may show up in leaves. Many insects and diseases also affect leaves.

Wilted leaves

If a plant is wilted, the leaves are losing water faster than it can be supplied by the roots. Plants vary in how much water they need. The exact cause of wilting must be determined by observing symptoms and the plant's environment. Some possibilities are discussed below.

Drought or lack of water

Symptoms—Soft growth wilts. Extended periods of dryness can cause early leaf drop, marginal and interveinal chlorosis (yellowing), and necrosis (tissue death).

Cause—Not enough water in the soil.

Remedies—Supply water. Increase soil water-holding capacity. Mulch. Plant drought-tolerant plants.

High temperature and bright sunlight

Symptoms—Leaf browning, blotch necrosis.

Cause—Plants exposed to hot sun.

Remedies—Shade the plant. Use heat and low humidity tolerant plants. Periodically syringe leaves with water for temporary cooling.

Lack of roots

Symptoms—Wilting, early leaf drop, chlorosis, necrosis, poor growth, death.

Causes—Rot or decay (caused by poor drainage), trenching, transplanting, or insects (e.g., root weevils).

Remedies—Determine the cause, then take appropriate action. Watering may help if the problem is not due to poor drainage.

Flooding

Symptoms—Plant is wilted or droopy.

Cause—Too much water limits available oxygen to roots, thereby reducing or stopping water uptake.

Remedies—Improve drainage. Decrease water supply. Plant on a berm or raised bed.

*Plugged vascular system***Symptom**—Wilting.**Cause**—Diseases such as verticillium wilt.**Remedy**—Determine the cause, take appropriate action (e.g., apply a registered fungicide or use resistant plants).*Salt damage***Symptoms**—Marginal to interveinal chlorosis or necrosis, rootlets brown instead of white. In containers, the soil surface or edge of the pot may be covered with white salt deposits.**Cause**—Soil can accumulate excessive salts from fertilizers, manures, and deicing materials. This problem may be more prevalent in containers than in gardens. It also is more common in arid areas than in regions where winter precipitation leaches away excess salts.**Remedy**—Leach salts from soil by applying irrigation water in excess of the water-holding capacity of the soil. See Chapter 2, Soils and Fertilizers, for more information.**Yellow (chlorotic) leaves***Nitrogen deficiency***Symptoms**—Overall yellowing, older leaves first.**Cause**—Not enough available nitrogen in the soil.**Remedy**—Fertilize with a nitrogen fertilizer.*High pH***Symptoms**—Interveinal chlorosis, newer leaves first. Chlorotic regions may die.**Cause**—Alkaline soil may cause iron and/or manganese to become unavailable.**Remedies**—Decrease soil pH with elemental sulfur, iron sulfate, or ammonium-based fertilizers. Spray the plant or drench the root system with iron or manganese chelate as a temporary measure. This will cause the plant to become greener, but does not improve the vigor or health of the plant, only the aesthetics.*Other causes*

Chlorosis also may be caused by drought, misuse of herbicides (see “Herbicide damage” below), bright sunlight, or natural leaf maturity. Some plants naturally have variegated or light green leaves.

Herbicide damage

Herbicides have specific toxicities to weeds, but also may damage desirable plants. Almost all herbicide damage results from misuse. Few problems arise when label directions are followed closely. The key is to read the label and think.

If many plants in one area show symptoms, suspect herbicide damage. Severity and type of damage depend on the type of herbicide, amount applied, plant species, and stage of growth at the time of application.

Table 2. Herbicide effects on plants.

Herbicide	Damage symptoms
Dichlobenil (Casoron)	Broadleaf plants: Chlorosis or necrosis of tips, margins, or interveinal areas. Sometimes more severe on leaves exposed to the afternoon sun. Conifers: needle tip chlorosis or necrosis.
Phenoxy compounds (2,4-D, MCPP, triclopyr)	Broadleaf plants: Twisted, distorted leaves and stems. Bark blistering on London plane trees. Grapes, Mahonia, and tomatoes are very sensitive. Conifers: Misshapen, distorted needles. Note: These herbicides are particularly susceptible to drift.
Dicamba (Banvel)	Broadleaf plants: Twisted, distorted new growth, chlorosis, necrosis, death of trunk tissue. Conifers: Distorted, twisted needles; needle necrosis from the base to the tip; club-shape growth.
Glyphosate (Roundup)	Broadleaf plants: Death of part or the entire plant, strap-shape new leaves, purplish cast to plant. Conifers: None noted.
Triazines, atrazine (AAtrex), simazine (Princep)	Broadleaf plants: Chlorosis, leaf tip to margin to interveinal; may become necrotic. Conifers: Needle tip chlorosis.
Long-term residuals	May cause plant damage or death if applied over the (chemical sterilants) root system of desirable plants.

Some herbicides act as plant hormones, causing twisted and distorted growth. Others inhibit photosynthesis and chlorophyll production, causing chlorosis.

Table 2 lists some common herbicides and their possible effects.

Even if only part of the root system is affected by an herbicide, damage may spiral up the plant. Know where the root zones of your desirable plants are. Take special care when applying turf herbicides for broadleaf weed control within the root zones of desirable plants.

Dormant oil used for insect and mite control may damage needled evergreens if applied during freezing weather or if not well mixed. Dormant oil will also wash off the blue color of Colorado blue spruce (*Picea pungens*) but does not otherwise harm the plant.

Winter Injury

Causes

Winter injury may be caused by a complex combination of circumstances rather than a single factor. Factors involved include:

Weather

- Deviation from normal minimum winter temperatures
- Dramatic fluctuations in winter temperatures
- Length of a severe cold period
- Time of year when a cold period occurs
- Bright, sunny days with frozen soil
- Depth to which the soil freezes
- Drying winds
- Low humidity
- Lack of snow cover, mulch, or other insulating materials

Site Influences

- Distance from a large body of water
- Solid fences, hedges, or barriers that trap cold air and create frost pockets
- Soil moisture availability before a freeze
- Soil conditions, soil type, and mulch
- Raised beds or containers
- Windbreaks

Plant

- Genetic hardiness of the species
- Genetic adaptation to a different geographic area (ecotype)
- Differences in hardiness of different plant tissues
- How well the plant is established
- Condition of the plant: dormant or partly dormant; stressed from drought, fertilizer burn, or insect damage
- Growth stage of the plant
- Protective reactions of the plant, e.g., leaf drop or leaf rolling

Why Winter Injury Happens

Winter injury to landscape plants occurs in various ways. By understanding how plants react to winter temperatures, you sometimes can predict the type and extent of damage that might occur and take actions to protect your plants.

The limits of winter hardiness are controlled genetically and varies greatly among species and even among plants within the same species. For example, Douglas-firs (*Pseudotsuga menziesii*) that evolved in the Rocky Mountains are hardier than those that evolved in the Cascades (Pacific Northwest). Likewise, flowering dogwoods (*Cornus florida*) from New York are hardier than those from Florida or Georgia, even though they are the same species.

Plants native to a geographic region have evolved in response to the area's climate and weather patterns. The hardiest plants survive and produce offspring, passing on their genetic hardiness. Thus, plants native to an area are usually able to survive winters characteristic of that area.

Many landscape plants are introduced (often called exotics). They may be adapted to completely different environments than they encounter here. Exotic or introduced plants often respond differently to local climatic patterns than native plants.

Cold hardiness develops each fall in an organized pattern as physiological changes take place in a plant. These changes are driven by the arrival of shorter days and cooler temperatures. The rate of acclimation varies by species and the extent of

cooling. If fall temperatures remain warm, plants may fail to adequately acclimate to cold.

Deacclimation or dehardening is the loss of hardiness. It is a plant's response to warming temperatures in late winter and early spring. Typically, deacclimation is gradual, but it can be rapid during an extended warm period. Some species, but not all, require a chilling requirement to exit dormancy. The chilling requirement is satisfied when the plant accumulates a set amount of exposure to low, non-freezing temperatures (45°F) during dormancy. Only after this requirement is met can plants deacclimate. The chilling requirement of a given species will vary depending on where it originated.

Cold temperature damage may occur at any time depending on the severity of the cold and the stage of hardiness of the plant. Damage is most common during:

- A sudden, dramatic drop in temperature following a relatively warm fall. Plants may not yet be acclimated to cold.
- Very cold midwinter temperatures. Even after a good acclimation period, marginally hardy plants may suffer damage.
- A sudden, severe temperature drop after a warm spell in late winter or early spring. Plants may have started to deacclimate.
- A late freeze after growth starts in the spring. New, soft growth usually cannot tolerate frost. Plants that bloom or start to grow early in the season, such as flowering cherries, magnolias, photinia, and some very early blooming rhododendrons, are susceptible to damage from spring freezes.

Types of Winter Injury

Bud and stem damage

Buds and stems die or are damaged if a plant is not genetically hardy or has deacclimated. Some buds or tissues may be killed, while others remain healthy. On some tender hydrangeas, cold may partially or completely kill flower buds. Thus, there may be fewer flowers than normal on these plants after a colder-than-normal winter.

Frozen roots

The medium in an aboveground container or B & B tree may freeze killing a plant's roots. In most plants, stem tissue is much hardier than roots so the top of the plant may not be damaged. It may leaf out in spring and then for no apparent reason wither and die. Check the roots to see whether this type of injury has occurred. Dead roots usually are brown or black and may be soft. Live roots have a white growing tip and are white to greenish under their bark.

You can reduce this type of damage by putting containerized plants in a protected area such as a cool garage or greenhouse during winter. It may be sufficient to bury containers in sawdust, ground bark, or soil to insulate roots during winter.

Sun and wind scald of leaves

During periods of severe cold combined with bright sunshine the leaves of some broadleaf evergreens deacclimate. When the sun sets, the deacclimated leaf tissue freezes. Ice forms in the cells rupturing their membranes and walls, and the cells die.

Damage usually is worse on leaves exposed to the afternoon sun (on the south or southwest side of the plant). Plants vary in their susceptibility to sunscald.

Winter wind and sun alone or in combination can damage evergreens by causing them to transpire (lose water) through their leaves or needles. The water is not replaced because roots cannot take in water from cold or frozen soil. Affected leaves turn brown, starting at the edges or tips and progressing between the veins or down the needles.

Prevent these maladies by protecting plants from wind or shading them.

Sunscald of bark

Trees can suffer sunscald on sunny winter days. Damage usually occurs on a trunk's exposed southwest side. Sunscald is more prevalent on stressed, recently transplanted, smooth-barked, or thin-barked trees. It occurs when bark and cambial tissues deacclimate and do not reacclimate quickly enough when the sun sets and the

temperature drops abruptly. The result is tissue damage or death. Sun scalded bark often cracks open or separates from the tree without splitting.

To prevent sunscald, wrap trunks of recently transplanted trees and those that were stressed during the growing season. Use light-colored wrapping and wrap from the soil line to the first set of branches. Leave the material on for the first winter and remove it at the beginning of the first growing season.

Leaf droop and leaf rolling

Drooping and rolling of leaves are protective reactions to cold. They reduce the amount of leaf surface exposed to cold and drying winds. Leaves return to normal as temperatures warm. On some rhododendron varieties, the leaves fold back flat against the stems or roll up tightly. If leaves are not killed by extreme cold, the plant will return to normal when the weather improves.

Limb and branch breakage

Branches may break because of heavy snow or ice loading. Prune the broken portion back to an undamaged branch or the main trunk. On large branches, make pruning cuts just outside the branch collar.

Delayed symptoms

The results of winter injury sometimes take months or years to appear. Sometimes, leaves live until their reserves are depleted, which occurs slowly in cool weather but rapidly when the weather suddenly warms.

Graft unions may be sensitive to damage from cold. Only a portion of the graft may be injured. It may function for years until another kind of stress causes it to fail.

Winter-damaged tissue may allow disease organisms and insects to enter. Again, these problems may not be evident for years.

Root systems, especially of shallow-rooted plants such as rhododendrons and blueberries, may be injured by cold. When damaged roots fail, the plant's top starts to die.

Preventing Winter Injury

- Select plants adapted to your local climate and soil conditions.
- If possible, place evergreen plants in areas that minimize their exposure to sun and wind. Otherwise, provide a windbreak or shading during winter.
- In the fall, wrap the trunks of young and recently transplanted trees with a white or light-colored woven wrap.
- Keep plants healthy by proper planting, fertilizing, watering, and pest control.
- Do not fertilize, prune, or water heavily late in the growing season. Doing so can encourage late-season growth that may not acclimate well.
- Protect shrubs from heavy snow accumulation (Figure 7).
- Water landscape plants, especially evergreens, during fall and early winter dry spells. Pay close attention to plants under overhangs or in other places where they may not receive rain or snow.

What to Do for Winter-injured Plants

Don't do anything until new growth begins on live wood, usually in late spring. It is easier to determine which stems actually are dead after growth begins. Sometimes, faded green branches begin to regrow and do not die. Even if leaves are dead, stems and vegetative buds still may be alive.

Before pruning a sad-looking plant to almost nothing or pulling it out altogether, check for signs of life. Scrape the bark away with a fingernail or make a shallow cut just under the bark with a pocketknife. Live branches are bright green or white just beneath the bark. Dead branches are brown and may look water soaked.

Check the plant in several places: at the twigs, farther down the branches, and at the crown or soil line. If the outer twigs are dead, move toward the trunk until you find live tissue; older wood may be hardier than young wood.

Once you determine the extent of the damage:

- Prune out and remove dead and severely damaged wood. Prune properly, leaving no stubs. Prune back to live, green, healthy wood: a bud, live stem, or trunk. Do not prune live wood.
- Water properly during the following growing season. Pay particular attention to plants beneath eaves.
- If the soil lacks adequate amounts of basic plant nutrients, add fertilizer. If growth appears normal, fertilize only lightly, if at all.
- Use a loose, organic mulch to maintain soil moisture and protect the upper roots from temperature extremes.
- On damaged fruit trees, remove as much developing fruit as possible to allow the plant to recover and rebuild reserves rather than produce fruit.

In short, the best thing you can do for a winter-injured plant is to avoid further stress during the coming season by giving it special attention and care.

Construction Damage

When clearing a building site, developers often leave large, well-established trees to enhance the property's aesthetic value. Often, however, these trees soon decline. They may exhibit stunted leaves or needles, short internodes, or dead branches and foliage throughout the plant.

Change of grade

When preparing a building site developers often move soil, sometimes to level areas that once were sloping, or to develop slopes where the soil was originally level. If trees are left standing, soil may be added over their roots. Reducing the soil grade removes tree roots along with the soil. These changes can cause significant damage and even death of trees.

Raising the grade can suffocate roots. The damage may depend on the kind of tree, the depth of the soil fill, and the texture of the fill. Most trees are adversely affected if several inches of soil fill are placed over their roots. Sandy or gravelly fills are less

damaging than heavier textured soils such as silt or clay.

Placing asphalt paving or concrete over a root system can have the same suffocating effect as raising the grade around a tree. These processes usually cause significant root damage.

Lowering the grade also can be detrimental. Most feeder roots, which supply the tree with water and nutrients, are located in the top 6 to 8 inches of soil. Removing soil removes or injures many of these roots. If enough large roots are lost, the tree may lack anchorage and fall. Also, damaged or broken roots sometimes rot back to and into the stem.

Grade changes also may affect the water table, either lowering or raising it in response to soil changes. Also, paved areas may direct more or less water into a tree's root zone. The larger and older the tree, the more difficult the recovery.

Soil compaction

Heavy equipment or repeated human or animal traffic compacts soil. Compacted soil is less open to air and water movement, thus creating adverse conditions for root growth. Sandy soils or soils high in organic matter tend to compact less than heavy, clayey soils.

Mechanical injury

Bulldozers and other equipment may gouge the bark off a tree's trunk or root crown, and can damage roots simply by moving over them. If bark is completely knocked off around its trunk, a tree will die. In less severe cases, decay organisms may enter wounds. Large, untreated stem wounds eventually can cause internal rot, sometimes called heart rot.

Digging trenches for foundations, pipes, and cables causes serious root loss and damage. The closer the trench to a tree, the more severe its effect will be. Damaged trees may die or fall.

Tree thinning

Sometimes builders or homeowners remove selected trees to create space, decrease shade, or give desirable trees more room. When trees are thinned, the

remaining trees are exposed to more wind. They may suffer damage ranging from a few broken limbs to completely blowing over. A stand's vulnerability increases when the larger trees (with large crowns) are taken out or blow down.

Preventing or lessening construction damage

Before land clearing and construction begin, mark off the dimensions of the building, driveway, and other major construction areas. Decide which trees to save (or transplant) based on their proximity to the construction area, health, age, and species. Then build a barrier to keep equipment away from the remaining trees. If trenching near desirable trees is necessary, tunnel under, rather than through, the root system. If you must raise the grade around a desired tree, construct a dry well around it. Consult an ISA-certified arborist for advice.

Care after Construction

Care for damaged trees

Usually the owner of a new house or other structure is not involved in land-clearing and construction decisions and has no idea what changes have taken place. Often, developers and builders do not take proper precautions with regard to trees. Thus, the owner may not be aware of damage until trees begin to show signs of stress. By that time, chances of saving them may be slim.

Even with prompt treatment, severely damaged trees may die. The sooner treatment is begun, the better the chance of recovery. Water and fertilize damaged and

possibly damaged trees and shrubs properly. In this case, water is much more important than fertilizer. If you fertilize use a complete fertilizer containing nitrogen and phosphorus in about equal proportions. Late fall and early winter are the best time for fertilizer application to damaged trees. See "Fertilizing" earlier in this chapter for more information.

If trees are wounded, remove loose and dead bark from around the wounded area and shape the wound margin with a sharp knife. If callus tissue (the ridge of tissue that forms around and eventually covers a wound) has started to form, do not cut into it. Wound dressing (wound paint) serves no useful purpose and may be detrimental.

Pruning—particularly excessive pruning—diverts carbohydrate production to a plant's top (shoots) at the expense of root growth. Thus, pruning is not a good idea if there is root loss. Otherwise, prune dead and damaged wood back to sound wood. Use thinning cuts.

Remove dead trees. If live trees are a hazard, remove or cable them. Have ISA certified arborists do all pruning and removal of large trees.

Care for protected trees

Even with proper land clearing and building, good tree care following construction is vital to continued life and growth of trees and large shrubs. Proper watering and fertilizing are necessary. Additional pruning may be necessary to direct future growth. Keep trees under observation for 8 to 10 years after construction and treat promptly if needed.

For More Information

Hundreds of species of trees, shrubs, vines, and groundcovers can be used as landscape ornamentals, specimen plants, container plants, or in countless other ways. A wealth of information is available to help you better understand specific plants or how to use them. Check with local bookstores or ask your county extension service for publications about growing plants in your area.

UK Extension Publications

Planting Balled and Burlapped Trees and Shrubs in Your Landscape (HO-91)

Botanical Diversity in the Landscape (HO-92)

Trees and Compacted Soils (HO-93)

Trees with Minimal Insect and Disease Problems for Kentucky Landscapes (HO-94)

Recognizing Trees of Significance (HO-95)

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Additional Resources

- American Nursery and Landscape Association. *Resource Catalog*. 250 I St. NW, Suite 500, Washington, DC 20005-3922.
- American Nurseryman Publishing Co. Distributes many books of horticultural interest. Suite 2100, 77 W. Washington St., Chicago, IL 60602-2904.
- International Society of Arboriculture. www.treesaregood.com.

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