The Morton Arboretum

Selecting and Planting Trees

White Oak, *Quercus alba*

The Morton Arboretum has developed these two companion publications to provide current, scientifically based tree selection and planting advice. Selecting and Planting Trees is the result of decades of research on the key issues to consider when planting a tree, including planting site characteristics, purchasing a quality tree, planting the tree, and maintaining a newly planted tree. The Northern Illinois Tree Species List describes species that grow well in the area and recommends best planting sites. This list emphasizes the importance of site characteristics and is a tool for broadening the diversity of our regional forest to promote resiliency.

Selecting and Planting Trees
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Northern Illinois Tree Species List
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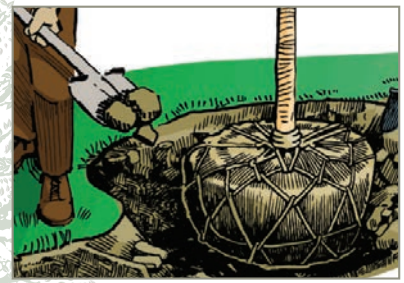
The Morton Arboretum

Chicago Region Trees Initiative

This publication was developed in collaboration with the Chicago Region Trees Initiative, a partnership of organizations working together for a healthier regional forest.

Selecting and Planting Trees

It takes only a short time to plant a tree, but how it is done can have a lasting influence on the tree's future growth. Mistakes made when planting trees usually cannot be corrected later. Improper planting can cause the tree to fail after a short time or to struggle for many years and never reach its full potential as a healthy addition to the urban forest.

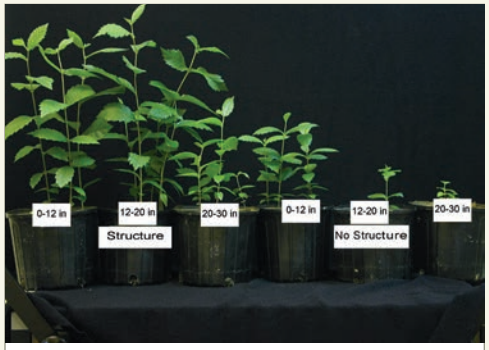


Planting Site Evaluation

ABOVEGROUND ENVIRONMENT. Environmental conditions in urban landscapes can differ widely over short distances. The amount of sunlight a tree receives and the time of day the sunlight is received can limit the kind of tree that can be planted. For example, the environment can be too harsh for some species on sites where heat and light are reflected from nearby buildings or pavement. An area with morning sun and afternoon shade often provides adequate sunlight early and protection during the hottest part of the day. An area with morning shade and direct sun during the hot afternoon hours may be more suitable for trees that are tolerant to heat or drought stress. The intensity of all-day shade can vary from open shade on the north sides of fences or low buildings to very dense shade under low tree branches.

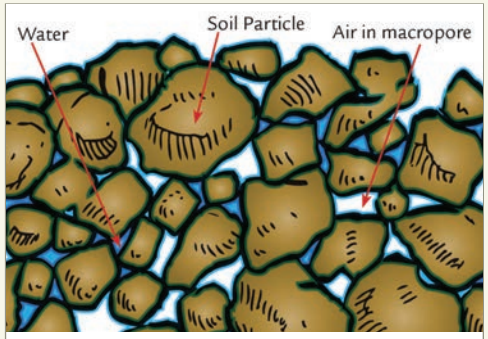
Aboveground space restrictions may need to be considered. Overhead utility wires may limit the size of trees that can be planted. It is a common mistake to plant a young tree too close to a building without sufficient room to grow. Species with aggressive root systems may also heave nearby pavements or contribute to damage to shallow foundations.

IMPORTANCE OF SOILS. Tree species are adapted to the environment in which they are found in nature. Few urban sites match any natural site or provide optimum conditions for tree growth. Poor soil conditions frequently limit planting success. Poorly drained soils with a high clay content, typical of many urban developments, require special planting procedures to improve survival and establishment.



Soil structure is important. When it is damaged, plant growth is reduced dramatically. Note that growth in the deepest subsoil with structure maintained is as good, or better, than any of the soil layers with structure destroyed.

Soil texture refers to the ratio of different particle sizes in a soil. Sandy-textured soils are composed mostly of large particles, while clayey soils contain many microscopic particles. Soil structure refers to the size and shape of soil aggregates (soil particles held together in groups by organic compounds). Between the aggregates are spaces that allow movement of air and water through the soil. As a result of compaction, urban soils are often poorly aggregated, with smaller spaces. Incorporation of composted organic matter can help improve structure.



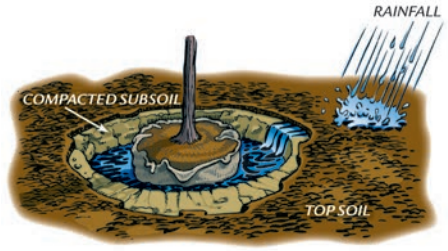
Water held in the micropores by capillary action is held tightly enough to be present in the root zone for extended periods, yet loosely enough for the plant to extract it. Water drains quickly from the larger pore spaces. All of the pores can be filled with water when the soil is too wet, eliminating the air in the soil that roots need.

Well-aggregated soils provide optimum aeration and water for plant roots. Soil water and oxygen availability are interrelated. If the majority of the pore spaces are filled with water, there will be insufficient oxygen available for the living roots. Trees killed by too much water are found most frequently in compacted clayey soils.

Drainage affects oxygen and water in the soil and is controlled by a number of factors including precipitation; soil texture and structure; permeability; infiltration characteristics; and landscape position. In the poorly drained, compacted soils typical of urban areas, drainage may need to be improved.

There is a very effective way to determine if soil has adequate drainage. After digging the planting hole, fill it full of water. If the water that fills the hole has not drained appreciably after an hour or two, drainage will be problematic, especially during wet seasons. If the soil is very well-drained, it may be difficult to fill the hole with water because it soaks into the soil so quickly.

Soil (chemical) reaction, known as pH, is a general indicator of nutrient availability. In slightly acid to neutral soils (pH between 5.5 and 7.2), most nutrients are available at optimal levels. Some nutrients, such as iron and manganese, become less available in alkaline soils (pH above 7.2) because of chemical changes caused by the alkalinity. Alkaline soils are common in urban landscapes and can result in nutrient deficiencies in certain species such as pin oak and river birch. These trees will exhibit yellow leaves, a condition known as chlorosis. Other nutrients also become less available in highly acid soils (pH less than 5.5), but these soils are not often encountered in urban landscapes.



Water that cannot penetrate compacted subsoil flows laterally to the lowest point. Planting holes can fill up with water and damage the root system.

SALT DAMAGE. De-icing salts from airborne deposits and runoff from melting snow on pavements can accumulate in the soil. High levels of soil salts can dehydrate tree roots and damage the entire plant. Excess sodium leads to poor soil structure, resulting in reduced soil permeability and poor aeration.

ROOT SPACE. Just as a potted plant can grow too large for the volume of soil in the container, a landscape tree can grow to a size where it becomes too large for the available root space. Roots typically spread further than the branches and most urban sites restrict root spread to at least some degree. Buildings are obvious restrictions to root spread, but pavement also limits root development. The compacted soil required to support a stable pavement surface and the impervious nature of the pavement itself severely limit root growth underneath the pavement. Growth of trees will be restricted in less than 20 years if there is less than 200 square feet of open soil around them. Smaller spaces will reduce growth sooner and to a greater extent.

Site Evaluation Checklist

Carefully evaluating the site in advance is critically important for successful tree selection and planting. Many trees fail because the site characteristics are either improperly evaluated or ignored entirely.

Above Ground

- ☑ Sunlight exposure (hours of sunlight, reflected light, and heat load)
- ☑ De-icing salt usage
- ☑ Pollution
- ☑ Overhead wires
- ☑ Proximity to buildings, structures, light fixtures, and signs
- ☑ Potential for vandalism

Below Ground

- ☑ Soil pH
- ☑ Soil texture and structure
- ☑ Soil compaction
- ☑ Drainage
- ☑ Soil salinity and other soil contaminants
- ☑ Root space restrictions

When to Plant

Survival is likely to be greatest and aftercare least demanding when a tree is transplanted while dormant. Spring and fall also have the advantage of moderate temperatures and plentiful rainfall. Summer planting is possible if a judicious watering program is followed, particularly if the tree was dug from the nursery in spring, or grown in a container.

All tree species can be dug from the field successfully in early spring. Some species, but not all, can be dug successfully in the fall. Those that cannot be dug in the fall can be dug in the spring and held for fall planting with proper care. The optimum time for fall planting is when there are several weeks of warm soil temperatures (above 50°F) that can support active root growth. Evergreens may benefit from a longer duration of warm soil to promote root regeneration after fall planting because they can lose considerable water through their foliage during fall and winter months.

Choose a Quality Tree

Choosing a high-quality tree contributes to planting success. It is important to know the source of the trees you purchase. If the tree was grown in a local nursery for several years, there is a good chance that it is adapted to the local climate.

NURSERY STOCK TYPE. Many choices of nursery stock are available from the nursery or garden center. Choosing the best nursery production method for each situation is essential. Each method has certain advantages and none is best for every situation.

> Bare-root plants are moved without soil, so the roots are exposed and must be protected to keep them from drying out. Bare-root trees are usually less than two-inch caliper and should be planted in late winter or early spring to allow as much time as possible for fine root development before the leaves emerge.
>
> Ball-and-burlap (B&B) is the most common method of transplanting field-grown trees. A ball of soil containing a portion of the root system is wrapped in burlap and twine or wire basket and moved with the tree. These materials stabilize the root ball during transport.
>
> Container-grown plants are grown in specially designed plastic containers. Because no digging is involved, container plants do not suffer substantial root loss during transplanting. However, container soils are very well-drained and the trees will still require frequent irrigation in the landscape to avoid water stress until their roots can spread into the surrounding soil. Cold winter temperatures that kill roots in above-ground containers limit container production of trees in northern Illinois unless additional root protection is provided. Trees in larger containers sold in local garden centers may be shipped from warmer climates and may not be hardy.

TREE HEALTH. Trees should exhibit vigorous growth during the most recent two to four years and have well-formed buds. Normal twig growth may vary from six to 24 inches annually and should be characteristic of the species. Trees should be vigorous specimens, free from insects and diseases. The trunk's bark should be firm, with no indication of disease, insect galls, wood borers, dieback, frost cracks, sun scald, or mechanical injury.

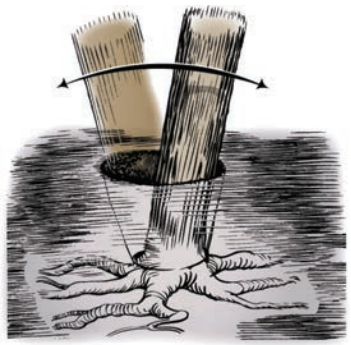
Avoid trees with codominant stems and included bark.

BRANCH STRUCTURE. Branches should be well spaced, both vertically and around the circumference of the trunk, for strong attachments and unrestricted flow of water and nutrients. Branches should diverge from the trunk at a wide angle except in cultivars that normally grow in narrow, upright forms. Ideally, a tree will have a single central stem. Two vertical trunks or stems that are nearly equal in diameter are known as codominant stems and are weaker in structure. Trees with codominant stems or included bark (bark imbedded between codominant stems or between branch and trunk) should be avoided.

CHECKING STRUCTURAL ROOT DEPTH. As a general rule for young nursery-grown trees, the large woody roots should be no more than an inch or two below the soil surface and should be well-distributed in all directions.

If you can see the roots emerging from the base of the trunk at the soil surface, it is an indication that the roots are at the correct depth. Some soil may have to be removed to see the top of the roots. Movement of the lower portion of the trunk, forming a gap between the trunk and the surrounding soil, is a sign that the roots are too deep. Many nursery-produced trees are grafted, with the trunk and branches of one species grafted onto the root system of another. These trees will have a bud union that should be visible about one to two inches above the soil.

In some production systems, liner stems are cut back during production, creating a visible wound and crook in the stem. If visible, this is an indication that the tree is planted at the same depth as originally planted in the nursery.



As the trunk moves in the wind, a gap forms around it if the roots are too deep. The deeper the root flare is buried, the wider the gap will be at the surface.

Planting

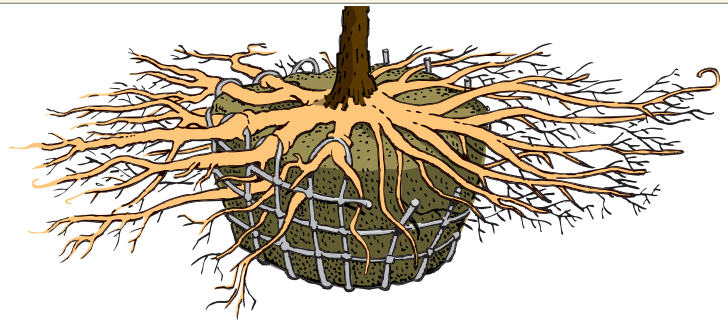
Attention to detail at planting time will pay dividends for many years. Mistakes made when planting trees usually cannot be corrected later.

PLANTING HOLE DEPTH AND WIDTH. On sites with poor quality soil that is compacted, clayey or poorly drained, the planting hole should be ***at least twice*** the width of the roots to accommodate root development during the first year. If the roots are unable to grow into the compacted subsoil, a hole with sloped sides will direct them back up toward the better-quality surrounding surface soils so they can spread beyond the planting hole. If a tree spade is used to transplant the tree, a similar effect can be achieved by cultivating the soil around the root ball to a depth of at least eight to 12 inches in a circle that extends at least half the width of the root ball. On sites with high-quality soil, the planting hole needs to be only wide enough to facilitate planting. If the sides of the hole dry out before you fill the hole back in, use a hand tool to break up the surface.

The planting hole should be only as deep as the root ball. A hole with sloped sides is easier to dig and provides an increased volume of friable soil for vigorous root development from the upper half of the root ball. Breaking down the sides of a traditional hole can reduce the work involved.

Roots of bare-root plants should be spread out so they do not circle or kink in the hole. The planting hole for B&B stock should be slightly shallower than the root ball to allow for flattening and settling of the root ball. Planting with the top of the root ball two inches above the surrounding grade is adequate for a two- to three-inch-caliper tree. The root ball should be placed on a stable subgrade to minimize settling.

STRUCTURAL ROOT DEPTH. The uppermost large woody lateral roots of bare-root stock should be planted within one to two inches of the soil surface. If the roots are slightly deeper in the root ball, the planting hole should be shallower to account for it. Do not remove the extra soil until the planting hole is backfilled. In some situations it may be preferable to leave the extra soil in place and allow it to erode away. Mulch can be used to cover the protruding root ball and make a more gradual slope.



If the upper half of the basket is removed before backfilling, most future root problems will be prevented.

REMOVING ROOT BALL WRAPPING MATERIALS. Remove all basket wires down to four to six inches below the top of the root ball so that the structural roots can grow above the wires and not be constricted in the future. Low-profile baskets are designed so that no wire needs to be removed. If synthetic materials, such as nylon twine or plastic burlap, are used, they should be removed completely. Natural burlap and twine usually decompose in the first season, but it still is preferable to remove them from the upper half of the root ball to be sure there is not a second layer of synthetic burlap or twine underneath that needs to be removed.

ELIMINATING ROOT DEFECTS. Container-grown plants can have many root defects. Because the natural spread of the root system is restricted by the container, lateral roots reaching the sides are deflected and can circle, ascend, descend, or kink. All these abnormal roots can eventually affect tree health and stability.

Shaving the container root ball is the best way to eliminate roots growing along the container wall.

The best way to eliminate root defects on the exterior of the root ball is to shave off a thin layer of the entire outer surface of the root ball. This will allow new roots to grow radially from the trunk, as they do in nature. Defects can also be present in the interior of the root ball from smaller containers used earlier in the production process. These cannot be corrected and this poor-quality stock should be avoided.

BACKFILLING THE PLANTING HOLE. Soil amendments may be added to the soil used to backfill the hole on sites with poor quality soil. They can improve soil structure, water-holding capacity, and drainage for better root growth. Add approximately 10 percent composted organic matter by volume, depending on the material. On sites with high-quality soil, there is no need to add any amendments. Compact some of the excavated soil around the base of the root ball to stabilize it. The rest of the soil should be tamped only lightly in the hole or left to settle on its own. Watering will assist in settling the soil naturally. Excessive tamping, especially when the soil is wet, can compact the soil and slow water penetration and root growth.

TRUNK PROTECTION. Plastic guards can help to protect trunks from mowers, weed whips, and other mechanical injuries. If used, they must be removed before the trunk grows large enough to be damaged by constriction. Trunks of trees with thin or smooth bark are sometimes wrapped to prevent sunscald injury from winter sun. Wraps should be light in color, porous to water, and biodegradable. The wrap should be applied in late fall from the bottom up so that it overlaps like roof shingles, and removed in the spring. A helpful way to remember is to apply the wrap around Thanksgiving and remove it around Easter.

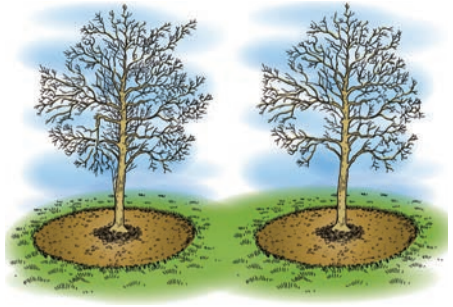
STAKING. Staking, guying, or bracing refer to mechanically supporting the trunk of a planted tree to keep it in an upright position. Container-grown and bare-root trees may require support until lateral or anchor roots develop. ***Staking is not usually necessary for properly handled and planted B&B stock.*** If the root ball is in good condition and has been stabilized by compacting soil around the base, the tree is not likely to lean or shift. There may be a few exceptions, such as very windy sites or sandy root balls. Two stakes with separate flexible ties are commonly used but three stakes will provide better support. Supports should be removed after one year to avoid trunk girdling.

WATERING. Water the root ball thoroughly after planting. Ten to 15 gallons is sufficient.

MULCHING. Properly applied mulch can increase tree growth in the first few years after planting. Apply mulch in an even layer over the planting hole and slightly beyond it. The mulch layer should be one to three inches deep after settling. Mulch should not be allowed to contact the base of the trunk. Avoid the common practice of applying mulch in a small, deep ring around the base of the trunk.

FERTILIZATION. Do not fertilize a newly planted tree. Until the root system can grow large enough to absorb more water, adding fertilizer is ineffective.

PRUNING. It is important to ensure the best possible branch structure while a tree is young. A central leader with adequately spaced lateral branches is the strongest structure a tree can have. Trees that are correctly pruned during production in the nursery should not require substantial pruning when planting. Because of the fast growth rate in the nursery, even high-quality nursery stock may benefit from minor structural corrective pruning to promote good branch structure. Cut back rapidly growing, upright, lateral branches that might compete with the central leader for dominance. Also remove all crossing branches and any twigs that were broken during transport.



Broken, weak, and interfering branches should be removed at the time of planting. Maintain the typical form of the species.

Checklist

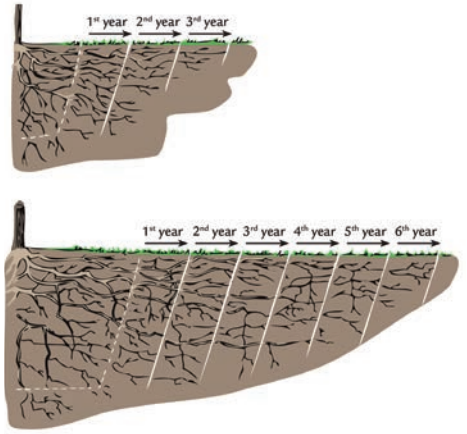
The final step in the planting process is inspection. There are many items that need to be checked:

- ☑ Is the planting depth correct?
- ☑ Have the upper portions of the root ball wrapping materials been cut away?
- ☑ Have the roots growing against the inside of the container been eliminated?
- ☑ Is the trunk straight?
- ☑ Has the tree been pruned to correct structural defects?
- ☑ Has mulch been applied in a light layer over the entire planting hole?
- ☑ Has the mulch been pulled away from the trunk of the tree?
- ☑ Were the root ball and backfill soil watered thoroughly?
- ☑ If the tree needed staking, do the ties allow for growth and movement of the trunk?

Why Trees Are Stressed by Transplanting

When a field-grown tree is dug from the nursery, most of the root system remains behind. The amount of water available to the partial root system in the root ball is a small fraction of what was available before digging. Even though root loss of container-grown plants is minimal when planted, their roots are confined to an abnormally small soil volume in the container, so the situation is very similar to a B&B tree. Initially after planting, both container and field-grown plants face the same challenge of marginal or insufficient water absorption by the root system. Until they can grow a normal spreading root system, newly planted trees are dependent on frequent irrigation. Water stress is a common cause of planting failure.

Roots grow at an average rate of approximately 18 inches per year in the Midwest climate. A three-inch-caliper tree will require approximately three years to completely replace the roots that were lost in transplanting. Root growth rates are similar for large and small trees, but the distance that roots must grow to redevelop the full spreading root system is much greater for a larger tree. A larger tree will require more annual root growth increments to replace the original root system after planting.



Several years of root growth are required for a newly planted tree to fully reestablish its root system. Roots grow at a similar rate regardless of tree size, but for a larger tree, roots must grow over a longer distance to redevelop a normal root spread after transplanting. This requires more years of growth and results in a longer establishment period for a large tree.

Until the root system is established, stress and reduced growth are common. The annual twig growth can be reduced substantially for the first year or two after transplanting. Stressed trees are susceptible to some serious disease and insect problems, such as wood borers and canker diseases, that don't usually affect established, vigorous trees. Proper maintenance helps minimize stress and increase natural resistance, but chemical control may be necessary at times. When attempting to manage pests, it is important to distinguish serious problems that justify chemical treatment from cosmetic ones for which chemical applications are unnecessary or even harmful. For example, wood borers would be considered a serious problem, whereas most late-season leaf diseases would not.

Maintaining Newly Planted Trees

Trees need maintenance throughout their lives but it is particularly important during the period of establishment after transplanting. As long as there is only a fraction of the tree's normal root system present to absorb water, the tree will require extra care.

WATERING. Proper watering is the single most important aspect of maintenance of transplanted trees. In the first year or two, it is important to keep the root ball moist but not over-watered. The root ball soil is the major source of water for the tree until the root system redevelops. Surrounding soils where there are few roots absorbing moisture often stay moist, while the root ball quickly dries out. During this time, monitor the moisture in the root ball. Throughout the warm, summer weather, the tree will

probably need water about twice each week. Approximately 10 to 15 gallons of water is sufficient to moisten the 24-inch diameter root ball of a two-inch-caliper tree.

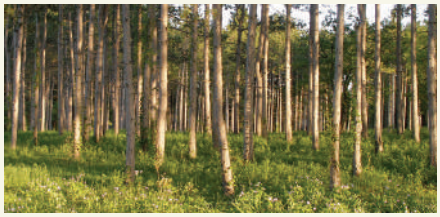
Tree watering bags, which have pinholes to allow water to drip into the soil near the trunk, are gaining popularity. One advantage is that they deliver water directly to the root ball. Little is known, however, about possible heat buildup on the trunk under an empty bag. An empty bag could also deflect rainwater away from the base of the tree where it is most needed.

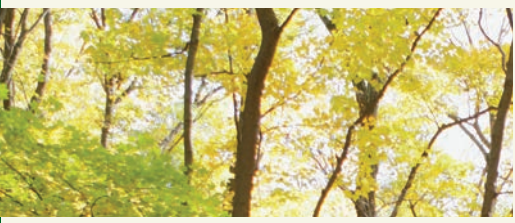
Sugar maple (Acer saccharum) root density is greater under mulch than when in competition with grass.

MULCHING. The mulched area should be expanded as the new roots spread beyond the planting hole. New organic mulch must be added periodically as the older mulch decomposes. Mulch eliminates competition from aggressive lawn grasses for soil moisture and nutrients. Compatible plantings may be added to enhance the landscape appearance. Most trees can tolerate root competition from woody shrubs, groundcovers, and perennials.

FERTILIZING. Fertilization should be delayed until a season or two after the tree is planted (longer for trees larger than two-inch caliper). Always apply fertilizers evenly over the entire root zone and remember that the roots can grow well beyond the branches in only a few years. Once vigor is regained, fertilize trees with a nitrogen fertilizer at a rate of up to ⅔ pound of actual nitrogen per 100 square feet per year (approximately 1½ to 2 cups of fertilizer for most high-nitrogen formulations, spread over a 10-foot-diameter circle). The amounts of potassium, phosphorous, and other nutrients in soils vary and these nutrients may not need to be added. A slow-release form of fertilizer should be used so that the nutrients are available throughout the season. Lawn fertilizers containing broadleaf weed killers and other herbicides should not be used in the vicinity of any tree–including over the root zone. Fertilization in the fall may stimulate new growth and reduce cold hardiness.

PRUNING. Proper tree selection will eliminate the need for major pruning to control size in the future. Planting a tree in the proper location will minimize the need for pruning to clear buildings and walkways as the tree grows. Pruning small trees for proper branch architecture should continue in the years after planting. Maintaining a strong central leader is important for most tree species. Even trees that were properly pruned in the nursery, or at planting, can revert back to an undesirable form in just a few years following planting. Prune out upright stems in the upper crown that could grow to compete with the main leader, and reduce large lateral branches to slow their growth.



OUR MISSION

The mission of The Morton Arboretum
is to collect and study trees, shrubs,
and other plants from around the world,
to display them across naturally beautiful landscapes
for people to study and enjoy,
and to learn how to grow them
in ways that enhance our environment.

Our goal is to encourage
the planting and protection of trees
and other plants for
a greener, healthier, and more beautiful world.

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