PLANTING AND TRANSPLANTING

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Pre-Planting Plant Selection

Trees, shrubs and herbaceous plants are major elements in residential and commercial landscapes with a long-term impact on the overall beauty and effectiveness of a neighborhood, community or metropolitan landscape. Many factors must be considered when selecting landscape plants including: plant tolerance to the local hardiness zone; conditions of the site where planted; size and shape of the plants; time required for the plants to grow to maturity; characteristics of the plants that will provide the benefits intended, and integration of the plants into a specific landscape plan. Plant tolerances, growth rate and habit, color, texture, foliage, bark, flowering and fruiting characteristics, maintenance requirements, wildlife impact, value, cost, and potential environmental effects are important factors that should be considered in the selection of plant materials and development of successful landscape designs and installations. Plants can be a lifetime investment of utility and beauty; plan for and understand the requirements of plants so that a comprehensive advantage can be obtained from their total contribution to the landscape.

Size – Select plants that will complement their surroundings when full grown. For example, smaller trees should be used if overhead wires cannot be avoided. Small trees will also keep a small yard from becoming overcrowded and a single-story home from being dwarfed. Conversely, a large yard and a two-or-more story home can be complemented by tall, large trees. This same reasoning applies to shrubs, wherein the size of a mature shrub must be considered when placing it near the house or under a window of the house. Although variation in size and shape will exist within species or within varieties due to site and growing conditions, nursery and landscape professionals must learn the approximate mature sizes of plants to insure their proper utilization.

Growth – The growth rate of trees and shrubs can vary considerably depending on a variety of genetic and environmental factors. Fast growing trees are often planted to provide instant shade. Unfortunately, some fast growing trees have characteristics that may make them undesirable as shade trees. They may be short-lived and have weak branches, and they may have shallow or suckering roots that can disrupt turf or pavement. The correct amount of light, water and nutrients can encourage slow growing plants to grow faster. For example, oak trees are often considered to be slow growing, however, under optimum growing conditions, oaks can grow two to three feet each year. Proper planting and cultural practices can make the difference between slow, medium, and fast growth of all plants.

Salt Tolerance – All plants are affected by de-icing salts used on streets and roads each winter. Some plants, however, tolerate salt better than others. Salt is leached from snow pushed up along streets, sidewalks and driveways. It collects in the soil, eventually becoming detrimental to nearby plants. Salt spray from high speed traffic can also quickly damage foliage or buds.

On heavily salted streets such as snow emergency routes, salt tolerant species should be planted. Trees that are tolerant of salt to a limited extent include: green ash, white ash, ginkgo, honeylocust, Norway maple, Russian olive, Russian mulberry, Kentucky coffeetree, black cherry, bur oak, white poplar, white oak, black locust, and red oak. Refer to the chapter on Plant Cold Hardiness and Winter Protection for additional information regarding plant salt tolerances.

Cold Hardiness – Minnesota winters dictate selecting and planting species that will grow well in Minnesota and are hardy in USDA Hardiness Zones 2, 3 or 4. Plants native in northern areas are adapted to withstand Minnesota winters. The USDA Hardiness Zone Map in the Cold Hardiness and Winter Protection chapter describes the zone boundaries based on minimum temperatures for the area. The hardiness zones, however, can be influenced by microclimates. For instance, a Zone 3 plant on an exposed, windward site in southern Minnesota may be killed during the winter, whereas the same plant, if planted in a protected, windless Zone 2 location, may survive. Soil conditions, plant vigor, and cultural practices also play a role in a plant's ability to withstand cold conditions.

Site Selection

The characteristics of the planting site are as important as the plant itself in determining plant performance. Soil type and drainage, available water and sunlight, exposure to drying winds, and other factors must be considered. Matching the requirements of the plant to the site increases the survivability, performance, and longevity of the plant selected. The ability of plants to tolerate the conditions of a particular site will vary considerably among plant species. Relationships between plant tolerances and specific site conditions will also affect plant performance. For example, impatiens are generally considered to be shade loving plants, however, with ample moisture and a soil with good moisture holding capacity, they will perform admirably in full sun. Selecting plants that are tolerant of the conditions of the planting site is critical to plant survival and future performance. Just because a plant is tolerant of a particular condition, such as shade, drought, or high soil pH, does not mean the plant will perform to its full potential under such conditions. For example, some shade tolerant plants will have better form, increased vigor, improved flowering and fruiting, and brighter fall color when planted in full sun.

Soil Texture and Drainage – The first step in assessing the condition of the planting site is to examine the soil. Is the soil sandy and well drained; is it moist and does it contain some organic material; or is it heavy clay and, therefore, wet and perhaps compacted? Construction practices such as cutting and filling, installation of underground utilities, and backfilling against foundations can create great diversity in soil structure from one small area to the next. This variability can change drastically with depth and between planting locations on the same property. Therefore, soil conditions throughout the entire planting site should be thoroughly analyzed before and after construction.

Soil texture and drainage are closely related. In general, sandy soils have large pore spaces, are well drained, and have low water holding capabilities. They are usually associated with dry conditions. Conversely, clay soils have much smaller pore spaces, are poorly drained, and can significantly deprive roots of oxygen. The pore spaces in soil are very important to plant growth because the oxygen that occupies them is essential for root growth.

Because plant roots require both moisture and oxygen for growth, soil drainage should be checked before planting. A poorly drained soil, which is high in moisture, but low in oxygen, prevents both proper root development and growth of beneficial soil microorganisms that are responsible for decomposing organic matter and releasing plant nutrients.

To test for soil drainage, dig a hole 18 inches deep, fill it with water and let it stand overnight. If the water has not drained by morning, there is a drainage problem. Do not test the drainage in this manner after a heavy rainfall or before the ground has thawed in the spring.

A plant planted in poorly drained soil will be slow to establish, it will lack vigor, and it may slowly die over time. Many herbaceous perennials are especially intolerant of poorly drained soils. In wet sites, it is necessary to plant species that are tolerant of poorly drained soils, or to artificially improve the drainage of the soil. Soil drainage can be improved by three methods as described below. If a hard pan, which is a compacted, impermeable layer of soil, is present with an underlying layer of well-drained soil, a hole can be dug down through the permeable layer to provide drainage for the planting hole as shown in Figure 1. If the soil is poorly drained and there is no well-drained layer below, a perforated tile system can be installed (Figure 2). This, however, is expensive and requires the assistance of a professional for proper design and installation. Simply adding gravel to the bottom of the planting hole will **not** provide adequate drainage. Adding gravel to the bottom of a hole without a hole down through the impervious layer is **not** recommended as it will create a perched water table and therefore, further decrease oxygen availability to the root system.

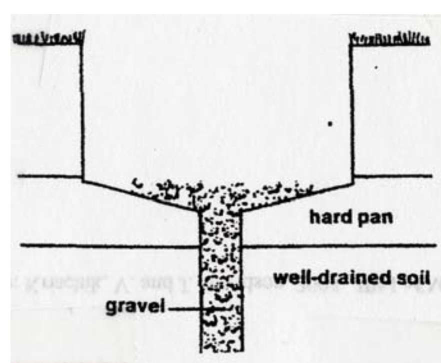


Figure 1. Development of drainage through a hardpan

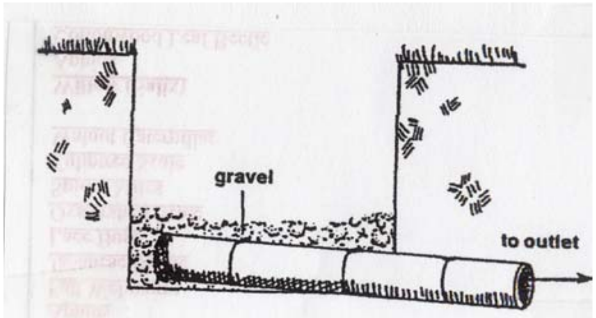


Figure 2. Installation of a drain tile system.

Creating a mound or berm is also a successful method for planting on a site with poorly drained soil conditions. To accomplish this method, import enough good topsoil, preferably a sandy loam, to create a mini-berm. Incorporate six inches of the topsoil as deep as possible into the native soil of the planting area to create a transition zone; then add another six inches of soil and mix with previously mixed area. The plant should be planted in the raised area (Figure 3).

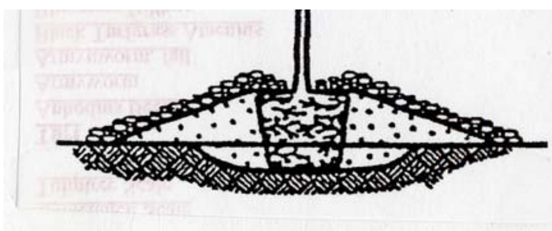


Figure 3. Installation of a mini-berm for one or more plants.

Organic matter, such as wood chips, **coarse** peat and **coarse** compost, can be added to a clay soil to increase pore space. This amendment must be coarse in texture to prevent further water logging of the soil. This organic matter can also be added to a sandy soil to improve water holding capacity. When amending the soil, care must be taken not to create an interface between the two soil types, which the roots will not penetrate and therefore will not grow beyond the amended soil into the existing soil. Soil amendments should be mixed with existing soil to create a transition zone into the existing soil profile.

Compaction of soil by vehicles or people can reduce pore space, reduce oxygen, restrict water infiltration, and physically damage plant roots. In compacted soil, oxygen is depleted and carbon dioxide accumulates, which is detrimental to root growth. Aerating the soil may help correct the problem.

Soil pH – Soil pH is a measure of the acidity or alkalinity of a soil and is measured on a scale of 1 to 14. A soil pH of 7 is neutral. A pH below 7 indicates an acidic soil, and a pH above 7 indicates an alkaline soil. Many plants have an optimal range of pH; some are acid loving, some plants tolerate an alkaline soil, and some grow best when the pH is near 7. Most plants thrive on a pH between 6.0 and 7.0. Soil pH can be raised for example from 6 to 7, by applying calcium carbonate or lime, and the pH can be lowered by adding sulfur, but it is better to choose plants that are adapted to the existing pH than to attempt to change the soil pH. Plant species that will tolerate a high pH should be considered for areas near foundations and sidewalks. Plant species considered tolerant of a high pH such as pH 7.2 to 8.0 include: green ash, white ash, silver maple, cottonwood, amur corktree, ginkgo, hackberry, honeylocust, bicolor oak, Kentucky coffee tree, ironwood, catalpa, black walnut, Norway maple, tartarian maple, and Russian olive.

Soil pH can also be lowered by the addition of acidic fertilizers such as ammonium sulfate or iron sulfate or by adding sulfur. Lowering the pH is a slow process and it is much more difficult to lower the pH than it is to increase it. In general, evergreens perform best in slightly acidic conditions. There are some exceptions such as arborvitae, ponderosa pine, most junipers, and Colorado spruce, which can all tolerate a wider pH range of 6.5 to 7.3. Azaleas, rhododendrons and blueberries are examples of plants that require an acidic pH of 4.5 to 5.5.

Water – The correct amount of water for plant growth is essential. Plants tolerant of excess water should be planted in low areas which remain wet, where the water table is very close to the surface, or where a heavy clay soil exists. Standing water or a high water table means low oxygen content in the soil. Trees that are able to tolerate excessive moisture and low oxygen are: green ash, river birch, hackberry, bicolor oak, red maple, Russian olive, alder, Freemanii maple, larch, poplar, elm, and willow. Drought tolerant trees can withstand extended periods with little water and are best suited for sandy soils. They include: green ash, amur corktree, ginkgo, hackberry, Kentucky coffeetree, Freemanii maple, Hawthorne, Honeylocust, aspen, poplar, pine, Northern pin oak, elm, red cedar, and Russian olive. Drought tolerant shrubs include amur maple, barberry, caragana, honeysuckle, sumac, alpine currant, elderberry, buffaloberry, spirea, lilac, potentilla, juniper and microbiota.

<u>Soil Fertility</u> – Proper soil fertility provides plants with the elements required for survival and growth. A balanced or complete fertilizer may be recommended for tree fertilization, although the greatest response will be obtained from nitrogen. Phosphorus and nitrogen are needed at the time of planting for proper root and shoot growth. Nitrogen may need to be applied annually, but phosphorus and potassium may be needed every second or third year. On larger sites, a soil test should be used to determine proper fertilization practices. In clay soils, fertilizer responses will be slower, but last longer as clay particles have a high cation exchange capacity to hold significant quantities of nutrients. A fertilizer response will be quicker in sandy soils, but not as much can be added and it will not have a long-lasting effect as it is easily leached through the sand, which has a lower cation exchange capacity. Refer to the chapter on Fertilization for Nursery and Landscape Management for additional information.

<u>Mycorrhizae</u> – Mycorrhizae comes from the Latin words "myco" and "rhizi", meaning fungus and roots. It refers to a partnership association between plants and soil-dwelling fungi. Mycorrhizae are a group of soil-inhabiting fungi that create this symbiotic root association, which in turn affects plant growth under specific conditions. Mycorrhizae exist as two major types:

1. Ectomycorrhizae.
2. Endomycorrhizae.

Ectomycorrhizae grow on the outside of the roots and are usually found in native stands of pine, oak, beech, fir and spruce. They can be considered an extension of the root system and are, therefore, most effective on species with small or damaged root systems. The Ectomycorrhizae fungus <u>Pisolithus</u> <u>tinctorius</u> (PT) is a common species used on pine and commercially available.

Endomycorrhizae penetrate deeply into roots. The most common types form structures called vesicular arbuscules, hence the name Vesicular Arbuscular Mycorrhizae (VAM). Endomycorrhizae are associated with hardwood deciduous species such as maple, liquidambar and tulip trees. They facilitate nutrient and water uptake by the roots. They are particularly effective in increasing phosphorous uptake in forest soils.

Another, less common type of Endomycorrhizae is the Ericoid. It is adapted to acid soils and is associated with the roots of acid-loving plants like azalea, rhododendron, and blueberry.

Although both the Ectomycorrhizae and Endomycorrhizae create a hyphal matrix or mycellum surrounding an infected root, only the Ectomycorrhizae fungi cause a visible alteration of the root morphology. These hyphae grow into soil surrounding the infected root and absorb water and nutrients that are subsequently moved into the infected root. Absorbing hyphae extend into the soil and serve as extensions of the root system, absorbing water and nutrients by functionally increasing the root-absorbing surface area. Although mycorrhizal fungi are known to take up over 15 essential nutrients, enhancement of phosphorus uptake by plant roots under conditions of low soil fertility is the most recognized nutritional benefit of mycorrhizae.

Mycorrhizae are most effective on sites that are deficient in nutrients, particularly phosphorous. Therefore, most fertile nursery sites do not respond with a significant growth increase to mycorrhizae inoculation. To use mycorrhizae properly, the particular fungal species must be matched to the plant species. They are usually quite host specific, therefore, not all mycorrhizae species will inoculate all plant species.

The concept of mycorrhizae does not mean that a root-fungal association is always beneficial. Specific soil situations occur where the fungus helps to enhance plant growth under one set of conditions, but has no effect, or causes a reduction in plant growth, under different conditions. The efficacy of mycorrhizae cannot be solely measured in terms of host plant phosphorus nutrition or an enhancement of plant growth. Other adaptational responses may be equally important. For example, under drought conditions, promotion of growth should be secondary to improved plant water relations. Or, plants recently transplanted into the landscape could benefit more from mycorrhizae fungi that promote root exploration of soil rather than promote shoot growth.

In nursery and landscape horticulture, practices and environmental conditions that affect mycorrhizae-plant interactions include soil fertility, water, organic matter, soil cultivation, compaction, disturbance, construction activities, soil erosion, and removal of vegetation or topsoil layers. Research on mycorrhizal fungi and urban landscapes suggests that it might take as long as 45 years for the re-establishment of a diversity of mycorrhizal fungi in soils after landscape installation. Since mycorrhizae fungi generally enhance host plant growth under suboptimal or less than optimal soil conditions, inoculation of nursery plants with appropriate mycorrhizae fungal populations during nursery production should not be viewed as a management strategy for enhancing crop turnover because most nursery production systems provide plants with near optimal growing conditions. Rather, inoculation of nursery plants with mycorrhizal fungi is most likely to benefit host plant performance only when transplanting into special landscape conditions. These conditions are low soil fertility, especially phosphorus; disturbed soil in new urban landscape developments; and restoration, reclamation, reforestation and re-vegetation sites. Points to consider if a nursery manager is considering whether or not to inoculate nursery plants with mycorrhizae fungal inoculum include:

1. Does the product contain species or geographic isolates of mycorrhizal fungi that will actually colonize the plant being inoculated?

2. Is the existing fertility high, particularly with high levels of phosphorus or organic matter?

3. Does the site have good soil and are existing landscape plants already thriving in this site? If so, new transplants may not derive much benefit from mycorrhizae.

4. Mycorrhizal fungi are living organisms that will not survive indefinitely as a purchased product inoculum. The product should be dated and shelf-life information should be provided.

5. Has a commercial inoculum product undergone an independent quality control assay?

While growth was not enhanced in blueberries inoculated with mycorrhizae, research in 2003 showed enhanced growth of inoculated bush morning glory plants. Thus, the potential exists to incorporate mycorrhizae into some nursery production systems to reduce fertilizer and pesticide usage, and to enhance crop vigor and survival during transplanting into field and landscape situations.

<u>Sunlight</u> – Although some plants can tolerate low light conditions, most require full sun to maintain their vigor and attain their optimum performance. Plants considered to be more tolerant of shade include: green ash, white ash, river birch, ironwood, Kentucky coffeetree, American linden, Norway maple, hackberry, red maple, sugar maple, Techny arborvitae, hydrangea, microbiota and balsam fir. Some plants such as serviceberry and blue beech may require some protective shade to prevent leaf scorch, and desiccation.

<u>Location</u> – The location of the planting site in relation to other trees and objects such as buildings and fences will have a considerable influence on temperature, light, and moisture, all of which affect plant growth. Prevailing westerly winds will have a drying effect on non-protected sites. The south side of a building will be much warmer and drier than the north side. The warming effect of the sun on a cold winter day may activate foliar cells in conifers and the cambium cells in shade trees. This may cause injury to the foliage and to the bark or may cause the tree trunk to split. For evergreens, this warming can also cause water loss and growth activity resulting in foliar damage when the temperature is again decreased. The hardiness of a particular plant can be greatly affected by the amount of protection provided by individual microclimates.

<u>Urban Sites</u> – Urban cityscapes can be difficult planting sites and can present real challenges for plant establishment and long-term performance and survival. Most city plantings are generally short lived. Urban soils have usually been greatly disturbed and are typically highly compacted. Urban soils are also typically low in fertility, low in organic matter, poorly drained and/or droughty. Also, beneficial microorganism activity in the soil is usually limited. Urban soils may also contain high levels of soluble salts and considerable debris from generations of construction. Toxic materials such as oil, concrete and creosote may also contaminate urban sites.

Plants in urban landscapes are often subject to moisture and heat stress. Moisture is often limiting in urban situations since most precipitation falls on paved surfaces and is diverted so that it is unavailable to plants. Extensive pavement absorbs and radiates heat, which increases air and soil temperatures resulting in very hot, dry microclimates. Supplemental irrigation is essential in most urban landscapes.

The negative effects of wind on plants can be increased in urban settings. Buildings can create wind tunnels and increase wind velocity. Combined with heat and moisture stress, and depending on plant species, wind can increase moisture stress through increased transpiration. High wind velocities also physically damage plants. The potential for additional mechanical damage to plants from vehicles, vandalism and other human activities is greatly increased in urban environments.

Successful establishment and long term maintenance of plants in urban sites is dependent on extensive site modification, mainly the soil, and supplementation of plant growth requirements including water and nutrients. Although important in any landscape plan, plant selection, installation and maintenance specifications based on a working knowledge of plant tolerance and site conditions are especially critical in successful urban landscape planting and transplanting.

Forms of Plants to Plant or Transplant

<u>Bare Root (BR)</u> – Bare root plants are dug from nursery fields in the fall or spring. Soil is removed from the roots, and plants are held in high humidity and temperature controlled storage over winter. They must be planted in the spring **before** growth begins. Because many roots are cut during field digging, bare root plants suffer severely from transplanting shock. Bare rootstock is normally the least expensive, but if handled improperly, can have the highest mortality. When handling or transporting bare root stock, **the roots must be kept moist and protected from the sun and wind at all times.**

<u>Packaged</u> – Packaged trees and shrubs are bare root plants with their roots packed in moist material such as peat moss or shingle tow. These plants must also be planted in the spring **before** growth starts. Keep packing materials moist, and the package cool and shaded until planted. These plants should be treated as bare root plants.

<u>Field-Potted</u> – Field-potted nursery stock consists of field grown plants dug with a ball of field soil intact which is then placed as is, into a container. It should be held only a short time before selling, as field soil will not provide good plant growth in a container. It is important that the root ball be **disturbed as little as possible** during the digging and planting process.

<u>Containerized</u> – Containerized trees and shrubs are dug from the nursery in the spring or fall as bare root stock, placed in a container with a special growing medium, and sold in the container. If containerized in early spring, most plants will be sufficiently established in the container and can be transplanted during the summer or fall. Plants containerized the previous year can be sold early the following spring. Roots must be established well enough in the container to keep the root ball in tack during transplanting. Do not completely break up the root ball at planting time, but **do cut any circulating roots prior to planting.** The tighter the root ball, the more the root system should be loosened or cut at transplanting.

<u>Container-Grown</u> – Container-grown stock has been growing in a container throughout most of its production cycle. Because the roots of these plants are not disturbed at the time of planting, container grown plants sustain little transplant shock and may be planted at any time during the growing season. Plants that have outgrown their containers may have deformed root systems, which can result in girdling roots. Large plants may be root bound in the container. **The root ball of these plants must be torn or cut open to eliminate subsequent circling or girdling roots** (Figure 5).

<u>Balled and Burlapped (B&B)</u> – Balled and Burlapped trees and shrubs are dug with a firm ball of soil around the roots. The ball is held securely in place with burlap and twine, or burlap and a wire basket. A broken, damaged, or dry soil ball can result in serious damage to the roots. The stem should not be loose in the soil ball. Because of the weight of the soil ball, B&B trees can be difficult to transport and plant without special equipment. B&B stock is often the most expensive, but if handled and planted properly, is as reliable as container grown stock. Always lift B&B plants from beneath the ball, never by the stem. Wire baskets need not be removed at the time of planting, but if the top one or two rings of wire are removed, it should not be done until the root ball is in the final location in the planting hole so that the root ball is not loosened or disturbed in any manner. It is very important that the ball be planted at the proper depth based on the root collar or root flare of the tree and not on the level of the soil on top of the ball. It may be necessary to remove soil from the top of the ball to establish the proper planting depth at the root flare. Some

recommendations indicated that soil should be removed from the top of the ball down to the first root. This, however, would be detrimental if the first root was naturally quite low and the root flare was obviously higher. Be aware of the planting depth requirement and that excess soil can accumulate around the root flare due to some cultural or planting practices during the production cycle. Refer to additional information on planting depth below. Always remove any twine from around trunks at the time of planting. B&B stock is harvested when dormant and held until needed for sale. B&B stock can be planted in spring, summer and fall.

Tree Spade – Larger plants are often moved from the production site to the landscape with a tree spade. A tree spade is a truck- or trailer-mounted machine that digs a mass of soil that includes the plant and some of its roots. Tree spades are available in a variety of types and sizes with some spades having the capacity to move trees with a maximum trunk diameter of eight to ten inches or a soil ball up to 102 inches in diameter. The size of the spade is critical. It must be large enough to accommodate a root ball that will sufficiently sustain the tree after transplanting. The plant and root ball are transported in the machine to where it is directly planted into a pre-dug, matching hole. Most tree spades move one tree at a time, but pod trailers are available to transport two to three trees at one time. The pod system requires two additional handlings of the root ball by the machine. Tree spade harvested trees may also be placed in a wire basket lined with burlap. In this operation, the size of the root ball is again critical and is species dependent. An experienced machine operator can make the difference between success and failure in harvesting a sound undisturbed root ball placed securely in a basket. Matching soils from digging site to planting site is also important. Soil compaction on the sides of the planting hole can be detrimental but, roughing up the side of the hole can offset some of this compaction. Plants can be moved in most seasons with a tree spade, however, evergreens should not be dug when new growth is emerging, and deciduous plants dug in summer and early fall should have an oversized ball and receive special attention relative to species, condition, handling, and irrigation. A general guide for determining the required ball size relative to the tree size is shown in Table 1.

Table 1. Tree spade size or root ball size relative to tree diameter and tree height.

From:http://hflp.sdstate.edu/exex6021.htm as modified by the authors of this chapter.

Tree Spade Size	**Trunk Diameter of Deciduous Trees[1]**	**Height of Evergreens**
44 Inches	2 to 3 Inches	5 to 7 Feet
66 Inches	3 to 5 Inches	7 to 10 Feet
92 Inches	6 to 8 Inches	10 to 12 Feet
102 Inches	8 to 10 Inches	12 to 15 Feet

[1]Trunk caliper diameter measured at six inches above the ground for trees four inches in diameter or smaller, and 12 inches above the ground for trees with a larger diameter.

There are differences between moving trees grown in a nursery and trees growing in the wild or in windbreaks. It is more successful to transplant nursery-grown trees because they have been subject to root pruning which promotes growth and development of more viable roots for maximum health and minimal transplanting stress. Trees grown in the wild are difficult to successfully transplant because they have grown in an understory environment resulting in large, shallow root systems and weakened trunks from a life of protection from thewind. Trees grown in windbreaks can be transplanted more successfully because they were originally transplanted early in life. However, this process is not recommended as these trees often have poor structure as well as environmental, insect and disease problems.

Transporting Plants

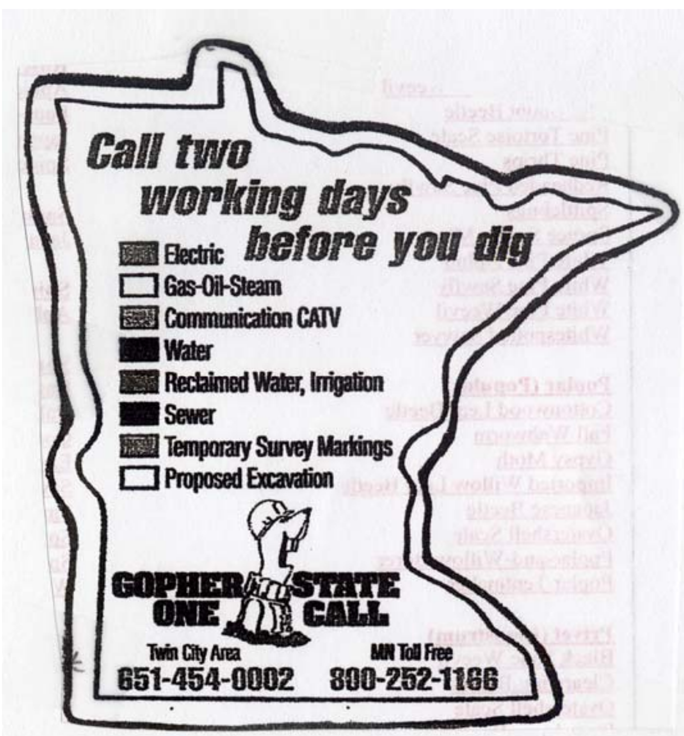
Special care should be taken when transporting plants from the nursery or a holding area. A covered or enclosed truck or trailer is required to reduce the possibility of injury from loading, unloading, and exposure to drying winds or cold conditions. Often the cost of delivery is well worth the reduced damage to the tree if proper equipment is not available to be transplanted by the customer. Protect leaves and needles from the sun and wind by wrapping, trapping or covering in some manner, while in transit. Stems and branches should be cushioned from injury. Always tie the plants down securely and avoid high speed travel. Avoid digging and moving plants in hot windy weather if possible. Trees moved in a tree spade should be sprayed with an anti-transpirant to prevent water loss. Refer to the chapter on Shipping and Handling for more detailed information.

The Planting Process

<u>Call Prior to Digging!</u> – It is mandatory according to Minnesota State Law and Gopher State One Call Law that prior to any digging with a tree spade, auger, or backhoe, that a "Gopher State One" call be made to locate all underground utilities so that safe digging can be accomplished without cutting any wire, cable, gas line, or other underground utility. Accidentally cutting of such utilities can be extremely dangerous and costly. Even hand digging can be dangerous if any of the lines are hit or severed. Call the Gopher State One utility locate numbers as follows:

> **<u>Gopher State One Call:</u>**
> **Twin Cities Area: 651-454-0002**
> **Minnesota: 1-800-252-1166**
> **Administration: 651-454-8388**
>
> www.gopherstateonecall.org

Make the call. It is better to be safe than sorry as severe personal injury can occur when digging in the areas of underground utilities.



<u>Preparing the Planting Hole</u> – Successful planting starts with proper site preparation. Digging the hole for a new plant is the first step. The hole should be at least one to two feet wider than the size of the root system except for direct tree spade planted trees. A larger hole will allow better root growth, especially in poor soil. Rough up the sides of the hole, and in sandy soils make the hole as wide at the bottom as it is at the top. An exception to this would be when planting in heavy soils, wherein the hole should be significantly wider on top or saucer shaped, to allow roots to grow in a better aerated root zone.

<u>Amendments</u> – Poor soils can be amended with organic material or loamy topsoil depending upon the improvement needed. Peat is not recommended for poorly drained clay soils, as it can act as a sump and draw too much water into the planting hole. **Never** completely backfill with a soil amendment. Create a transition zone to the existing soil where the roots must eventually grow by mixing approximately a 50:50 mixture of the appropriate amendment with the existing soil.

Too much soil amendment can create moisture gradients and cause roots to be confined to the planting hole. Remove rocks and debris from the hole and never put rocks or gravel in the bottom of the hole to improve drainage unless it is connected to a drain tile.

<u>Planting Depth</u> – Planting depth is **critical**. In all soils and particularly in heavy soils, trees and shrubs should be planted at, or slightly higher than, the natural root collar on the plant. Gently scrape some of the soil away from the trunk of the tree to locate the root collar. The root collar is the point where the root begins and the trunk ends. On most trees, a root collar is a visible feature on the bark. Look for a slight increase in diameter, which is the root flare and this, is where root tissue is initiated. Also look for a change in bark color and texture. In poorly drained soils, plants should be planted slightly higher with soil mounded up to cover the roots. This will improve oxygen availability to the roots. Allow for settling, especially if the hole has been dug deep and backfilled. Air pockets should be eliminated by watering during and after backfilling.

Root depth is a complicated and controversial issue within the Green Industry. Due to some cultural or transplant practices, primary feeding roots of trees can possibly become located deeper and deeper below the soil line throughout the planting and transplanting processes in route to the tree's final planting site. If this occurs, each step could be a compounding factor in the decline or death of the tree in the landscape. Improper planting depth is a phenomenon which has many avenues in which to enter the life of a transplanted tree and even a tree that has never been transplanted. Some, but all of these avenues and reasons for improper planting depth are listed below.

1. Bud placement is too high at the propagation phase.

2. Liners are planted deep to increase stability of the plant.

3. Planting is deep in the field, container or landscape because the bud or graft is placed at or below the soil line for aesthetic purposes.

4. Transplanting is deep in the landscape for plant stability purposes.

5. Field planting is deep due to settling of cultivated soils at planting time.

6. Landscape planting is deep from settling in the hole due to freshly disturbed site soils or improper planting.

7. Roots are deep due to excess soil placed around the plant as a result of tillage or cultivation practices.

8. Roots are deep as a result of loose soil placed on top of the ball during harvest procedures.

9. Roots are deep as a result of post installation Grading wherein established trees are partially buried.

10. Roots are deep as a result of landscape maintenance operations, which result in placing soil over the roots, or as a result of over mulching.

Since all of these practices can result in trees being planted too deeply, these practices are now carefully monitored by the professional grower and landscaper. In addition, the American Standards for Nursery Stock (ANSI Z60.l) was revised in 2004 to establish a relationship between the root flare of a tree and the soil line for both container and field-grown stock. This relationship is limited to two distinct contexts. First, when measuring the height or caliper of a tree, height is measured from the soil line, and caliper is measured six inches above the soil line or 12 inches above the soil line, if the caliper of the tree at the six-inch mark exceeds four inches. The Standard states that **the soil line "should be at or near the top of the root flare".**

Secondly, when measuring the depth of a soil ball to determine whether it meets the minimum requirement in the Standard, the Standard reads: "Soil located above the root flare, as a result of being deeply planted in the nursery as a young plant, or as a result of maintenance practices in the nursery, or as a result of being added during harvest, shall not be included in ball depth measurement."

The proposed revisions do **not** provide for the rejection of trees based solely on the presence of soil above the root flare. Trees can be rejected; however, if not including such soil in the ball depth measurement would result in an insufficient ball depth.

Structural Root Depth Best Management Practices (BMP) have also been developed to address the complex issue of tree decline resulting from excessive soil over the roots of a plant. The BMP's were developed by the Morton Arboretum, the American Nursery and Landscape Association, the International Society of Arboriculture, the American Society of Landscape Architects, the Professional Landcare Network, the Tree Care Industry Association and the American Society of Consulting Arborists. The Structural Root Depth Best Management Practices are guidelines intended to assist growers, landscape professionals, and arborists in learning to recognize, prevent, and take action to correct root systems that are too deep. A summary of the **Structural Root Depth Best Management Practices** released in 2005 is summarized below.

1. Generally, uppermost structural roots should be within one to three inches of the soil surface, measured four inches from the trunk, but there may be exceptions.

2. Probe the root ball for structural roots to check for structural root depth.

3. Soil above the root flare shall not be included in the rootball depth measurement (ANSI Z60.1, 2004). If the resulting depth measurement of the root ball does not meet the minimum, the tree should be rejected.

4. Plant the root ball so that the uppermost structural roots

are one to three inches below surrounding grade.

5. When soil is removed from the base of the trunk, the newly exposed tissue may be more susceptible to cold and sunscald damage. Temporary shading or light mulching may be required.

6. Mulch should be no more than two inches deep.

7. Trees recently planted with too much soil over the structural roots may require replanting.

8. For fully established trees, remove excess soil around the base of the trunk without injuring the bark.

Fertilization – Fertilization is essential at planting time for good establishment, survival and growth. Trees and shrubs should be fertilized at the time of planting with a slow-release, complete fertilizer, preferably one with adequate phosphorus. Fertilizer should not be placed directly on the roots, but rather, it should be mixed with the backfill. It is best to use a slow-release fertilizer, or fertilizer briquettes, at the time of planting as they release the nutrients slowly, they will not burn the roots, and they will have longer-lasting effects. Use all fertilizers in accordance with the label. Refer to the chapter on Fertilization for Nursery and Landscape Management for additional information.

Planting the Plant – Actual planting of the plant varies with the form of the plant. Planting procedures for five major forms of plants are described below.

1. Bare Root and Packaged Stock – Examine the stock and prune away any diseased or damaged roots or branches. Please refer to the chapter on Pruning Trees, Shrubs, and Evergreens in the Nursery and Landscape, for additional information on pruning. Dig the planting hole, then backfill with enough soil to hold the root collar of the plant at or slightly higher than the soil line. If possible, center trees with the lowest branch facing southwest to prevent sunscald on thin barked trees. Straighten the roots and spread them evenly within the planting hole. Cover the roots with soil, avoiding any clods, rocks and other debris. Gently raise and lower the plant while adding soil to eliminate air pockets. When the hole is three-quarters full, tamp the soil and fill the hole with water. This should fill any remaining air pockets. Finish filling the hole with soil, and then water thoroughly.

2. Balled and Burlapped (B&B) Stock – Carefully set the plant in the hole with the root collar at or slightly higher than the soil line. The root flare should indicate original planting depth. Take extra care not to loosen or break the soil ball. After placing the ball in the hole at the proper depth, fill the hole three-quarters full with soil, tamping to remove air pockets. Cut and remove **all twine** from around the trunk and hole. Pull burlap away from the trunk and top of ball. Water slowly to saturate the soil ball and to remove air pockets in the backfill. Finish filling the hole with soil. No burlap should remain above the soil surface as it may act as a wick and dry the root ball. For best results, evergreens should not be planted later than mid-October, as the roots will not become established.

3. Container-Grown and Containerized Stock – Carefully remove the container **at the planting site**. Cut the container if necessary. All containers should be removed, including biodegradable paper-maché containers. Newly containerized stock may be only slightly rooted, so the container must be removed with great care so as not to disturb the root ball. In contrast, container-grown stock may be root bound. If roots are growing in a spiral around the soil ball, the plant is root-bound. In this case, roots need to be cut or they will eventually girdle the plant. Make vertical cuts on the sides of the ball just deep enough to cut the circling net of roots (Figure 5). Also, make a criss-cross cut across the bottom of the ball. Plant the plant the same as a B&B plant. For best results, evergreens should not be planted later than mid-October, as the roots will not have a chance to become established.

4. Tree Spaded Stock – The use of mechanical tree spades has become a common method of tree planting. Trees should be watered thoroughly before moving to hydrate the plant and to avoid soil sifting out during transport. The sides of the planting holes should be roughed up with a shovel or rake to break up compaction and glazing caused by the spade. The tree's root flare should be placed at or slightly higher than the original grade to allow for settling. After planting, work loose soil into the area between the hole and the root ball, and water thoroughly.

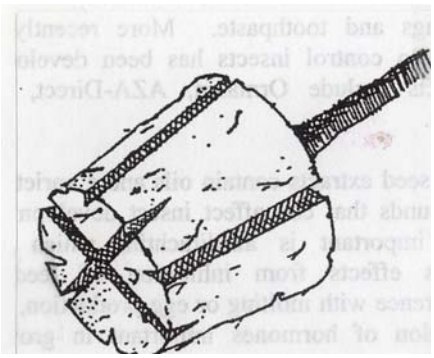


Figure 5. Root cutting pattern for root-bound container-grown stock.

Post-Planting Requirements

Irrigation – Newly planted plants require special watering. Soil and weather conditions will dictate how often and how much water to apply. Examine soil moisture four to eight inches deep to determine the need for water. If the soil feels dry or just slightly damp, watering is needed. Soil type and drainage must also be considered. Well drained, sandy soil will need more water, more often than a clay soil that may hold too much water. A slow trickle of water at the base of the plant for several hours or until the soil is soaked is the best method. Short, frequent watering should be avoided, as this does not promote deep root growth, but rather, the development of a shallow root system, which makes the plant vulnerable to environmental stresses. Refer to the chapter on Irrigation Management for additional information.

Mulching – Adding mulch around the base of the plant is a very important part of plant care that is often overlooked. By mulching plants, a more favorable environment is provided for plant roots. A mulch allows better infiltration of water, holds soil moisture, limits weed growth, moderates soil temperature in summer and winter, and discourages injury from lawn mowers and weed whips.

A two- to three-inch layer of mulch, spread to form a three- to six-foot diameter circle around the plant, should be applied. Keep the mulch material from direct contact with the trunk or stems of the plant. Fresh, not composted, wood and bark chips are good mulching materials. A porous landscape fabric that allows gas and water exchange can be used as a weed barrier underneath the chips. If such a fabric is not used, a thicker layer of mulch may be required for adequate weed control. Plastic films under mulch can limit soil moisture infiltration and they will cause severe injury to roots due to oxygen starvation. Plastic films are not recommended.

Fertilization – Fertilization of established plants should be done every two to three years in the fall after leaves have fallen or in early spring before growth begins. Fertilizer can be applied to the surface or placed in holes around the plants. Beware of burning turf if surface-applied. Surface applications should be watered in. Do not apply nitrogen in late summer unless the plant is nutrient deficient, as this can promote new growth that may not harden off properly and, therefore, may be damaged by winter weather. Phosphorous and potassium can be applied in the fall, as they will enhance winter acclimation. Refer to the chapters on Soils for Nursery and Landscape Management, and on Fertilization for Nursery and Landscape Management for additional information.

Pruning – Proper pruning is vital to the health and structure of many plants. Damaged limbs, damaged roots on bare root plants, and crossing or rubbing branches should be pruned at the time of planting. The pruning cut should **leave the branch collar, but do not leave a stub.** Improper cuts can lead to disease problems and decay. Pruning should be done when trees are dormant, never when leaves are falling. Trees that "bleed" should be pruned in August. Oak trees **should not** be pruned between April 15 and July 1 due to possible spread of oak wilt disease. If pruning of oaks during this time is unavoidable, or if trees are damaged by storms or construction, apply a non-toxic pruning paint **immediately**. Pruning paint is not recommended for other pruning cuts or wounds. Refer to the chapter on Pruning Trees, Shrubs, Evergreens and Perennials in the Nursery and Landscape for additional information.

Staking – Most newly planted trees will grow best **without** staking. Young trees standing alone with the tops free to move will develop stronger, more resilient trunks than those staked for several years. Trunk movement is required to develop trunk caliper and strong, tapered trunks.

If however, a tree is unstable in a strong wind or is pushed over, then staking is required. A common problem with staking trees is the girdling effect that the ties have on the tree. A piece of garden hose around a wire in a “figure 8” loop to allow movement can reduce this damage. However, it must be removed in a timely manner as it can also damage the trunk. Soft nylon webbing or carpet strips attached by grommets to a stake are recommended. Often times, wire is too tight around the trunk and will effectively girdle and kill the tree. Whatever material is used, be sure to allow for some movement and **remove the stakes and ties** once the tree is established, usually after one year or less. Refer to the chapter on Field Production of Nursery Crops for additional information on staking and tree caliper growth.

Winter Care – Proper winter care begins in the summer. Proper watering and fertilization in spring and summer is required. Watering can then be decreased in early fall and then increased in late fall to provide water needed to withstand the drying winds of winter. Plants need to go dormant, therefore, do not stimulate late growth by heavy watering and nitrogen fertilization in early fall. However, plants should be thoroughly watered in late fall just prior to the soil freezing.

Sunscald, characterized by sunken, dried, or cracked bark, is caused by the heating effect of the winter sun in cold weather. It usually occurs on the south or southwest side of the tree. In the fall, wrap young and thin-barked trees with commercial tree wrap from the bottom up to the first major branch. Remove the wrap in spring. Thin-barked species such as maple and honeylocust may require protection for several years.

Winter browning of evergreens is normally caused by the combined effects of wind and sun. Chlorophyll is degraded by light, and is not replaced at low temperatures during the winter. Also, trees lose water from the leaves or needles while roots are in frozen soil. To protect evergreens, place a screen of burlap or similar material on the south, west, and windward side of the tree to block the wind and sun. Antidesiccant sprays are not very effective in reducing water loss from evergreens during the winter and preventing the associated winter browning. Water evergreens well throughout the growing season, lightly in September, and then thoroughly again before the soil freezes. Select species and cultivars that tolerate winter conditions. It is wise to plant all species susceptible to winter injury in areas of minimal exposure to winter wind and sun. Refer to the chapter on Plant Cold Hardiness and Winter Protection for additional information.

Animal damage can be severe during the summer and winter. It is important to eliminate habitat within and around the perimeter of the nursery or landscape starting in late August. The perimeter and the site should be baited for mice prior to, and during the winter. Cleanliness is a major factor in rodent elimination. To protect individual trees from mice, place a cylinder of 1/4-inch mesh hardware cloth or **white** plastic drain pipe, not be black in color due to heat absorption, around the trunk. The cylinder should extend high enough to prevent rabbit or mice from feeding at and above snow level. It should be firmly anchored in the soil without disturbing the tree roots. Protection from rabbits requires coverage of one to two feet above snow level. Other means of fencing or animal control may be needed. If many trees and shrubs are to be protected, application of a commercial repellent may be more practical, although their effectiveness may be questionable. The repellent can be sprayed or painted on the trunks and branches. The effectiveness and duration of the repellent will depend on the severity of the winter and the availability of other food. **The only known sure method to effectively eliminate deer feeding and rubbing damage is through exclusion by properly designed and installed fencing.** However, the use of dogs controlled by electric underground wire and electronic collars are also effective.