

CMG GardenNotes #633

The Science of Planting Trees

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This *CMG GardenNotes* outlines research-based tree planting steps. The procedures apply to deciduous trees, evergreen trees, and shrubs planted in a landscape setting. As you review the content, pay attention to significant clarification in planting protocol. Based on the research consensus, it is not acceptable to plant a tree in a narrow planting hole with the burlap and wire basket left in place.

The Science of Planting Trees

Tree root systems are shallow and wide spreading. [Figure 1] Based on nursery standards, a field-grown, balled and burlapped (B&B) tree or container-grown tree has less than 5-20% of the fine absorbing roots of the same size tree in a landscape setting. This creates stress when the tree moves from the daily care in the nursery setting to the landscape. **The Science of Planting Trees is promoting rapid root growth to reduce the water stress imposed by the limited root system.** *Post-planting stress* (transplant shock) describes the stress factors induced by the limited root system.

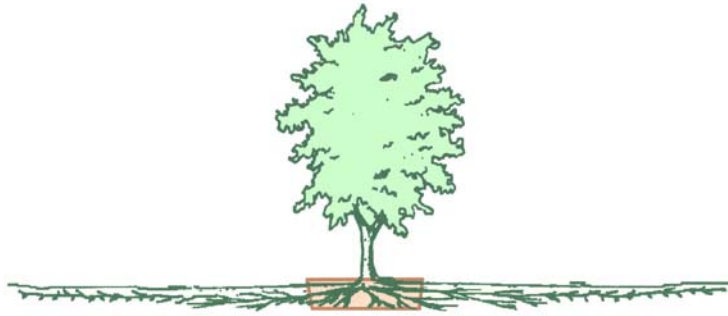


Figure 1. A tree's rooting system is shallow and wide spreading. Based on nursery standards, the container grown or field-grown, B&B tree has only 5-20% of the fine absorbing roots found on the same size tree in an open landscape. This places the new tree under stress.

Steps to Planting Container-Grown or Field-Grown B&B Nursery Stock

Step 1. Determine Depth of the Planting Hole

Planting trees too deep has become an epidemic leading to the decline and death of landscape trees. Trunk-girdling roots, caused by planting too deep, leads to more deaths of landscape trees than all other factors combined!

Trunk-girdling roots develop when a tree is planted too deep in the root ball and/or the root ball is planted too deep in the planting hole. Trunk-girdling roots may lead to decline and death some 12 to 20 years after planting. Trunk-girdling roots may be below ground.

To deal with this epidemic an industry-wide working group developed the following standards¹ for tree planting depth:

These standards have been adopted industry wide, including endorsement by the American Nursery and Landscape Association (ANLA), American Society of Consulting Arborists (ASCA), American Society of Landscape Architects (ASLA), Associated Landscape Contractors of America (ALCA), International Society of Arboriculture (ISA), and Tree Care Industry Association (TCIA).

Depth Of Root Ball In Planting Hole

In tree planting, **the root ball sits on undug soil.** This prevents the tree from sinking and tilting as the soil settles. If the hole is dug too deep, backfill and firm the soil on the bottom to the correct depth. (Roots grow out from the root ball, not down.)

To deal with the *soil texture interface* (actually the differences in soil pore space) between the root-ball soil and backfill soil, it is imperative that the root ball rise slightly above grade with no backfill soil over top of the root ball. For small (one-inch caliper) trees, the top of the root ball rises one inch above grade. For larger (2-4 inch caliper) trees, the top of the root ball rises about two inches above grade. Backfill soil should cover the “knees” tapering down to grade. [Figure 2]

If backfill covers the root ball, water and air will be slow to cross the texture interface. In this situation, water tends to move around the root ball and is slow to soak into the root ball. Root health will be compromised by lower soil oxygen levels. [Figure 3]

Figure 2. Depth of root ball in planting hole – Top of root ball rises 1-2 inches above soil grade. No soil is placed over top of the root ball. Backfill soil covers the “knees” tapering downward to the original soil grade. Root ball sits on un-dug/firmed soil to prevent sinking.

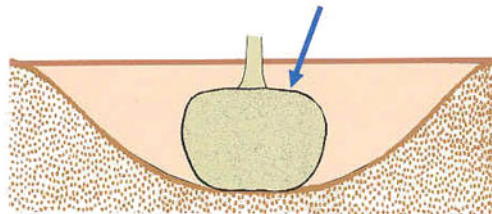
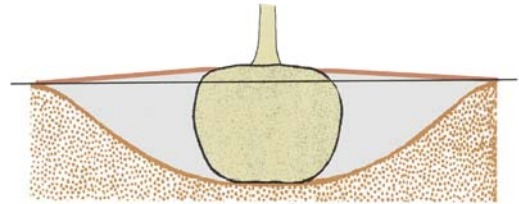


Figure 3. It is imperative that the root ball come to the surface, with no backfill on top of the root ball. When backfill soil is placed over top of the root ball, the *soil texture interface* impedes water and air movement into the root ball.

Depth of Tree in the Root Ball

- Generally, at least two structural roots should be within the top 1-3 inches of the root ball, measured 3-4 inches from the trunk.
- On species prone to trunk-circling roots (Crabapples, Green Ash, Hackberry, Littleleaf Linden, Poplar, Red Maple, and other species with aggressive root systems), the top structural root should be within the top one inch of the root ball.

Checking Depth of Tree in Root Ball

Check the depth of the tree in the root ball. Do not assume that it was planted correctly at the nursery.

- The presence of the root flare is an indication of good planting depth. However, small trees may have minimal root flare development, making it difficult to determine. Be careful not to mistake swelling of the trunk below the graft as the root flare.
- A good way to evaluate planting depth in the root ball is with a slender implement like a slender screwdriver, knitting needle, or barbecue skewer. Systematically probe the root ball 3-4 inches out from the trunk to locate structural roots and determine their depth. [Figure 4]



Figure 4. Systematically probe the root ball with a slender screwdriver. Generally, at least two structural roots should be found in the top 1-3 inches of soil, 3-4 inches out from the trunk. On species prone to trunk circling roots (Crabapples, Green Ash, Hackberry, Littleleaf Linden, Poplar, Red Maple, and other species with aggressive root systems) the top structural root should be within the top one inch of the root ball.

If the tree is planted too deep in the root ball, excess soil should be removed from the top in the backfill step of the planting process. Adjust the depth of the planting hole to compensate. [Figure 5]

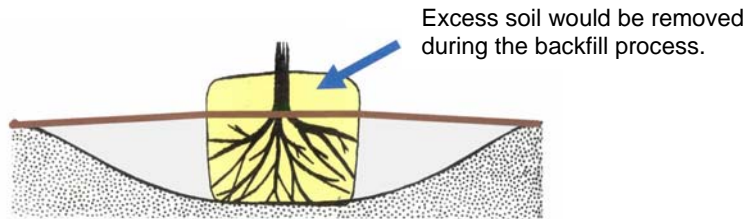


Figure 5. Adjust the depth of the planting hole to bring the root flare to the correct depth.

With trees planted too deep in the root ball, a better option is to not purchase the trees. In the root ball, the soil above the root flare generally does not contain roots so the total volume of roots may be too small to maintain tree health. In container-grown stock, trees planted too deep readily develop trunk-circling roots. [Figure 6]

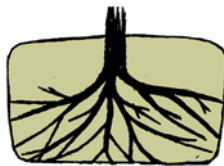


Figure 6. Another issue with soil levels above the root flare is root ball size. With roots only in a portion of the root ball area, the root ball may be too small for the tree to thrive following planting.

Summary: Depth of Planting Hole

Depth of the planting hole should be 1-2 inches less than the height of the root ball, adjusted (as needed) to correct the depth of the tree in the root ball.

For example, if a two-inch caliper tree has a root ball height of 16 inches, depth of the planting hole would be 14 inches. However, if the top structural roots are located five inches down in the root ball, between two to four inches of soil needs to be removed from the root ball in the backfill process. Depth of the planting hole would be adjusted to 10-12 inches.



Figure 7. In digging, measure the depth of the planting hole with a straight board (like rake handle) and a measuring tape.



Figure 8. Checking depth of root ball in planting hole with a straight board (like a rake handle).

Step 2. Dig Saucer-Shaped Planting Hole Three-Times Root Ball Diameter

Saucer-Shaped Planting Hole

To support rapid root regeneration, research suggests a wide, saucer-shaped planting hole. If the roots have difficulty penetrating compacted site soil (due to low soil oxygen levels), sloped sides direct roots upward and outward towards the higher oxygen soil near the surface rather than being trapped in the planting hole. Roots that do not penetrate the site soil may begin circling in the hole, leading to trunk-girdling roots. [Figure 9]

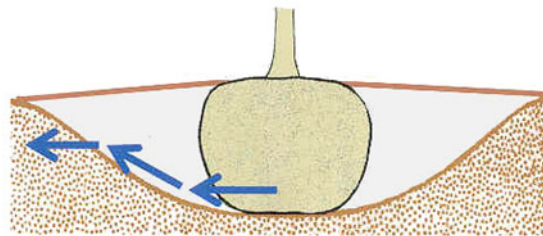


Figure 9. When roots cannot penetrate the site soil (due to low oxygen levels), the saucer-shaped planting hole directs the roots upward and outward into soils with higher oxygen levels.

Waterlogging concerns – The saucer-shaped planting hole actually gives the tree a larger margin for error in overwatering. In the saucer-shaped planting hole, three times the root ball diameter, the upper half contains 85% of the backfill soil, and the upper quarter contains 75% of the backfill soil. Water could saturate the lower 3/4 of the backfill soil and only affect 25% of the root system!

When the planting hole is dug with an auger, cut down the sides with a shovel to help eliminate the glazing and create the preferred sloping sides. An alternative is to rototill a 12-24" inch ring of soil around the planting hole after planting. [Figure 10]

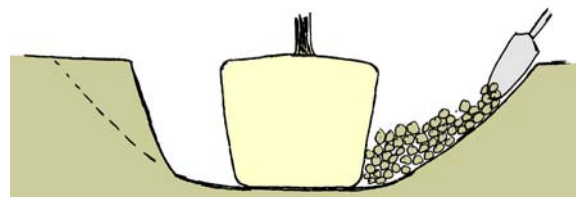


Figure 10. When dug with an auger, cut down the sides into the saucer shape during backfill process.

Planting Hole Depth

Depth of the planting hole is determined in Step 1. To measure depth of the dug hole, place a straight board or shovel handle across the hole and measure from the board/handle height to the bottom of the hole.

For stability, it is imperative that the root ball sits on undug soil. If the hole is dug too deep, backfill and firmly pack the soil to the correct depth. Remember that the planting hole is shallow and wide. As a point of clarification, primary growth of roots is outward, not downward.

Planting Hole Width

Planting hole width is the key to promoting rapid root growth, reducing *post-planting stress*. Depending on the soil's tilth, root growth slows when roots reach the undisturbed site soil beyond the backfill area. This is due to lower soil oxygen levels in the undisturbed soil.

25% wider – A planting hole with vertical sides that is only 25% wider than the root ball hinders root growth. If the soil is compacted and difficult to penetrate, the roots circle inside the hole just as if the root system were in a container. Size of the root system (before growth is slowed by the lower oxygen levels of the site soil) is insufficient to reduce *post-planting stress*.

Two times root ball – A saucer-shaped planting hole twice the diameter of the root ball will allow the root system to grow rapidly to 150% of the root ball size before growth is slowed by the lower oxygen levels of the site soil. This is not enough to avoid *post-planting stress* under normal conditions.

Three times root ball – A saucer-shaped planting hole three times the diameter of the root ball allows the root system to grow rapidly to 400% of the root ball size before being slowed by the lower oxygen levels of the site soil. This is enough to reduce *post-planting stress* under normal conditions. For example, a two-inch diameter tree with a 24-inch (two-foot) wide root ball needs a 72-inch (6-foot) wide, saucer-shaped planting hole. To promote root growth the planting hole is wide, shallow, and saucer-shaped!

The shallow, wide planting hole is the primary technique for encouraging rapid root growth, which is the objective in the *science of tree planting*. This is an important change in the mind-set of many folks who have been planting into a narrow, deep hole.

Summary: Planting Hole Specifications

Generally, at least two structural roots should be found in the top 1-3 inches of soil, 3-4 inches out from the trunk. On species prone to trunk-circling roots (such as Crabapples, Green Ash, Hackberry, Littleleaf Linden, Poplar, and Red Maple), the top structural root should be within the top one inch of the root ball.

Saucer-shaped planting hole, three times root ball diameter.

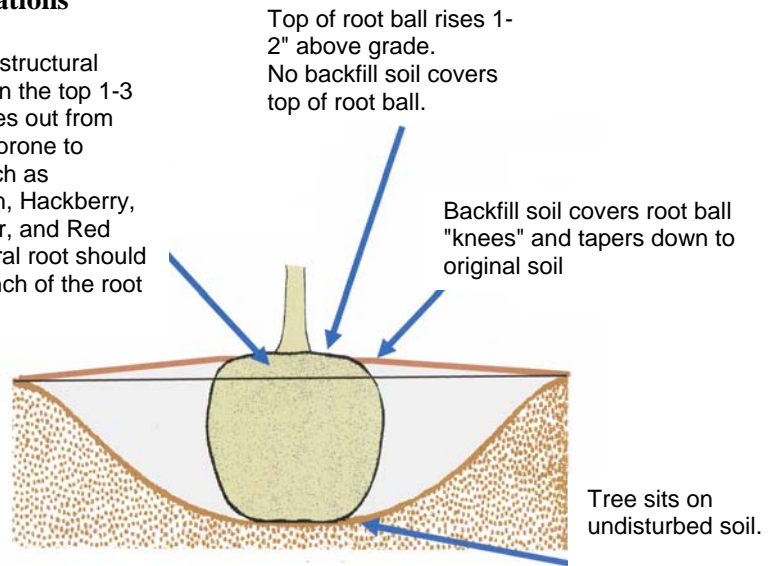


Figure 11. Planting hole criteria to promote rapid root establishment, reducing post-planting stress.

Modification for Wet Soils

On wet soils, raise planting depth so that 1/3 of the root ball is above grade. Cover root ball "knees" with soil, gradually tapering down to grade. Do not use mulch to cover knees, as roots will readily grow in moist mulch but will be killed when the mulch dries out. [Figure 12]

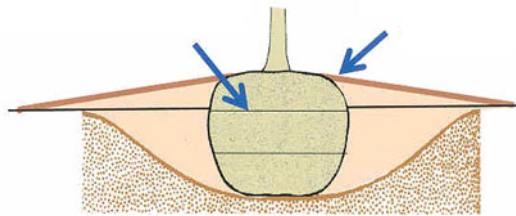


Figure 12. On wet soils, place root ball 1/3 above grade, covering knees with soil tapering down to grade.

Modification for Compacted Soils

On extremely compacted soils, rototilling a ring around the backfill area to a width of four, five, or more times the root ball diameter may be helpful. This should be done after planting is completed so the soil is not compacted by foot traffic during the planting process. [Figure 13]

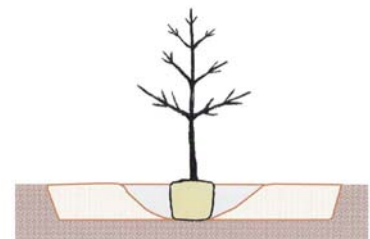


Figure 13. Rototilling a ring around the planting hole may help roots spread into compacted soil.

Planting on a Slope

When planting on a slope, plant "out-of-the-hill" by adjusting the grade around the planting hole as illustrated in Figure 14.

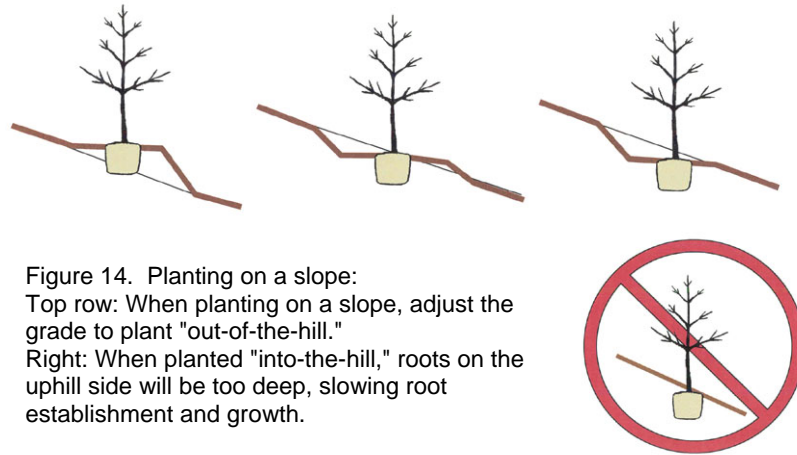


Figure 14. Planting on a slope:
Top row: When planting on a slope, adjust the grade to plant "out-of-the-hill."
Right: When planted "into-the-hill," roots on the uphill side will be too deep, slowing root establishment and growth.

Labor-Saving Techniques

A labor-saving technique is to dig the hole twice the root ball width with more-vertical sides. Place the tree in the hole, firm a ring of soil around the base of the root ball to stabilize it, remove wrappings, and check for circling roots. Then with a shovel cut the sides of the planting hole to form the saucer-shaped planting hole three times the root ball diameter. With this technique, part of the backfill soil does not have to be removed and shoveled back, but simply allowed to fall into the hole. Soil "peds" (dirt clods) up to the size of a small fist are acceptable. With this technique, it is not practical to mix in soil amendments, as amendments must be thoroughly mixed throughout the backfill soil. [Figure 15]

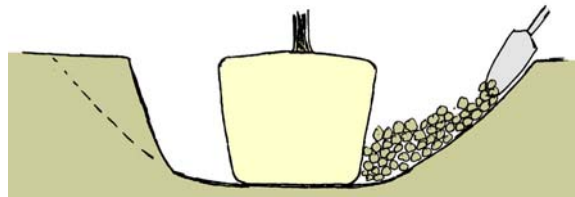


Figure 15. Planting hole widened into saucer-shape during the backfill process.

A small tiller or "garden weeder" makes for quick digging. Simply place the tiller where the hole will be and walk around in a circle. Stop periodically to remove the loosened soil from the hole, and continue walking and tilling in a circle. [Figure 16]

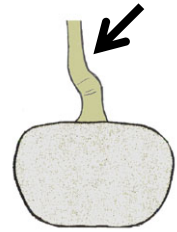
Figure 16. Digging the hole with a small tiller or "garden weeder."



Step 3. Set Tree In Place, Removing Container/Wrappings

In setting the tree in the planting hole, if the tree has a "dogleg" (a slight curve in the trunk just above the graft) the inside curve must face north to reduce winter bark injury. [Figure 17]

Figure 17. The inside curve of the graft crook or "dogleg" must face north to reduce winter bark injury.



Vertically align the tree with the top centered above the root ball. Due to curves along the trunk, the trunk may not necessarily look straight. It will appear straighter with growth.

In this step, techniques vary for *Container-Grown Trees* and Balled And Burlapped (B&B) Trees.

Container-Grown Nursery Stock

“Container-grown” nursery stock refers to trees and shrubs grown in containers using a variety of production methods. Spread of the root system is limited to the container size. An advantage of container stock is that it can be planted in spring, summer, or fall. Smaller trees and shrubs are commonly grown in containers.

There are many variations of container production. In many systems, like “pot-in-pot” and “grow-bags,” the container is in the ground. This protects roots from extreme heat and cold and prevents trees from blowing over.

In container-grown nursery stock, circling roots develop over time. These may be on the outside of the root ball (particularly at the bottom of the container) or just inside the root ball and not visible from the surface. Current research finds that the old standard of slitting the root ball on four sides does not adequately deal with circling roots. New standards call for the outer 1-1½” of the root ball to be shaved off with a knife, saw or pruners in the planting process. This encourages roots to grow outward and does not affect tree growth potential.



Figure 18. Container-grown nursery stock is prone to developing circling roots that will girdle the trunk several years after planting if not corrected.

Techniques With Container-Grown Stock

Actual planting techniques in this step vary with the type of container and extent of **root** development. Generic steps include:

- a) Lay the tree on its side in or near the planting hole.
- b) Wiggle off or cut off the container.
- c) Shave off the outer 1-1 ½” of the root ball with a knife, saw, or pruners. This step is important to deal with circling roots.
- d) Tilt the tree into place. Remember that the inside curve of any dogleg faces north.
- e) Check depth of the root ball in the planting hole. If incorrect, remove the tree and correct the depth, firming any soil added back to the hole.
- f) Align vertically.
- g) Firm a shallow ring of soil around the bottom of the root ball to stabilize it.

[Figure 19]

Figure 19. Stabilize the tree by firming a small ring of backfill soil around the base of the root ball.



- The ideal container-grown tree has a nice network of roots holding the root ball together. After the container is removed, the tree is gently tilted into place.
- If some of the soil falls off (often on the bottom), it may be necessary to adjust the depth of the planting hole. Backfill and pack the bottom of the planting hole to the correct depth.
- If most of the soil falls off the roots, the tree is planted as a bare-root tree (see below).
- Fabric grow bags must be removed from the sides. They are generally cut away after setting the tree in place.
- Generally, paper/pulp type containers should be removed. Most are slow to decompose and will complicate soil texture interface issues. Pulp containers often need to be cut off, as they may not slide off readily.
- In handling large trees (3-inch caliper and greater) it may be necessary to set the tree in place before removing the container.
- If the container is easy to cut, it may help to keep the root ball intact by first cutting off the bottom of the container, carefully setting the tree in place and tilting to align vertically, then cutting a slit down the side to remove the container.



Figure 20. If the container is easy to cut, many planters prefer to first cut off the bottom, then move the tree in place (helps hold root ball together) and then slit the container side to remove it.

Field-Grown, B&B Nursery Stock

Field-grown, balled and burlapped (B&B) trees and shrubs are dug from the growing field with the root ball soil intact. In the harvest process, only 5-20% of the feeder roots are retained in the root ball. B&B nursery stock is best transplanted in the cooler spring or fall season.

To prevent the root ball from breaking, the roots are balled and wrapped with burlap (or other fabrics) and twine (hence the name B&B). In nurseries today, there are many variations to B&B techniques. Some are also wrapped in plastic shrink-wrap, placed in a wire basket, or placed in a pot.

Larger plant materials are often sold as B&B stock. In field production, the roots may be routinely cut to encourage a more compact root ball. While this process improves the transplantability of the tree, it adds to production costs.

Depending on how long the tree has been held in the B&B condition, circling roots may begin to develop. If this has occurred, shave off the outer 1-1½ inches of the root ball as described above for container-grown trees.



Figure 21. Field-grown, B&B nursery stock needs to have the wrappings that hold the root ball together taken off AFTER the tree is set in place.

Techniques with B&B nursery stock

An advantage of the wider planting hole is that it gives room for the planter to remove root ball wrappings AFTER the tree is situated in the hole.

Based on research, **standard procedures are to remove root ball wrapping materials (burlap, fabric, grow bags, twine, ties, wire basket, etc.) from the upper 12 inches or 2/3 of the root ball, whichever is greater AFTER the tree is set in place.** Materials under the root ball are not a concern since roots grow outward, not downward.

Actual planting techniques in this step vary with the type of wrapping on the root ball. Generic steps include:

- a) Remove extra root ball wrapping added for convenience in marketing (like shrink-wrap and a container). However, do NOT remove the burlap (or fabric), wire basket and twine that hold the root ball together until the tree is set in place.
- b) Set the tree in place. Remember that the inside curve of any graft crook faces north.

- c) Check depth of the root ball in the planting hole. If incorrect, remove the tree and correct the depth, firming any soil added back to the hole.
- d) Align vertically.
- e) For stability, firm a shallow ring of soil around the bottom of the root ball. [Figure 22]

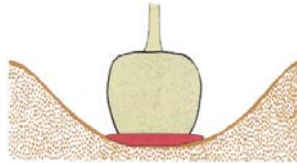


Figure 22. Stabilize the tree by firming a small ring of backfill soil around the base of the root ball.

- f) Remove all the wrapping (burlap, fabric, twine, wire basket, etc.) on the upper 12 inches or upper 2/3 of the root ball, whichever is greater.
- g) If circling roots are found in the root ball, shave off the outer 1-1½ inches of the root ball with a pruning saw and/or pruners.

Consensus from research is clear that leaving burlap, twine, and wire baskets on the sides of the root ball are not acceptable planting techniques.

- Burlap may be slow to decompose and will complicate soil texture interface issues.
- Burlap that comes to the surface wicks moisture from the root ball, leading to dry soils.
- Jute twine left around the trunk will be slow to decompose, often girdling the tree.
- Nylon twine never decomposes in the soil, often girdling trees several years after planting.
- Wire baskets take 30 plus years to decompose and may interfere with long-term root growth.
- With tapered wire baskets, some planters find it easier to cut off the bottom of the basket before setting the tree in the hole. The basket can still be used to help move the tree and is then easy to remove by simply cutting the rings on the side.

Optional Step 4. Underground Stabilization

One of the trends in tree planting is to use underground stabilization of the root ball rather than above-ground staking. Underground stabilization is out of the way and will not damage the trunk's bark. For information on underground stabilization, refer to *CMG GardenNotes* #634, *Tree Staking and Underground Stabilization*.

Staking became a routine procedure when trees were planted in deep holes and the trees sank and tilted as the soil settled. In the *Science of Planting Trees*, where trees are set on undisturbed soil and a ring of soil is firmed around the base before backfilling, staking or underground stabilization is not needed in many landscape settings.

Step 5. Backfill

In backfilling the planting hole, the best method is to simply return the soil and let water settle it. Avoid compacting the soil by walking or stamping on it. In the backfill process, the planting hole can be widened into the desired saucer shape.

No backfill soil goes on top of the root ball. Backfill soil covers the root ball "knees" tapering down to the original soil grade. [Figure 23]

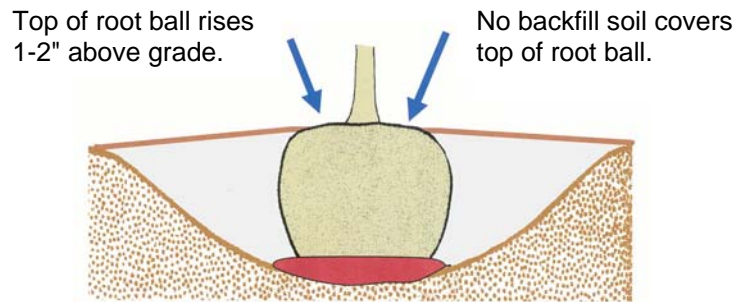


Figure 23. Backfill soil covers the "knees," tapering down to the original soil grade. It is imperative that no soil cover the top of the root ball.

In preparing any garden for planting, it is standard gardening procedure to *modify* the soil structure (i.e., loosen the soil) by cultivating. It is also routine to *amend* the soil by adding organic matter to improve the water-holding capacity of sandy soils or to increase large pore space in clayey soils. Modifying and amending, while related, are not the same process.

Ideally, soils in a tree's entire potential rooting area would be modified and amended to a 5% organic content.

Modifying the Backfill

When planting trees, soil in the planting hole is modified (loosened up) by digging the hole. The issue around "modifying the soil" is planting-hole width, as discussed above. Due to lower levels of soil oxygen in the site soil, root growth slows as roots reach the undisturbed site soil beyond the backfill. A saucer-shaped planting hole three times the diameter of the root ball supports rapid root growth, reducing post-planting stress. Amending backfill soil in a narrow planting hole will not substitute for modifying soil in the wider saucer-shaped planting hole.

For backfill, soil "peds" (dirt clods) up to the size of a small fist are acceptable. The soil does not need to be pulverized. In clayey soils, pulverizing the soil will destroy all structure and may lead to excessive re-compaction with minimal large pore space.

Amending the Backfill

Amending the soil just in the planting hole is a very complex issue. Too many soil-related variables play into this amended planting pit for a simple directive. In tree planting, it is a common procedure to amend backfill soil with organic matter. It is a good marketing technique for the nursery to recommend soil amendments with the sale of a tree.

Amended backfill soil to 5% organic matter is standard procedure in garden soil management and may be supportive to root growth in the planting hole during the first two years.

However, amending backfill the backfill to 25-50% is a common mistake! It helps containerize the roots and may also hinder root spread beyond the planting hole. It may hold excessive amounts of water, reducing soil oxygen levels. As the organic matter decomposes, the total volume of soil in the planting hole diminishes, allowing the tree to topple over.

If amending the soil, the organic matter needs to be thoroughly mixed with the backfill soil. Never backfill with organic matter in layers or clumps as this creates additional texture interface lines. Amendments should be well aged. Never use unfinished compost or fresh manure as it may burn tender roots.

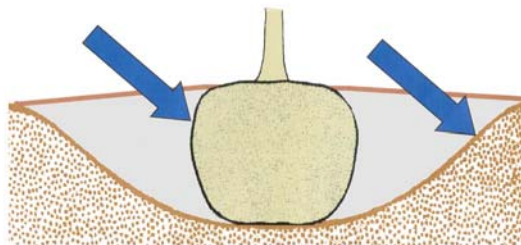


Figure 24. A labor-saving method is to dig the planting hole two times the root ball diameter with more-vertical walls and ease the tree in place. Then cut the planting hole into the three-times-root-ball width and saucer shape during the backfill process. This way much of the soil does not have to be moved twice. Dirt clods up to fist size are acceptable in the planting hole.

Texture Interface

Changes in soil texture (actually changes in soil pore space) create a *texture interface* that impedes water and air movement across the texture change. There will always be a texture interface between the root ball soil and backfill soil and between the backfill soil and undisturbed site soil. Amending the backfill soil will not diminish the interface. [Figure 25]

To deal with the interface, it is imperative that the root ball comes to the soil surface with no backfill soil over top of the root ball. If backfill soil covers the root ball soil, the interface between the root ball and backfill soil will impede water and air movement into the root ball.



Changes in soil texture (actually soil pore space) create a texture interface that impedes water and air movement.

There will always be a texture interface between the root ball and backfill soil.

Figure 25. To minimize the texture interface, the root ball must come to the soil surface with no backfill over top of the root ball.

Summary on Modifying and Amending

For rapid root establishment, the focus needs to be on planting hole width and correct depth. In most situations, amending or not amending the backfill has little significance compared to other planting protocols.

Optional Step 6. Staking

Staking became a routine procedure when trees were planted in deep holes and the trees sank and tilted as the soil settled. In the *Science of Planting Trees*, where trees are set on undisturbed soil and a ring of soil is firmed around the base before backfilling, staking is not needed in many landscape settings.

In areas with extreme winds, "anchor staking" may be needed for improved wind resilience. In some landscapes, new trees may need "protection staking" to protect trees from human activities (like the football game on the lawn). For additional information on staking, refer to *CMG GardenNotes* #634, Tree Staking and Underground Stabilization.

Step 7. Watering to Settle Soil

Watering is done after staking so the gardener does not compact the wet soil while installing the stakes. Watering is a tool to settle the soil without overly packing it. [Figure 26]

Discussion of how to water recently planted trees is covered in *CMG GardenNotes* #635, Care of Recently Planted Trees.



Figure 26. Water tree during planting; notice how soil has settled.

Step 8. Final Grade

In the wide, shallow planting hole, the backfill soil may settle in watering. Final grading may be needed after watering.



Figure 27. Final grade. Note how the root ball soil is visible on the surface, with no backfill covering the top of the root ball.

Step 9. Mulching

A mulch ring of bark/wood chips is suggested around all trees to help protect the trunks from lawnmower damage. On newly planted trees, organic mulch can increase fine root development by 400% compared to grass competition. This results in 20% faster canopy growth. The increase in growth is due to the lack of competition between the tree and grass and weeds.

Site-specific water needs should be considered regarding the use of mulch. Mulch over the rooting area helps conserve moisture and moderate soil temperatures. However, on wet sites the mulch may hold too much moisture, leading to root/crown rot, and may be undesirable. Wood/bark chips may blow in wind and therefore are not suitable for open, windy areas.

With newly planted trees, do NOT place mulch directly over the root ball. Rather mulch the backfill area and beyond. Never place mulch up against the trunk as this may lead to bark decay. Over the backfill area and beyond, 3-4 inches of wood chip mulch gives better weed control and prevents additional soil compaction from foot traffic. [Figure 28]



Figure 28. Do not make mulch volcanoes. Mulch piled up against the tree trunk may lead to bark decay and reduced trunk taper. Excessive mulch can reduce soil oxygen

Planting Bare-Root Trees

Bare-root nursery stock is sold without an established soil ball and is generally limited to smaller-caliper materials. Some evergreen materials will not transplant well as bare-root stock.

Cost for bare-root stock is significantly lower than the same plant as container-grown or B&B stock. Survivability drops rapidly once the plant leafs out. Some nurseries keep bare-root nursery stock in cold storage to delay leafing.

Roots dehydrate rapidly and must be protected. Bare-root stock is often marketed in individual units with roots bagged in moist sawdust or peat moss to prevent dehydration. Sometimes bare-root stock is temporarily potted to protect roots. Some nurseries maintain bare-root stock in moist piles of sawdust. At the time of sale, plants are pulled from the sawdust and the roots are wrapped with some moist sawdust for transport to the planting site. These need to be planted within 24 hours of purchase.

Techniques for Bare-Root Stock

Bare-root trees are planted with the same basic standards as container-grown or B&B stock, with the modification that the roots are spread out on a horizontal plane as the backfill soil is added. It is critical to minimize exposure of the roots as feeder roots dehydrate in minutes. [Figure 21] Generic steps include:

1. Unpack roots to measure root spread. Cover or repack to protect roots while the hole is dug. Some gardeners like to soak the roots in a bucket of water for a couple of hours. However, do not leave them in the water for more than a half day.
2. Dig a shallow, saucer-shaped planting hole three times the diameter of the root spread. Depth of the planting hole should accommodate the planting depth standards mentioned above.
 - Top of backfill will be one inch above grade.
 - Generally, at least two structural roots should be within the top 1-3 inches of the soil surface.
 - On species prone to trunk-circling roots (such as Crabapples, Green Ash, Hackberry, Littleleaf Linden, Poplar, and Red Maple), the top structural root should be within the top one inch of the root-ball soil surface.
 - The bottom root should rest on undug soil.
3. As backfill is added, spread roots out on a straight, horizontal plane.
4. Most bare-root trees will need staking.
5. Water.
6. Final grade.
7. Mulch.

Generally, at least two structural roots should be within the top 1-3" of the soil surface, measured 3-4" from the trunk. Noted exceptions include species prone to girdling roots, where the top structural root should be within the top 1" of soil.

Top of soil rises 1-2" above grade with backfill soil tapering away.

As backfill is added, spread roots out on a straight, horizontal plane.

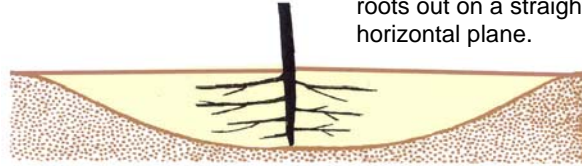


Figure 29. Planting bare-root trees

Shallow, saucer-shaped planting hole 3 times root spread.

Additional Information

CMG GardenNotes on Tree Selection and Planting

- #631 Tree Placement: Right Plant, Right Place
- #632 Tree Selection: Right Plant, Right Place
- #633 The Science of Planting Trees
- #634 Tree Staking and Underground Stabilization
- #635 Care of Newly Planted Trees
- #636 Tree Planting Steps

- Books: Watson, Gary W., and Himelick, E.B. *Principles and Practice of Planting Trees and Shrubs*. International Society of Arboriculture. 1997. ISBN: 1-881956-18-0.
- Web: Dr. Ed Gilman's tree planting information at <http://hort.ifas.ufl.edu/woody/planting.shtml>.

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Photographs and line drawing by David Whiting

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