Colorado Master Gardener[sm] Program
Colorado Gardener Certificate Training
Colorado State University Extension

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 feeder 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 the rapid root growth to reduce the water stress imposed by the limited root system.** *Post planting stress* (transplant shock) is the stress factors induced by the limited root system.

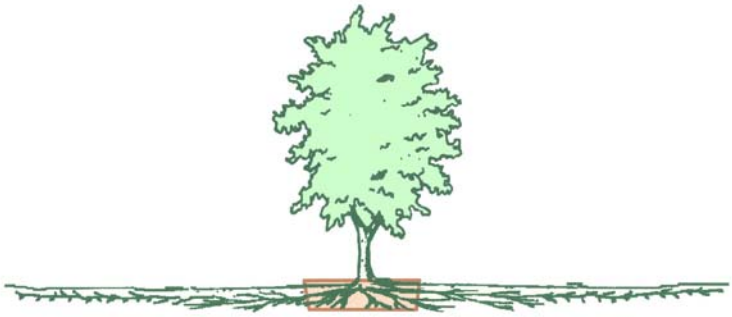


Figure 1. A tree's rooting system is shallow and wide spreading. Based on nursery standards, the container grown or field grown B&B tree has only 5-20% of the fine absorbing roots found on the same size tree in an open landscape. This places the new tree under stress.

Step to Planting Container Grown or Field Grown B&B Nursery Stock

Step 1. Determine Depth of Planting Hole

Planting trees too deep has become an epidemic leading to the decline and death of landscape trees. In the landscape, trunk girdling roots accounts for 57% of all tree deaths. 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 standards[1] for tree planting depth:

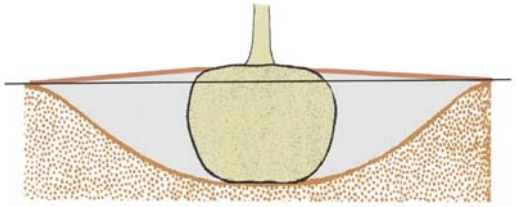
Depth of root ball in planting hole

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 rise about one inch above grade. For larger (2-4 inch caliper) trees, the top of the root balls rise about two inches above grade. Backfill soil should cover the “knees” tapering down to grade. [Figure 2]

[1] 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).

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.



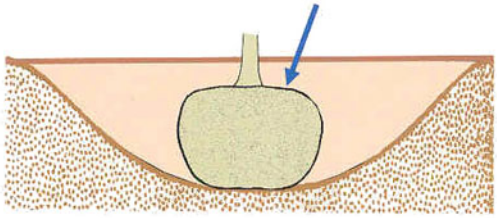


Figure 3. It is imperative that the root ball comes to the surface, with no backfill on top of the root ball. When backfill soil is placed over top of the root ball, the *soil texture interface* impedes water and air movement into the root ball.

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 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, barbeque skewer. Systematically probe the root ball 3-4 inches out from the trunk to locate structural roots and determine 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]

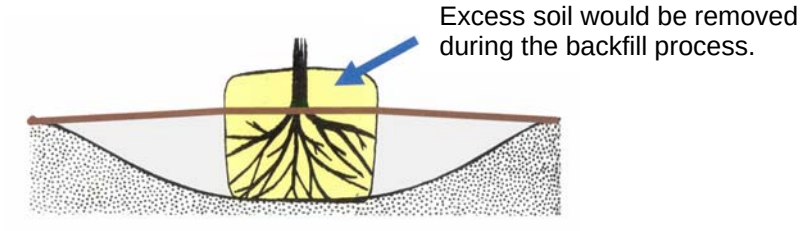


Figure 5. Adjust the depth of the planting hole to bring the root flare to the correct depth.

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]

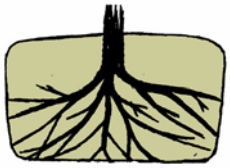


Figure 6. Another issue with soil levels above the root flare is root ball size. With roots only in a portion of the root ball area, the root ball may be too small for the tree to thrive following planting.

Depth of the planting hole should be 1-2 inches less than the height of the root ball. However, planting hole depth may need to be adjusted 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.

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 upwards and outwards 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 7]

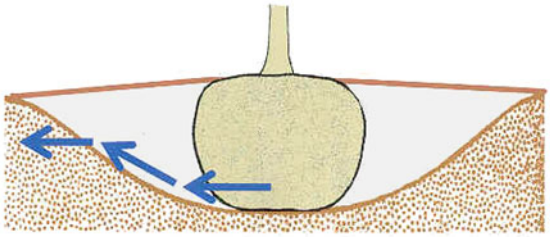


Figure 7. When roots cannot penetrate the site soil (due to low oxygen levels), the saucer-shaped planting hole directs the root upwards and outwards into soils with higher oxygen levels.

Water-logging concerns – The saucer-shaped planting hole actually gives the tree a larger margin for error in over-watering. In the saucer-shaped planting hole three-times the root ball diameter, the upper half contains 85% of the back fill soil and the upper 1/4 contains 75% of the back fill 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 roto-till a 12-24" inch ring of soil around the planting hole after planting. [Figure 8]

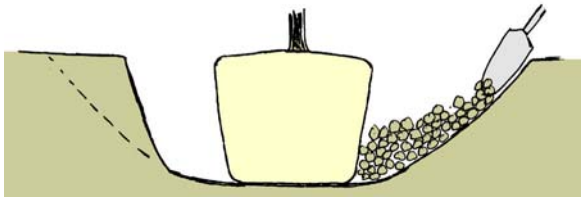


Figure 8. When dug with an auger, cut down the sides into the saucer shape during backfill process.

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, back fill 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 out, not down.

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 was 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

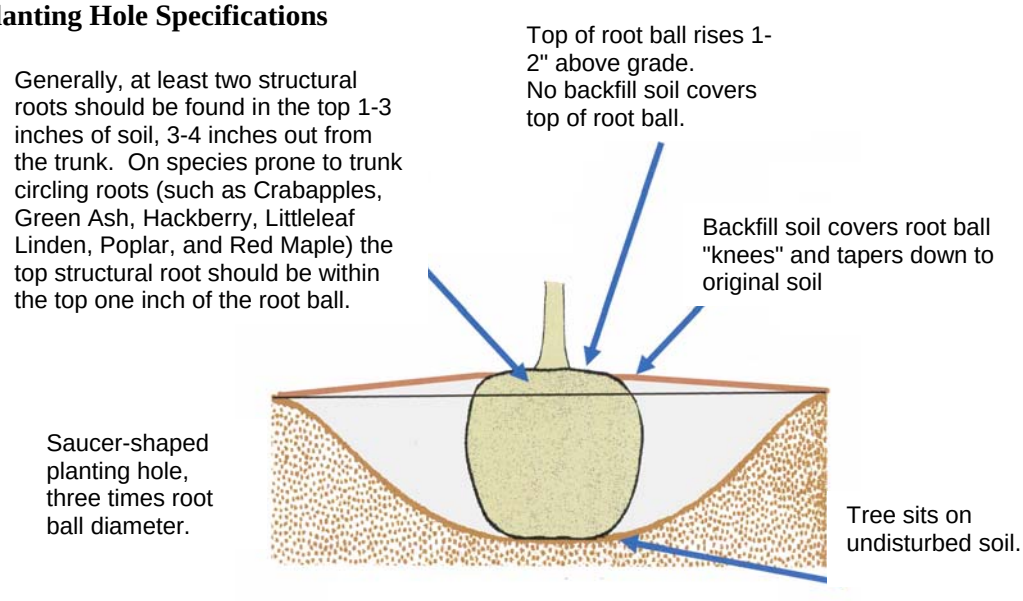


Figure 9. Planting hole criteria to promote rapid root establishment, reducing post-planting stress.

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 10]

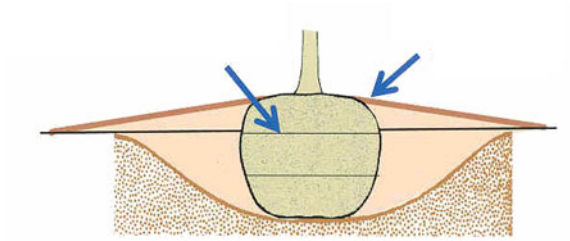


Figure 10. On wet soils, place root ball 1/3 above grade covering knees with soil tapering down to grade.

Modification for Compacted Soils

On extremely compacted soils, roto-tilling a ring around the backfill area to a width of four to five plus 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 11]

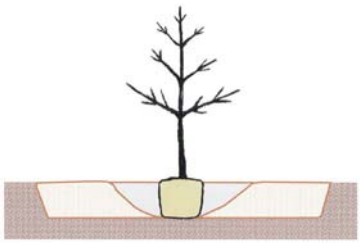


Figure 11. Roto-tilling a ring around the planting hole may help roots spread into compacted soil.

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 12.

Figure 12. 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, pack base, remove wrappings, and check for circling roots. Then with a shovel cut the sides of the planting hole to form the saucer-shape 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 13]

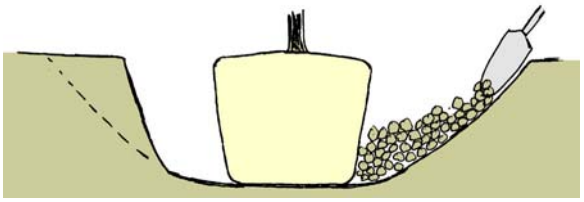


Figure 13. Planting hole widened into saucer-shape during the backfill process.

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 14]

Figure 14. 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 go to the north to avoid winter bark injury. [Figure 15].

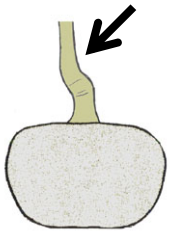


Figure 15. The inside curve of the graft crook or "dogleg" must go to the north to avoid winter bark injury.

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 Burlaped (B&B) Trees*.

Container Grown Nursery Stock

"Container grown nursery stock" includes a variety of production methods where the trees or shrubs are grown in the container. Spread of the root system is limited to the container size. An advantage of the container stock is that it can be planted spring, summer or fall. Container grown stock is common for smaller trees and shrubs.

In container nursery stock, circling roots may 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 not visible from the surface. Several techniques are used in the nursery industry to help minimize the development of circling roots.

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.

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 tree on side in or near the planting hole.
b) Wiggle off or cut off the container.
c) Cut circling roots.
d) Tilt tree into place. Remember that the inside curve of any dogleg goes to the north.
e) Check depth of root ball in planting hole. If needed, remove tree and correct depth of planting hole. Firm any soil return to the bottom of the hole.
f) Align vertically.
g) For stability, firm a shallow ring of soil around the bottom of the root ball. [Figure 16]

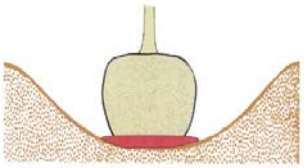


Figure 16. Stabilize the tree by firming a small ring of backfill soil around the base of the root ball.

h) Cut in 1 to 1½ inches, slit down four sides of the root ball cutting circling roots under the surface.

- 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 container 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.
- 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.
- In handling large trees (3-inch caliper and greater) it may be necessary to set the tree in place before removing the container.

Field Grown, B&B Nursery Stock

Field grown, balled and burlaped (B&B) type 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.

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 a 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 tree in place. Remember that the inside curve of any graft crook goes to the north.
c) Check depth of root ball in the planting hole. If incorrect, remove tree and correct 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 17]

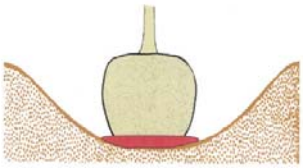


Figure 17. Stabilize the tree by firming a small ring of backfill soil around the base of the root ball.

f) Removed 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) Cut any circling roots and any dehydrated roots sticking out of the root ball.

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 do 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 Under Ground Stabilization*.

Staking became a routine procedure when trees were planted in deep holes and the trees sunk 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 sauce 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 18]

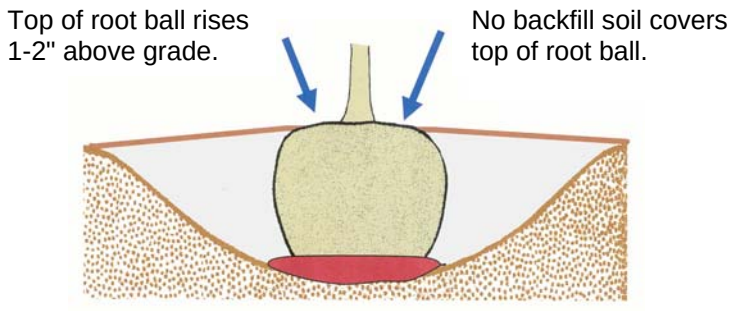


Figure 18. Backfill soil covers the "knees" tapering down to original soil grade. It is imperative that no soil cover the top of the root ball.

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 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. Amended backfill soil may be more supportive to root growth in the planting hole during the first two years. However, amended backfill may also hinder root spread beyond the planting hole.

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.

Container-grown nursery stock is typically in coarse textured soils or planting media (for drainage) with higher organic content (to hold water and nutrients). Since these soils are more prone to drought stress, some arborists prefer to amend the backfill for container-grown trees.

In 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.

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 issue 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 issue. [Figure 19]

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.

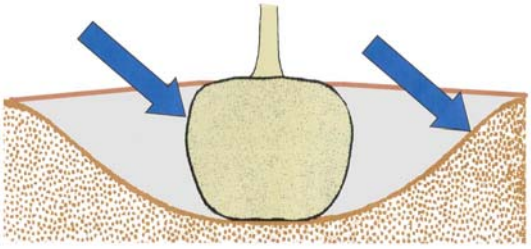


Figure 19. To minimize texture interface issues, the root ball must come to the soil surface with no backfill over top of the root ball.

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 difference between the root ball and backfill soil.

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 protocol.

Optional Step 6. Staking

Staking became a routine procedure when trees were planted in deep holes and the trees sunk 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 people 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 installing the stakes. Watering is a tool to settle the soil without overly packing it.

Step8. Final Grade

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

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 is growth is due to the lack of competition between the tree and grass or 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 help hold too much moisture leading to root/crown rots and may be undesirable. Wood/bark chips may blow in wind and therefore are not suitable for open, windy areas.

On 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 20]

Figure 20. 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 are generally limited to smaller caliper materials. Some evergreen materials will not transplant well as bare rootstock.

Cost for bare-root stock is significantly lower than the same plant as a 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 on a mound of firm soil. 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. Repack to protect roots while the hole is dug. Some planters 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 saucer shaped planting hole, three times the diameter of the root spread. The hole should have a mound of firmed soil in the middle on which the roots will be spread. Height of the mound should accommodate the planting depth standards.

    - Top of back fill will be 1-2” 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.

3. Spread roots on the mound and backfill, lightly packing soil. Pay attention to the correct planting depth of the tree.
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 rise 1-2" above grade with backfill soil tapering away.

Roots spread on mound of firm soil.

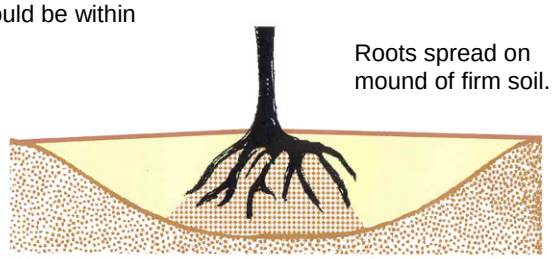


Figure 21. Planting bare-root trees

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 Practices 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

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