MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #630

Tree Planting

References and Review Material

Reading/Reference Materials

CSU GardenNotes

- https://cmg.extension.colostate.edu/volunteer-information/cmg-gardennotes-class-handouts/.
- #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 Recently Planted Trees*.
- #636 *Tree Planting Steps*.

CSU Extension Fact Sheets

- Trees & Shrubs https://extension.colostate.edu/topic-areas/yard-garden/?target=publications#trees.

Other

- Front Range Recommended Tree List, 2024: https://planttalk.colostate.edu/wp-content/uploads/2024/04/2024-Front-Range-Tree-List.pdf.
- Dr. Ed Gilman's Tree Planting Site at University of Florida, http://hort.ifas.ufl.edu/woody/planting.shtml.
- *Principles and Practice of Planting Trees and Shrubs*, Gary W. Watson and E.B. Himelick. International Society of Arboriculture, 1997. ISBN:1-881956-18-0.
- *Woody Landscape Plants for the High Plains,* D.H. Fairchild and J.E. Klett. Colorado State University Cooperative Extension Bulletin LTLB93-1. 1993. To order call the CSU Extension Bookstore at 970-491-0546.
- *Manual of Woody Landscape Plants*, Michael A. Dirr. Stipes Publishing, 2009. ISBN-10: 1588748685.

Learning Objectives

At the end of this training, the student will be able to:

- Discuss Right Plant, Right Place considerations for tree selection and tree placement in a given home landscape situation.
- Plant a tree for rapid root establishment.
- Describe post planting tree care.

Review Questions

Tree Placement & Selection: Right Plant, Right Place

1. What is the average life of a newly planted landscape tree? Why is it so short?
2. Describe functions of trees in landscape design.
3. Define a specimen tree, group planting, and mass planting.
4. For energy conservation, where should trees be placed to maximize summer shading and to maximize winter heating?
5. What percent of the sun's radiation will a tree block on a clear summer day?
6. What percent of the cooling effect of trees comes from evapotranspiration? How do drought and irrigation restrictions influence this cooling?
7. In order, list the four priorities for summer shading.
8. For energy conservation, what is the goal in urban forestry as to tree canopy cover?
9. For noise abatement, where should trees and shrubs be placed?
10. List benefits of shade trees.
11. What is the meaning behind "right plant, right place"? List examples of criteria to consider in selecting a tree species for a site.
12. Explain the criteria for above-ground space and below-ground rooting space in tree selection.
13. What happens when the root system cannot escape the root vault area?
14. Give examples of soil and water related considerations in tree selection.
15. Give examples of maintenance related considerations in tree selection.
16. List factors that play into a tree's hardiness. What does a hardiness zone map talk about hardiness? Explain how hardiness changes through the winter in relation to weather.
17. Explain how the microclimate around a home influences plant selection.
18. Give examples of other criteria in tree selection.
19. Explain the rule of thumb for what it takes to move a tree with a two foot, three foot, and four foot wide root ball.
20. Where do you find standards (regulations) for plant-size-to-root-size relationships for various types of nursery stock?
21. What are the advantages of selecting a small-caliper tree and a larger-caliper tree? Which will be the largest size in five years after planting?
22. Types of stock: Define the following terms and list advantages and limitations of each:
    - Container-grown.
    - In-ground, fabric grow bag.
    - Field-grown – Ball & Burlap (B&B).
    - Field-grown – Balled and Potted.
    - Bare root.
23. To avoid purchasing problems, list key points in the selection and inspection of nursery plants.
24. List key points in handling of nursery stock to minimize post-planting stress.

The Science of Planting Trees

25. What is the most limiting factor in a tree's root growth potential?
26. What percent of the fine absorbing roots will be found in the root ball of a B&B tree versus a container-grown tree?
27. What is meant by the "science of planting trees"?
28. What is the proper depth of a tree in the root ball? How can you tell if it is planted at the correct depth? What should be done by the planter if the tree is planted too deep in the root ball?
29. What is the proper depth of the root ball in the planting hole? Why should the tree sit on undisturbed soil? What should be done if the planting hole is accidentally dug too deep?
30. Explain the benefits of digging a saucer-shaped planting hole three times wider than the root ball. Explain the concerns about it filling with water.

31. If the planting hole is dug with an auger, how can it be readily modified so the tree has the benefits of a saucer-shaped hole?
32. Diagram and label the routine planting specifications, including depth of tree in the root ball, depth of root ball in planting hole, and planting hole depth and width.
33. How are the recommended planting criteria modified for the following planting situations?
    - Wet soil.
    - Compacted/Clayish soil.
    - Planting on slopes.
34. For container-grown nursery stock, discuss considerations in removing the container and setting trees in place.
35. For field-grown, B&B nursery stock, discuss considerations in setting tree in place and removing the wrappings.
36. For B&B materials, why is the wrapping material removed after setting the tree in place and packing soil around the bottom?
    - What about the packing materials on the bottom? Explain why it does not interfere with root growth.
    - What packing materials should be removed from the sides? How far down?
    - Do wire baskets interfere with root growth?
    - Will burlap decay fast enough to not interfere with root growth?
    - How fast does synthetic burlap, fabric grow bags, nylon twine, and wire baskets decay?
37. What should the planter do if the root ball has circling roots? What should the planter do if the root ball has roots sticking way out from the root ball?
38. Explain the statement that “unamended backfill soil” is not the same as unmodified backfill soil.” Discuss the issue of amending the backfill.
39. List the four types of above-ground staking. Describe criteria for each.
40. Describe techniques used in below-ground stabilization.
41. Describe criteria for mulching around a newly planted tree.
    - How deep should the mulch be applied?
    - What about mulch up against the trunk?
    - What is the problem with “mulch volcanoes”?
42. Describe steps in planting bare-root nursery stock.

Care After Planting

43. Describe the plan for watering newly planted trees based on size. How much should be applied? How often? For how long?
44. How should a tree in the establishment phase be fertilized?
45. What is the rule of thumb on how long the establishment phase lasts?

CMG GardenNotes #631

Tree Placement: Right Plant, Right Place

This publication outlines considerations for tree placement in the home landscape. The average life of a tree in the landscape is only eight years due to poor design and planting techniques. Homeowners and landscape designers often place trees in situations where trees have little chance to establish and thrive. Successful tree planting and establishment need attention in these five areas:

- Functional design
- Plant selection
- Pre-plant handling
- Planting techniques
- Post-planting care

Tree Placement in Landscape Design

In landscape design, placement of trees needs careful consideration to function and design elements. Trees are typically the major plant structure in a landscape. Trees give architectural form and organization to space.

In landscape design, trees should not be randomly placed around the property. Rather, place trees as specimens, group plantings, or mass plantings.

Specimen trees – The individual tree becomes the landscape feature. It is set off from other trees and plant materials by unique spacing, form, color, and/or texture. Specimen trees are often, but not always, a focal point in the design.

<u>Group plantings</u> – In group plantings, the trees <u>as a unit</u> become the landscape feature. Groupings are often, but not always, the same species. In group plantings, do not mix contrasting forms.

<u>Mass plantings</u> – In mass plantings, individual trees lose identity and appear as one larger unit in the design. A group planting may grow into a mass planting as trees mature.

Trees serve several key roles in landscape design. They often **define space**. Their spreading branches create a canopy that forms a ceiling for an outdoor room. Because we spend a lot of time indoors, people are more comfortable with this outdoor **ceiling effect**. [Figure 1]

Figure 1. Trees create a comfortable outdoor living space with their "ceiling effect."

Trees are used to **frame and mask views**. Vertical views are effectively framed with trees on both sides. The yard should flow into the view. Avoid specimen plants that draw attention away from the view. [Figure 2]

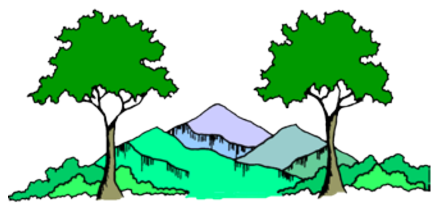


Figure 2. In framing a view, allow the yard to flow into the view.

When framing a house, consider trees in front and to the sides as well as trees that can be viewed over the roofline. For framing, use the point of reference from which most people would view the house rather than straight on. [Figure 3]

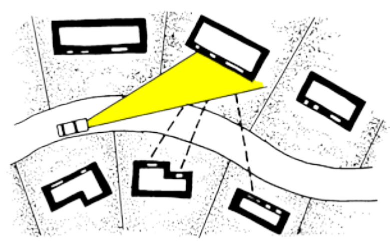


Figure 3. When framing a house, consider how others would look at the home rather than straight on.

Trees and Energy Conservation

Tree placement can play a significant role in energy conservation. Winter sun entering south-facing windows can effectively heat many homes. Summer shade on south- and west-facing windows provides summer cooling.

In evaluating shading and heating patterns, be aware that shade patterns change with the season and with the latitude. [Figure 4]

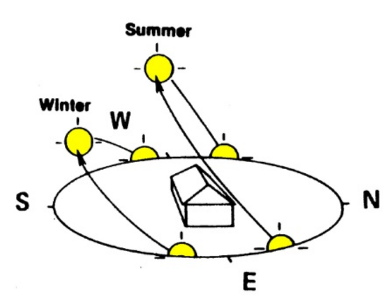


Figure 4. The shade pattern changes with the season and with latitude.

Maximizing Winter Solar Heating

Homes with south-facing windows have a great potential to capture winter solar heat.

In the winter, deciduous tree branches intercept 20-55% of the sun's radiation. For winter energy conservation, avoid placing trees where they would shade the windows in the winter, and open drapes to allow the sun's energy into the home. Winter shade patterns are large, approximately 2½ times the mature height of the tree at Colorado latitudes. [Figure 5]

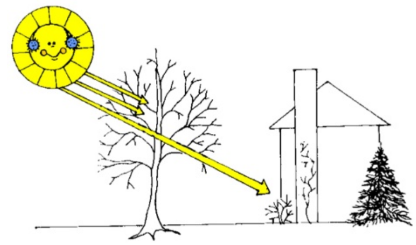


Figure 5. For homes with south-facing windows, tree placement can compromise winter heating potential.

Maximizing Summer Cooling

In the summer, trees block 70-90% of the sun's radiation on a clear summer day. When properly placed, trees can reduce air conditioning demands by 10-30%. Along the Colorado high plains and mountain communities, where temperatures typically cool in the evening, shading a home may adequately moderate temperatures without the expense of air conditioning. [Figure 6]

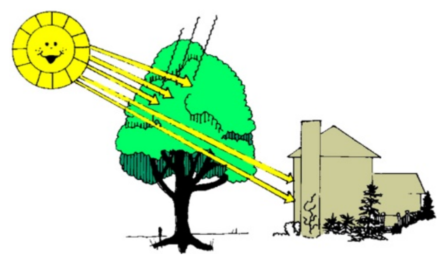


Figure 6. Carefully placed trees can reduce home cooling costs by 10-30%.

Evapotranspiration accounts for 70-80% of the cooling benefit. Under dry conditions (including water restrictions that prohibit landscape irrigation) evapotranspiration shuts down, photosynthesis stops (trees live off carbohydrate reserves), and the cooling effect is reduced. Community temperatures may rise significantly when landscape irrigation restrictions prohibit outdoor watering.

Shading the House

In shading the house, there is a 2-3 hour lag time on sun heat hitting the house and the house becoming extremely hot. Shading priorities at Colorado latitudes include the following:

1. Shade windows on south and west
2. Shade south walls
3. Shade west walls
4. Shade air-conditioning units

Shading Pavement

As illustrated in Figure 7, a paved area stores approximately 50% of the sun's energy. In comparison, a grass area only stores 5% of the energy and uses 50% for evapotranspiration, resulting in a cooling effect. This cooling effect is only operational when the grass has water for active growth.

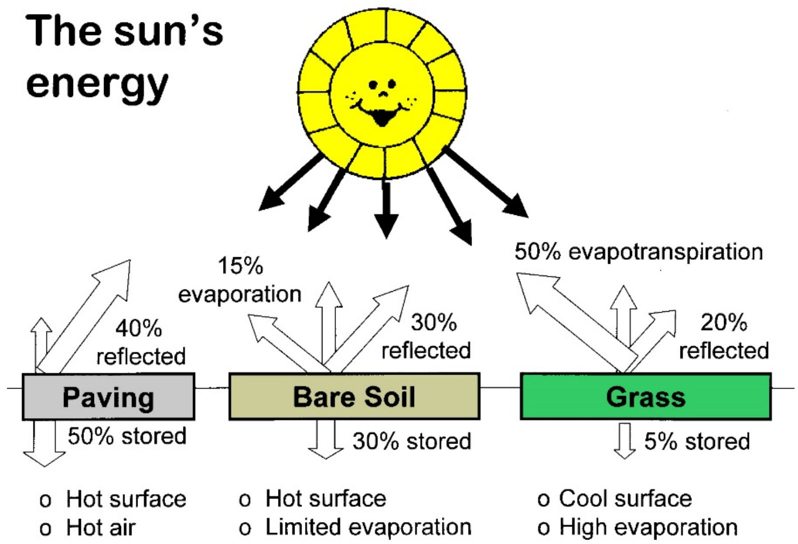


Figure 7. The sun's energy

Another important cooling technique is to shade pavement and other heat-storing materials like the patio and driveway. Also, minimizing paved surfaces helps keep the living area cool. [Figure 8]

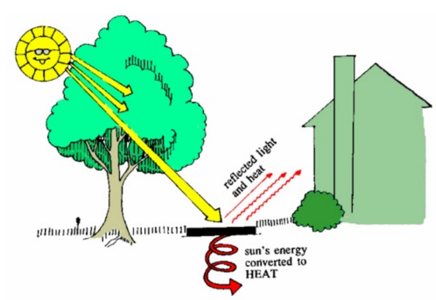


Figure 8. For cooling, shade heat-storing areas and minimize heat-storing surfaces.

Trees and other plant materials may also be used to shield the living space from stored and reflected heat. [Figure 9]

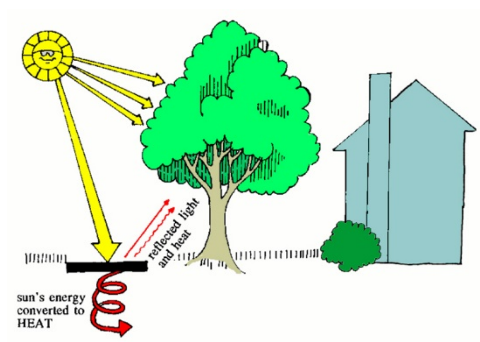


Figure 9. Use trees to cool the air between the heat-storing surface and living space.

Shading Streets

Older communities with tree-lined streets are noted for the pleasing, inviting surroundings that street trees create. Shaded streets are 10°F to 40°F cooler.

However, street trees are often predisposed to poor growth and limited life spans due to poor soil conditions. Tree roots can generally spread under a sidewalk into open lawn areas beyond. Root spread under a street is dependent on the soil properties created during road construction.

When the planting strip between the street and sidewalk is less than eight feet wide, tree health, vigor, and life span will be reduced. In most communities, planting strip width is set by the city ordinance in effect at the time of development.

An effective alternative for tree-lined streets is to plant trees in the lawn eight feet in from the street. This may give trees a better soil environment for root growth, resulting in improved tree vigor, growth, and longevity. In this situation, trees are also less likely to be hit by cars or damaged from road repairs. Eliminating the narrow planting area between the street and sidewalk is also an important water conservation technique as the "mow strip" is difficult to irrigate efficiently.

Noise Abatement with Trees and Shrubs

Tree and shrub hedgerows (planting belts) effectively abate noise pollution. To be most effective, place the hedgerow close to the noise source away from the living area. The hedgerow should be twice as long as the distance from the noise source to the living space. To be effective, the hedgerow needs to be dense. A few trees and shrubs here and there do little to abate noise. [Figure 10]

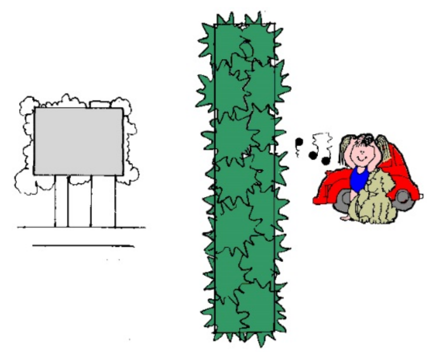


Figure 10. For effective noise abatement, place plant belt next to noise source.

Other Environmental Benefits of Trees

In a study by the USDA Forest Service, the 16,000 street trees in Fort Collins, Colorado, contribute $2.2 million in environmental benefits. The community forest has many important benefits, including:

- Energy saving from heating and cooling
- Noise abatement
- Carbon dioxide reduction – In a Sacramento California study, the carbon sequestration from the community forest more than offsets the inputs from human activity.
- Air-pollution abatement
- Hydrology (stormwater runoff)
- Property values

The USDA Forest Service evaluated the benefits of community forests. For each dollar that a city invests in a community tree program, large trees return $1.92 in environmental benefits. Medium-size trees return $1.36, while small trees return $1.00.
To maximize environmental benefits, the goal in community forestry is to have

50% of the land covered with tree canopy. That is, if we were to look down from an airplane, trees would cover 50% of the area. Here in the west, we have a great need to plant more trees in our communities. In wooded communities, the need may be to thin the forest.

To maximize the benefits of our community forests, homeowners and community leaders need to recognize that the primary benefits occur from large trees. We need to enhance efforts to protect and maintain large trees. We need to plan for large trees in landscape design. Small specimen trees may add to the landscape design, but large trees provide significantly more environmental benefits. We need to plant trees in situations where they have the potential to reach a mature size with longevity.

Growing Space

Size is a primary consideration in tree selection. Trees should fit in the available growing space without pruning. This is of primary concern under utility lines as the utility has the right-of-way. Frequent pruning required to keep utility lines clear adds to our utility rates.

As discussed previously, environmental benefits are significantly greater for larger trees. Consider large tree species whenever the space allows. With proper structural training, large trees have minimal potential for storm and wind damage.

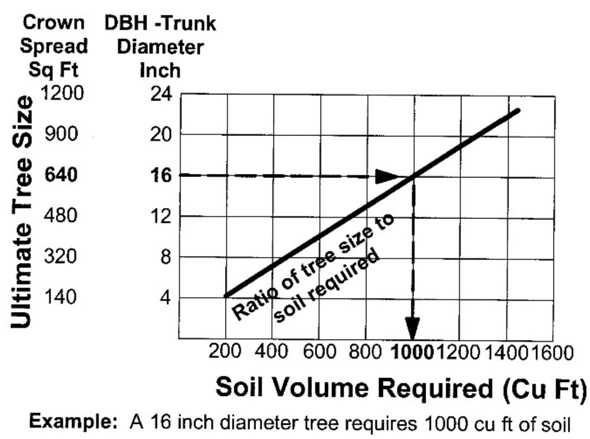
Homeowners often desire fast-growing trees. However, fast-growing species are typically more prone to insects, diseases, and internal decay. Fast-growing species typically have shorter life spans.

Rooting Space

Rooting space should be a primary consideration in tree selection. The mature size, growth rate, and longevity of a tree are directly related to the available rooting space. Many trees in the landscape are predisposed at planting to a short life and limited growth potential due to poor soil conditions and limited rooting space.

Figure 11 shows the relationship between root space and ultimate tree size. For example, a tree with a 16-inch diameter requires 1,000 cubic feet of soil. On a compacted, clayey soil, rooting depth may be restricted to 1 foot or less, and spread would be an area 36 feet in diameter. Anything less will reduce tree size, growth rates, vigor, and longevity. [Figure 11]

Figure 11. Ultimate tree size is set by the rooting space.



Tree roots can generally cross under a sidewalk to open lawn areas beyond. The ability of roots to cross under a street depends on the road base properties. A good road base does not typically support root growth due to compaction and low soil oxygen levels.

The rooting area does not need to be rounded; it can be about any shape. Trees can share rooting space.

Trees in Planters

Trees are often placed in planters and other sites with limited rooting potential. If the roots cannot escape the planting site (root vault) into other soils:

1. Root growth slows when the root vault area is filled.
2. Tree growth slows.
3. Tree declines.
4. Routine replacement is required.

The average life of trees in sidewalk planters and other restricted root vault sites is 8 years. Home gardener and landscape designers need to understand that with restricted rooting space, growth potential, and longevity are reduced accordingly.

Authors: David Whiting (CSU Extension, retired) with Carol O'Meara (CSU Extension). Artwork by David Whiting; used by permission.

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CMG GardenNotes #632

Tree Selection: Right Plant, Right Place

Outline:

The average life of a tree in the landscape is only eight years due to poor design and planting techniques. This publication outlines considerations in tree selection for the home landscape.

Species Selection

Many species of trees and shrubs are well suited to Colorado landscapes. Colorado State University Extension publications listing trees and shrubs for Colorado, including the following:

CSU Extension Fact Sheets available online at www.cmg.colostate.edu.

- Deciduous Shrubs, #7.415
- Evergreen Shrubs, #7.414
- Evergreen Trees, #7.403
- Hedges, #7.208
- Large Deciduous Trees for Street and Shade, #7.419
- Native Shrubs for Colorado Landscapes, #7.422
- Native Trees for Colorado Landscapes, #7.421
- Shrubs for Mountain Communities, #7.407
- Small Deciduous Trees, #7.418
- Trees and Shrubs for Mountain Areas, #7.423
- Xeriscaping: Trees and Shrubs, #7.229

Other Publications

- ***Front Range Tree Recommendation List*** available at http://www.ext.colostate.edu/pubs/garden/treereclist.pdf

In addition, many communities and nurseries have tree lists for local areas. Some communities have small arboretums in local parks where a variety of trees may be viewed.

In selecting trees for a home landscape, remember that there is NO perfect tree. All trees have good and bad characteristics. Select trees based on site considerations as well as personal likes.

The best advice for selecting trees is to intentionally plant a diversity of species in the neighborhood and community. Avoid frequent use of only a few tree species as this increases the likelihood of insect and disease problems. Dutch elm disease spread through the United States due to the over-planting of elm trees. Ash trees became a common replacement for Elms. Now the lilac/ash borer is commonplace. Currently honeylocust is very popular, and pest problems on honeylocust are becoming common. Aspen is popular along the Colorado Front Range. While native to our mountains, it is not native to the high plains and has many problems in irrigated yards along Front Range communities.

Mature Size

Size is a primary consideration in tree selection. Trees should fit in the available growing space without pruning. This is of primary concern under utility lines as the utility has the right-of-way.

Because large trees give a higher return in environmental benefits, plant large tree species whenever the space allows. Large trees can be structurally strong if attention is given to structural training while young.

Growth Rates

Homeowners often desire fast-growing trees. However, fast-growing species are typically more prone to insects, diseases, and internal decay. Fast-growing species typically have shorter life spans.

Soil Considerations

Suitable rooting space is a major limiting factor in tree growth. Poor soil conditions contribute to 80% of tree health issues. Unfortunately, many homeowners and landscape designers fail to consider soil limitations in tree selection and planting. Impacts of poor soil conditions include the following:

- Many trees fail to establish or are slow to establish.
- Growth rates will be reduced.

- Tree vigor will be low, predisposing trees to insects, diseases and other stress factors.
- Mature size will be smaller.
- Longevity will be shorter.

Soil texture, structure, and tilth are considerations in tree selection. Some trees perform poorly in compacted or clayey soils (due to low soil oxygen levels). On compacted or clayey soils, drainage can be a limiting factor. Reference books often list trees that are “flooding or compaction tolerant” as an indication of trees more tolerant of low soil oxygen and more adaptable to compacted or clayey soils. Other trees do poorly in dry sandy soils (due to drought).

If the soil has *free lime*, iron chlorosis is a common problem for some species of trees in heavily irrigated lawns. Avoid planting species susceptible to iron chlorosis (like silver maple and aspen) in this situation. For additional information, refer to *CMG GardenNotes* #223, **Iron Chlorosis**. [Figure 1]

Figure 1. Iron chlorosis (yellowing of younger leaves with veins remaining green) on aspen.

Water Needs and Tolerances

Water needs and tolerances are primary considerations in light of Colorado’s drought cycle. Gardeners need to understand that the water needed to maintain life is unrelated to the water needed for tree growth. Drought tolerance for any tree changes with the life cycle of the tree. Trees listed as drought-tolerant may not be suitable to extremely dry sites or prolonged water stress.

Scientists cannot yet answer the common question, “How many gallons of water does this tree need?” At best, listing of trees more tolerant of dryer sites is only observational based on routine dry spells, not extreme drought situations.

Another common issue about tree selection is tolerance to wet soils. Due to poor irrigation system design, maintenance, and management, most home lawns are significantly over-watered. Some trees, such as crabapples and aspen, are rather intolerant of the excessive irrigation.

Management Concerns

Common management issues are a consideration in tree selection.

Pruning – Trees with a decurrent growth habit are more prone to storm and wind damage. Damage potential can be minimized if the trees are structurally trained while young.

Common insect and disease problems should be a consideration. What are the common pests of the tree? Which are only cosmetic, and which can affect tree health? How tolerant are you of cosmetic pests? Under what situations would management efforts become warranted? What is your interest and willingness to make pest management efforts?

For example, stressed ash trees are highly susceptible to lilac/ash borer that may kill trees. For gardeners unwilling to routinely treat for borers, ash would be a poor choice, particularly on a site with limited rooting area. Aspen are highly susceptible to poplar twig gall when planted in a heavily irrigated lawn. If you do not like this cosmetic damage, do not plant aspen in routinely irrigated sites. Honeylocust are highly susceptible to the honeylocust spider mite (which can defoliate the tree midsummer) when planted on dry sites or with restricted rooting areas. If you are not willing to treat for spider mites, do not plant honeylocust on dry sites or those with restricted rooting areas.

Other maintenance factors include:

- Fruiting habit
- Leaf litter nuisance
- Seed germination
- Root and basal suckering

Climatic Adaptation

Exposure to sun, wind, heat, and cold are considerations in tree selection. Issues related to winter hardiness and winter burn can be reduced with winter watering on susceptible species.

Hardiness zones are an indication of the expected minimum low winter temperature. However, in Colorado we occasionally have an extremely cold winter that challenges the hardiness zone data as we approach record lows.

Hardiness (the ability of a plant to withstand cold) comes from many interrelated factors:

Photoperiod and genetics – The length of night (photoperiod) is the first signal trees receive that winter is approaching. When parent materials are collected from the south and then moved north, they may not be adapted to the differences in photoperiod, and winter damage may be more pronounced. Growers are becoming aware of this important issue in selection of nursery stock.

Minimum temperatures that trees tolerate are set by the plants' genetics and influenced by recent temperatures.

Recent temperatures – A tree's tolerance to cold is heavily influenced by the temperature patterns of the previous few days. When temperatures gradually drop over a period of weeks, trees are generally tolerant of extreme cold. However, trees are less tolerant of extreme cold when it appears suddenly following moderate temperatures.

Rapid temperature change is a primary factor limiting our plant selection. In Colorado it is common to have a spring thaw followed by an "arctic express" back to winter. Temperatures readily drop more than 50°F in an hour.

Water – Woody plants going into winter with dry soil conditions lose approximately 20°F in hardiness. Colorado's dry fall and winter weather reduces plant hardiness. Fall watering, after leaves drop but before soils freeze, helps minimize hardiness issues.

Wind exposure is another factor reducing hardiness in open areas of the high plains. Winter watering helps manage this issue.

Exposure to sun, including reflected sun from snow or structures, contributes to winter bark injury and frost cracks.

Carbohydrate reserves – Plants under stress, with lower carbohydrate reserves, are more susceptible to winter damage. During the drought of 2002-2004, Colorado trees experienced extensive winter injury related to stress, even without extreme cold.

Microclimates – The typical yard has dryer and wetter sites, windy and less windy areas, and warmer and cooler areas. These microclimates may create a site that is more or less suitable for some specific plants.

Other Selection Criteria

- Potential damage to hardscapes (sidewalks, gutters, etc.) from root growth
- Utility right-of-ways for above-ground and below-ground utilities
- Vandalism in public-access sites
- Car damage along streets
- Turf competition and herbicide use
- Pesticide drift from adjacent properties
- De-icing salts

The majority of landscape management problems are traceable back to the design flaws. Care in tree selection and placement will help minimize management problems.

Size Considerations

Size and Establishment

To give the “instant tree” appearance, larger-caliper trees are often the choice for homeowners and public-access sites. However, the root systems of larger trees also take longer to redevelop in the establishment phase of the life cycle before the trees shift into the growth phase. During the establishment phase, canopy growth will be minimal. For this reason, smaller trees are recommended on sites where less than ideal growing conditions exist.

In Hardiness Zones 4 and 5, with good planting techniques and good soil conditions, it typically takes one growing season per inch of trunk caliper (measured at six inches above soil line) for roots to establish following transplanting. That is, a one-inch caliper tree will take one season for the roots to establish, while a three-inch caliper tree will take three seasons. In cooler regions with shorter growing seasons, it will take longer. With longer growing seasons, like the southern United States, the establishment phase will be measured in months.

On sites with poor soils and poor planting techniques, the establishment phase may be longer, and trees must live off carbohydrate reserves until roots become established. It is common to see trees planted with poor planting techniques and/or poor soil conditions that never establish, but rather decline over a period of time. In recent years, poor planting techniques have killed more trees than any insect or disease outbreak!

Moving Trees – A Weight Issue

Size (weight) is another factor in tree selection. It takes two people to move a two inch caliper tree (measured six inches above the soil line). Larger trees require mechanical help. Trees up to four inch caliper can be moved with front-end loaders used in landscape installation. For larger-caliper trees, special tree-moving equipment is required.

Minimum Root Ball Size

The minimum size of the root ball for trees and shrubs is set by the Colorado Department of Agriculture in the ***Rules and Regulations of the Colorado Nursery Act***. [Tables 1 and 2]

Maximum tree size to move with a spade is given in Table 3. It is common mistake to expect tree to live when moved with an undersized tree spade! [Table 3]

Table 1.
Minimum Root Ball Diameter for Nursery-Grown, and B&B Shade Trees

Tree Caliper*	Minimum Root Ball Diameter
½ to ¾ inch	12 inches
¾ to 1 inch	14 inches
1 to 1 ¼ inches	16 inches
1 ¼ to 1 ½ inches	18 inches
1 ½ to 1 ¾ inches	20 inches
1 ¾ to 2 inches	24 inches
2 to 2 ½ inches	26 inches
2 ½ to 3 inches	28 inches
3 to 3 ½ inches	32 inches
3 ½ to 4 inches	36 inches

*Measured 6 inches above soil line.

Table 2.
Minimum Root Ball Size for Coniferous Evergreens

Height	Caliper[1]	Minimum Root Ball Diamter[2]
1 to 2 feet	½ to ¾ inches	12 inches
2 to 3 feet	¾ to 1 inch	14 inches
3 to 4 feet	1 to 1¼ inches	16 inches
4 to 5 feet	1¼ to 1½ inches	18 inches
5 to 6 feet	1½ to 1¾ inches	20 inches
6 to 7 feet	1¾ to 2 inches	24 inches
7 to 8 feet	2 to 2½ inches	26 inches
8 to 9 feet	2½ to 3 inches	28 inches
9 to 10 feet	3 to 3½ inches	32 inches
10 to 12 feet	3½ to 4 inches	36 inches

[1] Measured at 6 inches above the ground
[2] Root ball size based on the larger of height or caliper.
Source, Colorado Department of Agriculture: Colorado Nursery Act

Table 3.
Maximum Size for Tree Spades

Spade Size	Deciduous Trees Caliper	Evergreen Trees Height
44-inch	2-3 inches	5-7 feet
60-inch	3-4 inches	7-9 feet
78-inch	4-6 inches	9-14 feet
85-inch	6-8 inches	14-18 feet

Types of Nursery Stock

Bare-Root Nursery Stock

Bare-root plants are sold without an established soil ball. Bare-root stock is generally limited to smaller-caliper materials. Some evergreen materials will not transplant well as bare-root stock.
The cost of bare-root stock is significantly lower than the same plant as a

container-grown or B&B stock.

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 sawdust. As plants are removed at sale, roots are packed in moist sawdust for transport to the planting site. These need to be planted within 24 hours of purchase.

Survivability drops rapidly once the plant leafs out. Some nurseries keep bare-root stock in cold storage to delay leafing.

Field-Grown, Balled and Burlapped Nursery Stock

Field-grown, Balled and burlapped (B&B) trees are dug from the growing field with the root ball and soil intact. In the harvest process, only 5-20% of the small roots are retained in the root ball, the other 80-95% is left behind in the field. This puts trees under water stress until roots can reestablish. [Figure 2]

Figure 2. Field-grown B&B nursery stock

To prevent the root ball from breaking, the roots are Balled and wrapped with Burlap and twine (knows as 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.

B&B stock is best transplanted in the spring or fall.

The weight of the root ball readily becomes an issue with larger-caliper trees. A two inch caliper tree is the largest size two people can expect to move. Equipment will be needed for larger trees.

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 slows growth, adding to production costs.

Container-Grown Nursery Stock

Container-grown nursery stock is grown in the container. Because the root system is not seriously disturbed, container-grown nursery stock can be readily transplanted throughout the growing season; spring, summer or fall.

Figure 3. Container-grown nursery stock.

Light textured potting mixes are generally used in container production to reduce weight and waterlogging potential in the pot. However, this can make the newly planted tree more prone to drought during the first two years.

Since the roots cannot spread, the root system of container-grown stock will be only 5-20% of that found in field-grown plants. Thus, growth rates in the nursery may be slower.

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.

Selecting Plants – Don't Buy Problems

There are several considerations in plant selection at the nursery, including the following:

- Because **codominant trunks** (trunks of equal size) account for the majority of storm damage, avoid purchasing trees with codominant trunks. A single-trunk tree should have one trunk to the top, and all branches should be less than 1/2 the diameter of the adjacent trunk. (Refer to pruning fact sheets for details.) [Figure 4]

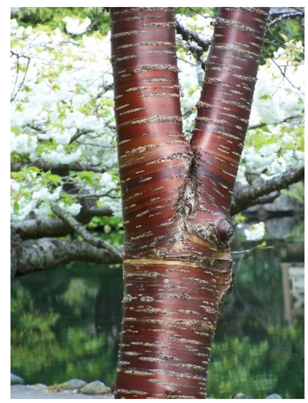

Figure 4. Codominant trunks account for the majority of storm damage. Avoid purchasing trees with codominant trunks or correct the situation with structural pruning.

- Consider what other **corrective pruning** will be needed to structurally train the tree. (Refer to pruning fact sheets for details.) Avoid trees with poor branching structure.

- Any **pruning wounds or bark injury** should be less than one inch or less than 25% of the trunk circumference.

- Trees should have good **growth** the past 2-4 years and good **leaf color**.

- Evaluate the potential long-term impacts of any **insect or disease problems**. While some insect and disease problems are not an issue, others could seriously affect the tree's health. Due to the water stress imposed by the harvest and planting process, young trees are less tolerant of most pests.

- **Planting depth of the tree in the root ball** – Generally, at least two structural roots should be within the top 1-3 inches of the soil surface, measured 3-4 inches out from the trunk. (Refer *CMG GardenNotes* #633, The Science of Planting Trees, for additional details and exceptions.)

  A visible trunk flare is another indication of proper planting depth in the root ball. However, on many small trees the trunk flair is hardly noticeable. A small gap between the trunk and soil indicates that the tree is planted too deep.

- **Healthy roots** are whitish, while dead roots are dark. **Girdling roots** can become a serious problem and will need to be cut in the planting process.

Shipment and Pre-Plant Handling

Pre-plant handling often predisposes new plantings to decline and death. Factors to pay attention to include the following:

- **Handle carefully.** The root ball is subject to cracking, killing the tree.
- **Lift by the root ball**, not the trunk. If lifted by the trunk, the roots may not be able to support the weight of the root ball soil, cracking the root ball.
- **Protect from mechanical injury** during shipment. The bark on young trees is tender and easily damaged by rubbing or bumping against the vehicle.
- **Protect from dehydration** during shipment. A shade cloth gives good wind protection. Many nurseries routinely wrap trees for shipment. Water upon delivery.
- **Protect from wind and heat** until planted.
- **Check water needs daily.**
- When possible, **plant immediately**.
- **Exposed roots** are readily killed by desiccation and should be cut off in the planting process.

Authors: David Whiting (CSU Extension, retired) with Carol O'Meara (CSU Extension).
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MASTER GARDENER
COLORADO STATE UNIVERSITY
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CMG GardenNotes #633

The Science of Planting Trees

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 goal of 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.

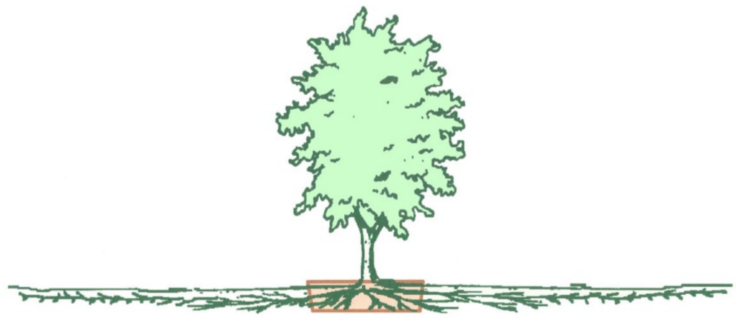


Figure 1. A tree's rooting system is shallow and wide spreading. Based on nursery standards, the container grown or field-grown, balled and burlapped tree has only 5-20% of the fine absorbing roots found on the same size tree in an open landscape. This places the new tree under stress.

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

Note: Call before you dig. Whether you plan on planting the tree yourself or hiring the work done, the site needs to have underground utilities marked before digging to plant a tree. In Colorado, this is easy to do by calling the **Utility Notification Center of Colorado** at 1-800-922-1987 or 8-1-1.) It can also be done online at **colorado811.org**. The utilities will be marketed within 72 business hours, so plan ahead.

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 standards[1] for tree planting depth:

[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).

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 (two to four 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]

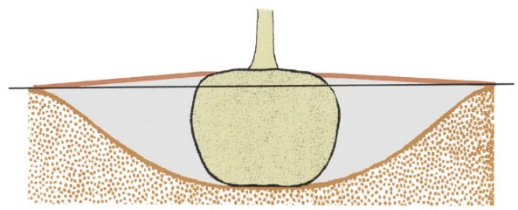


Figure 2. Depth of root ball in planting hole – Top of root ball rises 1-2 inches above soil grade. No soil is placed over top of the root ball. Backfill soil covers the "knees" tapering downward to the original soil grade. Root ball sits on un-dug/firmed soil to prevent sinking.

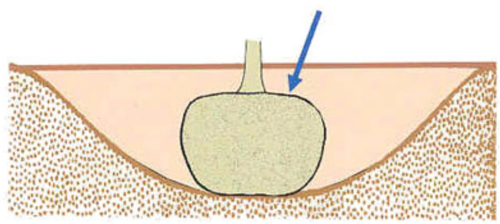


Figure 3. It is imperative that the root ball comes to the surface, with no backfill on top of the root ball. When backfill soil is placed over top of the root ball, the *soil texture interface* impedes water and air movement into the root ball.

Depth of Tree in the Root Ball

- Generally, at least two structural roots should be within the top one to three inches of the root ball, measured three to four 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 barbeque skewer. Systematically probe the root ball three to four 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]

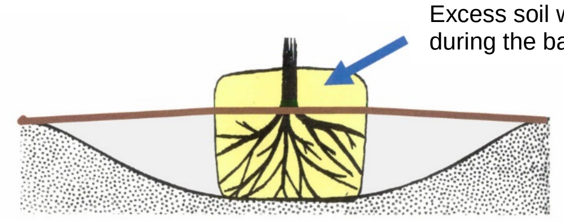
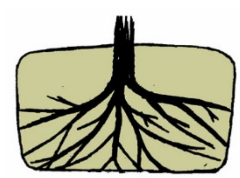


Figure 5. Adjust the depth of the planting hole to bring the root flare to the correct depth.

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.

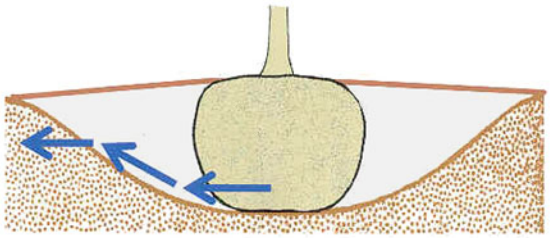
Figure 8. Checking depth of root ball in planting hole with a straight board (like a rake handle).

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 toward 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]

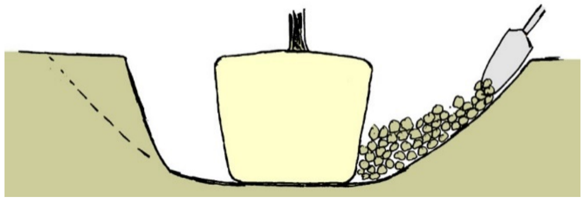
Figure 9. When roots cannot penetrate the site soil (due to low oxygen levels), the saucer-shaped planting hole directs the roots upward and outward into soils with higher oxygen levels.



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.* In soils with great *tilth* (conditions supportive to ideal root growth), width is probably not a minor concern. However, in a compacted clayey soil, typical of much of Colorado, 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.

Twenty-five percent wider – A planting hole with vertical sides that is only twenty-five percent 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.* Narrow planting holes are sometimes used as a labor saving technique. However, on less than idea soils, it will slow root establishment and may predispose the roots to circling.

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. A planting hole two times root ball diameter is common in commercial plantings as a labor savings technique. However, on less than idea soils, it may slow root establishment.

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 (six foot) wide saucer-shaped planting hole. To promote root growth, the planting hole is wide, shallow, and saucer-shaped!

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

Summary: Planting Hole Specifications [Figure 11]

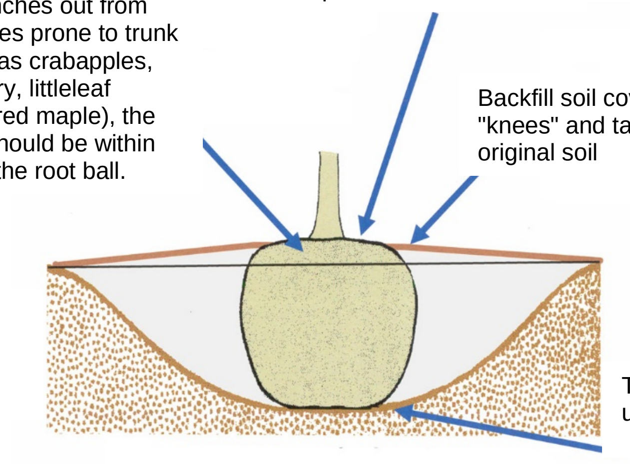


Figure 11. Planting hole criteria to promote rapid root establishment, reducing post-planting stress.

Modification for Wet Soils

On wet soils, raise planting depth so that one-third 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]

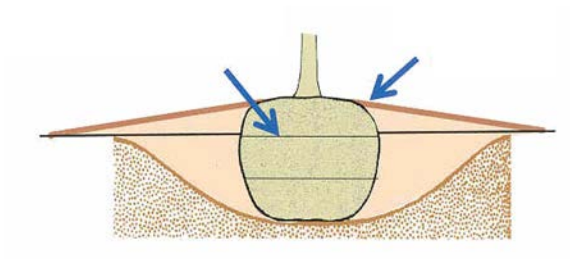


Figure 12. On wet soils, place root ball 1/3 above grade, covering knees with soil tapering down to grade.

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]

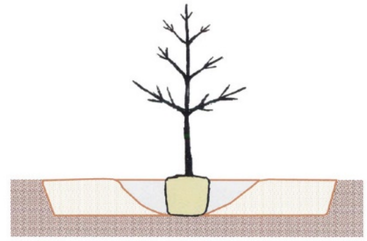


Figure 13. Rototilling a ring around the planting hole may help roots spread into compacted soil.

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]

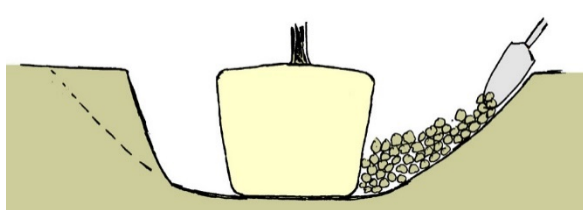


Figure 15. Planting hole widened into saucer-shape during the backfill process.

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]

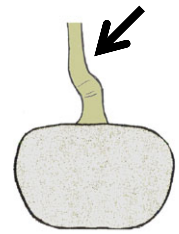


Figure 17. The inside curve of the graft crook or "dogleg" must face north to reduce winter bark injury.

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 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 inch 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 inch 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]

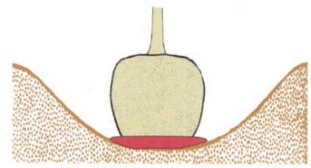


Figure 19. Stabilize the tree by firming a small ring of backfill soil around the base of the root ball.

- 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, Balled and Burlapped 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 previously 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 Balled and Burlapped 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]

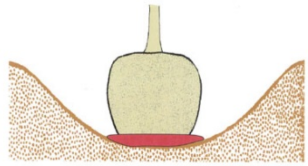


Figure 22. Stabilize the tree by firming a small ring of backfill soil around the base of the root ball.

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 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 23]

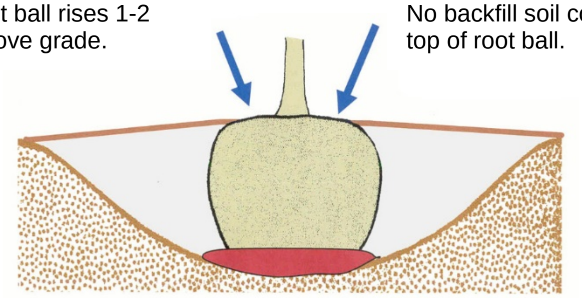


Figure 23. Backfill soil covers the "knees," tapering down to the original soil grade. It is imperative that no soil cover the top of the root ball.

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 previously. 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.

A labor-saving technique is to dig the planting hole two times root ball diameter with rather vertical walls. Then in the backfill step, cut the hole to the three times root ball, saucer-shaped hole. In this method, part of the soil does not have to be moved twice. Peds (dirt clods) up to fist size are acceptable in the backfill (Figure 24).

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.

Amending the Backfill

Amending the soil just in the planting hole is a 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.

Amending the backfill soil to five percent 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.

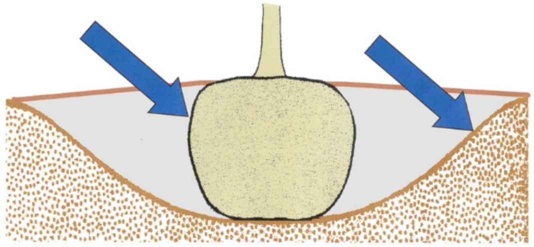
However, amending the backfill to twenty-five to fifty percent is a common mistake! It helps containerize the roots and may also hinder root spread beyond the planting hole. It may hold excessive amounts of water, reducing soil oxygen levels. As the organic matter decomposes, the total volume of soil 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.

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: 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.

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]

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 Nursery 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. Generic steps include the following:

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 previously. [Figure 29]

    - Top of backfill will be one inch above grade.
    - Generally, at least two structural roots should be within the top one to three 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.

Figure 29. Planting bare-root trees

3. As backfill is added, spread roots out on a straight, horizontal plane.
4. Many bare-root trees will need staking.
5. Water the newly planted tree.
6. Final grade.
7. Mulch, as needed

Additional Information

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.

Authors: David Whiting (CSU Extension, retired) with Joann Jones (CSU Extension, retired) and Alison O'Connor (CSU Extension). Photographs and line drawing by David Whiting; used by permission.

Revised October 2014

MASTER GARDENER
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CMG GardenNotes #634

Tree Staking and Underground Stabilization

Staking has been a routine step in the tree planting process. In CMG GardenNotes #633, *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. Staking straps can cause serious injury to trees if improperly attached or left on the tree for too long.

Consequences of Staking

The consequences of staking, using methods that prevent the tree from shifting in the planting hole, include the following:

- The tree grows taller and faster.
- Staking the tree tightly, preventing the lack of movement, can slow root spread.
- Caliper development may be uneven, resulting in the wider caliper development above the staking strap. This is called "reverse trunk taper."
- Staked trees experience more wind damage than un-staked trees of equal height (the top of the tree is not free to bend in the wind).
- Bark is often damaged by the ties.
- If the stake is close to the trunk, it can cause the tree to lean to the side. Keep stakes at least six inches away from the trunk.

Purposes of Staking

No Staking – In most home landscape settings, staking is not necessary if the tree is set on undisturbed soil (where it cannot sink and tilt), with soil firmed around the base of the root ball, which stabilizes the root ball, before backfilling. Exceptions include the three types of staking below.

Protection Staking – This is used where the tree needs protection from human activities.

Protection staking may include standard staking techniques with three or four posts and straps or a structure surrounding the tree but not actually touching the tree trunk. [**Figure 1**]

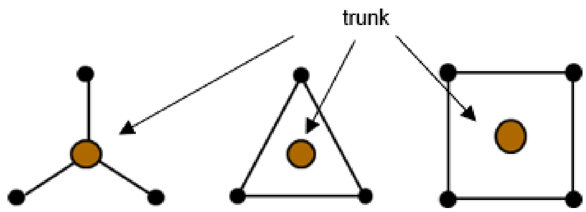


Figure 1. Configurations for protection staking

Anchor Staking – In areas of high, consistent winds, anchor staking may be needed. When anchor staking small trees, use two or three straps along the trunk about eighteen inches above the ground. [**Figure 2**]

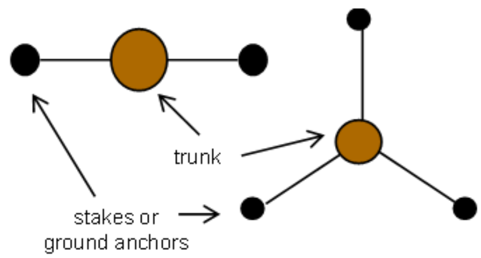


Figure 2. Configurations for anchor staking. Anchor staking may be needed in areas of high consistent winds.

Support Staking – If the tree has a floppy trunk that is not self-supporting, support staking will be needed. Straps would be located six inches above the point where the tree will stand upright, but at least three feet below the terminal leader. Buying trees that are not held to nursery standards is not encouraged – think twice before purchasing trees that cannot support themselves without support staking.

Above Ground Staking Procedures

When staking, use flat, grommeted straps [**Figure 3**] rather than ropes, wires, or hose segments against the trunk. The straps spread the pressure over a wider area, reducing the potential for bark damage. Straps should lie flat against the trunk and should not be bunched up or twisted. Each staking post would have one staking strap. A total of two to three posts and staking straps are routinely used.

Straps may be attached to wood or metal posts or to anchors in the ground. Plastic caps are available as a safety measure for the tops of metal posts. Place posts at least fifteen to eighteen inches out from the trunk. Never attach a post to the trunk, as it can cause the trunk to curve. Flag the guy-lines to help people see them and prevent injury. [**Figure 4**]

Figure 3. Grommeted straps.

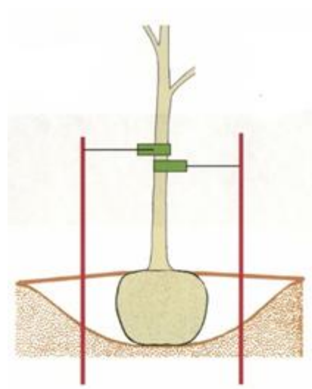


Figure 4. Properly staked tree.

In any staking system, it is best if the tree trunk has a little flexibility and the ability to move in the wind. Movement will encourage root growth and trunk caliper development.

Because staking straps can cause damage to tree trunks, remove them after one growing season. You can determine if the tree has rooted by gently pushing on the trunk and observing the root ball for any movement below the ground. In some cases, a spring-planted tree may be established by the fall and the staking straps can be removed. Staking straps left on trees can cause significant long-term damage and affect overall growth and health.

Underground Stabilization Methods

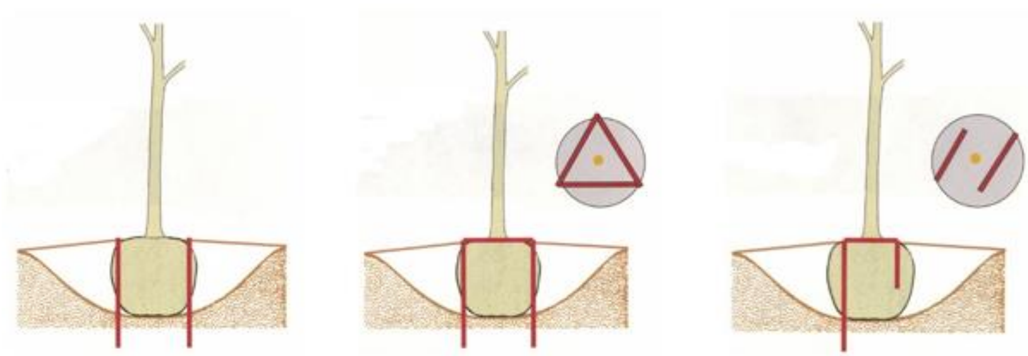
Several methods for underground stabilization are effective. They are applied prior to backfilling the planting hole. [**Figure 6**]

Two or three wood dowels driven into the ground at the edge of the root ball. The dowels will slowly decompose over time.

A 2×2 wood triangle over the top of the root ball is screwed into 2×2 wood stakes driven into the ground at the edge of the root ball. The wood will decompose over time.

Two metal root "staples." Several brands are on the market. The long leg of the staple goes into the ground at the edge of the root ball. The short leg of the staple goes into the root ball. The metal staple may pose a problem if the tree stump needs to be ground out in the future.

Figure 6. Methods for Underground Stabilization



Left: Two to three wood dowels are driven into the ground at the edge of the root ball.
Center: 2×2 lumber makes a triangle plate over the top of the root ball. It is screwed into wood stakes driven into the ground at the corners.
Right: Metal root "staples" are driven into the ground at the edge of the root ball and hook into the root ball.

Authors: David Whiting, CSU Extension, retired and Carol O'Meara, CSU Extension, retired. Artwork by David Whiting and Alison O'Connor. Used with permission. Revised October 2014. Reviewed August 2023 by Alison O'Connor, PhD, CSU Extension.

Reviewed August 2023

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CMG GardenNotes #635

Care of Recently Planted Trees

Root Establishment Phase

During tree establishment, primary growth occurs in the root system, with limited growth in the canopy. The science of planting trees is aimed at encouraging root growth and reducing post-planting stress. For additional information, refer to CMG GardenNotes #633, *The Science of Planting Trees.*

Depending on the size of the tree, it may take several years to fully establish its root system. Nursery trees are generally identified by their trunk caliper, measured six inches above the top of the root ball. A one-inch caliper tree will take 12-18 months to establish its root system following planting; a four-inch caliper tree will take four to six years. Cooler areas at higher elevations may take even longer.

It is difficult to determine when a tree is established following planting, but a sign can be a significant increase in annual twig growth, which indicates that roots have become established and that the tree is shifting into the growth phase. The purpose of this *GardenNote* is to summarize tree care during the establishment phase.

Containerized trees allow planting from spring to fall, if irrigation is available to promote tree establishment. Trees planted in the spring or early summer have a longer period to establish roots, but planting in late summer or early fall can also be successful, if irrigation can be provided until the ground freezes. All trees will benefit from fall and winter watering – refer to the section below.

Watering

Regular irrigation after planting encourages root development for tree establishment. Under-irrigation often leads to slow establishment, canopy dieback, and bark splits (frost cracks and sunscald) on the trunk. Recently planted trees and shrubs can establish quickly with light, frequent irrigation applied directly to the root ball.

Refer to **Table 1** for frequency and the volume of irrigation based on the size of tree planted. This information has been taken from the University of Minnesota publication, Watering Newly Planted Trees and Shrubs, by Kathy Zuzek. **Table 2** provides more detailed information based on the size of the tree planted and irrigation requirements.

Table 1. Irrigation and establishment time of newly planted trees based on caliper size.

Caliper size (measured 6 inches above the top of the root ball)	Gallons of water to apply at each irrigation	Root establishment time
One inch	1 to 1.5 gallons	1 to 1.5 years
Two inches	2 to 3 gallons	2 to 3 years
Three inches	3 to 4.5 gallons	3 to 4.5 years
Four inches	4 to 6 gallons	4 to 6 years
Five inches	5 to 7.5 gallons	5 to 7.5 years
Six inches	6 to 9 gallons	6 to 9 years

Frequency of irrigation should be applied as follows:

- 1-2 weeks after planting, water daily.
- 3-12 weeks after planting, water every 2 to 3 days.
- After 12 weeks, water weekly until roots are established.

Larger volumes of water applied infrequently may result in drought-stressed roots. Soil amendments added at planting do not reduce the need for frequent irrigation. Drought-tolerant and native species are not drought-tolerant until the root system becomes established - watering recommendations from Table 1 should be followed. In sites without ideal irrigation management, smaller-sized nursery stock and waterwise and native species should be considered.

When watering newly planted trees, check the soil frequently and water according to need. The soil could be dry in the root ball and wet in the backfill, or wet in the root ball and dry in the backfill. Monitor irrigation if the tree is planted in a newly sodded/seeded irrigated lawn.

Table 2. Estimated irrigation needs of newly planted trees and shrubs during the growing season.

Size of Nursery Stock	Irrigation Need for Vigor
<2-inch caliper	Daily for two weeks Every 2-3 days for two months Weekly until established
2-4-inch caliper	Daily for four weeks Every 2-3 days for three months Weekly until established
>4-inch caliper	Daily for six weeks Every other day for 5 months Weekly until established

Check if water is needed prior to irrigating; a common mistake on compacted and clayey soils (with poor drainage) is to apply too much water per irrigation, waterlogging the planting hole. Never apply irrigation if soil is saturated. In Colorado's dry, semi-arid climate, there is benefit from applying additional irrigation outside the root-ball area to maintain soil moisture in the rooting area.

Fall and Winter Watering

In Colorado winters without routine moisture, water newly planted trees monthly on sunny days when it is above 40 degrees F and the ground is not frozen. Water early in the day, if possible, to allow water to soak into the ground before it freezes at night. Refer to CSU Extension Fact Sheet #7.211 *Fall and Winter Watering* for additional information.

Mulch

Apply mulch around newly planted trees to protect them from lawnmowers, string trimmers, and grass competition. Wood or bark chip mulch is highly recommended on newly planted trees. Trees with a mulch ring typically have 20% increased growth compared to trees where grass grows up to the trunk, which competes with the tree for resources.

In a landscape setting, the mulch ring is a minimum of two to four feet wide but can be up to the width of the dripline (spread of branches). Apply wood chip mulch at a depth of 4-5 inches thick, which provides better weed control, soil moisture retention, and helps prevent soil compaction.

On newly planted trees, do not place mulch on top of the root ball. On established trees, keep mulch at least six inches away from the trunk. Never pile wood/bark chips up against the trunk. For those in fire-prone areas, do not use organic mulch near homes or structures. Refer to CSU Fact Sheet #6.303 *Fire-Resistant Landscaping* for more information.

Fertilization

During the establishment phase, fertilization needs for newly planted trees are very minimal. Providing high-nitrogen fertilizer may encourage canopy growth at the expense of root growth. In situations where soil fertility is low, but water and other growth factors are not limiting, a half-rate fertilizer application with a time-release product may be acceptable.

Never fertilize trees in the establishment phase that are showing signs of stress. When an unestablished tree is under stress, fertilizers can push new growth that a stressed tree cannot support. Woody plants do not respond to “starter fertilizers” like herbaceous plants.

Pruning

Pruning should be limited to the removal of dead and broken branches and minimal pruning to maintain a single leader or to correct for poor branching structure. When purchasing trees, select trees with good structure that will not require immediate pruning.

Structural training for the tree continues in the growth phase (after the roots have established and the canopy shows significant annual growth). For additional information on structural training, refer to CMG GardenNotes #614, *Structural Pruning of Young Shade Trees*.

In situations where trees will not receive any structural training while young, it may be desirable to correct structural major defects as part of the planting process. This is primarily removal of codominant trunks and spacing of secondary trunks. However, major pruning at planting may slow root establishment.

Authors: Linda McMulkin, with Laurel Potts, Darrin Parmenter, Irene Shonle, and David Whiting, Colorado State University Extension. Reviewed August 2024 by Alison O'Connor.

Reviewed August 2024

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CMG GardenNotes #636

Tree Planting Steps

This publication summarizes the tree-planting process. For an in-depth discussion on tree planting, refer to CMG GardenNotes #633, *The Science of Planting Trees*. The science of planting trees is aimed at promoting rapid root growth (regeneration) to reduce water stress imposed by the planting process. Post-planting stress (transplant shock) consists of the stress factors induced by the reduced root system.

Prior to planting, call before you dig. Whether you plan on planting the tree yourself or hiring the work done, the site needs to have underground utilities marked before digging. In Colorado, call the Utility Notification Center of Colorado at 8-1-1 or 1-800-922-1987. It can also be done online at https://www.colorado811.org/. Utilities will be marked within 72 business hours.

Step 1. Determine the Depth of the Planting Hole

Planting trees too deep is a common problem that can lead to the decline and death of landscape trees. Trunk-girdling roots, sometimes caused by planting too deep, can lead to early tree failure and loss. Trunk-girdling roots develop when a tree improperly planted at the nursery (often being planted too deep in the ground or container) and/or the root ball is planted too deep in the planting hole. These roots may lead to decline and death some twelve to twenty years after planting and may be located above or below ground.

Depth of Root Ball in Planting Hole

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

To deal with the soil texture interface (the differences in soil pore space) between the root-ball soil and backfill soil, it is imperative that the root ball sit slightly above grade with no backfill soil added over top of the root ball. Measure the height of the root ball and subtract 1 or 2 inches to account for the root ball sitting slightly above grade.

For small (1" caliper) trees, the top of the root ball should sit 1" above grade (subtract 1" from the total height of the root ball). For larger (2-to-4" caliper) trees, the top of the root ball should sit about 2" above grade (subtract 2" from the total height of the root ball).

Backfill soil should cover the "knees" (considered the edges of the root ball) tapering down to grade. **[Figure 1]** If the backfill covers the root ball, water and air may be slow to cross the texture interface. This may also result in decreased soil oxygen levels for roots. **[Figure 2]**

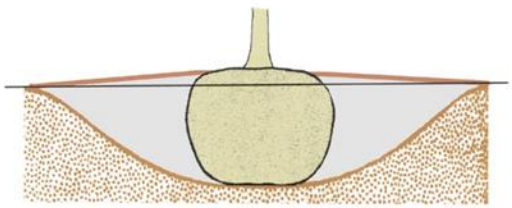


Figure 1. Depth of root ball in planting hole: The top of root ball sits 1-2" above soil grade. No soil is placed over top of the root ball. Backfill soil covers the "knees" tapering downward to the original soil grade. Root ball sits on un-dug, firmed soil to prevent sinking.

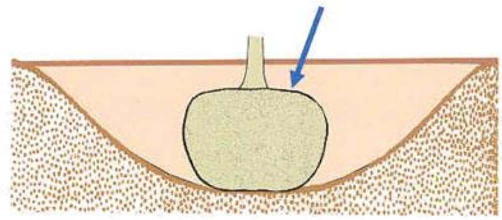


Figure 2. It is imperative that the root ball sits above the soil grade, with no backfill on top of the root ball. When backfill soil is placed over the top of the root ball, the soil texture interface can impede water and air movement into the root ball.

Depth of Tree in Root Ball

- Generally, at least two structural roots should be within the top 1-2" of the root ball, measured 3-4" from the trunk.
- On species prone to trunk-circling roots (crabapples, hackberry, linden, poplar, maple, and other species with fibrous root systems), the top structural root should be within the top 1" of the root ball.

Checking Depth of Tree in Root Ball

- The presence of the root flare is an indication of good planting depth. Be careful not to mistake the swollen graft union as the root flare.
- A good way to evaluate planting depth in the root ball is with a slender implement like a screwdriver. Gently probe the root ball 3-4" out from the trunk to locate structural roots and determine their depth.
- If the tree is planted too deeply 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.

Step 2. Dig a Saucer-Shaped Planting Hole 3X the Root Ball Diameter

The top of the root ball should sit 1-2" above grade and sit on undug soil. The width of the planting hole should be three times the width of the diameter of the root ball. A saucer-shaped planting hole 3 times the diameter of the root ball allows the root system to grow rapidly. [**Table 1]**

Table 1. Reference Chart to Determine Planting Hole Depth and Width

Size of tree	Height of root ball (example)	Top of root ball should sit	Depth of planting hole	Width of root ball	Width of planting hole	Depth and width of planting hole
1" caliper	12"	1" above soil grade	11"	20"	60"	11" deep x 60" wide
2" caliper	18"	2" above soil grade	16"	24"	72"	16" deep x 72" wide

Step 3. Set the Tree in Place and Remove Container/Wrappings

In this step, techniques will differ for container-grown trees, balled & burlapped (B&B) trees, and bare root stock.

Techniques for Container-Grown Nursery Stock

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

1. Lay the tree on its side in or near the planting hole.
2. Wiggle off or cut off the container, including removing any fabric. The ideal container-grown tree has a nice network of roots holding the root ball together. If some of the soil falls off (often on the bottom), it may be necessary to adjust the depth of the planting hole. Adjust the depth of the planting hole based on the new height of the root ball. If most of the soil falls off the roots, the tree should be planted as a bare-root tree (see below section on bare roots).
3. Shave off the outer 1-1 ½" of the root ball with a knife or saw. This step is important to deal with circling roots. Discard the shaved roots.
4. Move the tree into place. Limit using the trunk as a handle. The inside curve of the graft union should face north.
5. Check the depth of the root ball in the planting hole to ensure that the root ball is sitting about 1" above the soil grade. If incorrect, remove the tree and correct the planting hole depth, firming any soil added back to the hole.
6. Align the tree vertically, adding soil to the base of the root ball as needed. Check the tree from several angles to ensure the trunk is vertical/straight.
7. Firm a shallow ring of soil around the bottom of the root ball to stabilize it and potentially eliminate the need to stake. **[Figure 3]**

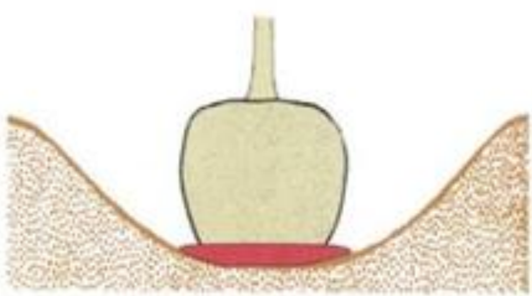


Figure 3. Stabilize the tree by firming a small ring of backfill soil around the base of the root ball.

Techniques with B&B Nursery Stock

B&B trees and shrubs are dug from the production field with the root ball soil intact. An advantage of the wider planting hole is that it gives room for the individual planting to remove the root ball wrappings after the tree is situated in the hole.

Based on research, the standard recommendations are to remove the root ball wrapping materials (burlap, fabric, grow bags, twine, ties, wire basket, etc.) from the upper twelve inches or 2/3 of the root ball, whichever is greater after the tree is set in place. Removing these materials outside of the planting hole and then moving the tree into the hole may cause the root ball to shatter. The materials left in the planting hole are not a concern since roots grow outward, not downward. Actual planting techniques in this step will vary.

Generic steps include:

1. Remove any extra root ball wrappings added for convenience in shipping and marketing (like shrink-wrap, ties, or a container). However, do not remove the burlap, wire basket, and twine that hold the root ball together until the tree is set in place and in the hole.
2. Set the tree in place in the planting hole. The inside curve of the graft faces north.
3. Check the depth of the root ball in the planting hole and ensure the top of the root ball sits 1-2" above the soil grade. If incorrect, remove the tree and correct the planting hole depth, firming any soil added back to the hole.
4. Align the tree vertically and check it from several angles to ensure the trunk is straight. If the tree is crooked, add soil under the root ball.
5. Remove all the wrapping (burlap, fabric, twine, wire basket, etc.) on the upper twelve inches or upper 2/3 of the root ball, whichever is greater.
6. For stability, firm a shallow ring of soil around the bottom of the root ball. This is done to eliminate the need to stake in many situations. **[Figure 4]**
7. 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. You can also remove these roots with a pair of pruners if the roots are larger.

Leaving burlap, twine, and wire baskets on the sides of the root ball are not acceptable planting techniques.

Techniques to Plant Bare Root Nursery Stock

Bare root trees are planted with the same basic steps as container-grown or B&B stock, with the modification that the roots are spread out on a mound of soil in a horizontal plane in the planting hole. It is critical to minimize exposure of the roots as feeder roots can dehydrate quickly.

Generic steps include the following:

1. Unpack roots to measure horizontal root spread. Cover or repack to protect roots while the hole is dug. Consider re-hydrating roots in a bucket of water for a couple of hours. Do not let them soak for more than half a day.
2. Dig a shallow, saucer-shaped planting hole three times the diameter of the root spread. The depth of the planting hole should accommodate the planting depth standards mentioned previously.
    a. Create a mound of soil at the base of the planting hole. The mound's height would be based on the tree's root structure and where the first structural roots are located. Generally, at least two structural roots should be within the top 1-2" of the soil

   surface. The mound height will take some trial and error.
   b. On species prone to trunk circling roots (such as crabapples, hackberry, linden, poplar, and maple), the structural roots should be within the top 1” of the root ball soil surface.
3. Gently spread the roots out on top of the mound on a straight, horizontal plane.
4. As backfill is added, gently tamp the soil around the roots and gently pull up on the tree to help fill in the air pockets around the roots. Do not stomp the soil with your feet but press on the soil to help secure the tree in place.
5. Many bare-root trees will need staking.

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 at the correct depth, firm a ring of soil around the base of the root ball to stabilize it, remove wrappings, and correct 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 falls back into the hole.

Step 4. Underground Stabilization (if Needed)

One option in tree planting is to use underground stabilization of the root ball rather than aboveground 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. It is also commonly done in public areas. In *The Practical Science of Planting Trees* (Gary W. Watson and E.B. Himelick, International Society of Arboriculture), 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 most landscape settings.

Step 5. Backfill

During the backfill process, the best method is to simply return the soil that was removed during digging the hole and let water settle it. Backfill should not be placed on the top of the root ball. The backfill soil should cover the root ball "knees" tapering down to the original soil grade.

Amending the soil in the planting hole is a complex issue and has been researched extensively. In tree planting, it is a common procedure to amend backfill soil with organic matter, such as compost. Amending the backfill soil to be five percent organic matter by volume is acceptable and may be supportive to root growth in the planting hole during the first two years. However, amending the backfill to twenty-five to fifty percent organic matter may also hinder root spread beyond the planting hole, hold excessive amounts of water, and decompose, reducing the total volume of soil in the planting hole.

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

Step 6. Staking (if Needed)

When trees are set on undisturbed soil and a ring of soil is firmed around the base before backfilling, staking is not needed in most 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 a soccer game on the lawn).

Step 7. Water to Settle Soil

Watering is done after planting and staking so the gardener does not compact the wet soil by walking on the area. It may take several applications of water to thoroughly soak the backfill and allow the soil to naturally settle so the final soil grade can be established. Watering settles the soil without overly packing it.

Step 8. Final Grade

In the wide, shallow planting hole, the backfill soil is likely to settle during watering. Final grading may be needed after watering.

Step 9. Mulch

A mulch ring of arborist wood chips or bark mulch is suggested around all trees to help protect the trunks from lawnmower and string trimmer damage. Mulch over the rooting area helps conserve moisture, moderate soil temperatures, and helps prevent weeds. Wood/bark chips may also blow away and may not be suitable for open, windy areas. Also consider the location of the trees and practice fire-wise landscaping techniques.

With newly planted trees, do NOT place mulch on top of the root ball. Mulch the backfill area and beyond. Avoid piling mulch against the trunk. Use several inches of arborist chips (four to five inches) to provide the best benefits.

Planting Summary

[**Figure 4]**

1. The tree sits on undisturbed soil.

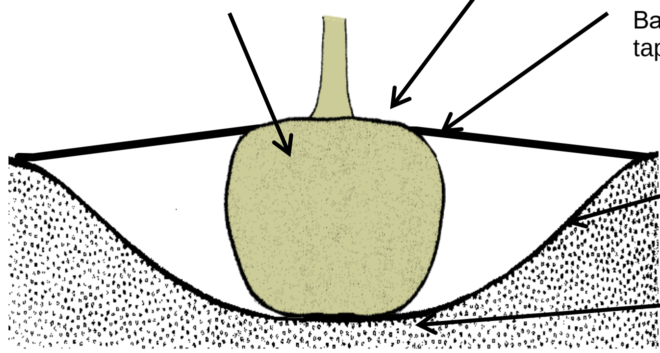
2. The saucer-shaped hole is 3x the root ball diameter.

3. At least two structural roots are within the top 1-3” of the soil surface, measured 3-4” from the trunk. Species prone to circling roots should have their top structural root within the top 1” of soil.

4. No backfill soil covers the top of the root ball. Soil covers the root ball knees and tapers down to the original soil grade.

5. The top of the root ball rises 1-2” above the original soil grade.

Figure 4. Diagram Showing All Planting Steps.



Authors: David Whiting (CSU Extension, retired), with Alison O’Connor (CSU Extension). Line drawings by David Whiting; used by permission. Reviewed August 2024 by Alison O’Connor.

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