MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #651

Fertilizing Shade Trees

When gardeners fertilize lawns, they see a quick response as the lawn greens up within days. The response is different with trees; it happens over a period of months as a re-balance of canopy and root growth. When growth-limiting nutrients (nitrogen) become available through fertilization, the tree shifts more resources into canopy growth and correspondingly less into root growth.

Nitrogen is the nutrient most limiting to tree growth. Symptoms of nitrogen stress in woody plants are unlike those in lawns and herbaceous plants. Trees with nitrogen stress simply slow canopy growth rates, but do not show the characteristic yellowing of older leaves like lawns and herbaceous plants.

Nitrogen should be applied to trees only in a controlled release/slow release form.

A tree's need for phosphorous and potassium is rather low. Colorado (western) soils are typically adequate in phosphorous and potassium. Phosphate fertilizers have not been shown to increase tree growth even on soils marginal low in phosphorus. Excessive levels of phosphorus can aggravate an iron chlorosis problem.

Iron is a common deficiency in some tree species. Iron chlorosis is usually aggravated by spring- time overwatering and by trunk girdling roots (tree planted too deep).

Fertilizer Application Rates

The need for fertilizer varies with the tree's growth phase.

Establishment phase - recently planted trees

During the root establishment phase, the growth objective is root growth. Nitrogen fertilizer increases canopy growth with a corresponding decrease in root growth, which is undesirable in this phase.

As a rule-of-thumb for Hardiness Zone 4-5, the establishment phase for recently transplanted trees lasts one year for each inch of trunk caliper (measured at 6" above ground level). In other words, the establishment period for a one inch caliper tree is typically one year, and three years for a three inch caliper tree. The establishment phase may be longer on sites with poor soil tilth, limited irrigation, and with poor planting techniques.

Unlike herbaceous plants, woody plants do not respond to "rooting fertilizers" (water soluble fertilizers) applied at planting. During the root establishment phase, fertilizer applications should be kept to a minimum, as follows:

- If the soil organic content is moderate to high (3-5% organic matter), no additional fertilizer is warranted.
- If the soil organic content is low (1% or less), a light application of a controlled release (slow release) nitrogen may be beneficial. Application should not exceed 0.1 pound actual nitrogen per 100 square feet (based on the area off the planting hole). Do not apply fertilizer on a site with growth limiting factors such as a limited irrigation.

Growth phase

Significant branch growth indicates a shift from the root establishment phase into the growth phase. In this growth phase, fertilization can encourage faster growth if desired. Application rate is based on several factors:

1. Natural growth rate of the tree – Use higher rates on faster growing species if rapid growth is desired.
2. Growth limiting factors such as limited irrigation, severe soil compaction, or limited root spread potential – Do not force growth. Heavy fertilization can push canopy growth that the roots cannot support in summer heat and wind.
3. Soil organic content
4. Desired growth rate. If rooting and/or canopy space will be limited for the maturing tree, you may not want to push growth.

The table on page 3 illustrates rate adjustments based on these factors.

Mature maintenance phase

As trees reach a mature size and growth slows, the need for nitrogen drops. In the maturing maintenance phase the standard maximum rate is 0.2 to 0.4 pounds nitrogen per 100 square feet over a 4-year period. It may be applied annually or with multi-year applications using controlled release fertilizers. Over fertilization may push canopy growth that a limited rooting system cannot support in summer heat and wind, leading to early decline. The table below shows rate adjustments based on soil organic content.

Application rate based on growth phase and soil organic content

The fertilizer application rate should be adjusted according to soil organic content as indicated in the table below.

Tree fertilizer rates based on growth phase and soil organic content

	Nitrogen application rate[1 & 4] (Pounds nitrogen per 100 square feet)		
Soil organic content	**Low** (0-1%)	**Medium** (2-3%)	**High** (4-5%)
Establishment phase	0 to 0.1 lbs/year	0	0
Growth phase			
Faster growing species[2]	0.2 to 0.4 lbs/year	0.1 to 0.2 lbs/year	0
Routine rate	0.1 to 0.2 lbs/year	0.05 to 0.1 lbs/year	0
Mature phase[3]	0.2 to 0.4 lbs / 4 years 0.1 to 0.2 lbs / 2 years 0.05 to 0.1 lbs / year	0.1 to 0.2 lbs / 4 years 0.05 to 0.1 lbs /2 years 0.025 to 0.05 lbs / year	0

1 Do not exceed lower rates to trees with growth limiting factors (such as limited irrigation, severe soil compaction, or limited root spread potential).
2 Use high rate only on fast growing species without any growth limiting factors where rapid growth is desired.
3 For multi-year applications, use controlled/time release products.
4 In lawn areas, do not apply more than 0.1 pounds nitrogen per 100 square feet per application. When higher rates are needed, split the application.

Time of year

The best time of year to fertilizer is early spring (4-6 weeks before bud break) or late fall after leaves drop (and soil temperatures are above 40^{o}). Avoid late summer and early fall fertilizations as they may interfere with winter hardiness.

Area to fertilize

Fertilizer application rate is based on the area of the ***Tree Protection Zone, TPZ***. To calculate a tree's TPZ area, first determine the ***Critical Root Radius,*** CRR, and then calculate the area in the TPZ using the CRR. The CCR typically extends a little beyond the drip line. The TPZ area is typically about 40% larger than the area in the drip-line for mature trees.

Calculating the CCR by the circumference method

1. Measure the circumference (inches around the tree) at 4.5 feet high.
2. Divide the number by 2.

3. Express the results in feet. This is the critical rooting radius.

Example:

1. Circumference = 24 inches
2. 24/2 = 12
3. CRR = 12 feet

Calculating the area (square feet) in the TPZ

To calculate the area in the TPZ, use the formula:

$CCR^2 \times 3.14 = TPZ$

Example: 12 feet x 12 feet x 3.14 = 452 square feet

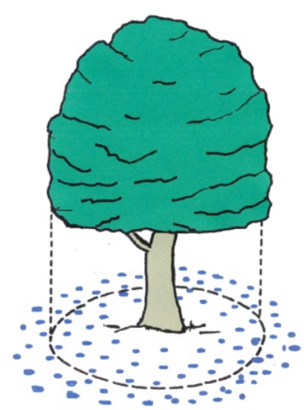
Unrestricted rooting area – For trees with an unrestricted rooting area (i.e., open lawn area) base the fertilizer application rate on the ***Tree Protection Zone, TPZ.*** This is the area where the fertilizer will be applied.

Trees with confined root zones – Calculate the fertilizer rate based on the **open** area within the TPZ, (i.e., the TPZ area not covered with sidewalks, driveways, streets, buildings, etc).

Fertilizer Application Methods

Broadcast applications are quick and easy. However, an actively growing turf takes up most of the soluble fertilizer within 48 hours.

An alternative is to apply the fertilizer in a series of holes or plugs drilled into the soil around the TPZ. Use caution to avoid hitting sprinkler lines and underground utilities.



Make plug holes:

- 1 ½ to 2 inch diameter
- 4-6" inches deep
- 2 foot intervals
- 2-5 rings around TPZ area
- Backfill with sand, compost, or vermiculite

Trees in Turf

In full sun, a healthy lawn has 20 to 400 times more root length than woody plants. The lawn will absorb most of a water-soluble nitrogen fertilizer applied within 48 hours. The following table summarizes the relationship to lawn fertilizer and tree fertilization.

Trees in Turf

Lawn Quality	Tree Grow Phase: Growth Phase	Tree Grow Phase: Mature Maintenance Phase
Routinely fertilized, actively growing, thick	**L**awn fertilization adequate for trees If rapid growth is desirable on faster growing species, supplemental vertical fertilization may be beneficial. Do not force growth when limiting factors exist, such as limited water, severe soil compaction or limited root spread potential.	**L**awn fertilization adequate for trees
Thin	Before fertilizing, evaluate why the lawn is thin and how this affects potential tree growth.	High nitrogen rates could push undesired tree canopy that roots cannot support in summer heat and wind.

Fertilizing Stressed Trees

When plants appear stressed, a common reaction is to fertilize. However, this can actually aggravate stress. Before fertilizing a stressed tree, evaluate whether or not a push of canopy growth with the corresponding decrease in root growth is desirable.

Nitrogen fertilization shifts the tree's balance of growth, favoring the canopy. If the stress is root related (i.e., soil compaction, restricted root spread, construction damage, extensive storm damage), this shift will aggravate it. Do not apply high levels of fertilizer to trees with root problems.

The tree invests energy reserves to take up nutrients. Thus, the short-term effects of a heavy fertilization will be an immediate reduction in a tree's carbohydrate levels, aggravating stress. If the tree shows severe stress, do not apply high levels of fertilizers. Work to alleviate stress factors to the extent possible.

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CMG GardenNotes #652

Tree Preservation During Construction

In tree preservation, take steps to prevent construction damage, as little can be done to correct it!

This CMG GardenNotes was written as an overview of tree preservation issues in a construction site. For additional information refer to:

- ***Trees and Development, A technical Guide to Preservation of Trees During Landscape Development*** by Nelda P Matheny and James R Clark. International Society of Arboriculture. 1998. ISBN: 1-881956-20-2
- ***Up By Roots: Healthy Soils and Tree in the Build Environment*** by James Urban. International Society of Arboriculture. 2008. ISBN: 1-881956-65-2

Guiding Principles of Tree Preservation

1. Goals in tree preservation include both *construction* AND *tree preservation.*

- Both goals have to be valued.
- Both sides have to make compromises.
- Polarizations of attitudes include 1) that it is cheaper, easier and faster to remove all trees at the start and 2) that all trees need to be saved. For tree preservation, comprise must be found in the middle.
- The goal is not to preserve trees just until occupancy occurs, but rather for twenty plus years.

2. **Preservation requires commitment of all parties, as a team effort.**

- Owners
- Engineers
- Architects and landscape architects
- Grading and demolition crews
- Construction and landscape crews
- Government agencies
- Arborists, who's role includes
    - Technical resources and tree knowledge
    - Familiar with local regulations and regulatory staff
    - Familiar with local growing conditions

3. **Tree preservation cannot wait until construction or afterwards.**

- Tree preservation takes place in the planning phase.
- Construction crews then follow the plans.

4. **All trees cannot and should not be preserved.**

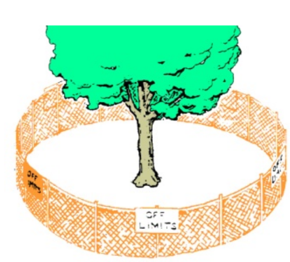
- Trees require that space be protected for their roots.
- Trees in poor health simply will not tolerate construction stress.
- Trees with poor structure have limited value.

5. **Tree preservation patterns must respect patterns of tree growth.**

- All players in design and construction must respect the ***Tree Protection Zone, TPZ.*** .

Trees have a root plate system, shallow and wide spreading.

6. **Tree preservation requires above and below ground space.**

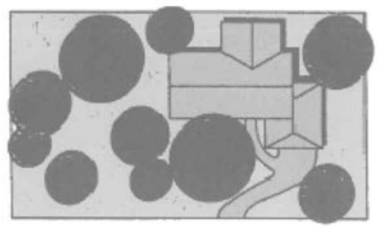


- Inside TPZ there is NO grading, trenching, parking, stock piling of building materials or dumping of waste products.

7. **Preservation focuses on preventing injury to trees, as little can be done to correct injury.**

8. **Construction impacts to trees are cumulative.** Small impacts add together for stress and tree decline.

9. **Tree preservation requires accurate site information.**



- Location of buildings, utilities and hardscape features
- Location of trees
- Species identification and tolerances to construction stress
- Evaluation of tree health and potential for preservation

10. **Arborists and design/construction professionals must communicate.**

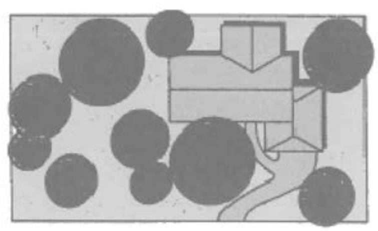
- Talk in technical terms.
- Both sides must be willing to compromise.

11. **Community attitudes and practices must support both tree preservation and development.**

- A compromise must be found between the polarizations of 1) aggressive tree preservation ordinances and practices that prohibit construction and 2) ignoring tree preservation in favor of construction.
- The same standards should apply to both private and public sector development.

Development Sequence

1. **Site design including *__tree report__***



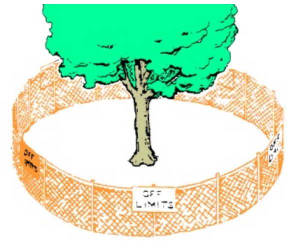
- Requires communication and compromise between all parties.
- This is the most important step in tree preservation.

2. **Review and approval by public agency**

- Conditions of approval
- Bonding: appraised value of trees preserved
- Permits

3. Site work

1. Tree work



- Tree work needs to be completed before other activities start.
- Due to construction schedule, the time frame for tree work may be very short.
- Tree protection needs to be in place during site work.

2. Demolition and clearing
3. Grading
4. Utilities and roads

4. Construction and landscaping

- Tree protection needs to be in place during site work.
- Implement *tree maintenance during construction plan.*
  - How/who will the tree be protected during construction?
  - How/who will the tree be watered and cared for during construction?

5. Occupancy

- Implement *post-construction maintenance plan.*
- In tree preservation, it should be expected that the tree lives for twenty plus years, not just until site occupancy.

Tree Report

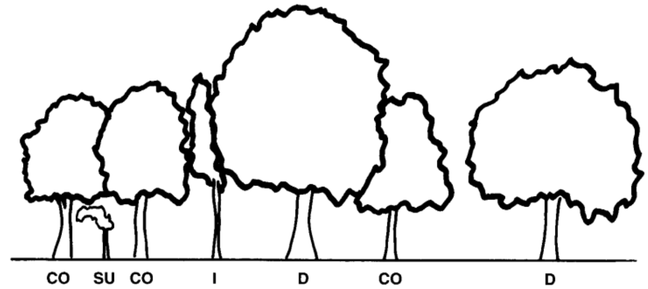
Step A – Inventory and Evaluation

- Identify trees suitable for preservation.
  - Species
  - Size
  - Health and vigor
  - Structural integrity
  - Age – Young trees are more tolerant of construction stress.

  - Species tolerance to construction stress
  - Maintenance requirements

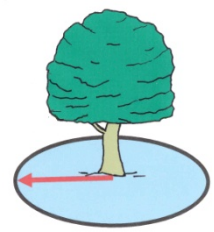
  - Trees suitability to new use
    - Group or specimen trees – Trees are often easier to preserve in a grouping rather than specimen trees.

- **Crown class**



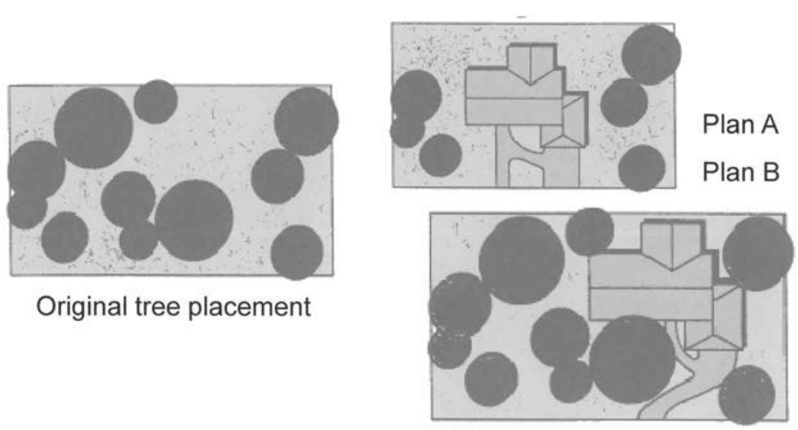
- ✓ ***Dominant trees*** make the best options for preservation.
- ✓ ***Co-dominant trees*** are best preserved in groupings.
- ✓ ***Intermediate trees*** make a poor choice for preservation.
- ✓ ***Subordinate trees*** make a poor choice for preservation due to inferior structure and sudden exposure.

Step B – Assess potential impacts by calculating the *Tree Protection Zones* for each tree.



- Trees under stress and/or decline are less tolerant of construction related stress and do not merit preservation.

Step C – Modify plan to accommodate TPZ and building plans



Step D – Identify tree work

- Work to be done by arborist not construction workers.
- There may be limitations on time of year for work to be done.
- There may have short time frame to complete work before construction begins.

Step E – Outline *<u>Tree Maintenance During Construction Plan</u>*

- Who and how will trees be protected during construction?
- Who and how will the tree be watered and cared for during construction?
- Who and how will the *tree protection plan* be communicated to all workers?
- Who and how will tree protection be monitored during construction?
- What penalties will be in place for individuals and companies who violate the tree protection plan?

Step F – Outline *<u>Post-Construction Maintenance Plan</u>*

- What will be done and who is responsible?

    - Soil management
    - Pruning: Cleaning
    - General care (watering, pest management**)**

Assessing Tree Tolerance

Species

- For comparison, classify species as **good**, **moderate** or **poor** tolerance.
- There is no comprehensive list of species tolerances.
- Ask experts about their experience with specific species.

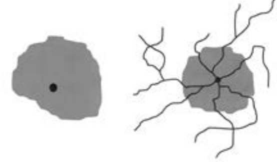
Age and longevity

- For comparison, classify as **good**, **moderate** or **poor** tolerance.

    - Young trees typically have good tolerance.
    - Medium age trees typically have moderate tolerance.
    - Over-mature and declining trees have poor tolerance and do not merit preservation.

Health and vigor – Trees in poor health will not survive construction related stress.

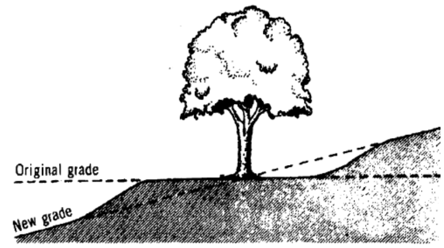
Actual crown and rooting area may not be uniformly distributed.



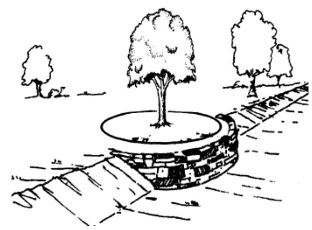
Structural stability – Preservation efforts are not warranted on structurally unsound trees.

Cuts and fills

- **Fills** are more tolerance on flooding tolerant species
- **Cuts** – more tolerance on drought tolerant species



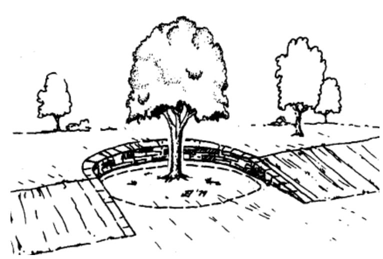
- **<u>Removing soil inside TPZ</u>**
  - On root severance **tolerant** species, may disturb up to **25% of TPZ <u>area</u>** (not diameter).
  - On root severance **sensitive** species, allow **extra space** beyond TPZ.



Root Severance Tolerance

Tolerant	**Intermediate**	**Sensitive**
<u>Up to 25% of TPZ area</u>	<u>TPZ area</u>	<u>Allow extra space in TPZ</u>
Ash: green, white, black Aspen: quaking & big-tooth Birch: river Boxelder Cottonwood: eastern Fir: balsam & white Hackberry Honeylocust Locust: black Maple: silver & red Mt. Ash Pine: white, jack, & red Spruce: black, white Willow	Birch: paper & yellow Buckeye: Ohio Catalpa Cherry: black Kentucky coffee Hawthorn Hickory: Bitternut Maple: sugar Spruce: Colorado blue Oak: bur & bi-color	Beech Butternut Ironwood Oak: white, northern pin and black Walnut: black

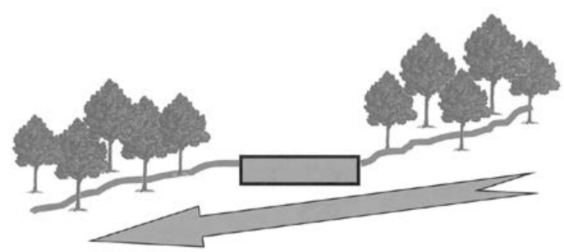
- **<u>Adding soil inside TPZ</u>**
  - If a compaction/flooding **tolerant** species, *may* successfully add **up to 6" *porous* fill**.
  - If a compaction-flooding **sensitive** species, **do NOT change grade**, and TPZ (as calculated with diameter method) may be too small.



Root Covering Tolerance

Tolerant	Intermediate	Sensitive
Add up to 6" porous soil	TPZ area	No change in TPZ
Ash: blue & green	Ash: white	Aspen: quaking & big-tooth
Cedar: northern white	Buckeye: Ohio	Basswood
Birch: river	Butternut	Beech: blue
Boxelder	Cherry: black	Birch: paper & yellow
Fir: balsam	Kentucky Coffee	Cedar: eastern red
Catalpa	Elm: American & slippery	Fir: white
Cottonwood: eastern	Hackberry	Ironwood
Maple: silver & red	Hawthorn	Locust: black
Spruce: Colorado blue & black	Hickory: bitternut	Maple: sugar
Tamarack	Honeylocust	Oak: red, white, black, & northern pin
Oak: bi-color	Mt Ash	Pine: white, jack, red, & scotch
Willow: black	Spruce: white	Plum: wild
	Oak: bur	
	Walnut: black	

Changes in soil hydrology (soil water)

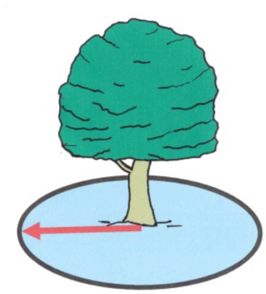


- **Ability to recover from stress factors**
    - o Insects and diseases
    - o Irrigation changes

Tree Protection Zone, TPZ

Trunk Diameter Method

The trunk diameter is probably the best method for general use on landscape trees. Size of the TPZ is based on the diameter of the trunk, increasing as the tree ages and become less tolerant of stress factors. It may be calculated by measuring the trunk circumference or diameter at DSH (diameter at standard height, 4.5 feet). For trees with a broad canopy in an open lawn, it is approximately 40% larger in area than the dripline method.



Trunk Diameter Method by Circumference

TPZ radius = 1 feet per 2 inches of trunk circumference

1. Measure the tree's circumference at DSH (4.5 feet) in <u>inches</u>.
2. Divide the number of inches by 2.
3. This is the radius, <u>in feet</u>, of the TPZ.

For example
1. Circumference = 24 inches
2. 24 / 2 = 12
3. TPZ radius = 12 feet

Trunk Diameter Method by Diameter

TPZ radius = 1.5 feet per inch of trunk diameter at DSH

1. Measure the tree's diameter at DSH (4.5 feet) <u>in inches</u>.
2. Multiply the diameter (in inches) by 1.5
3. This is the radius, <u>in feet</u>, of the TPZ

For example
1. Diameter = 8 inches
2. 8 x 1.5 = 12
3. TPZ radius = 12 feet

Area of the TPZ

The area of the TPZ can be calculated by the formula:

$[\text{TPZ radius}]^2 \times \pi$

For example - 12 foot radius:
12 feet X 12 feet X 3.14 = 452 square feet

<u>Stress Tolerance and Age Method</u>

This method is used in a construction site when compromise must be made to minimize the TPZ, allowing for construction activities.

1. Evaluate species tolerance to construction stress (good, moderate, poor)

- ✓ Transplant response
- ✓ Drought response
- ✓ Rooting pruning response
- ✓ Compartmentalization (decay response)
- ✓ Native range – tolerance to stress outside native ecosystem

2. Identify tree age

- Young = < ¼ life expectancy
- Mature = ¼ - ¾ life expectancy
- Over-mature = > ¾ life expectancy
- Older trees are less tolerant of stress and require larger TPZ

3. From the table, calculate minimum TPZ radius and area

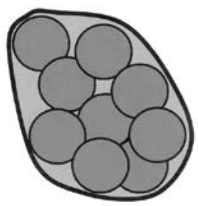
Stress Tolerance	Tree Age	Radius of TPZ* Feet/ inch trunk diameter
Good	Young	0.5
	Mature	0.75
	Over-mature	1.0
Moderate	Young	0.75
	Mature	1.0
	Over-mature	1.25
Poor	Young	1.0
	Mature	1.25
	Over-mature	1.5

- Additional space may be needed on compacted, clayey soils.

TPZ modifications

- Methods above are based on trees in open area with unlimited rooting space.
- Additional space may be needed for shallow rooted trees, like spruce and on compacted clayey soils.
- If low branches will interfere with work, extend the TPZ to include all the dripline area.

Trees in groupings



1. Calculate and plot the TPZ for each tree
2. Plot outer edge of tree group as the TPZ for the grouping

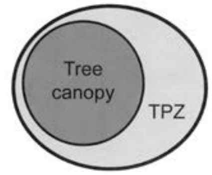
Multiple trunk trees

1. Calculate the trunk area for each trunk at DSH (4.5 feet).
2. Add the areas together.
3. Calculate the diameter of a tree that would have this size area in a single trunk.

   Area = Radius^2 x 3.14
   Radius = $\sqrt{}$area / 3.14

4. Use this as the trunk size to estimate the TPZ

To accommodate site needs, the TPZ area may be



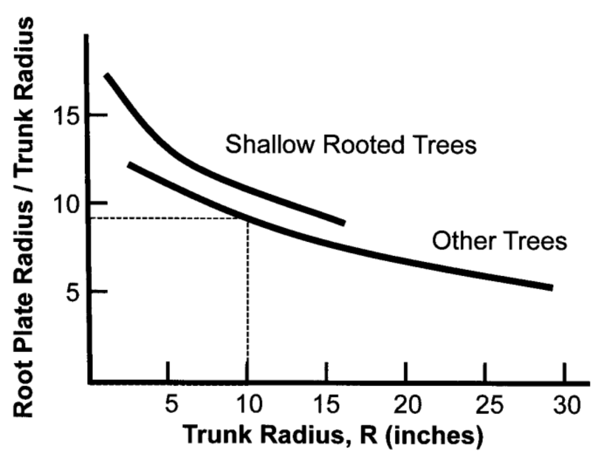
- Offset slightly
- Not necessarily round

Sites with urban hardscape restricting root spread

- Methods, as described above, will need adjustments.
- Need to actually check for root location.
    - o Backhoe (A good operator knows when he hits roots and will stop before cutting them.)
    - o Hand digging
    - o Air spade
- New sidewalks and parking areas are generally OK if they say inside the footprint of the old area without invading the rooting area.
- New buildings are generally OK if they say stay inside the footprint of the old building without invading the rooting area.

Tree Stability

- For wind stability, do not invade the root plate.
    - o **General formula**: radius of root plate is 3-6 times DSH (trunk diameter at standard height, 4.5 feet)
    - o **Bartlett Tree Lab Model**: radius of root plate is
        - 5 times DSH on one side AND
        - 3 times DSH on other three sides
    - o **Mattheck Model**

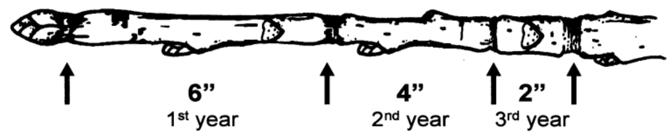


For example, a 10 inch trunk radius needs a root plate/trunk radius coefficient of 9. This would be 90" root plate radius (90"/10" = 9).

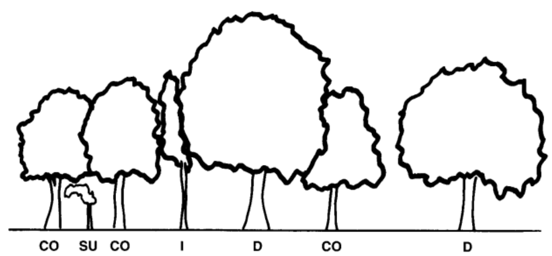
Symptoms of Construction Damage

Symptoms of construction damage include generic symptoms of stress and decline. Trees generally decline due to root decline and death.

- Reduced canopy growth – Compare how annual growth changes from year to year.



- Dieback on upper canopy
- Dieback of upper canopy on side related to root damage
- Small, poorly colored leaves
- Adventitious sprouting along trunk or lower scaffold branches
- Heavy seed set
- Mechanical injury to trunk and limbs
- New Edge” damage – Foliage and bark damage due to increased exposure to sun and wind.



Bottom line: Take steps to prevent construction damage, as little can be done to correct it.

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- Colorado Master Gardener *GardenNotes* are available on-line at www.cmg.colostate.edu.
- Colorado Master Gardener training is made possible, in part, by a grant from the *Colorado Garden Show, Inc.*
- Colorado State University, U.S. Department of Agriculture and Colorado counties cooperating.
- Extension programs are available to all without discrimination.

October 2014

CMG GardenNotes #653

Wrapping Trees For Winter

Why Use Wrap

Tree wrap is used to protect young, thin-barked trees during the winter months. Wrapping trees helps protect against sunscald and frost cracks, both of which are temperature related. Not all trees need to be wrapped. Species such as linden, maple, ginkgo, crabapple and redbud will benefit from tree wrap. Trees with thick, corky bark, like bur oak, do not need to be wrapped.

Sunscald

Sunscald is also known as "southwest injury" since it tends to occur on the south or southwest side of the tree. During the winter, the south/southwest side of the tree is warmest, due to the location and angle of the sun during the winter months. Sunny warm winter days "wake up" cells in the cambium (the living tissue in the tree), causing them to move water and nutrients. As temperatures drop at night, the cells freeze and burst, causing bark splitting. Sunscald creates a jagged wound along the trunk that can take a long time to seal over and be an entry point for disease and insects.

Figure 1 Sunscald damage

Frost Cracks

Frost cracks are vertical cracks in the trunk or stems of trees. Warm winter days cause the cells to warm up and expand. As the sun sets, the outer bark temperature cools quickly, but the inside of the tree remains warmer, which results in splitting. Younger trees are most susceptible. Frost cracks are usually not as detrimental to tree health as sunscald.

The rules for using tree wrap are as follows:

1. Wrap trees at the end of November and removed in early spring (mid-April). Tree wrap should not be left on all year.
2. Use a light-colored crepe-paper type wrap; using plastic, dark colored materials or burlap can result in tree damage. Crepe-paper wrap has some elasticity to it and sheds water, keeping the trunk dry.
3. Start wrapping at the bottom of the tree, overlapping by 1/3 until you reach the first branch. Tape the wrap to prevent it from slipping at the top of the tree. Or consider stapling the wrap to itself around the first branch. Do not staple the wrap into the tree!

Once the bark of the tree has hardened and become furrowed, it is not necessary to wrap trees. Trees should only be wrapped for the first one to three years following planting. It cannot be emphasized enough that wrapping is only a seasonal treatment.

Using Latex Paint

Latex paint is often used in nurseries and orchards since it is a cheaper and less labor-intensive option to wrapping trees individually. Paint is not as aesthetically pleasing and will take time to wear off. Only use water-based latex paint and not oil-based, as it can damage trees. Apply the paint in late fall when temperatures are above 50 degrees F so it can dry quickly.

Watch this short video on tree wrapping:
https://www.youtube.com/watch?v=B_KOaHXETb4

Figure 2 Tree wrap

Author: Alison O'Connor, Colorado State University Extension. Photos courtesy Alison O'Connor.

July 2017

CMG GardenNotes #654

Staking Trees

Many gardeners believe that tree staking during the planting process is necessary, but it is really only required in certain situations. More important than staking a tree is to ensure it is planted properly. Refer to the Colorado Master Gardener Garden Notes #633 or the shortened version #636 at www.cmg.colostate.edu.

When to stake

Staking is only necessary in the following situations:

1. Windy sites: When a tree is planted in a wind tunnel or in an area that is perpetually prone to wind and/or damage from wind, then staking can be justified.

2. Protecting the newly planted tree from people or activities: If the tree is planted in a public space that gets high amounts of traffic or is prone to vandalism, stakes may be used to help protect the tree. Sometimes just having posts (without staking straps attached) around the tree may divert vandals or harmful activity.

3. Supporting the weight of the tree because the tree cannot stand on its own. In this situation, the tree should not be planted, since quality of nursery stock is an important component when planting trees. However, if the tree was planted but cannot stand on its own, staking straps should be attached six inches above the point where the tree can support itself, but at least three feet below the terminal leader. Again, there is a responsibility of consumers to demand quality nursery stock—planting inferior trees should not be a standard practice.

Staking Straps

Always use wide canvas straps with grommets at either end to attach staking wires to trees. These wide straps help distribute the pressure evenly. Wire threaded through hose concentrates the pressure, causing girdling and other damage.
For details about staking trees properly, refer to the Colorado Master Gardener Garden Notes #634 at www.cmg.colostate.edu.

Staking can lead to increased tree height at the expense of caliper (diameter) development. It can also lead to a smaller root system, since the tree may not have the ability to sway/move with wind (which builds caliper and roots). Staking has also been found to damage the trunk as soon as six months after planting, causing girdling and compression injury to the trunk.

When stakes are used, they should be removed after **one growing season**. Stakes are often forgotten if left on the tree longer, leading to long-term damage. Materials can girdle or grow into the tree, creating weak points and potential failure.

Author: Dr. Alison O'Connor, Colorado State University Extension. Photos courtesy Mary Small, Colorado State University Extension

August 2017

MASTER GARDENER
COLORADO STATE UNIVERSITY
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CMG GardenNotes #655

Dealing with Leaves in the Landscape

Many gardeners find that raking and clearing leaves from their landscapes in the fall is tedious and never-ending task. Depending on the age of the neighborhood, the size of trees and the number planted in or near the property, it can take a fair amount of time and energy to manage them.

Uses For Leaves

Leaves are a valuable resource in the landscape. While they are not considered a fertilizer replacement, (it would take 100 pounds of leaves per 1000 square feet of turfgrass to apply one pound of nitrogen if the leaf nitrogen value was 1%), they do have other benefits. Try to avoid sending the leaves to a landfill and use them in the landscape.

1. ***Mow the leaves into the lawn.*** Set the lawnmower deck to the highest setting. Remove the bagging attachment and make at least two passes over the lawn, chopping the leaves into small pieces. As long as you can see some grass through the leaves, the layer is not too thick. Research has found that mowing leaves into the lawn will return nutrients to the soil, provide food for earthworms, increase moisture for the turf roots and reduce weeds. ***Leaves do not lead to thatch accumulation***.

Research at Purdue University found that mulching leaves into the lawn at high rates did not affect turf quality, color or soil pH. A study at Michigan State University found that mulching leaves into the lawn reduced perennial weed populations like dandelions and annual weeds like crabgrass after three years. The small leaf pieces sift down onto the turf surface and prevent weed germination from bare soil. It is important that the leaves are shredded or mulched and not left whole on the lawn.

2. ***Add leaves to compost bins***. Tree leaves are "brown" material and can be added to compost bins in combination with "green" materials. For more information on composting, refer to the Colorado Master Gardener Garden Notes #246 at www.cmg.colostate.edu.

3. ***Add leaves to garden beds or raised beds.*** Consider leaves a free source of organic matter. You can add up to six to eight inches of leaves (best if chopped by the lawnmower) into the vegetable garden. Water the surface, add some fertilizer to kick-start decomposition and let microbes break down the leaves through the winter. In the spring, till them into the soil or directly plant into the area. Be cautious about over-amending garden soils and consider having your soil tested first.

4. ***Use as mulch in the landscape.*** Leaves can be used as mulch around tender plants or those that are newly planted. Place a wire cage around the plant and pile three to six inches of shredded leaves inside the cage, next to the plant. As growth begins in the spring, remove the cage and leaves.

Author: Dr. Alison O'Connor, Colorado State University Extension. Photos from csu.cohorts.blogspot.com (Dr. Tony Koski) and (compost) farm3.staticflickr.com/2435/4022031843_65a2086098_z.jpg

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MASTER GARDENER
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CMG GardenNotes #656

Herbicide Use Around Landscape Trees

There are times when using pesticides around trees is necessary and it is important to understand how they can potentially affect tree health. The most common pesticides used around trees in the home landscape are herbicides.

How herbicides can damage trees

1. Direct "hits" to the canopy, suckers or trunk that contact live tissue.

2. Absorption through the root system, which can extend several times the width of the canopy and can be extensive. Depending on soil type, tree roots are generally located within the top 12" of soil. In compacted or mostly clay soils, more than half of tree roots can be located in the top six inches of the soil.

3. Drifting or volatization (become a gas) with movement to sensitive tree tissue when conditions are too windy, too hot or when the relative humidity is low.

Figure 1 Volatilization Injury to Ash Leaves

It is critical to read and follow all directions on the label of a pesticide product before using it. Reading the label in its entirety helps the homeowner determine if the product can cause damage to woody landscape plants. Some trees are more sensitive to certain herbicides than others.

It is also important to understand the herbicide's mode of action (how it works). Some may be contact herbicides, some may be root absorbed and some may be systemic.

Table 1. Post-emergence Herbicides that are Safe to Use Around Trees

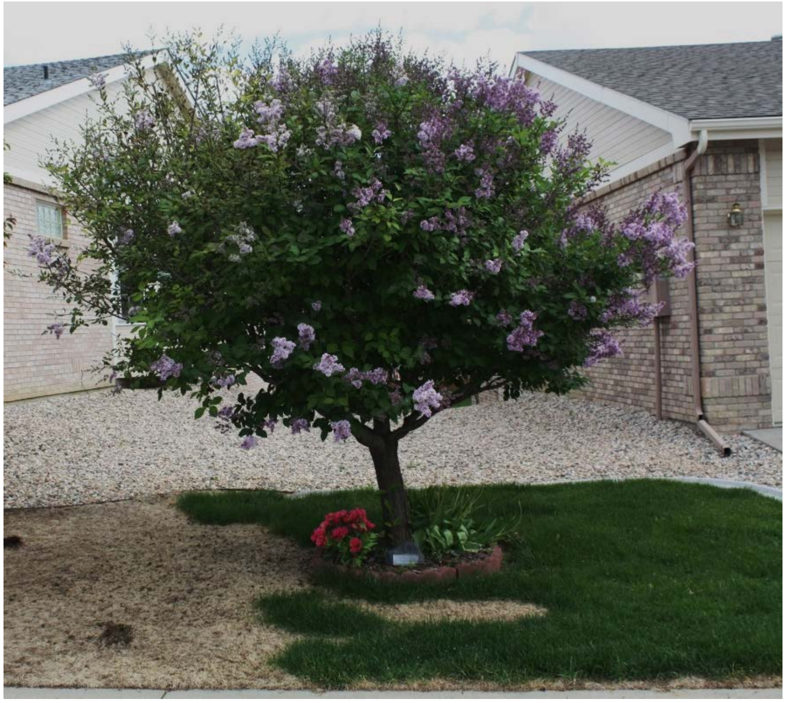
Class of Herbicide	**Products**	**Mode of Action**
Amino Acid inhibitors	• glyphosate (Roundup, Kleenup)	Foliar (systemic), but can be mixed with sterilants
Burndown products (non-selective)	• Diquat • Essential oil herbicides • Glufosinate (Finale) • Horticultural vinegar (20%) • Pelargonic acid (soaps) (Scythe)	Foliar (contact)
Phenoxys	• 2,4-D • Clethodim (Grass Out) (grasses only) • dichlorprop • Fluazifop (Grass B Gon) (grasses only) • MCPA • MCPP	Foliar (systemic)

Table 2. Preemergence Herbicides Safe for Use Around Trees.

Chemical Name	**Trade Name**
Isoxaben	Gallery
Oryazlin and trifluralin	Snapshot
Oryzalin	Surflan
Prodiamine	Barricade
Trifluralin	Preen

Weed and grass growth at the base of the trees is one area where herbicides may be applied frequently. In this situation, consider using mulch, mowing, hand pulling the weeds and grass, using glyphosate or burndown products (i.e. horticultural vinegar). When using glyphosate, only apply to the weeds or grass and do not spray the trunk, suckers or exposed roots of trees. Pre-emergence weed control products may be used under trees in spring.

Figure 2 Accidental root absorption of herbicide applied to rock mulch.



Author: Dr. Alison O'Connor, Colorado State University Extension. Photos courtesy Mary Small and Alison O'Connor, Colorado State University Extension.

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CMG GardenNotes #657

Watering Mature Shade Trees

Why Trees Need Water

All living things need water to survive and trees are no exception. Trees use water for physiological functions and growth processes. In the landscape, water moves from soil in three ways.

1. Available water is *absorbed* through plant root systems, transported upward and lost via transpiration from leaves and bark.
2. Water *evaporates* from the soil surface.
3. Water *drains* through soil due to gravitational forces.

As soils dry, water molecules are held more and more tightly by soil particles. These water molecules become unavailable for plant use, resulting in the *permanent wilting point* of plants (the point of "no return"). As drought and desiccation increase, normal plant functions may cease. During drought stress, normal physiological functions of plants are interrupted, including:

1. Reduction in photosynthesis; water is an important component of photosynthesis and the process is negatively affected during dry periods.
2. Stomata, which regulate water and gas exchange in the leaf, may close. This prevents water vapor and oxygen from leaving the plant, as well as carbon dioxide entering the plant (which is essential for photosynthesis).
3. There is likely a reduction in carbohydrate production and storage (due to reduced photosynthesis).
4. Plant growth is reduced (leaves, shoots, roots, fruit, etc.)

Plants under drought stress also have weakened defense systems, which can lead to problems with certain insects and diseases. Fortunately, trees can tolerate *some* drought and dry conditions. It is very difficult to detect short-term drought stress in trees. Prolonged drought stress, however, may result in wilting, early leaf drop, smaller-than-normal leaf size, early fall leaf color, scorch on leaf margins, purpling or browning of leaf tissue and increase in disease or insect pressure.

Tree Establishment

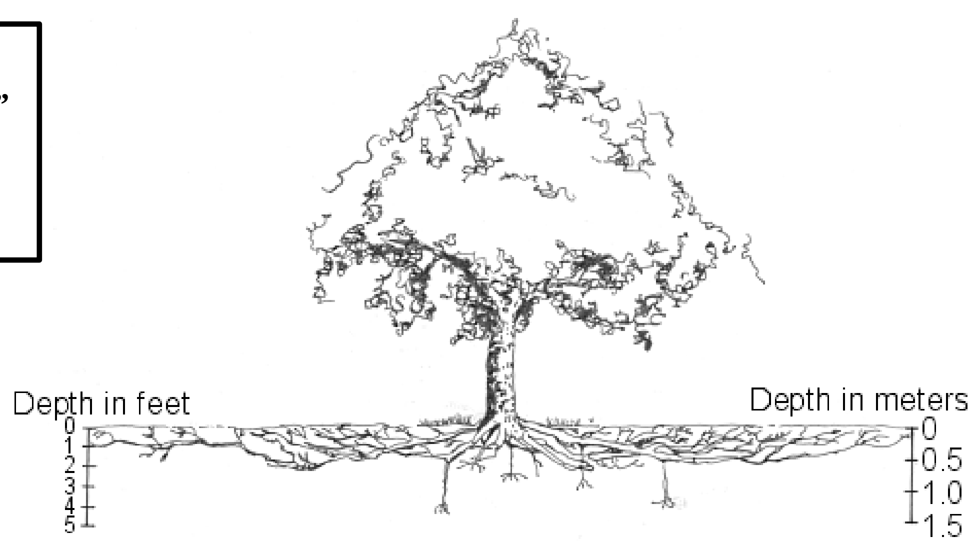
Established trees in the landscape don't require water as frequently as those that are recently planted. (Trees generally take a season to establish for each inch of trunk caliper; a 2" tree will take two years to establish). In Colorado's dry climate, trees will need supplemental irrigation during dry periods in the summer and during fall and winter. Keeping your trees well-watered will contribute to their overall health and survivability in the landscape. A general rule of thumb is that the bigger the tree, the more water it will need.

Tree Roots and Their Location

Tree roots tend to be shallow and most are located within the top 36" of soil. In compacted clay soils, up to 50% of roots may be located in the top six inches of the soil with nearly all roots located in the top 12 inches.

Tree roots can extend several times the width of the canopy. Trees planted near or in a lawn will share water with turf roots. Whichever was planted first has the advantage. New trees in an established lawn will have fewer roots to compete; mature trees with an extensive root system will outcompete turf grass.

In compacted or clay soils:
- **90-95% of roots in top 12"**
- **50% of roots in top 4-6 "**
- **Spread up to 5x canopy width**



Determining When to Water

It is difficult to look at a tree and determine if it needs water. Instead, take a slender screwdriver and poke it into the soil in several places around the tree, both inside and outside the dripline (where the canopy extends). If the screwdriver can easily penetrate the soil to a depth of six to eight inches, there is no need to apply water.

Amount of Water

The amount of water to apply will vary depending on the size and age of the tree, the time of year, soil type, watering method and other factors. Aim to apply one to two inches of water every two weeks during the growing season. If you prefer to measure in gallons, apply 10 gallons of water for each inch of trunk caliper - diameter- (e.g. a 4” caliper tree needs 40 gallons of water). These amounts are *recommendations only*. Adjust as necessary for your local situation and precipitation.

Methods of Watering

In general, it is easier to apply the entire amount slowly over one period of time instead of over a period of days. However, if your soil is very dry and cannot absorb the water - resulting in runoff - consider watering over several days to allow for absorption.

Trees growing in sandy soils will need to be watered more frequently than trees in clay soils, since sand drains more quickly and doesn’t hold water well.

It is much easier to keep soil continually moist throughout the season than to rehydrate dry soils. Dry soil often become hydrophobic and rewetting it takes a long time with multiple applications of small amounts of water.

There are many ways to water mature trees in the landscape: lawn irrigation, hose and sprinkler, drip irrigation, soaker hoses and self-watering devices.

<u>Lawn Irrigation</u>

When mature trees are planted in/near the lawn, using a lawn sprinkler system is an easy and effective way to water them. (Figure 1) Remember that the turf and tree roots are located in the shared rooting area and both are using the applied water. A good goal is to apply enough water to the lawn to compensate for evapotranspiration (ET); this is the amount of water used by the plants and lost from evaporation. The amount will

Figure 1

vary throughout the season. A typical bluegrass lawn may need one inch of water early in the summer (May-June), up to two inches during July and August and one inch in September and October. You can consider running additional cycles (perhaps a couple times per month) to supply additional water to tree roots. To measure how much water you are actually applying in an irrigation cycle, place several cups in the area and measure the amount of water in them. Multiply this by the number of days the system runs per week:

0.5 inches applied/cycle x 3 days per week = 1.5 inches of water applied per week
1.5 inches of water applied per week x 4 weeks/month = 6" of water per month

Hose and Sprinkler

A hose and sprinkler is an effective way to water trees. (Figure 2) A hose and sprinkler should always be used when the lawn irrigation system is turned off. Place several cups in the pattern of the sprinkler to collect output, or attach a water meter to the hose to determine how much water was applied. The most effective place to water mature trees is just outside the dripline (NOT at the trunk). Depending on the type of sprinkler, it may take 30-60 minutes of run time to apply one inch of water.

Figure 2

Drip Irrigation

Drip irrigation is often used to water newly planted trees. One mistake many homeowners make is leaving the drip irrigation in the original location for years. Emitters must be moved out and additional ones added as the tree grows or drought stress may occur. Depending on the location and tree species, drip irrigation may be eliminated after the tree matures. When using drip, understand the systems' emitter size and output to calculate the amount of gallons applied during each irrigation cycle. For example:

2 gallons/hour emitters x 4 emitters x 30 minutes per irrigation cycle = 4 gallons per cycle

Soaker Hoses ("leaky pipe hose")

Soaker hoses are probably most effective on smaller trees, but can be used on larger trees if there is enough hose available to apply in the tree's dripline. Soaker hoses apply water very slowly and need to run for long periods of time. It may take several hours to apply one inch of water, depending on pressure and hose size. A small container could be placed beneath the hose (or dug in a shallow hole) to collect water and determine total irrigation output. Do not coil soaker hose around trunks of mature trees.

Self-watering Devices

These systems, sometimes known as “Gator Bags”, are best used *only* on newly planted trees. They are not an effective or practical way to water mature trees. Even with newly planted trees there are some potential problems. First, the bag must be monitored to ensure that it is filled with water. Second, bags are often dark in color and when left around the trunk of the tree, can trap excess heat. Third, bags may keep the trunk and surrounding soil overly moist, leading to disease and insect problems. Self-watering devices may be used for the short term, but are not a reliable way to irrigate.

Deep Root Watering Devices

Since the majority of tree roots are not located deep within the soil profile, deep root waterers are not an effective method of irrigating. In addition, the device must frequently be moved around the tree, which is time consuming. A hose and sprinkler is a better option.

Following your method of irrigation, stick a slender screwdriver into the soil. If you cannot penetrate to a depth of six to eight inches, water again. Repeat this process until you have adequate soil moisture.

Fall and Winter Watering

Watering trees in Colorado’s dry fall and winter months is extremely important. Moist soils hold more heat than dry soils, leading to additional growth in the fall and increased time for establishment. Adequate soil moisture also leads to better plant hardiness and ability to survive cold, dry winters. Aim to water trees and other woody landscape plants monthly when natural precipitation between October and April is less than an inch per month.

Precipitation can be in the form of snowmelt or rain, but snow moisture can vary. Water on days when the temperature is above 40 degrees. Apply an inch of water early in the morning to allow it to soak into the soil before freezing at night. For additional information, refer to CSU Extension Fact Sheet #7.211 at www.extension.colostate.edu


Figure 3 Snow holds varying amounts of water

Obey All Ordinances

Be smart when watering and avoid irrigation during the hottest part of the day (10am to 6pm), when evaporation can occur more readily. Follow all HOA guidelines and town/city restrictions.

Authors: Dr. Alison O'Connor and Eric Hammond, Colorado State University Extension. Figure 1 source: By M.O. Stevens (Own work) [GFDL (http://www.gnu.org/copyleft/fdl.html) or CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons; Figure 3 courtesy of Mary Small, Colorado State University Extension

August 2017

MASTER GARDENER
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CMG GardenNotes #658

Mulching Trees

Mulch Importance and Benefits

Mulch is important to the long-term health of trees.

- It helps protect them from string trimmer and lawn mower damage.
- It helps retain soil moisture and reduces evaporation from the soil surface by 25-50%.
- Mulch helps moderate soil temperature extremes and controls erosion.
- It enables tree roots to outcompete grass roots for available nutrients and water.
- Fine root hairs of trees develop 400% more under mulch than under grass. This is important because root hairs absorb most of the water and nutrients for the tree.
- Mulch suppresses weed growth and gives landscapes a finished, polished look.

Mulch Disadvantages

While mulch has many benefits, there are some disadvantages.

- Used in moist areas, organic mulch can create conditions ideal for trunk or root rot, especially when placed too close to the trunk. Rot in this part of the tree leads to instability and makes a tree more susceptible to wind throw.
- Organic mulches may be attractive to voles that use it as shelter and then chew on tree bark for food.
- Lighter-weight mulch materials can blow away in very windy areas,
- Herbicides directed at weeds emerging through mulch may accidentally touch roots, green bark and sucker sprouts, leading to tree injury.
- When mulch is applied too deep around a tree stem- girdling root problems often follow and may kill a tree several years after planting.

Mulch Options

There are many options when it comes to choosing mulch, but not all mulch is best for tree health. Plastic mulch/sheets suppress weed growth, but might overheat the soil and damage roots. In addition, plastic mulch doesn't allow for proper oxygen flow to the tree root systems so roots tend to grow directly under the plastic, leading to potential problems. Large rocks do a poor job of suppressing weed growth and can overheat the soil and tree roots. Rock mulch may also have increased weed growth, as soil settles between rocks, providing ideal conditions for weed germination. Rubber mulch can lead to drainage problems and leach toxic metals into the soil. When choosing a tree mulch that is attractive, beneficial, and convenient it is hard to beat bark chunks, shredded bark, wood chips, and pine needles.

Mulch Application

Properly applying mulch is just as important as selecting it. Keep the mulch at least 6 inches away from the bark of the tree. This helps keep the lower trunk dry and reduce the likelihood of bark decay and rot.

Never apply mulch directly over the newly planted root ball since this encourages roots to grow up into the mulch and around the trunk or each other. This growth can girdle the tree within several years. Instead, mulch the backfill area and beyond if possible, to a 3 to 4 inch depth. Excessively mulched trees, sometimes called "mulch volcanoes", reduce the amount of available oxygen to tree roots, causing oxygen starvation and tree decline or death.

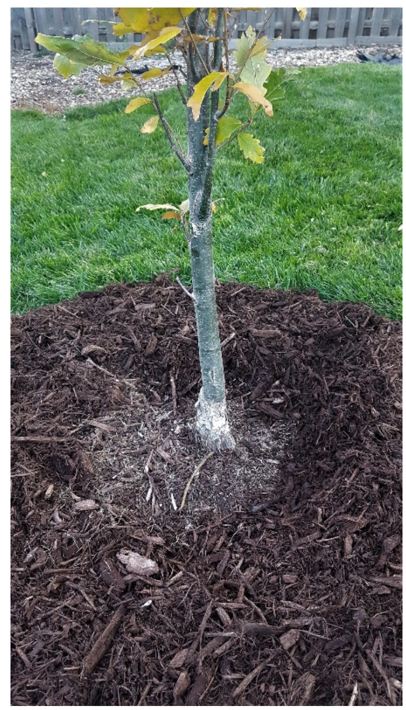

Figure 1. Keep mulch away from the trunk and off the root ball.

Authors: Tyler Mason, PhD candidate, Colorado State University Department of Horticulture and Landscape Architecture: Dr. Alison O'Connor and Mary Small, Colorado State University Extension. Photos courtesy Alison O'Connor, Colorado State University Extension.

October 2017

MASTER GARDENER
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CMG GardenNotes #659

Understanding Tree Roots

Functions of Tree Roots

Support\anchorage

Upended tree shows extent of root plate

A tree's root system keeps its trunk and canopy upright against the forces of wind and gravity. The strength of anchorage provided by a tree's root system depends on a variety of factors including soil type, soil moisture levels, tree species, root health and the depth and width of a tree's root plate. Sandy and overly wet soils provide worse anchorage.

The "root plate" is the area close to the trunk that contains the primary structural roots
The root plate occupies an area ~3 to 6 times the diameter of the trunk at DSH\DBH (Diameter at 4.5ft).

Absorption of water and mineral nutrients

Roots absorb water and nutrients for use by the plant. Mineral nutrients are only absorbed from forms dissolved in the soil solution. In some species, the architecture of the tree's vascular system is such that specific roots supply correspondingly specific branches with water and nutrients. For example, in ring porous species such as the oaks (*Quercus* spp.), a given root or suite of roots supplies a specific branch or suite of branches which are often on the same side of the tree as the root. Similarly, in many conifers, water and nutrients move up the trunk in a spiral pattern supplying branches along the way. In this case damage to a root manifests in branches along the spiral the root supplied. The specific vascular architecture of many species is not known.

Production of plant growth hormones

Cytokinins, gibberellins and abscisic acid are all produced by roots. Cytokinins are involved in cell division, cell differentiation, axillary bud growth and leaf senescence.

Gibberellins are involved in stem elongation, bud break and other processes. Abscisic acid is involved in drought stress response, maintaining apical dominance, suppressing stem elongation and promoting dormancy.

Storage of energy as sugars and starches

Energy created through photosynthesis can be transported to the roots of a tree as sugars, and then is stored as starch.

Describing Tree Roots

Types of tree roots

Woody roots (also called transport roots)

Example of woody roots

There are larger roots that may be up to 1 cm to 30 cm (.4 to 12 inches) or more in diameter in some cases. These roots provide anchorage, serve as storage sites for starches and sugars and are part of the system that transports water, nutrients and other compounds through the tree from fine feeder roots to leaves. They absorb very little water or mineral nutrients from the soil.

Specialized Woody Roots

1. **Tap Root**- A primary root that grows downward from the seed radical. Some species exhibit taproots when younger but by the time they reach maturity few trees have a true deep taproot due to low soil oxygen levels deeper in the soil.
2. **Sinker Roots-** Roots that grow downward from lateral woody roots. Formation of these roots is species and soil dependent. They are not common in landscape trees.

Fine feeder roots (absorptive roots)

These are smaller roots that are 2 mm (.4 to .008inches) or less in diameter.
These roots are the primary sites of water and mineral nutrient absorption. They are often short lived and can been killed or suppressed by low soil oxygen levels, drought or

fluctuations in soil temperature. Such events are stressful but healthy trees rapidly reproduce fine feeder roots.

Fine feeder roots are commonly colonized by symbiotic fungi. These fungi can help extend the reach of the root system, aid in the mineralization of plant nutrients, increase the trees' drought tolerance and help it to resist some diseases.

It is common for fine feeder roots to form grafts with the fine feeder roots of other members of the same species.

Size and extent of the root system

Width

A mature tree's root system often occupies a much wider area than its canopy. Depending on the species of tree and soil conditions the spread of a trees' root systems may be 2 to 5 times the width of its canopy or even greater in some cases.

Depth

The depth of a trees root system is governed by the availability of water, mineral nutrients, soil oxygen and the species of tree. In clayey, compacted or perpetually wet soils (soils with a shallow water table) roots tend to be shallower due to low soil oxygen levels in the deeper layers of such soils. In sandy soils, roots also tend to be massed near the soil's surface.   Sandy soils have low levels of mineral nutrients and having a large concentration of roots near the surface allows trees to capture nutrients released from decomposing leaf litter. In loamy soils, tree roots tend to be deeper as there is sufficient oxygen and nutrients to support their growth.

The rule of thumb for estimating rooting depth in clayey, compacted or perpetually wet soils (soils with a high water table) is that 90-95% of roots will be in the top 12 inches and 50% will be in the top 4 inches of soil. In favorable soils conditions 90-95% of roots will be in the top 36 inches and 50% will be in the top 12 inches of soil.

Surface area

The surface area of a root system is likely larger than that of the plants' leaves BEFORE you take into account symbiotic fungi.

Conditions that adversely affect roots

Heavy equipment traffic compacts soils

Soil Compaction

Soil compaction occurs when soil is compressed, pushing soil particles closer together. This reduces the overall volume of pore space in a soil and particularly reduces the volume of larger air holding pores. In landscapes, compaction can be caused by foot traffic, maintenance equipment or other vehicle traffic and other factors. Many soils are compacted during construction.

Compaction affects tree roots in a several negative ways. It can lower soil oxygen levels which adversely affect root and tree health (see below). Compaction also increases the strength of soil making it physically harder for roots to grow through it. This can slow the establishment and growth of a tree.

Low soil oxygen levels

Roots require oxygen to perform respiration (the process that turns the products of photosynthesis into usable energy). As roots (and other soil life) consume oxygen it is replenished though diffusion from the atmosphere. When adequate oxygen is not in the soil, root growth slows. Low soil oxygen levels also leads to stomata (located on plant leaves) closing which reduces water and nutrient uptake, reduces translocation of water, nutrients and hormones within the plant and can potentially led to wilting. Low soil oxygen can also lead to root cells “self- poisoning” due to accumulation of the byproducts of anaerobic respiration.

Conditions leading to low soil oxygen levels

Overwatering\Waterlogged Soils

In soils that are perpetually wet, soil pores are mostly filled with water (soil solution). Relatively few pores are filled with air. There also may be few clear contiguous pathways from the air-filled pores to the soil surface, slowing the rate of diffusion of oxygen between the atmosphere and the soil.

Compaction

Compaction reduces the overall volume of pore space in a soil and especially reduces the volume of “large” pore spaces. The “large” pores are those that tend to be filled with air after gravitational water has drained. They are also the easiest pathways for diffusion of gasses. So, compaction reduces the volume of air-holding pores in soil and can reduce the rate of diffusion between the atmosphere and the soil.

Improper mulching

Appling organic mulch too thickly can slow diffusion of gasses, including oxygen, from the atmosphere into the soil. Generally, no more than four inches of organic mulch should be applied to avoid this. Plastic sheet or fabric mulches limit the exchange of gasses between the atmosphere and the soil.

Grade Changes

Adding soil over the top of an established root system can have the same effect as adding a mulch layer that is too thick.

Other common root issues

Girdling Roots

Girdling roots are roots that are wrapped around other parts of the plant. Stem girdling roots are roots wrapped around or growing across the stem of a tree. Root girdling roots are wrapped around another root (somewhat less of a concern).

Stems girdling roots compress newly produced phloem (and eventually xylem) which impairs the ability of the tree to move material through these tissues. This leads to stress and potentially, decline.

Girdling roots

Symptoms

i. Flat sections of a tree’s trunk where it enters the soil (non-flared).
ii. Swelling above and below the girdling root.
iii. Generally poor health or dieback without any obvious cause.

Causes of Girdling Roots

i. Root deflection and circling at the edge of a container.
ii. Root deflection at edge of planting hole.
iii. Trees placed too deeply in nursery containers. This leads to roots growing upward and potentially to circling roots in a container above the root flare.
iv. Upward growing roots as the result of low soil oxygen due to deep planting, root pruning in the field during nursery production or combination of the two.
v. Mulch over the root ball or root flare.

Dealing with girdling roots

A root collar excavation, which is the process of removing the soil from the base of the tree, can be performed to expose the root flare and any girdling or potentially girdling roots. Girdling roots can then be removed, preferably back to a point where they will grow outward from the trunk. Some roots may be too in-grown to remove and may result in greater damage to the tree if removal is attempted.

Proper management and pruning of root systems in nurseries and at planting as well as proper planting practices can prevent girdling roots from forming.

Surface roots


Surface roots

Trees roots may develop at or partially above the soil surface creating a nuisance in turf and a potential health risk for the tree as exposed roots are often wounded by mowers or other landscape maintenance activities.

Some trees are prone to developing surface roots. However, their formation is encouraged by low soil oxygen levels that are caused by compaction or overwatering or both.

Once surface roots develop, little can be done. A soil of courser texture can be added over the surface roots but it is **likely a short term solution**. As roots increase in diameter they will surface again. Adding too much soil or too fine a soil can reduce soil oxygen levels and harm the tree. Mulching the area so that it no longer needs to be maintained as intensively is the best management option.

Installation and maintenance practices that promote better soil aeration can help prevent surface roots. Such practices include amending soil with organic matter and regular core aeration of turf.

Suckering


Suckers growing around base of tree

Roots may produce adventitious shoots known as suckers. Suckers arise from adventitious or latent buds along a trees' root system. (They are different from seedlings with are the result of seeds created through sexual reproduction.) Production of suckers is partially species dependent and some species are more prone to suckering. Damage to roots from trenching, flooding or other causes can also in courage suckering. Removing a tree can cause its remaining root system to sucker. Suckering can also be a response to general stress.

What can be done?

ii. Avoid planting species that are prone to suckering.
iii. Avoid damaging tree root systems.

iv. Try “Sucker Stopper” which is an artificial plant growth hormone that prevents buds from opening. Read label directions before using as it works better on some species than others.
v. Try herbicides - if you do not care about the health of the tree that is producing the suckers, herbicides can be used.
vi. Tolerate suckers.

Key Points for Talking With Clients about Tree Roots

- Tree root systems are much wider than their canopies, if space permits.
- Tree root systems are relatively shallow.
- Proper planting practices and species selection are the best way to avoid common root issues.

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