



Colorado MASTER GARDENER

Structural Training of Trees with Multiple Scaffold Branches

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Young trees require little pruning. However, the training a tree receives while young determines its structural integrity for life. Many trees become prone to wind and storm damage as they mature due to the lack of structural training they received while trunk and branches were small. Ideally, all pruning of a tree occurs on branches 2 inches in diameter and smaller.

The desired branching structure depends on the natural growth habit of the tree. Trees with a **decurent** growth habit develop a rounded form, as multiple **scaffold branches** (primary branches or secondary trunks) originate from the trunk. Examples of decurent trees include maple, ash, and elm.

Note: the technical term to identify the first level of branching arising from the trunk is **scaffold branch**.

Trees with an excurrent growth habit develop with a **central leader** (single trunk) to the top. Examples of excurrent trees include pine, spruce, and aspen. Training of central leader (excurrent) trees is discussed in the fact sheet 7.822, *Structural Training of Trees with a Central Leader*.

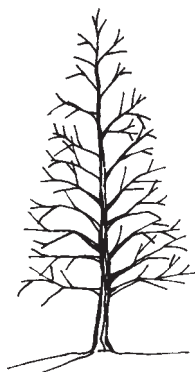


Figure 1. Left: Excurrent tree with a single trunk to the top. Right: Decurent tree with multiple scaffold branches. Scaffold branches are the first level of branches arising from the trunk and become the main structural system of the tree.



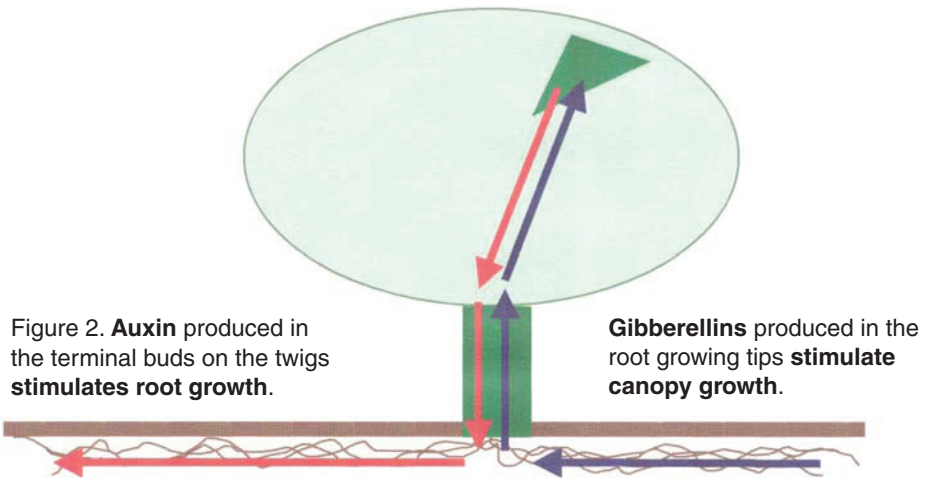
Pruning at Planting

Any pruning of a newly planted tree should be kept to a minimum. Only do the minimal pruning necessary to: 1) maintain a single trunk; and 2) remove broken or damaged branches. The hormone *Auxin* produced in the twig's growing tips stimulates root growth. Thus, heavy pruning slows root regeneration. As roots re-establish, Gibberellins (hormones produced in the root growing tips) stimulate canopy growth.

Pruning (structural training) of the young tree begins for the gardener when it shows significant twig growth after planting/transplanting. This indicates that the root system has adequately reestablished to support branch and leaf growth.

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Putting Knowledge to Work



In USDA hardiness zone 5, with good soil and planting techniques, it takes approximately one growing season for the roots of a 1-inch diameter tree to reestablish a root system supportive to canopy growth. Approximately two years on a 2-inch diameter tree, three years on a 3-inch diameter tree, and so forth. (Note: Trunk diameter is measured on small trees at 6 inches above soil line.) In Colorado mountain communities with shorter growing seasons and trees planted into poor soil conditions, a longer root establishment period may be required.

Structural Training with Multiple Scaffold Branches

While young trees don't require a lot of pruning, the training a tree receives the first four to 10 years is critical to establish its structural integrity. The lack of training while young will predispose the mature tree to wind and storm damage. Training requires evaluation and corrective pruning on an annual basis. Late winter to early spring, before growth starts, would be the best time for structural pruning.

Structural training of decurrent trees is a multi-year investment. On young, vigorous growing trees without stress factors up to 25 percent of the total foliage may be removed per season. Significantly less should be removed on trees with reduced growth rates. Do not remove live foliage on trees showing stress.

Achieving desired branching structure on decurrent growth habit trees with **scaffold branches** (major primary branches arising from the trunk) is complex. Give attention to co-dominant trunks, scaffold branch spacing, and branch union (crotch) angles. Follow these five pruning objectives for training shade trees with multiple scaffold branching structure:

Objective 1 – Remove Broken, Damaged, and Competing Branches

As in any pruning job, the first training objective is to remove broken, damaged, or competing branches. Competing branches are branches growing in the same space with the potential to rub and damage others.

Objective 2 – Maintain Single Dominant Trunk into the Tree's Upper Region

On decurrent trees maintain a single dominant trunk well into the upper region of the mature tree size. For example if the mature tree size is 40 feet, a single trunk should dominate the tree's structure up to 25 plus feet. All branches originating from the trunk should be less than one-half (preferably less than one-third) the diameter of the trunk.

Most decurrent form trees do not naturally grow this way; rather they develop multiple secondary trunks originating near the same location. This predisposes trees to storm damage.

If multiple trunks start to develop, remove all but one. If the leader is killed, select a side branch to become the new leader, removing competition. It

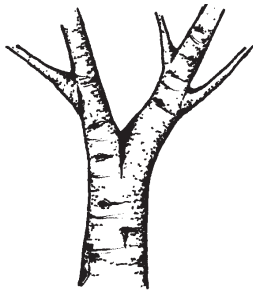


Figure 3. **Co-dominant trunks**

– A branch union with two trunks (or branches) of similar size is structurally weak and prone to storm damage. Included (or hidden) bark between the trunks prevents the wood from growing together. Without a branch collar, wood of the two trunks does not knit together.

In structural pruning, there is zero tolerance for co-dominant trunks!

may be helpful to loosely tie the new leader to a stick to bend it to an upward orientation.

If vigorous growing lower branches choke out the central leader, heavy pruning will be required over time to reestablish the central leader. Some trees put out many upward growing secondary trunks. Again, heavy pruning over a period of years will be desirable to establish a dominant central leader with subordinate smaller side branches.

Do not “head-back” (prune) the leader.

Co-Dominant Trunks

In training trees, arborists have zero tolerance for co-dominant trunks (trunks of similar diameter). Co-dominant trunks account for the majority of tree failures in Colorado storms.

With co-dominant trunks, no branch collar develops to knit the two trunks together. The branch union (crotch) is structurally weak and prone to breakage as the trunks reach a size greater than 3 to 4 inches in diameter.

In training a young tree, always eliminate co-dominant trunks. By technical definition, a side branch is less than half the diameter of the trunk.

Note: In selecting a tree, it is advisable to avoid purchasing trees with co-dominant trunks.

Objective 3 – Select Lowest Scaffold Branch

It’s often desirable to “limb up” (remove) lower branches so they are out of the way of people and lawn mowers. For shade trees in lawns, patios, and along sidewalks, the lowest permanent branch generally starts 7 to 10 feet above ground level. Along streets, lowest branches start at 14 feet. On smaller specimen trees in a garden bed, lower branching may be preferred. As a fire management technique in a wooded setting, it’s advisable to limb up trees to at least 10 feet.

The third training objective is to select the lowest scaffold branch. (Scaffold branch is the term for those major branches that originate off of the trunk, sometimes viewed as secondary trunks.) All branches below the lowest permanent scaffold branch are **temporary branches**. Based on identification of the lowest scaffold branch, other branches will be considered for additional scaffold branches considered temporary branches, or simply removed.

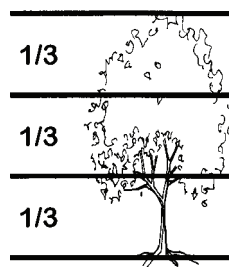


Figure 4. To develop a strong trunk taper at least one-half of the foliage must be in the lower two-thirds of the tree.

Temporary branches below the lowest permanent branches will be removed over time.

Many gardeners mistakenly plan to remove lower branches as the tree reaches a more mature size. However, this is difficult to do, as the lower branches are generally the largest branches, making up a significant portion of the tree. Removing these larger branches as the tree matures opens the tree to internal decay.

In establishing the lowest scaffold branch, don’t limb-up a young tree too early in its growth. To develop a trunk taper resilient to wind, one-half of the leafing area should be found in the lower two-thirds of the tree. Lower **temporary branches** should be removed only as the tree expands in height, but before they reach 2-inch diameter.

Objective 4 – Select Other Scaffold Branches

The selection of other scaffold branches takes place over a few years as the tree grows in height. Branches along the trunk not destined to become a scaffold branch are **temporary branches** or are removed entirely.

In selecting other scaffold branches, consider branch spacing and branch union (crotch) angles. A decurrent form tree naturally develops more branches than desirable, predisposing the tree to wind and storm damage as the tree matures. The objective of training is to correct this situation while the tree is young.

Branch spacing – Spacing for scaffold branches depends on the mature size of the tree, as follows:

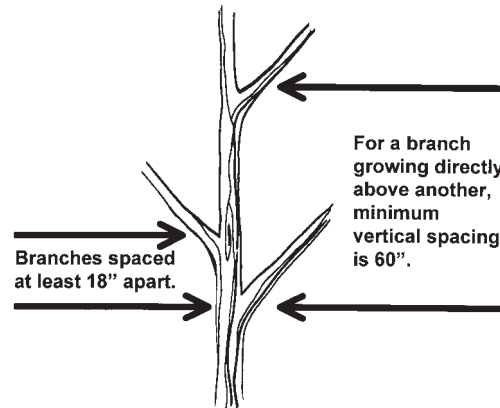


Figure 5. Spacing of scaffold branches is essential for branch collars to develop strong branch unions.

Minimum scaffold branch spacing is 18 inches for large trees (mature height greater than 30 feet) and 6 inches for small trees (mature height smaller than 30 feet).

Table 1. New standards for branch space set the minimum spacing on the mature size of the tree as follows:

Mature Tree Height	Minimum Scaffold Branch Spacing
20 feet	1 foot
30 feet	1.5 feet
40 feet	2 feet
50 feet	2.5 feet
60 feet	3 feet
70 feet	3.5 feet
80 feet	4 feet
90 feet	4.5 feet
100 feet	5 feet

- For large trees (mature height above 30 feet and/or mature trunk diameter greater than 18 inches), scaffold branches should be at least 18 inches apart.
- For small trees (mature height less than 30 feet and/or mature trunk diameter less than 18 inches), scaffold branches should be at least 6 inches apart.

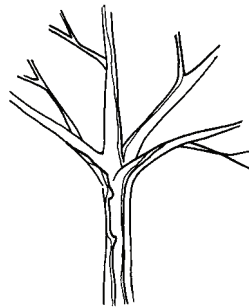


Figure 6. Multiple branches originating from the same location are structurally weak, so an objective in structural training is to space branches. Many common shade trees naturally develop too many branches to be wind and snow load resistant.

Select scaffold branches with even distribution around the tree trunk. Where a scaffold branch is growing directly above another, vertical spacing should be at least 60 inches on large-growing trees (15-36 inch spacing on small-growing trees).

Multiple branching at one spot – Where multiple branches arise from the same area, the branch collar cannot knit together into a strong branch union. These branches become vulnerable to storm and wind damage. In training a young tree, eliminate multiple branches arising at the same location. Many common shade trees, including maples, cottonwoods, poplars, and elms naturally develop multiple branching.

Branch union angles – Branches with a narrow branch union (crotch) angle of attachment to the trunk are prone to breakage and wind damage.

Actually, it's not the angle but rather how the wood of the trunk and branch fold together to form a **branch collar** (the area where the trunk tissues fold in the branch tissues like a deck of cards being shuffled). In lumber, the branch collar is called the knot.)

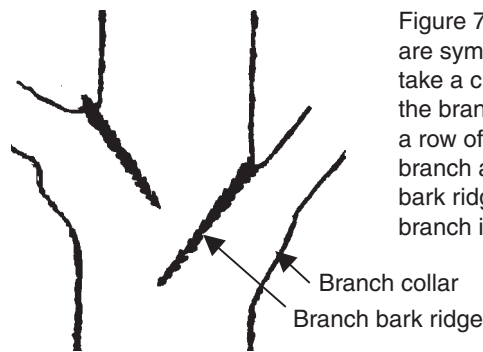


Figure 7. Narrow branch union (crotch) angles are symptoms of weakly attached limbs. However, take a close-up look at the branch bark ridge. If the branch bark ridge pushes up in the crotch (like a row of mountains going through a valley) the branch attachment is strong (left). If the branch bark ridge vanishes in the crotch (right side), the branch is weakly attached and prone to breakage.

For the branch collar to properly develop and be structurally strong, the diameter of the side branch must be less than $\frac{1}{2}$ the diameter of the trunk, as measured just above the branch union. With a strong branch collar, the branch bark ridge is pushed up in the branch union forming a u-shaped crotch.

Without a properly developed branch collar, the branch bark ridge disappears in the valley between the trunk and side branch, creating a v-shaped crotch. As the trunk and branch grow, it will incorporate a layer of bark called *included bark*, between the trunk and side branch. Included bark further weakens the branch union. Without the proper folding together of the trunk and branch woods, the branch union is structurally weak and prone to storm damage.

Objective 5 – Manage Temporary Branches, Removing Them Over Time

Temporary branches on the lower trunk are important to the tree's early growth. The carbohydrates produced by photosynthesis in the lower leaves help develop the natural trunk taper, giving wind resilience. Shading by the lower foliage helps reduce sunscald of the tender bark.

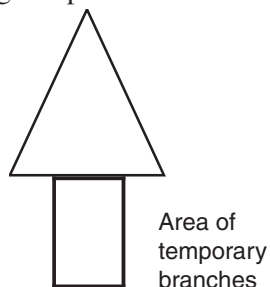


Figure 8. General shape of a young tree: temporary branches on the lower trunk (below the lowest scaffold branch) create a narrow cylinder of short branches.

Keeping the temporary branches short encourages desired growth in the upper canopy.

Manage growth on temporary branches by keeping them short. On small trees, keep temporary branches pruned back to a few buds. On temporary branches that have been allowed to grow significantly before training begins, start by cutting them back by around 50 percent, removing more over time.

Keeping temporary branches short suppresses their rapid growth in diameter while encouraging the desired growth up in the scaffold branch structure. During the early training process, a young tree will have a cylinder of short temporary branches along the lower trunk (below the lowest scaffold branch), with the tree's significant growth developing up in the scaffold branch structure.

Preferred vertical spacing of temporary branches is 4 to 6 inches. Thus some branches would be removed outright. No temporary branch should be within 6 inches of a potentially permanent scaffold branch.

Branches between scaffold branches are also considered temporary branches until removed. Maintain temporary branches for one to five years, removing them before they reach a 2-inch diameter. Remove temporary branches over a period of years, as the tree grows in height.

Lateral Branches Along Limbs

As we move out on the scaffold branches, side branches should be less than one-half (less than one-third preferable) the diameter of the parent branch. Permanent lateral branches should be at least 2 feet out from the trunk.

Additional Information

Fact Sheets on Pruning

- 7.820, *Tree Growth and Decay*
- 7.821, *Pruning Cuts*
- 7.822, *Structural Training of Trees with a Central Leader*
- 7.823, *Structural Training of Trees with Multiple Scaffold Branches*
- 7.824, *Structural Training of Trees – Pruning Flow Chart*
- 7.825, *Pruning Mature Shade Trees*
- 7.826, *Pruning Flowering Shrubs*
- 7.827, *Pruning Evergreens*

Books

Edward F Gilman. *An Illustrated Guide to Pruning*, Second Edition. Delmar. 2002.

Web

<http://hort.ifas.ufl.edu/woody/pruning/>

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