Pruning Oaks: Training the Young to Achieve Grandeur

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ABSTRACT

Training young trees may be one of the most important, yet most neglected, procedures in growing oaks. These trees need to be pruned correctly when they are young in order to develop into the long-lived patriarchs that are their potential. We include discussion of the unique phyllotaxis of *Quercus*; growth hormone interactions; orthotropism versus plagiotropism; pruning seasons; basic ANSI A300 pruning standards; early correction of structural flaws such as parallel and crossing limbs, whorls, and codominant leaders; scaffold development; managing temporary branches and sprouts; root training; and aesthetic considerations for young trees that are in their first 7 meters (23 feet) of growth.

Keywords: *Quercus*, oak, pruning, phyllotaxis, tropism, auxin, cytokinin

Introduction

Training young specimens may be one of the most important yet most neglected procedures in growing oaks. Many young trees need to be pruned correctly when they are small in order to develop into the majestic, long-lived patriarchs that are their potential. Some need such attention much more than others, and some seem to do just fine on their own, but nearly every tree will be better if care is given to tweaking its structural development during the early years. One could debate for eternity whether bad pruning is worse than no pruning, but good pruning always will win.

I have learned much from successes I have had, and mistakes I have made, during my personal experience growing oaks, dating back to 1961. This has been supplemented with sound advice from some very good arborists and biologists, and from observations of the consequences of incorrect or neglected pruning. In a nutshell, there are some correct ways and some very incorrect ways to prune young oaks. Here is a summary of what I have found through a half century of oak culture, focusing upon the first seven meters of a young tree's development.

Goals of pruning young trees

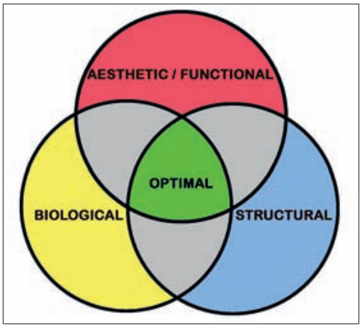

Figure 1/ A Venn diagram of pruning.

Pruning is done for three primary reasons. When it can be accomplished in a way that reflects all of those reasons, it is a job well done. Consider pruning strategies in the form of a Venn diagram with overlapping circles (Figure 1).

The first circle consists of ***structural development***. This comprises elimination of codominant leaders, parallel branches, whorls, water sprouts, inward-directed growth, girdling roots, and damage. Without attention to these problems, your oak is less likely to persist into maturity and, gradually, attain the grandeur for which the genus is known. During structural pruning, we try to plan ahead to minimize the diameters of the present and future cuts to be made, and we cut just beyond the natural collars formed by that portion of the vascular system that bypasses the part of the tree being removed. We select competing vertical shoots, weak growth, clustered limbs, and misdirected branches that I like to say "have no future" for removal, leaving a strong, balanced scaffold of both permanent and temporary limbs.

The second circle represents ***biological health***. This is at least as much a matter of knowing what (and when) NOT to prune as it is of knowing how to prune. We prune to increase, and in a way which will not diminish, the vitality and pest resistance of the tree. Managing existing or projected decay is a critical part of this, although that also is linked directly to the structure circle mentioned above. We prune in a way, and during a season, which will not expose the tree to increased pressure from insects – especially those that are known to vector diseases or cause significant damage. During pruning, we consider the production of auxins and cytokinins in the tree, and try either to minimize the disruption of their natural ratio or to tilt that ratio toward one or the other in a deliberate attempt to influence the growth balance of the tree. We prune to aid in stress recovery by removing decadent or suppressed portions of the crown, taking broken branches back to forks or nodes, and re-forming the tree in its most effective, natural habit for future development. We do not prune excessively, following accepted American National Standards Institute (ANSI) A300 standards of limitation on the amount of meristematic tissue (number of buds) removed during any one annual cycle (in general, removing no more than 25% on a young tree).

The third circle is the top circle – the reason the other circles exist. We grow and maintain trees for ***aesthetic and functional values***, and pruning properly for structure and biological health helps us achieve this goal. In most cases, at least with oaks, the goal should be a future mature tree with a graceful, symmetrical habit characteristic of the species and without significant flaws. In some cases (certainly too many, in my view!), the functional goal might be a pollard, espalier, hedge, topiary, or utility clearance. Each of these goals requires a targeted approach.

Phyllotaxis

Meristems – the growing points of trees – are found in buds, root tips, cambial, and parenchymal tissue. The arrangement of buds (phyllotaxis) on oaks differs from that of most other trees, and this is critical to understanding how oaks grow.

An oak twig will have a dominant ***terminal (or apical) bud*** because oaks exhibit determinate growth. They flush and grow for a set time, then stop elongation to set buds and focus upon diameter growth and root extension. Terminal buds are the tree's primary Auxin producers. As the twig extends, lateral (axillary) buds are formed in the leaf axils. These lateral buds are arranged on oaks in a helical pattern with a repetition number of five. Every bud will be positioned 40% farther around the twig than the previous bud.

Figure 2/ Loss of the dominant terminal bud.

After making two complete revolutions of the twig, the fifth bud will be positioned in line with the first. This might not be apparent on horizontal twigs because the leave petioles will bend to position the leaf blades in horizontal (diatropic) positions, but once the leaves fall the helical pattern can be seen in the buds. At the end of the growth cycle (called a “flush”), the last lateral buds are compressed together to form a ring of ***subapical buds*** surrounding the terminal bud. Often a vigorous twig will have five subapical buds (one complete helix cycle), with more or fewer being common as well (see photo, p. 151) This resembles the whorls of buds seen on pines (*Pinus* spp.), and functions similarly, except that oaks may produce more than one growth flush per season unlike most pines.

Apical buds are dominant, especially in young trees, and become the extensions of the stem and limbs. Loss of a terminal bud will stimulate the development of subapical buds (Figure 2; p. 153). Lateral buds are not dominant but some also can develop if enough light and nutrients are available; they tend to produce smaller branches that emerge at an angle acute to the axis of the branch. Subapical buds are intermediate in dominance, and produce several types of growth. A large subapical bud may produce a co-dominant leader, resulting in a structural problem for the tree. When several subapical buds in one ring develop, a whorl of branches is formed, also creating structural problems with scaffold development.

Tropism

Understanding the ways trees grow is crucial to guiding their growth. Trees, and other plants, follow stimulus-response rules known as ***tropisms***. Several types of tropism combine to direct growth in oaks

Because direct exposure to sunlight reduces stem elongation and etiolation, trees bend toward light due to positive growth hormone action on the shaded side. The effect is called ***phototropism***, or growth in the direction of light. Any oak tree that has been lit primarily from one side will exhibit this habit.

As acorns germinate and young oaks develop, their hypocotyls (future roots) grow downward and their plumules (future stems) grow upward, even in the absence of light. This phenomenon is a hormonal response to gravity, being positive in the hypocotyls and negative in the plumules, and it is called ***geotropism***. It enables the seedling trees to establish themselves in an upright position (wise old nurserymen say “green side up”). Phototropism and geotropism combine to direct vertical growth.

As the young sapling develops, and throughout the life of the tree, other tropism effects can be seen. The primary stems of vigorous young trees and sprouts maintain apical dominance and grow vertically, exhibiting ***orthotropism***. Having one orthotropic leader makes a strong, symmetrical tree; competing leaders usually should be subordinated or removed to avoid conflict. Conversely, lateral branches and twigs are most effective when their foliage is displayed in a horizontal plane normal to the mean direction of the sun, to intercept the maximum amount of insolation; this is called ***diatropism***. As the tree or branch ages, or the topmost part of the tree reaches its physiological height limit (and beyond the focus of this paper), apical buds become less dominant and subapical buds may assume dominance, causing bends and kinks in the tree or branch. This oblique growth condition is known as ***plagiotropism***, and it manifests as picturesque or even contorted growth in old trees.

Knowing how trees, and their parts, respond to external stimuli such as gravity, light, and damage is an important step toward understanding pruning.

Growth hormones

The following is a very simplified explanation of a very complex biochemistry. Think of an oak stem and limbs as a two-lane highway system. Terminal buds, and to a lesser extend other buds, and their associated leaves produce ***auxins*** that are sent to the roots. Root tips produce ***cytokinins*** which in turn are sent upward. As long as traffic is balanced on the stem highway, growth is normally balanced as well.

However, if roots are cut (as in transplanting), the hormone traffic is no longer balanced. The tree is triggered to direct more of its resources to restore the balance by generating more root growth. If the parts of the tree above ground are cut back severely or otherwise damaged, the imbalance is reversed, and the tree will direct its resources to replace the lost buds. This can trigger growth responses in buds that otherwise would remain dormant, and it can cause excessive, structurally unsound wood to form. This is how biology and structure are not always on the same page, as the tree struggles to fix itself. Heavy pruning during transplanting also will lessen the tree's restoration growth of its damaged root system because the hormone balance is artificially restored.

In addition, growth hormones induce the formation of wound-response callus (woundwood) by stimulating cell differentiation of phloem and xylem, regenerating damaged tissues. Beyond the stimulation or depression of root development and woundwood formation, auxins also cause apical dominance. This makes the central leader the most vigorous, orthotropic part of a young tree. Removal of the terminal bud, where the greatest production of auxin is located, will release subapical and lateral buds from inhibition and result in excessive branching and multiple leaders (good for hedges and pollards, bad for "real" trees). Maintaining a reasonable hormone balance in your tree by pruning properly will minimize such problems.

Seasonal considerations

In the late 1800s, fruit tree research suggested a seasonal distribution of growth versus reserve energy now called the ***Askenasy Potential Energy Curve***. Much of this work is applicable to oaks as well. Basically, trees carry their maximum reserve energy level when dormant. As new root growth begins in late winter, some of this energy is consumed. Initiation of springwood (early, very porous wood) formation in oaks, pre-budbreak, takes more stored energy. New leaf and twig formation in spring then consumes much more energy. As the first growth flush hardens and the leaves reach peak photosynthesis, some energy restoration is accomplished; but this is offset by additional growth, both as elongation of supplemental flushes and as diameter growth during summerwood formation. Fruit development in late summer consumes large amounts of energy. Finally, as all of this growth comes to an end toward autumn while photosynthesis continues, the energy level is restored to its peak level at the close of the growing season.

The relevance of this to pruning is that removing live branches during dormancy results in little metabolic cost, whereas pruning during the growing season has variable costs depending upon the growth stage. Dead branches may be removed at any time, and damaged or diseased branches usually should be removed as part of sanitation despite the season. Rapid wound closure also is enhanced by pruning during the peak summerwood growth season if pruning is very light and does not remove much photosynthetic tissue. However, significant removal of healthy branches usually should be deferred until the dormant season to conserve maximum levels of energy in the tree and to prevent disease.

In much of North America, and in other regions where pathogenic fungi or bacteria are vectored by insects attracted to fresh wounds, no pruning of live wood should be done during active stages of those vector species. If damage dictates such pruning, non-phytotoxic wound dressings should be applied to discourage the access of these vectors to the wound. The most serious widespread problem is oak wilt, *Ceratocystis fagacearum* (T.W. Bretz) J. Hunt, but other diseases or opportunistic phytophagous insects could become part of the equation as well.

Pruning during the dormant season also affords a better view of the habit of the young tree and the possible presence of incipient structural problems that, if ignored, will become larger problems. The bottom line is that for reasons of architecture and physiology as well as pathology, we usually should avoid pruning live wood on young oaks during the growing season.

Collar formation and compartmentalization

As trees branch, part of the vascular system follows the branch and the remainder continues around the base of the branch to serve other branches. The overlap zone where this happens creates a swelling at the base of the branch, called the ***branch collar***. In some cases the collar is very noticeable, and in others it is hardly detectible. Often, this swelling can be more easily felt than seen. A procedure called ***target pruning*** is followed to prevent cutting through the portion of the wood connected to the distal portions of the main branch by cutting just outside of the collar. This leaves a slight swelling of active tissue at the cut, and minimizes the size of the wound and the damage done to the remainder of the tree. Such cuts close over rapidly from all directions via ***callus formation*** if the tree is vigorous.

Cuts made flush with the main branch or trunk do not seal uniformly or quickly, increasing the window of entry for decay fungi and phytophagous insects and disrupting vascular flow along the stem. Conversely, leaving long stubs places the cut beyond the quick reach of callus formation, resulting in a long exposure of the open wound. Following Shigo's principles of ***compartmentalization of decay in trees*** (CODIT), stubbing is still better than flush cutting. Because the likelihood of ultimate decay advance in oaks is generally limited to the old wood present at the time of the pruning, and because small wounds surrounded by active cambial meristematic tissue which is supported by strong distal growth close most quickly, small wounds are better than large ones. In this discussion, "small" is a proportionate term meaning the wound is much smaller in diameter than the remaining part of the tree at the wound location. A 2 cm (.78 in) wound on a 3 cm (1.2 in) branch will close more slowly than a 3 cm wound on a 10 cm (4 in) branch because of the increased callus energy available from distal portions of the larger branch. If absolutely necessary, usually due to storm breakage, heading (stub cutting) should be done distal to nodes to encourage regrowth from latent subapical buds. Such growth sometimes is described as endocormic, versus the typical epicormic, weakly attached sprouts formed from adventitious internodal buds. This situation is more likely to be important with larger trees than with the young trees being discussed here.

Observations of natural branch shedding confirm that target pruning mimics how trees have evolved to eliminate lower, shaded, unproductive branches that otherwise would be metabolic sinks. Branches that break off leaving long stubs mimic internodal heading cuts, and they often resprout vigorously to try to close the wound, resulting in weak multiple branches and setting the stage for future failure. Tear-outs, where large limbs are ripped away down the trunk, mimic flush pruning. Trees with tear outs usually become hollow at best, and fail very prematurely at worst.

Figure 3/ Target line for pruning a weak secondary leader.

Structural elements

Pruning young oaks should address a series of potential problems with the goal of developing a young tree with a bright future:

1. **Codominant leaders** must be eliminated during the dormant season as soon as they are found (Figure 3). If they are noticed as they first begin to form, they may be snapped off by hand as they begin to develop in spring. Leaving codominant leaders for future resolution will result in unnecessarily large pruning wounds in immediate proximity to the remaining leader. Due to their codominance, these double leaders do not form branch collars, so their removal when large causes excessive damage to the tree.

2. If a codominant leader was missed early in the pruning cycle, the next best approach is to subordinate it heavily so that it will be outgrown by the selected leader. **Subordination** (also called suppression) is the removal of a large portion of the main (distal) end of a branch back to a smaller, diatropic side branch or abaxial fork. This is severe pruning and often involves removing roughly half or more of the codominant leader being treated. If it is necessary, it should be done when the tree is as small as possible.

3. Branches which are parallel, crossing, clustered, damaged, or directed back toward the trunk will cause structural problems as they grow. They should be removed during each pruning cycle.

4. **Low branches** on the trunk can serve a useful, if usually temporary, function in development of a strong taper, and they can discourage antler rubbing by deer and damage from close mowing or cultivation by careless workers. Their removal should be delayed, and then done gradually once the base of the tree reaches a non-vulnerable size and can resist deer damage. However, permitting them to grow unchecked may result in their development of a large caliper that will cause an unnecessarily large pruning wound if they are removed later. Subordinate them by cutting back to small, outward- or downward-growing side branches. This process keeps their diameter growth in check while the trunk continues to expand, making the eventual pruning wound proportionately smaller and quicker to callus over and seal.

Figure 4/ Phased thinning and subordination of an orthotropic branch.

Figure 5/ Phased removal of a whorl.

5. **Crown raising** for traffic clearance and opening views should be phased in, with some cuts being made gradually throughout the height of the portion of the trunk being cleared and other branches being subordinated to retard their diameter growth pending future removal (Figure 4).

6. **Whorls** formed by subapical buds should be thinned to no more than one or two branches by staging pruning over several years in order to prevent a bottleneck girdling effect at the whorl site, thereby discouraging water sprout formation. If crown raising is complicated by a whorl consisting of more than two branches emerging from the same level at the trunk, remove branches one and three or one and four this year, then subordinate the remainder for removal over the following one or two years (Figure 5). Choose the largest or most orthotropic branches for subordination or removal first.

7. When pruning requires removal of a significant branch, **resprouting** due to hormone disruption sometimes cannot be avoided. The sprouts which develop from the lower side of the cut may be desirable if they can be kept growing in a comparatively diatropic direction, but those originating from the top of the cut frequently are orthotropic and must be redirected or removed (Figure 6). Such removal can be accompanied by a **hormone application** on the cut surface to discourage recurrence. The most effective chemical treatment I have used is dithiopyr, 3, 5-pyridinedicarbothioic acid, 2-(difluoromethyl) -4 - (2-methopropyl) - 6-(trifluoromethyl) -S, S-dimethyl ester (available commercially). Another product, useful mostly to treat new sprout growth after it begins to expand, is Ethyl 1-naphthaleneacetate, (available commercially). Neither is inexpensive!

8. **Circling or girdling roots** can strangle the tree and must be cut while they are still small to prevent heavy damage to the remainder of the buttress (Figure 7; p. 160). Sometimes this requires careful excavation (with a brush, or a water blast or air gun) at the base of the tree to determine if such roots are present. Removal is best done with a chisel, lopper, or chain saw, positioned with the cut parallel to the direction of the primary flare root being released in order to minimize vascular disruption of that primary root from accidentally cutting past the intended area. Girdling roots often result from

Figure 6/ Removal of orthotropic shoots.

planting container-grown trees without spreading or pruning the roots at planting, or from planting too deeply. All too frequently, girdling roots go unnoticed for many years until the tree begins to decline, or the buttress flare becomes conspicuously one-sided due to strangulation, or the tree simply falls over. Spontaneous seedlings seldom develop girdling roots.

Experts and professionals

Tree experts are certified by the ***International Society of Arboriculture*** (ISA) or a similar organization or agency. They must pass examinations and accrue continuing education in order to remain current and stay certified. These are the people who should be looked to for examples of proper tree care. Find them through the organizations that foster development of skills and knowledge among arborists. In Europe, see the web site of the European Arboricultural Council (www.eac-arboriculture.com); and worldwide, seek out the ISA (www.isa-arbor.com).

When pruning your young oaks, always remember that you are creating the potential for them to become grand trees that will give lasting benefits in terms of aesthetics and function far beyond your lifetime. Pruning oaks is not mowing turf! Take the time, and the care, to do it right.

Figure 7/ A badly girdled root system.

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Further reading

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