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MYTH BUSTING FOR EXTENSION EDUCATORS: REVIEWING THE LITERATURE ON PRUNING WOODY PLANTS

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ABSTRACT

Homeowners and landscape professionals alike are interested in proper pruning techniques for their trees and shrubs. Hundreds of popular books and online resources present confusing and conflicting pruning instructions, many of which are not science-based. In this literature review, we explain how woody plant physiology predicts tree and shrub responses to pruning and dispel some common myths that increase the risk injuring or killing trees.

INTRODUCTION

Pruning trees and shrubs is often framed as a necessary activity for the health of the plant. For the most part, this is incorrect: pruning is generally an activity that's done to suit human needs. Some common reasons to prune trees and shrubs include:

- Reducing interference with utility lines (Figures 1a-b)
- Removing spent flower buds
- Providing clearance for walkways (Figure 2)
- Maintaining a shorter canopy on fruit trees for easier harvest (Figure 3)
- Creating formal landscape designs, like topiary and espalier (Figures 4a-b)
- Reducing risk to people and property (Figure 5)
- Removing damaged or dead branches (Figure 6)

Figures 1a-b. Utility lines must be kept clear of vegetation. Choosing the proper trees species is preferrable to constant pruning. Photos by L. Chalker-Scott.


Figures 2-3. Proper pruning can provide clearance for walkways (Figure 2) and create a shorter canopy (Figure 3) for harvesting fruit. Photos by L. Chalker-Scott.


Figures 4a-b. This espaliered, pollarded apple tree requires consistent pruning to maintain its unusual form. Photos by L. Chalker-Scott.


Figures 5-6. Reducing risk to people and property may require pruning both healthy trees and those that have been damaged by storms or other events. Photo 5 by Linda Chalker-Scott; photo 6 by A.J. Downer.

These and other reasons are why people may prune, but none are done for the health of the plant – not even the last one listed. As we discussed in an earlier myth article (Chalker-Scott and Downer, 2018), woody plants have evolved sophisticated biochemical pathways to deal with injuries. We choose to remove dead and damaged branches because it's more aesthetically pleasing, or to reduce risk. Arguments are made for removing a solitary branch that was infested (by tent caterpillars, for instance) or diseased (e.g., fire blight), but the risk of opening a large wound on otherwise healthy wood should be considered. Furthermore, there is a growing movement to retain dead portions of trees as they are used for wildlife habitat and increase the biodiversity of landscapes. When risk to property and people is low, it's worth considering this alternative.

HOW WOODY PLANTS RESPOND TO PRUNING

This is a topic that is covered widely in the popular literature (Gilman, 2011; and Reich, 2010 are two reliable, science-based resources) and is supported by decades of published experimental research, but an overview of the established facts will help in addressing pruning myths.

Short term effects of crown pruning at any time:

- Thinning cuts (Figure 7a) have little to no effect on regrowth below the cut (Figure 7b). Thinning cuts made on trees and shrubs are often unnoticeable to casual observers and are made to preserve a more natural form.
- Heading cuts (Figure 8a) stimulate regrowth below the cut (Figure 8b). Heading cuts are often done deliberately to stimulate bushy growth in roses and other trees and shrubs where a bushy form is desired.


Figures 7a-b. A thinning cut (a) reduces the likelihood of regrowth beneath the cut (b). Photo 7a by A.J. Downer; photo 7b by L. Chalker-Scott.


Figures 8a-b. A heading cut (a) results in robust growth (b) as buds beneath the cut are released from dormancy. Photo 8a by A.J.Downer; photo 8b by L. Chalker-Scott..

Long term effects of pruning during the growing season:

- Crown pruning removes stored photosynthates and changes resource allocation
  - New regrowth demands additional resources
  - Lower trunk receives fewer resources, reducing taper growth
  - Roots receive fewer resources, reducing root development
  - Beneficial microbes associated with the roots receive fewer resources
  - Tree growth is reduced
- Chronic crown pruning dwarfs trees. (This may be a desirable outcome depending on the tree in question. The centuries-old art of crown-pruning bonsai trees maintains the small stature these trees [Figure 9]).
- Excessive crown reduction leads to increased epicormic shoot production (Figure 10)
- Insect pests are more likely to attack heavily pruned trees (Nuorteva, 2002)


Figures 9-10. Bonsai trees are shaped by heading cuts and require high maintenance to prevent resprouting. Without constant maintenance, heavily pruned crowns produce excessive regrowth that reduces tree structural integrity and health. Photos by L. Chalker-Scott.

Environmental conditions also influence these responses and complicate understanding physiological responses. In general, if environmental conditions are stressful (particularly under extreme temperatures or periods of drought), the stress associated with pruning is intensified. And as we discussed in our earlier paper, pruning at transplant is never a good practice (Chalker-Scott and Downer, 2018).

With a basic understanding of how woody plants respond to crown pruning, we dispel some of the most common myths about pruning and provide science-based advice for homeowners and landscape professionals.

MYTH #1: “BUILD A BETTER TREE”

This is a two-part myth: both parts have origins in nursery production and have unfortunately spread to influence those who work in retail nurseries or landscape management, and homeowners as well. In all cases, the underlying motivation is to prune a tree or shrub into an unnatural form. While many types of formal pruning, such as espalier, topiary, pollarding, and pleaching, also create unnatural forms, it's understood that constant maintenance pruning will be required to preserve the form. The "building a better tree" approach often leaves out the necessity for subsequent pruning, with disastrous results. Only corrective pruning can restore a tree or shrub to its (more or less) natural form.

The first part of "building a better tree" includes the topping of young trees, often at the production nursery but sometimes at higher end retail nurseries as well. The most common reasons for topping (also called heading back) are to reduce the height of trees and shrubs for shipping (Figure 11), to create "miniature adults" to attract retail customers (Figure 12), or to create a more columnar form of the plant (Figure 13). This last reason requires some explanation to understand.

Figures 11-13. Production and retail nurseries often make heading cuts to plants to facilitate shipping, or to create smaller or more columnar forms. Photos by L. Chalker-Scott..

As mentioned in our introduction, the result of a heading cut is to stimulate new growth below the cut. Removing the leader of a tree or shrub can result in multiple new leaders below this point. An additional phenomenon that can occur, especially if a leader is continuously removed, is that lateral branches become more vertically oriented. Trees and shrubs trained into columnar forms are more easily placed in narrow spots like parking strips, where they initially look fine. But unnatural forms must be constantly pruned to maintain their shape, and this rarely happens with most trees planted in public areas where maintenance budgets are often nonexistent. Multiple leaders develop (Figure 14), and as they thicken in girth, they fuse with one another (Figure 15), creating a weakly attached mass that is subject to later failure. Risk of failure, with ensuing damage to property and personal injury or death, results in severe pruning to remove most of these branches (Figure 16). The resulting tree is not only less attractive than a naturally grown one, it also is at risk of opportunistic pests and diseases that can attack large pruning wounds.

Figures 14-16. Trees that have been headed will develop multiple leaders (Figure 14) that over time will thicken and fuse with one another (Figure 15), creating potential risk from breakage that requires severe pruning to ameliorate Figure 16). Photos by L. Chalker-Scott.

The second part of "building a better tree" is the removal of lateral branches on young trees. Juvenile trees have short, temporary lateral branches (Figure 17) that many people find unsightly. At the retail nursery, these branches are removed (Figure 18) so the tree resembles a miniature adult; homeowners are encouraged to do this themselves after seeing such trees at the nursery. Unfortunately, this poor pruning practice results in structural damage to the tree – some of it permanent.


Figures 17-18. Juvenile trees have short, temporary lateral branches (Figure 17) that should be retained, not removed (Figure 18). Photos by L. Chalker-Scott.

The short lateral branches on young trees serve two crucial functions: their leaves provide sugars to the trunk attachment area, and they help shade the bark from sun damage. In a previous article (Chalker-Scott and Downer, 2018) we discuss the importance of short laterals in the context of tree staking. The sugars provided by the lateral branches support trunk growth and girth development. Reducing nourishment through branch removal impairs the growth of all trunk tissues, resulting in a spindly tree with thinner bark. The bark of young trees is already thin and easily damaged by cold temperature, weed whackers (Figure 19), and animals, as well as by the sun (Figure 20). This damage is irreversible and while it is usually not fatal, it can open the tree to invasion by pests or disease and is arguably more unsightly than the temporary lateral branches that used to be there.


Figures 19-20. The bark of young trees is already thin and easily damaged by cold temperature, weed whackers (Figure 19), and sun exposure (Figure 20). Photo 19 by A.J. Downer; photo 20 by L. Chlaker-Scott..

RECOMMENDATIONS

The “building a better tree” myth makes the false assumption that woody plants need a pruning intervention to fit some artificial condition or ideal. In fact, trees left to develop naturally are a guide to their best usage. If a planting site requires a columnar or short tree, then it’s up to us to choose the right species, or variety, or cultivar, that will naturally meet those criteria. Lateral branches on young trees should be left to grow and die per the tree’s physiological timeline: once those laterals have lost their usefulness, they will be pruned naturally through programmed senescence.

MYTH #2: “ANCIENT TREES SHOULD BE RETRENCHED TO MIMIC WHAT HAPPENS NATURALLY.”

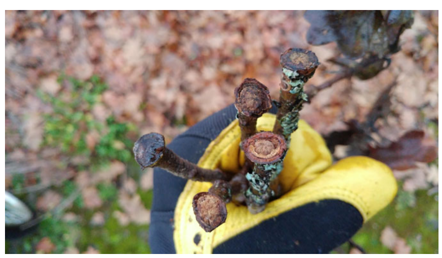
Retrenchment pruning is a relatively new tree care industry practice, but its roots can be traced through centuries of record-keeping on very old trees in Europe. Such trees experience numerous natural events throughout the years that break branches, split crowns, and otherwise add the patina of age to these ancient trees. The philosophy of retrenchment pruning is a belief that mimicking naturally occurring environmental damage by removing large portions of the crown will stimulate growth and rejuvenate old trees (Fay, 2003; Figures 21a-b). Moreover, proponents believe that creating large, jagged cuts in the crown will allow microbes to colonize the crevices and increase crown biodiversity.

Figures 21a-b. Retrenchment pruning removes large branches from ancient trees (a) rather than following natural target pruning guidelines (b). Photos by L. Chalker-Scott.

It is crucial to understand that this practice is not science based: it is strictly based on observation and conjecture. Any type of experimental approach comparing retrenchment pruning to conventional techniques requires multiple ancient trees of the same age and species – and this is not feasible. Therefore, we rely on published research on ancient tree physiology and apply that information to the practice to judge its validity. Briefly, research demonstrates these facts:

1. Tree height is primarily limited by water availability. With increased tree height comes increased difficulty in moving water to the top (Hubbard et al., 1999; Lanner and Connor, 2001; Phillips et al., 2008), limiting continued upward growth.
2. Stems and foliage of ancient trees grow more slowly, have more chemical defenses, and live longer than those of younger trees (Apple et al., 2002; Wolkerstorfer et al., 2011). Thus, they represent a greater source of long-term stored resources (Fletcher et al., 2010; Ishii et al., 2007).
3. The upper crown is the most productive portion of the tree (Li et al., 2003).
4. Trees self-prune branches that are less productive (Fiora and Cescatti, 2008)

Many people do not know that trees naturally self-prune as branches become less productive and require more resources than they provide. This process, termed cladoptosis, is triggered by environmental factors such as light and water availability: reduction in either or both necessities cause the tree to begin the senescence process. Cladoptosis (clad = stem; ptosis = falling) is a slow process, often taking years from the point of growth cessation to branch fall (Figures 22a-b). Thus, trees have an internal mechanism by which to identify the branches that are the biggest drain on resources and preferentially remove them.



Figures 22a-b. Cladoptosis can be seen in branches that have ceased growth but whose branch collars are still expanding (a). The ends of naturally pruned twigs (b) show the internal cleavage plate that develops. Photos by L. Chalker-Scott.

Here is the problem that retrenchment pruning poses: branch and trunk removal is done with no regard to the productivity of the tissues. In ancient trees it takes longer for branches and foliage to grow, and these tissues are full of defensive compounds to protect them from pests and disease (Apple et al., 2002). To the untrained eye, these branches appear to be less valuable to the tree because they don't look like young, vigorous growth. Removal of these healthy branches drastically reduces the tree's stored resources, meaning it is now under long-term physiological stress as discussed in the introduction. And because these are older trees, their ability to recover is slower and less certain compared to younger trees. In fact, new vigorous growth in the upper crown may not be supported given the limitations to water at the tree's maximum height as mentioned earlier.

Ancient trees are irreplaceable treasures. Retrenchment pruning is an activity unsupported by any applied or theoretical research and is in fact contraindicated by a robust body of physiological research. By design, retrenchment pruning removes outer crown branches, representing a substantial portion of the most productive part of the tree, along with their stored resources. Centuries of success stories represent only the successes: there are no records kept on failures, and a biased set of observations cannot be used to inform tree care practices. We can support these historic trees through good soil management (Chalker-Scott and Downer, 2019 and 2020), but wanton pruning to meet an imagined ideal is both destructive and aesthetically unappealing.

RECOMMENDATIONS

Avoid opening the canopy of trees and shrubs, especially when temperatures are hot or cold. Exposing the inner canopy to harsh environmental conditions, such as full sunlight or freezing temperatures can damage or kill leaves and buds. The loss of these tissues, in addition to those removed by pruning, reduces the resources available to roots. Furthermore, newly exposed bark can be damaged by heat or cold, killing the living tissues beneath it.

Do not leave stubs. Stub cutting is recognized as a poor pruning practice, as the stub can become diseased as it dies back. Moreover, this practice encourages latent buds beneath the cut to develop, leading to bushy regrowth and increased shading to tissues further inside the canopy (Krajewski and Krajewski, 2011). And from a tree worker standpoint, these stubs can be dangerous to climber safety.

Do not leave rough cut ends. Cut ends that have pockets and furrows are less likely to seal naturally through the tree's natural defense processes and likely will be colonized by pests or disease-causing organisms.

MYTH #3: "MAKE ANGLED CUTS WHEN PRUNING TREES AND SHRUBS."

A popular debate among gardeners is what cutting angle should be made when removing vertical stems from trees and shrubs. Perhaps the greatest assertion for making angled heading cuts comes from rose aficionados. Conventional wisdom among rose growers is that a 45-degree angled cut (Figure 23a) on canes will prevent water from sitting on the cut surface and reduce disease or insect attack. Likewise, the scientific literature contains recommendations for making angled cuts in rose pruning (French and Appleton, 1994; Sagers, 2012; Figure 23b), in tree height reduction (Kuhns, 1998; Coder, 2003), or in natural target pruning (Davidson and DeGomez, 2015). The apparent approval of angled cuts by researchers makes this a difficult myth to dispel.

Figures 23a-b. Many sources recommend angles pruning cuts (a), especially on roses (b). Photo 23a by AJD; photo 23b by Jim Scott.

BRANCH BIOLOGY

Natural target pruning represents the current best pruning practice in arboriculture. Alex Shigo (1984) described the natural target pruning method as one based on branch morphology. This method involves removing the branch at, not within, the branch collar (Figure 24a). These cuts are made parallel to the branch collar (or branch bark ridge or swelling) – in other words, a 90-degree cut relative to the branch itself (Figure 24b). The branch collar is a region which seals itself off after pruning; by leaving the branch collar intact, wound wood forms and the risk of decay is minimized (Figure 25).

Figure 24a. The branch collar is easily seen where the branch bark transitions to a "wrinkly" collar at the trunk. The cut is made parallel to the collar (Figure 24b). Photos by L. Chalker-Scott.

Figures 25-26. Pruning that preserves the branch collar facilitates wound wood development (Figure 25), while flush cuts (Figure 26) remove the collar and are more susceptible to pests, peeling, and subsequent disease development. Photo 25 by A.J. Downer; photo 26 by L. Chalker-Scott.

In contrast, cuts made into the branch collar – or flush cuts – not only breach this natural barrier but create a wound surface area two to three times greater than 90-degree cuts made on branches (Dujesiefken and Stobbe, 2002). Flush cuts (which are parallel to the trunk surface) used to be the default approach to tree pruning (Figure 26) but are no longer recommended.

PRUNING CUT GEOMETRY

An important goal in pruning woody plants is to keep cut surface areas as small as possible. A cut made at 90 degrees to the long axis of the removed stem produces a circular wound—the smallest surface area per stem diameter (Figure 27a). An angled cut makes a diagonal line across the stem and creates the larger oval wound (Figure 27b). Cuts of any angle will produce oval surfaces areas that are greater than the circles made by perpendicular cuts, and larger wounds are likely more susceptible to attack by fungal pathogens. Research indicates cuts made perpendicular to the removed branch are the least likely to develop decay (Grabosky and Gilman, 2007).

Figures 27a-b. A 90-degree cut creates a wound with a smaller surface area (a) than one made at a 45-degree angle (b); smaller wounds are faster to callus over. Photos by A. J. Downer.

RECOMMENDATIONS

There is no published research supporting angled pruning cuts, and geometry of cut surfaces suggests the opposite. Pruning cuts should always be made perpendicular to the branch and leave branch collars intact. Pruning branches ninety degrees relative to their axis is quick, requires no complicated angle calculations, and is independent of branch departure angles. This method respects branch integrity and the resulting wound will seal faster than those on angled cuts (Skovsgaard et al., 2018).

MYTH #4: "BE SURE TO STERILIZE PRUNING TOOLS WITH BLEACH TO PREVENT TRANSFERRING DISEASE"

Home gardeners, fruit growers, and landscape professionals are often concerned about spreading disease from plant to plant using "contaminated" pruning equipment. It's common to find assertions that pruning tools must be sterilized with bleach between cuts to avoid this possibility. Extension personnel should exercise caution when discussing this topic with clients, as off-label uses of bleach and other household disinfectants should never be recommended.

There are several reasons that chemical sterilizers should not be used.

- Home remedies should never be recommended or encouraged.
- There are few commercial products labeled as surface disinfectants for use by homeowners and other nonprofessionals.
- Bleach and other oxidizing agents will corrode pruners and other metallic tools.
- Most of the time, pruning equipment does not need to be sanitized.

By addressing this last point, homeowners can become better educated in understanding plant diseases and the best means to control them.

FACTS ABOUT DISEASE TRANSMISSION

Not all diseases are created equal, especially in terms of transmissibility

- Plant diseases are most often spread by agricultural equipment creating wounds as they move down rows of monocultural crops. Wounding among clusters of plants of the same species increases the chances of infection by pathogens such as *Pseudomonas savastanoi* pv *savastanoi* - the cause of olive knot disease (Nguyen et al., 2017).
- Some pathogens are only transferable during certain seasons. A good example of this is fireblight, which is transferred easily by pollinators and results in peduncle infections during bloom. For thirty years, Professor Robert Raabe at UC Berkeley tried to transmit fireblight through pruners while teaching plant pathology; he was never successful. Since fireblight is commonly transmitted by bees, infected branches can be pruned out without concern for clipper sanitation since bloom stage is past.

On the other hand there are exceptions

- Infectious diseases such as boxwood blight in monocultural ornamental settings can occur, since dozens or hundreds of boxwood plants are planted in rows and then sheared successively with power equipment (Bush et al., 2016).
- Some pathogens, such as tobacco mosaic virus, tomato mosaic virus and others, are highly transmissible and can be mechanically transmitted from plant to plant (Pategus et al., 1989).
- Crown gall (Figure 28) is another highly infectious disease caused by *Agrobacterium tumefasciens*. The bacterium occurs in soil and can cause infection in many plants where wounds allow entrance.

Figure 28. Crown gall visible at the base of this tree. Photo courtesy of University of California.

SCIENCE-BASED MAINTENANCE FOR GARDENING TOOLS

It's important to emphasize that **there are no research studies documenting the transfer of disease agents through tools used by gardeners**. Furthermore, if you do not know the cause of a disease, or which disease you are attempting to control, there may be little need to sanitize pruning equipment (Figure 29).

Unfortunately, there are many Extension publications that recommend, without published evidence, the use of readily available household chemicals for pruning tool sanitation. Some of these are mentioned below.

- Recommended use of bleach or Lysol to sanitize pruning equipment (Bush et al., 2016)
- Recommended use of bleach and quaternary ammonium salts to sanitize pruning equipment (Duman et al., 2018)
- Recommended use of bleach, pine oil cleaner, rubbing alcohol, denatured alcohol, or quaternary ammonium salts for sanitizing pruning equipment (Palmateer and Tarnowski, 2011).

Certainly, keeping tools clean is a good idea when **known** pathogenic agents are present. But these steps should be taken deliberately to slow the progress of disease in a population of plants, not as a routine procedure. In such cases, flame sanitation of tools (Figure 30) should be considered. Heating a cleaned saw or bypass clipper blade for a few seconds is highly effective in killing pathogens in any organic matter residues remaining on the surface (Downer et al., 2009). Flame sanitation requires no pesticide authorization or labeling. Of course, caution should be taken not to overheat blades and ruin their temper, and you should wear protective gear around flames. Pruning equipment cools rapidly and only needs to be heated for a few seconds on each side of the cutting surfaces for adequate sanitation.

Figures 29-30. A simple scrubbing with a stiff brush (Figure 29) is often all pruning tools need; if there are concerns about transmissible diseases, a quick flaming of the metal blade (Figure 30) will sterilize the surface. Photos by A. J. Downer.

Some viroids causing pruning-transmissible diseases (such as some in citrus) are not well controlled by heat, and other methods must be used for sanitation (Fake, 2012). Disinfecting solutions can work **when research supports the efficacy of the active ingredient against a specific pathogen.** Local pesticide laws and label instructions must always be followed.

RECOMMENDATIONS

Gardeners rarely need to sterilize their pruning equipment: in most cases, pruning out the diseased tissues is all that is necessary. If multiple members of a plant species in a garden are diseased, pruning equipment can be sanitized between plants with a torch. Garden monocultures can be avoided by using multi-species hedges which will prevent movement of pathogens like boxwood blight. Any attempt to sanitize garden equipment should be coupled with knowledge of the pest or pathogen that is being controlled.

CONCLUSIONS

Pruning ornamental landscapes is done primarily for the owner's benefit; it is not something that trees, and shrubs require to maintain health. Improper and unnecessary pruning threatens woody plant health and should be avoided. Gardeners and landscape managers should ask why they want to prune and then determine if that goal is in the best interest of long-term tree and shrub health. When warranted, pruning should follow natural target guidelines and create circular wounds that will encourage natural and rapid sealing. Pruning methods promoted without published, peer-reviewed research to support the practice should be avoided, especially in irreplaceable trees. Pruning wounds should not be painted with wound treatments for reasons we discussed in a previous article (Chalker-Scott and Downer, 2018), and use of any sanitizers on pruning equipment must follow label instructions and state pesticide regulations.

The option to retain dead portions of trees as wildlife habitat is worth considering when feasible. Risk should be assessed by a certified arborist as decay proceeds to ensure safety to people and property. The benefits from retaining such trees (Figures 31a-b) can be more rewarding than maintaining an artificially pristine landscape.

Figures 31a-b. Dead parts of trees, or entire trees (a), are habitat for a variety of wildlife (b). Photos by L. Chalker-Scott.

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