

# Guidelines for Renovation Pruning of Overgrown Apple and Pear Trees

## Introduction

These guidelines are for non-commercial growers (stewards) who have overgrown apple and pear trees in need of renovation. By employing a few basic principles, these overgrown trees can be restored for easy maintenance and to produce quality fruit that will be easy to harvest.

There are many differing opinions regarding restoration pruning since the approach for tree restoration is far different than for annual maintenance pruning. Advice varies on everything from how much wood is safe to remove at once, to what is the best time of year to prune, to how tall the tree should be afterward. But the fact is, there is no ridged “formula” for renovation pruning, so the steward has a lot of latitude in working with the tree.

**Simply stated, the single most important principal for a healthy tree to produce the best fruit is for all areas to receive adequate sunlight and air flow: “Light and Air.”**

For those not familiar with common tree and pruning terms, check the “**Terminology**” section toward the end for before proceeding.

## The Fascinating Process of Converting Sunlight to Fruit

Fruit trees are magnificent solar collectors and fruit factories. The simplified sequence from sunlight-to-fruit is:

- In the spring, the spur leaves in the fruit bud are the first to break dormancy.
- The reserve nutrients from the roots support the growth of the spur leaves and the blossoms, until they bloom a short time later. Blossoms last about 10 days.
- After blooming, the support from reserve nutrients fades. For the next 3 weeks or so, each separate whorl of spur leaves, with its pollinated blossoms, is its own little standalone factory for fruit production. Development of the fruit relies almost entirely upon photosynthesis from the spur leaves, converting sunlight to sugars.
- During this initial phase of 4-6 weeks, it is critical that the spurs have good sunlight exposure to 1) set the fruit, 2) produce good fruit size, yield and quality, 3) develop fruit buds for next year.
- Once the new vegetative shoots have grown and leafed-out enough, they also add nutrients for the continued development of the fruit. Additionally, they produce nutrient reserves, stored mostly in the roots, to support the initial growth in the following spring.

So, it's easy to see that during both renovation and annual maintenance pruning, the goal of the steward is to open up the canopy to allow strong exposure to sunlight, to support multiple physiological processes.

## **Characteristics of Overgrown Trees**

All neglected, overgrown trees share similar features, regardless of age or shape:

- Too tall, due to unrestrained leader growth or old water sprouts
- Branches and foliage are too dense, restricting light and air into the tree, particularly in the center and lower areas.
- Branches are tangled, crossed, rubbing, or pointing in the wrong direction. Some are weak and/or too long, making the tree too wide or unable to support a fruit load.
- Lots of dead/diseased wood, some with obvious cankers. Trunks or structural wood may be hollow or otherwise rotted.
- May produce some fruit where light and air can reach. Fruit is usually small and often deformed.

**The Moderately Overgrown Tree** will have some old but still productive fruit spurs in the lower area of the canopy that can be saved during thinning and height reduction. These will continue to produce fruit and can be gradually pruned out as new laterals come into production over the next 2-5 years. After the initial pruning, these trees will have lots of leafing and fruiting branches of proper density. Fruit quality will improve by opening the canopy to light and air.

**The Severely Overgrown Tree** may have some fruit production high in the tree where there is access to light and air. Sails are 15-25' tall and started as water sprouts, while weeping branches started as weaker water sprouts and arched over. The lower canopy is so dense and shaded that there are few fruit spurs and the branches are long and weak. After pruning, all that might be left are some shortened scaffold branches, a few laterals and some structural wood as a framework to renew the tree. This wood will produce prolific new shoots in the following growing seasons, but new shoots typically will not produce much fruit until the 3<sup>rd</sup> growing season.

## **Overgrown Tree shapes**

There are 3 common shapes for most overgrown trees:

**Central leader trees** originally had a single, central trunk with side scaffold branches forming a conical shape. Uncared for, these trees turn gangly with multiple tall "leaders" that have turned into multiple trunks. The scaffold branches and long laterals may be arched or weeping and lots of old water sprouts will have grown into sails, thick and tall.

**Open center trees** have four-to-six main structural limbs, beginning 24"- 48" above the ground. Growing outwardly, these limbs form a vase or bowl-shape 8-15' tall, at which point they may transition to outward and horizontal. Scaffold branches originate from the structural limbs and water sprouts propagate from the tops of all the branches. Many heritage trees were trained as open center for ease of maintenance and harvest.

**Umbrella trees** are extremely overgrown open center trees. These older, neglected, open center trees have developed overlapping layers of long, weeping scaffold and lateral branches that originated from the 4-6 main structural limbs. These weeping branches started as water sprouts but over time drooped to form an umbrella shape. They may also have thick, overgrown vertical sails, 20'+ tall. Once renovated, these trees can become stately, specimen trees.

## How much to prune

Many authors advise against removing more than 1/3 (or less) of the live wood in any one season, to reduce stress. The concern is **not** that the tree will die. Limiting to <1/3 is to maintain fruit production and to reduce the explosive new shoot growth, which is the response to severe pruning. Even when much more than 1/3 of the wood is removed during extreme pruning and the tree looks brutalized, vigorous new shoots will appear.

The approach presented here is to do all the renovation pruning in one session and also reduce the tree height to about 10' so the entire tree can be reached from the ground or a short ladder for pruning and harvesting. However, not all trees are suitable for a 10' height, so the grower may decide that taller is more appropriate.

The benefits to removing the excess canopy all at once are:

- A tree shortened to ~10' is easier to reach for pruning, starting in the next growing season when lots of new growth will need pruning.
- Every old branch that is pruned away is one less site for excessive new shoot growth or for fungal infection remaining on old wood.
- Training for a new canopy shape as well as improved fruit production can begin in the first growing season after pruning.

When reducing the height to about 10' and removing all unwanted wood with a cordless sawzall and hand tools, most trees can be fully renovated in 2 hours or less. Still, some stewards renovate and prune over several seasons because one session seems too drastic. There are some online sites and YouTube video references at the end to provide those options.

## **When to prune**

Renovation pruning is the most severe pruning the tree will ever experience, and it will stimulate prolific new growth. **Choosing the right time to prune can reduce the next season's excessive regrowth.**

Pruning during summer's peak growing tends to slow growth by removing leaves that manufacture nourishment for the next year. Conversely, pruning during winter tends to promote vigorous tree growth the following summer, when energy stored from the past summer is channeled to the reduced number of remaining buds. Therefore, for multiple years after severe pruning, the best time for maintenance pruning to reduce vigor is from May until August. Excessive regrowth can also be managed in the winter when there are no leaves present, and it is easier to figure out which regrowth to take out and what needs to be left.

It is ideal to avoid pruning in the spring and fall when the weather/temperature make the spread of fungal infection somewhat greater, but that should not be an over-riding concern for the steward of old trees. Overgrown trees can be pruned whenever the opportunity presents itself, as the primary goal is to restore light and air circulation into the canopy.

## **Fungal diseases**

Fungal disease is not a death-sentence for an old tree over the short term. There are many large old trees that are infected, have survived for decades, and are still strong, vigorous and produce copious amounts fruit. With renovation pruning, most of the diseased wood can be removed and new sprouts will start out fungus-free. Opening up the canopy to light and air will reduce the potential for further infection. Regardless, the practical remedy for the steward of old trees is to simply prune away the diseased wood as much possible during the renovation and subsequent annual maintenance pruning. A further step for control is a spray program to treat the disease.

Pest control and fertilization are not covered here, as there are many resources and specialists available on these topics. One caution is to avoid nitrogen fertilizers for several years after renovation pruning, as it stimulates even more growth.

## **Renovation Pruning Guidelines**

The following procedures are for common, open center trees, but the same concepts apply to central leader trees or trees that have just "gone wild." The steward can adjust them to suit their own strategy.



The goal is that, after final pruning, the canopy for open center trees should:

- Be shaped like a “donut” when viewed from above, with a height of ~10’.
- Have a uniform density, with the branches far enough apart to “throw a hat through it,” i.e., most laterals and branches separated by 12-18”.
- Have scaffold branches and long laterals headed back (shortened) to stimulate new shoots along the branch.
- Contain as many fruit spurs as could be saved, for continued fruit production.

## **Pruning 1 - 2 - 3 - 4**

The directions in *red font* are the physical steps. The black font is the explanation or recommendation.

### **1) Evaluate the tree, make a plan:**

*Choose the best 4-10 scaffold branches to be saved and mark them with flagging tape.* All unmarked branches and excess structural wood will be removed.

The scaffolds to be saved:

- May be original structural wood or scaffolds
- May be weeping, old water sprouts or laterals that have grown too long
- Should be robust enough to support the weight of future fruit
- Are outward-pointing and evenly spaced around the circumference of the tree, like spokes of a wheel
- Hollow branches or trunks are acceptable if structurally sound and still vigorous

### **2) Begin with major pruning cuts:**

- *Remove excess structural wood that is not supporting flagged scaffold branches.* Could be for these reasons:
  - Lower the height
  - reduce density
  - rubbing
  - too long and in danger of breaking at the crotch under heavy snow or fruit load
  - in the center of open center trees.
- Except for those with flagging tape, *Remove all other branches from the remaining structural wood:*
  - Sails
  - Verticals

- Weak and excess laterals
- Excess scaffolds
- Branches in the center
- Crossing/rubbing/wrong direction
- Reduce density
- Dead/diseased. If fungal damage is found on the trees, the practical control is to prune away the affected areas.

**3) Make the finishing cuts.** The only wood left is the structural wood and the flagged scaffold branches:

- *Head back the branches that extend beyond the desired circumference of the canopy* to establish the new perimeter of the canopy and stimulate new shoots. Often these long branches extend far past the desired circumference and can be shortened by 4-8'.
- *Use a thinning cut to remove:*
  - Up/down/inward facing branches and dead or diseased wood. Keep outward facing branches between 9:00 and 11:00 o'clock or weeping branches if present.
  - Secondary scaffolds and laterals that are too dense by leaving a 12-18" spacing between those to be kept.
- *Do not head laterals into 1 yr wood in the dormant season.* "tipping" a branch in winter just simulates more unwanted, excess wood on mature trees.
- *Head older laterals into 2 yr or older wood if needed* in summer or winter to promote new lateral shoots, fruit buds and spur formation, to stop lengthening and/or stiffen the branch.
- *Adjust the direction of the branches to fill holes* in the canopy by wedging them apart, tying in place or weighing them down.
- *Adjust the overall density and shape* by removing additional structural wood or scaffolds, if needed. Perform a final pruning to attain 12-18" spacing between branches, particularly at the ends of branches around the perimeter.

#### **4) Pruning guidelines for subsequent growing seasons**

During the next 3-4 growing seasons, the steward will contend with an astounding growth of new shoots.

- *Remove the majority of water sprouts during the summer* to reduce the quantity of nutrients stored over the winter.
- *Summer pruning and fruit production will minimize excess vigor* in heavily pruned trees.

*Perform the pruning sequence in **Step 3), Make the finishing cuts** for ongoing annual maintenance pruning. Add in a session of winter pruning if excess growth occurs after summer*

pruning. Regardless of how extreme the renovation pruning was, after several years the canopy will fill in and the tree will regain its balance. Old laterals from before the renovation can be pruned away. New secondary scaffold wood and new laterals will be in place and producing fruit. The grower can transition to more conventional pruning practices of winter and/or summer pruning, as desired.

### **Cultural best practices**

- If disease is detected, it is best to prune it off without delay.
- Remove infected leaves and fruit from the tree and those that have fallen, too.
- Make slanting cuts on major limbs so water runs off, to minimize future rot.
- Remove all cut wood from the orchard. Burn diseased wood.
- Periodically sterilize tools, especially after pruning a diseased tree, with 70% alcohol or Lysol (bleach will corrode your steel tools).
- Moss and lichens are not harmful. Leave them alone.
- The current industry practice is to leave the pruning wounds open- do not paint them or apply tree-wound seal.

### **Safety considerations**

- Use a chain saw with caution. Kickback in close quarters, using a gas saw with a short bar, is inevitable and can cause very serious injury. Small, one-handed cordless chainsaws, or those on a pole, are safer. Wear a hard hat with visor.
- A cordless sawzall is a safer option than a chainsaw. Smaller ones can be operated with one hand.
- Use a ladder rather than climbing the tree. Branches are slick and old (or rotten) wood doesn't hold as much weight as you may think.
- Orchard ladders are safer than extension ladders or step ladders on uneven ground.
- If you're going to climb higher in a tree, use a harness and safety line.
- Use a long-reach pruner to reduce the need for a ladder.
- Wear safety glasses. Branches cut at a 45-degree angle at the tip will invariably poke you somewhere. A hat with visor (or hardhat) is useful for the same reason.
- Work with a buddy so there are two of you on-site, but only one person at a time works on a tree.
- Have a cell phone for emergencies.
- Stop working when you're tired.

## Before and after examples



**Severely  
overgrown open  
center umbrella  
apple, before  
pruning**

Last pruned: ~14 yrs  
Total height: ~30-  
35'

Sails: ~ 15-20' long,  
2-3" dia.

Layered, dense  
weeping branches.

Spread: ~40'

Pruned in July.



**After pruning**

Open center,  
umbrella tree

Height: ~15'



Weeping branches  
were thinned and  
headed.

This tree will bear  
some fruit next  
season.





**Moderately overgrown open center apple, before pruning**

Last pruned: ~8 yrs  
Total height: ~25'

Spread: ~20'

Water sprouts are "thicker than dog hair."  
Long, weak laterals. Crossing/rubbing branches.  
Dense center.  
Not many fruit spurs in lower canopy.

Pruned in June



**After pruning**

Open center,  
Height: 8-9'

Long, weak laterals were removed or headed back.  
Summer growth water sprouts were pruned in the fall.  
A few fruit buds remain.





**Moderately overgrown open center apple, before pruning**

Last pruned: ~4 yrs

Total Height: ~15'

Spread: ~20'

Water sprouts.  
Excess scaffolds.  
Dense center.

Pruned in September.



**After pruning**

Open center.  
Height: ~8'

Note prolific fruit spurs on water sprouts headed back to 3-4 yr wood. These will be thinned in future years as new, sloping laterals appear and bear fruit.





**Severely overgrown  
open center apple,  
before pruning**

Last pruned: ~20 yrs  
Total Height: ~35'  
Sails: ~ 25' long, 3-4"  
dia.  
Spread: ~30'

Old water sprouts.  
Long, weak laterals.  
Crossing/rubbing  
branches.  
Very dense center  
with few fruit spurs at  
<10'

Pruned in October.



**After pruning**

Open center  
Height: ~8'

Strong scaffold  
branches, headed  
back.  
A very few fruit spurs  
remain.  
New lateral shoots  
will bear fruit in 3rd  
growing season.





**Open center apple with split trunk, before pruning**

Height: ~25' w/sails

Trunk is split at the crotch. The trunks are sound and vigorous. Potential weight at far ends during snow/ice dictated removal of the long levers.



**After pruning.**

Height: ~12'

The main structural limbs were severely cut back. Similar to pollarding. Note the few remaining viable laterals at the top of the highest limb. New shoots are expected along the length of the remaining wood and will be trained to an open center style over an extended number of years. This tree could be productive for a few more decades?



**Fungal disease.** Even diseased, these 50-100 year old trees are strong and produce fruit



Anthracnose "fiddle string" cankers on apple



No need to remove Burrknot



Old canker, healing process underway, apple



Cankers? on cherry trunk



Canker on bottom of apple branch

## Terminology and principles of pruning:

- **Vigor, vigorous:** refers to the differing rates of growth in new shoots. A vertical water sprout will show strong vigor (vigorous growth) by growing several feet or more in a season. Lateral branches at a near-horizontal orientation may only grow a few inches, so are not as vigorous as water sprouts. Standard trees (full size) have a much larger root system than dwarf/semi-dwarf trees so produce more vigorous growth, requiring more annual pruning to control canopy height and spread.
- **Structural wood:** the large, main components of a tree, forming the basic shape, such as the trunk of a central leader tree or the trunk and “arms” of an open center tree. The primary scaffold branches originate from the structural wood.
- **Scaffold branch, scaffold:** a primary or secondary scaffold branch supports the lateral branches. Old laterals become scaffolds as they branch off with new lateral shoots and no longer produce fruit.
- **Lateral branch:** originates from a scaffold branch, oriented from 9 o’clock to 11 o’clock in slope. These branches produce fruit spurs on 2 yr wood and older.
- **Shoot:** 1 yr wood at any location on the tree.
- **Water sprout:** branch that grows straight up or leans only slightly.
- **Sail:** An old waterspout that has grown tall, 15-20’+. May look like a separate tree on top of a structural limb. May impose a structural overload due to windage or snow/icing conditions.
- **Sucker:** sprouts that form at the base of a tree, often from the root stock used for grafting. Remove them when found.
- **Vegetative buds:** are formed on new shoots during the first growing season and look like smooth, small scales at the leaf nodes on 1 yr wood.
- **Fruit bud, Flower bud:** are produced from vegetative buds during the second growing season and on the end of fruit spurs on older wood, are fat, fuzzy and shaped like the end of a football. Don’t remove them unnecessarily.
- **Fruit spur:** a short branch growing from a lateral branch, tipped with a fruit bud. Each year they add a small amount of growth giving it the appearance of having wrinkled rings around the spur. They are good for 4-6 yrs of the best fruit production, and then productivity tapers off, but can still be productive.
- **Apical bud, Terminal bud:** The fat bud at a shoot tip or leader that always grows first and fastest.
- **Bud scar:** a ring on a branch that marks the point where the terminal bud begins growing after the dormant season. This is the division between the 1- and 2 yr wood, 2- and 3 yr wood, etc. This ring is visible between wood of different ages and often the wood from earlier years will have a different color or texture.
- **Canker:** A diseased area of the bark caused by fungal infection.

- **Development of new laterals to produce fruit:**
  - 1 yr wood: begins as a new shoot in its first growing season, producing all vegetative buds by fall. This section is 1 yr wood through the first year of dormancy.
  - 2 yr wood: in the spring of the second growing season, vegetative buds on 1 yr wood produce leaves and form fruit buds by fall. This same section is now 2 yr wood through the second year of dormancy.
  - 3 yr wood: blossoms form in spring of the third growing season on 2 yr wood and develop fruit by the fall. This same section is now 3 yr wood through the third year of dormancy.
  
- **The primary pruning cuts:**
  - Thinning cut: Cutting a branch back all the way to where it originates from a larger branch or a “Y”, at the collar.
    - Reduces density.
    - Used for water sprouts
  
  - Heading cut: shortening a branch:
    - On 1 yr wood pruned in winter- winter heading cuts are used infrequently on 1 yr wood and will delay fruiting on that branch. Use this only if the tree needs to be bigger. A heading cut above an outward-facing bud will increase the length of the branch in the direction the bud is pointing. At least 1 bud below the cut will produce new shoots to lengthen the branch.
    - On 1 yr wood pruned in summer- heading back to 6-16” long in July/August usually leaves 3-4 buds on 1 yr wood. This promotes early fruit buds by fall instead of vegetative buds and can produce some blossoms and fruit on next season’s 2 yr wood.
    - On 2 yr and older wood pruned in summer or winter- heading back to fruit buds stops a branch from lengthening, thickens it and forces water sprouts and side lateral shoots from the remaining branch. Sometimes called a “shortening cut”.
    - On older branches found on neglected trees that are weeping, or oriented between 9:00 and 11:00 o’clock, a heading cut of 1/3 or more of the original length will promote vigorous growth on the remainder of the branch. This new growth can be trained and pruned over several years to restore the desired shape and density of the canopy.

## **Tree biology as it applies to pruning principles.**

There are many complex physiological processes involving hormones and nutrients that control a tree's growth. Here are a few of the factors that apply to pruning and the subsequent results.

### **The effect of hormones-**

Cytokinin [sīdə'kīnin] - is a hormone created mainly in roots. It is transported up the tree and breaks dormancy of the apical buds, initiating the production of auxin. Cytokinin stimulates new cells through cell division during active growth and also promotes lateral bud formation.

Auxin- is a hormone produced in actively growing apical buds and promotes cell elongation and shoot extension in the stem. It flows down the branch by gravity and inhibits new shoots from growing from vegetative buds on last year's wood.

Apical Dominance- A condition in plants where the apex of a leader or branch dominates by preventing the development of lateral branches near the apex. It is controlled by auxin produced at the apical bud. Close to the bud, the auxin concentration is high and inhibits lateral growth. Removal of the apical bud results in branching near the cut end.

To some extent, the strength of the hormones and the ratio of auxin-to-cytokinin determines how the tree develops.

- When the apical bud is removed from the end of a branch in the dormant season, the concentration of auxin is reduced during the next seasons active growing. Lateral shoot growth is no longer inhibited by auxin, so one or more buds below the cut will react to the higher ratio of cytokinin-to-auxin, initiating new lateral shoots.
- Apical growth is strongest (vigor) in vertical shoots (leader or water sprouts). The further the branch leans away from the vertical, the effect of auxin from the apical bud is gradually reduced. Sloping branches don't grow as long as vertical branches in a season (reduced vigor). There is little auxin effect in a branch that is bent below the horizontal.

### **Topworking**

Many stewards are concerned about removing too much wood during pruning. This section introduces the industry-wide practice of topworking that removes almost all of the wood from a tree, and yet the tree flourishes. During topworking, all structural limbs are cut off and a few small nurse limbs are left. Severely cutting back promotes a flush of new shoots. Cuttings from a new variety are grafted onto the new shoots, or bark-grafted directly into the cut-off limbs.





Top working an apple tree to stimulate new shoots to receive grafting cuttings.

Structural limbs were cut in March on a 50 yr old apple tree, leaving a few thin nurse branches.



Vigorous growth by the end of June, suitable for grafting. Note shoots lower down on the trunk.

ref: Stephen Hayes-  
see the video link

## References and Useful Links

### For Renovation pruning:

1A) Michigan St. University. Excellent video of renovation pruning on a badly overgrown tree, lots of wood removed, height reduction, thinning. Pruned in March with follow-up the next March.

Initial renovation pruning: [Renovation Pruning an Old Apple Tree - YouTube](#)

Results and maintenance pruning one year later: [Apple Renovation - 1st Year Follow Up Pruning - YouTube](#)

1B) Michigan St. University. Good text description of extreme pruning for renovations: [Renovating Old Apple Trees - Fedco Trees \(fedcoseeds.com\)](#)

2) [Gary Heilig](#). Large, moderately overgrown apple tree. Good description of concepts and demo. Leaves the tree taller. [How to Prune A Really Neglected Apple Tree - YouTube](#)

3) [Lonely Pines](#). Good on principles, uses cordless sawzall. Leaves the tree taller: [How to Prune an Overgrown Fruit Tree | Neglected Apple Tree Pruning - YouTube](#)

4) [Grow to learn](#). Removes tall sails, opens up center, good result [How to Prune A Really Neglected Apple Tree, How to Prune an Apple Tree!, How to prune an old tree, - YouTube](#)

5) [Waardenburg Family Farm](#). Smaller, moderately overgrown, good result: [Pruning the Old Apple Tree - YouTube](#)

6) [Stephen Hayes](#) is a veteran UK orchardist. Has 10+ years of YT videos dealing with all aspects of apple trees and orcharding. A valuable resource.

Stephen Hayes- Excellent. Shows 50 yr old tree just after removal of all major wood in early March, with mass of new vigorous shoots ~4 months later in late June for grafting. [Apple tree graft over follow up - YouTube](#)

Stephen Hayes- He cut off the tree at the trunk in winter. Shows strong growth in August for grafting: [Working over apple trees, result of brutal pruning - YouTube](#)

7) [Alan](#) is a veteran arborist and has some sage advice on renovations on this forum thread: [Pruning Old Apple Trees - General Fruit Growing - Growing Fruit](#)

8) [OSU](#), good for new and renovation. Includes umbrella trees: [Training and Pruning Your Home Orchard | OSU Extension Service \(oregonstate.edu\)](#)

**For General pruning guidelines**, not necessarily renovation pruning

9) Master Gardener, Excellent, comprehensive: [Pruning Fruit Trees - UC Master Gardener Program of Alameda County \(ucanr.edu\)](https://ucanr.edu/pruning-fruit-trees)

10) OSU- Excellent, covers regular fruit tree pruning: [Tree pruning basics | OSU Extension Service \(oregonstate.edu\)](https://oregonstate.edu/tree-pruning-basics)

11) WSU- Covers regular fruit tree pruning: [Pruning and Training Systems | WSU Tree Fruit | Washington State University](https://wsu.edu/pruning-training-systems)

12) Penn St.: [Apple Top-Working: Managing the New Grafts \(psu.edu\)](https://psu.edu/apple-top-working)

### **Tree physiology**

13) [Auxins and Cytokinins - What's the difference? | How do they work? - Southside Plants](https://southsideplants.com/auxins-cytokinins)

14) [Spreading shoots of young apple trees | Good Fruit Grower](https://goodfruitgrower.com/spreading-shoots)

15) [Tree Fruit Lakso \(cornell.edu\)](https://cornell.edu/tree-fruit-lakso)

16) [Why apples need both spur and shoot leaves to grow \(treefruit.com.au\)](https://treefruit.com.au/why-apples-need-both-spur-and-shoot-leaves)

### **Fungus, disease and pest info**

17) WSU, description of common diseases and pests:

[hortsense.cahnrs.wsu.edu/Search/MainMenuWithFactSheet.aspx?CategoryId=3&PlantDefId=59&ProblemId=16](https://hortsense.cahnrs.wsu.edu/Search/MainMenuWithFactSheet.aspx?CategoryId=3&PlantDefId=59&ProblemId=16)

18) WSU, anthracnose description: [Apple Anthracnose | WSU Tree Fruit | Washington State University](https://wsu.edu/apple-anthrax)

19) WSU Extension Publications | [Anthracnose Canker Integrated Management Plan for Home Gardeners \(Home Garden Series\)](https://wsu.edu/anthracnose-canker)

20) WSU powdery mildew description: [Apple Powdery Mildew | WSU Tree Fruit | Washington State University](https://wsu.edu/apple-powdery-mildew)

21) Video: [How to Identify and Remove Canker from Apple Trees - YouTube](https://www.youtube.com/watch?v=...)

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**Steve Gaber,**  
February-2023