



INTRODUCTION

If you have ever participated in a pruning and training demonstration workshop, you will understand the difficulty of giving general recommendations for pruning and training. There are many styles and methods of pruning. Practices are even evolving quickly because of regional factors and new rootstocks that have unique characteristics. Ultimately, there is no one best way to prune, but there are recommended practices.

So how can you learn to prune and train?

- Continue reading this factsheet for fundamental principles and regionally-specific comments
- Participate in local workshops and other professional development opportunities
- Watch recently published videos from recognized extension sources
- Find hands-on opportunities to practice and revisit trees to assess pruning response so you can learn from personal experience and observations

Pruning or training, what's the difference?

Training refers to the development of the structural framework of the trees. While some training may be necessary after the tree comes into production, this activity is largely confined to the nonbearing years. The objective of the training program is to develop a framework that effectively displays a large surface area of the tree canopy to full sunlight and will support heavy crop loads. Pruning is one method of accomplishing the training program.

PRUNING

When to Prune

Dormant Pruning

In Nova Scotia, if pruning is done in late fall or early winter before the dormant period is reached, it can contribute to winterkill or freezing damage. When the trees have not fully hardened-off they are not prepared for extreme cold. Pruning can delay hardening off, especially if many cuts are made. Therefore, the safe period for dormant pruning begins in early March and is best finished by bloom.



Growers that cannot wait until early March to begin pruning should at least wait until the end of January and prune during stable weather conditions. The risk factor associated with pruning in late January and February can be reduced by:

- Avoiding extreme temperature lows or temperature swings in winter
- Pruning only blocks that are due for removal in the near future
- Those that bore light crops
- Trees that require only light pruning or hardy varieties

Pruning is best finished by bloom when the tree is expending resources. After growth has begun, the growth response to pruning cuts will be less than that obtained for dormant pruned trees.

Summer Pruning

The most important objective of summer pruning is to increase light penetration in the canopy to improve fruit colour, and it can also be used to remove vigour. In Nova Scotia, summer pruning is practiced:

- During the last of July into early August, once the terminal bud has been set. Removing a shoot at this time in the season will not stimulate vegetative growth. Summer pruning prior to this can promote weak shoot growth that is prone to winter kill.
- Only when leaves are dry and when two days of dry weather are forecast in order to prevent spreading fire blight. Blocks with a history of severe fire blight pressure could be avoided.

PRINCIPLES OF PRUNING

Consider the following fundamental scientific principles that never change.

- 1. **Pruning can never make a tree larger.** Parts of the tree are removed, so it is a dwarfing process.
- 2. Pruning encourages shoot growth. It reduces the shoot or bud competition, so each remaining shoot grows with access to relatively more resources.
- 3. Removing large branches has a big impact. Removal of large branches removes more reserves, is less stimulating and thus more dwarfing than is the removal of many small branches having an equivalent number of growing points (buds).

- 4. Removing undesirable shoots is most effective early. It is best to remove undesirable shoots that will not be fruitful before trees waste the energy in supplying them with resources. Young trees should be trained to an appropriate shape as early as possible.
- 5. Correct pruning is critical as the tree fills its space and becomes crowded. In modern high-density plantings, training and pruning must be carefully planned and executed.
- Renewal pruning maintains fruiting buds on healthy wood that is exposed to good light.
 Fruiting buds are primarily found on the spurs that are two or more years old.

INFLUENCE OF TREE SHAPE

The productivity of an orchard is directly related to the amount of light intercepted by the orchard canopy. Light influences flower bud formation, productivity and fruit quality. When light levels drop below 30% of full sunlight, flower-bud formation is reduced, spur vigour is lost and fruit produced in this zone is small and of poor quality. Over time fruit production will decline in this area as a result of the death of fruiting spurs.

Consider the influence of tree size and shape on the amount of light intercepted by the orchard canopy:

- **Tree Spread:** Tree spread impacts the area of inadequate light by as much as 25% in a large central leader tree to as little as 1.6% in a dwarfed tree. The relatively smaller area of a nonproductive zone is one reason why smaller trees can be more productive than large trees.
- **Tree Height:** With tree height, the top of the tree is increasingly likely to shade the bottom of the tree and the bottom of adjacent trees and rows. In fruiting walls and trellis systems, the light interception is optimized when the tree height is equal to the distance between rows in a 1:1 ratio. However, with the risk of exposure to high winds, maintain a shorter tree height at 0.9 x row width.
- **Tree Shape:** A fruiting wall, conic, or pyramidal shape produces a much more favourable light distribution than that of the globular form that was typical of standard trees. The most productive portion of the globular tree is the top third where the fruit is difficult to access.



The natural growing habit of apple trees differs by variety. They are classified into four categories based on shoot gradient and the relative vigour of the branches and fruiting habit. For more information, search online for 'Lespinasse four ideotypes.'

PRUNING TECHNIQUES

Pruning practices are done to promote uniform vigour and fruitfulness, reduce shading and maintain one leader (except in multileader systems). There are several types of pruning cuts that can be made:

- 1. A heading cut removes part of a shoot or limb, not the entire shoot. The response can be aggressive regrowth.
- 2. A thinning-out cut removes the entire shoot or limb at the point of origin. In the Nova Scotia climate, thinning out may not regenerate a new branch in its place.
- **3.** Stubbing is a severe heading cut where only a small portion of the branch remains, often 2-4 inches. This is known as a renewal pruning cut that is used to regenerate a fruiting branch by encouraging new growth, preferably from the underside of the stub (Figure 1).



Figure 1: Renewal pruning or stubbing is the practice of cutting the branch back to two to four inches from the point of origin during the dormant season. When growth resumes in spring, a branch will typically regenerate and renew the fruiting zone. Branches that regenerate on the underside are preferable because they are most likely to have a horizontal growth habit.

When choosing where and how many cuts to make, note the function of branch types and the vigour of the tree as a whole to inform the pruning plan.

Branch Types

• Upright branches are excessively vigorous and only moderately fruitful

- Drooping branches are weak, heavily shaded and sparingly fruitful
- Horizontal branches are moderately vigorous and very fruitful

Vigour Cases

- On a vigorous tree, the goal is to control the vigour. A few big cuts will stimulate less growth than a lot of small cuts.
- On a weak tree, the goal is to encourage vigour. Heading back branches with many small cuts stimulates growth.
- Trees with a heavy spur system and limited shoot growth can be balanced by spur pruning, meaning removing 1/4 to 1/3 of the spurs. The condition of having weakly growing branches with abundant spurs is known as spur bound (Figure 2).



Figure 2: Trees with a heavy spur system have limited shoot growth and they are termed spur bound. Vigour and fruitfulness can be balanced by spur pruning to remove excessive spurs. Dwarfing rootstocks like B.9 are most likely to become spur bound.

Universal Pruning and Training Rules

The shape and health of a tree is maintained using the following three methods. The training systems described in the next section are a supplement to these basic rules.

- On all trees, remove limbs below 60 cm in height from the soil line to allow for cultural operations under the tree canopy.
- 2. Remove damaged or diseased limbs.
- The influence of cropping on training cannot be substituted for by pruning. Cropping is a component of the training system because it reduces tree vigour and helps maintain structure.



TRAINING SYSTEMS

Orchard training systems evolve with time and continue to be developed to fit a particular variety or growing trend. This publication describes six systems that are options in the Atlantic Region, but preference is given to high-density systems that lend themselves to the present production trends.

Low Density vs. High Density

The goal of training low-density systems is to build a strong set of scaffold limbs and an extensive tree framework to support the weight of future crops. Growing a tree delays the time to cropping and creates shading inside the canopy. Low-density systems are not recommended for commercial production, which requires high volumes of high-quality fruit to stay competitive.

In high-density systems, vigorous growth is discouraged, and instead, trees are reinforced with trellis and leader supports. High-density plantings are successful because the high number of trees per acre contributes speed to filling the canopy area. Planting density impacts the time it takes an orchard to reach the mature yield, and if a system reaches its mature yield quickly, then apples start paying off the planting costs.

The optimum density currently being reported in New York is around 1300 trees per acre. In Nova Scotia, trees in new plantings are typically spaced 12' between rows and 3' within rows. The spacing varies with more or less vigorous rootstocks and varieties to ultimately fill the space and maintain trees in the allotted space. In the Atlantic region, lack of vigour with dwarf and semi-dwarf planting systems is more common than excessive vigour. The spacing between rows also depends on the size of the equipment available to travel within rows.

The following training systems are presented in order of low- to high-density for comparative purposes, and they are summarized in Table 1.

Table 1: Characteristics of training systems for a range of planting densities and in relation to yield expectations. Measurements are presented in the imperial format that is currently the industry standard.

| CHARACTERISTIC | FREESTANDING CENTRAL | SPINDLE BUSH | VERTICAL AXIS | SLENDER SPINDLE | TALL SPINDLE | SUPER SPINDLE |
|---------------------------------|----------------------------------|--------------------------------------|---|------------------------|---|---|
| Density (trees/acre) | 156 | 340 | 484-670 | 871-908 | 908-1452 | 1452-2178 |
| In-row spacing (ft) | 14 | 8 | 5-6 | 4-5 | 3-4 | 2-3 |
| Between-row spacing (ft) | 20 | 16 | 13-15 | 10-12 | 10-12 | 10 |
| Tree height (ft) | 14-16 | 10-12 | 10-14 | 7-8 | 10-11 | 9-10 |
| Tree spread at the base (ft) | 12 | 6 | 5 | 3-5 | 3-4 | 2-3 |
| Rootstock Size | Semi-vigorous and semi-dwarf | Semi-vigorous and semi-dwarf | Semi-dwarf | Semi-dwarf | Semi-dwarf and dwarf | Semi-dwarf and dwarf |
| Rootstock Examples | BA, EMLA 111, Bud 118, MM 106 | EMLA 111, Bud 118, MM 106, EMLA 7 | EMLA 26, EMLA 7 | EMLA 26, EMLA 7 | EMLA 26, EMLA 7, EMLA 9, B9 | EMLA 26, EMLA 9, B9 |
| Support system required | no | leader strong post | trellis, and leader support recommended | leader slender post | superior trellis and leader support | superior trellis and leader support |
| Scaffold limbs | permanent | permanent | semi- permanent | semi- permanent | none | none |
| Shape | pyramid | pyramid | narrow pyramid | conical | fruiting wall | fruiting wall |
| Yield expectations, years 3-4 | low | low | medium | medium | high | high |
| Yield expectations, years 5-10 | medium | medium | high | high | high | high |

Note: Table adapted and updated from NC State Extension article "AG-581 High-Density Apple Orchard Management" published Jan 1, 1998.



FREESTANDING CENTRAL LEADER

Summary

The freestanding central leader is a low-density system that does not require tree support (Figure 3). Trees are spaced at a distance of 14' in the row and 20' between rows for a tree density of 155 trees per acre. This planting density is not recommended for commercial production and is included only for comparative purposes.



Figure 3: The Freestanding Central Leader is a low-density training system that does not require tree support. Trees are trained to a pyramidal shape with a strong branching structure. This training system is not recommended for commercial production that demands early production, high-quality fruit, and labour efficiency.

Key Features

- The basic frame is a 5-way tree. There should be a central leader above four well-spaced laterals (permanent scaffold limbs) at the base of the tree. Preferably these laterals should form an X along the row rather than a +. This limb ordination allows for better spray penetration and ease of harvesting.
- There are three to four tiers of permanent scaffolds with gaps in between.

 Training to a pyramidal or Christmas tree shape maintains a large productive fruiting zone. Limbs in the upper portion of the tree must never be allowed to spread outward and dominate over limbs located in the bottom portion.

Young Tree (1-4 years)

Keep the leader dominant and in balance with the tiers of four lateral limbs.

- Head back whips (one-year-old nursery trees without lateral shoots) to 1-1.2 m at time of planting. If branched trees are planted, head the leader back by one third on vigorous trees or one half on low vigour trees. Heading will create strong scaffold limbs, induce lateral limbs and create vigorously growing leaders.
- Choose a dominant leader by removing nearby competing shoots.
- Avoid allowing limb diameter to become greater than half of the diameter of the leader.
- If there are less than four limbs on the tree, stub back all limbs to avoid the development of strong laterals that compete with the leader.
- Otherwise, select four first-tier scaffold branches and remove competing lateral branches. Continue to select scaffold limbs in tiers on the previous season's growth. Train tiers of scaffold limbs to lie horizontal and to decrease in vigour up the height of the central leader.
- A good leader is maintained by spacing scaffold branches well apart and not allowing several branches to develop at the same height or directly opposite each other.
- Use clothespins, wooden toothpicks, twine or other spreaders where necessary to correct crotch angles and control vigorous growth. Spread lower scaffold to form crotch angles of 60° to 45° from vertical. Varieties with strong upright growth such as Red Delicious, Northern Spy and Ambrosia tend to produce shoots with a strong upright growth habit.



Developing Tree

After the basic tree structure is established, it should not be necessary to do much pruning until the tree has borne several crops of apples. Focus on maintaining a balance between vegetative growth and fruit production.

- Thin out unnecessary vigorous limbs.
- Shorten scaffolds by pruning back to a weaker side branch only if; 1) extension growth has been poor or excessive, 2) the plane of the limb is bent beyond 45% (tip of the limb is bent towards the ground), and 3) if the cultivar normally develops few side branches, ie. Cortland.
- Remove laterals with poor crotch angles that cannot be corrected by tying or spreading.

Mature Bearing Tree

Begin cropping when the trees are nearing one-half of their mature spread at 2 meters across.

- Pruning should take the form of containment pruning to control the size of the full mature tree, known as scaffold renewal.
- Remove 1 to 3 of the largest limbs in the thickest upper parts of the tree with follow-up details as required by the variety. If a renewal limb is desired in the same location as the limb being removed, then use a stub cut.
- Leave a permanent set of scaffold limbs in the bottom third of the tree canopy.
- Ideally, the leader will bend with the weight of the crop to restrict the tree height. Otherwise, to control height, cut the leader back to a weaker lateral branch.
- To manage pruning labour, perform large cuts first and detail cuts second. The detail may be subdivided into three steps - removal of strong upright new shoots, removal of down-hanging low branches and detailed handwork along the remaining branches to improve light interception.

SPINDLE BUSH

Summary

The spindle bush is also a low-density system that trains a central leader to develop a pyramid-shaped tree with permanent scaffold limbs. Trees are spaced at a distance of 8' in the row and 16' between rows for a tree density of 340 trees per acre. Use the method outlined for a freestanding central leader with the following additional considerations.

Key Features

• The spindle bush is supported by a post or wire support system to support relatively earlier cropping compared with freestanding trees.

Young Tree (1-4 years)

- Do not head the leader of the tree unless starting with a one-year whip or a poorly branched tree.
- Pruning cuts in the second and third years should be restricted as much as possible in order to induce early cropping where tree canopy permits it.
- If leader growth is excessive, it can be cut back to the next suitable weaker lateral, which is tied up and trained to take the place of the removed leader.
- Focus on achieving the desired tree height on precocious rootstocks such as EMLA 26 through maintaining tree structure and avoiding early heavy cropping.

Developing Tree

- If the leader is allowed to become too weak from overcropping or lateral limb competition, the dominance may be lost. In many cases, loss of the leader results in a reduced tree canopy, which translates into reduced productivity.
- If the leader is allowed to become too strong, lateral growth and development will be reduced and negatively impact production.
- Light fruit cropping is possible in the third year provided that good tree growth is being obtained. Avoid cropping on the upper third of the leader, as it will weaken the leader.



VERTICAL AXIS

(Other names: French Axis, Vertical Axe, French Axe)

Summary

The vertical axis is a medium-density system that requires tree support (Figure 4). Trees are spaced at a distance of 5' in the row and 14' between rows for a tree density of 622 trees per acre. The system is a modified central leader training style with a narrow pyramid shape and semipermanent scaffold limbs.



Figure 4: The Vertical Axis is a medium-density system that requires tree support. Trees are trained to a narrow pyramidal shape with a set of semi-permanent scaffold limbs at the base.

Key Features

- This system allows for early cropping, reduced pruning and training time and improved light distribution within the canopy, thus increasing fruit size and colour.
- A support system is used to encourage rapid development of the leader to the desired height.
 A trellis system usually consists of 1 to 3 wires, and often the leader is supported by bamboo or

conduit piping attached to the trellis. If the leader is not adequately supported when cropped, it could weaken and break.

• Trees are rarely headed in order to avoid strong basal limbs.

First Leaf

- Large well-feathered trees are recommended because they will fill their allotted spacing, allow for earlier fruiting and reach full production sooner.
- Do not head the leader of the tree. However, if using a one-year whip, head back to 80 cm in the first summer. If using a poorly branched tree, remove laterals with a stub cut and head back the leader to 80 cm.
- Where a well-feathered nursery tree is planted (5 to 8 strong laterals with wide crotch angles), remove laterals from the top third of the tree, remove laterals with a narrow crotch angle, leave only 5 to 6 large laterals between 45 and 75 cm, evenly distributed around the trunk. Remove one or two when they are directly over one another, leaving laterals spaced up and down the axis, not all at one height.
- In late spring or early summer, select the strongest shoot in the top of the tree as the leader and remove any other shoot at the same level or 10 cm immediately below. Remove the tip of young shoots by pinching if they appear to be upright and strong enough to compete with the leader. Pinching should be done every 2 to 3 weeks.
- Spread or bend limbs on varieties that produce thick, strong laterals low in the tree, such as Gravenstein, Ambrosia and spur type Delicious. Spread or tie only those limbs that appear to need it or remove them with a stub cut.

Second Leaf

- No dormant pruning should be needed if proper summer training was carried out.
- If summer training was not carried out, remove competing laterals, vigorous upright growth, low branches and poorly placed growth. Do not head the leader.
- Bending may be required, as mentioned for first leaf.



Third and Fourth Leaf

- Practice similar training techniques. Limited cropping can begin in year three if adequate growth has occurred.
- The ideal vertical axis tree has a basal tier of about six limbs of similar diameter and positioned from 0.6 to 1.1 m above the ground. Above that tier is a gap with only small fruiting arms so that adequate light reaches the lower tier. Above the gap is an informal array of fruiting limbs that are not permanent but are renewed close to the central leader after they have fruited and bent downward. The bottom portion of the tree must always be wider than the top.
- Maintain semi-permanent scaffold limbs by shortening bottom tier scaffolds where needed back to side branches to allow for equipment movement and to maintain fruit quality. Shorten branches that have become pendant (hanging down) back to a horizontal portion of the branch.
- On Type One trees that branch predominantly at the base of the stem (basitonic), the bottom portion of the canopy can become dominant, resulting in poor leader development. Reduce the number of laterals in the lower portion of the tree to retain strong leader growth.
- On Type Four trees like Cortland that branch predominantly toward the tip of a stem (acrontonic), the top portion of the tree can become stronger than the lower branches. Selective removal of limbs in the top portion of the tree will encourage stronger growth in the lower portion of the tree.

Mature Tree

- Once the tree is cropping, the number of limbs in the bottom tier should be gradually reduced. The least desirable should be removed annually until there are only four semi-permanent scaffold limbs in the 0.6 to 1.1 m zone above the soil line.
- By year five, it may be necessary to start renewing fruiting limbs in the upper portion of the canopy.
- Use thinning cuts as much as possible because they are not as invigorating as heading cuts. Thinning branches encourages fruit production close to the trunk. A heading cut should only be used where stiffening of a limb is desired.

Pruning steps for medium density systems (mature vertical axis and slender spindle):

- 1. Branch size: Leave no branches larger than 50% of the leader's diameter at the point of origin.
- 2. Branch density: Remove excessive and older wood to enhance light penetration and renew wood even if it is less than 50% of trunk diameter. Remove one to two fruiting limbs in the upper portion of the tree canopy annually using a stub cut for renewal or thin out for removal.
- 3. Branch complexity: Leave no side wood greater than 50% of the branch diameter at the point of origin. The exception is the relatively large semipermanent scaffolds in the base of the vertical axis tree. Thin by removing spurs under branches, remove vigorous upright shoots and cut back into weak, hanging wood.
- Leader height: Once the desired height has been reached, maintain the leader by replacing it with a weak side limb as needed to control tree height.
- 5. Tree shape: Maintain the vertical axis narrow pyramid shape or the slender spindle narrow cone shape by renewing long shoots in the top third of the canopy. Shorten bottom tier scaffold limbs to side branches to allow for machinery movement and to maintain fruit quality. Heading back scaffolds to weak laterals will stiffen and keep the tree compact with healthy wood close to the trunk.

SLENDER SPINDLE

(Other names: Slender Axis)

Summary

The slender spindle is a medium-density system that requires tree support. Trees are spaced at a distance of 4' in the row and 12' between rows for a tree density of 908 trees per acre. Apple trees trained to the slender spindle system have more of a conical shape than the pyramidal shape of a central leader or spindle bush tree. This shape is achieved by limiting lateral limb spread through partial removal. Use the method outlined for vertical axis with the following additional considerations.



Key Features

- Tree height is restricted to 7-8', which is convenient for performing tasks from ground level. However, this short system sacrifices the yield possible in taller trees.
- Limbs are trained to at or below the horizontal position in order to control tree vigour and induce early fruit production.
- Secondary limbs are spaced out radially and vertically.

Young Tree

- On a vigorous tree, head the central leader into twoyear old wood to retrain to a weaker lateral. Choose a weak and tilted shoot for the leader. Choosing new laterals as leaders over several seasons creates a zigzag central axis and restricts height.
- On a weak tree, head the central leader by half to a third of the previous season's growth to stimulate vigour and maintain leader vigour to fill the space.
- Dormant pruning results in sharp-angled limbs in the top of the tree where side-branching is actually needed throughout the top. A late May or early June cut to the leader forces flat-angled side branches from flower buds. A May or June cut may be used instead of a dormant cut if the dormant cut is too invigorating. Do not cut one-year-old wood above 60 cm at the tip.

Mature Tree

A well-trained tree should have a tapered appearance with weak fruiting laterals in the top of the canopy and limbs getting progressively larger as limbs descend down the leader. Continue with annual maintenance pruning to prevent shading in the canopy. Renewal pruning done annually avoids the need for heavy pruning that results in excessive vigour response. Follow the pruning steps for medium-density trees.

TALL SPINDLE AND SUPER SPINDLE

Summary

The tall spindle is a tall evolution of the slender spindle system. Tall spindle trees are spaced at a distance of 3' in the row and 12' between rows for a tree density of 1210 trees per acre. Super spindle is spaced even closer together at 2' apart, and rows are 10' for a density of up to 2178 trees per acre. The tall spindle and super spindle are high-density systems that require superior tree support capable of holding the weight of high early yields. Both systems produce a fruiting wall at maturity, and all limbs are renewed over time to keep fruiting wood close to the trunk (Figure 5).



Figure 5: The Tall Spindle and Super Spindle are high-density systems that require superior tree support capable of holding the weight of high early yields. A) All limbs are renewed to keep fruiting wood close to the trunk. B) Both systems are trained to the shape of a fruiting wall.

Key Features

- Branches are continuously renewed when they become too large, and no permanent scaffold limbs develop. The fruiting wall simplifies pruning and allows partial mechanization with motorized platforms.
- Trees that fill their space quickly produce high early yields. In the Atlantic region, weak varieties like Honeycrisp that are cropped too early run the risk of runting the growth of the leader. The goal is for the leader to reach the top wire by the third leaf and begin cropping by the fourth leaf.



- The tall tree height lends itself to extra yield in treetops. However, the height of the system should not exceed 1 x row width, or it would shade the base of the neighbouring row.
- Yields produced by super spindle are reportedly only marginally better than tall spindle even though super spindle investment costs are significantly higher.

Young Tree

- Plant the tree with the graft union 4-6 inches above ground.
- Do not head trees.
- Remove limbs greater than 2/3 the diameter of the leader.
- If there are less than three good limbs, stub them all to prevent competition with the leader.
- Stub back branches that compete with the leader and remove branches with narrow crotch angles.

Pruning steps for high-density systems (mature tall spindle and super spindle):

- 1. Branch size and density: Remove 2-3 big limbs (greater than 2/3 diameter of leader or 3/4" diameter) or excessive branches using stub cuts for renewal. Remember to include bottom branches in this renewal process. This step will accomplish most of the pruning work and help maintain the fruiting wall shape.
- Branch complexity: Simplify branches by removing vigorous upright growth using thinning-out cuts. Remove drooping branches. Simplify forked ends down to one shoot.
- **3. Leader height:** Single the leader. If needed, control height by cutting back to a weak lateral branch.
- 4. **Tree shape:** Ensure the tractor row is clear. Remember, the tree limb will bend from the weight of fruit and could block the row. Constant renewal of short branches should prevent this.

MULTI-LEADER SYSTEMS

In a single leader system, a tree is equivalent to one leader. As training systems become more closely spaced together, the tree requirements increase greatly to fill the space with upright fruiting leaders. Some growers have tried multileader systems that use one tree to produce two or more leaders. The results have been:

- The vigour of one tree is split between two leaders. In our northern Atlantic region, trees usually lack vigour and splitting the vigour can slow down the time it takes to reach production (Figure 6).
- Heading trees and restarting the growth in the field can result in an uneven height of leaders.
- The immediate costs of the trees are less than in a single leader system, but the trellis can be elaborate and expensive, coupled with meticulous tree training to fit the system.
- The trellis must be strong to support a crop that is largely hanging on the trellis without a central tree structure.



Figure 6: In a two-leader system, known as multi-leader, a single tree is trained to produce two leaders. In the Atlantic region where vigour is lacking, splitting the vigour can slow down early production. Photo was taken in Michigan during the 2020 IFTA Annual Conference and Tours.



OTHER PRACTICES

MECHANICAL HEDGING

Mechanical hedging and topping are the indiscriminate heading-back of shoots and branches. Hedging is done using a mechanical pruner as an attachment to a tractor. It is driven down the orchard row to trim the trees uniformly (Figure 7).



Figure 7: Mechanical hedging is done using a mechanical pruner as an attachment to a tractor to trim the trees indiscriminately but uniformly. The practice is best suited to dwarfing rootstocks in high-density systems to control the height and width of trees in support of mechanization. Manual pruning of unwanted branches to maintain the shape of the tree is still necessary.

The practice is best suited to dwarfing rootstocks in highdensity systems:

- Hedging practices tried in the 60s and 70s on full size, and semi-dwarf trees led to poor results because cuts on big branches would respond with an explosion of shoot growth.
- Trees on dwarfing rootstock are relatively calm and respond with weak shoot growth.
- The response will not be as vigorous in high-density systems with mainly small-diameter branches.

Hedging is most commonly used in Atlantic Canada to 'set the box' of a high-density system, meaning it is used to control the height and width of the trees in the row. Hedging can, therefore, reduce pruning time and create uniformity. The uniform canopy lends itself to mechanization like harvest platforms that improve worker efficiency.

Other considerations for hedging include:

- The implement can be tilted to keep limbs longer at the bottom of the tree for optimal sunlight interception.
- The grower still needs to visit trees individually to remove unwanted branches and maintain the shape of the tree.
- Hedging to control tree height and width is recommended during the dormant period or early spring prior to bloom. If trees are not dormant, consider the risk of spreading fire blight bacteria.
- Hedging during late summer will not stimulate as much vigour as dormant pruning because the tree has already expended resources. However, this timing may increase the risk of winter injury.
- Hedging is easiest to execute when it is considered in the design of a new planting. However, it is possible to transition an existing block from strictly hand pruning to incorporate hedging. Big limbs should be removed manually over several dormant pruning seasons prior to hedging, and some production will be lost.

Trial this new method on a small area first if you are unfamiliar with the results it will create. Hedging is not practical and beneficial for every system.

PRECISION PRUNING

Precision pruning is an opportunity to practice crop load management prior to chemical thinning and hand thinning. It involves removing fruit buds as a way to reduce crop load on a tree to the amount that is necessary to set a crop. By reducing the bud load early in the season, the remaining fruit have access to more resources for size, quality and return bloom. The detailed pruning is time-consuming, so high-density growing systems like the Tall Spindle or Super Spindle are most practical because of their uniformity and small tree size.

The method is as follows:



- 1. Determine the **target fruit bud load** per tree based on yield and fruit size requirements.
- **2.** Determine the reasonable bud load by multiplying the target fruit bud load by an insurance factor of 1.5.
- **3.** Determine the necessary bud load based on the proportion of buds that are floral as opposed to vegetative.
 - **a.** Sample 2 dormant branches from 3 representative trees and place them in water in a warm location.
 - **b.** When buds push, calculate the percentage of buds that are floral (Figure 8).
 - **c.** Divide the reasonable bud load by the percentage of buds that are floral.



Figure 8: Dormant buds are tricky to identify as floral or vegetative, so it is helpful to force a sample of buds to push. A) When the chilling requirement has been met, dormant branches are sampled. B) After being placed in water at room temperature for one week the buds push. C) The difference in bud type becomes apparent, allowing evaluation of the percentage of buds that are floral.

Example: The target fruit bud load is 100 per tree. The reasonable bud load is 150 (100 x 1.5). The percentage of buds that are floral is 75%, so the necessary bud load is 200 (150/0.75).

- **4.** Count the number of buds on several representative trees of a variety in a block.
- 5. Prune to remove buds in excess of the necessary bud load.

6. Perform chemical and hand thinning if needed to reduce the number of fruit in each bud cluster.

For more information, refer to the source article <u>Precision</u> <u>Crop Load Management Part 2</u>. Updates to the process were sourced from Dr. Terence Robinson's presentation at IFTA in Grand Rapids, Michigan and minor adaptations were made.

INDUCING BRANCHING

Some varieties produce very few laterals the year of planting (Northern Spy) or develop blind wood (Honeycrisp).

Notching

Notching paradormant buds can induce them to grow and develop into laterals. Notching is the removal of a section of bark and cambium above a vegetative bud (Figure 9). This prevents the flow of the growth-inhibiting hormones from the tip of a shoot to the notched bud, thus breaking apical dominance and allowing bud growth. Notching can be done quickly with an ordinary hacksaw blade.



Figure 9: Notching above a paradormant bud breaks the flow of growth-inhibiting hormones and allows the bud to grow. The practice can be used to correct blind wood in apple trees. Notching can be successful on old wood if promoted by registered plant growth regulators.

- The blade is placed about 1 cm above the bud and drawn horizontal across the leader or limb. Make sure that the bark is removed right down to the wood to remove the cambium.
- Not all notched buds will push growth, so two or more buds should be notched to achieve the desired results.



- Check local management guides for plant growth regulator (PGR) products registered to help elongate shoots and increase lateral bud breaks.
 - » Note that PGRs have not been widely adopted by the industry for this purpose because of cost, variable results and ease of management.
 - » Notching is most successful on young wood. Yet, when used with PGRs, research shows that notching can be successful on old wood that is four to seven years old.
- The optimum time of notching appears to be four to two weeks prior to bloom (green tip to ½-inch green) unless otherwise indicated for use of the practice with a PGR.
- Note that scoring is an alternative to notching, but it does not always work because the wound can heal over quickly.

RECOMMENDED VIDEO RESOURCES

Tall Spindle

- Jon Clements UMass Pruning the Tall Spindle Apple, Take 1 (McIntosh) https://www.youtube.com/ watch?v=AXpOXS6Dbc4
- Jon Clements UMass Pruning the Tall Spindle Take 2 (Ruby Mac and Honeycrisp) https://www.youtube.com/ watch?v=MbR9GZe2pUA
- Jon Clements UMass Pruning the Tall Spindle Take 3 (Honeycrisp – including spur removal) https://www.youtube.com/watch?v=I9T4aolc9b0
- Dr. Terence Robinson Cornell 4 rules for pruning tall-spindle apples (mainly Gala) https://www.youtube.com/ watch?v=ZqZPQV9I9jA
- Leslie Huffman OMAFRA Training Young High Density Apple Trees https://www.youtube.com/ watch?v=q0i5vqzO98M

Vertical Axis

 Dr. Terence Robinson Cornell, Pruning Vertical Axis Apple Trees (1/15/2009) https://www.youtube.com/watch?v=6osHELs4n-I

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