

PNW 667

CHERRY

training systems

L. Long, G. Lang, S. Musacchi, M. Whiting

A Pacific Northwest Extension Publication

OREGON STATE UNIVERSITY ■ WASHINGTON STATE UNIVERSITY ■ UNIVERSITY OF IDAHO

in cooperation with MICHIGAN STATE UNIVERSITY

CHERRY training systems



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Pacific Northwest Extension publications are produced cooperatively by the three Pacific Northwest land-grant universities: Oregon State University, Washington State University, and the University of Idaho. For this publication, Cherry Training Systems (PNW 667), Michigan State University was a key partner in producing and reviewing the content.

Cherry Training Systems

L. Long, G. Lang, S. Musacchi, and M. Whiting

Any tree fruit training system will provide a framework with the potential to produce large quantities of high-quality fruit. However, many traditional training systems create complex canopies, take years to fully develop, lack a systematic plan to renew fruiting wood, and are difficult to clearly and specifically explain. Due to the rising cost of production, an increasingly limited skilled labor pool, and escalating competition on the world market, modern training systems must offer growers results such as these:

- Precocity or early fruiting for high early yields and a more rapid return on investment
- Production on well-exposed wood of moderate vigor to provide high-quality fruit
- A systematic process to renew fruiting wood
- Repeated canopy units for simplicity in training and pruning

Cherry growers around the world use many training systems, both supported and freestanding. This publication describes eight commercially successful systems: Kym Green Bush (KGB), Spanish Bush (SB), Steep Leader (SL), Super Slender Axe (SSA), Tall Spindle Axe (TSA), Upright Fruiting Offshoots (UFO), Upright Fruiting Offshoots “Y” Trellis (UFO-Y) and Vogel Central Leader (VCL), all of which can be achieved with a whip (vs. feathered) nursery tree. Each system has benefits and limitations. Choosing the right system depends on growing conditions, variety, rootstock, labor availability, and management skills. This training manual will provide readers with the information needed to choose a training system for new plantings. You will learn how to implement the chosen system to meet your production goals.

Understanding the Natural Tree

Undisturbed in its native environment, the young sweet cherry (*Prunus avium*) will grow as a central leader tree. Growth is rapid and apical dominance is strong. Thus, the tree tends to branch only just below the terminal bud of annual growth, can grow to 60 feet, and is non-precocious so it can establish a competitive “footprint” in the forest before shifting resources to fruiting. All growers face the challenge of managing sweet cherry so that the tree remains small, generates branches at the desired locations, and begins producing fruit by the second or third leaf.

- Excessively vigorous growth – Cherry trees are inherently large and vigorous. Without intervention when young, they produce long shoots with few lateral branches or fruiting spurs. This trait makes orchard canopy development challenging and limits fruit production.
- Narrow crotch angles – Cherry trees tend to produce branches with narrow crotch angles. Such angles often are weak and prone to bark inclusion, a condition in which bark is trapped between the trunk and the branch, preventing layers of annual wood from growing together. Splitting and/or bacterial canker infections (caused by the freezing of water trapped in a narrow crotch) can occur at these locations. Narrow crotch angles are associated with upright vigorous growth that competes with the leader and is less productive than lateral growth of moderate vigor and wider crotch angles.

- Delayed fruiting – On their own roots, cherry trees can take 5 to 6 years or more to produce fruit. Pruning can modify tree vigor and increase branch production. However, pruning—and especially dormant heading cuts—tends to delay fruit production in young trees by stimulating vegetative growth. Other factors, such as deep, productive soils or over-fertilization, increase tree vigor and delay the onset of floral initiation.

Dwarfing and precocious rootstocks have made it possible to harvest a crop in the second or third leaf, more easily control tree size, and encourage wider branch angles at desired locations. Proper management and training of trees on dwarfing rootstocks controls fruit set, balances leaf area with crop load, and promotes larger fruit.

Annual shoot elongation is imperative for maximum fruit quality. The largest and highest quality cherries are produced at the base of the previous season's growth and on young spurs. The orchard manager's goal should be to produce an abundance of new shoots about 24 inches in length in targeted zones throughout the tree, depending on the training system, while removing old spurs.

Training System Options

Consider carefully before selecting a training system. Make the right choice for your orchard by understanding the intensity of required management and how training factors interact to promote flower bud initiation, vegetative growth, and renewal wood when and where it is advantageous. Realize that the recommended tree and row spacings, target shoot/branch/scaffold numbers, etc. in this guide usually are ranges that will vary according to the specific combination of factors associated with each orchard site, such as soil fertility, terrain, growing season length and climate, rootstock vigor, cultivar growth habit, orchard equipment size, and management skill.

Kym Green Bush (KGB)

The Kym Green Bush (KGB) is a free-standing tree that consists of multiple temporary vertical fruiting units to moderate tree vigor, enabling the system to be grown with full-size or semi-dwarfing rootstocks. The vertical fruiting units are renewed regularly to keep spurs young and productive. The KGB is the only system covered in this manual that creates a

fully pedestrian orchard—one that can be harvested without ladders or platforms. Tree formation is easy and requires minimal labor; mature pruning is simple and follows a repeatable plan.

Spanish Bush (SB)

The Spanish Bush (SB) is a free-standing tree that consists of multiple permanent leaders to moderate tree vigor, enabling the system to be grown with full-size or semi-dwarfing rootstocks. Lateral fruiting units are developed and renewed on the leaders. The SB produces a semi-pedestrian orchard that can be harvested from small ladders. Tree formation is easy and requires minimal labor; mature pruning consists of renewing horizontal fruiting wood on the permanent vertical scaffolds.

Steep Leader (SL)

The Steep Leader (SL) can best be described as a free-standing tri- or quad-axe multiple leader tree with horizontal scaffold branches projecting from the base of each leader. This canopy architecture creates a pyramidal shape that facilitates good light distribution throughout the tree. Due to the limited number of leaders, SL trees on full-size rootstocks can grow from 18 to 20 feet or more. Fruiting wood is developed on the permanent vertical and horizontal scaffolds, and each scaffold is treated as an individual one-sided spindle tree. Mature pruning consists of regular renewal of a portion of all fruiting wood.

Super Slender Axe (SSA)

The Super Slender Axe (SSA) is a very high density, semi-pedestrian system of up to 2,000 semi-free-standing single leader trees per acre, usually requiring dwarfing rootstocks and a top-wire trellis. The production habit of SSA trees is significantly different from other systems, with the majority of the fruit grown on axillary flower buds produced at the base of 1-year-old branches. This aspect, combined with the fact that fruiting is located in the proximity of the axis, has a positive effect on fruit size. Mature pruning consists of annual renewal of all lateral branches on the axis, thereby requiring simplified but extensive annual labor.

Tall Spindle Axe (TSA)

The Tall Spindle Axe (TSA) is an evolution of the Vogel Central Leader (see below) and Zahn Spindle

systems, incorporating new concepts to these earlier free-standing, single leader systems. The TSA tree canopy is characterized by a continuous whorl of moderately vigorous lateral branches developed by activation of selected buds (via bud scoring, bud removal, or growth regulator application), usually on semi-dwarfing rootstocks for a semi-pedestrian orchard. The TSA is further differentiated by two key concepts: 1) annual heading of lateral shoots to balance leaf-to-fruit ratios and future crop loads, and 2) annual renewal of the oldest fruiting branches so that the only permanent structure is the central leader.

Upright Fruiting Offshoots (UFO) and “Y” Trellis (UFO-Y)

The Upright Fruiting Offshoots (UFO) is a fully-trellised system that optimizes labor efficiency and fruit quality by creating a narrow fruiting wall that is precocious and easy to harvest and prune. Like the KGB system, it produces fruit on renewable vertical fruiting units, which arise from a low horizontal trunk or cordon. Mature pruning is reduced to a simple two-step process. The advantages of this semi-pedestrian system are high early and mature yields, and good air movement and light distribution to reduce disease incidence and promote uniform, high-quality fruit throughout the canopy. Although the system is easy to prune and maintain at maturity, establishment of the trellised canopy uprights is more intensive, time-consuming, and costly than the other systems.

The UFO can be trained to a dual-plane “Y” canopy architecture (UFO-Y) that is developed and managed similarly to the single-plane UFO vertical trellis; however, the renewable fruiting units are trained alternately to grow about 30 degrees off vertical, forming both sides of a “Y” trellis. The UFO-Y offers the advantage of higher yields due to greater light interception, as well as the potential for mechanical or mechanical-assist harvesting.

Vogel Central Leader (VCL)

The Vogel Central Leader (VCL) is a free-standing, single leader tree with renewable fruiting scaffolds that promotes early yields in moderately high-density orchards. The VCL fosters precocity by minimal early pruning and establishing flat branch angles, thereby requiring relatively high

labor inputs in the establishment years, but low maintenance levels at maturity. The pyramidal tree shape promotes good light distribution throughout the canopy. Due to the single leader nature of this system, a dwarfing rootstock is necessary to help maintain tree height at 10 to 12 feet at maturity, creating a semi-pedestrian orchard.

Rootstock Options

Just as training systems modify the natural growth habit of the tree, the choice of rootstock impacts tree growth and response to training system techniques. Therefore, training system and rootstock must be considered together, along with vigor of the orchard site (i.e., soil quality and growing climate); some training systems are more or less suitable for trees that exhibit greater or reduced vigor, precocious or delayed cropping, etc. For this guide, rootstocks are categorized into four levels of growth promotion:

Vigorous:	e.g., Mazzard, Mahaleb, Colt
Semi-vigorous:	e.g., Gisela®6, Gisela®12, Krymsk®5, MaxMa®14, CAB6P
Semi-dwarfing:	e.g., Gisela®5, Krymsk®6
Dwarfing:	e.g., Gisela®3

Pruning and Training Techniques

The development of these canopy systems uses the following pruning and training techniques.

Thinning cut

A thinning cut removes a branch at its point of origin or back to a lateral branch that is large enough to assume the terminal function. The thinning cut often is used to reduce the height of a tree or to reduce the size of a branch system that is shading a lower branch. Thinning cuts permit better light penetration and do not stimulate as much re-growth as heading cuts, thereby reducing the risk of delayed fruiting in young trees.

Heading cut into 1-year-old wood

This cut stimulates the growth of lateral branches and often is used in the early developmental stages of cherry training systems to force branching. Since heading into young wood invigorates the area around the cut, this type of cut tends to delay fruiting on young trees that have not yet flowered.

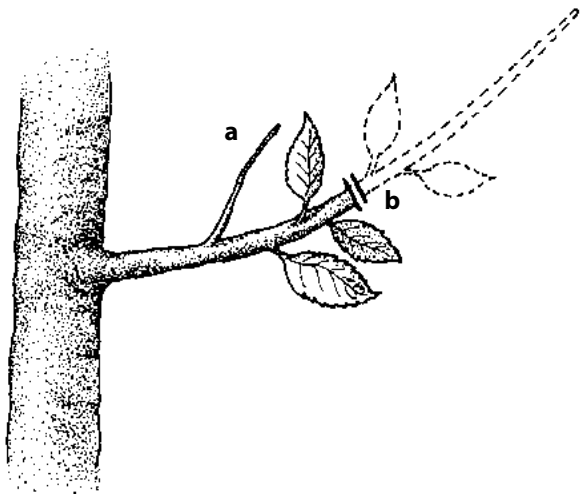


Figure 1. The stub cut or renewal cut

On bearing trees, heading cuts into 1-year-old wood (often called tipping) are used to reduce the subsequent season's crop on highly productive varieties or rootstocks. Tipping removes future flowering sites before they develop on 2-year-old wood and helps maintain a balanced leaf-to-fruit ratio.

Stub or renewal cut

A stub cut is used to renew fruiting wood to keep it young and productive. The term "stub cut" usually describes a heading cut that removes all but a few inches of growth on a branch, although it is possible for a stub of 1 foot or longer to be left. If the wood is relatively young, visible buds below the cut may be stimulated to grow and replace the older branch. When older wood is stubbed back, visible buds may no longer be present. In this case, adventitious buds located beneath the bark may begin to grow and develop into a replacement branch.

Another form of a stub cut can be made when a branch is too upright or is simply becoming too mature. If a lateral branch is present, head the primary branch so that the cut is slightly below the terminal point of the secondary lateral (Figure 1). It is important that the secondary branch terminal (a) be higher than the remaining stub (b). This discourages vigorous vertical wood from growing out of the stub, and it keeps the secondary branch more horizontal and less vigorous.

Making stub cuts late in the dormant season or at bloom will provide a higher percentage of regrowth than during other seasons.

Sectorial double pruning cut

A sectorial double pruning cut is made during the dormant season at an upright-oriented (top) bud. As the buds break and begin to grow, the top-oriented bud will be very vigorous and grow vertically. One or two subtending buds, located on the sides or bottom of the cut branch, also will break and grow, though more slowly than the primary bud and thus more horizontally. The vertical branch is then removed later that season, or in some cases, the following dormant season, leaving the less vigorous and horizontal branch to produce fruit.

Limb manipulation and spreading

Spreading or manipulating tree limbs improves light penetration, reduces branch growth, encourages precocity, and avoids bark inclusion and subsequent weak limb attachments.

Branch angles are best manipulated while the tissue is still green but after new shoots have grown to 3 or 4 inches in length. To establish wide crotch angles, place a toothpick between the trunk and a young, 3- to 4-inch shoot growing from the trunk.

In moist climates where toothpicks may increase the risk of bacterial canker infection, a clamp-type clothespin can be used as a spreader. Attach the clamp to the trunk just above the developing branch and force the shoot to a 90-degree angle.

One of the easiest ways to spread more mature branches is to use 1 in. x 2 ft. spreader sticks with notches cut into the ends. These force a branch to grow more horizontally, although they may blow out in windy conditions. A more stable method is to tie branches to the ground using twine and a "W"-shaped clip (used in hop production) pressed into the soil.

Summer pruning

Summer pruning reduces tree vigor and the potential for pruning cut disease infection. It is commonly used with the Spanish Bush and KGB systems to quickly establish a target number of multiple leaders for the tree framework. Summer pruning done by mid- to late-June (prior to the

summer solstice) allows time for regrowth. Pruning later in mid-summer can result in narrow crotch angles and weak growth that may not cold-acclimate well in the fall. By late summer and early fall, the chance of regrowth from summer pruning is much reduced.

Bud selection and activation to create lateral or upright shoots

The selection and activation of buds to form shoots on a whip nursery tree (or on previous season leader growth) can be key for early formation of canopy structure in some training systems. This increased precision in promoting branching can be accomplished in a number of ways:

1. Application of a cytokinin+gibberellin-based plant growth regulator, e.g., Promalin®, to selected buds at the green tip stage of bud swell. Note that this bud activation gives the best results when temperatures after application are relatively warm; extended cool temperatures may result in a lack of activity and poor shoot outgrowth.
2. Scoring (cutting through the bark and green cambial layer with a moderately coarse saw blade about $\frac{3}{32}$ -inch wide) above the selected buds where shoot formation is desired. This bud activation has a bit longer window, from initial bud swell through budbreak, than the use of growth regulators, and it is not sensitive to temperature.
3. As buds are selected by position for future shoot formation, removal of the intervening buds between those selected will promote activation of the selected buds by removing competition for stored energy and resources. This bud activation has the longest window, from the dormant bud stage to post-budbreak (though buds are easiest to remove when swelling has begun), and it is not sensitive to temperature.

Note that scoring or, to a lesser extent, bud removal may increase the risk of bacterial canker infection; if practiced, treatment should be timed to forecasts of several days of dry weather, and pre-and

post-wounding application of antibiotics like copper may be valuable to reduce bacteria populations. Also, bud activation techniques tend to be more successful on newly-planted trees when transplant stress is minimized and on trees with more-established root systems (such as fall-planted trees or second-year trees that failed to form the desired shoots in the year of planting).

Sweet cherry growth and fruiting habit

To be successful with any training system for sweet cherry, it is helpful to understand the inherent growth and fruiting pattern of the tree. In nature, sweet cherry is a forest tree, genetically programmed to grow a tall trunk and annually form a tier of strongly upright, vigorous branches positioned where the previous season's growth terminated. In the forest, this is essential to successfully compete for light with other forest trees before eventually shifting into fruiting mode. In the orchard, we generally want short trees with branches of weak-to-moderate vigor that are well-distributed along the trunk, rather than in vigorous annual tiers separated by gaps that lack branching. In a commercial orchard, one prunes annually, from Year 1, to modify tree structure and improve light interception so the tree doesn't need to compete with other trees.

Training systems were created to manage tree vigor and fruitfulness, as well as increase orchard operational efficiencies, in various strategic ways. Vigorous tree growth takes longer to begin forming flower buds and spurs. Except for developing the essential primary structure of the tree, strongly vigorous growth is not conducive to precocious, productive fruit yields. Therefore, orchardists moderate growth and increase earlier and higher levels of fruiting by the use of precocious or dwarfing rootstocks; shoot and limb bending, tying, or positioning to a less upright orientation; and/or providing moderate levels of water and nutrients (primarily nitrogen) during the growth cycle, especially postharvest.

The basic fruiting unit of a sweet cherry tree on precocious rootstocks, or managed for weak-to-moderate vigor, takes three seasons to form a complete complement of fruiting components, which include three types of leaves and two types of

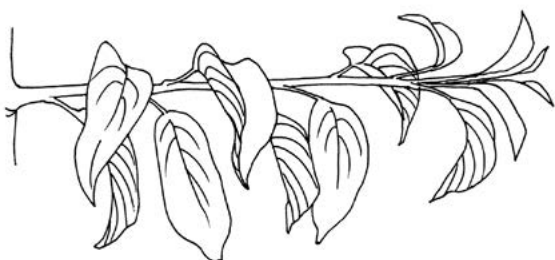


Figure 2. Year 1—new shoot growth with single leaves at each node.



Figure 3. Year 2—first season growth forms non-fruiting spurs, with greater spur density in the terminal portion and a few basal non-spur fruit buds.



Figure 4. Year 3—first season growth forms fruiting spurs, with more flower buds per spur (and greater spur density) in the terminal portion.

fruiting sites. A shoot that forms in Year 1 has large single leaves at each node (Figure 2). In Year 2, those nodes will become non-fruiting spurs with six to eight leaves each, except for the most basal nodes on the shoot which can have solitary flower buds (with no vegetative bud) (Figure 3). So, some basal (non-spur) flowering may occur in Year 2; these nodes become “blind” after flowering and fruiting since there are no vegetative buds present. During the Year 2 growing season, flower buds begin forming in leaf axils on the non-fruiting spurs. Thus, in Year 3, each node now has the potential to be a fruiting spur, with

6 to 8 leaves and one to 10 flower buds, depending on variety, vigor, and spur location (Figure 4). Spurs near the shoot terminus tend to have more flower buds per spur than more basal spurs. These spurs may remain fruitful for many years, if managed correctly for light and nutrition. However, the best quality fruit usually is borne on younger spurs and the basal (non-spur) flowers within a fruiting unit. Thus, many training systems are designed to manage and renew these fruiting units for optimal fruit quality.

Table 1. Appropriate Plant Material Considerations and Uses of Various Training Systems

	KGB	SB	SL	SSA	TSA	UFO	UFO-Y	VCL
ROOTSTOCKS								
Full-size rootstock	X	X	X					
Semi-dwarfing rootstocks	X	X	X	on low vigor sites	X	X	X	X
Dwarfing rootstocks			X	X	X			X
FRUITING HABIT								
Spur type	X	X	X		X	X	X	X
Non-spur type		X	X	X	X			X
CHARACTERISTICS OF THE TRAINING SYSTEM								
Precocious				X	X	X	X	X
Low establishment costs	X	X						
Consists of repeatable units that simplify maintenance	X			X		X	X	
Reduces harvest cost	X	X		X		X	X	



Recommended spacing

Between rows	
vigorous rootstock	16–18'
semi-vigorous rootstock	14–16'
semi-dwarfing or dwarfing	not recommended
Between trees	
vigorous rootstock	8–10'
semi-vigorous rootstock	6–8'

KYM GREEN BUSH (KGB)

The Kym Green Bush (KGB) is the only system covered in this manual that creates a fully pedestrian orchard—one that can be harvested without ladders or platforms. Tree formation is easy and requires minimal labor; mature pruning is simple and follows a repeatable plan. Although most varieties grow and produce well with a KGB system, it is not recommended for non-spur type varieties such as ‘Regina’ and ‘Attika’, which produce a significant proportion of fruit at the base of 1-year-old shoots. This wood is eliminated in the KGB system.

The establishment years of the KGB system are similar to the Spanish Bush (SB); however, once the structure is formed, the two systems diverge significantly. In the SB tree, all upright leaders are permanent and fruit is produced on small laterals that are renewed regularly. This contrasts with the KGB tree, where all vertical leaders eventually are renewed and the only permanent wood is the lower framework of the tree. The KGB utilizes vigorous or semi-vigorous rootstocks, and the number of vertical leaders established should be proportional to tree vigor.

STAGE: *At planting*

GOALS

- **Promote strong root system establishment in the first growing season**
- **Promote moderate growth throughout the establishment period by providing adequate nutrients**
- **Begin forming structure**

SYSTEM DEVELOPMENT

- Head nursery tree 18 inches above ground (Figure 5).
- Ensure that there are three or four live buds below the cut.
- Expect a minimum of 24 inches of growth on each leader during the first growing season.



Figure 5

STAGE: *First dormant season*

GOALS

- **Continue forming tree structure**
- **Promote uniformity of growth**

SYSTEM DEVELOPMENT

- Head all leaders to 2–5 inches in length (Figure 6).
- Head strong leaders to the shorter length and weak leaders to the longer length.
- Remove very strong or very weak leaders to obtain uniformity.
- In areas with high bacterial canker pressure, these cuts can be made at the end of the preceding growing season, i.e., late summer or early autumn when the weather is dry.
- Proper pruning results in a tree with a flat top and strong, upright leaders cut shorter than outside weaker leaders.

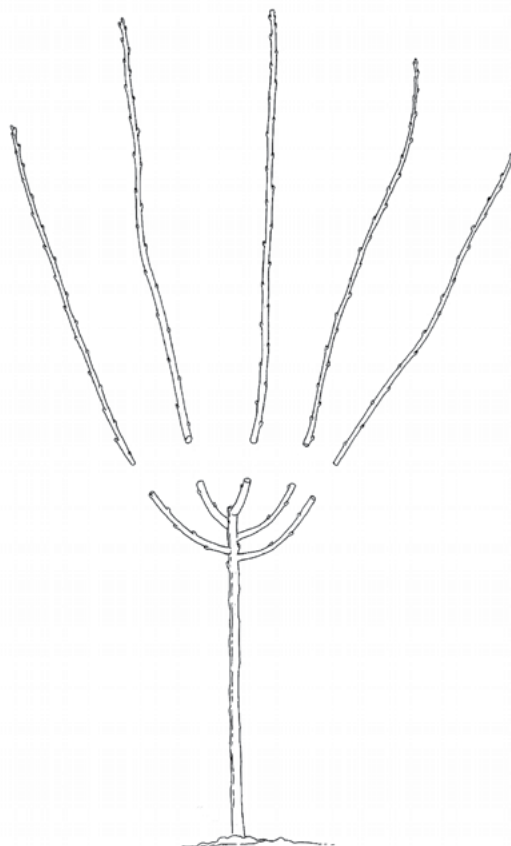


Figure 6

STAGE: *Second growing season*

GOALS

- **Promote moderate growth throughout the establishment period by providing adequate nutrients**
- **Continue forming tree structure**
- **Promote uniformity of growth**

SYSTEM DEVELOPMENT

- Prior to the summer solstice (first day of summer), head all leaders to 2–5 inches in length (Figure 7).
- Head strong leaders shorter than weak leaders.
- Remove very strong or very weak leaders to obtain uniform leader development throughout the tree.
- Proper pruning results in a tree with a flat top and strong, upright leaders cut shorter than outside weaker leaders.



Figure 7

STAGE: *Second dormant season*

GOALS

- **Promote moderate vigor through leader numbers**
- **Continue forming tree structure**

SYSTEM DEVELOPMENT

- For trees on full-size rootstocks, repeat the steps described in “First dormant season” section.
- These steps are important for trees on full-size rootstocks in order to obtain a balanced tree without excessive vigor.
- Suggested number of leaders to establish a balanced framework of fruiting units: semi-vigorous rootstocks, 20–25 leaders; vigorous rootstocks, 25–30 leaders
- Leader numbers may vary depending on soil fertility and other conditions. The target is to achieve annual elongation of 24–36 inches per leader, so leader number should be adjusted higher if annual elongation is greater than the target, or lower if annual elongation is less than the target.
- Trees on semi-vigorous rootstocks should now have enough branches and are not pruned at this time.

STAGE: *Third dormant season*

GOALS

- **Begin crop load management**

SYSTEM DEVELOPMENT

- Leaders on moderately or highly productive varieties of semi-vigorous rootstocks and highly productive varieties of full-sized rootstocks must be tipped. Remove a quarter of the new growth to balance the leaf-area-to-fruit ratio and produce high-quality fruit (Figure 8).

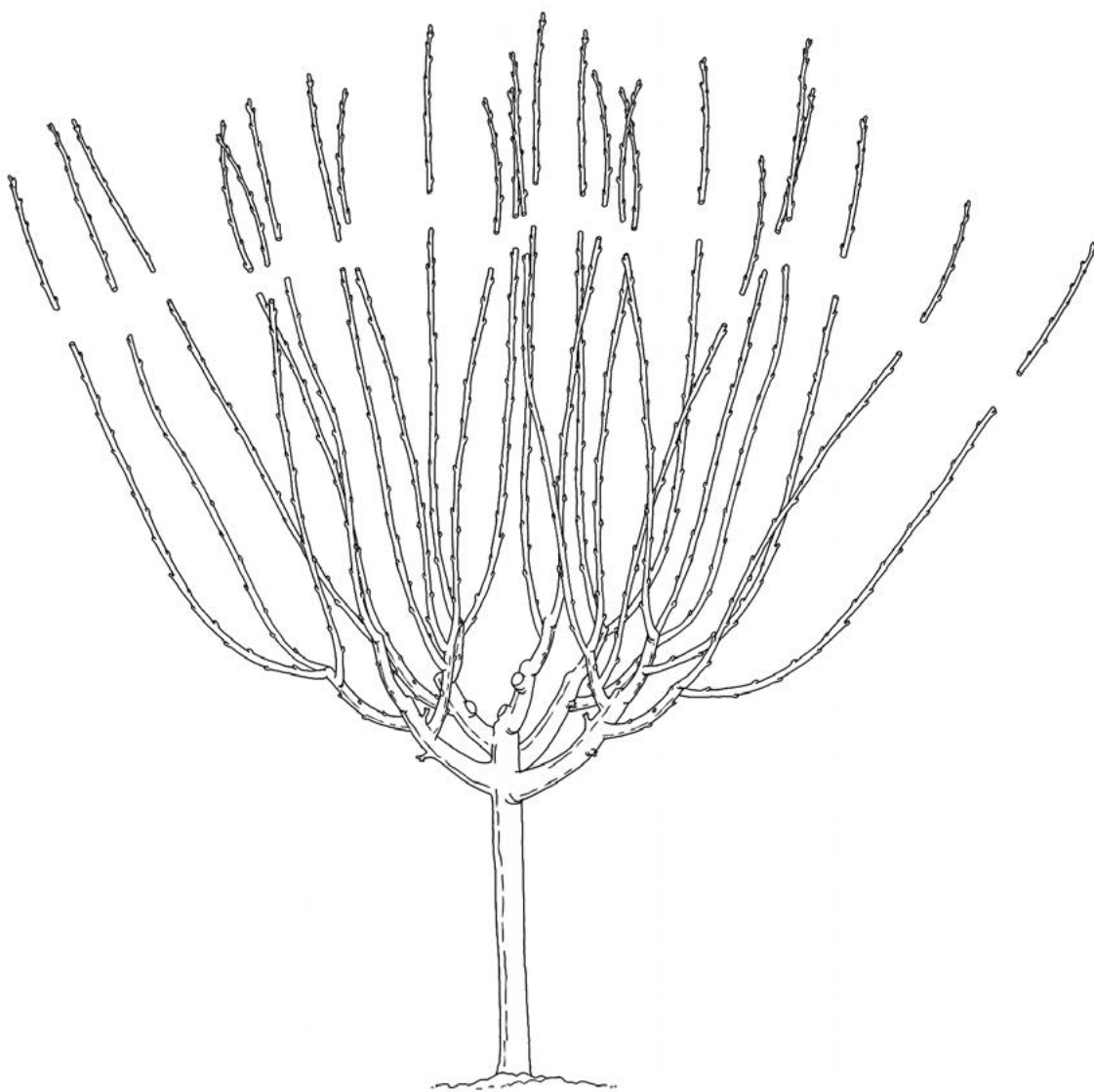


Figure 8

STAGE: *Third and subsequent growing seasons*

GOALS

- **Initial minor fruiting on shoot basal flower buds for trees on semi-vigorous rootstock in the third year**
- **First commercial harvest (mixed spur and shoot basal fruiting sites) for trees on semi-vigorous rootstocks in the fourth year**
- **Promote light distribution**
- **Manage tree vigor**

SYSTEM DEVELOPMENT

- The presence of yellow leaves at the bottoms of the leaders indicates excessive shading; two to four strategically placed leaders should be removed from the center of the tree to improve light penetration (Figure 9).
- If leader growth is weak (i.e., less than 24 inches per year), remove additional leaders.
- Suggested number of leaders at maturity to maintain a balanced, productive tree: semi-vigorous rootstocks, 12–16 leaders; vigorous rootstocks, 15–20 leaders
- Leader numbers may vary depending on soil fertility and other conditions.
- The idea is to produce a tree of moderate vigor with annual leader elongation of 24–36 inches.



Figure 9

STAGE: *Mature pruning*

GOALS

- **Establish mature height to maintain pedestrian profile**
- **Promote light distribution**

SYSTEM DEVELOPMENT

- Top the tree at 8 feet. This can be done mechanically or by hand.
- If the tree is not yet 8 feet tall, remove a quarter of the new shoot growth from each leader (Figure 8, page 13).
- Remove all easily reached lateral branches. Leaving stubs of approximately 3 inches will allow fruit-bearing axillary buds located at the base of this 1-year-old wood to produce fruit for one season (Figure 10). Non-spur-bearing varieties such as 'Regina' can produce significant fruit at this point. These small stubs will die after fruiting and can be removed the following year.

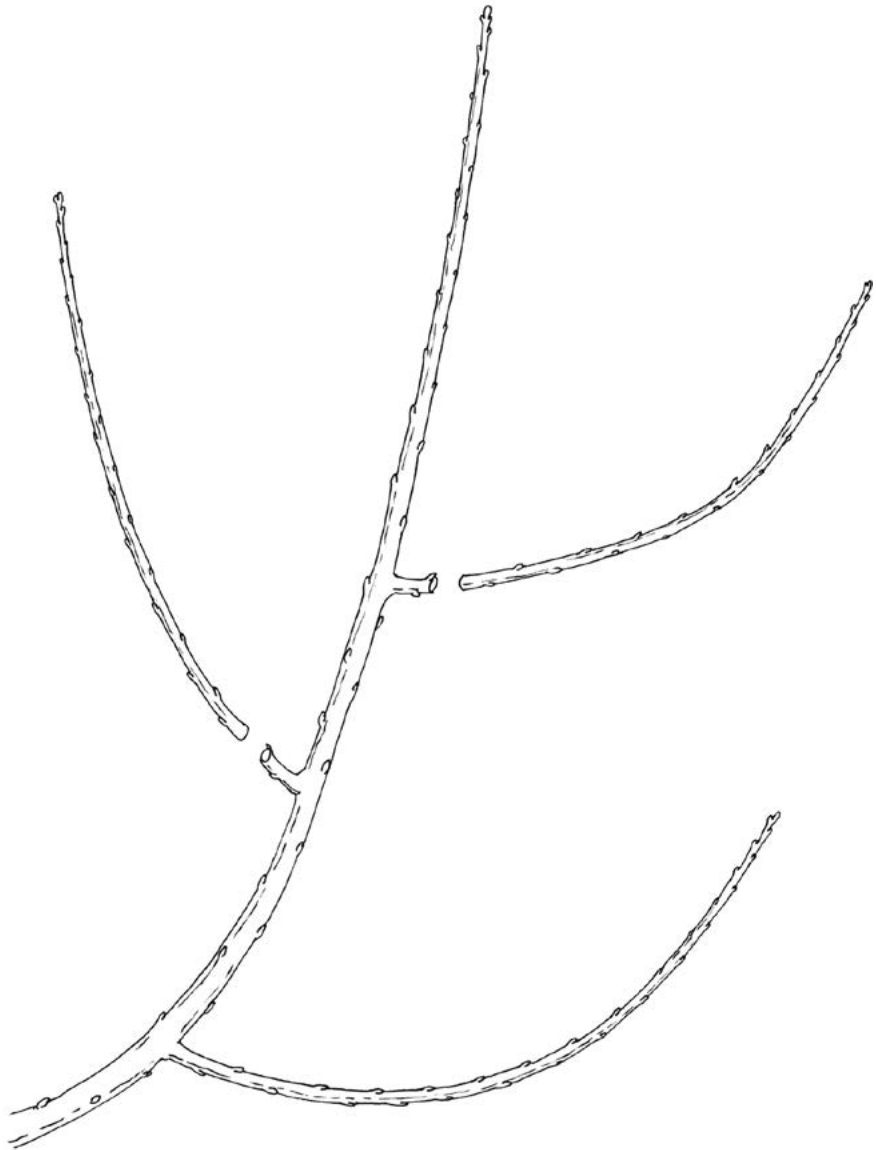


Figure 10

STAGE: *Dormant or bloom*

GOALS

➤ **Renew fruiting wood**

SYSTEM DEVELOPMENT

- Select the largest leaders for renewal. Renew any leader that cannot be pulled down easily for harvest.
- Renewal is accomplished by removing the selected leaders back to a stub of approximately 10 inches with three to four buds. A replacement leader will grow from this stub to form new fruiting wood (Figure 11).

Continued on page 17

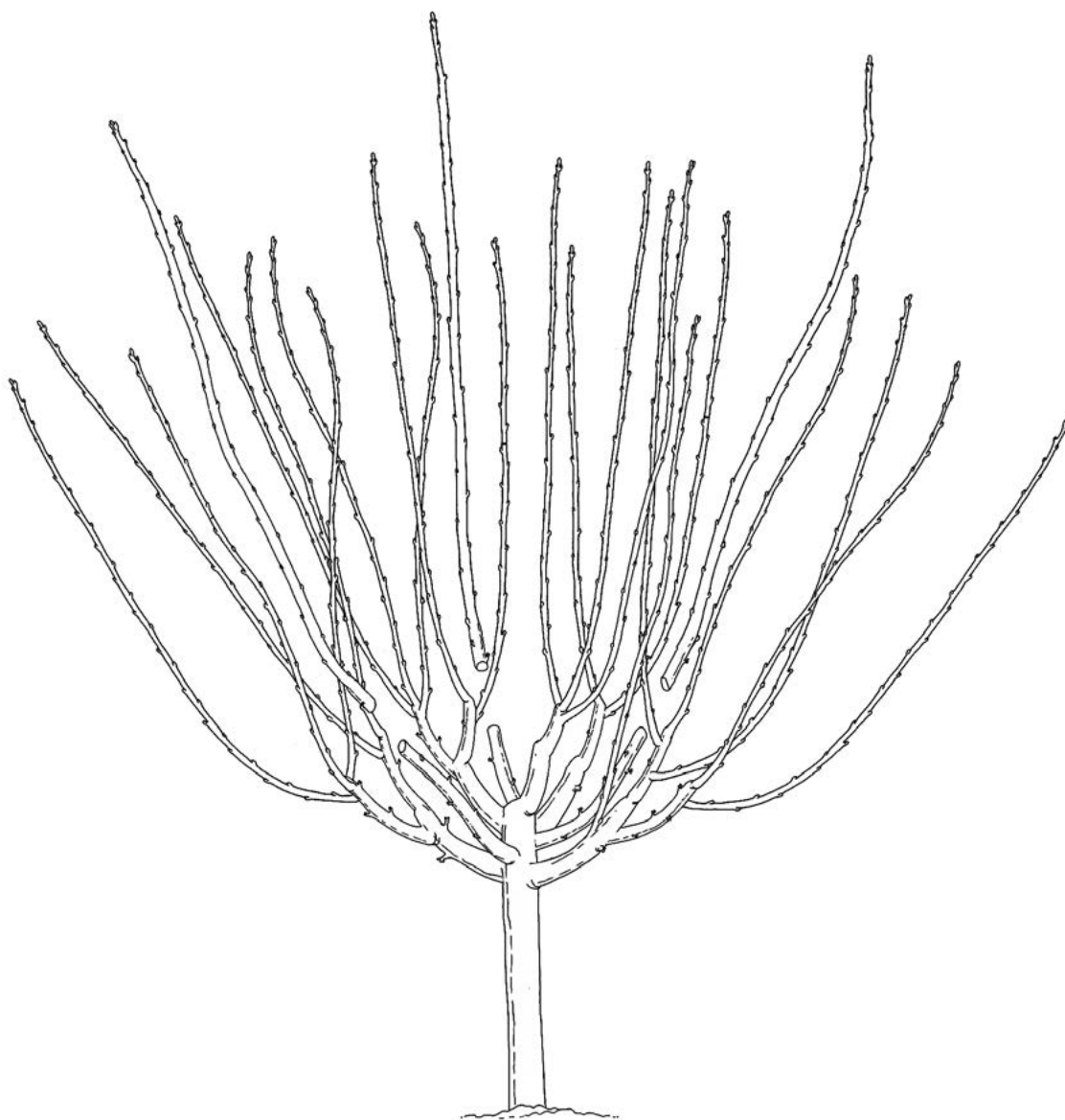


Figure 11

STAGE: *Dormant or bloom (con't)*

SYSTEM DEVELOPMENT

- Renew all leaders associated with a basal fork. Failure to do so will result in the unheaded leader becoming dominant and only weak regrowth will proceed from the adjacent stubbed leader (Figure 12).
- When multiple renewal leaders grow from the stub, they should be thinned to the one or two strongest. Remove weak leaders as soon as possible to enhance the strength of the renewal leader to keep it vertical as it grows and becomes fruitful (Figure 13).

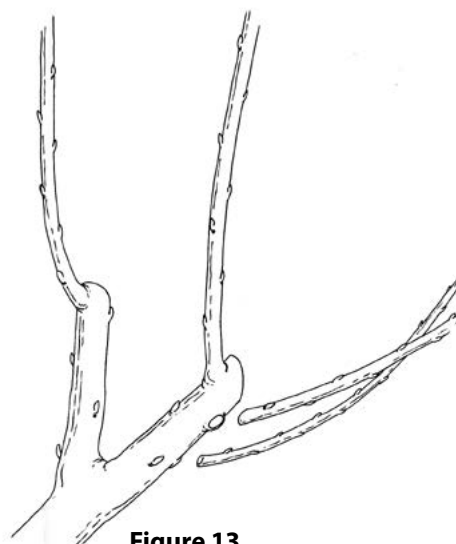


Figure 13

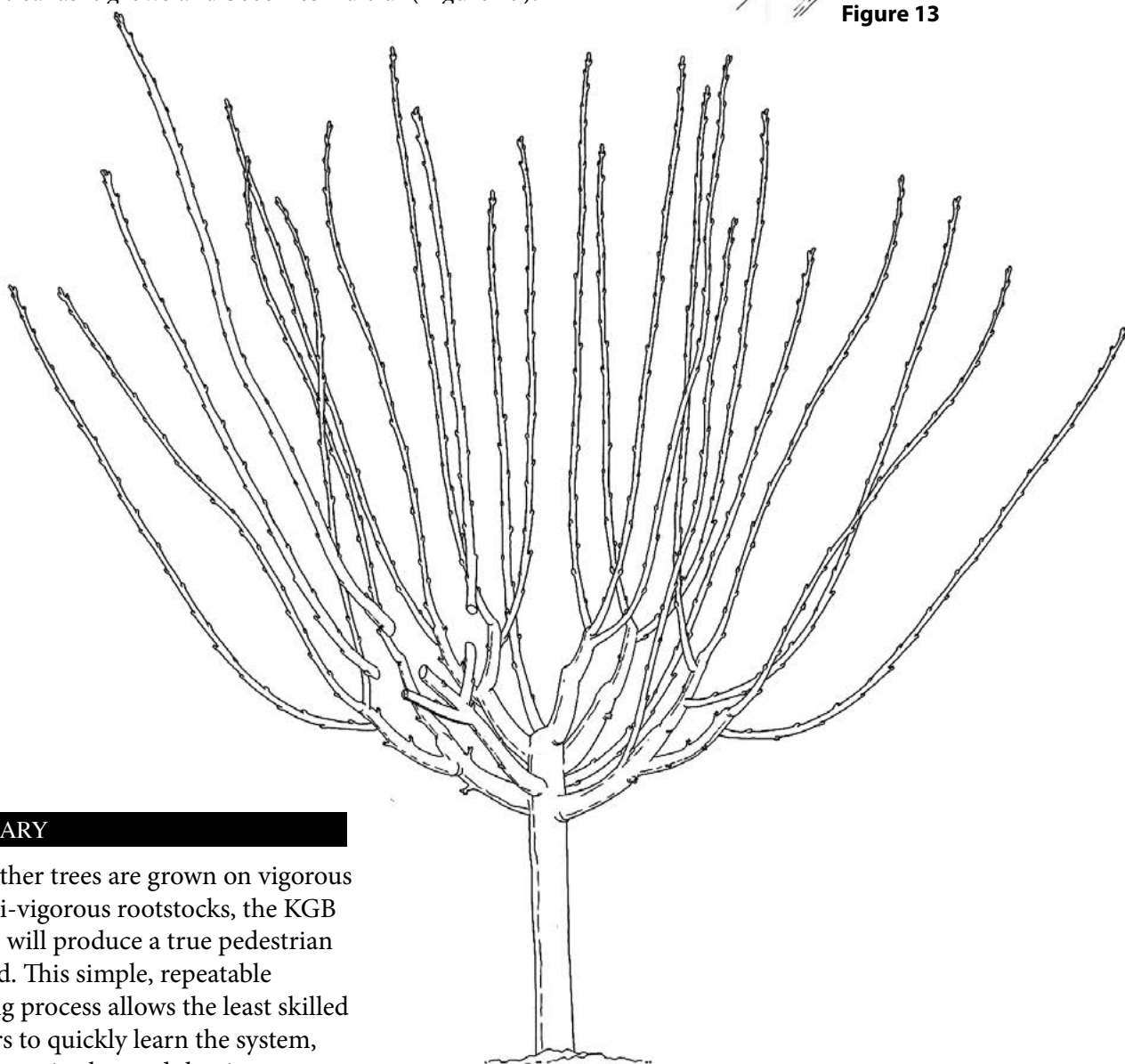


Figure 12

SUMMARY

Whether trees are grown on vigorous or semi-vigorous rootstocks, the KGB system will produce a true pedestrian orchard. This simple, repeatable pruning process allows the least skilled workers to quickly learn the system, reducing mistakes and the time required to prune.



Recommended spacing

Between rows	
vigorous rootstock	16–18'
semi-vigorous rootstock	14–16'
semi-dwarfing or dwarfing	not recommended
Between trees	
vigorous rootstock	8–10'
semi-vigorous rootstock	6–8'

SPANISH BUSH (SB)

The Spanish Bush (SB) training system promotes the production of numerous scaffolds and branches that reduce vigor, impart a small tree structure, and permit fast and easy tree maintenance and harvest. A deliberate branch renewal plan produces a steady supply of young fruiting wood. Pruning steps that establish the framework of the tree are very similar to the establishment steps in the KGB system. The SB utilizes vigorous or semi-vigorous rootstocks, and the number of vertical leaders established should be proportional to tree vigor.

STAGE: *At planting*

GOALS

- **Promote strong root system establishment in the first growing season**
- **Promote moderate growth throughout the establishment period by providing adequate nutrients**
- **Begin forming structure**

SYSTEM DEVELOPMENT

- Head nursery tree 18 inches above the ground (Figure 14).
- Ensure that three or four live buds remain below the cut.
- Expect a minimum of 24 inches of growth on each leader during the first growing season.



Figure 14

STAGE: *First dormant season*

GOALS

- **Continue forming tree structure**
- **Promote uniformity of growth**

SYSTEM DEVELOPMENT

- Head all leaders to 2–5 inches in length (Figure 15).
- Head strong leaders to the shorter length and weak leaders to the longer length.
- Remove very strong or very weak leaders to obtain uniformity.
- In areas with high bacterial canker pressure, these cuts can be made at the end of the preceding growing season, i.e., late summer or early autumn when the weather is dry.
- Proper pruning results in a tree with a flat top and strong, upright leaders cut shorter than outside weaker leaders.

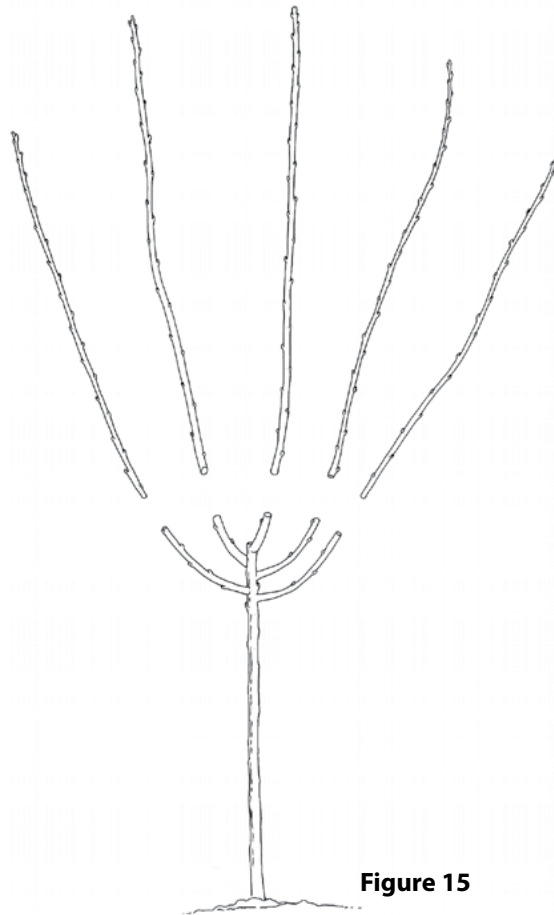


Figure 15

STAGE: *Second growing season*

GOALS

- **Promote moderate growth throughout the establishment period by providing adequate nutrients**
- **Continue forming tree structure**
- **Promote uniformity of growth**

SYSTEM DEVELOPMENT

- Prior to the summer solstice (first day of summer), head all leaders to 2–5 inches in length (Figure 16).
- Head strong leaders shorter than weak leaders.
- Remove very strong or very weak leaders to obtain uniform scaffold development throughout the tree.
- Proper pruning results in a tree with a flat top and strong, upright scaffolds cut shorter than outside weaker leaders.

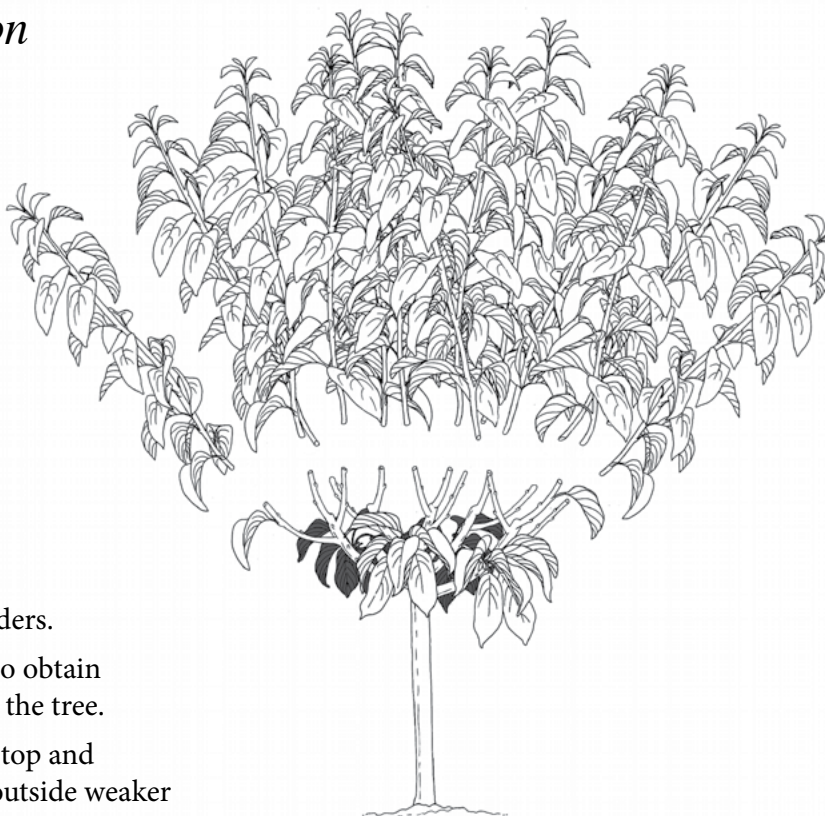


Figure 16

STAGE: *Second dormant season*

GOALS

- **Promote moderate vigor through leader numbers**
- **Encourage branching on trees with semi-vigorous rootstocks**

SYSTEM DEVELOPMENT

- For trees on full-size rootstocks, repeat the steps described in “First dormant season” section.
- These steps are important for trees on full-size rootstocks in order to obtain a balanced tree without excessive vigor.
- Suggested number of leaders to establish a balanced framework of fruiting units: semi-vigorous rootstocks, 20–25 leaders; vigorous rootstocks, 25–30 leaders.
- Leader numbers may vary depending on soil fertility and other conditions. The target is to achieve annual elongation of 24–36 inches per leader, so leader number should be adjusted higher if annual elongation is greater than the target, or lower if annual elongation is less than the target.
- Trees on semi-vigorous rootstocks should now have enough branches, and all leaders should be tipped to encourage branching by removing a quarter of the new shoot growth.

STAGE: *Third dormant season*

GOALS

➤ **Begin crop load management**

SYSTEM DEVELOPMENT

- Leaders on moderately or highly productive varieties of semi-vigorous rootstocks and highly productive varieties of full-sized rootstocks must be tipped. Remove a quarter of the new growth to balance the leaf-area-to-fruit ratio and produce high-quality fruit (Figure 17).

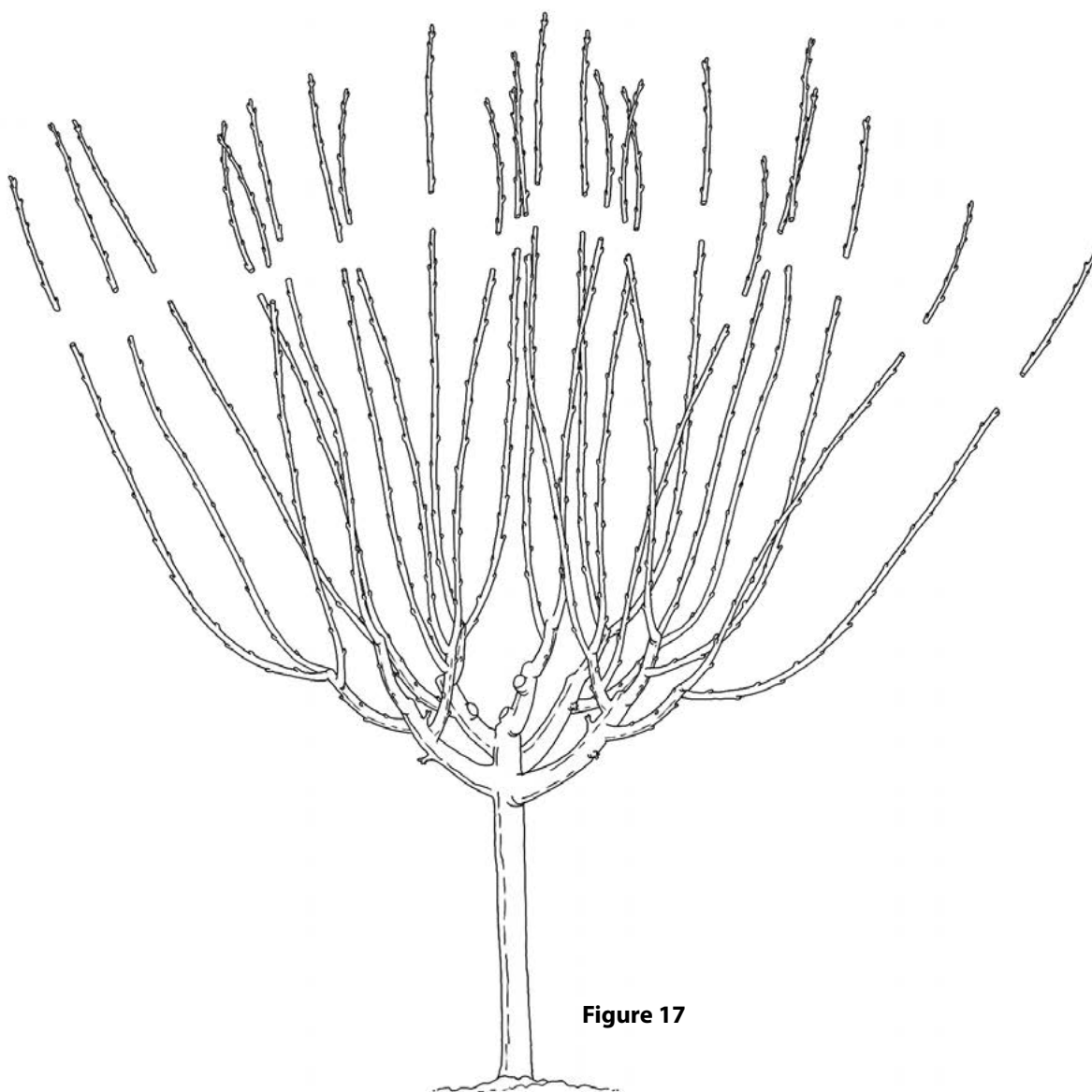


Figure 17

STAGE: *Third and subsequent growing seasons*

GOALS

- **Initial minor fruiting on shoot basal flower buds for trees on semi-vigorous rootstock in the third year**
- **First commercial harvest (mixed spur and shoot basal fruiting sites) for trees on semi-vigorous rootstocks in the fourth year**
- **Promote light distribution**
- **Manage tree vigor**

SYSTEM DEVELOPMENT

- The presence of yellow leaves at the bottoms of the leaders indicates excessive shading; two to four strategically placed leaders should be removed from the center of the tree to improve light penetration (Figure 18).
- If leader growth is weak (i.e., less than 24 inches per year), remove additional leaders.
- Suggested number of leaders at maturity to maintain a balanced, productive tree: semi-vigorous rootstocks, 12–16 leaders; vigorous rootstocks, 15–20 leaders
- Leader numbers may vary depending on soil fertility and other conditions.

- The idea is to produce a tree of moderate vigor with annual leader elongation of 24–36 inches.

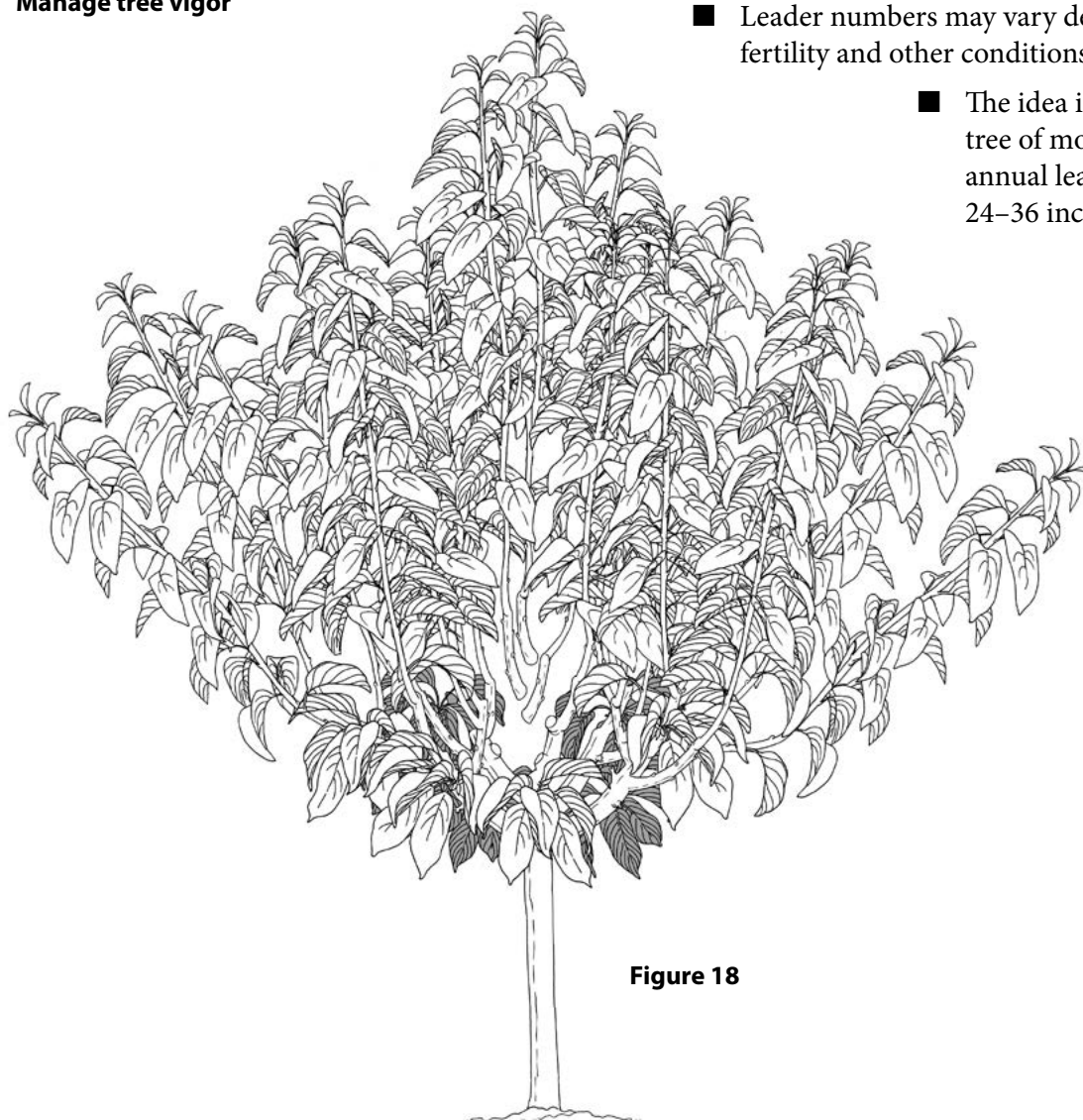


Figure 18

STAGE: *Mature pruning*

GOALS

- **Establish mature height**
- **Renew fruiting wood**
- **Continue to monitor and manage tree vigor**

SYSTEM DEVELOPMENT

- In the SB system, lateral branches are allowed to develop on each scaffold and fruit for several years before being renewed.

LATE SUMMER OR EARLY FALL

- Top the tree at 8 feet. This can be done mechanically or by hand (Figure 19).
- If the tree is not yet 8 feet tall, remove a quarter of the new shoot growth from each leader. (Figure 17, page 21)
- Hedge the sides of the tree each year, mechanically or by hand (Figure 19).

DORMANT OR BLOOM

- Stub back approximately 20 percent of all fruiting lateral shoots each year so that spurs are no more than 5 years old (Figure 20).
- Renew or remove any lateral branches larger than half the diameter of the primary scaffold (Figure 21).

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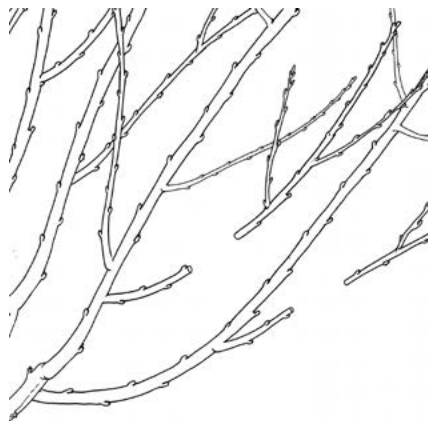
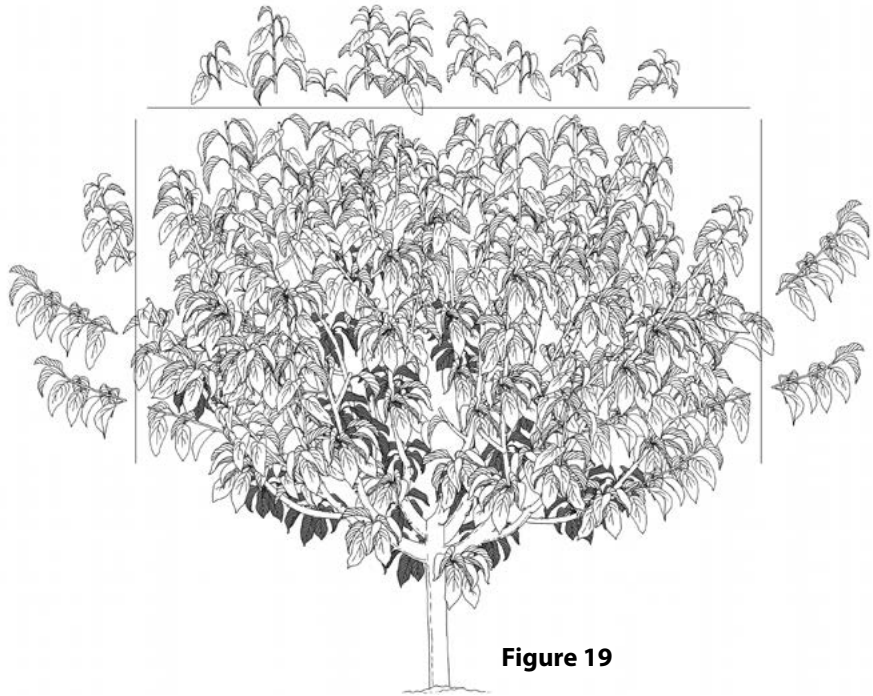


Figure 20



Figure 21

STAGE: *Mature pruning (con't)*

SYSTEM DEVELOPMENT

DORMANT OR BLOOM

- Renew lateral branches by stubbing them back to a vegetative bud at late dormant or bloom. If no vegetative bud is visible, leave a stub 4 to 6 inches in length. Renew 20 percent of the fruiting branches each year. Younger branches will more readily produce renewal wood than older branches.
- If terminal growth decreases to less than 24 inches per year, remove one or more scaffolds to increase the vigor throughout the rest of the tree (Figure 22).

SUMMARY

The Spanish Bush training system produces trees that are a maximum height of 8 feet, making this a semi-pedestrian system that is easy to harvest and maintain. Non-spur type varieties such as 'Regina' and 'Attika' perform well under Spanish Bush training, since these varieties produce a significant proportion of fruit on the basal buds of 1-year-old shoots.

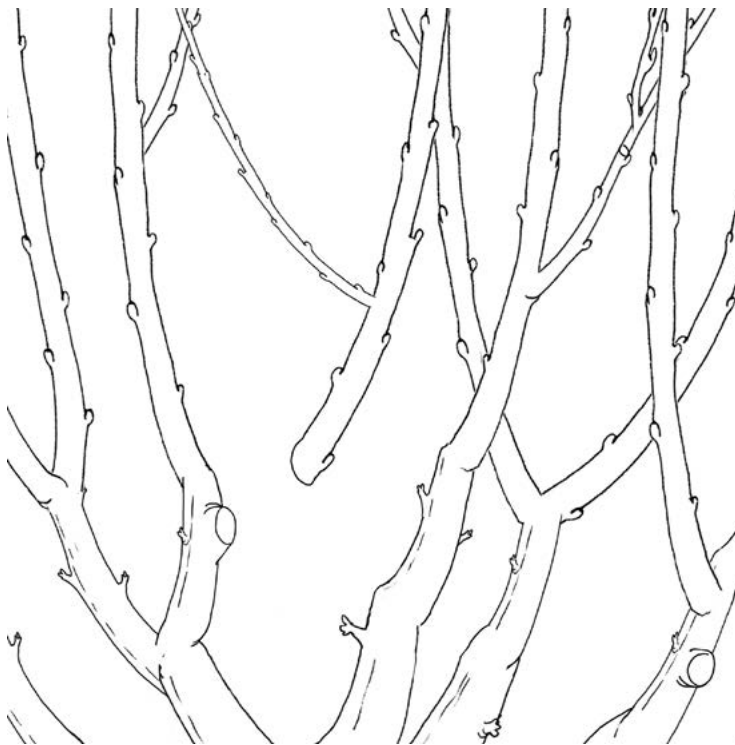


Figure 22



The Spanish Bush training system



Recommended spacing

Between rows	
vigorous rootstock	16–18'
semi-vigorous rootstock	14–15'
semi-dwarfing or dwarfing	not recommended
Between trees	
vigorous rootstock	14–16'
semi-vigorous rootstock	10–12'

STEEP LEADER (SL)

The Steep Leader (SL) training system was developed by growers in Washington State. It consists of three or four vertical leaders emerging from the base of the tree with horizontal scaffold branches to develop a pyramidal shape at maturity. Fruiting occurs on temporary lateral branches that grow from the vertical leaders and horizontal scaffolds. Each leader mimics a one-sided spindle tree.

STAGE: *At planting*

GOALS

- **Initiate candidate shoots for future formation of multiple steep leaders**

SYSTEM DEVELOPMENT

- Head nursery tree 30–36 inches above ground, depending on desired height of the future steep leaders (Figure 23).

STAGE: *First growing season*

GOALS

- **Establish wide angles for future leaders and an open young tree form**

SYSTEM DEVELOPMENT

- When developing lateral shoots are 3–4 inches long, establish wide angles with toothpicks or clothespins (Figure 24).

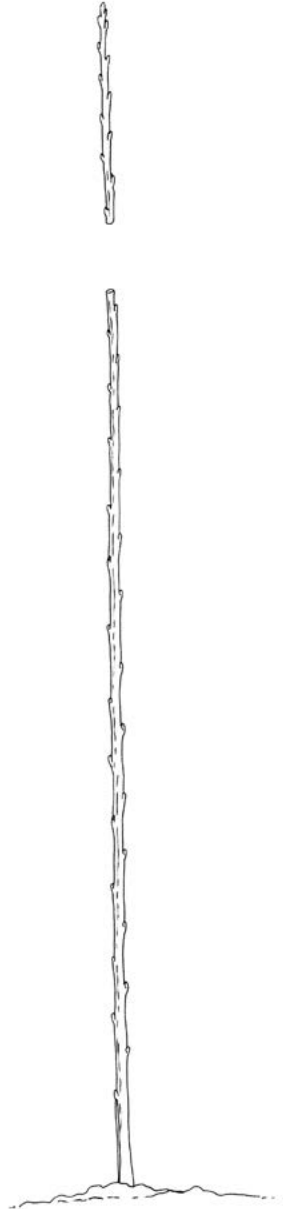


Figure 23



Figure 24

STAGE: *First dormant season*

GOALS

- **Select leaders for future development**
- **Promote development of permanent bottom lateral scaffolds**

SYSTEM DEVELOPMENT

- Select three or four upright growing leaders of uniform vigor. These will form the main leaders and should be allowed to grow vertically.
- If the tree is growing on a semi-vigorous rootstock and one or two very strong leaders developed from the cut made at planting, remove these to keep the tree in balance (Figure 25).
- If the tree is growing on a vigorous rootstock and one or two very strong leaders developed from the cut made at planting, leave these temporary leaders to absorb excess vigor. Removing them during dormancy could invigorate the tree.
- Head all leaders about 24 inches from their base in order to promote branching and establish a permanent bottom whorl of lateral scaffolds (Figure 26).
- Leave other leaders temporarily to moderate tree growth.
- In areas with high bacterial canker pressure, these cuts can be made at the end of the preceding growing season, i.e., late summer or early autumn when the weather is dry.

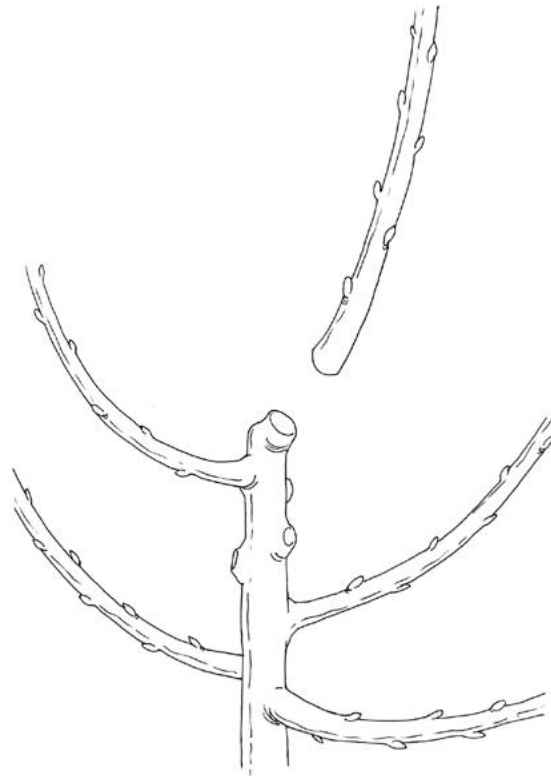


Figure 25

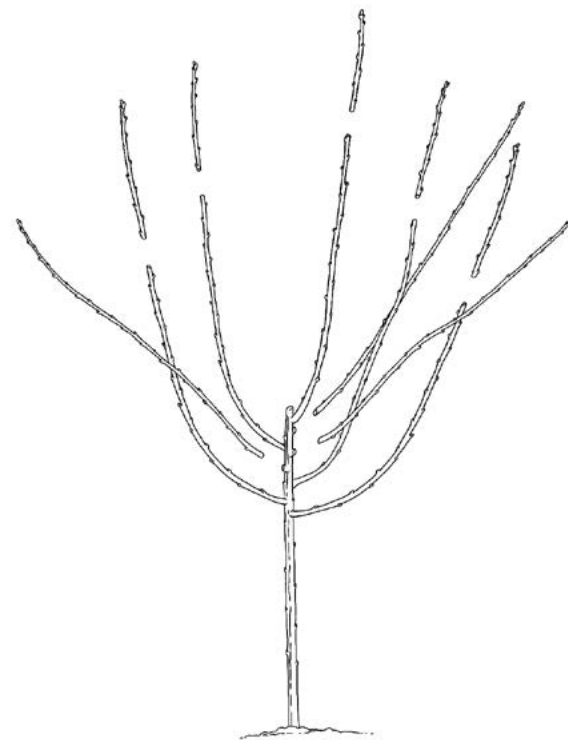


Figure 26

STAGE: *Second dormant season*

GOALS

- **Continue developing leaders**
- **Select and train scaffold branches for permanent bottom whorl**

SYSTEM DEVELOPMENT

- Select one vertically growing shoot per leader to serve as the vertical extension of the leader.
- Head this shoot approximately 24 inches from its previous season point of origin if ultimate tree height is to be less than 12 feet, or at 24–36 inches if tree height will be greater than 12 feet (Figure 27).
- Select one outward-facing lateral shoot to serve as the permanent bottom whorl. Tie this branch down to a horizontal position to establish a wide base. Head this branch 24 inches from its base (Figure 28). **Tie downs will be removed at the end of the third growing season.**
- Remove any inward-oriented lateral shoots to keep the interior area between leaders open.

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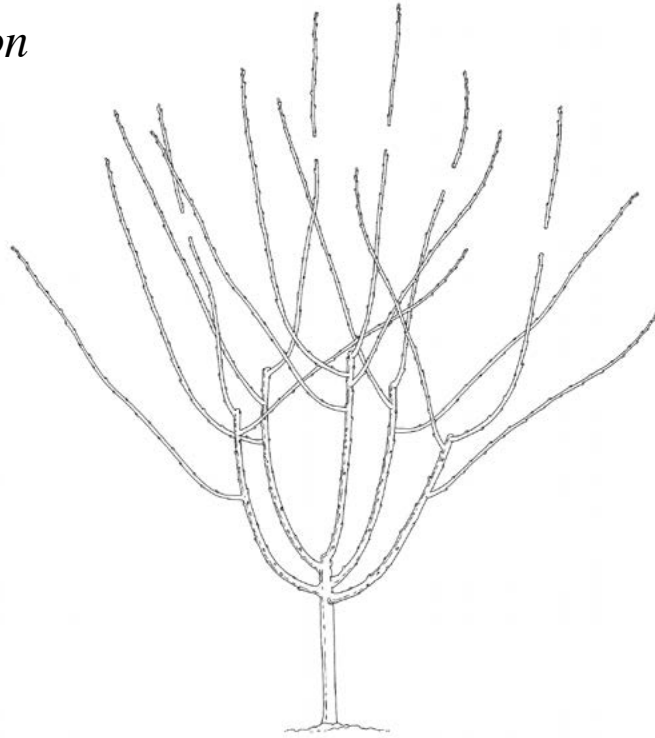


Figure 27

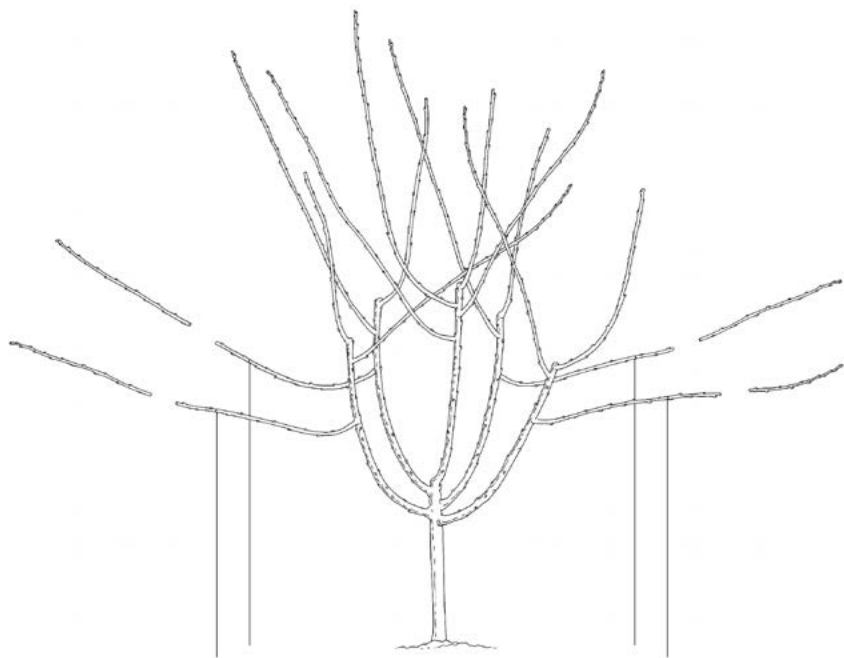


Figure 28

STAGE: *Second dormant season (con't)*

SYSTEM DEVELOPMENT

- Until fruiting begins, several temporary branches will help control overall tree vigor. These should be headed at about 24 inches. (Figure 29).
- Select smaller and weaker wood as permanent branches for SL trees on vigorous rootstocks. Thin out very strong wood (Figure 30).
- On semi-vigorous rootstocks, leave moderately growing branches and prune out thin, weak branches (Figure 31).

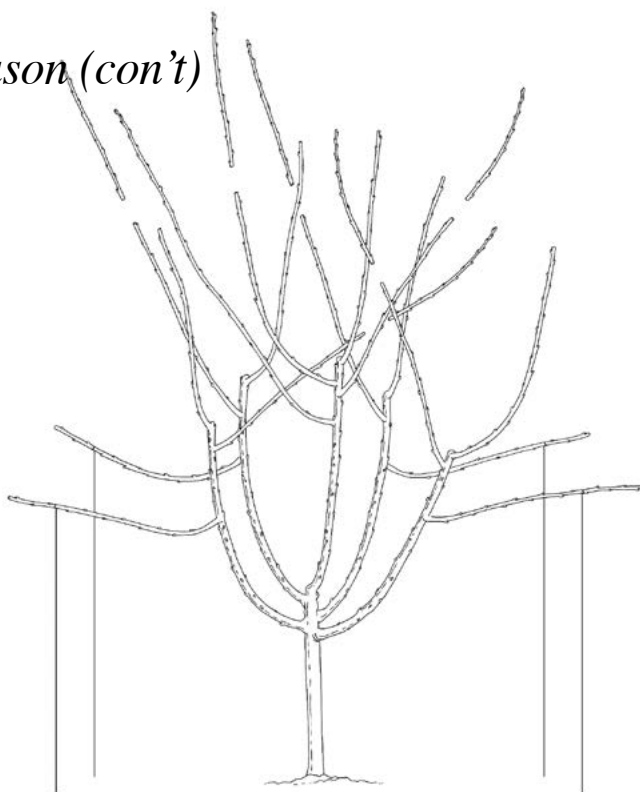


Figure 29

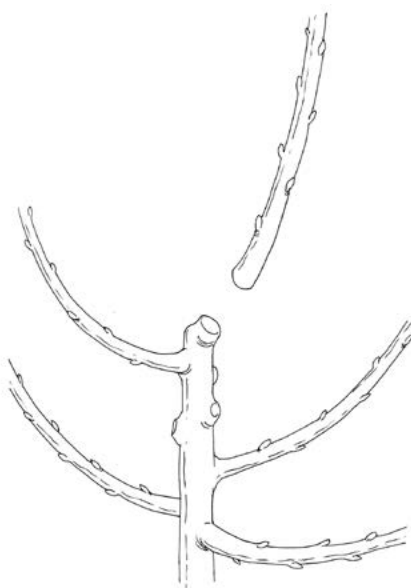


Figure 30

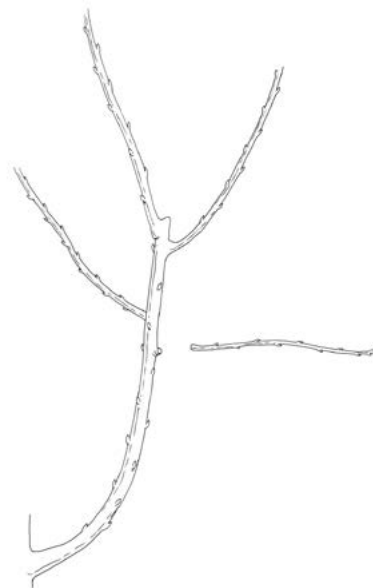


Figure 31

STAGE: *Dormant pruning until maturity*

GOALS

- **Continue leader and lateral fruiting whorl development.**
- **Promote fruiting on temporary branches**

SYSTEM DEVELOPMENT

- To promote lateral branch development, continue to head leader extension at 24–36 inches from its previous season point of origin as explained in the directions for the second dormant season (Figure 32).
- Head new terminal growth on the horizontal bottom whorl 24 inches from point of origin.
- Allow the temporary branches that were left in the first dormant season to fruit. Once growth begins to slow due to fruiting, remove these to improve light distribution to the tree bottom (Figure 33).
- SL trees of bearing age will have three or four permanent, vertical, well-branched leaders for fruit production.
- The tree base will include one permanent, horizontal, well-branched scaffold per leader.
- Fruit will be produced on small temporary branches emerging from the permanent vertical and horizontal wood.

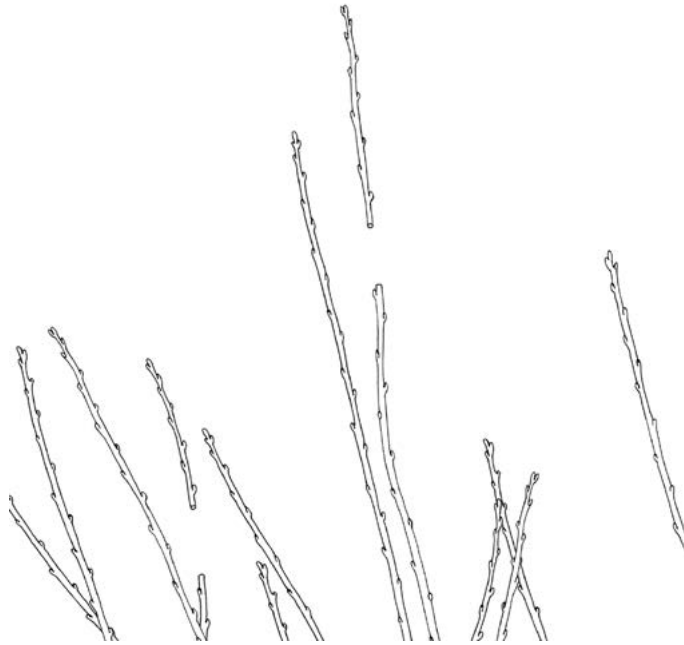


Figure 32

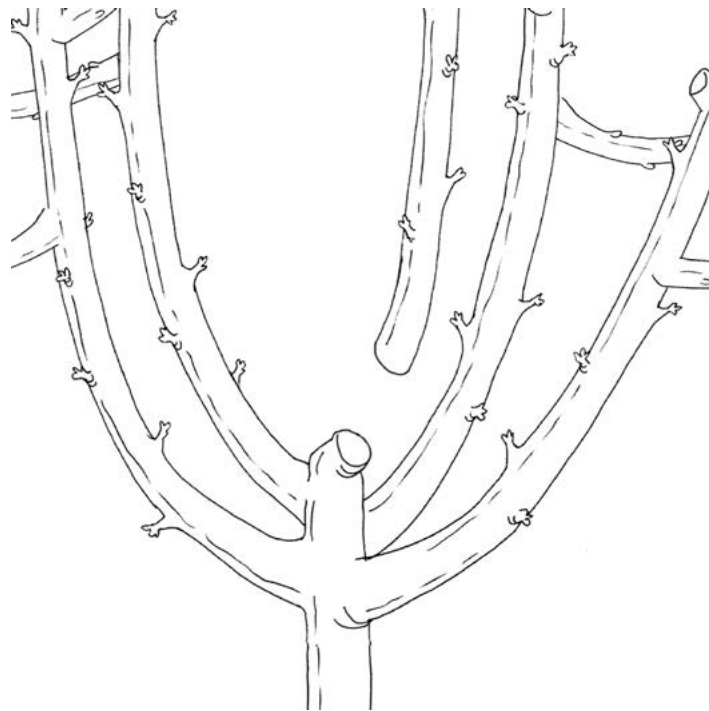


Figure 33

STAGE: *Mature pruning*

GOALS

- **Renew fruiting wood**
- **Promote light distribution**
- **Promote quality fruiting sites**
- **Reduce and maintain desired tree height**

SYSTEM DEVELOPMENT

LATERAL BRANCH (FRUITING WOOD) MAINTENANCE AND RENEWAL

- Treat each leader as an individual one-sided spindle tree.
- In order to keep shading at a minimum, do not allow lateral branches to grow larger than one-half the diameter of the parent branch. Remove very large branches. Keep in mind the concept of retaining “big, smaller, smallest” wood as the tree is pruned from lower to higher in the canopy (Figure 34).
- Establish a regular fruiting-wood renewal process. Allow lateral branches to fruit several years before renewal (Figure 35). The highest quality fruit develops at the base of 1-year-old shoots and on young spurs.

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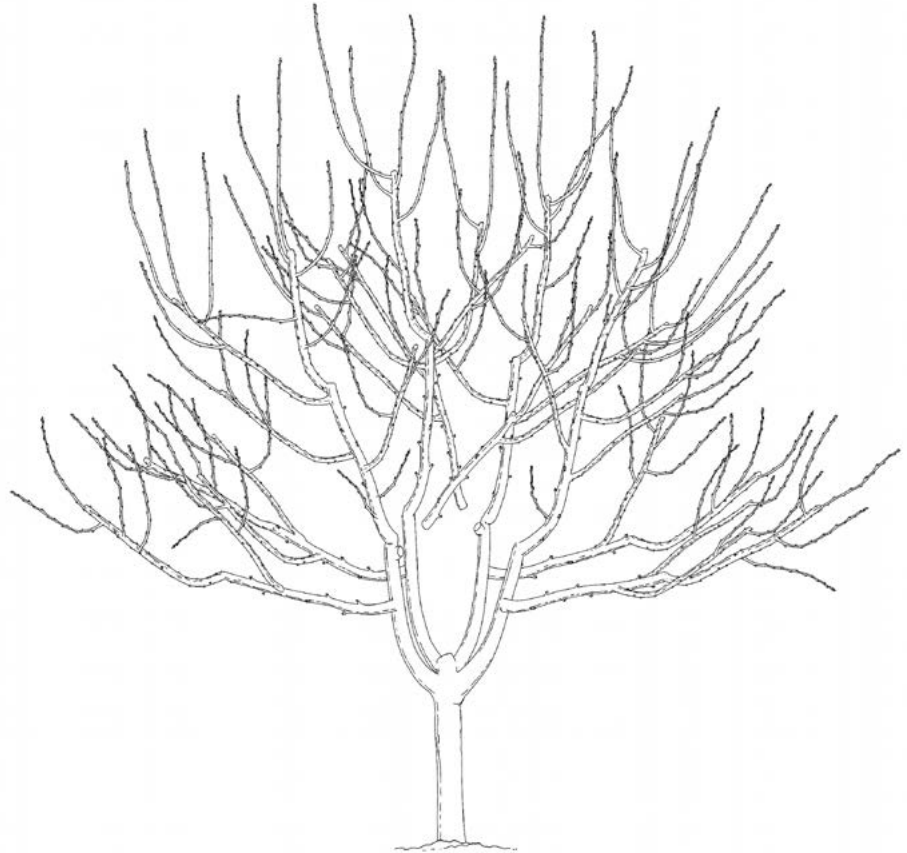


Figure 34



Figure 35

STAGE: *Mature pruning (con't)*

SYSTEM DEVELOPMENT

- At late dormant or bloom, stub back approximately 20 percent of all fruiting wood each year so that spurs are no more than 5 years old.
- Renew branches each year by stubbing them back to a vegetative bud, or, where no vegetative bud is visible, leave a stub approximately 4–6 inches in length. Older branches will not renew as successfully as younger branches.

MAINTAIN LIGHT CHANNELS

- Remove or cut back large branches that extend beyond the lower branches in order to maintain light channels and fruiting wood throughout the tree (Figure 36).

WEAK AND PENDENT WOOD

- Remove weak or pendent wood, which tends to overset and produce small fruit (Figure 37).

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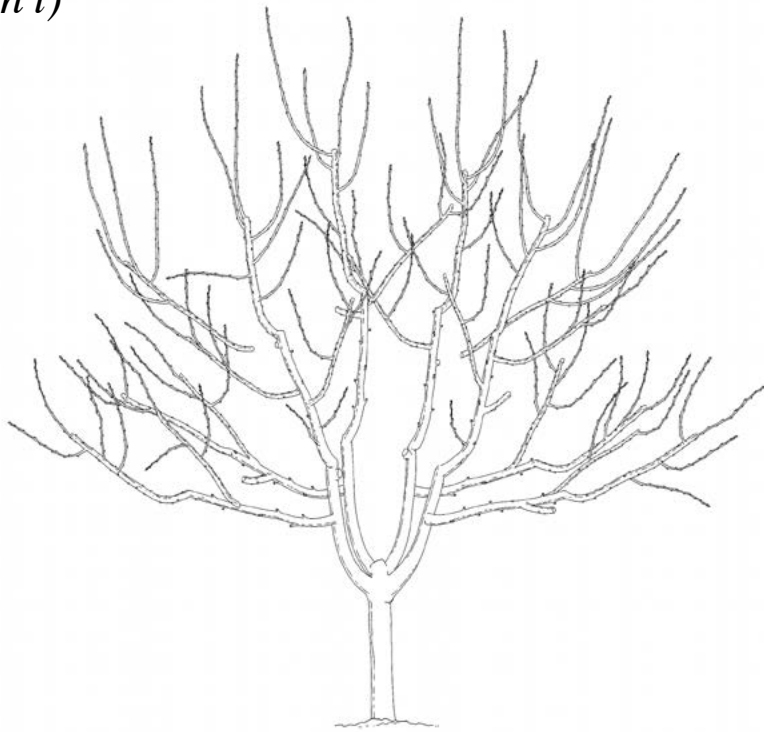


Figure 36



Figure 37

STAGE: *Mature pruning (con't)*

SYSTEM DEVELOPMENT

BRANCH TERMINALS

- Where adjacent branches are the same size, remove one in order to improve light penetration (Figure 38).

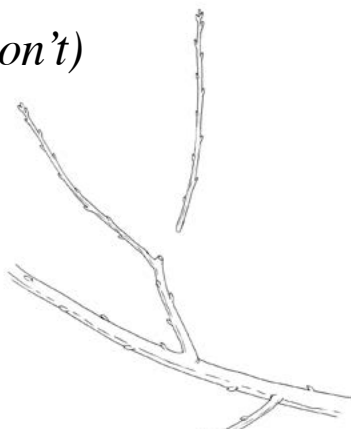


Figure 38

TREE TOP

- As the tree reaches maximum height, prune the top back to one weak lateral, generally in late summer (Figure 39).

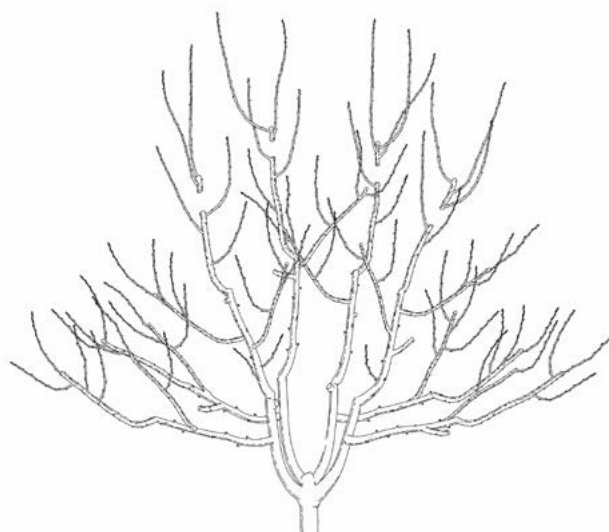


Figure 39

GENERAL MAINTENANCE

- On less productive SL trees, tip and remove up to a third of the new growth of only those lateral branches you can reach while standing on the ground. This will invigorate the bottom of the tree and stimulate new growth in an area otherwise difficult to re-invigorate (Figure 40).

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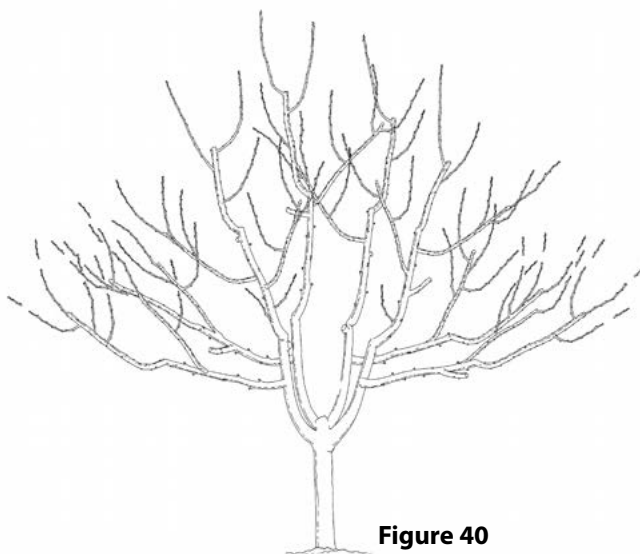


Figure 40

STAGE: *Mature pruning (con't)*

SYSTEM DEVELOPMENT

GENERAL MAINTENANCE

- To balance crop load if the tree is very productive, tip and remove a quarter to a third of the new growth of all lateral branches (Figure 41).

SUMMARY

The goal of mature tree pruning in the SL training system is to encourage light penetration and good fruit quality throughout the tree by maintaining a pyramidal shape. Branches from bottom to top should follow the pattern of “big, smaller, smallest.”

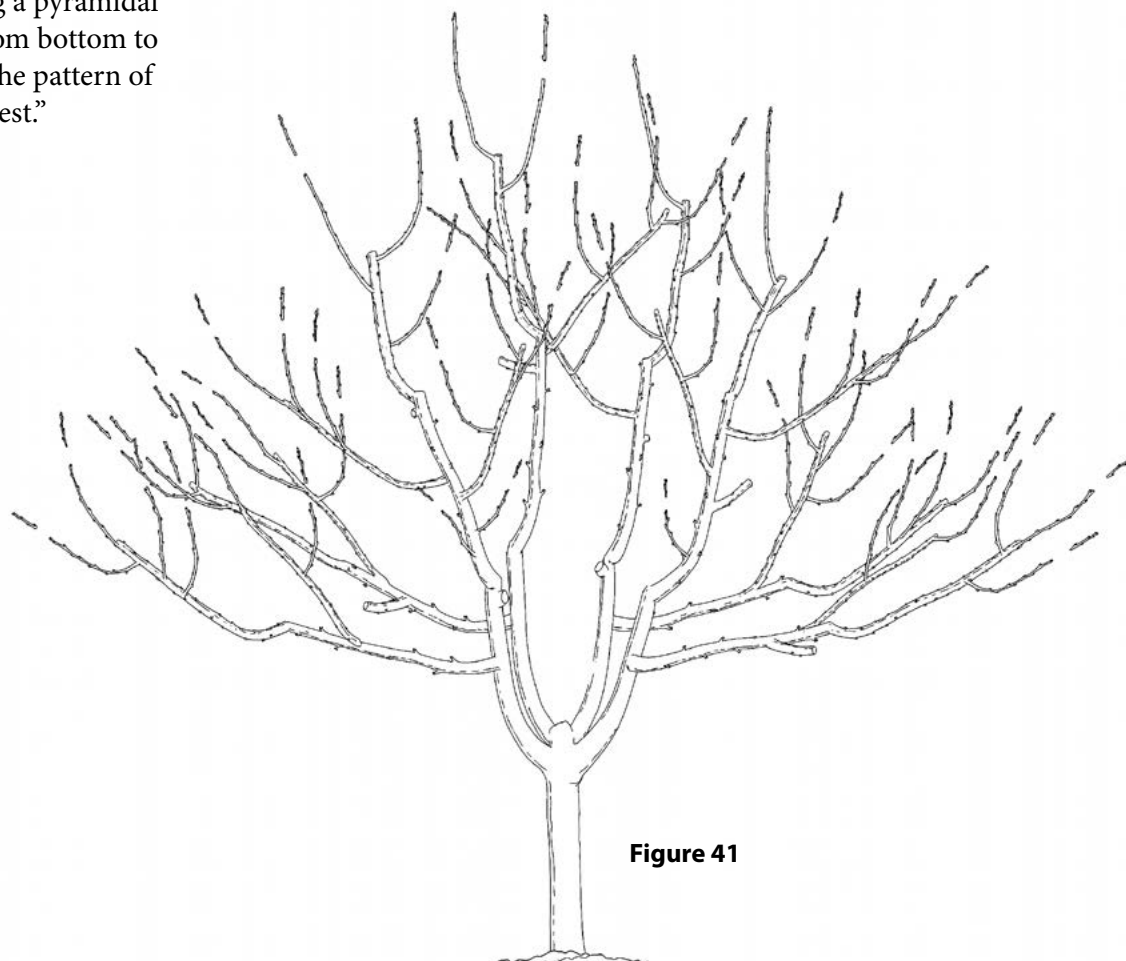


Figure 41



SUPER SLENDER AXE (SSA)

Recommended spacing

Between rows	
on dwarfing or semi-dwarfing rootstocks, e.g., Gisela®3 or Gisela®5	10'
on semi-vigorous, precocious rootstock, e.g., Gisela®6 or Gisela®12	11.5'
non-precocious, vigorous rootstock	not recommended
Between trees	
dwarfing rootstock	20"
semi-vigorous rootstock	40"

The Super Slender Axe (SSA) was developed as a modification of the spindle to gain greater control of tree growth. The SSA needs dwarfing and precocious rootstocks such as Gisela®5 and Gisela®3. In the case of low vigor sites or self-fertile varieties, it may be possible to use more vigorous precocious rootstocks, such as Gisela®6 or Gisela®12. Varieties with good vigor, upright growth habits, and the ability to produce lateral shoots are preferred. The most important characteristic for a suitable variety is the capacity to produce fruit on basal buds of 1-year-old shoots.

The production habit of this system is significantly different from other systems. Instead of producing fruit on spurs with multiple small flower buds, SSA utilizes the solitary large flower buds at the base of 1-year-old shoots. This results in a favorable fruit/leaf ratio that yields very good fruit size and quality. The low production capacity per tree is compensated by the high planting density.

STAGE: *At planting*

GOALS

- **Promote strong root system establishment in the first growing season**
- **Impose bud-activation techniques to stimulate extensive lateral shoot formation**

SSA TREE SELECTION

- Nursery trees should have a height between 40 and 50 inches above the graft union (Figure A). It is important that the trees have short internodes, preferably with strong buds well-distributed from the middle through the apical part of the tree.
- Bench-grafted, 6- to 8-month-old trees with a height of 30–40 inches also are suitable (Figure B).



Figure A

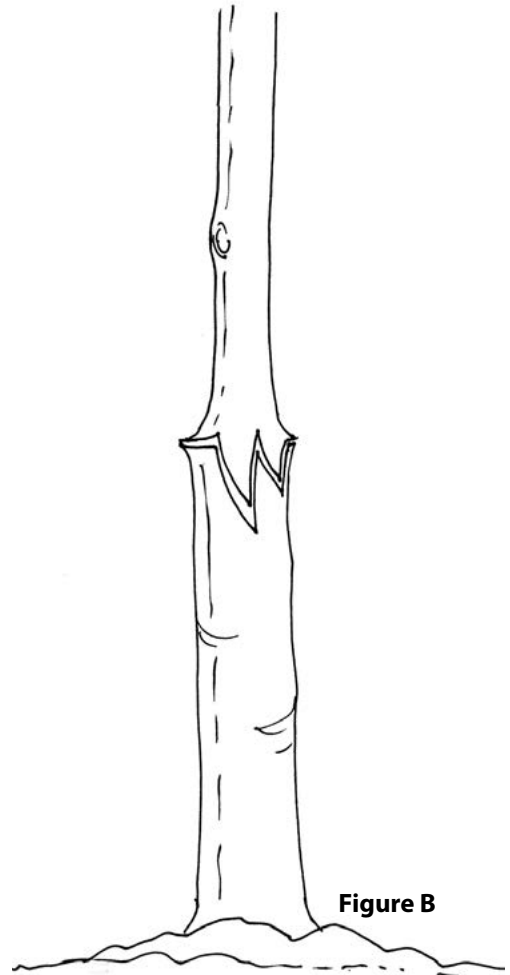


Figure B

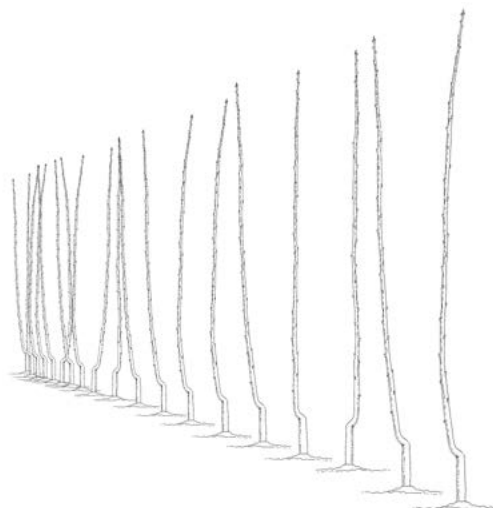


Figure C. A newly planted SSA orchard. Note the absence of feathery foliage.

STAGE: *At planting*

SYSTEM DEVELOPMENT

- If feathered trees are planted, the terminal is removed to enhance shoot growth and feathers are cut back to two or three vegetative buds (Figure 42).
- It is critical to induce 10 or more lateral branches on the leader during each year of canopy development. This can be done via girdling of the trunk or application of a cytokinin-gibberellin growth regulator (e.g., Promalin), at green tip; bud removal is NOT recommended (Figure 43).

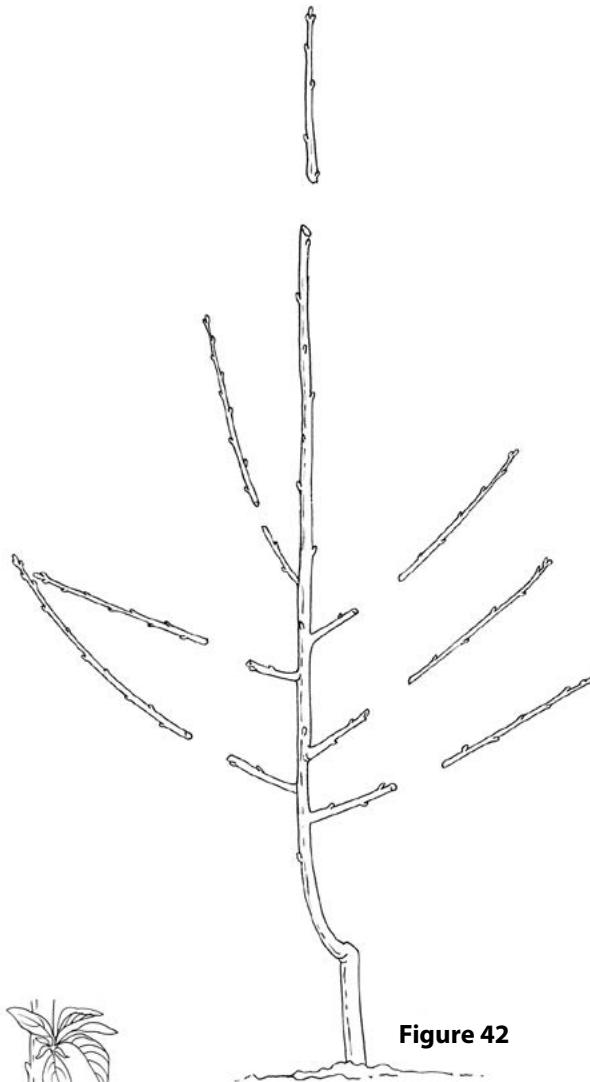


Figure 43

STAGE: *First growing season*

GOALS

- **Develop at least 75 percent of the final leader height**
- **Develop 10 or more well-distributed lateral branches with relatively uniform moderate vigor, which will provide shoot basal fruiting capacity in the second year**

SYSTEM DEVELOPMENT

- When 3–4 inches long, the more upright-growing lateral shoots can be adjusted to horizontal crotch angles by attaching a clothespin at a 90-degree angle to the trunk just above the shoots.
- Clothespins can be removed after 2–3 weeks, or re-set to just behind the shoot tip to help keep the shoot from turning upwards.
- Figure 44 illustrates the type of desired lateral shoot activation and growth at the end of first year compared to a tree with no bud activation (Figure 45).
- A high single-wire trellis may be useful for aligning the tops of the SSA trees.

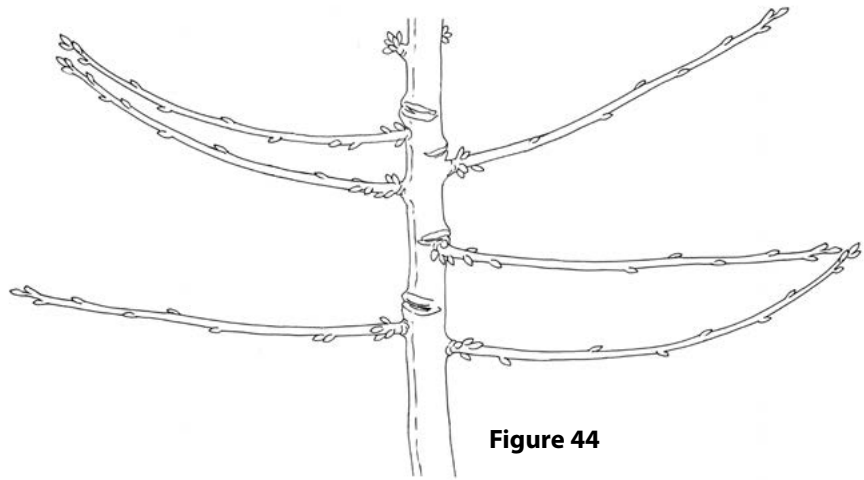


Figure 44

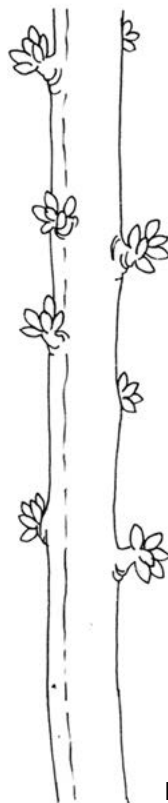


Figure 45

Figure 44 illustrates the type of desired lateral shoot activation and growth at the end of first year. Figure 45 illustrates a tree with no bud activation.

STAGE: *First dormant season*

GOALS

- **Impose bud-activation techniques to stimulate additional extensive lateral shoot formation on leader.**
- **Begin “short-pruning” of existing lateral shoots to simultaneously balance leaf area with second-year crop load and renew or initiate new fruiting laterals.**



Figure 46a



Figure 46b

SYSTEM DEVELOPMENT

- SSA “short-pruning” is done by removing the majority of the length of each 1-year-old (previous season) shoot, retaining only the basal flower buds plus at least two vegetative buds for new shoot formation (Figure 46a). Lower branches can be left slightly longer than upper branches.
- Short-pruning may be accomplished best during bud swell, when it is easier to differentiate between the rounded flower buds and the more pointed vegetative buds (Figure 46b).
- When leader extension has been moderate, bud activation steps can be taken (as described above) to induce another 10 or more lateral branches on this leader growth, repeating as needed until the full tree height is achieved.

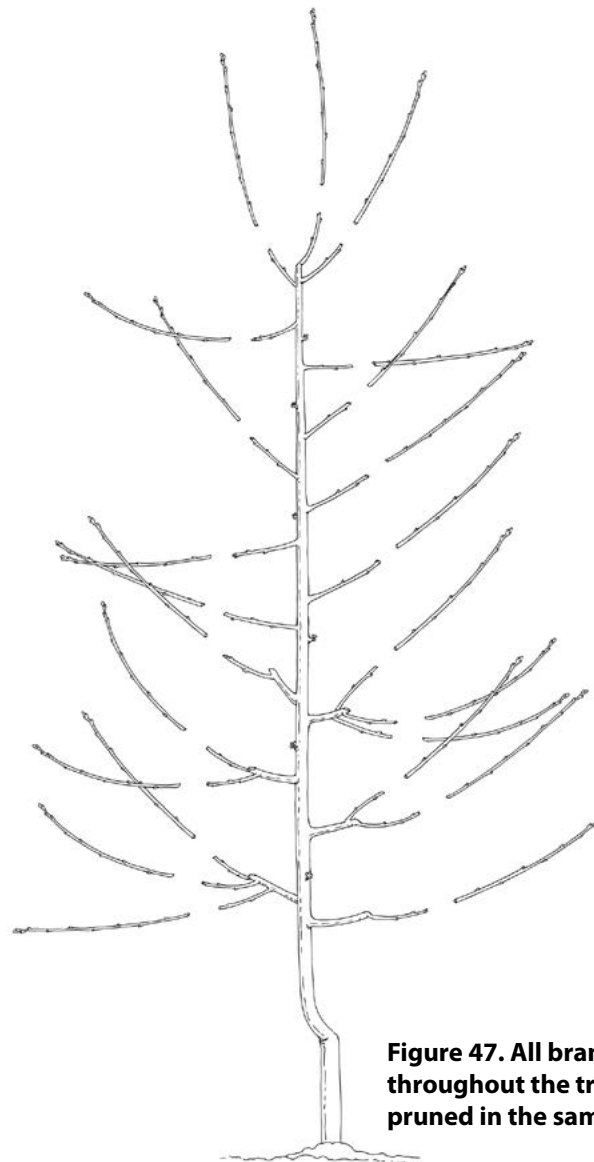


Figure 47. All branches throughout the tree are short pruned in the same manner.

STAGE: *Second and subsequent growing seasons*

GOALS

- **Achieve final leader height in the second year**
- **Complete formation of well-distributed lateral shoots on 75 percent of the leader in the second year and on 100 percent of the leader in the third year**
- **Begin cropping in the second year, achieving full production by the fourth and fifth years**
- **Maintain permanent canopy height without invigorating the tree top**

SYSTEM DEVELOPMENT

- When 3–4 inches in length, the more upright-growing lateral shoots on the leader can be adjusted to a horizontal crotch with clothespins.
- Once the leader has reached its mature height, it should be headed back to a relatively weak lateral shoot just below the preferred mature height, either done at a delayed budbreak timing (4–5 weeks after budbreak) or postharvest (mid-summer) to minimize regrowth.

STAGE: *Second and subsequent dormant seasons*

GOALS

- **Impose “short-pruning” on all lateral shoots to achieve 100 percent annual renewal of all fruiting laterals**
- **Maintain balanced and moderate vigor and fruitfulness throughout canopy**

SYSTEM DEVELOPMENT

- Every “fruiting feather” is short-pruned annually, leaving two to three vegetative buds for leaf area renewal plus the basal flower buds for cropping (Figure 48); feather length should decrease slightly from canopy base to apex (Figure 49).

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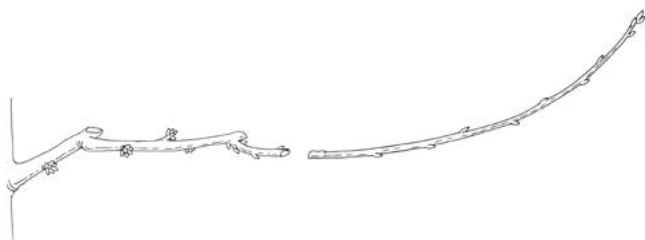


Figure 48

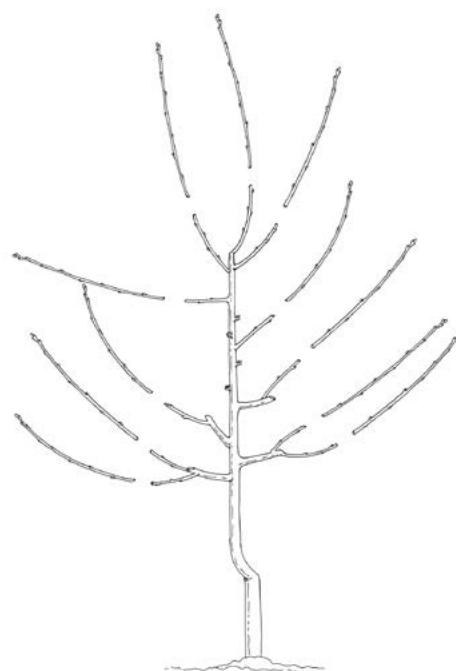


Figure 49

STAGE: *Second and subsequent growing seasons (con't)*

SYSTEM DEVELOPMENT

- Short pruning maintains the production close to the central leader (Figures 50a and 50b).

Continued on next page



Figure 50a



Figure 50b

STAGE: *Second and subsequent growing seasons (con't)*

SYSTEM DEVELOPMENT

- When fruiting feathers become too long, they can be removed with a short stub to promote renewal of shoots close to the leader (Figure 51).
- On SSA trees, flowering (Figure 52) and cropping (Figure 53) should occur primarily on basal bud 1-year-old shoots through the life of the orchard.

SUMMARY

The SSA training system produces a high-density orchard of central axis trees with short limbs and fruiting primarily on 1-year-old shoots. Renewal of nearly 100 percent of the fruiting units is accomplished with annual dormant pruning. All operations, such as pruning and harvest (approximately 80 percent), can be managed from the ground. A limitation of this system is the inability of specific cultivars to form fertile basal flower buds; therefore, this trait must be evaluated for each potential cultivar to be considered.



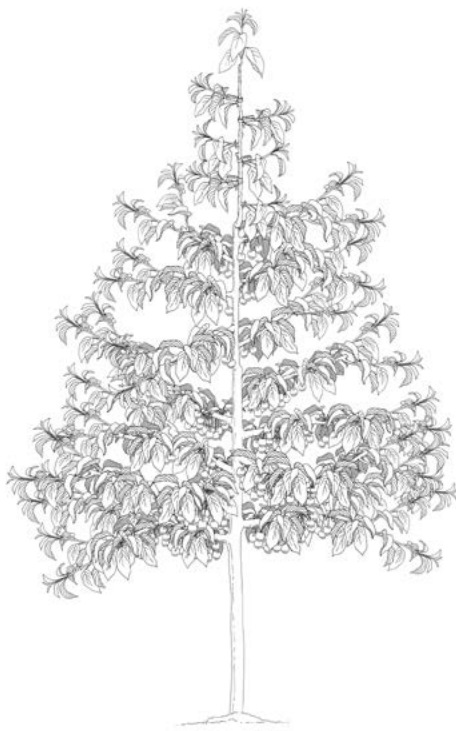
Figure 51



Figure 52



Figure 53



TALL SPINDLE AXE (TSA)

Recommended spacing

Between rows	
vigorous to semi-vigorous rootstock	13–14'
dwarfing to semi-dwarfing rootstock	11–12'
Between trees	
vigorous to semi-vigorous rootstock	6–8'
dwarfing to semi-dwarfing rootstock	5–6'

Like other spindle-type canopy training systems (e.g., the Vogel Central Leader, the Zahn Spindle), the Tall Spindle Axe (TSA) tree canopy is characterized by the sweet cherry tree's natural forest growth habit of developing a central leader. However, the TSA modifies the natural branching habit, replacing annual tiers of four to five strong lateral branches with a continuously spiraled whorl of moderately vigorous lateral branches, preferably forming about 10 or more per year during canopy development, to ultimately form a conical "Christmas tree" shape. The system is further differentiated by two key concepts: 1) annual heading of lateral shoots to balance leaf-to-fruit ratios and future crop loads, and 2) annual renewal of the oldest fruiting branches so that the only permanent structure is the central leader.

The TSA is a training system well-suited for dwarfing to semi-vigorous rootstocks, or vigorous rootstocks on weak soils, since growth is comprised primarily of lateral shoots of moderate vigor borne on a single vertical leader.

STAGE: *At planting*

GOALS

- **Promote strong root system establishment in the first growing season**
- **Impose bud activation techniques to stimulate lateral shoot formation**

SYSTEM DEVELOPMENT

- Do not head nursery tree.
- Remove any side branches by cutting back to the most basal (bottom) vegetative bud (Figure 54).
- Remove any buds below about 1.5 feet (can be rubbed off) (Figure 54).
- Retain the most terminal healthy bud on the central leader, then remove the next five to six buds.
- Select a bud about every 4–4.5 inches down the leader that has the potential to form a continuous whorl of shoots around the leader (Figure 55).
- The selected buds should be activated to form new shoots by application of Promalin, scoring or notching above each selected bud, or removal of intervening buds.
- Expectations for the first growing season are to obtain 8 to 12 lateral shoots well-distributed down the leader.
- The greater the number of lateral shoots that are activated to grow in the first year, the more likely the resulting vigor of those shoots will be balanced and moderate.

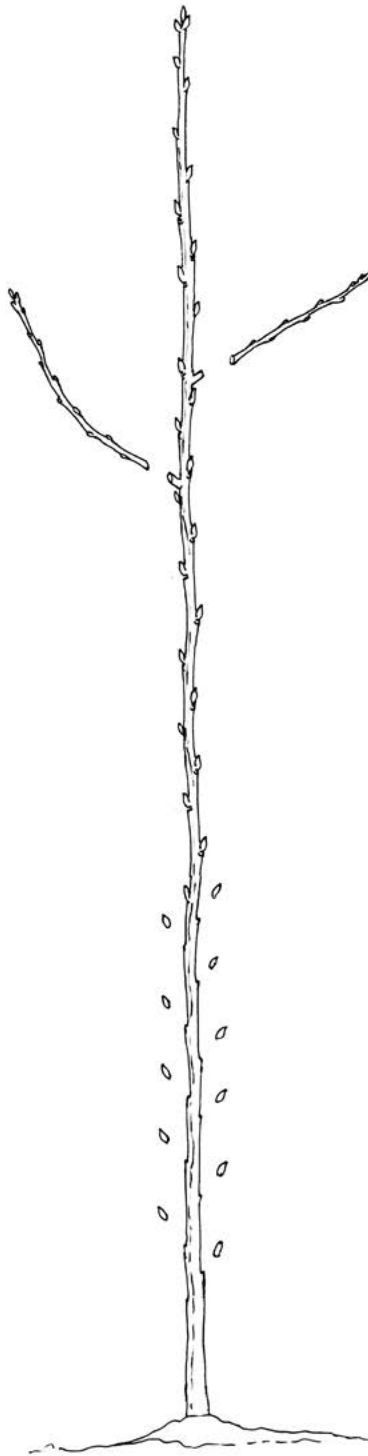


Figure 54

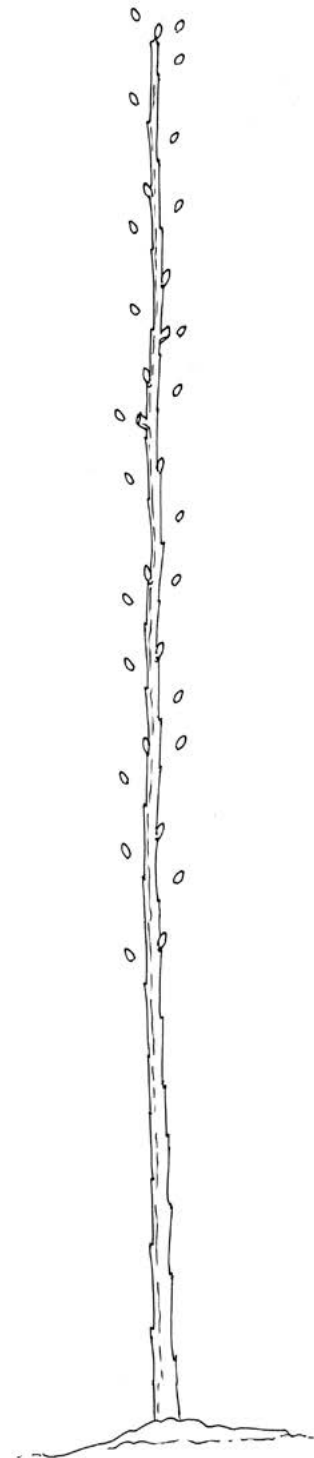


Figure 55

STAGE: *First growing season*

GOALS

- **Develop at least 65 percent of the final leader height**
- **Develop about 10 well-distributed lateral branches with relatively uniform moderate vigor, which will provide shoot basal fruiting capacity in the second year and spur fruiting capacity in the third year**

SYSTEM DEVELOPMENT

- When 3–4 inches in length, new lateral shoots can be adjusted to horizontal crotch angles by attaching a clothespin at a 90 degree angle to the trunk just above the shoots.
- Clothespins can be removed after 2 to 3 weeks, or set to just behind the shoot tip to help keep the shoot from turning upwards (Figure 56).

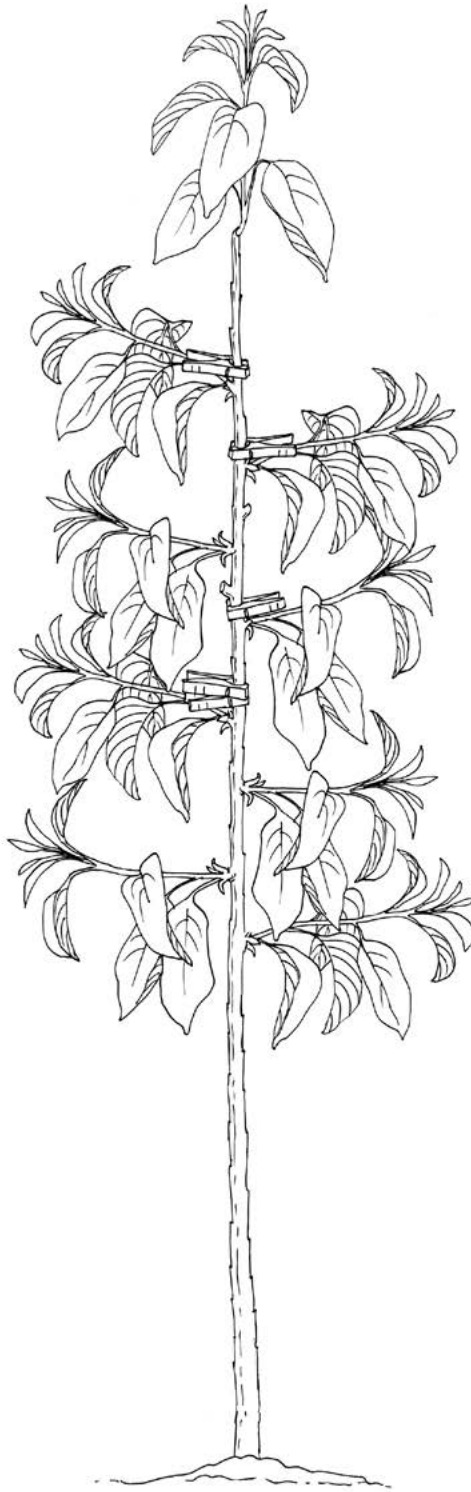


Figure 56

STAGE: *First dormant season*

GOALS

- **Impose bud-activation techniques to stimulate additional lateral shoot formation on leader**
- **Stimulate secondary lateral-shoot formation and begin managing future cropping capacity**

SYSTEM DEVELOPMENT

- If six or more lateral branches were not achieved in the first year, all existing lateral shoots should be restarted by cutting back to the most basal (bottom) vegetative bud.
- If six or more lateral branches were achieved in the first year, these should be headed, preferably just beyond two side-oriented buds, to remove 15–25 percent of the length (less for weaker shoots, more for stronger shoots) (Figure 57).
- Since every shoot that formed in the first year should form flowering spurs in the third year, this heading of laterals is a strategy to not only fill out the canopy, but to also begin balancing the crop load (i.e., leaf-to-fruit ratio) for the third year and beyond.
- The new portion of the leader (which grew in Year 1) should be treated the same as the nursery leader in Year 1 regarding bud removal, selection, and activation (see above).
- Expectations for the Year 2 growing season are to obtain 8 to 12 new lateral shoots well-distributed down the leader growth from Year 1 and a doubling of lateral shoots from those lateral shoots that developed in Year 1.
- If terminal leader growth in Year 1 was excessively vigorous (e.g., 4 feet or more), the leader should be headed back to about 3 to 4 feet of new terminal before sub-terminal bud removal and imposing a bud activation strategy.

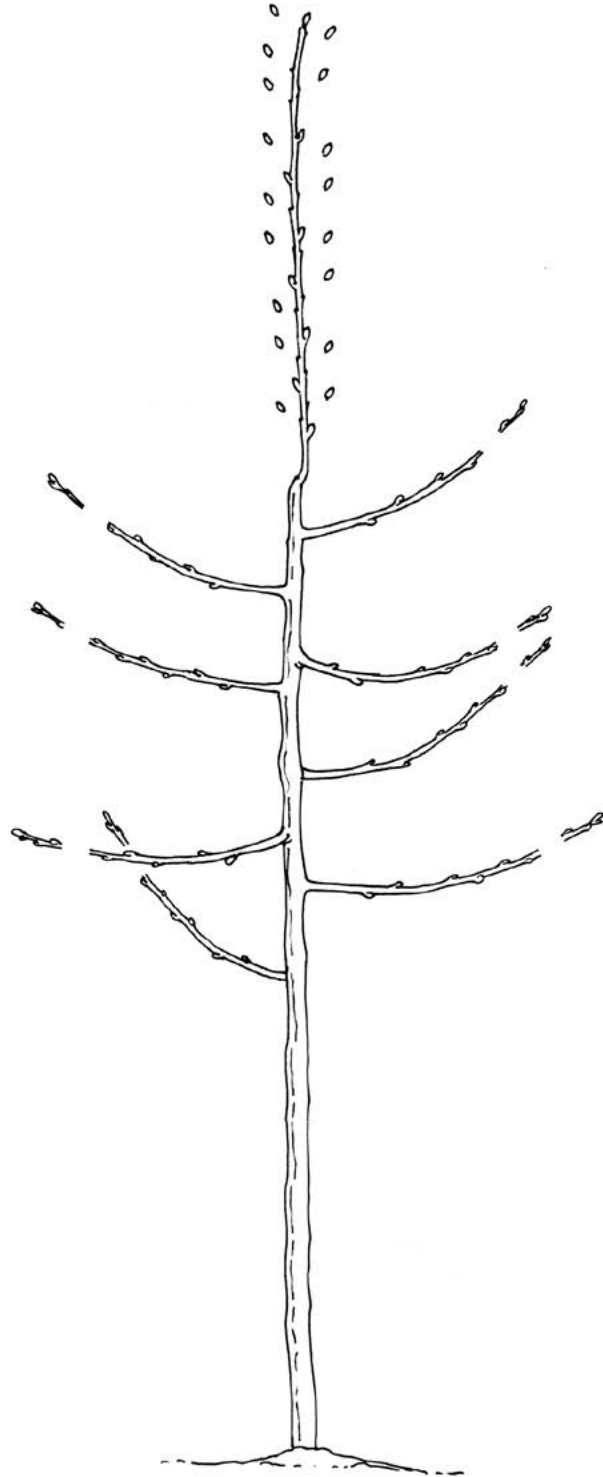


Figure 57

STAGE: *Second growing season*

GOALS

- **Initial minor fruiting on leader spurs and shoot basal flower buds**
- **Develop at least 90 percent of the final leader height**
- **Develop about 8 to 12 more well-distributed primary lateral branches of moderate vigor, which will provide shoot basal fruiting capacity in Year 3 and spur fruiting capacity in Year 4**
- **Develop 15–20 well-distributed secondary lateral branches of relatively uniform moderate vigor, to fill at least 65 percent of the allotted orchard area per tree**

SYSTEM DEVELOPMENT

- The use of clothespins for developing good crotch angles of new lateral shoots in Year 1 also applies to new lateral shoots off the leader in Year 2 (Figure 58).
- On precocious rootstocks, there likely will be a small amount of fruit in the second year borne on spurs on the portion of the leader that came from the nursery, as well as on the non-spur flowering sites that form at the base of previous season shoots.

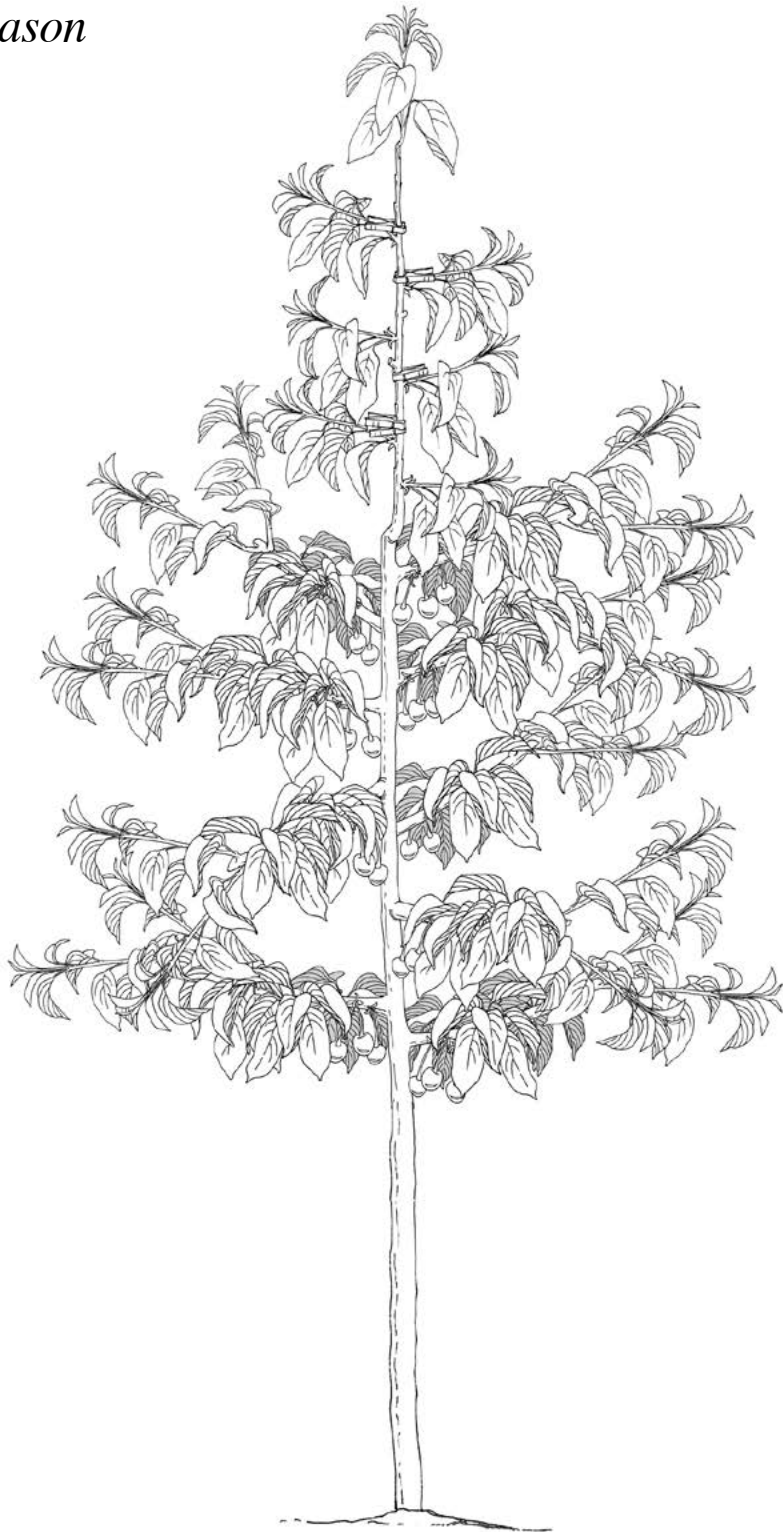


Figure 58

STAGE: *Second and subsequent dormant seasons*

GOALS

- **Stimulate secondary/tertiary lateral shoot formation and manage future cropping capacity**
- **Maintain good canopy light distribution by thinning out laterals as needed**
- **Begin fruiting branch renewal in Year 5**

SYSTEM DEVELOPMENT

- Bud selection and activation on the leader should continue until the tree has reached its mature height (usually by Year 3 at the latest).
- Most lateral shoots should again be headed to remove 15–25 percent of the previous season's shoot length growth (Figure 59).
- Overlapping shoots, weak shoots, pendent shoots, or watersprout-type upright shoots should be removed to maintain good light distribution along all fruit-bearing sites (Figure 60).
- Branches in the lower portion of the canopy can be left longer than in the middle or upper portions, to maintain the Christmas tree-like conical shape.

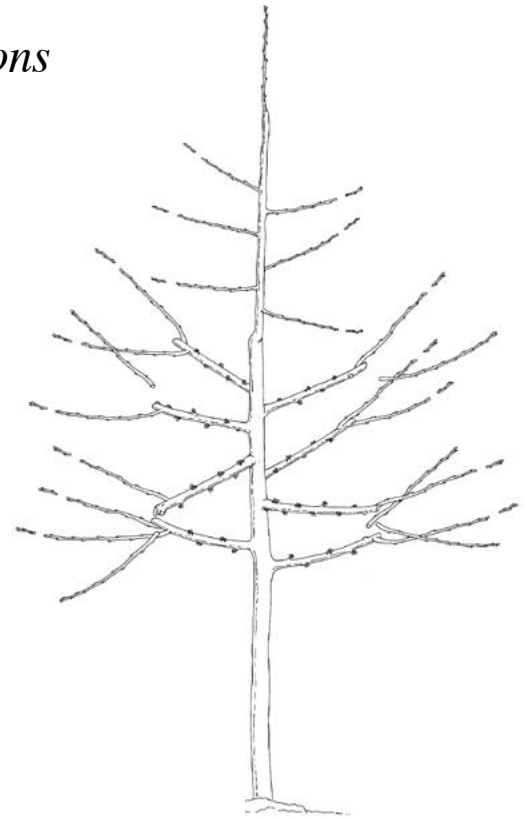


Figure 59



Figure 60

STAGE: *Third and subsequent growing seasons*

GOALS

- **First commercial harvest (mixed spur and shoot basal fruiting sites) in Year 3**
- **Complete 100 percent of the final leader height in Year 3. Lowest tertiary branches should fill 100 percent of the allotted orchard area per tree in Year 3**
- **Continue filling canopy fruiting volume with secondary and tertiary branches in Years 3 and 4**

SYSTEM DEVELOPMENT

- Once the leader has reached its mature height, it should be headed back to a relatively weak lateral shoot just below the preferred mature height, either done at a delayed budbreak timing (4 to 6 weeks after budbreak) or postharvest (mid-summer) to minimize regrowth (Figure 61).
- As fruiting branches reach 5–6 years old, the largest two or three should be cut back to a basal weak shoot, spur, or bud (if present), or approximately 8-inch stub from the leader, to stimulate fruiting branch replacement (Figures 62–63).

SUMMARY

The TSA system will produce relatively compact, freestanding trees that fruit precociously with good yields of high-quality fruit that can be picked mostly from the ground.



Figure 61



Figure 62



Figure 63



UPRIGHT FRUITING OFFSHOOTS (UFO)

Recommended spacing

Between rows	
vertical UFO	9–10'
dual-angled UFO-Y	12–14'
Between trees (UFO)	
vigorous rootstock	6–7'
semi-vigorous rootstock	5–6'
semi-dwarfing rootstock	4–5'
Between trees (UFO-Y)	
vigorous rootstock	5–6'
semi-vigorous rootstock	4–5'
semi-dwarfing rootstock	3–4'

The Upright Fruiting Offshoots (UFO) system was developed to:

1. Simplify training, pruning, and crop load management
2. Utilize the sweet cherry's natural upright growth habit and manage vigor by establishing multiple vertical structural fruiting units (number of vertical units should be proportional to tree vigor)
3. Optimize input efficiencies (e.g., light, labor, agrochemicals) and achieve high, uniform light distribution to fruiting sites
4. Facilitate the adoption of orchard mechanization and automation technologies

At maturity, the UFO system yields a planar fruiting wall architecture that is precocious, productive, and simple to maintain. Each tree is comprised of a permanent single horizontal trunk (or cordon) from which renewable fruiting leaders are grown vertically. Fruit are borne predominantly on spurs but also at the base of 1-year-old shoots, all on vertical wood. The UFO system may be configured to a single vertical or dual-angled (Y, each plane 30 degrees off vertical) system, both requiring trellising (about five wires per plane). UFO training may be used to establish a pedestrian orchard, though higher yields in the single vertical wall UFO can be achieved by maintaining a tree height about 20 percent taller than the inter-row spacing.

Establishing the UFO system is straightforward with little to no pruning required at planting.

STAGE: *At planting*

GOALS

- Fill the in-row tree space with the horizontal nursery tree leader.
- Promote formation of multiple upright fruiting offshoots (vertical leaders) on trunk
- Maintain upright growth of the tree terminal growing point



Example of a UFO-Y trellis

SYSTEM DEVELOPMENT

- Unheaded and unbranched (whip) nursery trees are recommended. This requires close communication with the contracted nursery, since standard commercial practice is to head trees back to about 4 feet for shipping.
- Plant trees at a 45-degree angle pointing the terminal to the south (northern hemisphere) or to the north (southern hemisphere) (Figure 64). This reduces the potential for sunburn on the trunk during establishment. Important: do not plant the trees vertically and bend them to a 45-degree angle.
- Clip/tie the trunk where it intersects the lowest wire (20 inches above ground) to maintain the planting angle. There is a single lowest wire in both the UFO and the UFO-Y trellises.
- Remove any nursery tree feathers with thinning cuts.
- Manually rub off all buds below the first trellis wire.
- Impose bud-activation techniques to upper buds about every 8 inches (UFO) or about every 4 inches (UFO-Y) to stimulate vertical shoot formation.

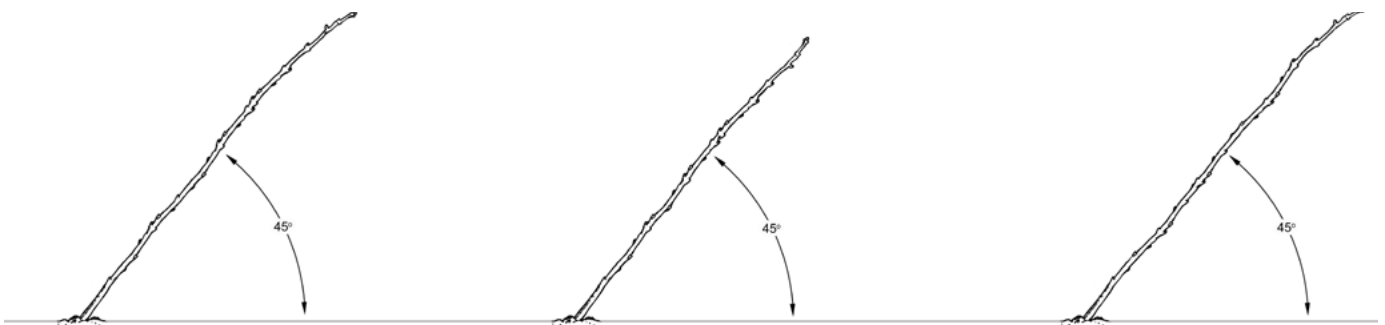


Figure 64

STAGE: *First growing season*

GOALS

- **Develop about 10 well-distributed vertical leaders, which will provide basal fruiting capacity in Year 2 and spur fruiting capacity in Year 3**
- **Promote relatively uniform, moderate vigor among the vertical leaders**
- **Eliminate vigorous shoots that form below the first trellis wire**

SYSTEM DEVELOPMENT

- Remove any shoots that form below the first trellis wire.
- In late spring, evaluate growth uniformity of vertical shoots; head any excessively strong shoots to a stub of no more than 2 inches with several leaves to promote regrowth of each as new dual shoots to be more in balance with the existing moderate shoots.
- Once new shoots at the terminal end are 12 inches or longer, train trees to the lowest wire by removing the initial clip and placing it further along the trunk so that the orientation is slightly above horizontal (Figures 65 and 66).

Continued on next page



Figure 65

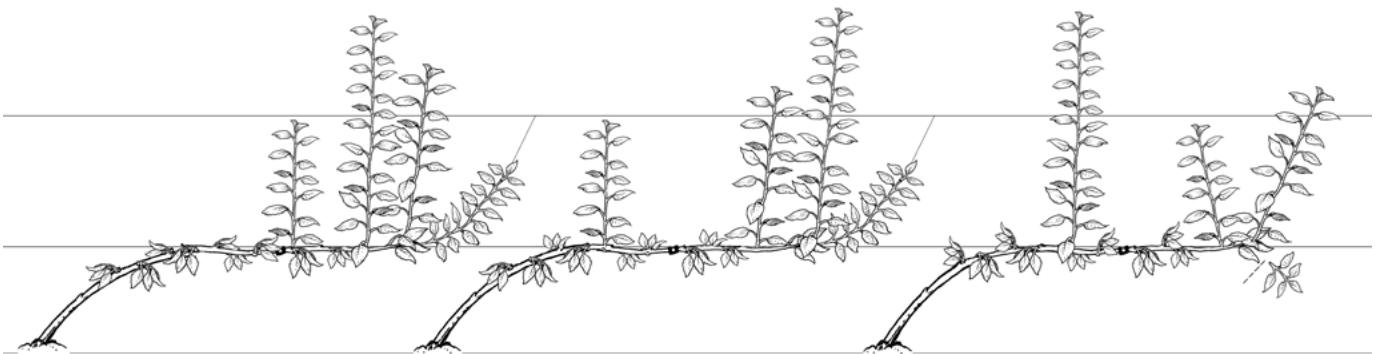


Figure 66

STAGE: *First growing season (con't)*

SYSTEM DEVELOPMENT

- Important: Do not train the trunk below a horizontal plane.
- If tree length exceeds tree spacing, train the terminal end as a vertical shoot (Figure 66).
- In mid summer, if any shoots still exhibit excessively vigorous growth ("bull" shoots), remove them entirely with a thinning cut.

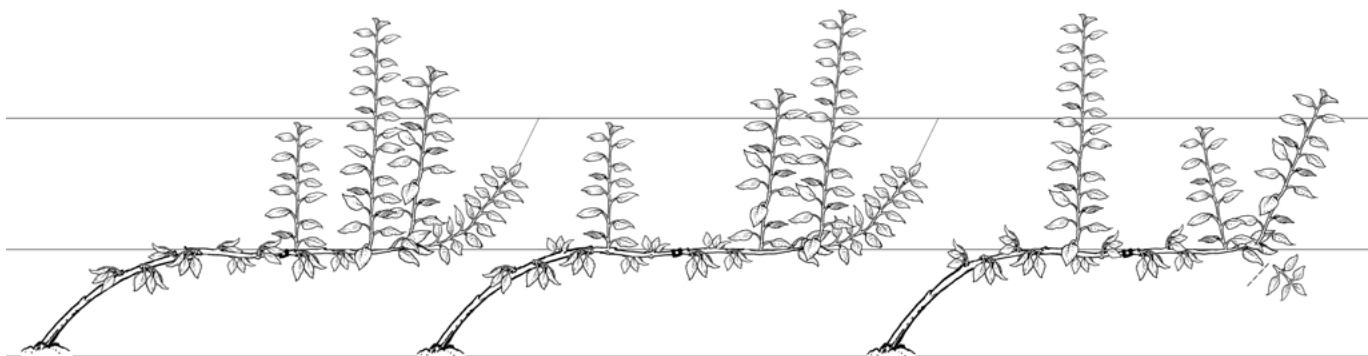


Figure 66

STAGE: *First dormant season*

GOALS

- **Promote uniformity in upright shoot growth**
- **Space and orient upright shoots uniformly to upper wires**

SYSTEM DEVELOPMENT

- Thin out weakest or most vigorous shoots if density exceeds one per approximately 8 inches (UFO) or approximately 4 inches (UFO-Y).
- Where possible, clip or tie shoots to the second wire (UFO) or to the dual second wires (UFO-Y, in an alternating pattern) as appropriate.
- Using thinning cuts, remove any shoots growing below horizontal from the main leader.

STAGE: *Second growing season*

GOALS

- **Fill in horizontal gaps with upright shoots every 8 inches (UFO) or 4 inches (UFO-Y)**
- **Begin filling vertical space in fruiting wall by promoting balanced upright growth of 24–30 inches per shoot**
- **Harvest initial fruit along the horizontal scaffold or base or both of previous season vertical shoots**

SYSTEM DEVELOPMENT

- Where gaps on the horizontal trunk exist, impose bud activation techniques to upper facing buds to promote completion of vertical shoot formation.
- Tie or clip upright shoots to successive vertical (UFO) or angled (UFO-Y) trellis wires as growth allows (Figure 67).
- Using thinning cuts, remove any new shoots from below the first trellis wire.
- In late spring, evaluate growth uniformity of new vertical shoots; head any excessively strong shoots to a stub of no more than 2 inches with several leaves to promote regrowth of each as new dual shoots to be more in balance with the existing moderate shoots.
- In mid summer, remove excessively vigorous uprights with a



Figure 67

STAGE: *Second dormant season*

GOALS

- **Promote uniform light distribution along the vertical length of each upright leader**

SYSTEM DEVELOPMENT

- Thin out weakest or most vigorous leaders if density exceeds one per approximately 8 inches (UFO) or one per approximately 4 inches (UFO-Y).
- For highly productive varieties, remove all lateral shoots on upright leaders with thinning cuts (Figure 68); on moderately productive varieties, remove all lateral shoots on upright leaders with stub cuts (i.e., leaving three to seven buds at the base of the lateral shoots for additional fruiting). NOTE: this removal of lateral shoots also can be done by summer hedging about 4 to 6 weeks after harvest.
- Tie or clip upright shoots to wires.

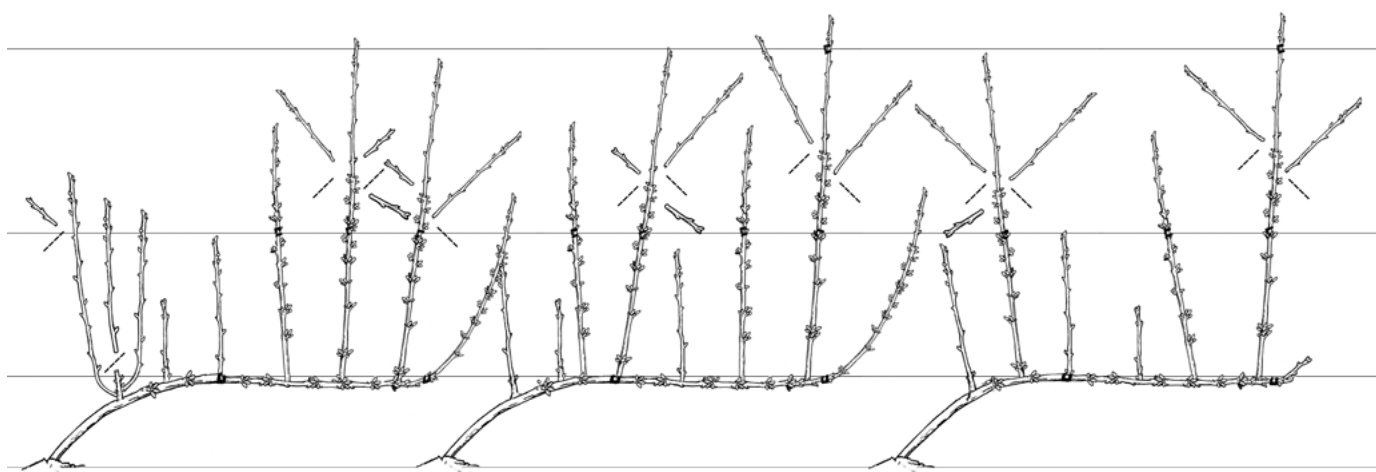


Figure 68

STAGE: *Third and subsequent growing seasons*

GOALS

- **Finish filling vertical space in fruiting wall by promoting balanced upright growth of 24–30 inches per leader**
- **Maintain maximum fruiting wall height**
- **Maintain adequate leader spacing and vigor balance**

SYSTEM DEVELOPMENT

- Tie or clip upright shoots to successive vertical (UFO) or angled (UFO-Y) trellis wires as growth allows.
- Remove any excessively dense (closer than one per approximately 8 inches for UFO or one per approximately 4 inches for UFO-Y) or vigorous leaders out of balance with the others by using a thinning cut after harvest.
- Trees may be topped, either manually or mechanically, at a height ratio of about 1.1–1.2 times the row spacing for the vertical UFO (i.e., 11–12 feet for 10-foot rows) or to about 10 feet for the angled UFO-Y. Topping 4 to 6 weeks after harvest will devigorate the tree top. Regrowth will be minimal, and no dormant pruning will be necessary to maintain fruiting wall height.

STAGE: *Mature pruning for cropping*

GOALS

- **Renew 15–20 percent of the fruiting vertical (UFO) or angled (UFO-Y) leaders per year**
- **Promote uniform light distribution along the vertical length of each upright leader**

SYSTEM DEVELOPMENT

There are two pruning rules for maintaining yields of mature UFO trees:

1. Renew vigorous upright leaders

- Select the largest one or two leaders for renewal every year; ideally, no leader should be more than 6 or 7 years old. Remove these with a stub cut during or just prior to bloom, leaving one or two live nodes for regrowth.
- As new uprights are generated from renewal cuts, manage these following the same rules for uprights when establishing the system.
- Any weak uprights should be removed with thinning cuts.

2. Remove lateral branches

- For highly productive varieties, remove all lateral shoots on upright leaders with thinning cuts; on moderately productive varieties, remove all lateral shoots on upright leaders with stub cuts (i.e., leaving three to seven buds at the base of the lateral shoots). These short stubs are retained to bear fruit and subsequently can be eliminated after harvest or, if a vegetative bud is present, can be managed as fruiting laterals similar to those in the SSA system.
- NOTE: the removal of lateral shoots growing into the alley also can be done by summer hedging about 4 to 6 weeks after harvest; follow-up removal of lateral shoots growing between trees in the row can be done during dormancy.

SUMMARY

The UFO training system produces a uniform fruiting wall orchard somewhat comparable to the SSA system, but with about half the density of trees required. The fruiting units are renewable and vertical, similar to the KGB system but with greater precocity and greater potential for partial mechanization. To achieve these advantages, it requires a more extensive trellis system than the SSA and more attention to establishment tasks than the KGB.



Recommended spacing

Between rows	
Semi-vigorous rootstock	15–16'
semi-dwarfing or dwarfing rootstock	13–14'
Between trees	
semi-vigorous rootstock	8–9'
semi-dwarfing or dwarfing rootstock	6–8'

VOGEL CENTRAL LEADER (VCL)

The Vogel Central Leader (VCL) system requires little establishment pruning because it takes advantage of the inherent central leader nature of the young cherry tree. Minimal pruning, a modest growth rate due to dwarfing or semi-dwarfing rootstocks, minimal fertilization during establishment, and an intermediate planting density result in relatively high early yields. Without additional manipulation, a vigorous rootstock will produce a very tall VCL tree.

The “Christmas tree” shape promotes good light distribution throughout the canopy, and fruiting wood is renewed on a regular basis with this system.

STAGE: *At planting*

GOALS

- **Establish lateral shoot formation**

SYSTEM DEVELOPMENT

- Head nursery tree 30–36 inches above the ground, depending on the desired height of the first scaffold branches (Figure 69).
- As buds begin to swell in early spring, retain the top two buds and remove the next five to six buds (Figure 70).



Figure 69



Figure 70

STAGE: *First growing season*

GOALS

- **Establish wide branch angles and an open tree form**

SYSTEM DEVELOPMENT

- Establish branch angle when the lateral shoots have grown 3–4 inches in length by attaching a clothespin perpendicular to the trunk just above these shoots (Figure 71A).
- Move the clothespins to the shoot tip after 2–3 weeks to help keep the shoot flat. For added weight, use large plastic clothespins rather than wooden pins (Figure 71b).
- Avoid fertilizers until cropping begins to maintain moderate growth and promote horizontal branch angles.
- Branch angle should be approximately 60 degrees. To maintain this angle as branches grow, they may need to be spread or tied down.

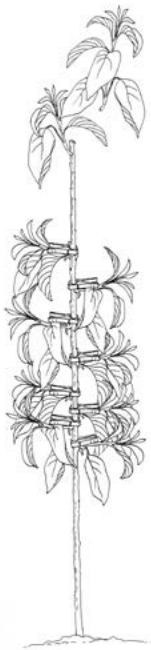


Figure 71A



Figure 71B



Figure 71C. Remove the stronger shoot if both top buds grew. The weaker shoot will form the new leader.

STAGE: *First and second dormant season*

GOALS

- **Impose bud activation techniques to stimulate lateral shoot formation**
- **Promote wide branch angles and an open tree form**

SYSTEM DEVELOPMENT

- Head the leader only if its growth during the previous year was greater than 30 inches.
- Treat the leader as in the establishment year. Retain the top two buds and remove the next five to six buds (Figure 72).
- Promote branching by scoring or bud removal as described on page 58.
- Encourage branches to grow throughout the entire length of the trunk in a spiral rather than allowing distinct whorls to develop (Figure 72).
- Promote adequate light penetration by thinning closely spaced branches (Figure 72)

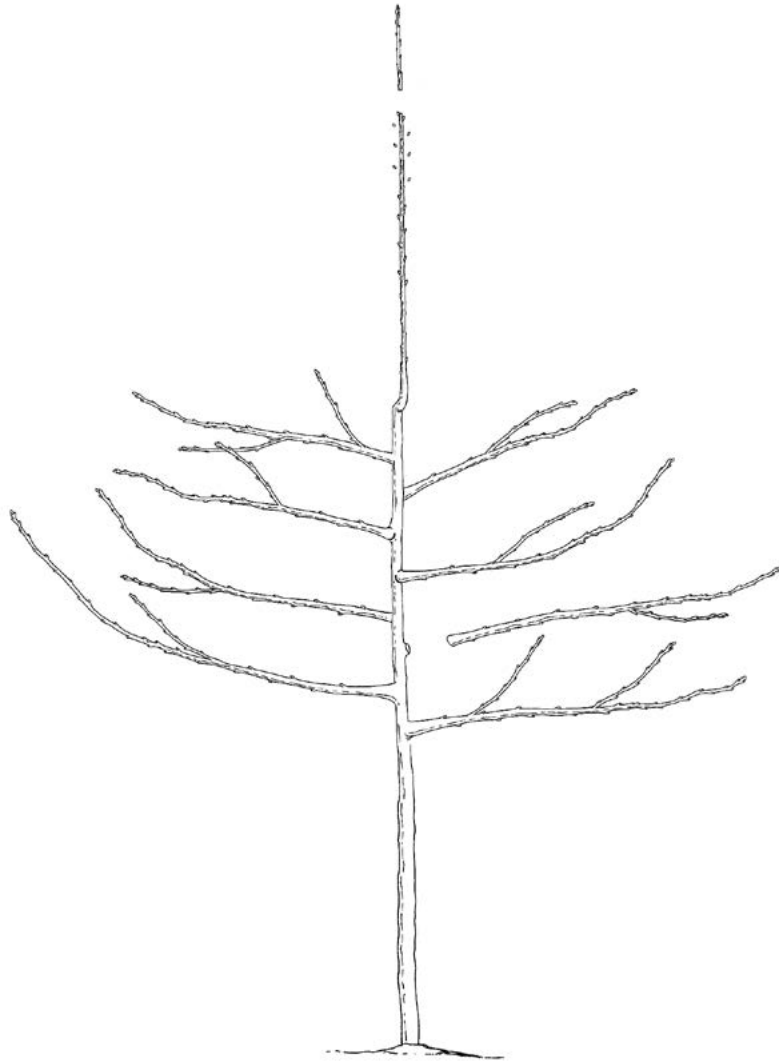


Figure 72

STAGE: *Second and third growing season, until maturity*

GOALS

- Initial minor fruiting on leader spurs and shoot basal flower buds in Year 2
- Develop about 10 more well-distributed primary lateral branches of moderate vigor in Year 2, which will provide shoot basal fruiting capacity in Year 3 and spur fruiting capacity in Year 4
- Promote wide branch angles and an open tree form.
- First commercial harvest (mixed spur and shoot basal fruiting sites) in Year 3.
- Complete 100 percent of the final leader height in Year 3.
- Lowest tertiary branches should fill 100 percent of the allotted orchard area per tree in Year 3.

SYSTEM DEVELOPMENT

- Apply clothespins to emerging shoots as before, through Years 2 and 3.
- Branch angle should be approximately 60 degrees. To maintain this angle as branches grow, they may need to be spread or tied down.
- If necessary, thin new shoots to promote good light distribution throughout the canopy (Figure 73).
- Pinch back vertical shoots growing from primary laterals. Remove vertical shoots completely if they grow within a few inches of the trunk (Figure 73).
- Maintain a dominant terminal on all lateral branches.

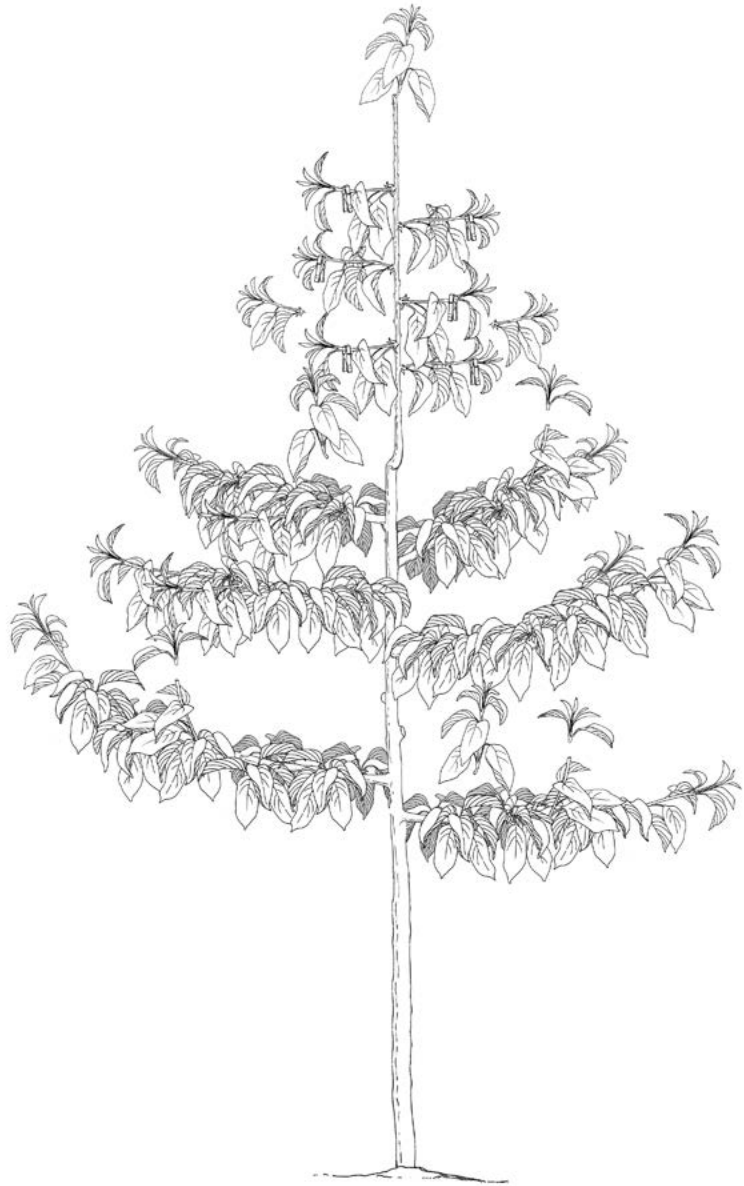


Figure 73

STAGE: *Mature pruning, dormant season*

GOALS

- **Begin fruiting branch renewal in Year 5**
- **Promote light distribution**

SYSTEM DEVELOPMENT

- Allow all shoots growing from the primary lateral branches to develop as potential renewal branches (Figure 74).
- Stub back primary laterals that grow vigorously upright, being sure to leave a live stub (Figure 74).
- Stub back or remove thick branches. No branch should be larger at the base than half the diameter of the trunk (Figure 75).
- Maintain good light distribution for the development of fruiting wood.
- Fruiting wood should be renewed in the VCL on a regular basis. The highest quality fruit will develop on the base of 1-year-old wood and young spurs. Spurs should be no more than 5 years old.
- Make stub cuts during the dormant season or at bloom to renew the fruiting wood (Figure 76).
- Stub length is determined by its location in the tree. Stubs near the top may be only 3–4 inches long. At the base, stubs may be as much as 12–18 inches.
- Renew branches by cutting back to existing lateral branches (Figure 76).

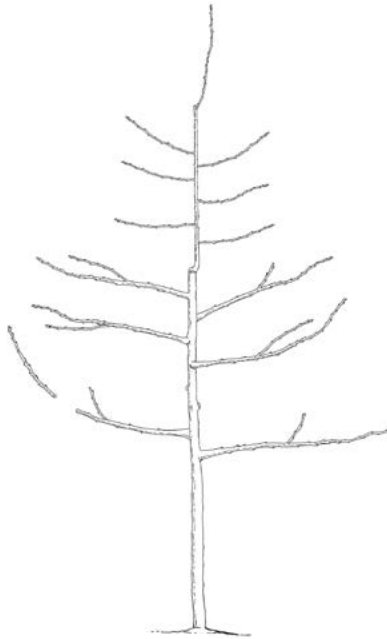


Figure 74



Figure 75

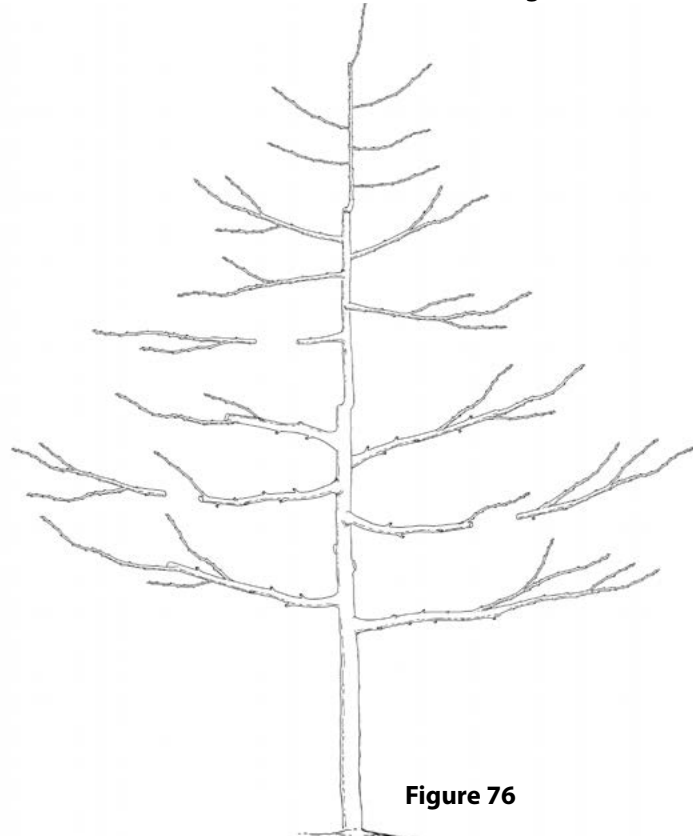


Figure 76

STAGE: *Mature pruning, growing season*

GOALS

- **Reduce and maintain desired tree height**

SYSTEM DEVELOPMENT

- Control tree height only when tree growth has begun to slow due to cropping.
- Reduce tree height by cutting the top back to a weak lateral in late summer or early fall (Figure 77). Remove 36–48 inches of height in this way, depending on tree vigor.

SUMMARY

Due to minimal pruning in the establishment years and the use of scoring to induce branching and limb bending, the VCL system is labor intensive in the first 2 years. However, the tree responds by producing early, high quality crops. By maturity, labor input with this system is similar to other systems, such as the KGB and SL. The VCL system is particularly suitable for varieties having lower productivity, such as 'Regina', because it does not include branch tipping, which tends to reduce crop load. More productive varieties grown as a central leader tree are better suited to the TSA system which incorporates crop load moderation via pruning.



Figure 77



Acknowledgements

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Published and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914, by the Oregon State University Extension Service, Washington State University Extension, University of Idaho Extension, and the U.S. Department of Agriculture cooperating.

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Published April 2015.