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Agriculture and Natural Resources

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Two-Scaffold Perpendicular V – A New Training System for Arkansas Peach and Nectarine Orchards

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Introduction and Impact

For modern orchards to be profitable, the training system used must produce fruit early in the life of the orchard, have high annual yields and be relatively easy to manage. These traits allow growers flexibility in making decisions to change cultivars as demanded by consumers and in replanting older, low-productive blocks to return money to the operation or to pay off loans for the establishment of the orchard.

In the traditional open-center training system, 110 to 170 peach trees are planted per acre. Although peach trees grow vigorously and start to bear fruit in the third or fourth growing season, trees in this system do not fill their allotted space until they are six to eight years of age. During this time, tree loss may significantly reduce economic vitality of a block. Low-density orchard plantings are used because of the lack of adapted size-controlling rootstocks. Other methods, specifically pruning and training, must be used to control tree size and increase early and total production. The high-density, two-scaffold perpendicular V system for peach has proven to be highly productive and easy to manage in research trials. It is recommended for peach orchards in Arkansas and the surrounding region.

Benefits of the High-Density, Two-Scaffold Perpendicular V System for Peach

Traditional peach planting systems (110-170 trees per acre) achieve their production capacity in their sixth to eighth season. However, by that age, peach trees are often prone to problems causing yield reduction and tree loss. High-density orchards with 375-580 trees per acre (Table 1) result in higher early yields that more than offset the added cost of planting. Assuming that trees cost $2.50 at planting, it would cost an additional $535 per acre to plant the high-density (375 trees/acre), perpendicular V system compared to the traditional low-density (161 trees/acre), open-center system.

In the first harvest season (year 3 or 4), it is estimated that the perpendicular V yields 300-400 bu/acre (Table 2) and the open-center trees yield 150 bu/acre. At a value of $20/bushel for mature fruit ($0.45/lb), the perpendicular V system would generate $8,000/acre (gross revenue), whereas the open-center trees would generate $3,000/acre. The difference in yield due to the planting density would produce an increase in net revenue of approximately $5,000. This is almost a ten-fold return on the investment of purchasing the additional trees for the high-density system.

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Furthermore, as trees die in an orchard, losing 10 trees in a traditional orchard may result in a 10-percent reduction in yield. Losing 10 trees in a high-density orchard results in significantly lower loss because more trees are planted on a per-acre basis.

Orchardists working in the two-scaffold perpendicular V system have found it very easy to establish and prune. Research trials indicate that the V system is easier to prune and train than traditional systems if simple pruning and training rules are followed. Another advantage to this system is fruit thinning management and crop prediction. Yield can be accurately managed by thinning to specific fruit numbers along the limb and then predicting by counting maturing fruit on sample trees (Table 2). Lastly, it has been observed that fruit harvest is easier in this system. Experience in other regions indicates the system is flexible for both harvested production and pick-your-own operations.

Drawbacks to the Perpendicular V System

In the traditional open-center system, most of the fruit is in the upper third of the canopy. Fruit in the perpendicular V system should be evenly distributed along the entire axis of the scaffolds, from top to bottom. The location of fruit in lower portions of the canopy in the perpendicular V system indicates that frosts during bloom may create problems. To take full advantage of the system and ensure annual cropping, a frost prevention strategy must be planned and implemented.

Table 1. Suggested planting distances and densities for using the two-scaffold perpendicular V training system for peaches and nectarines in Arkansas.

In-Row Spacing / Between-Row Spacing	5.0 ft	6.0 ft	6.5 ft
15 ft	**580 trees/acre** – Use for weak cultivars or stocks – Use on weak soils	**485 trees/acre**	
16 ft	**545 trees/acre**	**454 trees/acre**	**419 trees/acre**
18 ft	**484 trees/acre** – Use for weak cultivars, stocks or soils unless there are equipment limitations	**405 trees/acre** – Use for average-vigor trees – Use for average to strong soils ***This is the average spacing for this system***	**375 trees/acre** – Use for strong cultivars or stocks – Use for strong, fertile soils

Table 2. Fruit cropping targets for the two-scaffold perpendicular V training system based upon 405 trees planted per acre (6 ft x 18 ft spacing).

Tree Age	No. of Fruit/Scaffold Limb	No. Fruit/Tree	Estimated Bu/Acre
3 yrs	45 - 65	90 - 130	250 - 350
4 yrs	55 - 75	110 - 150	300 - 400
5 yrs	65 - 80	130 - 160	350 - 450
6 yrs and beyond	80 - 90	160 - 185	450 - 500

The perpendicular V also requires summer pruning. Research at the Department of Horticulture at the University of Arkansas has demonstrated that summer pruning is useful in traditional open-center trees to increase fruit size, color and soluble solids and to reduce preharvest rots. However, in the perpendicular V, summer pruning is essential to maintain fruiting wood and fruit quality along the scaffolds.

Conclusion on Use of Perpendicular V System

Studies at the University of Arkansas and similar research in peach-growing regions have concluded that the two-scaffold perpendicular V system offers significant advantages. The primary advantages of the system are early and sustained fruit cropping, high fruit quality and ease of management. It is our experience, and that of others, that the perpendicular V system achieves mature production early, at least by the third or fourth harvest season. Traditional peach training systems may take six to eight years to achieve maximum potential. At maturity, the two-scaffold perpendicular V system will not necessarily yield more than other systems. Growers should start by planting experimental blocks to gain experience with this system. It should be noted that high-density orchards, while having significant economic and horticultural benefits, also require higher management intensity. Likewise, a reliable irrigation system during periods of drought is necessary. Growers using this system must, because of the capital investment and risk of the system, ensure annual cropping with a frost prevention strategy.

Training and Managing the Perpendicular V

Years 1 and 2

Tree Selection and Planting

Purchase high-quality, spring-budded nursery trees of approximately 3/8 inch in diameter and 24 to 36 inches in height with a good root system from a reputable nursery. Recommended rootstocks for peach and nectarine for Arkansas orchards are 'Lovell', 'Bailey' and 'Halford'. If soils have a high incidence of replant disorders or a short life for peach trees, then 'Guardian' rootstock should be used.

Trees should be planted as early in the spring as possible to ensure good establishment. The best time to plant peach trees is after the threat of severe cold winter temperatures has passed, but before the onset of hot temperatures. A target window for planting in Arkansas should be between February 15 and March 15. Experience shows that planting trees after April 15, when temperatures are warm to hot, limits tree growth during the first season. Trees should be planted with the bud union at or below the soil line.

Space trees 5 to 6.5 feet apart within the row, and allow 15 to 18 feet between rows, giving a tree density of 375 to 580 trees per acre (Table 1). Use closer spacing for weaker, compact or more upright cultivars or when planting on weak soils. For more vigorous or spreading cultivars, or when planting on stronger soils, use the wider spacing. Planting too closely may provide some early increases in yield, but may result in difficult-to-manage trees later in the orchard life and reduced yield and fruit quality due to inter-tree shading. If trees are planted too far apart, the advantage of increased early production with the high-density planting and the tree size control caused by close spacing is lost.

Pruning and Training

As in traditional peach training systems, any limbs on the leader that are 24 inches from the ground or lower should be removed right after planting. Allowing limbs to grow too low to the ground may cause management problems later in the orchard life, specifically difficulties with mechanical weed control (Figure 1).

As the tree starts to grow during the first season, summer pruning should be used to head-back the leader at approximately 36 to 48 inches in height to stimulate the lateral branching (Figure 2).

In the middle of the first growing season, select two main laterals that are most perpendicular to the tree row and extend into the drive row to remain, and head-back the other limbs (Figure 3). This process further stimulates growth of the new main scaffolds. The two scaffolds should be at a height of 24 to 36 inches above the soil and spaced 6 to 12 inches apart along the trunk of the tree. It is best not to have them develop directly on opposite sides of the trunk, as this is somewhat architecturally weak and may lead to limb breakage when the tree is mature and carrying a full crop load. Limbs should not be started at heights greater than 40 inches on the trunk, as these result in a very tall tree and reduced production due to loss of canopy-bearing surface. In addition, any limbs that are growing straight down on the selected scaffold should be thinned out.

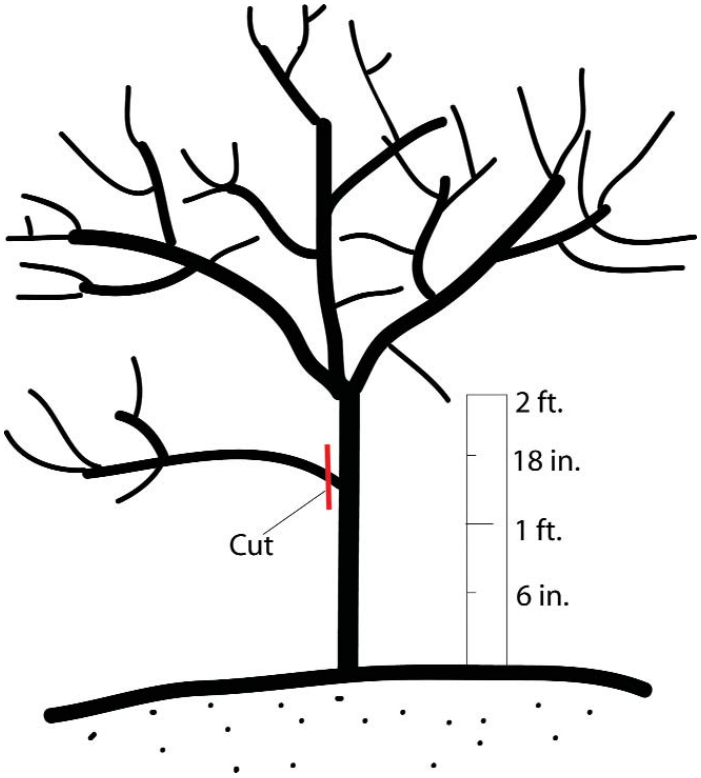

Figure 1. Remove any limbs 24 inches or lower from the ground.

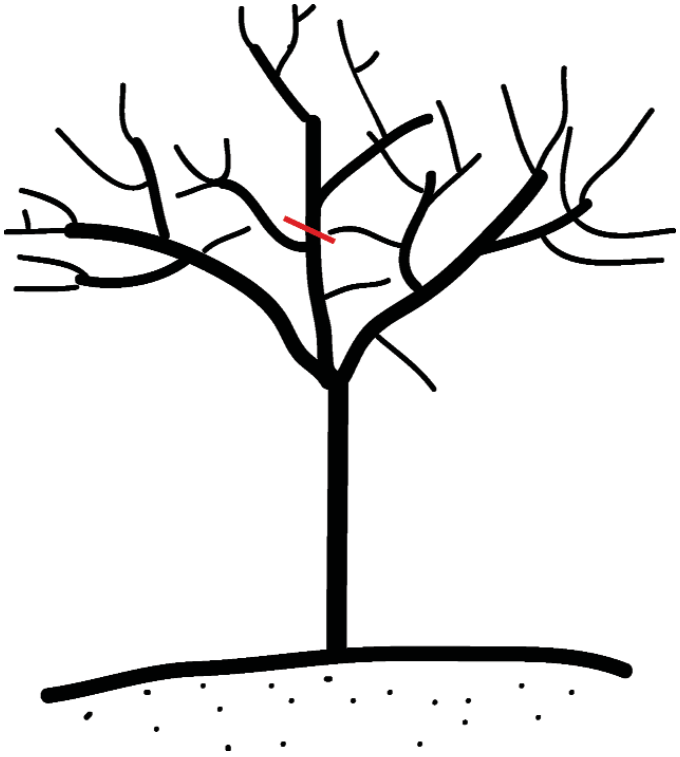

Figure 2. During early summer, head-back the leader at approximately 36 to 48 inches to stimulate lateral branch formation.

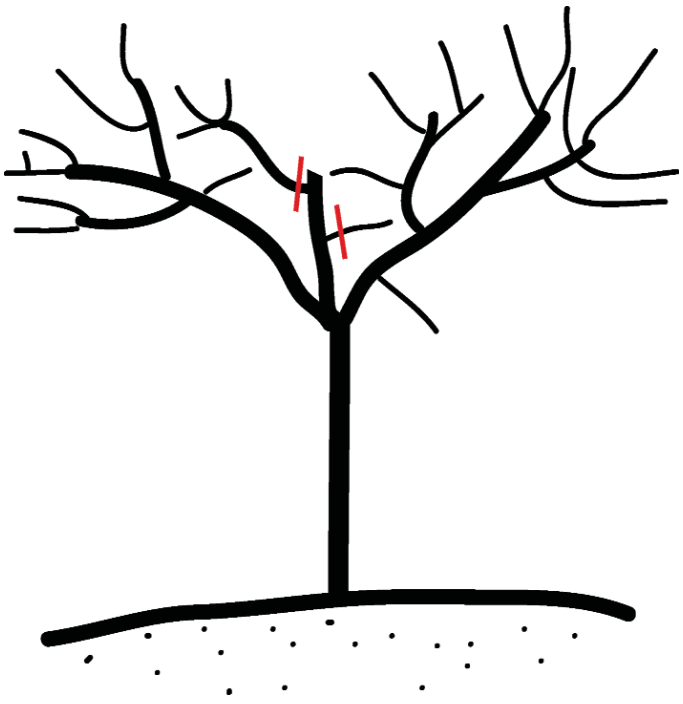

Figure 3. Select two main laterals that are perpendicular to the tree row to become the permanent scaffolds and head-back the other limbs.

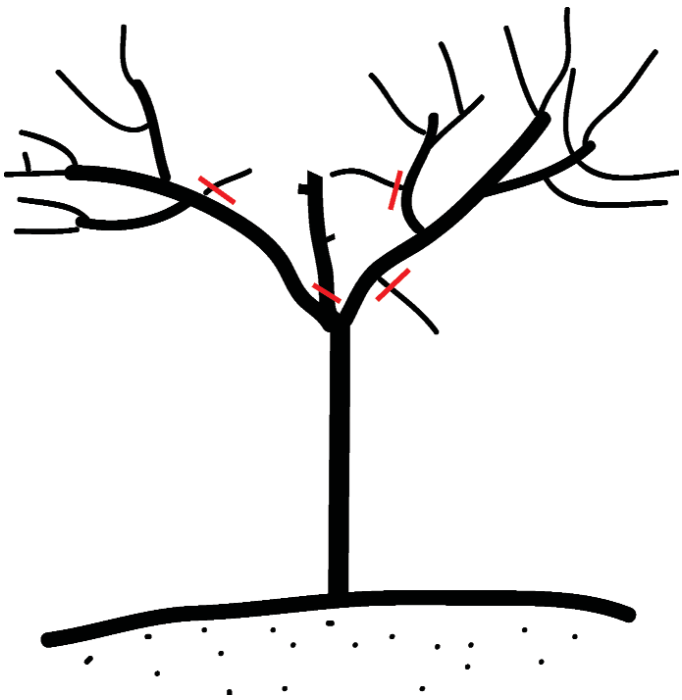

Figure 4. During the first dormant season, remove the central leader, leaving only the two previously selected limbs. Remove any strong side shoots growing downward or vertically inward.

First-Year Dormant Pruning

During the dormant season following the first season of growth, trees should be pruned to remove the central leader and all side limbs, except for the two primary scaffolds selected (Figure 4). The grower should visualize the "V" or a "Y" shape of the trees down the row and prune and train to accomplish that shape.

The two scaffold limbs should be pruned as you would normally prune scaffold limbs in peaches to extend their growth. We have not had any experience on the effectiveness of heading the scaffold. This probably depends on the vigor of the plant, the nature of the cultivar and whether or not the scaffold limb is growing too vertically and should be encouraged to grow more angled outwardly. Strong side shoots along the scaffold should be removed as well as all upright shoots on the inward side of the "V" (Figure 4).

Second-Year Summer Pruning

In late June or early July, remove all vigorous, upright watersprouts growing from the main scaffolds. Remove any shoots that arise below the scaffolds. Summer prune in late June or early July to continue encouraging growth of the scaffolds and to remove all inward growth. Trees should not be cropped during the second season, but allowed to grow vegetatively.

Second-Year Dormant Pruning

Trees require extensive pruning during the dormant season following the second growing season. Remove all side shoots on the underside or top/inward side of the scaffold. Ideally, only horizontal (or nearly horizontal) shoots that are pencil diameter up to 3/8 inch in diameter and 18 to 24 inches long should extend laterally from the scaffold between adjacent trees (Figure 5a). The side shoots along the scaffold limbs provide fruiting wood the following growing season and should be spaced 4 to 10 inches apart (Figure 5b).

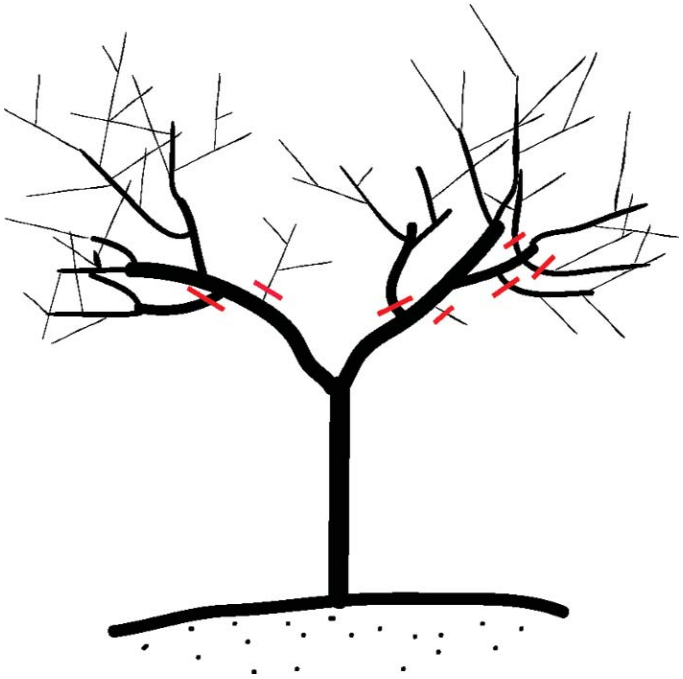

Figure 5a. During the dormant season, remove all side shoots on the underside or top/inward side of the scaffold. Ideally, only horizontal (or nearly horizontal) shoots that are pencil diameter up to 3/8 inch in diameter and 18 to 24 inches long should extend laterally from the scaffold between adjacent trees.

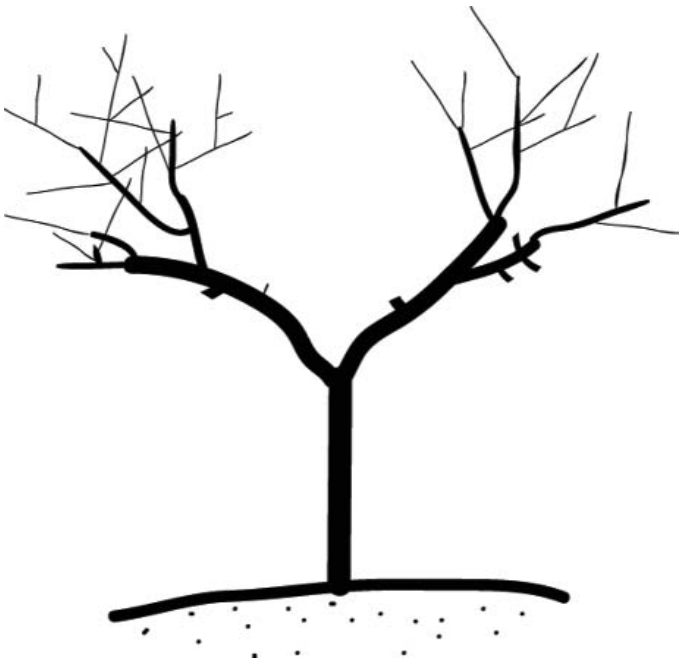

Figure 5b. Peach tree after pruning during the second dormant season.

Years 3 to 5

As the trees grow, scaffold limbs should be angled 60 to 80 degrees apart (or 30 to 40 degrees from the vertical plane; Figure 6). Trees growing too upright are usually tall and very vigorous, which results in low productivity and shading within the canopy. Trees growing with too flat of a limb angle result in low-vigor, structurally weak trees. To achieve the proper angle, limbs may need to be spread or tied down to increase limb angles, or tied together to reduce limb angles. It may be necessary to band scaffolds together if their angle is too wide and support the fruit crop load. Scaffold limbs will naturally spread more horizontally with age and after carrying a heavy crop load.

If trees have reached a height of at least 6 feet by the third growing season, they should be allowed to fruit. Prune trees to leave side fruiting shoots along the two opposite sides of each scaffold spaced approximately 4 to 8 inches apart. This should result in approximately 18 to 20 shoots on each side of the scaffold limb (Figure 5). Fruiting wood of pencil diameter and approximately 1 to 2 feet in length is desired. Fruit should be thinned as in traditional training systems to encourage good size. Each side shoot should be able to carry 1 to 3 fruits per shoot. A target yield in the first cropping season is 250 to 350 bushels of fruit (Table 1). To achieve this yield, each tree must have 90 to 130 fruits per tree or 45 to 65 fruits per scaffold limb. Fruit should not be allowed to develop on the terminal 12 to 24 inches of the scaffolds so that they will continue to grow. In the second harvest season (fourth year), growers should strive for a target yield of 300 to 400 bushels/acre of fruit, approaching the maximum for the system. Maximum yields of 450 bu/acre or more should be targeted for the third harvest season.

Maturity

By year 5 or 6, the trees should reach a mature height of 10 to 14 feet, and the gap between the scaffold limb tips of adjacent rows above the tractor drive row should be 6 to 8 feet. Trees will continue to need dormant and summer pruning (Figures 5a and 5b). At both pruning times, remove inward growing limbs in the center of the "V." Summer prune between two and three weeks prior to harvest. After summer pruning, the grower should be able to look down the row and clearly see a V shape. The canopy is maintained as a hedgerow. Each side of the hedgerow is probably 3- to 4-feet thick and extends 10 to 14 feet upward. This produces about 8 to 12 feet of productive-bearing surface area.

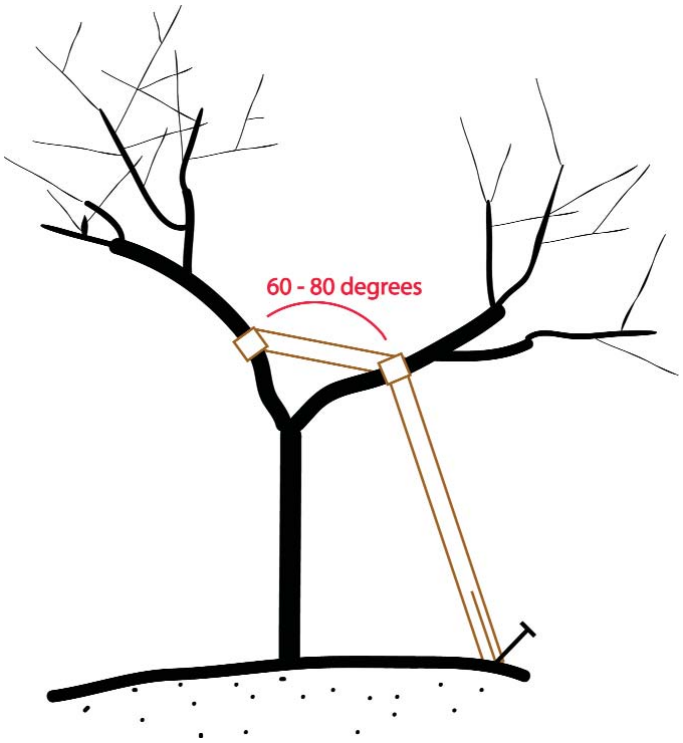

Figure 6. Limb spreading may be necessary to achieve proper limb angles.

During dormant pruning, limbs that are growing downward along the underside of the scaffold should also be removed. No permanent laterals along the scaffold should be allowed to remain, and strong side shoots must be removed annually. Only fruiting wood of pencil diameter up to 3/8 inch in diameter and 24 to 36 inches in length extending horizontally from the scaffold between adjacent trees should be allowed to remain. However, we have found that sometimes short stubs of 6 to 8 inches in length at the bottom of the scaffold may be needed to encourage annual shoot regrowth. Pruning should encourage new fruiting

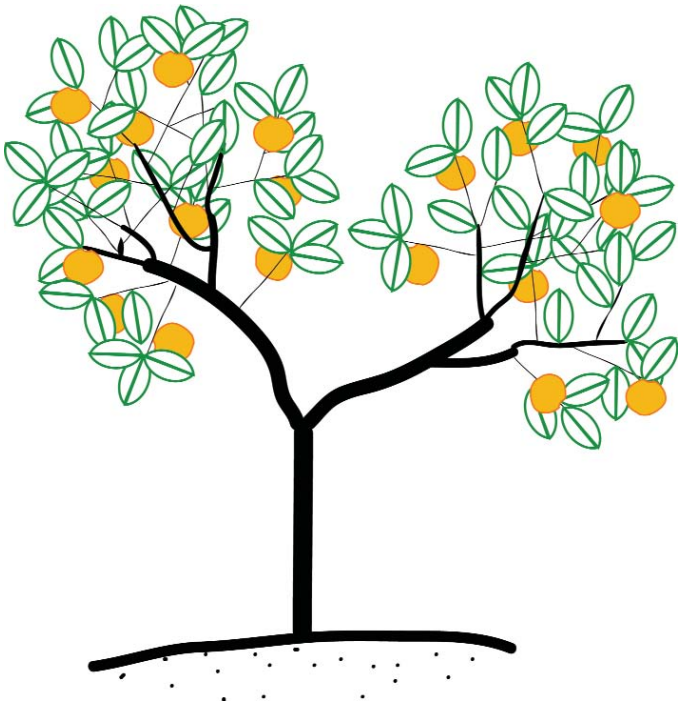

Figure 7. Fruiting peach tree demonstrating the two-scaffold perpendicular V system.

wood to grow annually and be used to balance current fruiting wood with regrowth wood. After dormant pruning, the scaffold should have a fishbone or fish skeleton look as you look down along the scaffold into the center of the tree, and there should be a 2- to 3-foot gap between limbs of adjacent trees so that a person could walk between trees in a row (Figure 7). Looking down the row, the system has a clear V-shaped open center.

Fruit Thinning

Fruit should be thinned prior to pit hardening, as in traditional systems. Earlier thinning will result in larger fruit size. Fruit should be thinned to leave one to three fruits per side shoot along the scaffold limbs. Fruit close to the scaffold may develop rub-marks and may need to be removed. Fruiting should be evenly spread from the top to the bottom of the scaffold. If regrowth in the bottom of the canopy becomes a problem, sometimes the fruit is thinned so that two-thirds of the crop is in the upper half of the canopy, with the other one-third of the crop extending down the scaffold. Because of the tree vigor in the perpendicular V system, it can be easy to overcrop trees. Overcropping limits vegetative growth and development of fruiting wood for the following season crop. Thus, biennial bearing should not occur in this system. It is important to balance crop load to the vigor of the tree and encourage annual vegetative regrowth for sustained annual production. At maturity, each tree should produce 1 to 1.5 bushels of fruit per tree, or 160 to 190 fruits.

Frost Control

Annual cropping is essential for the high-density perpendicular V system to be economical and efficient. Cropping does not only have an economic benefit, but it is also part of the vigor management of the system. If a tree loses a crop due to frost, trees may become too vigorous, requiring significant summer and dormant pruning to get trees back into their allotted space. Thus, frost, the most common reason for peach crop failure in Arkansas, must be prevented. Frost may be averted by proper site and cultivar selection. However, frost control such as wind machines and irrigation is useful for this system.

Pest Management

Pest management of the two-scaffold perpendicular system is no different from that of traditional orchard systems. However, because of the spatially restricted canopy (two planes of relatively thin canopy), there is about 10 to 20 percent less canopy volume on an acre basis at maturity than in conventional orchards. Thus, using canopy volume adjustments for spray applications, 10 to 20 percent less chemical per acre may be needed for adequate pest control. Further, it has been observed that because the open canopy has good light penetration, daily dews tend to dry more quickly and may reduce problems with fungal diseases.

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