Quote: The primary advantage of central leader trees . . . is the reduction of labor.

# HIGH DENSITY PEACH PRODUCTION IN ONTARIO

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The Niagara region, the area between Lake Ontario and Lake Erie, in Ontario, Canada, produces more than 85% of Canada's peaches and nectarines. Other primary production areas include the extreme southwestern section of Ontario (along the northwestern shore of Lake Erie and southwest of Detroit, Michigan) and in British Columbia. In the Niagara region, peach and nectarine production is limited to a narrow strip of land 2 to 10 km wide and 60 km long (1.2 to 6.2 miles wide and 37 miles long) between the south shore of Lake Ontario and the Niagara escarpment, a bluff rising 100 to 200 m (325 to 650 ft) above the lake.

The unique microclimate formed between the lake and the escarpment is suitable for the production of "tender fruits" such as peaches, nectarines, sweet and sour cherries, pears, plums and apricots and grapes. Flower and vegetable greenhouses, nurseries and poultry farms also flourish in this microclimate. To compete with these crops for the limited land base and to produce the domestic supply for fresh and processing fruit, peaches and nectarines must be productive and profitable.

The Ontario peach and nectarine industry is on the northern frontier for commercial production. The Niagara tender fruit belt climate is characterized by harsh winters with the lowest recorded minimum of -26.7˚C (-16˚F), short growing seasons (182 frost free days), and cool summers with an average temperature for June, July and August of 20.2˚C (68˚F). Under these conditions, tree growth and vigor is limited. Fruit production is consistent from year to year (1981 and 1994 were the only years in recent history when yields were significantly lower than average); however, productivity in a given year is less than desirable (5.5 tons/acre provincial average).

The standard training systems in Ontario have been the open center and modified leader. To improve the productivity and efficiency of Ontario orchards, many growers have been replacing the standard open center and the modified leader training systems with central leader training technology. In previous research, it was determined that better productivity could be obtained from trellis trained central leader trees (Miles, 1992, 1998). This technology was modified to freestanding central leader trees to eliminate trellis costs.

The primary advantage of central leader trees over the previous systems used is the reduction of labor. More than two-thirds of the fruit is produced on the four major scaffolds that are oriented close to the ground. Because tasks such as pruning, thinning and harvesting can be done without ladders, fewer labor inputs are required. Orchard workers can easily learn the concepts of training and pruning central leader peach trees. Other advantages include improved light distribution and better spray distribution within the canopy.

The central leader peach tree system used in Ontario orchards is similar to the central leader training system commonly used in apple orchards. The properly trained tree has four distinctive parts: a strong central trunk, a vigorous apical bud, four major scaffolds arising from the lower portion of the trunk, and numerous small branches along the upper portion of the trunk (Figure 1).

Establishing a central leader orchard starts with initial training at planting time and continues semiannually with spring pruning (bloom period) and summer pruning (coinciding with pit hardening). In the first few years, four strong scaffold branches are established in the four compass directions and spaced vertically 10 to 15 cm (4 to 6 inches) apart along the lower trunk. The lowest branch should be directed into the prevailing wind and originate 50 to 76 cm (20 to 30 inches) above the soil. Pruning cuts direct the growth outwardly and encourage rebranching and stiffening of the scaffold. A strong and vertical central trunk that terminates at a vigorous apical bud is encouraged at each pruning. Numerous small branches are encouraged to grow along the upper portion of the central leader. These branches are restricted by heading them back. This prevents overgrowth of the top of the tree and allows excellent light penetration into the lower canopy.

Well-feathered nursery trees are best for establishing the central leader orchard (Figure 2). After planting, remove low and undesirable branches, top the tree at 48 inches (just above a healthy bud oriented into the prevailing wind) and stub as many as eight well-spaced, healthy branches to two buds. Summer pruning is done 6 to 8 weeks later, after growth has initiated and shoots have begun to elongate. Undesirable growth below the lowest scaffold and upright shoots from the scaffolds are rubbed off. The leader is singled out and growth from the scaffolds is directed outward. Use caution to remove as few shoots as possible to avoid removing too much leaf surface.

The important cuts to make when pruning the following spring, year 2 (Figure 3), are heading back the leader to a strong bud, removing branches competing with the leader and spacing the scaffolds properly along the lower trunk. Additional cuts may be necessary to direct the growth of the scaffolds outwards. It is important to summer prune as in the previous year.

The 3-year-old tree (Figure 4) is ready to produce its first major crop. Training cuts are needed for structural purposes but also to establish good conditions for development of the crop. In addition to the types of cuts made the previous year, it is necessary to select fruiting laterals in the upper portion of the trunk. At this stage, it is important to direct terminal growth of the scaffolds laterally. Again, summer pruning is necessary to direct growth from the scaffolds laterally and to remove unwanted upright and vigorous growth.

By the fourth year, the structure of the tree should be established and there is a large enough potential canopy to support nearly a full crop (Figure 5). As in other years, it is necessary to maintain the upright growth of the leader, remove branches competing with the leader, restrict the growth of the branches on the upper trunk and, most importantly, direct the growth of the scaffolds outward. Be sure to eliminate competing scaffolds. Summer pruning will continue to be useful to remove vigorous competing growth that shades the “working leaves” on the fruiting wood.

Pruning the mature tree follows the same principles. A careful balance is required to restrict growth from the upper portion of the tree without serious reduction of the vigor of the central trunk. Heading back cuts may be necessary to maintain the tractor aisle and restrict overlapping of the trees. Care should be used when summer pruning so that tree vigor is not reduced excessively.

## IMPROVING PRODUCTION EFFICIENCY OF CENTRAL LEADER ORCHARDS

Cooperatively with three growers and one nurseryman, we are developing management procedures to improve the productivity of central leader trained peach and nectarine trees. Spacing and nitrogen fertilizer rates are being compared. The varieties included were Vinegold, Virgil, and Babygold 5 processing peaches and Harblaze and Fantasia nectarines. All were propagated on Bailey rootstock. The experimental plots were one acre in size.

Trees were spaced at either 1.4, 2.3 or 3.5 m (4.5, 7.5 or 11.5 ft) apart in the rows, which are spaced 5.5 m (18 ft) apart with 1329, 798 and 519 trees/ha (538, 323 and 210 trees/acre), respectively. The trees spaced 7.5 and 11.5 ft apart were pruned as 4-scaffold central leader trees as described previously. Trees at the closest spacing will be pruned as 2-scaffold trees (Figure 6). The concept of pruning is the same, but only two scaffolds will be permitted on the mature trees, both oriented into the aisle between the rows.

Nitrogen fertilizer application rates are 100, 50 and 25% of the amount recommended for commercial peach production in Ontario (Ontario Ministry of Agriculture, Food and Rural Affairs, 1998). It was applied at bud break as a granular fertilizer (ammonium nitrate) to the soil surface at the drip line of the trees in 1997 and 1998. No fertilizer was applied during the planting year, 1996. Recommended amounts of potassium fertilizer were applied in the same manner. Other orchard management and integrated pest management procedures were standard for commercial orchards in the area.

The trees were planted in the spring of 1996 and records of growth and fruiting have been maintained. Information presented is for only one variety, Vinegold, and at one cooperator’s orchard (Smith). It is representative of data from other varieties and at other orchard locations.

Tree growth in all varieties and orchards has been vigorous. The average height of the Vinegold trees at the Smith orchard at the end of the third growing season, 1998, was 3.35 m (11 ft) and the spread was 3.05 m (10 ft) (data not included). Trunk cross-sectional area (TCA) after the third growing season was affected minimally by rates of fertilizer application (Table 1). The sandy loam soils of the orchard site supported strong tree growth during the early development of the orchard with minimal rates of nitrogen fertilizer. No nitrogen was applied during the planting year. The TCA of the more widely spaced trees at 11.5 ft, tended to be larger than the TCA of the closer spaced trees at 4.5 ft. These differences in tree sizes occurred mainly during 1998 when competition among trees was greatest at the closer spacing (Table 2). Also, trees at the closer spacing were trained with only two scaffolds, which required the removal of more wood during pruning.

Accumulated yields per tree through the third growing season, 1998, were not affected by the rates of application of nitrogen fertilizer (Table 3). However, trees spaced at 11.5 ft produced slightly more fruit than those trees planted at 4.5 ft apart. This difference occurred during the third growing season (Table 4). Pounds of fruit per tree were positively correlated to tree size (Tables 3 and 4). Tree spacing had little effect on yield per tree during the tree development phase of the orchards. As the trees become older, spacing is expected to cause differences in tree size.

Yield per acre through the third growing season was affected by tree density more than by nitrogen fertilizer application rates (Table 5). Per acre yield from trees spaced 4.5 ft apart was double the yield of trees spaced 11.5 ft apart. Per acre yields increased dramatically from 1997 to 1998, as would be expected from a young orchard (Table 6). However impressive these data are, it is important to consider that the orchard remains in the growth stage and long-term production, especially as the trees mature, will be important. It will be necessary to continue to observe the growth and fruiting over the life of the orchard and to assess the economic feasibility to ascertain any real benefit for increasing tree density. Figure 7 shows the expected yields from central leader orchards and the actual yields that have been obtained through year 3.

## HIGH DENSITY FUSETTO ORCHARDS

We also are attempting to develop procedures for the production of peaches from high density orchards of vertically trained fusetto trees. As before, this is being accomplished with the cooperation of three growers.

Trees in these orchards are spaced 1.22 m (4 ft) apart in rows 4.36 m (14 ft) apart, giving 1924 trees/ha (777 trees/acre). The varieties being compared, Veecling, Babygold 5 and Babygold 7, all are nonmelting clingstone peaches for processing. Factors studied include variety, rootstock, trellis support systems, ground covers and pruning techniques. The experimental orchards range in size between .4 and 2 ha (1 and 5 acres). The orchards were established in 1996 and, except for the factors being compared, they have been maintained under cultural and integrated pest management practices that are standard for the area.

The training system used is an adaptation of the fusetto system that is similar to the spindle system used for apples. The tall and narrow cone-shaped trees have an upright central trunk terminating with an apical bud (Figure 8). There are numerous small scaffold branches spiraled along the dominant upright trunk.

At planting, the nursery trees were pruned the same way as the central leader tree described above. During the first growing season, it was important to obtain maximum leaf surface early. A minimal number of summer pruning cuts was needed to single out the leader and eliminate undesirable growth such as upright shoots. The following years, both late dormant and summer pruning were used again to single out the leader and to select and direct the scaffolds outwardly at regular intervals along the trunk. Scaffolds selected were 1) less than a third of the diameter of the central trunk, 2) oriented somewhat horizontally and 3) of medium vigor. They were encouraged to develop lateral secondary scaffolds and branches. Vigor was reduced by eliminating more upright growth in favor of lateral growth. Branches in the upper part of the canopy were shorter than those in the lower canopy to provide strong light conditions that encourage more vigor in the lower branches.

Pruning was always done in two stages. During the spring pruning, problem branches were eliminated. During the summer pruning, fine cuts assured proper spacing of the fruiting branches and directed the growth properly. These cuts restricted the tree growth and encouraged secondary growth from the scaffolds.

Our trees developed rapidly and quickly established a large enough canopy to support a crop (Table 7). Trees were taller than 1.83 m (6 ft) at the end of the first growing season and, by the end of the third growing season, they were taller than 3.35 m (11 ft) with a maximum width of 2.3 m (7.5 ft). As a result, accumulated yields through the third leaf were 12 tons/acre in the Rydal Park orchard (Table 8) and 6-8 tons/acre in the Belmor Farm (Table 9). Babygold 5 trees were more productive than either Veecling or Babygold 7 trees (Table 10), and production also was affected by rootstock. Veecling and Babygold 5 were more productive on the standard Bailey rootstock while Babygold 7 was most productive on Chui Lum Tao (CLT) rootstock. The data are from nonreplicated plots so variations in growth and production could be related to site variability.

Figure 9 compares the actual yield to the goals established for the experiment. During the first 3 years, production was near the goal. Fruit size, color and quality seemed to be normal for these varieties and quite acceptable for processing standards.

After the third leaf, the tree canopy appears to be established well enough to support a larger crop next year. Training procedures used have created the desirable upright tree canopy that exposes leaves and fruit to optimal sunlight conditions.

These high density orchards of fusetto trees have provided encouraging results through the developmental stage of the orchard. There remain serious concerns whether the trees can be maintained within the allotted space yet continue to be productive throughout the life of the orchard. However, the outlook for the 1999 crop is encouraging.

## CONCLUSION

Ontario peach orchardists have a strong need to develop and adopt training procedures that will promote better production efficiency. They have been encouraged by the benefits of central leader trained trees—primarily reduced labor costs. The central leader has changed the shape of Ontario orchards. Now, over two-thirds of the canopy remains close enough to the ground so that hand labor can be accomplished without the use of ladders. Attempts to improve the system likely will lead to orchards with closer spaced trees within the rows.

The fusetto high density orchard, if shown to be an improvement, will reshape Ontario orchards once again. The orchards of the future would contain upright and narrow cone-shaped trees with leaves and fruit well exposed to sunlight. New procedures and redesigned orchard equipment will be necessary for managing the orchards and harvesting the fruit.

The preliminary results from the high density fusetto orchards are encouraging.

## LITERATURE CITED

Miles, N.W. 1998. New training approaches for Ontario peach and nectarine trees. 127th Annual Report of the Secretary of the State Horticultural Society of Michigan. pp. 102-6.

Miles, N.W. 1992. Production efficiency of peaches on trellises. Compact Fruit Tree 25:87-89.

Ontario Ministry of Agriculture, Food and Rural Affairs. 1998. Fruit Production Recommendations 1998-1999, Pub. 360. pp. 15-26.

Table 1. Trunk cross-sectional area ($cm^2$) of central leader trained Vinegold peach trees after the third growing season in relation to tree spacing within the row and nitrogen fertilizer application rates (Smith Orchard).

| N fertilizer % of recommended | Tree spacing within rows (m; ft in brackets) 1.4 (4.5) | 2.2 (7.5) | 3.4 (11.5) | Average |
|---|---|---|---|---|
| | Trunk cross-sectional area ($cm^2$) | | | |
| 25 | 25 | 28 | 30 | 27 |
| 50 | 20 | 29 | 30 | 26 |
| 100 | 28 | 29 | 35 | 30 |
| Average | 24 | 28 | 31 | |

Table 2. Growth rate in the first three seasons of central leader trained Vinegold peach trees planted in 1996 at various within-row spacings (Smith Orchard).

| Date measured | Tree spacing within rows (m; ft in brackets) 1.4 (4.5) | 2.2 (7.5) | 3.4 (11.5) |
|---|---|---|---|
| | Trunk cross-sectional area ($cm^2$) | | |
| Planting | 1.9 | 1.7 | 1.7 |
| Fall 1996 | 6.7 | 6.6 | 5.6 |
| Fall 1997 | 16.0 | 18.9 | 18.5 |
| Fall 1998 | 24.0 | 28.4 | 30.0 |

Table 3. Accumulated yield (1997 + 1998) per tree from central leader trained Vinegold peach trees planted in 1996 related to tree spacing within the row and nitrogen fertilizer application rates, Smith Orchard.

| N fertilizer % of recommended | Tree spacing within rows (m; ft in brackets) 1.4 (4.5) | 2.2 (7.5) | 3.4 (11.5) | Average |
|---|---|---|---|---|
| | kg/tree (lbs/tree in brackets) | | | |
| 25 | 14 (31) | 15 (34) | 19 (42) | 16 (36) |
| 50 | 13 (29) | 17 (37) | 18 (39) | 16 (35) |
| 100 | 16 (35) | 16 (36) | 15 (34) | 16 (35) |
| Average | 15 (32) | 16 (36) | 17 (38) | |

Table 4. Yield per tree from central leader trained Vinegold peach trees planted in 1996 at various within-row spacings, Smith Orchard.

| Year | Tree spacing within rows (m; ft in brackets) 1.4 (4.5) | 2.2 (7.5) | 3.4 (11.5) |
|---|---|---|---|
| | kg/tree (lbs/tree in brackets) | | |
| 1997 | 3 (6) | 3 (6) | 2 (5) |
| 1998 | 12 (26) | 14 (30) | 15 (34) |
| Accumulated | 15 (32) | 16 (36) | 17 (38) |

Table 5. Accumulated yield (1997 + 1998) per acre from central leader trained Vinegold peach trees planted in 1996 related to within-row tree spacing and nitrogen fertilizer application rates (Smith Orchard).

| N fertilizer % of recommended | Tree spacing within rows (m; ft in brackets) 1.4 (4.5) | 2.2 (7.5) | 3.4 (11.5) | Average |
|---|---|---|---|---|
| | MT/ha (tons/acre in brackets) | | | |
| 25 | 18 (8) | 13 (6) | 9 (4) | 13 (6) |
| 50 | 17 (8) | 13 (6) | 9 (4) | 12 (6) |
| 100 | 21 (9) | 13 (6) | 8 (4) | 13 (6) |
| Average | 18 (8) | 13 (6) | 9 (4) | |

Table 6. Yield per acre from central leader trained Vinegold peach trees planted in 1996 at various within-row spacings (Smith Orchard).

| Year | Tree spacing within rows (m; ft in brackets) 1.4 (4.5) | 2.2 (7.5) | 3.4 (11.5) |
|---|---|---|---|
| | Tons/acre | | |
| 1997 | 1.5 | 0.9 | 0.5 |
| 1998 | 6.9 | 4.8 | 3.5 |
| Average | 8.5 | 5.8 | 4.1 |

Table 7. Growth of Fusetto trained Veecling peach trees, 1996 through 1998, in a high density orchard (4 x 14 ft, 777 trees/acre) (Rydal Park Farms).

| Year | Trunk cross-sectional area ($cm^2$) |
|---|---|
| At planting | 2.5 |
| Fall 1996 | 6.7 |
| Fall 1997 | 14.3 |
| Fall 1998 | 18.8 |

Table 8. Yield per acre from Fusetto trained Veecling peach trees in a high density orchard (4 x 14 ft, 777 trees/acre) as affected by pruning treatment at planting (Rydal Park Farms).

| | Pruning treatment at planting | |
|---|---|---|
| Year | Stub | Long |
| | MT/ha (tons/acre in brackets) | |
| 1997 | 9.4 (4.2) | 10.3 (4.6) |
| 1998 | 17.7 (7.9) | 16.8 (7.5) |
| Accumulated | 27.1 (12.1) | 27.1 (12.1) |

Table 9. Comparative yields per acre (1997 through 1998) from Fusetto trained peach trees of 3 different peach varieties planted in a high density orchard (4 x 14 ft, 777 trees/acre) in 1996 (Belmor Farms).

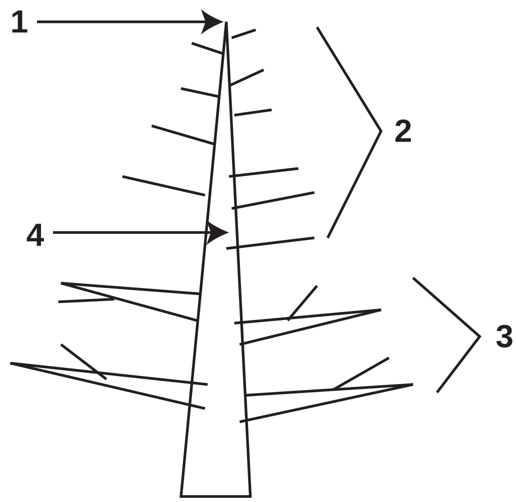
| | Variety | | |
|---|---|---|---|
| Year | Veecling | Babygold 5 | Babygold 7 |
| | MT/ha (tons/acre in brackets) | | |
| 1997 | 1.8 (0.8) | 1.6 (0.7) | 1.6 (0.7) |
| 1998 | 12.8 (5.7) | 16.8 (7.5) | 11.4 (5.1) |
| Accumulated | 14.6 (6.5) | 18.4 (8.2) | 13.0 (5.8) |

Table 10. Accumulated yields per acre (1997 through 1998) from Fusetto trained peach trees of 3 different peach varieties propagated on 3 different rootstocks and planted in a high density orchard (4 x 14 ft, 777 trees/acre) in 1996 (Belmor Farms).

| | Rootstock | | |
|---|---|---|---|
| Variety | Bailey | CLT[z] | TPT[z] |
| | MT/ha (tons/acre in brackets) | | |
| Veecling | 14.3 (6.4) | 9.4 (4.2) | 12.5 (5.6) |
| Babygold 5 | 18.4 (8.2) | 17.5 (7.8) | 15.7 (7.0) |
| Babygold 7 | 13.0 (5.8) | 17.5 (7.8) | 14.8 (6.6) |

[z] CLT = Chui Lum Tao; TPT = Tzim Pee Tao.

**Central Leader**




1. Apical Bud
2. Renewable Branches
3. Permanent Scaffold Branches
4. Central Trunk

**Figure 1. Diagrammatic sketch of the 4-scaffold central leader trained peach tree.**

**Year 1 (at planting)**

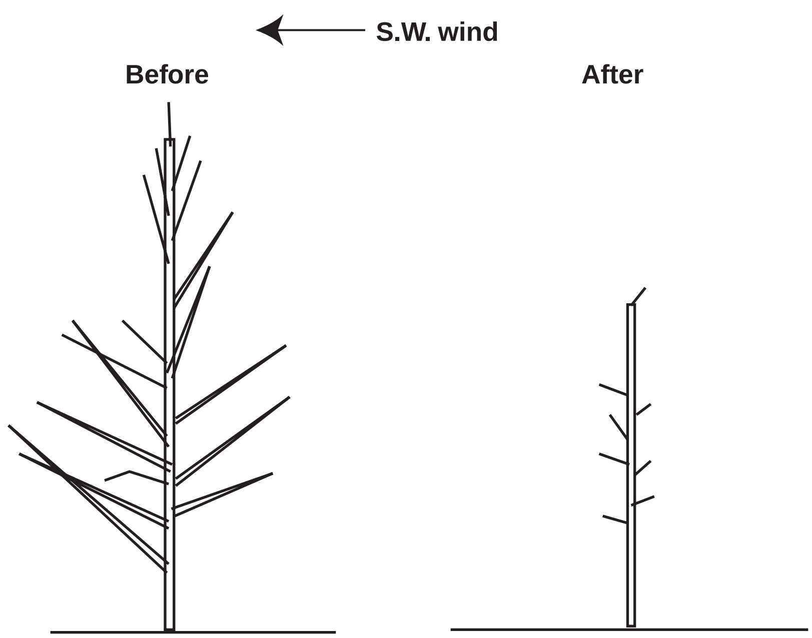



**Figure 2. A well-feathered nursery tree to be used to develop a central leader peach tree (left, before pruning; right, after pruning).**

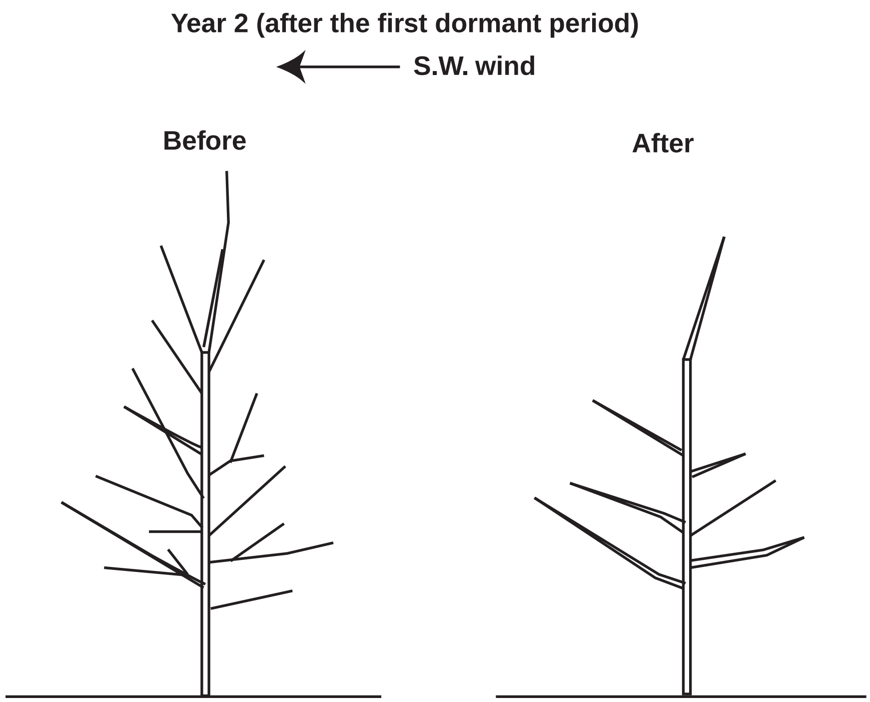



Figure 3. The central leader peach tree in year 2, after the first dormancy (left, before pruning; right, after pruning).

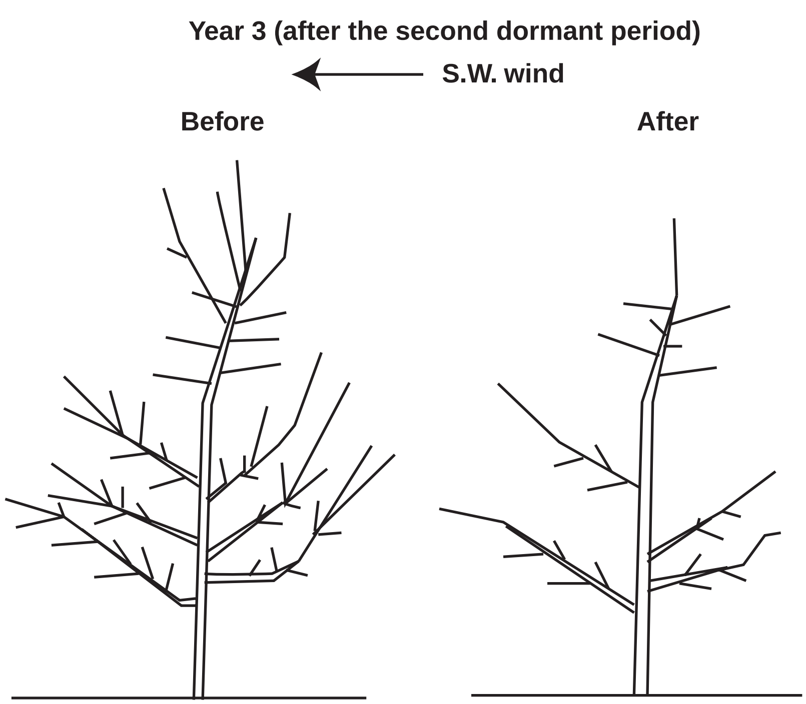



Figure 4. The central leader peach tree in year 3, after the second dormancy (left, before pruning; right, after pruning).

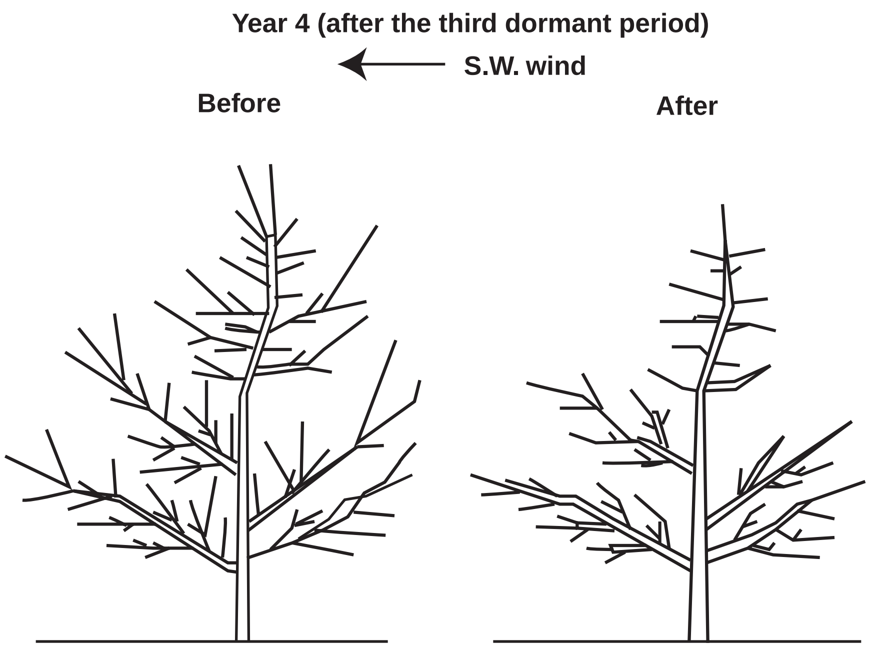



Figure 5. The central leader peach tree in year 4, after the third dormancy (left, before pruning; right, after pruning).

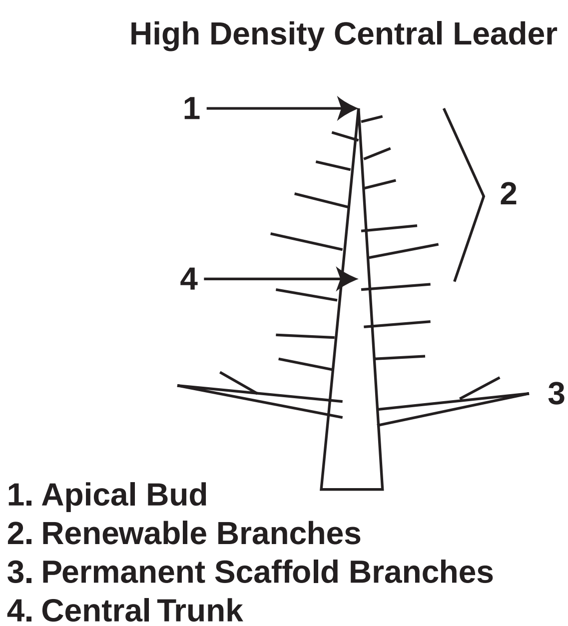



Figure 6. Diagrammatic sketch of the 2-scaffold central leader trained peach tree.

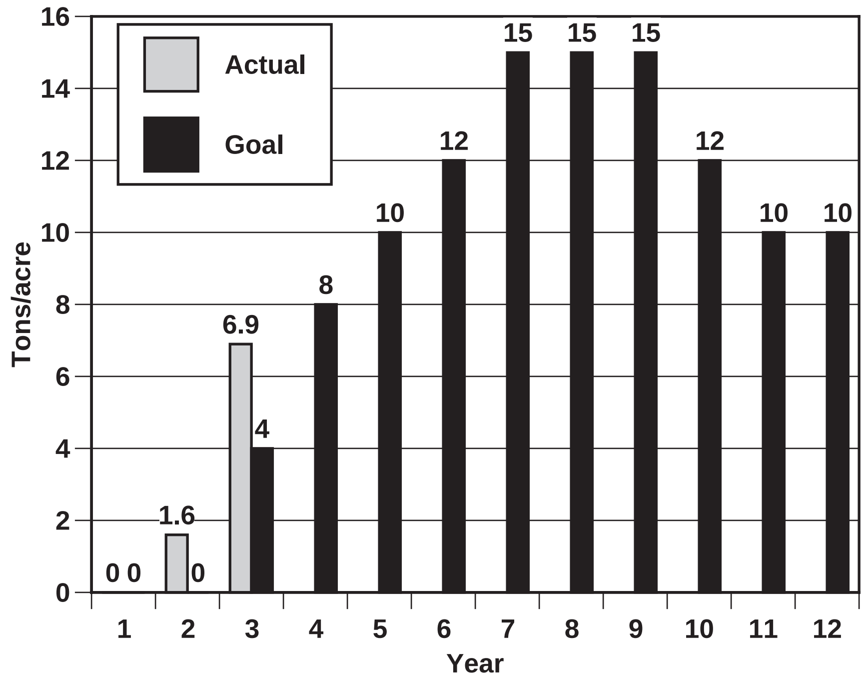



Figure 7. Expected goal for production in tons/a from central leader trained peach orchards over the 12-year life of the orchard vs. actual production obtained in years 2 and 3.

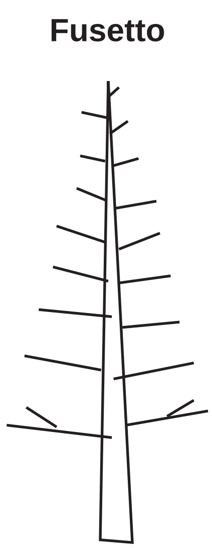



Figure 8. Diagrammatic sketch of the fusetto trained peach tree.

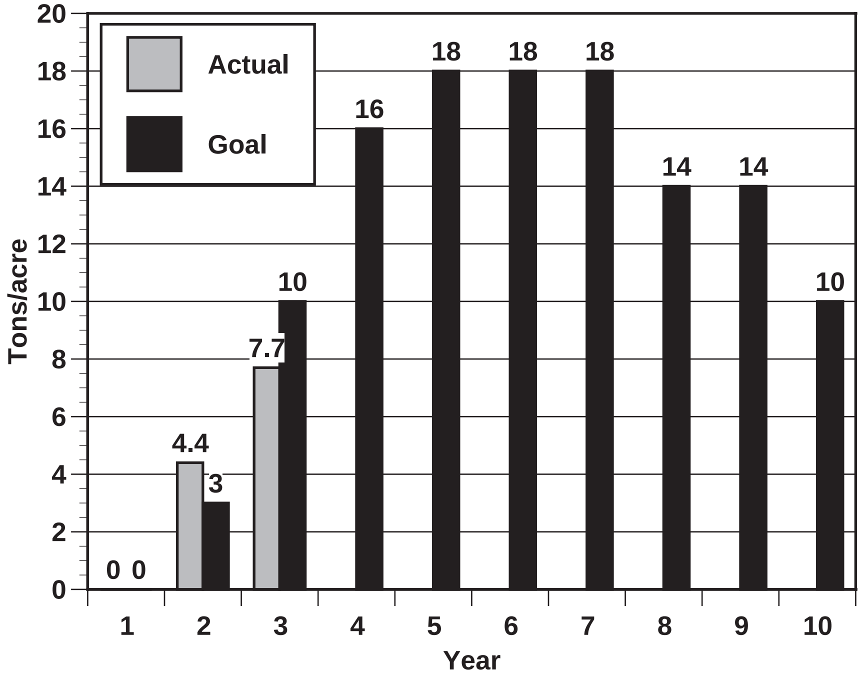



Figure 9. Expected goal for production in tons/a from Fusetto trained peach orchards over the 10-year life of the orchard vs. actual production obtained in years 2 and 3.