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Quote: Basically, in growing fruit you are farming light.

New Trends in Specific Variety Training and Pruning

John Wilton
Deciduous Fruits Specialist
AgFirst Consultants HB Ltd.
New Zealand

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This topic will be addressed from a New Zealand perspective, colored by experiences recently gained from working in Chile and in the Rio Negro, Argentina.

Basically, in growing fruit you are farming light. Satisfactory bud development and fruit quality will occur only in positions within the tree where light levels are adequate. In hot climates, fruit growers often have fear of sunburn and consequently maintain dense canopies to supposedly protect fruit from sunburn. My experience and observations indicate that even in hot climates trees need to be managed for good light penetration throughout the canopy. It is, therefore, critical that in the development of the apple tree you focus on the fundamentals of canopy management for quality fruit and not become sidetracked by the side issue of sunburn. Establish the canopy first, then make the subtle adjustments necessary to handle the sunburn issue.

In New Zealand, we pay fairly high wages, usually around US \$50 per day for orchard labor, so we have developed low labor input growing systems in order to remain competitive with low labor cost competitors.

Over the last 40 years, we have been growing medium density orchards on moderately vigorous rootstocks, using a central leader tree form. In that time our tree management system has evolved from a formal, stylized tree with intensive training and pruning to a minimal input system based as nearly as possible to the tree's natural growth habit.

Our present system is very similar to the French axis centrale (vertical axis) described by J. M. Lespinasse (1977, 1980).

OPTIMUM TREE FORM

When we plan an orchard, our objective is to grow the tree rapidly to fill its allotted space quickly, making as much use as possible of its natural growth habit. Once the tree occupies its allotted space, we have to settle it down into a mature tree growth/cropping balance and hold it at that size for the life of the orchard. We have found the slender spindle or central axis style tree well suited to these objectives.

During the development period, the leader is normally left unpruned from planting until it has grown at least one season beyond the desired mature tree height. For good results with this technique, the tree has to be disease and pest free and have moderately good vigor. In climates that experience high levels of heat during summer, or marginal winter chilling conditions, the natural bud break may not be sufficient to give adequate side laterals. Where this happens, use of dormancy-breaking products such as Dormex or the practice of delayed leader tipping when leader extension growth is 5 to 10 cm (2 to 4 inches) will stimulate side bud growth without destroying apical dominance. Leader tipping, where required, should be just into the previous year's shoot growth and should remove no more than about one-tenth of the last season's leader extension.

To grow an easily managed central leader tree, it is absolutely critical that strong apical dominance of the main leader is preserved. Dormant leader heading cuts stimulate strong competing side shoots with acute weak crotch angles. Such shoots make excessively strong side branches and require considerable tree training effort. Where the leader is left uncut, or delayed heading is practiced, distribution of side shoots is better and their strength relative to the leader is much weaker. Such shoots readily establish good tree balance and form naturally into well-positioned side branches without the need for labor intensive branch training.

During the first few growing seasons, lateral branches are continually developed along the central leader, commencing about 80 cm (32 inches) above ground level. Initially these laterals are thinned down to a density of 8 to 12 per meter of central leader extension in their first winter. I prefer not to make shoot selection during the growing season for the following reasons:

1. The need to maximize early trunk and root development by retaining as much leaf as possible.
2. Presence of surplus laterals widens the selection choices during the first winter and enables tree form to be more easily balanced.
3. Inter-shoot competition aids tree training by forcing lateral growth to lower rather than steeper gradients.

During each winter, unwanted side shoots are pruned out. These are selected on the basis of vigor relative to their position within the tree, taking into account crotch angle and gradient (upward branch angle) so that a well-balanced pyramid-shaped tree can be formed with minimal training effort. Toward the top of the branch hierarchy excessively strong laterals are removed. Lower in the tree weaker, smothered laterals are removed to end up with a natural pyramid shape. Strong, steep gradient branches are nearly always removed because, if left in, they will also force any laterals arising directly above them into steep gradients.

Sites which are exposed to a prevailing wind often require lateral branch opening during the first growing season to counter the effects of the wind. Sites not affected by wind will not need significant branch opening until late spring/early summer of their second growing season. By delaying branch training until this stage of growth, branch extension is maximized and stimulation of unwanted vertical shoots, which often occurs from branches trained flat in their first growing season, is minimized.

As these trees mature, a distinct tier of lower branches is established around 1 to 1.5 m (3.2 to 4.9 feet) above ground level. This tier usually contains 3 to 5 or 6 branches above which a gap of 0.75 to 1 m (2.5 to 3.2 feet) is established to allow light into these lower branches. The upper tree commences about 2 m (6.5 feet) above ground level and consists of a narrow spindle bush with numerous short, temporary fruiting arms arranged with decreasing size toward the top of the tree to maintain the pyramid shape. To maintain good fruit quality in the lower tree, light must penetrate into the lower tier of branches and therefore within the rows it is necessary to keep a gap between each tree.

Tree height and spread are determined by tree spacing and, to some degree, tree vigor. The ratio of height to between-row spacings at these latitudes should be 0.8 to 1:1.

TREE GROWTH HABIT

Training of a specific variety needs to recognize that variety's natural growth and fruiting habit. J.M. Lespinasse (1977, 1980) has studied the range of types found in apple varieties and classified them into four types on the basis of growth and fruiting habit (Fig. 1). Shoot gradient and the relative vigor of branches within the branch hierarchy and fruiting habit are the basis of this classification.

Fruiting habit and branch vigor behavior are perhaps the more important of these three characteristics when it comes to pruning and training trees. The two basic types of growth habit are referred to as:

1. Basitonic—dominant shoot growth from the base of the tree (Type I).
2. Acrotonic—dominant shoot growth from the top of the tree (Type IV).

These represent the two extremes in growth habit. Trees with strong basitonic tendencies have poor leader dominance, but very large lower branches, whereas those at the other extreme have dominant leaders and poor, weak lower branches. Most apple varieties fall somewhere in between these extremes and those with growth behavior in the middle range of both classification criteria are the most easily managed, e.g., Golden Delicious or Royal Gala, Type III.

Fruiting habit covers the range from predominantly spurs at the base of the 2- and 3-year-old shoots (Type I) to tip bearing (Type IV).

Once the growth and fruiting habit of a variety has been established, it is relatively easy to develop training and pruning strategies for it. The best way to establish the natural growth habit is to plant the tree and let it grow for 4 or 5 years without any pruning or training. By studying the way it grows in a disease and pest-free environment, it is then relatively easy to relate its behavior to known varieties and, from our experience of managing those varieties, develop an appropriate pruning and training method for the new variety.

PLANTING DENSITY

In recent years there has been an accelerating movement to closer planting in order to reduce the nonbearing period and give more easily managed orchards.

Once trees are planted at close spacings, the need to develop large structural side branches disappears and the main emphasis has to be on filling the allotted space with high quality fruiting wood while minimizing the proportion of the tree devoted to structure. At very close spacings, the central leader becomes the only structural branch in the tree and all side branches are merely replaceable fruiting laterals. For those of you accustomed to growing older style, widely spaced trees, there needs to be a complete re-thinking of tree pruning and training practices.

In the high density orchard, growing tree leader height quickly becomes the primary objective because there is little room for the tree to spread out sideways. At tree spacings below 1.5 m

(4.9 feet) in the row, a well-grown feathered tree from the nursery virtually fills its allotted space down the row when it is planted. To bring such a tree into production, all you have to do is make its leader grow to the desired height and yield enough fruitful side shoots to furnish the leader with fruiting wood.

Providing you have a good understanding of tree growth habit and plant physiology, it is possible to adapt the tree relatively easily to a slender spindle or central axis tree form suitable for plantings in the range of 4 to 5 m (13 to 16 feet) between rows and 1.5 to 3 m (4.9 to 9.8 feet) row spacing.

Incidentally, optimum orchard density is determined by tree vigor and that is a function of scion and rootstock vigor interacting with the depth and fertility of the soil on the orchard site. The latter can be modified to some degree by fertilizer and irrigation management.

Irrespective of tree density and site vigor characteristics, production of high yield and quality fruit is possible only from trees which have sufficient space to enable the correct balance between tree vigor and cropping to be established.

Well-balanced, mature fruiting trees need to make annual shoot growth in the range of 20 to 40 cm (8 to 16 inches), depending on the variety. Trees making in excess of 60 cm (24 inches) of annual extension are clearly too vigorous and need either more space or some form of vigor control to bring them into balance.

READING THE TREE

Careful study of the tree over the growing season to observe how it grows, which wood carries the best fruit, its vigor status and how it reacted to past pruning practice is what is meant by “reading the tree.” Next year this year’s annual shoot will look like a similarly positioned 2-year shoot does now and in 2 years’ time it is going to look like a piece of this year’s 3-year-old wood. By observing the tree in this manner, it is possible to build up a good understanding of how it will react to pruning and training.

PRUNING TO MODIFY GROWTH BEHAVIOR

Trees with basitonic characteristics tend to suffer weak leader development due to strangulation of the leader by excessively vigorous lower branches. In these trees better leader extension growth can be stimulated by:

1. Spreading branches along the leader.
2. Removing stronger lower branches.
3. Maintaining as much leaf as practical in the upper tree.

Conversely, acrotonic tendencies can be countered by removing large, vigorous, shading shoots from the upper tree.

EFFECTS OF SHOOT GRADIENT AND BRANCH STRENGTH

1. Upright shoots are most vigorous and least fruitful.
2. Flat and downward-pointing shoots have the weakest growth and most fruit but may have poor quality fruit.
3. For most varieties, the best fruits are carried on shoots which lie between the horizontal and gradients of up to 60° above the horizontal.
4. Branch vigor depends on its diameter relative to length and the other branches with which it competes. For easy management of the central axis, tree diameter of the leader in the developing tree needs to be 3 to 4 times the diameter of any side branch. In mature trees, branches which exceed diameters of around 3 cm (1.2 inches) per meter (3.2 feet) of length adjacent to the leader tend to become excessively vegetative.
5. The strongest shoots tend to arise from the highest point on a branch or where there is a sharp change in branch gradient.

RESPONSES TO PRUNING

Pruning removes established wood and stimulates new growth near the pruning cut. This new growth takes the place of potential fruit production.

Dormant season pruning into 1-year-old shoots destroys apical dominance, stimulates competing sharp crotch angled shoots immediately below the cut, but suppresses shoot growth and bud break further down the shoot. In contrast, unpruned shoots retain their apical dominance with a single strong shoot from their tip, providing there is no terminal fruit bud, and give weaker wide crotch angled shoots further down the shoot.

Spring pruning 1-year-old shoots after new growth begins stimulates more regular bud break down the shoot and avoids production of competing shoots immediately below the cut.

While pruning stimulates annual growth, its overall effect is to reduce tree size and rate of development. Late spring and summer pruning is more devigorating than dormant pruning.

Shortening of heavy branches stimulates stronger and more numerous annual shoot growth than similar pruning of weaker branches.

Complete removal of branches stimulates increased growth on those nearby shoots which remain, specifically those which may have been shaded by the branch which has been cut out.

Pruning of fruiting wood reduces total fruit numbers but increases size and quality of fruit which is carried on the remaining fruiting wood.

PRUNING AND TRAINING RULES

1. Choose wide-angled laterals for future structural branches.
2. Avoid leader strangulation by selecting shoots for side branches which are well spread along the leader.
3. Never shorten strong, upright laterals or branches—either prune out completely or wait until they have come down with crop weight, then shorten.
4. Control branch length and leader height by shortening to weaker side laterals.
5. Balance branch strengths by maintaining weaker branches at steeper gradients than stronger branches.
6. When a branch reaches its desired length, restrict further development by lowering its gradient and allowing its terminal extension growth to fall below the horizontal.
7. Spread branches after terminal growth ceases or in late spring/early summer.
8. Rotate fruiting wood on a regular basis.
9. Maintain open-textured fruiting canopies by pruning out obvious shading branches and those showing excessive vegetative growth.

MANAGING SUNBURN

In hot climates, localities where summer light levels are subject to sudden fluctuation due to weather conditions changing from cloudy weather to bright sunshine, sunburn damage to fruit is a major problem.

Damage is most severe in younger trees which have flexible branches and change their position during the growing season due to increasing fruit weight causing hitherto shaded fruit to be exposed suddenly to bright sunshine. Stabilizing flexible branches to prevent movement during the hot part of the growing season will reduce the problem. Once tree vigor comes under control as the tree becomes well furnished with fruit buds, shortening cuts to weaker, more flexible laterals

will stiffen them and stimulate more shoot growth to provide foliage to shade the exposed fruit. This needs to be done without stimulating excess vigor and shade. Delaying shortening fruit laterals until after flowering in the early fruit set period enables stronger growing laterals to be shortened without stimulation of excessive vegetative growth. Where tree growth is weak and lateral growth mainly of flatter gradient or horizontal, this shortening is best done during the dormant period.

REFERENCES

Lespinasse, J. M. 1977 and 1980. *La Conduite du Pommier I and II*. Publication du Centre Technique Interprofessionne des fruits et Legumes (CTIFL), 22 Ru Bergere 75009 Paris.

Figure Caption

Figure 1. Four apple tree growth habit types described by J. M. Lespinasse based on branch development (basitonic vs. acrotonic) and fruiting habit (spur vs. tip bearing).

