Manipulating apple tree structure to optimise fruit yield and quality

By Stuart Tustin, Ben van Hooijdonk, Ken Breen, Simon Middleton, John Wilkie, Heidi Parkes, Osi Tabing, Dugald Close and Sally Bound

Creating the perfect apple tree canopy structure can make a big difference to productivity and has been a key focus of the PIPS team. They share some of their findings here.

The Productivity, Irrigation, Pests and Soils program (PIPS) undertakes integrated research and development to increase the efficiency of apple and pear orchard production. It also aims to provide apple and pear growers with the knowledge to assist the long-term sustainability of their orchards.

The PIPS Tree Structure project aims to optimise orchard yields and fruit quality by increasing tree efficiency using new production techniques that help improve the performance of high-density orchards. The five-year research project investigates new management approaches aimed at increasing annual productivity, while enhancing fruit quality to meet premium market segments. New management systems will provide practical ways for growers to minimise inputs and increase labour efficiency.

Figure 1: *Six branches per metre of tree canopy height maximises productivity potential as shown in this canopy structure from spring 2012 (left) and of the same tree in spring 2013 (right).*

The PIPS Tree Structure project is cooperating with commercial orchards located in three Australian apple production regions: Huon Valley, Tasmania; Stanthorpe, Queensland and Goulburn Valley, Victoria. Some of the cooperating orchards are also active in the APAL Future Orchards® program to enable future extension activities.

A strong philosophical basis of the research approach in the PIPS Tree Structure project is to shift horticultural thinking to be more similar to the engineering world. We are investigating 'precision management' of crop production, where precise methods of crop load regulation are imposed early in the season to consistently achieve the target yield and fruit quality.

Part of this approach is to develop alternative and very reliable methods of crop load control that could provide growers with an alternative approach to chemical thinning.

PIPS progress

Over the next six months, a series of articles in Australian Fruitgrower magazine will describe new canopy and crop management concepts, why they are important for improving orchard productivity and the significant progress the PIPS Tree Structure team has made in testing their methods in orchard production systems. ▶

Figure 2: *A nicely orientated branch after tying down with string the previous growing season. Training of this branch to a slightly pendant position has encouraged the development of numerous spurs and bourse shoots along its length and has reduced shoot extension growth.*

The first steps towards a 'precision management' approach for tree canopy design and crop production is to determine the best overall tree structure needed to maximise productivity of an Australian apple orchard. It is important to optimise the structure of the tree canopy before attempting to introduce more detailed canopy manipulations. Therefore, optimising tree structure is the focus of this first article.

Branch density

In many orchards, a common problem is that more branches are kept within the tree canopy than are necessary. In addition, pruning often does not remove excessive and high-vigour branches as trees transition from young canopies into their mature size. Retaining too many branches and/or strong branches for too long creates shading that not only reduces fruit quality, but limits the retention and replacement of fruiting spurs and branches. During winter pruning, our recommendation to optimise branch density within central leader trees on dwarf or semi-dwarf rootstocks is to **retain six branches per metre of tree canopy height, beginning from the lowest-most branch** *(Figure 1)*.

Branch orientation

Branch vigour and fruitfulness are modified by branch orientation. To get the best results our recommendation is to train branches to a slightly pendant position (i.e., 5-15° below horizontal) to reduce vegetative growth and maximise productivity potential *(Figure 2)*. Preferably, branches should emerge from the trunk slightly pendant too, to help subdue vigour *(see Figure 1)*.

Tree height

One of the most common causes of loss of vigour control, shape and productivity of mature apple tree canopies occurs when attempts are made to control the height of trees during winter or summer pruning. Although pruning produces an immediate reduction in tree height, trees respond by producing vigorous shoot growth in subsequent seasons.

A better method to control tree height is to promote high and regular annual

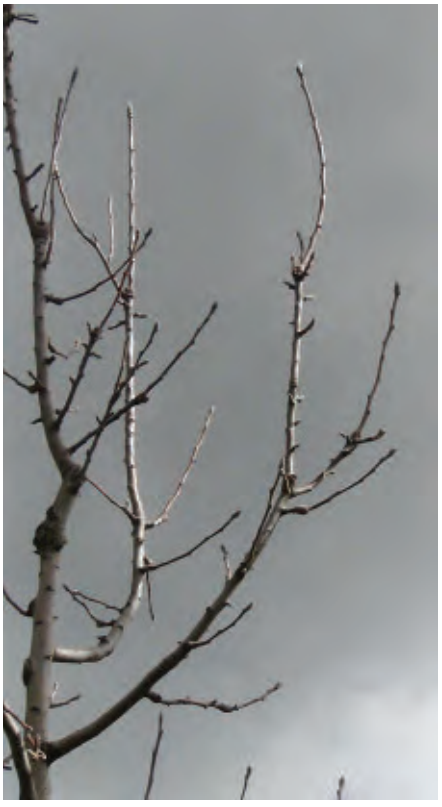

Figure 3: *A badly orientated branch. Vertically-oriented branches have more vigorous shoot extension growth and much reduced spur and bourse shoot development along the whole length of the branch.*

Figure 4: *Tree height control achieved by regular annual cropping and using "fruit load" rather than a "heading cut" to control tree height. This canopy has subdued vigour, requires minimal winter pruning and will be highly productive.*

Figure 5: *Tree height control using a heading cut made in the previous winter has caused excessive annual shoot growth, shading, fewer fruit buds and lower cropping potential in the upper canopy*

cropping by appropriate training and maintenance of the tree branch population. Tree vigour is directly related to the crop load borne each year. Training upper canopy branches into a slightly pendant orientation (5-15° below horizontal) creates high cropping potential and a redistribution of growth that reduces overall vigour. Our recommendation is to **maintain high cropping performance annually to dramatically reduce overall tree vigour and growth in the top of the tree, resulting in less pruning and a much quieter tree canopy (compare Figures 4 and 5). We also recommend avoiding the use of heading cuts to reduce tree height** *(Figure 5)* **because they promote vigour.** :afg

Summary of key points:

- Orchard tree canopies often contain more branches than is necessary for high cropping potential and optimum fruit quality.
- During winter pruning, a simple metric for optimising tree branch density is to retain six branches per metre of effective tree canopy height. Additional branches in the canopy are likely to increase shading, reducing the quality of fruit buds and fruit.
- Training branches to a slightly pendant position (5-15° below horizontal) reduces excessive vegetative growth and promotes the development of high-quality fruit buds.
- Branch training and cropping management are the most effective tools to control tree height and vigour.

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