New directions in crop load management

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As we are aware, optimal management of crop load is a difficult task and most orchardists find the spring period very stressful as they try to juggle the currently available tools for crop load management with unstable weather conditions in an effort to maintain regular yields, consistent production of high quality fruit and high pack-out percentages.

The current recommendations of a combination of dormant pruning to remove weak spurs and unbalanced limbs to open up the tree, followed by the use of chemical thinning during flowering and the early post-bloom period can be successful. However the responses from chemical thinning are often unpredictable, leading to the need for considerable hand-thinning that is both expensive and time consuming. The end result is often reduced fruit quality and sub-optimal return bloom the following year.

Under the umbrella of the Australian apple and pear industry five year Productivity, Irrigation, Pests and Soils (PIPS) flagship program funded through Horticulture Australia Limited (HAL), researchers from New Zealand, Queensland, and Tasmania are working together to optimise tree function by manipulating structure – this is the Tree Structure component of the PIPS program.

Tree Structure research team:

- PFR (NZ): Dr Stuart Tustin, Dr Ben van Hooijdonk, Ken Breen
- Agri-Science Queensland (DAFF): Dr Simon Middleton, Dr John Wilkie
- TIA: Dr Dugald Close, Dr Sally Bound.

The Tree Structure project is undertaking similar studies in multiple environments across Australia. This component of the program aims to improve orchard productivity and optimise fruit quality by improving tree functional efficiency as part of the ongoing drive in development of high density orchard systems.

Outcomes of the project will include management strategies for Australian growing environments and provision of tools and systems for manipulating tree structure that can be used to optimise orchard productivity.

Apple varieties under investigation are 'Royal Gala' and 'Cripps Pink' in the Huon Valley, Tasmania; Stanthorpe, Queensland; Lenswood, South Australia – Year 1 only; and Shepparton, Victoria – Years 2-5; and the new cultivar RS103-130 in Queensland.

The program has now been running for three years. Fruiting efficiency on different bud types was examined in Year 1, and Years 2-5 are focussing on comparing precision-managed and conventionally-managed trees with equivalent crop loads over a four year period.

Floral bud type and fruit quality

The objective in Year 1 (2009-10) was to quantify the genotypic expression and regulation of fruit traits of the principal Australian-grown apple cultivars, 'Royal Gala' and Cripps Pink', in three locations with differing environmental stresses: Stanthorpe, Adelaide Hills and Huon Valley. The potential new cultivar RS103-130 was also included at Stanthorpe.

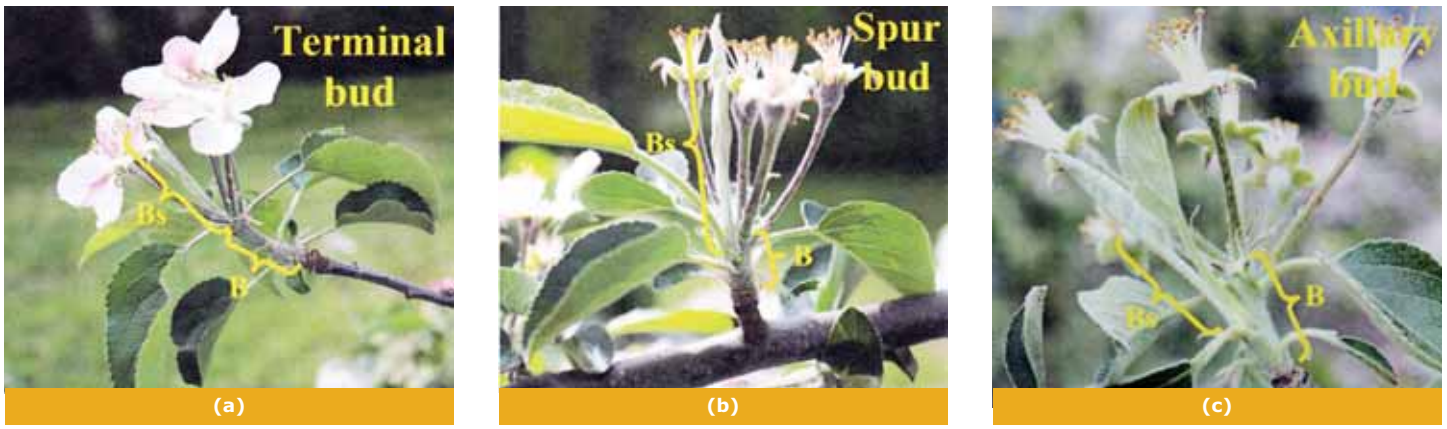
Results from the first year studies have clearly demonstrated that not all flower buds are equal when it comes to fruit size. Axillary flower buds (on 1st year wood) always produce smaller fruit. In 'Cripps Pink' fruit size was greatest on terminal buds across all regions. No difference in 'Gala' fruit size was noted between spurs and terminals in South Australia, but in Tasmania and Queensland terminals produced bigger fruit than spurs.

The greater fruit size potential of terminal floral buds appears to be associated with a greater leaf area and photosynthetic potential.

Precision management versus conventional management

Artificial Spur Extinction (ASE) is a tree training and bud thinning method which precisely defines where and how much fruit is set on the tree. The aim of ASE is to promote the vigour and performance of floral spurs, stimulate spur strength and improve fruit quality and regularity of production.

The initial setup of trees for ASE involves removal of unbalanced (large) limbs and training of remaining limbs to a slightly pendulous or drooping position, which optimises fruiting whilst restricting excessive vegetative growth. Floral spurs are then selectively removed while ▶



Developing bourse (B) and bourse shoot (Bs) of (a) floral terminal buds on short to medium one-year-old shoots, (b) floral spurs on two-year-old wood or older, and (c) floral axillary buds on one-year-old shoots (Photos courtesy Ben van Hooijdonk, PFR NZ).

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trees are still dormant to precisely define the density and location of potential fruit on the tree.

This means that at bud burst ASE trees will be carrying smaller numbers of stronger fruit buds than a conventionally pruned tree, hence the tree can direct more energy into these buds and potentially carry a greater crop load of quality fruit.

Once set up, ASE orchards should require less annual maintenance of vegetative growth and produce more consistent fruit set each year.

Influence of tree structure on fruit set

We have now had two seasons of the ASE cropping management component of the program. Data are still being analysed for the second season, but results from the first season are looking good. Return bloom was adequate to provide full crop load potential even though chemical thinning was avoided in these trees.

Under conventional tree management the proportion of spur and terminal buds that fail to set any fruit can vary from 30 to 50 per cent. In the ASE treatments, fruit set was increased in individual floral buds, and this response was seen most clearly at the lower floral bud densities. The number of spurs not setting any fruit was reduced to as low as 10 per cent, and the number of doubles increased.

Where to from here?

If fruit quality and yield continue to be equivalent or better under the ASE production system over the remainder of the trial period, then ASE may provide a potential alternative production technique. Using ASE to precisely adjust potential fruit numbers before bud-break will enhance fruit set on selected buds.

Once trees are set up, pruning requirements will be reduced with only light maintenance pruning each year, and hand-thinning will be reduced to breaking up clusters to singles. Thus the need for chemical thinning will be removed.

The consequences are more reliable yields and yield-estimations early in the season, and production should be less labour intensive – a major advantage when labour is one of the biggest expenses in production.

Information on how to set up trees using ASE will be provided through the Future Orchards™ program over the next couple of years.

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'Gala' tree (Shepparton site) prior to pruning

'Gala' tree (Shepparton site) post pruning

In the interim

Ensure your thinning program starts in the dormant period with pruning to remove unbalanced branches and weak spurs, allowing for development of new wood. Tie branches down to reduce vigour.

Use a combination of bloom and post-bloom chemical thinners as previously recommended. Remember that the chemical thinning program needs to start early in the flowering period using the chemical/s of your choice. Available blossom thinners are: ethephon, NAA or ATS (ammonium thiosulphate). There are two post-bloom thinners registered in Australia: 6-benzyladenine [registered as Maxcel® (Valent BioSciences), BAPSol® (Gro-Chem NZ), Exilis® (Fine Agrochemicals Limited)]; and carbaryl/thiram.

Under our present tree management systems, despite the limitations of chemical thinners, a chemical thinning program produces markedly superior results to hand thinning, both economically and in terms of tree physiology. The most effective chemical thinning programs combine blossom and post-bloom thinners.

A sequential spray program allows lower quantities of chemical to be used at each timing, thus reducing the risk of over-thinning. If the chemical thinners have been effective then all that should be required is a subsequent light hand thin to remove damaged fruit or break up any remaining bunches.

To achieve good thinning and fruit quality, all chemical thinners need to be applied at the appropriate physiological stage and under the climatic conditions which are best suited to each chemical. A non-ionic surfactant such as Kendene® (Tween 20) is recommended with all thinners, except for carbaryl/thiram. Choice of thinning chemical is important as some cultivars do not respond well to some chemicals. The currently recommended chemical/cultivar combinations are shown in *Table 1.*

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Table 1: Recommended chemical/cultivar combinations for Australian conditions.

	Delicious Delicious	Golden	Fuji	Granny Smith	Gala	Pink Lady	Sun-downer
NAA – primary thinner	✔	✔	✔	✔	✔	✔	–
ethephon – primary thinner	✔	–	✔	–	–	✔	✔
NAA - 3-7 d after NAA @FB	✔	✔	✔	–	✔	✔	–
ethephon - 5-7 d after NAA @FB	–	✔	✔	–	–	–	–
ATS - primary thinner	✔	✔	✔	✔	✔	✔	✔
Carbaryl/thiram - secondary thinner	✔	✔	✔	✔	✔	✔	✔
Benzyladenine (BA) - secondary thinner	✔	✔	✔	–	✔	–	–
Dormex - dormancy breaker	✔	✔	✔	✔	✔	✔	✔
Waiken - dormancy breaker	✔	✔	✔	✔	✔	✔	✔