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Intensive apple orchard systems

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In 2006–2008, the peak industry body Apple and Pear Australia Limited, conducted an educational workshop series for apple and pear orchardists called 'Future Orchards 2012'. The aim of the two-year project was to provide growers with the knowledge, skills and confidence to plant new orchards to intensive systems. Technical content for the project was provided by the consultants AgFirst New Zealand and other invited Australian and international speakers.

This Primefact is a brief summary of some of the topics presented to orchardists as part of the orchard walk program in NSW.

What is an intensive system?

In Australia, apple orchards that have a minimum 2500 trees per hectare and are planted on dwarfing rootstocks are considered to be intensive systems.

An example of this density is 4 m between rows, with 1 m between trees in the row (2500 trees per hectare).

On flat ground, row widths of 3 m are possible with suitable machinery. A 3 m x 1 m planting is equivalent to 3333 trees/ha.

Some growers are also experimenting with closer in-row spacing, as close as 0.5m.

What are the advantages?

Worldwide, orchards have been grown at high densities for at least 20 years. Europe has been the leader with these systems for many years because of the limited availability and high value of land suitable for horticulture.

Under Australian conditions, the main drivers for adopting high density systems are as follows.

- Earlier production, aiming for commercially acceptable yields from the third year, rather than years four and five
- Higher overall yield potential per hectare
- Easier canopy management, as pruning systems are simplified
- Higher and more uniform fruit quality
- Earlier return on investment
- Ease of management of seasonal workers, as less training is required for key tasks such as pruning
- Ease of picking, as fruit is easy to see, and ease of access to the canopy.

A well managed high density (3.5 m x 1 m) planting, four years old. This is equal to 2857 trees per hectare.

Disadvantages

- High up-front establishment costs, mainly due to the increased tree cost per hectare.
- Requirement for a dramatic change in orchard management practices and mind-set. This may take some time to get used to for established producers who have grown trees under other systems.
- Higher requirement of care for young trees to ensure earlier production.
- Secure access to irrigation water and good delivery infrastructure is essential. At least six megalitres of water per hectare of orchard is recommended.
- May also require additional costs such as hail or bird netting, to ensure a crop each year and offset some financial risk.

Getting started

It is essential to check on a few factors when deciding on the orchard site. These are really no different to what has always been recommended for orchard establishment.

Site factors

- *Frost risk.* Apple growing districts are often prone to frost in spring. Avoid planting at the bottom of slopes or in hollows where cold air is unable to drain. Be careful near shelter belts, as these can prevent cold air from draining away, causing frost pockets. Avoid frost prone areas as they would severely limit the productive potential of an orchard.
- *Aspect.* Avoid planting on slopes facing south, as these are colder and are often frost prone. In addition, they may not be warm enough in spring for bees to actively pollinate the flowers. North facing slopes are the ideal as they capture more light and are warmer.
- *Wind.* Windy sites can create several problems such as fruit damage, increased evaporation and pollination issues. Windbreaks may help in slowing down wind speed, but can impact on the crops by casting shade and, if trees are used, robbing soil moisture from the orchard. Tree windbreaks can also be a haven for birds that can attack the crop close to harvest.
- *Slope*. Sloping sites can be a safety issue, and side slippage of equipment such as tractors and spray rigs can damage trees. Never plant rows across a slope on sites that are steep enough to be a roll-over risk for machinery.

Soil

Soils should be well drained, with a good capacity to hold moisture. Most apple orchards in NSW are sited on clay textured soils, which are derived from basalt, granite or alluvial parent materials.

Soils in apple growing regions are commonly clay-loam, silty clay-loam or sandy clay-loam textures.

Most soils in these classes have both a good water and nutrient holding capacity, but are free draining enough to avoid root rot problems

Soil pH for apples should be between 5.5 and 6.5. Soils with lower (acid) pH need to be amended and checked again well before planting.

Nutrition

Soil nutrient deficiencies will negatively affect the growth of young trees. Sites for orchards should always be checked by soil testing to ensure that soil pH is acceptable, that there is not a salinity problem and that there are adequate macro and trace nutrients present. Highly acidic soils often have problems with aluminium toxicity.

Problems with pH, nutrient deficiencies and/or toxicity must be fixed well before trees are planted, as it is difficult to do so once trees are in the ground.

See Primefact Apple and pear nutrition for more information.

Replant disease

Apples are prone to a disease complex known as Specific Apple Replant Disease or SARD. When apples are grown in ground that has been used previously to grow apples, a range of soil fungi and sometimes nematodes build up in the soil. These pests will severely limit the ability of young trees to grow well on the site.

Re-plant sites should always be treated prior to planting. The most effective options are:

- Treatment with a chemical fumigant. (Note that in NSW most fumigant chemicals must be applied by a licensed fumigation contractor.)
- Growing a bio-fumigant crop such as brassicas or mustard, and ploughing in the crop to release the active isothiocyanate compounds to fumigate the soil. There are a few branded seed blends that have been tested to produce high levels of active fumigant compounds.

Some growers prefer to prepare old ground by allowing the site to lay fallow for several years, adding organic matter either as composts or ‘green manure crops’ or adding DAP fertilisers. Although these will improve the soil, they have not been proven to be as effective as fumigants or bio-fumigants in controlling replant disease pests and pathogens.

Selecting plant material

The success of high density orchards depends on tree selection and quality. It is essential that precocious, dwarfing rootstocks are used in the intensive system to control vigour in close plantings.

In NSW the most commonly used dwarfing stocks are M9 (Malling 9) and M26 (Malling 26). There are several clone variants of these in the country, with different amounts of vigour, so check with the nursery which clone is most suitable for your conditions.

See Agfact H4.1.10 Apple rootstock identification for more information on rootstocks.

M9 is the most dwarfing of the two stocks. Although it is the less vigorous of the two stocks, it is considered to be more tolerant of apple replant disease than M26, probably due to its greater tolerance of *Phytophthora*. It is not considered suitable for some varieties as it can be too dwarfing.

M26 is more vigorous than M9, and is also a popular choice for growers using re-plant sites because of its higher vigour. However, it seems to be less tolerant to replant disease than M9 once in the orchard because it is susceptible to *Phytophthora*. M26 may be more suitable for varieties such as Fuji, where M9 is too weak.

MM106 traditionally has been the rootstock of choice for apple replant sites due to its high vigour, good anchorage and tolerance of woolly aphid. It is not considered to be a suitable rootstock for modern high density orchards in NSW with fertile soils. MM106 blocks with vigorous scion varieties often become unmanageable under NSW conditions early in the life of the orchard.

Virus tested and certified material

At present, most stocks of M9 and M26 available in Australia are from older selections that have not been virus-tested. These stocks may carry viruses that can limit growth potential.

The Australian Pome Fruit Improvement Program has virus tested M9 and M26 clones at certified nurseries, but the supplies are limited. Where virus tested ‘Certified’ stocks are available, these should be the first choice of the grower when using virus tested scion varieties.

Nursery tree quality

Well feathered nursery trees are the ideal tree form that should be purchased where possible. Growers who plant feathered, two year old trees in preference to rods are better able to maximise canopy growth in the first two years of orchard establishment.

The graft union should be between 10 and 20 cm above soil level, and branches should not be closer than 80 cm to ground level (roughly hip height).

Branches should be well spaced up the main trunk, and the leader and side branches should be intact and not damaged.

There should be at least six feathers, preferably more. Ensure that there is sufficient root volume on each tree and these roots are healthy and free of root diseases.

Well-feathered ‘knipp-boom’ style nursery trees at planting.

To get the best quality trees possible from the nurseries, orchardists must order trees well in advance (minimum two years). A list of specifications should also accompany the order so that both nurseryman and grower have clear expectations of what the end product will be at delivery. Some nurseries also welcome visits to inspect the trees whilst they are growing in the nursery.

Young trees must be irrigated regularly from planting onwards to reduce transplant shock.

Tree support structures

All orchards planted on dwarfing rootstocks will require the installation of tree support structure, as the root systems of the dwarfing stocks are weak.

A trellis is the most common support system used in NSW. Ideally the trellis should run north to south to maximise sunlight and reduce shading.

Height

High density trees need to be allowed to grow to a height within half a metre of row width, to fully maximise the cropping potential of the block. For example, a block with 4 m between rows can support trees up to 4 m tall.

Trellis posts and wires must be tall enough to allow for this, otherwise cropping potential will be limited as the tops of unsupported trees can snap under the weight of the crop.

Load rating

Trellis systems must be designed to support in excess of 70 tonnes of fruit per hectare. In New Zealand and Europe, orchards are capable of producing 100 tonne crops.

Many trellis systems in Australia would struggle to carry a 40 t crop as the trellis is too short, and posts are spaced too far apart within the row. Under a heavy crop, trellis failure and tree damage are a real possibility on older designs when there are strong winds.

A strong, modern high density orchard trellis system will have a maximum distance of 10 m between support posts. The design of end assemblies depends on the soil type.

Crop wires

Crop wires are an important part of the trellis. Ideally the lowest two wires will be installed when trees are planted, to allow them to be supported immediately. Usually the first wire is 50 cm to 1 m from the ground, and is often used to support irrigation lines.

From this point upwards, a crop wire at least every metre is required. Half a metre is better, but this may limit the ability of workers to move through rows. Wires should be added as the trees grow, to avoid growing tips rubbing on wires and being snapped on windy days. Placing wires on alternate sides of the tree trunks provides additional support.

Tree trunks are attached to the wires either by flexible ties or staples. Crop wires can also be used for branch training.

Bird and hail netting

If protective netting is going to be installed, the support structure can be modified to incorporate the tree trellis.

Most netting companies also provide a design service as part of the construction cost. Growers should thoroughly discuss their needs and future plans with the company at the design stage to ensure the best design is built.

Planning for pollination

Apples are usually self-infertile and require honey bees for pollination and successful fruit set.

Traditionally orchardists have used other commercial fruiting varieties as pollen sources in the orchard. For ease of picker management, these were often arranged in full row systems, so that one variety could be easily separated from the other within the block.

In close plantings and under netting, bees will naturally fly down rows and not across them. This effectively limits the success of pollination from full row systems. A staggered polleniser layout, where pollenisers are planted evenly throughout the rows is thus more effective.

See Agnote DAI/132 Pollination of apples by honey bees and Agnote 4/77 Crab apples as pollinators for more information.

To avoid mix ups at harvest in a staggered system, crab apple varieties are now the preferred pollenisers. Crab apples are preferred by orchardists for the following reasons.

- There is minimal risk of varietal mix-up at harvest by pickers as crab fruits are usually small.
- They can easily be placed in a staggered layout within the block for better pollination performance under hail netting
- Because they only need to grow blossoms and leaves, only one year old wood is needed and pruning is simple.
- They can be planted right next to a trellis post to save space. Many growers now plant a crab apple at every second trellis post in a staggered arrangement across the block. This allows for rapid identification of the pollenisers at pruning time and at thinning, where crab-apple fruit can be stripped if required.
- By only having one commercial variety per block, chemical and fertiliser management can be simplified, and the block treated as one unit.

Pruning and training

Growing trees in a high density system requires a new approach to pruning and training.

In close plantings there is no room for heavy, less productive wood. There are no scaffold branches in these systems. Branches need to be simple, and made of lightweight, calm, fruitful wood to maximise productivity. Trees need to quickly fill their space in the first two years to get production income. Once the space is filled growers need to prune in a manner that will calm the tree. (A ‘calm’ tree is one with moderate vigour and balanced leaf and fruit growth.)

Tree architecture

The ideal tree shape for close plantings is a narrow cone. The tree will have a single trunk, with fruiting limbs (units) arranged evenly from hip height to the top.

Trees should have one dominant leader. Ideally the leader is not cut until the tree grows too tall, and is then only cut back to a suitable replacement shoot to maintain apical dominance. The tops of the trees are separate from each other and form a sawtooth pattern.

In a well managed block it is possible to see through the row to other trees behind it. If this is not possible, there will be insufficient light entering the canopy and poor fruit colour will result.

This tree structure is often described as a 'super spindle' in overseas literature.

Branch management and training

Fruiting limbs that are half the diameter of the trunk or more are less productive and more likely to grow unwanted leafy shoots. These are removed flush at the trunk. The '3:1 rule' is too severe in high density systems, and if used will cause productive wood to be removed too soon from the system.

Fruiting limbs that hang below horizontal (the 'pendant position') are the key to calm trees with good vigour control. The hormones that promote fruit production are more dominant in branches hanging in this position. They will be highly productive and much less leafy than if left to grow upright.

Although lightweight wood will naturally tend to fall into the pendant position under the weight of a crop, limbs can also be tied down into this position to achieve vigour control sooner. This is done after branch elongation stops, in late summer to autumn on branches that are at least one metre long.

Tying down limbs that are too small will stunt the growth on the limb. Twisting the branch as it is gently bent downward will reduce the risk of snapping it off at the trunk.

Pruning

Ideally fruiting units will be a single lined branch with short, light laterals or 'pencils' coming off them. Forks in branches are not encouraged.

Branches are not tipped or 'headed' as this creates vigorous leafy regrowth, and multiple shoots at the pruning site. These branches also stiffen up and often require removal the following year as they are not easily manipulated into the desired position.

Laterals growing on the tops and undersides of the fruiting branch in the 'twelve o'clock and six o'clock' positions are removed at pruning time, as they contribute to shading within the tree canopy.

A line-pruned 'Cripps Pink' tree near harvest time, with evenly spaced fruit along each branch. All branches one metre or longer are in the pendant position and fruit and leaf growth are balanced.

This pruning technique is used extensively in New Zealand and other countries and is known as 'long pruning', 'line pruning' or 'straight lining'.

Further reading for Australian commercial orchardists

Extensive workshop notes and grower resources from the 'Future Orchards 2012' program are available to levy paying members on the member's portal of the APAL website www.apal.org.au

A registered user name and password are required to access the portal.

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