Getting New Orchard Plantings to Perform

prepared by
Craig Hornblow and John Wilton
AgFirst

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As we stressed in our first Future Orchards 2012 orchard walks, the key to making orchard development successful is rapid and full fruiting canopy development.

The major cause of low orchard productivity is "too much air between the trees". In young orchards, vigour is your friend until the trees' allotted space is filled. There are many ways to manage vigour, and bring it under control, but few, if any, ways to make stubborn trees that have stalled grow well.

Once you have determined the optimum tree spacing for your particular block, the main objective then is to fill the tree canopy volume with efficient fruiting wood rapidly.

Maximum orchard productivity occurs when the canopy captures in excess of 60% mid season light interception.

For single row intensive systems tree height needs to match between row spacing to maximize yield in our latitudes. Multirow "V" systems may reach full potential at lower heights. Hopefully the data being gathered in this project will confirm this.

Estimates of tree row volumes required for maximum yields are:

Intensive orchards	> 1,900 trees/ha	10,000 to 12,000 m3/ha
Semi-intensive orchards	1,000 to 1,900 trees/ha	12,000 to 15,000 m3/ha
Extensive orchards	< 1,000 trees/ha	18,000 to 20,000 +m3/ha

Trunk cross sectional area in developing orchards gives a stronger relationship with yields potential. Full production is achieved when total trunk cross sectional area (TCA) per hectare is in or above the 50,000 to 60,000 cm2/ha.

The table below shows individual tree size at various tree densities required to achieve these levels of TCA/ha.

Tree density/ha	**50,000 cm^2**	**60,000 cm^2**
Single Rows		
666 (5 x 3 m)	75 cm^2	90 cm^2
1250 (4 x 2 m)	40 cm^2	48 cm^2
1500 (3.7 x 1.8 m)	33 cm^2	40 cm^2
1900 (3.5 x 1.5 m)	26 cm^2	32 cm^2
2020 (3.3 x 1.5 m)	25 cm^2	30 cm^2
2424 (3.3 x 1.25 m)	21 cm^2	25 cm^2
3030 (3.3 x 1.0 m)	16.5 cm^2	20 cm^2
Double Rows		
2222 6 m x (1.5) twice	22.5 cm^2	27 cm^2
2667 5 m x (1.5) twice	19 cm^2	22 cm^2
3333 6 m x (1) twice	15 cm^2	18 cm^2
4000 5 m x (1) twice	12.5 cm^2	15 cm^2

A typical tree from the nursery will have TCAs in the range of 0.8 cm^2 to 2 cm^2, depending on whether it is a poor tree or a good tree. To bring these trees up to full cropping potential the poor nursery tree will have to grow its TCA by 15 to 100 fold, and a well grown tree by 6 to 40 fold depending on planting density and this has got to be done in the first three to five years for the planting to be successful.

This level of growth can only be achieved if all limiting factors to growth have been identified and corrected. These limiting factors can be divided into two categories:

1 those needing attention before planting
2 those affecting tree growth after planting

Pre Planting Preparation

Critical limiting factors are:

The trees

Tree Health Status — Trees should be virus tested and free of known viruses. Free of pests and disease.

Trueness of Type	Rootstocks properly labeled, budwood carefully selected. In the cause of red colour sports must come fruiting trees that have been checked for colour.
Tree Size	Specification laid down and delivered to that specification.
The site	Soil surveyed to determine depth, structure, pH and nutrient status, drainage characteristics, previous cropping history, possible nematode and disease problems which will need to be rectified before the new orchard is planted. Most soil related limiting factors can only be satisfactorily dealt with prior to the trees being planted.

Replanting Old Orchards

In addition to the normal soil problems, most soils that have grown pipfruit will be infected with a condition referred to as Specific Apple Replant Disease (SARD), which drastically reduces new apple or pear tree growth when the same species is replanted back into orchard soil.

Comparisons we have for Jazz™ on M9 rootstocks in replant soil shows TRV of trees growing on non-fumigated soil to be only 55% of those on adjacent fumigated soil at the end of their second growing season. M9 is a rootstock with good SARD tolerance. M26 and MM106 rootstocks are generally more sensitive to SARD.

Severity of SARD depends on soil type, previous tree root density, and length of fallow between susceptible crops. There is also some suggestion that certain break crops may reduce the impact of SARD.

Soils can be tested for SARD by comparing the growth of seedling apples in fumigated and non-fumigated samples of the orchard site soil. This needs to be done one year before the orchard is to be replanted.

The causes of SARD are not well understood and for this reason there is no certainty that measures that control SARD in one locality will work equally well elsewhere.

So far the most effective treatments for SARD are pre-plant soil fumigation with chloropicrin, formalin drenches or other fungi controlling soil fumigants.

Other measures known to minimise the effects of SARD include:

- Careful and thorough removal of previous apple or pear crop root debris.
- Fallowing the soil for at least two or more years before re-planting (note; does not work in all situations).

- Increasing tree density by 50% - compensates for slower tree growth, but will not fully overcome SARD affects of lower specific tree performance and smaller fruit size which are sometimes significant where a SARD problem exists.
- Maintaining soil fertility in the root zone, particularly for nitrogen and phosphorus. Replant trees fertilized with Mono-ammonium phosphate (MAP) usually perform better than those not fertilized, even where soil analysis would indicate soil phosphorus levels more than adequate for tree growth.
- No water stress.

Planting

The site needs to be well cultivated with open friable soil conducive to good root growth in the root zone. Where soil organic matter is low, adding compost or other suitable organic matter at 50 t/ha will improve soil conditions for root growth.

On duplex soils where drainage is poor, top soil shallow, planting on ridges will give better tree growth provided irrigation is in place to maintain soil moisture at optimum levels for growth. Be wary of ridging in very hot climates, because soil temperatures are usually higher on ridges and high soil temperatures adversely affect apple tree root growth.

In very heavy clays do not backfill the planting hole with lighter textured soil than that of the surrounding soil because planting holes often become waterlogged when this is done.

It is preferable to plant trees as early as possible in the dormant season so their root systems are well established before leaf and shoot growth commences.

Do not plant into wet soil.

Do not allow tree roots to dry out in this transplanting process. If they do become dried out, re-hydrate by soaking in water prior to planting.

When planting into dry soil, irrigate immediately then firm the soil around the roots to establish good soil contact with the roots.

To avoid scion rooting and irregular growth, the scion rootstock union needs to be at least 10 cm above soil level, preferably 15 cm.

Once Planted

1 Establish and secure trees to support structure
2 Get irrigation systems in and ready to go before the trees leaf out

The Support Structure

Our experience with intensification shows that in-adequate tree support has been a major problem in getting high performance from intensive orchards. For a 70 t/ha fruit crop your support structure will have to hold up 25 kg of fruit per metre of row at 3.5 m between row spacing.

Tree support needs to be within 0.5 m of final tree height.

Support posts should be at seven to eight trees apart ie about 10 m between posts where wire fence structures are being used for tree support.

Strong end assembly strainers are essential. They need to support in excess of 2.5 t of fruit plus tree weight per 100 m of row length.

Dwarf rootstocks have weak root systems, and sometime weak unions between scion and rootstock. Rapidly growing trees develop sail area quickly and are easily damaged by wind. The trees must be firmly attached to their support structure from day one.

Where wire trellis support is being used, first year trees need three wires for support. Support wires should be at 50 cm intervals or less. The support wires will work best where alternated on either side of the tree trunk. Our most cost effective method for attaching trees to wires is with a staple driven by a pneumatic staple gun.

Use 14 mm staples on trunks less than 20 cm diameter and 18 or 19 mm staples once trunks exceed 20 mm diameter. Trunk size less than 10 to 12 mm can be taped to the support wire.

As trees grow add further wires once tree height passes the new wire height.

Trees which are below wire height need twine support to guide their leader shoot growth past the wire without shoot damage.

Making the Trees Grow

High density orchard trees do not need strong structural branch development.

Establishing tree height quickly is the key to early/high productivity. I belong to the school of thought which says you do not head the leaders of young trees. Leader pruning is counter productive to the objective of growing tree height quickly.

Balancing the Tree

Even so, the young tree will require some pruning after planting to balance its structure. This should include:

1 Removal of feathers or branches below 0.8 to 1 metre above ground. They are too low to be useful.
2 Balance the tree by removing any overly strong side branches that may compete with the leader
3 Where feather development is poor, or feathers not uniformly distributed around the tree, bring the tree back to a rod by taking off all feathers and side branches.

Irrigation Management

When young trees fail to grow well, the most likely reason will be water stress between green tip and the end of normal shoot extension growth, usually mid-summer.

Growth stops in trees suffering water stress, then terminal fruit buds form. Once this happens it's very difficult to start growth again that growing season.

Newly planted trees have limited root run so cannot take up water readily from deeper soil layers, or away from their limited root spread. Maintaining optimum soil moisture in the 0-30 cm soil layer within tree root spread in the first growing season is critical to good tree growth. The highest performing young orchard in our "HortWatch™" irrigation monitoring service maintained soil moisture for the 0-30 cm depth in the target zone 87% of the time for the first growing season, with levels below trigger point only 9% of the time. This orchard produced over 45 t/ha in the second season and almost 70 t/ha in the third growing season.

Studies on young tree water use indicate that water requirement will be about 2 to 2.5 times the potential evaporation of the area covered by their mid-day shadows. At mid-summer daily water evaporation of say 7mm, a tree casting a shadow of 1 m2 is likely to need between 14 and 18 l per day to meet its' daily water use.

Frequency of irrigation will depend on soil moisture holding capacity, the volume of soil utilized by the tree roots, or the volume of soil being wet within the trees rooting zone by the irrigation system, the size of the tree canopy shadow and daily evapotranspiration. Note: soil moisture outside of the root zone does not count.

Estimated Available Water per m2 to 30 cm Depth

Soil Texture	
Fine sand	21 to 24 l
Sandy loam	30 l
Fine sandy loam	39 to 42 l
Loam	45 to 48 l
Silt loam	48 to 50 l
Light clay loam	50 to 54 l

Depending on soil texture, the root zone of the first year tree is likely to hold somewhere between one and about four days water supply in mid-summer. Light sandy soils may need daily watering, while soils with good moisture holding characteristics may need water only every three or four days, or perhaps longer.

Where water supplies are good, and regular, our experience is that trickle systems are the most efficient and cost effective watering systems for establishing intensive orchards because they target water directly to the root system with little wastage if well managed. In heavier soils, care must be taken not to position emitters directly over the tree trunk because of the danger of water logging the planting hole. We have seen trees die of *phytophthora* root disease where this has happened.

Sprinkler systems can be used to water intensive orchards, but they do not target their water directly to the root system so they cannot match the water use efficiency of drip systems. Their management needs to be driven by what soil moisture levels within the effective rooting zone are doing. In the absence of surface mulches, water loss from sprinkler systems can be very high where they are used frequently and the soil surface is wet for a large period of the time. To minimise evaporation losses, sprinkler systems should not be used more often than at four or five day intervals unless soil moisture holding capacity is low and necessitates more frequent application to maintain optimum soil moisture status.

As tree canopy develops through the growing season, the developing orchard water requirement will increase.

With any irrigation system the volume applied at any run should be constant because it's the same volume of soil to be re-wet each time. It's the interval between waterings that changes and is dependent on water use.

As the orchard canopy grows it needs more water. Where trickle systems are installed, adding a second line or converting to min-sprinklers in the third or fourth season may be necessary.

Mulching

In hot dry climates, or on light soils where soil moisture holding capacity is low, a thick organic mulch will conserve moisture and cool the soil down. This reduces both irrigation and heat stress with improvement in tree growth.

In grassed orchards, mowers which feed the chippings sideways towards the tree row can be an effective way of mulching the tree row.

Fertilisers

During the establishment phase, young orchards need regular fertilizer applications to maximise tree growth.

In fully irrigated orchards, particularly those with drip systems, fertigation is the most effective way to apply major fertilizer nutrients.

The fertilizer programme will be determined by the natural fertility of the site and its ability to meet the trees nutrient needs. Major base nutrient levels, and pH, should have been addressed during the pre-planting preparation. The fertilizer programme we are talking about here is the side-dressing programme to make the trees grow well.

The fertilizer regime for the developing orchard differs markedly from that applied to producing orchards because we want strong vegetative growth and do not need to be too concerned about adverse affects the fertilizer programme may have towards fruit quality.

Nitrogen, because of its transient availability will be the main fertilizer requirement, possibly supported by magnesium, potassium and certain trace elements where deficiencies are known to exist.

Nitrogen applications, including planting time MAP and regular side-dressings, or through fertigation, in the order of 100 kg N/ha (about 50 g N per tree) are being routinely applied to young intensive orchards in their first and second growing seasons.

In year one the aim is to apply around 2 g nitrogen element per tree per week in irrigation water. Note: the nitrogen source needs to be buffered, or neutral in it's soil pH reaction except in situations where pH is excessive and acidifying nitrogen forms can be used to bring pH down to a more desired level.

Potassium nitrate can be substituted for one or two runs if potassium fertilizer is required.

Magnesium Sulphate is applied for magnesium deficiency.

Trace elements are best supplied as foliar applications.

In year two a similar programme is followed.

Where fertilizer is not applied through the irrigation, side-dressings are made at monthly intervals through the active vegetative growth period applying 20 to 25 kg N/ha per application.

Once significant cropping begins the fertilizer programme should revert to the normal producing orchard programme. This will probably occur in year three.

Weed Control

Young orchard trees need a minimum weed free strip of at least 1 m in width to prevent weed competition from reducing tree growth.

As contact herbicides use is tricky in young orchards, I prefer to use residual herbicides in young orchards.

Pest and Disease Control

Non-bearing orchards need good pest and disease control focused mainly at those diseases and pests which damage foliage or root health.

Critical diseases to be controlled include:

Apple scab	*Verturia inaequalis*
Pear scab	*Verturia pirina*
Powdery mildew	
Phytophthora root rots	

Insect pests

Woolly Apple Aphid
Mites
Other leaf damaging insects

Mammalian and Avian pests

Rabbits/hares
Various Australian indigenous species

As a minimum, young orchards require a good fungicide programme over the active leaf growth period, pre-leaf fall phosphorus acid sprays to protect from *Phytophthora.*

Targeted insecticide applications when and if insect pests appear.

Protection measures against damage from Mammalian and Avian pest animals.

Cropping

Intensively planted trees on dwarf rootstocks are capable of carrying light to moderate crop loads without compromising tree growth. In fact there is some evidence to show trees on dwarfing rootstocks such as M9 and M26 will make better growth with a light crop eg 7 fruit cm2 TCA than with no crop at all.

Further Reading

Wilton, J. 2006. Intensive Benchmarking Field Days. "The Orchardist", vol27, 3 (April 2006) p 12 to 17
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Good fruit grower, April 15 2004: A calm tree is a productive tree.