

SEPTEMBER 09 FUTURE ORCHARD 2012 WALK



Vigour Management

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Introduction

High performing orchards have uniform fruiting canopies, with stable vigour/crop balance and regular cropping from season to season. The objective of this paper is to:

1. Define acceptable vigour standards for orchards.
2. Identify factors that are usually associated with tree vigour problems.
3. Suggest techniques for managing tree development and vigour problems.

Developing young orchard blocks

These notes complement previous FO2012 notes particularly “Young Tree Growth” (Hornblow, 2007) and “Getting New Orchards to Perform” (Wilton & Hornblow, 1996)

The first step is to define a performance standard for young orchards for growers to be able to benchmark their own block performance. Measurements AgFirst have made in developing orchards of tree growth and cropping behaviour indicate that it is possible to draw up a performance standard for orchards.

Growth Objective

Tree height to equal between row space by the end of fourth growing season in the orchard. This allows us to meet the objective of 60% light interception as quickly as possible.

Where trees are in balance annual leader extension growth reduces year on year.

Growing season	Leader extension target (3.5m M9)	Leader extension target (4.0m M26 or CG202)	Percentage of Ultimate tree Height
Nursery	1.5m	1.8m	45%
1 st	0.7m	0.8m	20%
2 nd	0.6m	0.7m	17%
3 rd	0.5m	0.5m	13%
4 th	0.2m	0.2m	5%

Trees that are tall and well feathered at planting tend to show less leader extension than trees planted as unfeathered rods. Short trees at planting will catch up to bigger trees if there are less competing side branches than on stronger trees.



As a rule, production lags growth by two seasons, eg,

- Year 1 leader or shoot extension occurs.
- Year 2 flowering buds or short shoots with terminal flowers develop.
- Year 3 flowering buds developed in year 2 set fruit.

Cropping can commence in year 2 after planting with fruit mainly carried on those parts of the canopy that were on the tree at time of planting.

Year 3 after planting is generally the first significant commercial crop and its volume is dependent on the amount of potential cropping canopy grown in year 1.

For trees with good growth and fruiting balance, yield will increase progressively year on year until mature fruiting canopy fills the allotted space. Where the tree growth objective of tree height matching between row spacing by end of the fourth growing season is achieved, full bearing potential can be reached in the fifth or sixth year from planting. Yield data studies of developing orchards show increases in yield will normally occur beyond this tree age, at least to year 10. This is because tree growth across orchard blocks is not uniform, so in time the slower growing trees eventually catch up with the more advanced trees, hence the further yield increases beyond year 6.

Where trees are growing well:

Growing season	Crop	Target crop load (t/ha)	Exceptional performance (t/ha)	Yield Increase target
1 st		0	0	
2 nd	1	15	20	
3 rd	2	30	40	Between 1 st and 2 nd crop yield doubles.
4 th	3	50	60	Between 2 nd and 3 rd crop yield increases 50 to 70%.
5 th	4	60	75	Between 3 rd and 4 th crop yield increases 25 to 35%.
6 th	5	65	75	Between 4 th and 5 th crop yield increases 8 to 12%.

This is the ideal world. In the real world yield progression from year to year will be more variable due to the impact of climate over the growing season.

Growing a uniform fruiting canopy is the key to high orchard block performance. Uniformity is dependent on proactively managing tree growth and vigour across the orchard block.

Tools for Managing Tree Development and Low Vigour

Trees with low vigour often fail to fill their allotted space, so cannot bring the orchard up to its full potential.

Low vigour problems can be defined as inadequate shoot growth to enable the tree to reach tree height by end of 4th leaf, or fill the in row lower tree canopy by 3rd or 4th leaf.



Step 1

Map tree vigour and size across the block. Often trees with poor vigour tend to be grouped within an orchard block. Their distribution pattern is likely to indicate possible reasons for their low vigour, eg poor growth in depressions or hollows could indicate drainage problems or over-irrigation. Weak growth on ridges and high points in the block may be due to shallow top soil, water stress or wind exposure.

Step 2

Try to determine the cause of poor tree growth. Causes of poor tree growth are numerous and often obscure. A detailed site examination including checking soil factors that may limit root growth, objective assessment of tree and orchard management practices that could affect tree growth is required. For best results, poor growth problems need to be identified early in the life of the orchard, because once trees “park up” it is often difficult to get them going again.

The vigour management paper from Future Orchards 2012 notes – Orchard Walk 6, August 2007, lists the causes of vigour problems in orchards and suggests some solutions.

Step 3

Rectifying low tree vigour. Once the underlying limiting factors to growth have been found, addressing them is the first step to getting tree growth going. This commonly held belief that low vigour problems can be overcome by heavy pruning is false. Heavy pruning stimulates vigorous annual shoot growth, but if the underlying factors that lead to the low vigour have not been rectified, tree growth will again stall when its canopy volume exceeds the size the soil and root system is able to support.

Common Causes of Low Tree Vigour

Specific Apple Replant Disease (SARD)

This complex problem can result in tree vigour reductions of greater than 50% and accounts for many poor performing replant orchard blocks. It was well discussed in a previous FO2012 paper “Soil treatments against replant pests and diseases” (Brown, 2008)

Poor Drainage

In dry climates it may take several years for the effects of poor drainage to appear. Sometimes trees grow well in the season of planting then fail to continue growing well. This indicates a problem with high winter water tables damaging root health. Often tree death from phytophthora root rots follow even on rootstocks with good tolerance of this disease e.g. M9.

Saline soils are often associated with impeded drainage in hot dry climates. The key to solving both these problems lies in better drainage and control of winter water table levels. In the case of soil salinity problems, the drainage needs to be supplemented by gypsum applications with increased irrigation to flush the salts out of the rooting zones.

Hard Pans, Shallow Soils and Poor Soil Preparation

These should have been addressed in the pre-planting soil preparation, because they are much more difficult to fix after planting. Refer “Getting New Orchard Plantings to Perform” (Wilton & Hornblow, 1996). Where underlying drainage is good, deep ripping between the rows can overcome hard pan problems. Often it is necessary for the ripping soil treatment to be undertaken in two directions and usually at angles running across the old row orientation if replanting.



Mulching with bulky organic materials assists improving growth in shallow soils, as does pulsing irrigation to maintain optimum soil moisture availability at times of stress. A good fertigation system will further improve growth by overcoming any nutritional limiting factors.

Good soil preparation is critical to maximizing young tree growth. Newly planted trees have extremely small root systems with very little fine root necessary to absorb water and nutrients. Good soil/root contact is critical and this requires a fine tilth of the planting row or hole. If soil is worked under poor conditions ie too wet, it is virtually impossible to achieve a fine soil tilth. It is better to wait for good cultivation conditions and place the trees in coolstore than work the soil in less the optimum conditions.

Water Stress

Water stress is probably the single biggest cause of low vigour in developing orchards. Dehydration between the nursery and the tree root systems becoming well established in the orchard soil is frequently seen and shows up as delayed spring bud break in year of planting, followed by little or no extension growth or in severe cases tree death.

Dehydration can be avoided by soaking the tree roots for 24 to 48 hours immediately prior to planting, then if the soil is too dry at planting watering the trees in at planting together with firming the soil around the roots to secure good root to soil contact.

Irrigation systems need to be installed and in working order by the time bud break occurs. Young trees need regular watering and once green tissue appears and maximum temperatures exceed 20° Celsius.

In times of water scarcity, recently planted orchard blocks need to have priority over older more established blocks, particularly in the first half of the growing season because once growth stalls through water stress, it is almost impossible to restart again in the same growing season. Older blocks have more extensive root systems, need less annual shoot growth with their most responsive irrigation stage closer to harvest.

Nutrient Deficiencies

Address any known nutrient deficiencies commonly associated with the particular orchard soil type. Some Australian soils require deep subsoil fertility adjustment which can best be achieved with deep incorporation prior to planting. Monitor regularly to check soil and plant nutrient status.

Over the first two to three years, nitrogen will be the key nutrient required to drive tree growth. Up to 150 kg N/ha delivered regularly in small doses over the active growth period may be needed. Highly efficient fertigation systems will only need about half this amount. Once the orchard canopy matures, only a third to a half of the nitrogen rate of the young orchard will be required, but other nutrients needed by crop such as potassium may have increased demand.

Young apple and pear trees, particularly in replant sites are often very responsive to soluble phosphorus fertilizers, even though soil test results suggest there is plenty available.

Tree Management

Crop load, branch numbers and training practices strongly influence tree vigour. In the absence of limiting factors, such as water stress or root growth problems, young trees from their 2nd leaf can handle crop loads in the range of 5 to 7 fruit/cm² TCA without adversely affected vegetative growth. In high vigour situations, crop loads up to 10 to 12 fruit/cm² TCA will moderate growth, but still allow sufficient to meet orchard canopy development requirements.

Where growth is inadequate, flower removal, leaving spur and vegetative bud leaves behind will give the best growth response. The earlier the excess fruit is removed, the stronger the vigour response.



Where further leader extension is required, remove any competing side laterals, limit the number of branches in the lower tree and spread them along the trunk to avoid choking the leader growth. In the lower tree six to eight branches per running metre of leader beginning at 0.9-1.0 m height above ground is considered optimum number.

Branch gradient determines branch extension growth. The steeper the gradient, the stronger terminal extension growth will be. In the lower half of the tree branch length needs to be about 80% of in row tree spacing. Maintain positive branch gradients until this level of branch length is reached, then tie the branches into a pendant position, eg, about 30 to 40° below the horizontal, to stall further extension growth. Overtraining of small branches into pendant positions is a common cause of poor canopy development.

Remove fruiting branches that are likely to compete with further leader development. In the perfect world only branches with diameters 1/3 the size of the leader would be retained, however in our experience this simple rule often removes too much of a young trees potential bearing surface. Branches with diameters greater than 1/2 the size of the trunk should definitely be removed and ones less than 1/2 but larger than 1/3 can be retained if needed, but need to be trained into a pendant position.

Weed Competition

Recently planted trees are very sensitive to weed competition during the spring/early summer period. Maintenance of a weed free strip, 1 to 1.5 m wide along the tree row from late dormant stage through to after normal termination of shoot growth is essential to minimize the effects of weed competition on tree growth and development.

Excess Vigour

Excess vigour can be defined as annual shoot growth exceeding leader, canopy development and fruiting wood renewal requirements. This is normally a mature canopy problem however can occur during the early development period in an orchard, where excess vigour can create tree management problems. For intensively planted orchards leader extension growth greater than 80 cm to 1 m per annum can be excessive, and is definitely excessive once the tree approaches its desired height.

Side lateral annual shoot growth vigour becomes excessive in the lower tree once its growth matches 50% of the in row tree spacing. In the upper tree, annual lateral shoot growth vigour becomes excessive once it exceeds 20 to 30% of in-row tree spacing. For side branches two years' growth is generally necessary before they can carry sufficient fruit load to calm their vigour down. Trees in which branches outgrow their allotted space within two growing seasons have an excess vigour problem.

Once the mature tree cropping stage is reached, annual shoot extension growth of greater than 20 to 30 cm represents excess vigour. Excess vigour problems can be a whole tree problem, or confined to particular branches or parts of the tree canopy.

Controlling Excess Vigour

Vigour control options include:

- Branch type
- Pruning style
- Crop Load
- Trunk girdling or scoring.



- Root pruning
- Growth regulators.
- Regulated deficit irrigation (RDI)

Branch Type

Often excess vigour does not affect the whole tree, but is confined to particular branches or a part of the tree canopy. When this happens the strong growing parts of the tree are out of balance with the rest of the tree. Problem branches need to be identified early in their development and action taken to deal with them.

In their first year of growth, such laterals grow more strongly than those nearby, have shoot basal diameters greater than $\frac{1}{2}$ of the leader or branch they are growing on, and tend to grow at steeper gradients than those around them.

In subsequent years these stronger growing problem branches tend to abort their potential fruit buds into profuse vegetative shoot growth, which further increases their size and vigour.

There is a strong relationship between branch diameter (adjacent to the leader or main branch), branch length and vigour. Branches of greater diameter than 2.5 to 3 cm per metre of branch length tend to become excessively vigorous with numerous annual shoots >20 to 30 cm in length.

In year 1, excessively strong shoots are usually found at the top of the lateral shoot hierarchy arising from the second leaf tree structure. It is common practice to rub off the stronger shoots close to the leader tip in their first few weeks of growth. While this helps the leader get away without competition, the excess vigour problem is simply transferred to those shoots immediately below them.

A better approach to managing strong current season shoot growth is to use it to moderate lower shoot vigour, then summer prune or stub it back later in the growing season.

Manage excessively strong branches by:

- 1 Pruning out.
- 2 Training down into pendant positions.
- 3 Summer pruning unwanted shoot growth.

Pruning Style

Vigour will be increased if a tree or branch is pruned using a lot of shortening cuts particularly into upright wood. Conversely pruning done using thinning cuts and minimal shortening will induce a lower vigour response.

Crop Load

Cropping is the best tree vigour control tool. Cropping brings branch and tree vigour under control when there is sufficient fruit numbers to prevent significant photosynthate export from the cropping unit to the trunk and roots to fuel future excess tree growth (Robinson, 2007)

- Crop loads need to be in the region of 4 to 5 fruit per cm² branch cross sectional area (cm²/BCA) to control branch vigour and size.



Trunk Girdling or Scoring

When correctly implemented is a very useful technique for controlling excess tree vigour. It has the advantage of individual tree treatment within blocks of variable tree vigour. The degree of vigour control is determined by timing and severity of technique. The treatment window extends from bloom/early petal fall stage through to after the natural fruit shedding period.

Treatment at the bloom/petal fall period can reduce shoot vigour by 70 to 80%, increase fruitlet retention and return bloom. Useful only where vigour is very excessive and adversely affecting fruit retention. Reduction in shoot vigour progressively declines as treatment is delayed.

Where fruit set is satisfactory, delaying trunk girdling to the natural fruit drop period gives the best overall result. Shoot vigour control is in the range of about 30% with this timing, and return bloom still enhanced.

Trunk girdling before the thinning sprays and natural fruit drop is occurring will increase fruit retention. This can be positive and negative and needs to be taken into account by management.

Implementation needs to be carefully supervised as variance in the depth of cut, cut overlap and distance between cuts, will all impact on tree effect. If the job is not done consistently the individual trees within the block will become highly variable. This is a major limiting factor with girdling treatments and is often the reason growers choose to use growth regulators or root pruning as alternatives.

There is a number of techniques used, ranging from chainsaw cuts into the trunk, removal of bark strips, to a single knife cut.

Girdling works by restricting the downward movement of photosynthates from the upper tree to the root system. To be effective it needs to interrupt the phloem sap flow, but not completely eliminate it. To be successful the girdling or trunk scoring treatment needs to sever the cambium layer, ie, reach into the woody tissue beneath the bark. A small portion of the phloem tissue needs to remain intact to keep the rooting system alive.

Note the chainsaw treatment cuts phloem and xylem cells, hence not only effecting the supply of photosynthates to the roots but also the transport of water and nutrients to the upper part of the tree. The chainsaw treatment is therefore the most severe of all and is best only used on extremely vigorous blocks and with real care.

Techniques include:

Ringing the trunk with a single blade cut. Do not join the ring but overlap the ends, eg, 10 mm overlap, 5 mm separation.

Spiral or double “C” cuts. The double “C” is easiest to implement and check. Generally done with a double bladed tool that removes a 2 to 6 mm bark strip down to the cambium layer. Cuts require overlapping for effective response. A common specification is 50 mm separation of the double “C” with one on each side of the trunk and 50 mm overlap on each side.

Vigour control effect can be increased by increasing the length of overlap, reducing the separation distance between the two cuts or removing a wider strip of bark. Conversely, reducing overlap, widening the distance between the “C” cuts or reducing the width of the cut itself, lowers vigour control response.

Chainsaw cuts made into the trunk are the most severe form of incision for vigour control. The depth of cut and distance apart is dependent on the degree of vigour control required. Typically the cut is one third to half way through the trunk (never more than ½ way), one each side at least 50 cm apart. This technique is



suitable only for large, high vigour trees. In windy climates good upper tree support is necessary to avoid trees being blown over and breaking the trunk in the weakened zone between the saw cuts.

Scoring to stimulate growth lower in the tree

Often stronger growing branches in the upper tree suppress lower branch growth and development. When poor branch development or lack of branches happens in the lower or middle tree, ringing or scoring the leader immediately above the zone where branch invigoration is required will stimulate branch vigour and development below this level, while at the same time suppressing upper tree vigour.

Root Pruning

This technique is widely used in Europe for vigour control in intensive orchards. Vigour control by root pruning usually commences when the orchard reaches full canopy and is implemented by pulling a cutting blade through the orchard 30 to 60 cm out from the trunk to sever the surface feeder roots down to about 30 cm depth.

Timing is critical to success. Usually the roots on only one side of the tree are pruned at one time. Typical timing for the first cut is during the dormant period. If further vigour control is required in the same growing season, roots on the other side of the tree are pruned during summer.

Caution needs to be practiced with root pruning in harsh, stressful climates, and shallow soils particularly if irrigation is unavailable or limited. Root pruning may also have a place to control vegetative growth in situations where the trees have lost their crop load, or failed to set sufficient crop to control vigour.

Growth Regulators

Regalis® and Etephon control shoot growth. Regalis® is significantly more effective for controlling annual extension growth than etephon. Growth control with growth regulators, particularly Regalis® needs to commence early in the growing season before shoot length is beyond about 5 cm length.

Regalis® has contact action, which only affects the shoots that receive the spray coverage. Where lower tree vigour control is required, sprays directed to the lower tree will suppress shoot growth in that part of the tree while allowing the upper tree to grow normally and vice versa.

Typically two applications is considered minimal to achieve a significant result. Optimal rates and the number of applications required will be specific to each individual block and typically will take some experience to arrive at the optimum number of applications and rate for individual blocks .

Regalis® is incapable of controlling shoot growth once strong shoot growth is underway. It also has little or no effect on second flush shoot growth. Combining early Regalis treatment with later trunk girdling is one successful technique for keeping later season shoot growth in check.

RDI

The Australian climate is suited to this technique for vigour control. It is the best option for vigour control in pears and summerfruit. In the case of apples, it will control vigour but may increase some fruit quality issues such as skin cracking problems and sunburn.

The technique involves reducing water supply to the roots between fruit set and termination of active shoot growth, then restoring a normal irrigation regime four or five weeks prior to harvest for fruit sizing.

RDI is difficult to implement in high summer rainfall districts or in blocks with variable tree vigour. Anne-Maree Bolands address FO2102 Sept 2009, gives growers better insight into the use of irrigation and deficits to optimize pipfruit production.



Avoid Scion Rooting

Scion rooting occurs when the bud union between the rootstock and the scion variety is buried below soil level, or is at or near soil level. This enables the scion to send out roots. Very quickly the scion root system becomes dominant removing any dwarfing effect of the clonal rootstock.

It is avoided by planting with the union between rootstock and scion well above soil level, preferably at least 10 to 15 cm above soil level.

When scion rooting occurs, the soil around the rootstock/scion union needs to be excavated and any scion roots removed.

Bibliography

Brown, G. S. (2008). *Soil treatments against replant pests and diseases*. Retrieved from www.apal.org.au.

Hornblow. (2007). *Young Tree Growth*.

Robinson, T. (2007, Feb). *Orchard Systems*. Retrieved Sept 2009, from www.apal.org.au.

Wilton, W. J., & Hornblow, C. (1996, Nov). *Getting New Orchards to Perform*. Retrieved 2009, from <http://www.apal.org.au>.

