FUTURE ORCHARDS 2012

Crop Loading

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Crop load has a major impact on crop out turn and profitability and is one of the few production factors under the growers direct control.

The following depend on crop load:

- Yield
- Fruit size
- Fruit quality
    - Soluble solids
    - Fruit pressure
    - Rate and degree of colour development
    - Harvest window
    - Storage potential

Excess cropping level lowers fruit size and quality, reduces fruit sugar, delays colour development and 'impairs' ability to harvest at optimum fruit quality.

Low crop reduces yield and profit below orchard potential, and increases risk of post harvest disorders, particularly those associated with fruit calcium such as bitter pit.

What is the Optimum Crop Load

Cropping potential is determined by the following:

- Tree size, and/or canopy volume
- Market requirement in terms of fruit size range, colour and selling season.
- Limitations imposed by seasonal weather conditions
- Orchard site soil and micro-climate

Setting Crop Load Targets

Matching Fruit Numbers to Tree Size
In young orchards that have not filled their canopy space fully, trunk cross sectional area (TCA) gives the most reliable guide to cropping potential.

As tree age increases optimum crop load expressed as fruit number/cm^2 TCA declines. Under good growing conditions specific crop loads in the range of 7 to 10

fruit/cm^2/TCA can be carried on two and three year old trees without compromising tree growth and canopy development. Tustin et al (1997) in their paper "The International Apple Growth Study" found young tree apple productivity to vary widely among the climates they studied indicating that specific crop load/cm^2 TCA will need to be calibrated against tree cropping performance to establish optimum crop loads for different varieties, rootstocks and growing conditions.

AgFirst have developed a simple spreadsheet that enables growers to use the Fruit no/TCA technique easily. It is recommended that the grower measure the trunk diameter of 10 trees in the block. The measurement should be made 20cm above the rootstock/scion union. These measurements are then entered into the spreadsheet, which will calculate average TCA automatically. The spreadsheet then uses 3 common crop loading factors : 5, 7 and 10 fruit per TCA to calculate the recommended average fruit number to carry per tree. There is also the ability for the grower to enter their own crop factor if they have good history on their blocks cropping potential.

An example of the spreadsheet is shown in Figure 1 over . A working copy of the spreadsheet can be downloaded from the Future Orchards 2012 website in the library section under Field walks Nov 2007.

Figure 1:

CROP LOADING CALCULATOR
BASED ON TRUNK CROSS SECTIONAL AREA

Block Name		Royal Gala North	Fuji east	Honey Crisp Road							
	Tree No	Trunk diameter (mm)	Trunk diameter (mm)	Trunk diameter (mm)	Trunk diameter (mm)	Trunk diameter (mm)	Trunk diameter (mm)	Trunk diameter (mm)	Trunk diameter (mm)	Trunk diameter (mm)	Trunk diameter (mm)
	1	51	25	20							
	2	53	23	21							
	3	63	26	22							
	4	85	28	25							
	5	96	30	26							
	6	45	32	28							
	7	25	33	29							
	8	56	35	30							
	9	35	40	32							
	10	48	25	29							
Average (mm)		*56*	*30*	*26*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
TCA (cm^2)		*24.4*	*6.9*	*5.4*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Crop Target	5	*122*	*35*	*27*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
	7	*170*	*48*	*38*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
	10	*244*	*69*	*54*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Specific Target	8.5	*207*	*59*	*46*	*0*	*0*	*0*	*0*	*0*	*0*	*0*

Instructions:
Only enter data into the yellow shaded cells. Measure the trunk diameter of 10 trees in the block. The calculator will calculate target fruit number at 5, 7 and 10 fruit/TCA. You can also input a specific target if your records indicate your target is not covered within the default values. Note: This technique does not work once the block exceeds 50,000cm2 per ha. After this point revert to historical performance and use the Tonnes/ha or TCE/ha target method.

For mature canopies fruit/cm^2 of branch cross-sectional area (BCA) can be used to describe crop load provided the branches or sections of branches are in the range of 2 to 5 cm in diameter.

BCA can also be used on developing orchards too. As a general rule optimum crop loads for branches are about half that of TCA levels, usually in the range of 3 to 6 fruit per cm^2 BCA. Thinning to specific crop loads on a branch basis is an effective method for obtaining a consistent thinning job over the orchard.

The method is easy to set up by simply measuring a few branches, then thinning down to fruit numbers that give the target crop load for those branches. This quickly gives a visual picture of what the target crop load looks like in regard to fruit density on the branch. It also makes checking the thinning relatively simple and quick. Branches in the size range 2 to 5 cm diameter can be selected at random, fruit counted and checked against tables giving fruit member for these branch sizes at the desired specific crop load.

When using BCA as a basis for thinning its necessary to check the numbers on a few whole trees to make sure that the crop load is within the target range.

Published data indicates that maximum potential yield is achieved once total TCA per hectare reaches 50,000 cm^2. Once the orchard has in excess of 50,000 cm^2/ha TCA canopy volume, or historical yield performance is a better measure of cropping potential.

Growers should know for each block that they farm, the yield per ha harvested, and have a good appreciation of the resulting fruit size and quality. Once this data has been built up for a number of years, it allows the grower to set accurate crop loads in the coming season to achieve an optimum outcome of yield and quality.

For example Joe Bloggs has a block of Royal Gala that has the following history:

Year	Harvested Yield (kg/ha)	Average Fruit Size
2005	50000	105
2006	80000	135
2007	65000	110

Based on this history Joe decides that profitability is likely to be maximised at 65,000kg/ha and a 110 average fruit size. The 2006 crop at 80t/ha gave small fruit size and 65t/ha of a count 110 is more profitable than 50t/ha at a 105. The important thing to note is that all blocks and all growers will have different optimum crop load targets depending on their blocks attributes and the market positioning of their fruit.

AGFIRST have created another simple spreadsheet that allows the grower to nominate yield and fruit size targets for different tree spacings with the spreadsheet calculating the target fruit number automatically. This is found within the same file as for Figure 1 but on another tab. A working example of Joe Bloggs Royal Gala blocks is shown in Figure 2 on the following page.

Joe has entered the row and tree spacing (5x3), has entered 65,000 kg/ha and fruit size of 110. The only other entry required is his estimate of the fruit percentage that remains after hand thinning but does not make it into a bin. This percentage can be variable by block. In our experience it can be as low as 5% in an open young canopy but as high as 20% in a dense canopy of short-stemmed apples. In our example Joe has used 10%. Once this data is entered the calculator calculates the optimum fruit no per tree at 634.

The only challenge left for Joe is to ensure each thinner achieves close to this number. Some of the monitoring techniques mentioned in this handout will be useful to assist.

Figure 2

Crop Load Calculator
KGS / HA

This simple calculator helps you calculate fruit number targets per tree at hand thinng. Enter your blocks data into the yellow boxes and the target number will calculate automatically. Targets should be based on historical performance of the block and an understanding of climatic conditions this season. Losses from thinning to harvest will vary with variety and tree age. Typically young trees will only be 5%. In a mature Braeburn for example this can be up to 15%. Fruit Size target is the weighted average number of fruit per Tray Carton Equivalent (18.6kg pack weight)

Orchard Name	Joe Bloggs

Block	Row Space	Tree Space	Tree No /ha
	5.0	3.0	667

Harvest target (kg/ha)	65000
Fruit Size target (avg fruit no/tce)	110
Average fruit weight (gms)	169
Estimate loss from thinning to harvest	10%
Fruit No at Thinning	**634**

Fruit Size

Crop load is the main driver of fruit size and generally accounts for around 70 to 80% of between tree fruit size variation. For trees carrying fruit loads in the normal cropping range the influences of fruit number on fruit size is around about 2:1 so if you need to lift fruit size by say 10%, then fruit numbers will need to be reduced by 20%.

Incidentally thinning strategy will also influence fruit size at harvest. For most varieties the best fruit size is from the king bloom flowers on terminal shoot buds, and well positioned 2 year and older spurs that develop good bourse shoots. Lateral bud 1 year wood flowers produce significantly smaller fruit.

During hand thinning, priority should be given to removing fruitlets from lateral bud 1 year wood, and poorer spur sites if the objective is to grow good crops of larger sized fruit. With long stemmed high colour varieties such as the redder strains of Gala its possible to grow good fruit in bunches of two or three fruit so it's a good strategy with these varieties to thin fruit by fruitlet size, removing the smallest fruit and retaining the largest fruit, even though this may mean leaving a few bunches of 2's and even 3's.

Short stemmed varieties, and partially coloured varieties for which high fruit colour development is required are best thinned down to single fruit, and spaced. If fruiting sites are limited it may be necessary to leave fruit in 2's to obtain the desired cropping level.

Where good data for fruit size growth curves is available its possible to set fruitlet size specifications for the thinners once the crop is around 42 days from full bloom.

Thinners can be instructed to remove any fruitlets below a certain size. As fruit is growing the reference size needs to be adjusted upwards every few days. In addition some total tree fruit counts need to be done to calibrate the minimum fruit size target against the target crop load.

Growing Conditions

Lower than average temperatures during the first 40 to 50 days after full bloom (AFB) reduce fruit size potential through limiting cell division, where as higher than average temperatures over this period increase fruit cell division and lift fruit size potential. Where a particular fruit size range is required some adjustment of target crop load may be necessary.

High summer temperatures can limit mid-growing season fruit sizing so crops which look satisfactory at time of hand thinning may not continue to develop well if abnormally high temperatures are experienced between hand thinning and harvest.

Water stress seriously affects fruit sizing so that in situations where irrigation, or rainfall is not able to maintain soil moisture at satisfactory levels for fruit sizing to continue, target crop loads should be drastically reduced. A Naor et al (1997) showed in a study of apple response to irrigation that satisfactory fruit size would still be grown when irrigation supply was limited if fruit numbers were reduced to around half normal crop load.

Where fruit sizing is being checked on a regular basis a sharp reduction in the growth rate can signal excess crop load for the growing conditions. If such a drop in growth rate is detected and acted on quickly with further thinning to bring crop load down to what the tree can manage, this will enable the remaining crop to continue sizing normally. Again the strategy should be to remove small, or damaged fruitlets.

In hot climates, or climates which experience large fluctuation in temperatures and sunlight levels fruit which is suddenly exposed, or excessively exposed to sun for large periods has high risk of sunburn injury. Hand thinning early before the hot weather arrives, and thinning off fruit with poor leaf cover in preference to more protected fruit can reduce the level of sunburn in the crop.

Hail Net

Hail net alters growing conditions within the orchard by moderating the micro-climate within the orchard to one more favourable for tree performance.

When orchards are given hail net protection there should be a corresponding increase in their productive potential in the harsh Australian climate. Wind run is usually halved, and evapotranspiration rates lowered which means that water use becomes more efficient. These charges are reflected in tree behaviour. Initially through a

vigour response which, if well managed, should enable crop loads to be lifted while fruit size range is maintained.

Lifting Crop Load Potential

There are a number of techniques which can be investigated to lift crop loads while maintaining fruit size and quality.

Some are already mentioned above and include:

- Selective thinning by fruitlet size
- Selective thinning by wood type
- Selective thinning by spur and bourse shoot leaf number or area

For varieties with high susceptibility to biennial bearing crop loads can be lifted with reduced risk of biennial bearing by thinning to 2's and thereby increasing the ratio of non-fruiting to fruiting sites than would be the case if the same crop load was carried as singles.

Setting up trial trees with differing crop loads and tracking the fruit sizing behaviour through to harvest then checking fruit quality parameters at harvest will give a good indication of where optimum crop load is for a particular situation. If you already have an established crop load level from historical performance looking at differing crop loads either side of this level may enable fine tuning of the orchard cropping to improve yields on print quality.

As a starting point setting up crop loads at 25% plus and minus your usual crop load will give a picture of the way crop load influences yield and quality.

For example if normal crop load is 7 fruit/cm^2 lowering crop load to 5.25 fruit/cm^2, and increasing crop load to 8.75 fruit/cm^2 would be a good demonstration of the influence different crop load on tree growth, and fruit quality.

Another approach would be to use the natural variation in crop load which is usually present in most orchard blocks, and at harvest check the crop loads being held by individual trees over the range present in the block. Then objectively assessing fruit size and quality on these trees with different crop loads. This will give a good impression of how crop load is impacting on orchard performance and fruit quality.

References

Naor et al (1977) "Irrigation and Crop Load Interactions in Relation to Apple Yield and Fruit Size Distribution", J. American Society Hort Science, 122(3) pp 411-414.

Tustin et al (1977) "The International Apple Growth Study" Acta Hort 451, ISHS pp 693-699.