MAXIMISING QUALITY BEGINS RIGHT FROM THE START OF THE SEASON.
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If you want your fruit to possess high quality and a high inherent durability to present at the point of sale, then the count down starts from the break of dormancy and on through the growing period, the ripening phase and the 'long term, medium term and short term' storage phase.
Each critical stage is listed below.

The pre- shutdown after harvest.
In this short period after harvest, the usual autumn application of N:P:K. is applied as a ground fertilise dressing. It is important to apply this as soon after harvest as possible. For Gala, there is plenty of time between harvest and dormancy, but in the case of Pink Lady™ and Sundowner™ the fertiliser should be applied before the last picks if time, personnel and tractors are available during the busy harvest period. The reason for this autumn fertiliser application is to get the fertiliser nutrients to the root zone because white root growth is being actively laid down before the trees go to sleep for winter. Good white roots and a reserve of nutrients in these roots greatly stimulates an active break of dormancy.

The shutdown stage.
During this period the tree is responding to biological signals than are activated by rapidly diminishing sunshine hours and daytime temperature.
In this short but critical period the following things happen.

1. There is a translocation of macro and micro-nutrient and hormones from the upper part of the tree to the root zone.
2. There is a need to position a supply of N.B.Mg and Zn. Preferably from a spray application, onto the growth and fruiting buds before leaf fall. (Radio autography shows that these sprayed on nutrients, although small in actual quantity are on target, are available, and do not translocate to the roots or move laterally within the tree canopy in the period immediately prior to dormancy). They are on target for immediate availability at the break of dormancy.

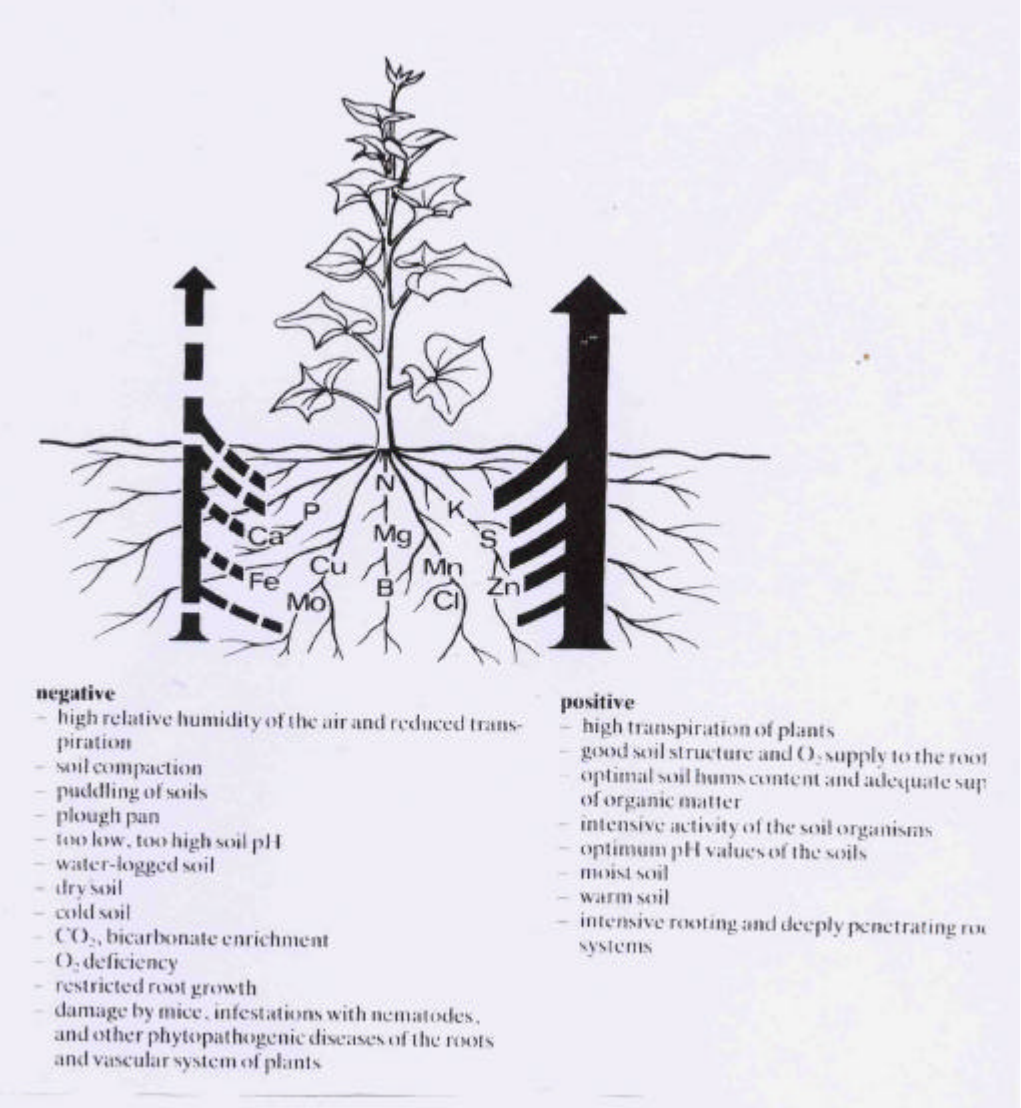
The start-up stage.
Break of dormancy is the most active stage in a temperate fruit tree's yearly cycle. A temperate fruit tree likes a cool winter with several frosts, a definite spring break with and not too many 'stop / start' sequences in the critical weather period from full bloom to '50 days after full bloom. (50 DAFB).
A good 'start-up' needs.

1. An increase in temperature and sunshine hours.
2. Availability of soil moisture to field capacity but preferably not to saturation. (In severe drought there is usually low humidity, severe frost, dry roots and a water allocation that is usually less than optimal). Under these conditions the tree is

usually restricted from performing to it's maximum.

3. In an ideal Spring-time there is an increase in transpiration and this assists in the movement of nutrients that are stored as reserves in the roots to the emerging green tips.

Figure.1. Things that are negative or positive in relation to the efficiency of the tree system from Green Tip on to (50 DAFB).



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During the start–up stage after dormancy there is a constant flow of reserves from the roots along with hormones (cytokinins) all carried in sap flow via the xylem up to the emerging vegetative zone (green tip to full leaf). A reverse flow downwards carries new energy (carbohydrates) that can only be produced as the new green leaves emerge. This

reverse flow downwards also carries the hormone auxin. Auxin and carbohydrate is transported from the vegetative zone to the roots viz the Phloem. This cycle is most vigorous in the period from full bloom on to (50 DAFB).
Things that either assist or restrict sap flow rate are itemised in Figure1.
Cincturing, or girdling is a crude way of restricting sap movement. While it certainly does reduce vegetative vigour it strangles the tree and weakens the return flower bud for the next season. It also can cause marginal leaf burn, leaf curl and reduced fruit size if hot dry drought conditions follow on through summer and autumn.

Critical growth stages.

1).The period from 'green tip' to (50DAFB).

Assuming the N:P:K. applied in autumn is available in this period, the next thing is to provide the micro-nutrients that can be inadequate in this period. Boron is needed at pink bud and at early flowering. Magnesium is needed at petal fall and on to 40 days out from full bloom. In this period the window for all chemical thinning has passed.
Actual chemical thinning schedules are available from the service industry in all fruit growing areas.
If flower buds are weak, a more cautious thinning program is needed.
Flower buds are weak.
*If there has been low winter chill.
*If the current seasons flowers, that were initiated last December, were formed after a heavy blossom had set, the latter stages of chemical thinning failed to break clusters, and hand thinning was not completed until after late December.
*If hand thinning in the current season is delayed to the point where seed has set in the current crop of fruitlets. If this is so, the seed load takes priority over the available hormone supply and leaves a deficiency for the new fruit buds that are being initiated now for next spring.
*If drought and lack of adequate water through spring, summer, and autumn was the pattern in the previous season.

2).The period of 'cell division' in the current crop.

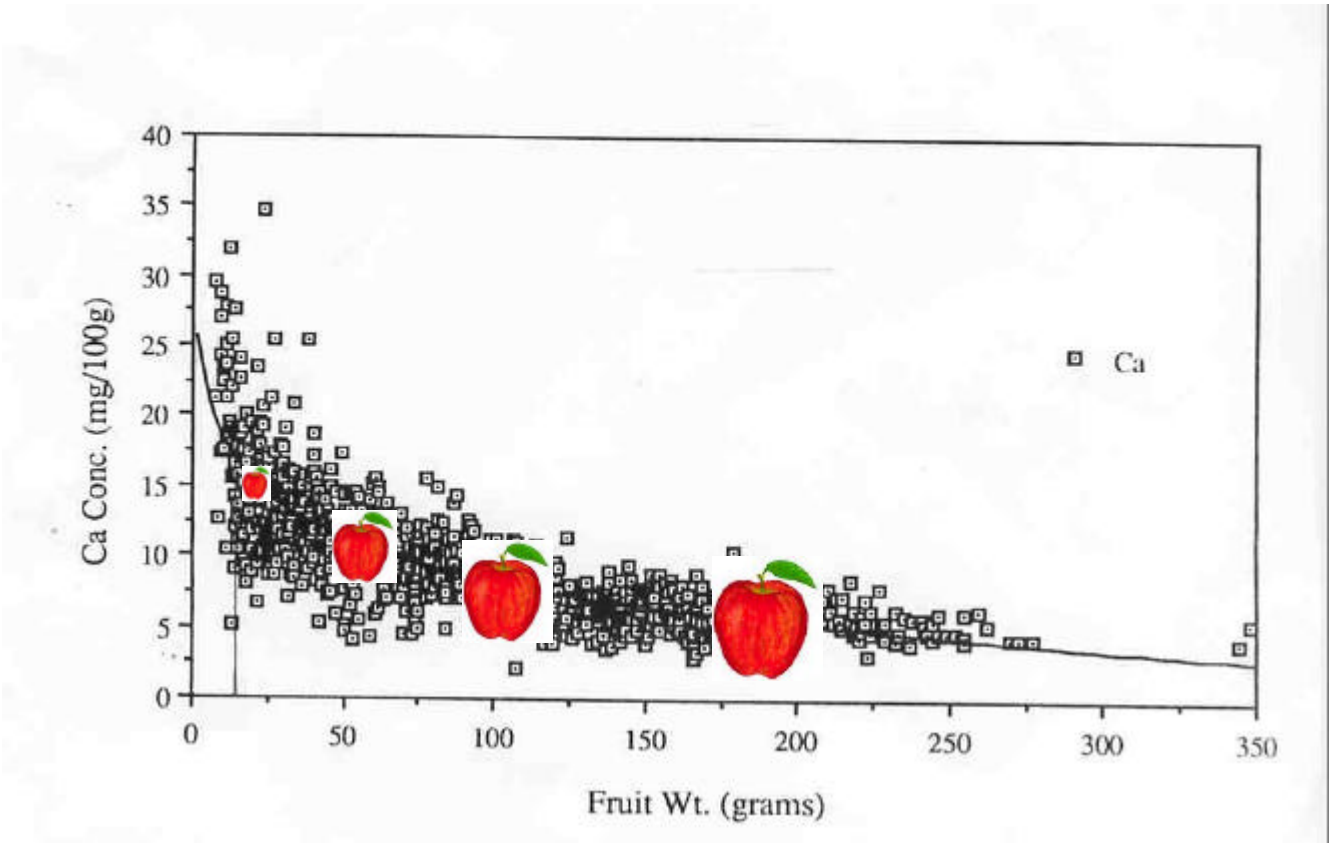
This occurs from petal fall on to (50DAFB).
*In this stage, adequate phosphate is needed.
*In Australia phosphate tends to be less than adequate.
*Translocation of phosphate from the soil into the tree system is very slow.
*Supplementary phosphate is most efficiently delivered on target to the fruit and leafy canopy of the tree by foliar sprays.
*Calcium starts to dilute rapidly from the later stage of cell division and on to harvest.
*In Australia, potassium and nitrogen is usually adequate during the period of cell division.
*Excess nitrogen in this stage is a disadvantage as it tends to over-stimulate vegetative

growth and this reduces light interception through the canopy and robs calcium from the fruit.

*All macro and micro-nutrients in a fruit crop dilutes from the time of set on to harvest. The main reason for this is that the fruit are enlarging from the end of cell division all the way to harvest. As fruit diameter increases by 1, fruit volume increases by 4. Thus there is an inevitable mineral dilution with increasing fruit size. A typical rate of dilution for calcium is shown in Figure 2. Similar graphs are available for N.P.K.Mg.S.Mn.Cu.Zn.and B.

*The only way to be sure that macro and micro-nutrients are maintained to benchmark levels is to have fruit tested in early December (25 to 30 gms. weight) and again two weeks out from harvest. In addition a leaf test in January for Gala and early February for other varieties.

Figure 2. This graph shows the rate of calcium dilution in apples that takes place from early December on to harvest.



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3.The period of cell enlargement in the current crop.

This occurs through January and on to harvest. In the case of Gala, this period lasts for 45 to 60 days, depending on location. For Pink Lady™ and Sundowner™ this period lasts for 105 to 120 days.
During this period, calcium dilution is rapid and in most cases levels in the fruit become deficient unless supplementary calcium is applied to the fruit and tree canopy via sprays. Failure to reduce the rate of calcium decline during cell enlargement often leads to a reverse ratio of calcium to magnesium, and in pit prone varieties (Ginger Gold. Gala, Jonathan, Firmgold, Golden Delicious and Granny Smith) this greatly increases the risk of tree pit and storage pit. For Gala, in some locations, this condition is difficult to alleviate, as there is insufficient time to apply sufficient calcium sprays during the constricted period of cell enlargement. In the case of Granny Smith, Pink Lady™ and Sundowner ™there is an extra 50 to 60 days to apply an additional 4 to 5 sprays of calcium.
In this period, depending on the results from leaf and fruit analyses, additional Nitrogen (from calcium nitrate fertigation) and Potassium from (potassium thiosulphate fertigation) can be applied. Never mix these two formulations as they are incompatible.
Three weeks out from harvest foliar phosphate sprays are useful as they can improve red colour if there is sufficient chilling in autumn. These phosphate sprays will assist in providing a minimal increase in available phosphate in the tree before 'shut down' in autumn.
In hot dry summer conditions following on from a dry spring leaf chlorophyll may decline. To minimise this effect apply a foliar application of Manganese. Manganese deficiency is more likely on dwarfing stocks as they are surface rooting and do not draw from mid-soil or sub-soil layers that are always more acidic in wet areas and the Manganese level is high. (The reverse situation applies in the mid-Murray, Sunrasia and Renmark that are semi-desert locations).

4. Fruit maturation.
This stage is marked by a rapid increase in the starch level in apples. This development coincides with a start in the slow down rate of size increase in apples and occurs four weeks out from harvest.

5. Fruit ripening.
This is the most critical of all the stages in fruit growth.
Within a three-week period, apples change from being at a suitable stage of ripeness for 'Long Term CA' (LTCA) to 'Medium Term CA' (MTCA) to 'Short Term CA' (STCA). Apples can move in a seven day period from being at a 'best stage of ripeness for (LTCA) to the best stage of ripeness for (MTCA), and in a further seven days to being at the best stage of ripeness for (STCA). In a further seven days the fruit are fully tree ripe and are suitable for immediate marketing.
During the twenty-five days from the start of ripening on to when apples are fully

tree-ripe, starch in the apples is converted to sugar, ethylene is produced and there is a decline in fruit firmness. Iodine is used as a reagent to monitor the rate of starch decline. The iodine stains the cut surface of an apple to black when the fruit are immature on to no stain when the apples are tree ripe. In addition to using the starch index for measuring the rate of ripening a penetrometer is used to measure flesh firmness and a refractometer is used to measure sugar content.
Benchmark values are available that give starch, firmness and sugar levels at each stage of maturity for all of the apple varieties grown in Victoria.
A more accurate way of measuring maturity is to sample for 'internal ethylene content' (IEC) or for the rate of ethylene production by the fruit. (The EP. or green life test). (IEC) (EP) and (Green life) tests are slow and require specalised laboratory equipment.

The use of a starch-staining index for pears is unreliable. While there is a change in starch staining with the progression of ripening, the major change occurs when the fruit are starting to ripen on the tree and this is too late for storage. Measurement of firmness, sugar and fruit'bumpiness' are the main parameters to detect ripeness in pears.

6. Seasonal affects on fruit ripening.
In the period from 1993 on to 2007 I have measured the rate of fruit ripening on the same orchard blocks in the Goulburn Valley, the North East, Harcourt, the Yarra Valley, the Eastern Metropolitan and the Mornington Peninsula districts of Victoria. In this period, 1993 was a flood year throughout Victoria, and soil moisture levels were at saturation levels for most months of the year. From 1997, seasons were drier than the long-term normal. In 2002/2003 and again in 2006/2007 winter, spring, summer and autumn received rainfall levels that were below the long-term average. In these two seasons soil moisture out of winter and into spring was below field capacity. Severe summer heat events, and smoke from severe bushfires blurred the sun for more than 20 consecutive days in both drought years. In some of the dry seasons between 1997 and 2007, there were reasonable spring rains and although summers were dry, cool conditions prevailed in autumn.

In the 10-year period from 1997 on to 2007 seasonal factors caused the following response from Pink Lady™ apples.

1997. Wet spring, wet autumn. Pink Lady™ just introduced. Very juvenile. LOW SUGAR.

1998. Normal.

1999. Dry spring. Heavy fruit set. Tropical summer rain. Dry hot autumn. EARLY RIPENING, LOW SUGAR, POOR RED COLOUR.

2000. Normal.

2003. Severe drought. EARLY BLOSSOM, LATE RIPENING,

2004. Good spring rain then dry and cool. FIRM FRUIT, HIGH SUGAR, LATE RIPENING, GOOD COLOUR.

2005. Cool moist spring then dry to autumn. FIRM FRUIT. GOOD COLOUR, BUT FIRST ROSY GLOW POOLED INTO PINK LADY DATA GIVES A HIGHER THAN NORMAL COLOUR RATING.

2005. Spring rain then dry on to autumn. LATE RIPENING AND HIGH SUGAR. ROSY GLOW INCREASING OVERALL COLOUR SCORES.

2006. Cool season. Dry spring summer and autumn. HIGH COLOUR SCORE.

2007. Severe drought season Early blossom but late ripening. VERY HIGH SUGAR. WASHED OUT COLOUR EVEN ON ROSY GLOW AND RUBY PINK. POOR SIZE AND HIGH INCIDENCE OF CALYX END CRACKING.

TABLE. Performance of the six apple growing locations in Victoria in relation to earliness, firmness, sugar, colour, and yield for Pink Lady™over a ten year period. (In each column, attributes are listed in descending order. Example, internal browning in Pink Lady ™ tends to be at a higher level in the Metropolitan location and least in the Goulburn Valley).

Earliness	Firmness	Sugar	Red colo ur	Yield	Internal browning
Goulburn Valley**	Harcourt**	Harcourt **	Harcourt**	Metropolitan **	Metropolitan **
Yarra valley	North East	Peninsula	Peninsula	Goulburn Valley	Yarra Valley
Metropolitan	Peninsula	North East	North East	Yarra Valley	Peninsula
North East	Yarra Valley	Yarra Valley	Yarra Valley	Peninsula	North East
Harcourt	Metropolitan	Metropolit an	Metropolitan	North East	Harcourt
Peninsula*	Goulburn Valley*	Goulburn Valley*	Goulburn Valley*	Harcourt*	Goulburn Valley*

** Highest score. * Lowest score.