CUTTING Edge

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How Cool Is Cool?

The Cutting Edge is a regular article written by Dr Jonathan Cutting for the New Zealand avocado industry magazine, AvoScene.

A good cold and crisp winter sure has a way of focussing avocado growers, especially if you are in a cold trapping gully, somewhere in the Western Bay of Plenty. It also provides me with an ideal opportunity to further advance the discussion we began last edition of *AvoScene* on how to improve yields. Again I wish to remind all readers that the ***Cutting Edge*** is designed to be provocative, robust and to stimulate thought and discussion. It is not intended to offend anyone but I do accept that some offence may be taken, and most importantly it is not official AGA policy – just a number of ideas and concepts twisting around in my head.

As outlined previously *"In very simple terms the avocado tree is exposed to inputs; namely light, water and minerals (both gaseous and in solution). From these raw elements the tree produces photosynthates and uses photosynthates for respiration and growth. Temperature affects the rate at which these processes happen. Stated simply the production of photosynthetic products must exceed the use of the photosynthates for respiration, tree growth and maintenance. The surplus goes to fruit production and carbohydrate reserve storage. I accept this is an over simplification and that many subtleties determine how this happens. Our challenge, as growers and technical advisors, is to understand, modify and adapt the production system, based on sound scientific principles and knowledge, to perform better in terms of net photosynthetic gain. We harvest the benefits and effectiveness of our interventions in terms of regular and heavy cropping."*

So how do we advance from the obvious? Firstly, I believe, we have to accept that we do not grow avocados in an optimal climate. Most of the production areas in New Zealand are actually quite far from optimal. We are a warm temperate climate heavily influenced by the ocean and without big land mass influences. Mean annual temperatures in New Zealand avocado production areas are around 15-16°C. In reality what this climatic information tells us is that our "warm" summers are not warm, just pleasant, and that our winters are not mild, they are very cool and sometimes even cold. The impact of temperature on spring and autumn can be catastrophic. Compare our temperatures to mean annual temperatures of 19-21°C in avocado production areas in California, Spain, Israel, South Africa and Australia. The established literature would caution against growing avocados under our climates and we probably need to accept

that micro climate selection based on temperature is more critical for New Zealanders than for any other country growing avocados.

So what is the impact of low temperature on avocado trees? Well let us go back to our simple model – what is the impact on photosynthesis? Optimum temperature for avocado photosynthesis is in the range 20-24°C. A reduction, of as little as 5°C, reduces photosynthesis by as much as 20%. At 15°C day temperatures photosynthesis is reduced by 33%. When night temperatures drop below 10°C daytime photosynthesis is reduced by half. Avocados grown under cool conditions (which include short duration night temperatures below 10°C) experience chilling injury in leaves. Chilling injury results in the inhibition of photosynthesis. In avocados cold induced photo-inhibition (reduced photosynthesis) can occur over a very long period, in some years for more than 6 months. A further complication of growing tropical or subtropical trees under cool conditions is that temperatures below 8°C cause photo-oxidation of leaves. Photo-oxidation is the yellowing of leaves often seen in winter in our orchards and which develops in response to long-term exposure to non-freezing low temperatures. The literature tells us that photo-oxidation in leaves reduces the rate of net photosynthesis.

Photo-oxidation is reversible and we have some strategies for managing that in New Zealand although they are poorly understood, expensive and not widely used (an example is foliar urea, choice of rootstock or high leaf nitrogen going into winter). What we know in New Zealand is that late summer and autumn flush is most susceptible to photo-oxidation. This is largely due to the truncated summer flush when avocados are grown under cool climates and the bias toward one or at most two flushes per year. Our late summer autumn flush only becomes functional in April and May at temperatures which are too low for optimal photosynthesis. This is quite different to production in warmer climates where mean annual temperatures are such that the summer flush is fully function at optimal temperatures (20-24°C), carbohydrate accumulation is rapid in autumn and all fruit can be harvested within a 12 month period.

Growers need to be strongly cautioned as to the relevance of production practices, particularly timings, from warmer production regions. I would strongly suggest that very little of what is done in Queensland or the South African Transvaal escarpment has any relevance in New Zealand. Even the majority of the research conducted in these countries requires strong interpretation as almost invariably none of their treatments covers our climate and temperature conditions.

Better that smart New Zealand growers should be investing in production strategies aimed at maximising functional leaf early in the season (November, December and January) to maximise net photosynthetic gain at a time when temperatures are above 20°C. The AIC is currently determining the number of hours per month when temperatures exceed 20°C. A provisional look at the data shows that it is unfortunately not many hours, and the period only runs from November through to early April. The key issues are:

- How to maximise leaf area (leaf number and size) for time periods when temperatures are optimal

- Retention of functional leaves through winter so that they can contribute through spring and early summer (when temperatures are suitable) and reduce or minimise the impact of the new spring flush
- How to maintain leaf quality through winter by reversing photo-oxidation to capitalise on reduced photosynthesis on clear sunny days when temperatures are above 15°C.

Sounds simple but it probably involves everything from being smarter about shelter, through clever managed harvesting strategies, to being deliberate about fertiliser and meticulous about irrigation and integrating pollination strategies into your orchard. It is also important to maximise leaf size and minimise leaf damage by either wind or insect.

Continuing the climate theme, the effect of soil moisture should always be considered, both too much and too little. Too little soil moisture is easy and the literature is great. It is also simple and easy to understand. Dry soil, really anything below about -20kPa, causes leaf water potential to drop and this results in a rapid reduction in avocado photosynthesis. Relative humidity plays a part as well but this is probably to New Zealand's advantage with our high relative humidity when compared to desert environments.

In New Zealand the soils need to be moist in the period from flowering (September) until the air temperatures during the day drop below 15°C (typically late April). There is no good data on what is adequate soil moisture, but some work in South Africa showed yield reduction when soils were allowed to dry beyond -20kPa and we should use that as a guide but be aware of water logging and *Phytophthora* risks.

Water logged soils pose far greater risk to avocado production than dry soils. Avocado trees are relatively flood sensitive when compared to other trees. This is especially the case for soils high in organic material, with low pH and high water holding capacity (typical New Zealand volcanic soils). Photosynthesis is reduced or shuts down shortly after flooding. Water logged or flooded soils cause root necrosis in avocado. Interestingly the cause of the root necrosis (damage caused by water logging or for other reasons) has a profound difference on tree physiology as measured by net photosynthesis for the same amount of root damage. For example avocado trees with root damage caused by water logging measured at 40% necrosis had nil net photosynthesis but avocado trees with root damage, caused by other reasons (for example *Phytophthora* or normal root turnover) also with 40% necrosis had only a 20% reduction in net photosynthesis when compared to undamaged roots.

What does this mean? Clearly we should be focussing on minimising, or better still, eliminating flood risk and water logging in our orchards. There are many ways of doing this and I will not go into them all now. I have not considered oxygen in the soil at this stage but we need to remind ourselves that oxygen is important in avocados and that our BOP soils can become anaerobic rather than "hard and sealed" over time due to compaction. This is a big problem in old pasture paddocks where cows have effectively compacted the soil with their "power floating" hooves. Root growth is another whole topic and I

may address that at some time in the future.

So if I do nothing and just follow the conventional New Zealand approach what will happen? What is the alternative to a strong "input push" approach focussed on leaf quality and availability advanced in this article?

The alternative is taking two years to build up enough carbohydrate to sustain a crop (alternate bearing). Typically the "off" year is characterised by a massive vegetative spring flush (with little or no flower), followed by reduced summer flush and moderate to heavy autumn flowering. The "on" year is characterised by strong photo-oxidation in the previous winter, moderate autumn flowering, heavy determine flowering, heavy leaf drop before or at flowering, heavy fruit sets, no or limited leaf flush and difficulty sizing the crop. The cycle then repeats itself and literally wears the tree out.

I accept that there will not be much argument or discussion about the underlying research and data reported here but that there will be quite strong views on how that information should be interpreted and used (in other words how we should generate knowledge and wisdom from the data). There is nothing wrong with that and it does contribute to progress as we try many different approaches, use those that work and discard those that don't. However, it does require us to be objective, intellectually honest and dispassionate, not to be overly attached to a certain "style", and move on quickly from approaches that do not deliver. At the end of the day we are not trying to be gardeners and grow pretty ornamental trees, rather we are trying to be professional horticulturalists and the only measure of success is the amount and quality of the fruit we produce, with a strong emphasis on the amount.

How do we go forward from here? Growers need to realise that they have to be competitive in the global avocado world. In simple terms they will have to produce fruit, put it in a package and place it in global markets for less than the competition can. There will always be niche opportunities but those opportunities will open and close over short periods of time, especially for a high value commodity like avocado. You absolutely want to be there to exploit these niches but you cannot bank on them. What am I saying? We need to produce more fruit and increase yields to become more competitive and remain competitive. We are on the edge climatically and need to do more, and do things differently, compared to other avocado growers in other countries. We need to be more creative and innovative, to be more honest, to have more open minds and to encourage the development of New Zealand solutions to our problems. Very importantly we need to reduce our reliance on off-shore "off the shelf" approaches which over time will just make us less competitive. It is almost worth thinking about!