

# Talking Avocados



**Gary Lubach Memorial Plate recipients  
Beverley and Roy Williams with Robyn Lubach  
and John Bolton**

- Natures Fruit Company Conference
- Technology Exchange
- Improving Avocado Quality
- Foliar Applied Nutrients in Avocados

# AUSTRALIAN AVOCADO GROWERS' FEDERATION

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### Printing

H.W. Inprint Pty Ltd, Devonport

ISSN 1039-2394

This publication is published using Corel Ventura and is distributed free to all Australian avocado growers and is available on subscription.

**Australia** - \$27.50 (\$52.50 for 2 years) includes GST  
**NZ** - \$35 (\$68 for 2 years)

**Other Overseas Countries** \$40 (\$78 for 2 years)  
Only Australian currency accepted.

Talking Avocados is the official magazine of the Australian Avocado Growers' Federation and in conjunction with the Australian Horticultural Corporation is published four times a year (March, June, September and December).

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## Calendar of Events

### July

- 19 **Bundaberg & District Orchardists Association** - meeting Fruit & Vegetable Growers' Office, Barolin St., Bundaberg commencing 7.30 p.m.

### August

- 1 **Avocado Growers' Association of WA** - meeting Conference Room, Market City, commencing 5.30 p.m.
- 9-19 **SCAGA** - manning required for the avocado stand at the Brisbane EKKA.
- 16 **Bundaberg & District Orchardists Association** - meeting Fruit & Vegetable Growers' Office, Barolin St., Bundaberg, commencing 7.30 p.m.

### September

- 6 **SCAGA** - Quarterly General Meeting to be held in conjunction with a Field Day or guest speaker.
- 20 **Bundaberg & District Orchardists Association** - meeting Fruit & Vegetable Growers' Office, Barolin St., Bundaberg, commencing 7.30 p.m.
- 25-27 **AAGF** - Annual Reporting session. To be held at Mt Tamborine, Qld. Details to be advised.
- ? **Coffs Harbour Field Day**. Details to be advised.

### October

- 3 **Avocado Growers' Association of WA** - meeting Conference Room, Market City, commencing 5.30 p.m.
- 18 **Bundaberg & District Orchardists Association** - meeting Fruit & Vegetable Growers' Office, Barolin St., Bundaberg, commencing 7.30 p.m.

### Front Cover:

*Beverley and Roy Williams being presented with the Gary Lubach Memorial Plate by Robyn Lubach., Natures Fruit Company. Chairman, John Bolton, looks on.*

### Back Cover:

*Top - An outdoor poster to advertise avocado as a replacement for butter.*

*Bottom - An advertisement that will be appearing in several magazines.*

# Editorial - Orf Bartrop

I was saddened to hear that Astrid Kennedy was leaving the AAGF. She has held the position of Executive Officer for many years and has been a tower of strength not only to me but the whole industry. You may not know that here at TA I am a one-man-band and put the magazine together all by my self. Astrid's support has been crucial to the success of TA and I will miss her help and advice. All the best in your new endeavour Astrid!

Australia Post have given all properties in Australia a unique address, something to do with bar codes. I do not know whether it is their policy or just new posties appearing on the scene but

I am getting more and more magazines being returned showing "Address unknown". Now if all 1300+ recipients send me their mail wrapper with a corrected address, I will be swamped, but never fear, I will cope somehow!

Australian subscribers will notice on the previous page that subscriptions to this magazine have increased by 10% due to the introduction of the Goods and Services Tax (GST). Overseas subscriptions will remain at the old rate because our new GST does not affect exports. The AAGF is absorbing the GST for this year and future local subscribers will receive a Tax Invoice on renewing their subscription.

## Online Pest Management Info

Australia's largest database of pest and product information for the plant and veterinary markets has been launched on the web at [www.pestgenie.com.au](http://www.pestgenie.com.au).

Pest Genie is a free service that provides instant access to a comprehensive database of diagnostic help to assist in identification of pest problems. The system also helps users to access vital data to enable them to correctly and safely apply pest management solutions.

Pest Genie is the brainchild of Zel Bodulovic, a plant protection and IT specialist. "Our organisation is made up of agricultural and information technology specialists who are recognised experts in their field. The project is managed by people with more than 20 years hands-on experience in R & D and technical support of plant protection and veterinary products with major multinational companies," Mr Bodulovic said.

The idea for the database arose from frustration by Mr Bodulovic and many people he came in contact with concerning a lack of central information on agricultural products - their types, uses, registrations and applications.

"A huge amount of time can be spent chasing up information about individual products that are needed to solve a problem."

Mr Bodulovic's aim for Plant Genie is to see it used as the first point of contact for people seeking pest control information.

"As well as providing immediate information on products, use situations, pests (including images), packaging and use

rates, Pest Genie also provides on demand (via e-mail) all labels, technical bulletins and material safety data sheets on products on the database," he said.

Pest Genie is claimed to be the most up to date information source available in its field and it is free of charge to users. □

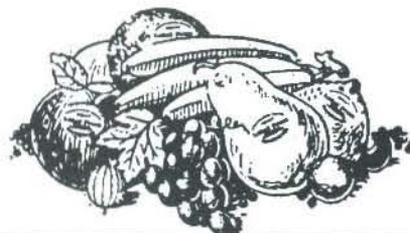
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# President's Perspective

By Rod Dalton, President AAGF

It was with regret that I received Astrid Kennedy's resignation as Executive Officer for the AAGF in late March. Astrid had held the position for more than 5 years and had professionally managed the business of the AAGF. She will be missed by all involved in our industry.

The challenge for the AAGF Board will be to find a capable replacement as soon as possible.

The recent AAGF Board meeting (April 3-5) saw a number of changes around the table. Russell Proudfoot (Central Burnett), Alan Ross (Mount Tamborine), Peter Molenaar and Chris Nelson (NSW) were welcomed to the Board. I would like to take this opportunity to thank the retiring Board members, George Green, Charlie Eden Barry Daley and Geoff Betts for their efforts and contribution to the AAGF and the avocado industry during their time on the Board. George Green has agreed to stay on

as Chairman of the RD&E committee and I thank him for that commitment.

Planning for the 2001 Conference has begun and is reported on page 19. This promises to be an excellent opportunity for growers to be updated on a wide range of research and marketing issues. A number of our major projects will be close to completion by June 2001 so the presentations will be up to date and will focus on issues of interest to growers.

The Horticultural Industry Alliance process finally gained government approval and the new company to provide the marketing and research management services to Horticulture should be established by the end of the year. There remains considerable work to be done to negotiate through all the issues involved and your Board will be needing to address a number of issues in the coming months. It is not envisaged that the current HRDC research or AHC

marketing programs will be affected by the changes in the medium term.

The 2000 Annual Reporting session to Industry is being planned for Mount Tamborine on 25 September. Please make a note of the date in your diaries. The Board looks forward to seeing a large number of growers at this important meeting. It is an opportunity for many growers to hear first hand how their industry is performing. Further details will be included in the next issue of Talking Avocados.

As is reported opposite, our new promotion program will be launched in June. This will be a highly visible program in our major marketplace (the cities) and I look forward to your feedback. In response to the market situation, in mid May some additional promotion was done using radio in Sydney, Melbourne and Brisbane in an attempt to lift demand before the new program starts in June. □

## Visit to USA

By Rod Dalton, President AAGF

I recently made a private visit to California and Florida and would like to report on a little of what I saw.

The mood in the Californian industry is quite positive at this time with a good crop being harvested, retail prices holding well and returns to growers being good despite the crop size. For example a supermarket in California was selling local Hass for \$1.99 (25s) and \$2.99 (18s) and Mexican Mangoes for 99c. Most of the fruit at retail level, I saw, was being sold in the hard green stage, which helps explain why they can still pack and ship fruit in bulk boxes. The quality at retail level was difficult to evaluate for this reason, although presentation was no better than is normally seen in Australia.

The large packing sheds can be very efficient and cost effective although their task is made easier by not having trace back systems to individual grower consignments.

The large local Mexican population appears to have a significant impact on the consumption of avocados in California. The usage of avocado by the food service industry was disappointing when compared with what we are used to in Australia. The Mexican workers are also crucial in the field where the use of machinery is severely limited by the terrain and many orchards rely

on workers using extension ladders and picking poles to harvest. Minimum wage rates are now in the order of \$5.75 per hour although much of the work is done using piece rates. Availability of farm labour is becoming a problem for their industry.

The threat of Mexican avocados gaining access to the Californian markets remains a major issue for the Californian Avocado Commission. The CAC is funded by a levy of 3.75% of wholesale price of which only 0.25% is committed to research. I met with Tom Bellamore, Senior Vice President of the CAC, and established a good line of communication between our industries on a range of issues such as promotions, access to the USA market and understanding the Mexican pest situation. The CAC manage an extensive promotion program throughout the USA and interestingly at the moment it is focused on "Genuine" Californian Avocados. The CAC website (<http://www.avoinfo.com/>) is well worth a visit.

Canopy management is a major challenge to the Californian industry as it is to us. The fact that they will not get access to growth regulators such as Cultar® and Sunny® means that they are doing some interesting work on alternative strategies such as cincturing and other growth regulators.

The cost of water is a major input expense for production. Most orchards are currently paying in the order of \$400 per acre-foot which I think equates to about \$325 per megalitre.

This very well organised industry is doing well in its domestic market. The availability of suitable land and the cost of critical inputs such as water and labour will influence future expansion. □

## AUSSIE-AVO-NET

Do you want to:

- Solve your avocado problems?
- Learn more about avocado culture and management?
- Notify other avocado growers of events in your district?
- Find out what is happening in the industry?

Then join the many growers already using QDPI's AUSSIE-AVO-NET. Log on to the Internet and go to <http://lists.dpi.qld.gov.au/AUSSIE-AVO-NET.html> (see TA March 2000; page 8 for full details).



## Industry Manager's say .....

By Wayne Prowse



### AVE AN AVO TODAY

A new advertising image for avocados has been launched for the 2000 season. Building on strong feedback from growers who want to see avocados consumed more regularly by

consumers than the "special occasions" as shown by research, the campaign will revolve around the slogan "ave an avo today".

The core emphasis will be to encourage consumers to use avocados as an alternative to butter. In this way consumers will be able to perceive using avocados daily as they use butter and margarine. Apart from the complementary taste of avocados used with other spreads, the campaign will focus hard on the health benefits with the headline "some butters actually lower your cholesterol".

Outdoor posters (see back cover) at 85 sites around major shopping centres will get attention with a cut avocado and butter knife clearly linking the use of an avocado to the daily ritual of spreading butter. These will be seen for 4-6 weeks from mid June, and again in October.

Food focused magazines such as Australian Good Taste and Australian Table will carry half page ads featuring an avocado spread on toast (see back cover). The theme will be linked to in store material via retail posters and new recipe leaflets with simple and warm "everyday" recipe suggestions that involve using avocados as a spread. Ads will appear from July issues through to November.

The campaign has been developed by Odd Fellows Advertising in response to a new brief prepared by the Marketing Forum. It is an excellent example of how growers' views have been heard and used as the basis for a new campaign.

### FOOD & HOTEL ASIA

**Singapore - April 10-14.** The Australian Horticultural Corporation included a dedicated section for avocados at its stand at Food & Hotel Asia (FHA) this year in Singapore. The AHC's role at the exhibition was to raise awareness of fresh Australian fruit and vegetable products and introduce

customers to Australian suppliers. FHA is one of the premier food exhibitions in the region and attracted over 50,000 visitors from throughout the Asian region.

With growing industry interest in Avocado exports to the region it was an opportunity to test customer reaction to Australian avocados and find more about the hurdles that the Australian industry must clear if it is realise new opportunities for exports.

The avocado display generated considerable interest and the most common comments was "I have never seen such large avocados". Although they were a count 23-25 of Shepards and Hass varieties a look at the avocados displayed in 3 supermarkets confirmed the background of the comment. Avocados in Singapore (in April at least) were all supplied from Carmel in Israel, were very small (bulk pack) inconsistent degrees of ripeness and not too appealing. Prices ranged from 99c to \$1.49 each and not surprising the \$1.49 avocados were in the worst "over ripe" condition, probably because they were not moving.

Avocados are not well known in Asia though many who knew avocados used them as a smoothie type drink with honey and milk. A few café owners remarked how they were using avocados as a spread and becoming popular with customers, while another used avocado as a drink base at "Tropical Drinks Corner" in Singapore.

Opportunities to supply major hotel chains exist; however, there is obviously lack of knowledge on how to ripen and prepare avocados. At one dinner we attended, sliced avocado was served in a hard green state, not in the way we expect avocados to serve.

In the supermarkets Australian avocados could compete with the smaller varieties and command a premium in the longer term; however, this would need to be supported by a significant promotion program to encourage correct handling and use of avocados. When we have difficulty in supplying a consistently clean flesh product in Australia where consumers are more aware of avocados, the challenge to supply supermarkets directly in Asia and generate demand over the cheaper and smaller avocados is much greater.

Not surprisingly one of the issues that came through was the ability of Australia to supply long lines of consistent quality fruit

at a consistent price. People lost interest when finding out that Shepard avocados were only available for 3 months. Whilst we could potentially supply Hass avocados year round with co operation between East Coast, SA and WA suppliers, consistent year round prices remain a challenge when prices are high in domestic markets.

In 1998/99 Australian avocado exports were a small 151 tonnes, mainly to Singapore, and Hong Kong. Certainly opportunities exist in niche areas. Real growth in exports to Asia will not happen without considerable cooperation between suppliers and customers and a much greater understanding of consumer needs. □

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## TALKING AVOCADOS - HAVE YOUR SAY

Dear Sir,

As a member of the organising committee of the NSW Avocado Growers Association Nutrition Presentations and Field Day held on 14 May 1999 at Ballina NSW, I make no apologies for the content matter presented on the day. In attendance were almost 100 growers, the largest gathering in the Richmond area in some time. The committee received not one complaint from any attendee but did receive many favourable comments.

There has been some criticism of just one of the four presentations, that of Nutri-Tech Solutions (NTS).

I make reference to the opening paragraphs of the address in question (Talking Avocados December 1999, page 11). "We (NTS) have adopted an educational policy where we have attempted to increase grower awareness of the mechanics of fertility and the techniques required to increase sustainability without loss of production or profits."

**Is this not what all growers are striving to achieve?**

As an Avocado grower I do not have the technical expertise to make comment on any scientific points raised in the presentation. Suffice to say, having read about the NTS way for some time now I am gaining a much better understanding of nutrition and its impact on growing quality avocados.

I have been using NTS personnel prescription blends for the past 3 seasons.

It is in my opinion it is too early to make an unqualified recommendation but for the information of my fellow growers I have some production figures that may be of interest. The figures are for Fuerte shown as a percentage between Grade 1 and 2 and the last column is total production (TP) using 1997 as a base.

YEAR	1 <sup>st</sup> Grade	2 <sup>nd</sup> Grade	TP
1997	64%	36%	100%
1998	73%	27%	138%
1999	67%	33%	140%
2000	82%	18%	168%

As my fruit is marketed through a group marketing company and packed through a HACCP accredited ISO9002 audited packshed, I have the opportunity to benchmark the quality of my product against other growers in our area. At the end of this letter is a testament from the packshed manager at Summerland Fruit Packers.

As the season progresses I will monitor the Hass crop and would be pleased to report further as production figures become available.

As 1998 was the first season in which NTS prescription blends were used in our

program it may now be having some impact on the quality of our product. Of course there are many factors which come in to play in our quest to produce the perfect crop and nutrition is just one of these, albeit a very important one.

May I suggest to my fellow growers to maintain an open mind in this all-important area of nutrition. And remember, if you haven't tasted the wine how do you know it is sour.

Warren Everingham  
Lismore

### Testament by Summerland Fruit Packers

The first noticeable difference in Warren's fruit is the superior quality. The fruit on arrival is far better in size, shape and colour than other fruit we receive for packing.

At this stage of the 2000 Fuerte season the pack out across all growers has been 60% first grade, 40% second grade

Warren's fruit has packed at 82% first grade and 18% second grade.

The most significant statistic is the percentage of optimum size fruit—avocados in the 16 to 25 size range—which give the grower the highest return from the market place.

The shed average for first grade fruit in the optimum size range is 51% of all fruit packed, Warren's is 74%.

From a packing shed perspective, this is the ideal fruit to pack. Firstly, it achieves the maximum return for the grower and secondly, it flows through the shed quicker than poor quality fruit requiring fewer grading personnel and consequently costing the grower less per unit in pack costs.

JOHN PARMITER  
Pack Shed Manager  
Summerland Fruit Packers  
Wardell Road  
ALSTONVILLE NSW

### Avoguard™ - Not Registered, Not Tested Geoff Waite, Principal Entomologist

Growers of all sorts of crops including avocados, macadamias and custard apples have been inquiring about Avoguard™, an organic product that is promoted as being a repellent/feeding deterrent for fruitspotting bugs and with bonus effects on various other crop problems.

Company literature supporting this product infers that appropriate testing has been conducted by me and that the results are fantastic (anything that can restrict fruitspotting bug damage to less than 0.5% as claimed, under heavy pressure, has got to be a miracle cure!). The fact is that I have not tested the product in the field apart from a small caged fruit experiment that I conducted in March after a laboratory experiment showed no repellency whatsoever.

The field experiment also showed no effect! A proper large-scale field trial was not conducted because the sample of Avoguard™ was not received until January, long after most fruitspotting bug damage had occurred in all crops.

I would be ecstatic if a product such as this could be used to manage fruitspotting bugs, especially if the 30 day effect in fine weather and the 21 day effect in wet weather as claimed on the label, were achieved. However, until proper field trials with comparative alternatively managed blocks are undertaken, I reserve my judgement.

If anyone has used Avoguard™ or intends to use it next season, I would be pleased to receive any comments and to monitor its effect in the field. I can be contacted by Ph: 07 5444 9626 or E-mail: waiteg@dpi.qld.gov.au



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# Australian Round-up



At the time of writing this report, we are about to start picking this season's avocados. Talking to growers in the area it seems to be an average to heavy crop.

The SAAGA AGM and Seminar was held on 17 May at Waikerie. It was well attended with 45 growers present from Robinvale in Victoria, Sunraysia, through to McLaren Vale south of Adelaide. The growers did not come only for the AGM, but also to hear and learn from our guest speaker, Mr. Jan Toerien, talking on Total Canopy Management.

Jan spoke on what is needed to control an avocado canopy and to increase production per hectare. He told the audience how this was being addressed in Queensland, South Africa, Chile and Israel. Jan stressed the need for pruning for shape and timing of application of Plant Growth Regulators.

After lunch, the group went into an orchard and was shown what Jan had talked about. Growers asked many questions and discussed Jan's methods. Most of the questions were centred around the effect of the different climates, soil pH and timing of picking.

After the orchard walk, the day ended with a BBQ and a good supply of red wines.

A big thank you to all those who helped, especially Chiquita for supplying avocados for lunch and meat and nibbles for the BBQ.

The next big item on our calendar is the Royal Adelaide Show in September. □

to go in terms of fruit handling, packaging and marketing strategies.

**Fruit handling** is now the subject of a very important project, sponsored by AAGF.

**Packaging** inconsistencies urgently need attention. Packaging in Australia is somewhere around 6kg—it is not 4 kg, nor 5 kg, nor 5.5 kg—as a matter of fact it is anything but a standard minimum weight.

**Marketing strategies** need to include export aspects, not only to high exposure areas like Europe or US, but also to niche markets in other parts of the world.

These issues, which are of crucial importance to the Australian avocado industry, are on the AAGF agenda and hopefully there will be significant movement on all three in the near future. □



The NSW harvest is finally underway for Fuerte. April and May have seen many wet days which has played havoc with

our ability to harvest. This extended wet weather is having a detrimental effect on the quality of our fruit, with fungal diseases taking their toll.

Some growers have also reported record damage from Fruit Spotting Bug. As is often the case, the FSB will cost many growers dearly.

A Field Day for late September is being organised by the Coffs Harbour branch. Once details are known we will let you know. □

## Sunshine Coast

In January 2000, the Sunshine Coast Avocado Growers Association Inc became an incorporated body with QFVG Inc. All the administrative requirements have been put

in place and growers input about new rules are sought in an endeavour to shape and streamline the new entity.

Thanks go to the SCAGA outgoing office bearers and members of the executive for a job well done. Thanks in particular to Barry Back for taking the reins of the association during the difficult transformation period while the association became an incorporated entity.

Henry Kwaczynski recently visited a number of avocado producing and consuming countries and it was painfully obvious to him that Australia has a long way

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# Natures Fruit Company's First Conference An Overwhelming Success

By Col Scotney, Marketing Line Consultancy, Bundaberg

Over one hundred and thirty company members and industry representatives attended this year's inaugural Natures Fruit Company conference held at the Noosa Lakes Resort on Queensland's Sunshine Coast. The avocado conference, under the theme 'Growing for Profit', took place on the 3 and 4 of February. It was an outstanding event, both in content and presentation.

The conference was officially opened by the Queensland Horticulture Institute (QHI) Director, Grant Hall. Mr Hall praised the role Natures Fruit Company played in the industry. "The company," he said, "provided a very good model for cooperative marketing.

"The consumer wants quality and presentation," Mr Hall said. "This will drive producer groups to establish and participate in more effective and integrated industry organisational structures involving the whole supply chain."

Mr Hall used the opportunity to speak on the future direction of Queensland Horticultural Institute (QHI). "The focus of QHI's role was changing," he said, "from research to marketing—post farm gate. Having reached a stage of maturity, I believe the avocado industry to be leading edge in successfully marketing its product."

'Growing for profit' was what this conference was all about with keen interest from the 110 grower members of Natures Fruit Company present. The company's current membership of 200 avocado growers extends from the Atherton Tableland in north Queensland to the NSW north coast and west to Toowoomba. Packing shed facilities are based at Nambour, the Atherton Tableland and the NSW north coast.

Along with the company's far-flung membership, 'TEAM Avocado' growers from New Zealand also attended the conference.

## Presentations

Natures Fruit Company Director, consultant and conference convener, Graeme Thomas, spoke of the need to focus on maximising yields and growing fruit within an ideal size range. "Growing for profit," he said, "meant increasing fruit production per hectare."

Mr Thomas presented the Australian average seasonal yields of 7 tonnes per hectare. Whilst a physiological obtainable yield of 33 tonnes per hectare was possible with a sustainable yield of 25 tonnes, he believed an achievable yield for growers was 20 tonnes per hectare. He said that the message from these examples was clear, "Increase fruit production per hectare and increase profits."

Key conference speakers from Queensland's Department of Primary Industries (QDPI) reported on avocado research projects currently being undertaken in the state.

Dr Tony Whiley spoke on the 'Phytophthora and Canopy Management' project being funded by the AAGF (through its R&D Levy), the HRDC and the QHI. He believed five metres to be a good working height for trees and discussed various tree width percentages and their production advantages.

Dr Sonia Willingham gave presentations on 'Anthracnose Fruit Rot Management' with the project's aim being to develop disease control by boosting natural resistance.

Also from the QDPI were Dr Peter Hofman who gave a presentations on 'The effects of handling practices on Avocado Quality' and 'Cold Disinfestation for Export' while Dr Chris Searle gave a comprehensive report on the Fourth World Avocado Congress held last year in Mexico.

Home to the avocado, Mexico has approximately 124,823 hectares of commercially grown avocados producing up to 1,148,547 tonnes of fruit annually. Over 90% of Mexican fruit is consumed on the domestic market with the remainder being exported to other central American countries, the USA and Europe.

Dr Searle says there is a window of opportunity for Australian producers in the USA market. At this stage, only 19 North/Eastern states accept avocado imports from Mexico and then only under strict quarantine regulations. "Export spraying to meet quarantine requirements is having a major ecological impact on production practices," he said, adding, "and they cannot implement an Integrated Pest Management (IPM) program."

Graeme Thomas said that irradiation was now an accepted means of disinfesting a range of horticultural products in a number of countries including the USA.

Reporting to the conference on irradiation trials undertaken by the company in October last year, he said that although they were successful from a disinfestation point of view, the discolouration of the flesh had ruled out this process as an option.

"Irradiation has proved successful with fruit due to its sugar content; however, the oil in avocados caused browning discolouration of the flesh which made the fruit unmarketable," he said.

A collaborative project, involving the Natures Fruit Company and Childers growers, John and Jay Dorrian and Ron Simpson, is currently being undertaken by the QHI to research 'Cold disinfestation for export'. Dr Peter Hofman reported on a possible breakthrough in holding avocados with cold air at 10 degrees for a number of days—the exact number of days is currently 'under wraps'.

Considerable interest in this breakthrough came from the New Zealanders at the conference. New Zealand production is estimated at over 2 million trays for 2000/2001, rising to 3.4 million by 2005/2006.

Colin Partridge, the Technical Manager of the NZ company 'Team Avocado', addressed the conference on his company's involvement in the exporting (over the past three seasons) of Hass avocado to California, USA. He spoke of challenges encountered in developing the export market due to long shipping and storage times of up to 30 days.

"Meeting and overcoming these challenges," he said, "involves a range of disciplines comprising the implementation and application of technical, operational, logistical, monitoring and administrative systems."

There was much to learn at this inaugural Natures Fruit Company conference with an incredible volume of information conveyed to delegates.

There were speakers on topics such as 'Size Picking to maximise profits' (George Green), the 'World Avocado Market' (Tony Walsh of the AHEA), 'Protocols and Procedures' (Rod Dalton) and 'Processing

## NATURES FRUIT COMPANY

Grant Hall, Director QHI, Chairman John Bolton opening the conference.

Chairman John Bolton addressing the conference



Avocados' (John Dorrian of Dorrian Farms).

The GST (and its implications for growers) was on the conference agenda as was marketing, with an excellent presentation from Damian George of Simon George and Sons.

Mr George spoke of the trends, needs and the implications for the future of the three key customer groups—the market place, the food industry and the consumer.

Wayne Prowse, AHC Program Manager, outlined the industry's 2000 avocado

promotional campaign that, he said, would deliver a stronger 'year round usage' message to consumers. He estimated that the total value of the media coverage was in the vicinity of \$406,000, if we had to pay for the free promotional space achieved by careful strategic planning.

In 2000, Natures Fruit Company's promotional campaign will target the young with free giveaways such as a Baby Bib, Kindy Bag and Lunch Box. And on the company's promotional 'drawing board' are snack

packs, pasta pack recipes, pre-packs of avocado and salad and a Mexican promotion.

### Summary

The conference theme, Growing for Profit, was well targeted throughout the two-day proceedings. The inaugural event was extremely professionally organised with outstanding venue facilities. And the all-inclusive registration cost to the company's 200 membership was a mere \$100.

The value for delegates was incredible with excellent presentations, a magnificent conference dinner with top entertainment, free giveaways such as a company shirt and cap—the list goes on.

Company chairman, John Bolton, said the low cost registration was achievable only through generous sponsorship for the event. He thanked the sponsors for their overwhelming support, many of whom participated in an exhibition adjacent to the conference room.

Natures Fruit Company is a significant Queensland industry success story along with other cooperatives such as Gaypak based at Gayndah in the central Burnett. The company's eleven-year success story confirms its growers as major stakeholders in the Australian avocado industry. For the Natures Fruit Company, this inaugural conference was a celebration of this achievement. □

## 1999 Natures Fruit Company Awards Presented

By Col Scotney, Marketing Line Consultancy, Bundaberg

Natures Fruit Company recently announced the recipients of its 1999 Quality Awards at the Gala Dinner of the company's inaugural conference held on Queensland's Sunshine Coast. Venue for the conference was the Noosa Lakes Resort.

Natures Fruit Company is a cooperative of currently 200 avocado growers with a membership stretching from the Atherton Tableland in north Queensland to central NSW and west to Toowoomba. Its main packing and marketing operations are carried out at the company's Nambour base.

The awards were created in 1998 to acknowledge those grower members who made that extra effort to produce an outstanding quality product. Last year's recipients of these prestigious quality awards for the 1998 season were **Philp Orchards** at Hampton, north of Toowoomba (up to 2500 trays) and **Montrose Nominees** (over 2500 trays) at Mt Tamborine.

For the 1999 season, this year's award presentations went to **Ken and Carol Groundwater** from Stuarts Point in central NSW (under 2500 trays) and **Tom and Robert Gorton** from Winfield, north of Bundaberg for quality packouts over 2500 trays.

Natures Fruit Company's chairman, John Bolton, congratulated the growers on their awards, praising their efforts to achieve outstanding quality fruit in 1999. The Groundwaters had a Natures Reserve premium packout of 87% and the Gortons a packout of 82% for tray sizes 18 to 25.

The Gary Lubach Memorial Plate, a perpetual trophy, was a new award created in memory of the late Gary Lubach, a company stalwart and director, who passed away last year. The award recognises the grower who produces the highest increase in first grade quality fruit.

**Roy and Beverley Williams** from Blackbutt in the South Burnett, were the inaugural recipients of the trophy

presented by Mrs Robyn Lubach. Accompanying all the awards was a weekend for two at the Noosa Lakes Resort (see front cover).

"Growing for profit," Mr Bolton said, "is what our company is about and quality has always been the keystone of our eleven years of operational success. That success would be unachievable without the efforts and dedication of our members.

"After all, it is a quality avocado product that is the foundation of the company's reputation as a consistent long-line supplier." Natures Fruit Company expects to market in excess of its 1999 throughput for the 2000 season, confirming its growers as the major stakeholder in the Australian industry.

Mr Bolton said that the quality awards were, he believed, a first for the avocado industry and created friendly competition among co-op members. □

# Technology Exchange Within The Avocado Industry

By Simon Newett and Geoff Waite, QDPI Nambour, Chris Searle, QDPI Bundaberg, and Alan Blight, AAGF R & D Committee, West Australia

The authors of this report attended the World Avocado Congress in Mexico last year. While overseas, they took time out to visit South Africa and the United States of America. Articles on several subjects appeared in the March 2000 editions of this magazine and here are a few more extracts from their visit report. Further articles will appear in the next issue of Talking Avocados.

## Nutrition

### Nutrition observations in Mexico

In most of the orchards visited in Mexico, boron and zinc deficiency symptoms were widespread (Figures 1 and 2). Leaf analysis data supported these observations. Leaf boron was around 25 ppm and leaf zinc was around 24 ppm. Soil boron was around 0.6-1.0% (clay loam soils) and soil zinc around 2-4 ppm. Soil phosphorus was also very low at some sites (as confirmed by classic P deficiency symptoms in corn growing in the area), for example 3-9 ppm (Bray test).

Some research had been done on soil P levels and yield response, which indicated an optimum soil P level of about 40 ppm (Olsen test).

Leaf and soil analysis was used to some extent. Very high leaf potassium (3.77%), which apparently was due to inherently high potassium in the soil was noted in one orchard; however, potassium fertiliser was still being regularly applied.

### Application of manure to orchards in Mexico and excess nitrogen

An observation trial at an orchard in Mexico indicated that a rate of 360 kg/tree

**Figure 1. Characteristic swollen internodes of Boron deficiency and the mottled leaf symptoms of Zinc deficiency in Mexico.**



of fresh cow manure, reduced yield. This was blamed on excessive nitrogen. The cut-off nitrogen leaf levels for yield increase were about 2.3% in Hass and about 2% in Fuerte.

### The DRIS system (Diagnostic Recommendation Integrated System)

Dr J. Cutting presented an overview of this approach, which was developed by Dr Beaufilet at the University of Natal, South Africa. This is a system for determining plant nutritional requirements based on correlating crop performance with nutrient levels and balances. It is equivalent to a

**Figure 2. Small leaves and mottling are symptoms of Zinc deficiency; leaf Zinc levels were typically around 20 ppm in Mexican orchards.**



large experiment, with data collected from participating orchards. Dr Cutting has been applying it to avocado orchards in New Zealand where orchards yield over 15 t/ha and have a fruit size typically over 280 grams.

### Important ratios are:

N:Ca 0.6 – 0.7 -if too high, excessive vegetative growth and low yield.  
-if too low, tree lacks vigour and has small fruit.  
Ca:K 2 -if too low, post harvest breakdown occurs.

However correct ratios can be found in both high and low yielding trees.

The DRIS system tends to aim for leaf target levels rather than ranges, and soil target levels rather than norms. Ratios and target levels tend to be specific for each soil type. Under NZ conditions the target Ca level is greater than two, and the target leaf B level is lower than in Australia. The presence of Ca appears to enhance K uptake.

### Boron research in South Africa – Zac Bard

This research was done by Zac Bard as an MSc study supervised by Prof Nigel Wolstenholme. It aimed to test the findings of Whiley & Smith in Australia under South African conditions. A survey of orchards showed leaf boron levels to be mainly in the 20-40 ppm range. As a rootstock, Edranol was shown to be 40% more efficient at taking up boron than is Duke 7. It took 18 months to get leaf boron levels up to the 40-60 ppm range.



The article on this page is sponsored by HRDC and the avocado industry.

## Foliar nutrient applications – Carol Lovatt

In order to develop strategies to increase fruit set, size and quality, a closer look was taken at foliar nutrients. Foliar nutrients have the potential to be applied in lesser quantities and are therefore less expensive and less polluting to ground water.

Uptake from foliar nutrients has to be via open stomata. The thickness of the waxy cuticle also influences the degree of uptake and this has been found to vary in the avocado leaf in different growing environments. Leaves need to be still developing and not more than 2/3 expanded. They cannot take up urea once they have hardened.

### Effect on pollination

In order to improve effective pollination, the two critical elements of pollen tube growth and of ovule viability were investigated. Foliar boron was investigated to

speed pollen tube growth and foliar nitrogen was investigated to improve the longevity of the ovule. The four treatments, applied at the "cauliflower" stage of flower bud development, were as follows:

- Control
- Boron only (6.15 g of boron as solubor in 15 litres of water)
- Nitrogen only (160 g of nitrogen as urea in 15 litres of water)
- Boron and nitrogen

The trees treated were Hass and three years of data were collected. The only treatment to have a positive effect was the foliar boron in Year 2.

The combined B + N treatment resulted in more flowers with double stigmas, styles and ovaries that then abscised and actually resulted in a slight

decrease in yield. The most likely reason why foliar boron worked in some years and not others was temperature at flowering—if it was too cold there was no outcrossing.

Temperature	Success Rate
27°C day & 20°C night	95%
17°C day & 12°C night	32%

There were only hardened leaves at the time of foliar applications suggesting that nutrient uptake was through the flowers. Trunk injection of boron increased boron levels in the leaf but did not increase yield, suggesting the importance of boron levels in the flowers.

Temperature	Boron	Result
Low	X	Pollen tube dies
Low	✓	Pollen tube grows but no fertilisation of ovules
Favourable	✓	Successful pollination

## Physiology

### The evolutionary ecophysiology of the avocado tree as a basis for pre-harvest management – Nigel Wolstenholme & Tony Whaley

Evidence suggests that the avocado has been used as a food source since 7000-8000 BC. There are genetically diverse types. Avocados were first grafted in commercial numbers only in 1920, so we are still in the process of domesticating it.

	Good growers	Best growers
Yields achieved in semi-arid conditions	8 to 12 t/ha	12 to 15 t/ha
Yields achieved in warm subtropics	12 to 15 t/ha	15 to 20 t/ha

The fruit stores oil, which is more expensive for the plant in terms of the energy used to manufacture it, compared with sugars.

In the wild, Mexican and Guatemalan types grow at high altitudes under high summer rainfall and dry winters in montane neotropical cloud forests. Avocados are canopy trees that can grow to 20-30 m, the canopy has a relatively low photosynthesis rate, productivity is limited by low light (cloudy conditions) and the tree has high construction and maintenance costs (tall trunk and long limbs).

The avocado follows the Raul model of growth that is characterised by rhythmic flushes, flowering on the periphery and

very plastic reiteration (can easily assume shape again after pruning). There is competition between the spring flush and fruiting. Leaves have a short life and the last flush is most likely to flower.

### Adaptive strategies of avocados:

- Vegetative.
- If light is scarce it needs to grow very rapidly.
- Shade tolerant.
- Self mulching.

- Litter feeder.
- Hoarding and recycling nutrients where scarce (natural environment is usually low in nitrogen and phosphorus).

### Reproductive:

- High light requirement for heavy flowering.
- Heavy peripheral flowering wasteful of resources.
- Very low fruit set with bottleneck at flowering.
- Exceptional potential to adjust crop load.
- Irregular fruiting.
- Large seed full of nutrient.

### Succession spectrum:

- Giant trees.
- Long juvenile stage.
- Seeds can establish in shade.
- Well protected (chemically) leaves.

### Pioneer features:

- Short leaf life.
- Tall.
- Superficial rooting.
- Low light density growth.
- Reproductive capacity – small gap successionist.

### Seed dispersal ecology:

- Delayed fruit ripening.
- Adapted for now-extinct mega-herbivores.
- Inedible seeds.

### Key physiological features:

High carbon fixation potential but carbon reserves are easily depleted because there are few leaves intercepting light. The tree has an ability to adapt and to store carbohydrates but these carbohydrate levels can be easily depleted under stress.

### Water relations:

Sensitive to atmospheric moisture deficit, the tree tolerates it by closing down stomata but this comes at a cost.

Perseitol, the white crystalline substance seen on wounds, is one of the main sugar transporting chemicals. It will receive more recognition in the future as an important compound in avocados.

The goal of the tree is to produce seed; the goal of the grower is to produce flesh.

## Alternate bearing in Hass and the role of nitrogen – Carol Lovatt

Alternate bearing in Hass is generally considered a problem because in an “on-year” the fruit price in the market is reduced, whilst in an “off-year” prices are good but there is not enough fruit.

An “alternate bearing index” has been developed:

$$\% \text{ alternate bearing} = \frac{(\text{Yield 1} - \text{Yield 2}) \times 100}{(\text{Yield 1} + \text{Yield 2})}$$

- If there is no alternate bearing the index = 0.
- If the alternate bearing is extreme the index = 100%.
- In California the index generally lies between 57 to 90%.

Alternate bearing is initiated by environmental conditions that either limit yield or lead to excessive crop production.

### Environmental factors that can limit crop production are:

- Too little chilling.
- Adverse climate.
- Excessive summer fruit drop.

### Environmental factors that can lead to excessive production:

- Optimum chilling.
- Optimum conditions.

### Alternate bearing is perpetuated by:

- Carbohydrate availability (not always a major factor as a vegetative tree can still have high carbohydrate levels).
- Nitrogen availability (not always a major factor and if too low can lead to an “off-year”).
- Plant growth regulators (plant hormones, thought to “turn-off” flowering in off-years).

### Alternate bearing is a function of the number of flowers. The effect of the “on-year” is to:

- Reduce the number of inflorescences.
- Increase the number of vegetative shoots.

- Reduce the summer/autumn vegetative flush thus limiting the amount of bearing wood.
- Indeterminate wood carrying the current fruit does not produce flowers, only vegetative flush.

The treatments in the following Table were applied in order to investigate whether nitrogen can be used to manipulate alternate bearing.

Trials with plant growth regulators (PGRs) increased yield and reduced the Alternate Bearing Index by 15%. Naturally produced PGRs from the fruit still on the tree, suppressed flowering.

NITROGEN TREATMENT (equivalent southern hemisphere times)		CUMULATIVE YIELD OVER 4 YEARS
a	Standard only (140 kg N/ha split into 5 doses)	
b	Standard + July 56 kg N/ha	
c	Standard + August 56 kg N/ha	
d	Standard + October 56 kg N/ha	6.8 t/ha extra, larger fruit, alternate bearing index reduced by 15%
e	Standard + December 56 kg N/ha	
f	Standard + May 56 kg N/ha	8.6 t/ha extra, larger fruit, alternate bearing index reduced by 18%

## Canopy Management

### South Africa

A day was spent with Jan Toerien, avocado consultant in South Africa and Australia and former Managing Director of Westfalia Estates and then President of the International Avocado Society. Jan Toerien has been working with Professor Isaak Adato and Ehud Gafni both of Israel to adapt an Israeli canopy management system to work in South Africa.

The system combines excellent growing practices with carefully timed shaping, pruning and Sunny® spraying in a total management system. Jan stressed that for the system to work management must be of the highest order and trees must first be in perfect health.

We were accompanied on our visit by Professor J.M. Kotze, now retired, but formerly Managing Director Westfalia Estates and Professor of the Department of Microbiology and Plant Pathology,

University of Pretoria. A second day was spent with Derek Donkin visiting nurseries and Westfalia Estates.

### The essential elements of the new canopy management system in South Africa

- The system is an integrated, total management process.
- Trees must be healthy to start with.
- Orchard management must be of the highest order.
- Nitrogen and water must be managed very carefully.
- Fruit needs to be picked soon after it is legally mature, if fruit is picked late then yield cannot be sustained since carbohydrate levels in the tree run down.
- A shaping cut is required every few years to create the desired Christmas-tree shaped hedgerow (Figures 4 to 7) and to create a flat fruit bearing surface or platform.
- Plant Growth Regulators are sprayed on the flowers to improve fruit set and size.

- Since the spring flush does not produce bearing wood but the summer flush does, it is the spring flush that gets trimmed off and it is the summer flush that is managed.
- The summer flush (that appears about 5 weeks after the spring flush is trimmed off) is managed by spraying it with Plant Growth Regulator to reduce its growth.
- The objective is to have mature wood (from the summer flush) exposed to direct sunlight in autumn for flower initiation.

### Canopy Management at ZZ2 estates

Soekie Verspach (production manager) and Ben Durand (agronomist who attended AVOMAN training) hosted the visit. ZZ2's main crop is tomatoes, but they have about 200 ha of avocados and some mangos. The main orchard visited was at Mooketsi in a warm dry environment, situated at about 660 m in a rain shadow area (about 380 mm



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per year). Soils varied but were mostly a sandy loam with some gravel.

### 1st block visited (Mooketsi):

Spacing 7 X 7, Hass and Fuerte, 19 years old. Trees were overgrown, forming a complete canopy. Recent yield history:

- Prior to canopy management system - 15 t/ha.
- First year of canopy management system - 18 t/ha (in spite of the severe prune, yield increased and packout reached 95% due to increase in light penetration into the canopy).
- Second year of canopy management system - 21 t/ha.

### **Treatment:**

1. Soon after harvest was completed (May on the Fuerte and August on the Hass) a severe vertical side cut was made on eastern face of each row at a distance of 3m from the tree trunk, this removed 2m of growth.
2. In November/December a fine cut (this time at an angle to the vertical) was made to the same side removing about 15-25 cm of growth (the spring leaf flush outside the fruit).
3. About five weeks later the resulting regrowth (summer leaf flush) from this light prune was sprayed with Sunny® at 0.5% (just to the E face). This is the regrowth that will initiate flowers the next year.
4. At flowering a 1% Sunny® spray was applied.
5. After harvest in Year 2 the western face was severely pruned.
6. In November/December a fine cut (this time at an angle to the vertical) was made to both sides removing about 15-25 cm of growth (outside the fruit).
7. About 5 weeks later the resulting regrowth from this light prune was sprayed on E & W faces with Sunny® at 0.5%.
8. At flowering both sides sprayed with Sunny® at 1%.

It was claimed that there was no season without yield with this system (see Figures 3 and 4).

### 2nd block visited (Mooketsi):

Block on 5 X 5m that was severely pruned on both sides (refer to Figure 7) at the same time to give a pyramid shape (Figure 3). Because the interrow spacing was close (5m) the angle of cut had to be quite steep in this orchard. White plastic water-soluble paint had been applied to the remaining trunks and branches to prevent

**Figure 3.** A method used in South Africa to deal with severely overgrown orchards. A mechanical saw is used to achieve the Christmas-tree hedgerow shape. The trees in the foreground have been pruned a few months whilst those in the background were pruned a year earlier. They claim only one year of production is lost. The protective paint can be sprayed on.



**Figure 4.** An example of the tree shape and size that is being aimed for under the new canopy management system in South Africa. Note the triangular tree shape to optimise light interception and the tree height of about 4 to 5 metres.



sunburn. Trees that had been pruned this way the previous year were recovering well. The grower stated that only one year of production was lost.

### 3rd block visited (Mooketsi):

Fuerte on 10 X 5 m spacing, under the canopy management system and doing very well. This had originally been a 5 X 5 m spacing but alternate rows had

been removed. However, 10 m was recognised as being too wide an interrow. The trees had been mechanically pruned to give an interrow laneway of 4 m which was regarded as unnecessarily wide and a canopy

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width of 6 m. This canopy width was also too wide, not conforming to the 3<sup>rd</sup> tree size rule ("no part of the canopy should be more than 2 to 2.5 m from direct sunlight"), and as a result the interior of the canopy was devoid of leaf and fruit.

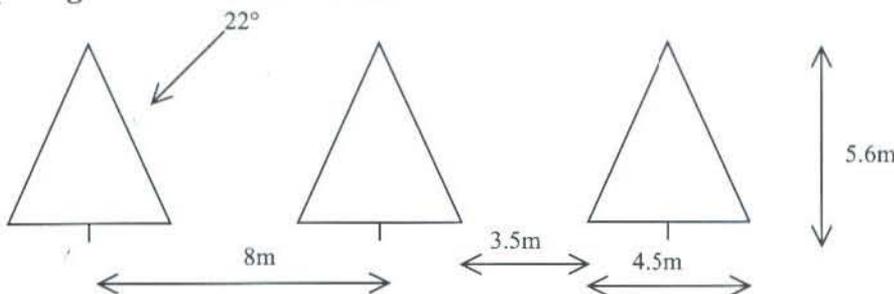
**4th block visited (Duiwelskloof):**

Spacing 5 X 5 m, between Tzaneen and Duiwelskloof on the Modjadji road growing in a much wetter environment. Vigour was too high due to excessive nitrogen (up to 3%) and higher rainfall. Generally considered that the 5 X 5m spacing is too close and that it will require a high degree of management to control the canopy, especially in this wetter environment. Originally, plantings at this 5 X 5 m spacing were to incorporate a diagonal tree thinning to leave a 7 X 7m spacing.

**Notes**

- North/south row orientation.
- Aiming for a hedgerow.
- Aiming for a pyramid shape, topping is NOT done, the angle cutting will take care of the height. Individual limbs are removed if they are very tall.
- Advantages of mechanical prune vs. individual limb removal—the regrowth is diluted over a much larger proportion of the tree.
- Important to understand the difference between a "shaping" prune and a "management prune".
- Important to control vigour by limiting nitrogen applications—may involve aiming for a leaf level of about 2 to 2.2% N.
- ZZ2 irrigates every day at Mooketsi (this is a very dry area) with 200 litres per tree (two 50 L/hr sprinklers per tree for 2 hours).
- Fertigation is done weekly and can include urea, potassium nitrate, calcium nitrate, magnesium nitrate and phosphoric acid.
- In Jan Toerien's opinion 8 X 4 m would be the ideal spacing.

**Figure 5. Current thinking on preferred hedgerow dimensions and shape, as it would look immediately after pruning. Assumes 4 X 8m spacing and North/South rows.**



- See "Rules of thumb" for tree size Figure 5.

All pruning was done using a mechanical saw. ZZ2 are pursuing a management system that is as mechanised as possible.

**Summary of the new canopy management approach**

1. A shaping cut immediately after harvest (about August for Hass, and about May for Fuerte in South Africa) at approximately a 22° angle from the vertical on the eastern (denser) side. On overgrown trees this may involve removing about 1.5 m of growth. This creates a bearing "platform".
2. A trim in about November at the same angle just outside the set fruit in order to remove 20-25 cm of the spring leaf flush and generate a new flush of growth.
3. About 5 weeks later (about Dec/Jan) when the summer new flush is emerging apply a low volume spray of Sunny® at 0.5%.
4. A light shaping cut to the western side after harvest but before flowering (if required).
5. At flowering, apply a second Sunny® spray this time at 1% (about Aug/Sep).
6. Thereafter, a trim in November followed by Sunny® 5 weeks later at 0.5% and so on.
7. Note that trees must be very healthy and management very good for this integrated system to work. It is also important to note that fruit must be picked early in the season for sustainable yields to be achieved each year.

**Rejuvenating overcrowded orchards in South Africa - highlights from the paper by Stassen, Bard, Snijder and Penter**

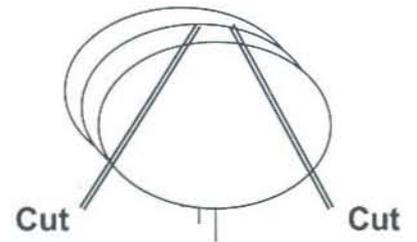
This system was presented by Zac Bard at the World Congress on behalf of Piet

Stassen and also described by Piet Stassen himself in California. A system was required in South Africa because 69% of their trees are more than 10 years old. This system is primarily to address the issue of poorly-lit unproductive areas inside the canopy of overgrown trees.

Tree thinning (done on the diagonal), is now seen as only a temporary solution and has to be repeated three years later. Staghorning is a proven system but results in a significant loss of yield for at least two years.

For orchards that are **not yet severely overgrown**

**Figure 6. Position of the pruning cuts for trees not yet excessively overgrown**

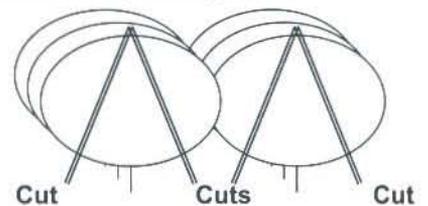


The main aim of these pruning cuts is to get more even light distribution to the lower parts of the canopy. In South Africa the trees will still bear a crop the year after the pruning if harvest is done as soon as fruit is mature and the cut made immediately after this (winter time in South Africa).

For severely encroached orchards where tree architecture has been lost and low branches have been overshadowed

- a. A more drastic initial cut is required to allow light to reach the lowest parts of the tree but yield is lost only for one season in South Africa if the cut is done early enough in winter:
  - (1) Summer pruning:
    - remove water shoots
- b. Follow-up maintenance is essential:

**Figure 7. Position of the pruning cuts for trees that are excessively overgrown**



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- lightly prune the regrowth on the shaped face
- do some selective "window" pruning to avoid a "green wall".

(2) Use of Plant Growth Regulators:

- Uniconazole (Sunny®) or Paclobutrazole (Cultar®)

(3) Fertiliser management:

- reduce nitrogen rates
- correct timing of nitrogen applications is important.

One of the results of this system is to even out biennial bearing patterns (see Figure 8).

Challenges still facing the pruning system are:

- Controlling the vigorous regrowth.
- Preventing formation of a "green wall".

**Conclusions:**

- Avocados can be successfully pruned in subtropical climates.
- Drastic cuts are required in severely encroached orchards.
- Pruning maintenance after the initial cut is of the utmost importance (ie. canopy management cannot be viewed as a one-off cut, it must be viewed as an ongoing task).
- A vase shape has been found to be unsatisfactory as it closes up within one season and prevents light from reaching the lower part of the canopy.

**Tree training and maintaining young orchards in South Africa - highlights from the paper by Stassen & Snijder**

New orchards need to be well-planned prior to planting. Factors such as row orientation, varieties, spacing and the canopy management system need to be carefully thought out.

This system for young orchards recommends pruning to a central leader system. Tree training commences in the nursery—the growing point at the apex of the tree must **NOT** be tipped. After planting (preferably in north/south oriented rows) tree training is directed at creating a pyramid-shaped tree. Apical dominance amongst **SIDE** branches must be broken. If the side branch stem is more than half the diameter of the central leader stem it is removed. Side branches that are between one third and one half the diameter of the central leader are cut back but not completely removed. Any fruit that are set near the top of the central leader are removed so that they

do not result in the central leader bending over.

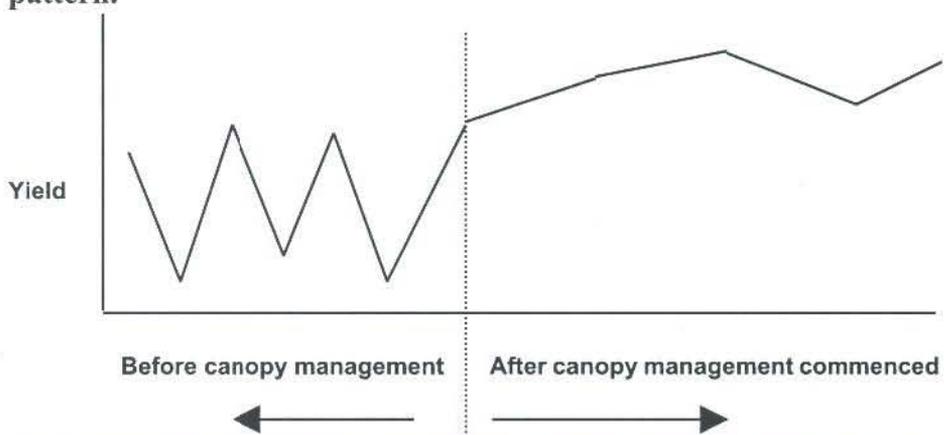
This system is being adopted in California on very close plantings (2 X 2.5m) of Reed and Lamb Hass. In California no plant growth regulators are registered for use in avocado. Although there is a greater input of labour for this system to work the promising yields (48 t/ha have been achieved so far) make it worthwhile. Australian growers should however bear in mind that growth rates in California are significantly less than eastern Australia.

A trial of Hass on Duke 7 rootstock at a 2.5 X 5m spacing using the central leader system of tree training produced the yields shown in the first Table below.

Unpruned vs. central leader pruned Hass on Duke 7 on a 5.5 X 5m spacing gave the yields as shown in the second Table.

A comparison of different varieties at high density with the central leader pruning approach gave the results shown in the third Table.

**Figure 8. Effect of canopy management system on biennial bearing pattern.**



	1996	1997	1998	1999
Tree age (years)	3	4	5	6
Yield (t/ha)	9.3	15.4	28.1	18.3

Tree age	3 years	4 years	5 years
Central leader pruned	2.5 t/ha	9 t/ha	7 t/ha
Control (unpruned)	2.0 t/ha	11 t/ha	7 t/ha

Variety	Spacing	Yield @ 1.5 years (t/ha)	Yield @ 2.5 years (t/ha)	Yield @ 3.5 years (t/ha)
Pinkerton	5.5 X 3m (606 trees/ha)	0.7	7	8.1
	4 X 1.5m (1667 trees/ha)	1.35	12.4	9.3
Edranol	5.5 X 3m	0	6.1	17.2
	4 X 1.5m	0	7.5	22.4
Fuerte*	5.5 X 3m	0	3.1	6.25
	4 X 1.5m	0	3.4	5.3
Hass	5.5 X 3m	0.5	4.9	9.3
	4 X 1.5m	1.2	8.8	13.6

\* Fuerte does not lend itself to close spacing and this canopy management system, due to its lateral growth habit and vigorous growth.

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**Conclusions:**

- Avocados can be pruned to a central leader.
- Soils with high nitrogen levels result in extreme vigour.
- The varieties Hass, Pinkerton and Edranol can be maintained at 5.5 X 3m and 4 X 1.5m spacing.

Spacing recommendations for South Africa where this system of canopy management is to be used is given in the Table to the right.

**Other canopy management notes**

- A 30m tall tree was found to need 75% of all the carbohydrate it manufactured just to support itself.
- Canopy management is all about "light management".
- Direct sunlight appears important for flower initiation and development.

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**Do you want the full report?**

The article "Technology Exchange Within The Avocado Industry" written by Alan Blight, Simon Newett, Chris Searle and Geoff Waite is part of a report called: Technology Exchange at 4th International Avocado Congress in Mexico during October 1999, including information from a visit to South Africa and California.

The report can be purchased from the HRDC for AUD\$20 or US\$30 for orders from outside Australia. Credit card facilities are only available for orders placed through the HRDC/AHC website <http://www.horticulture.com.au>

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VARIETY	SPACING	TREES/HA
Fuerte	7 X 3.5m	408
Hass	6 X 3m	556
Pinkerton	5 X 2.5m	800
Ryan	5.5m X 3m	606



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## Pruning angles for East/West rows

It is acknowledged that north/south rows are best for production. However where this is not possible, the following idea is proposed for pruning angles. Essentially the aspect facing the sun (northern aspect in Australia) is pruned at a wide angle to the vertical, whilst the opposite side is pruned at an angle close to vertical (see Figure 9).

## Three tree size "rules of thumb":

The height of the tree should not exceed 80% of the distance between trees across the row (see top Table below).

Tree height should be less than 2.5 X the width of the canopy-free interrow laneway (see bottom Table below).

No part of the tree canopy should be more than 2 to 2.5 m from direct sunlight, so maximum canopy width is 4 to 5 m.

## Other canopy management issues important for Australian conditions

Canopy management is important in Australia for reasons in addition to light interception. These include:

- cost of harvesting
- safety of harvesters
- spray penetration and coverage
- enough light reaching the orchard floor for the growth of an interrow sward to reduce soil erosion.

## Canopy Management in California

When considering canopy management in California it must be borne in mind the different growing conditions that exist in California vs. the subtropical conditions of Queensland and Northern NSW. The climate in California is Mediterranean with hot dry summers and cool wet winters (last season they only received 250 mm of rain). Although they have a serious canopy management problem, their climate does not result in the vigorous vegetative growth that we experience in eastern Australia. More than 70% of orchards are on slopes of greater than 15% (to avoid frost) and 70% of orchards are managed for absentee owners. As a result of a series of poor seasons these owners have been reluctant to invest in canopy management and as a consequence, many orchards are completely closed over with no direct sunlight reaching the orchard floor.

No plant growth regulators (eg. Cultar®, Sunny®) are registered for use in California.

Tree spacing varies from about 5.5 m X 6 m (300 trees/ha) to 2 m X 2.5 m (2000 trees/ha). Varieties grown are mainly Hass but also include significant numbers of Pinkerton, Reed, Fuerte and recently Lamb Hass. Pollinator trees such as Ettinger and Bacon are interplanted throughout the orchard.

## Canopy management approach #1 (Fallbrook area) for overgrown orchards

One of Len Francis' managed orchards, 20 year old Hass trees on 5 X 6.3 m spacing that were completely canopied over at 9 to 10.5 m in height.

### Canopy management approach:

1997 – one major branch cut off in spring, fruit harvested off the branch. Yield 5t/ha.

1998 – No pruning. Yield 6 t/ha and bigger sized fruit (Itzak Regev from Israel considers this is as a result of an improved shoot:root ratio).

1999 – 2<sup>nd</sup> major branch cut off in spring and picked. Tree tip-pruned in autumn (October). Yield 7 t/ha.

2000 – Estimated yield 8 t/ha.

Some of the branches to be cut off were girdled one year prior to cutting off. The branches were cut off to leave stumps from which they could re-shoot. This approach was certainly improving light penetration into the orchard, but two year-old regrowth was not yet fruiting. This was thought by some to be due to the fact that the irrigation rate had not been reduced to match the reduced canopy size. The ultimate objective is to keep the trees less than 4.5m tall by pruning to 3.6 m every year.

Some branches were being girdled in autumn prior to being removed in spring.

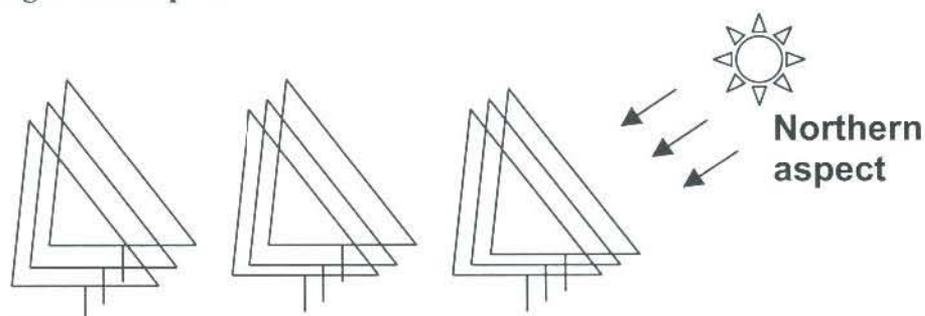
## Canopy management approach #2 (Fallbrook area) for overgrown orchards

Reben Hofshi's orchard. Blocks of trees that were overgrown and had canopied over were cut off at 3 to 3.5 m above ground level in mid-winter (February 1997). These trees were re-shooting and yielding 13 t/ha one year after cutting. Note

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**Figure 9. Pruning angles for hedgerows (southern hemisphere) that have to be planted in an East/West direction, in order to maximise light interception.**



INTERROW SPACING	SUGGESTED MAXIMUM TREE HEIGHT
10 m	8 m
8 m	6.4 m
7 m	5.6 m
6 m	4.8 m
5 m	4 m

OPEN LANEWAY BETWEEN ROWS	SUGGESTED MAXIMUM TREE HEIGHT
1m	2.5m
2m	5m
3m	7.5m

however that they were healthy prior to cutting. When we enquired why the trees were cut so high above ground level we were told that the lower you cut, the longer the fruit takes to come back. Irrigation rates were cut back in proportion to canopy size.

One of the blocks of trees pruned in this manner has also been the subject of a girdling trial:

1. Girdled in Nov'97
2. Girdled in Nov'98
3. Control

Yield, fruit size, fruit grade, % dry matter (girdling has been reported to advance maturity) and leaf chlorophyll count were measured, but no significant differences were found.

### Canopy management approach #3 (Fallbrook area) for very high density

Reben Hofshi is planting blocks of Reed and Lamb Hass at 2.5 X 2 m (2000 trees/ha). These varieties lend themselves quite well to high density planting due to their upright and compact growth habit. The canopy management approach is to keep each tree as a separate entity (ie. not hedgerowed) and to keep each pruned to a columnar shape no more than about a metre in canopy diameter.

Reuben is following Piet Stassen's single leader approach (any branch with a stem diameter more than half that of the leader is cut off, and any branch with a stem diameter more than one third that of the leader, is cut back). In addition the tree height is kept to about 2.5m. Yields of up to 80 t/ha are expected. The best so far are 48 t/ha off Reed and 27 t/ha off Lamb Hass.

Conditions are such on this orchard that a large degree of control is possible over

growing conditions, rainfall is only about 250 mm per year, soils are fairly inert decomposed granite and irrigation and nutrition are carefully monitored and adjusted by irrigation and fertigation.

Great importance is placed on cross pollination and high levels of bee activity (Reuben has 3000 of his own hives, see the pollination article on the next page). Even canopy temperature will be controlled to some extent by evaporative cooling irrigation (see the irrigation section on page 16 of the March 2000 Talking Avocados).

### A system for rejuvenating and making trees more resistant to hurricanes (Florida)

This system was described by Tom Davenport from the University of Florida. Essentially it is a system developed to rejuvenate overgrown orchards and to develop trees that are more resistant to hurricanes.

The example used was of an orchard of "Lula", which had reached 12 m in height. The whole tree was topped to a height of 1.2 m. In Year 2 the regrowth was topped to a height of 1.8 m and in Year 3 the tree was topped to a height of 2.4 m. Thereafter, the tree was kept to a maximum height of 3.6 m. This system develops a "stumpy" tree with thick branches.

### Canopy Management in Israel

#### An Israeli approach for overgrown orchards not using PGRs

This system was described by Itzak Regev, Extension Officer with the Israeli Department of Agriculture.

Essentially, it involves cutting off all branches except one, in a staghorn fashion. The remaining branch bears a good crop of good-sized fruit as a result of more light

penetration etc. The stumps regrow and are allowed to reach only a predetermined height. Note that the presence of the unpruned branch suppresses the growth of the others to some extent through its apical dominance.

The branch that was not cut off is eventually shortened to the predetermined height as well with the cut being made just above a lateral. Itzak acknowledged that Hass was more difficult to manage than some others such as Reed.

### System described by Cliff Lahav, Israel, for rejuvenating orchards

The system was applied to an orchard of Hass planted in North/South rows at 6 X 4 m spacing (420 trees/ha). Cliff believes that conditions are such in Israel and California that this system can work without the use of PGRs. However the system described here does involve the use of PGRs. It follows roughly a five year schedule and keeps the trees to a maximum of 4.5 m high and 3.5 m wide.

#### Year 1

- Shape one side of the tree post harvest using a severe cut if necessary with a mechanical saw.
- Spray PGRs at bloom.
- Trim the shaped side of tree after summer flush.
- Spray PGRs 3 weeks after trimming the summer flush.

#### Year 3

- Shape the other side of the tree post harvest.
- Spray PGRs at bloom.
- Trim both sides after summer flush.
- Spray PGRs 3 weeks after trimming the summer flush.

#### Year 5

- Repeat Year 1.

#### Year 7

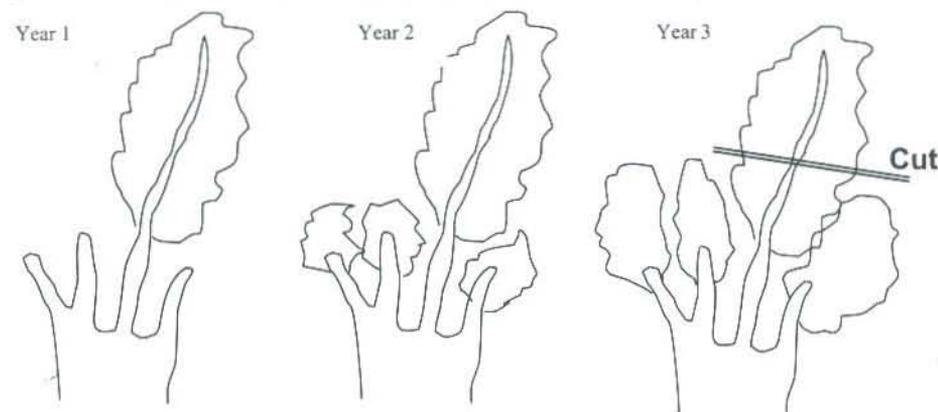
- Repeat Year 3 and so on.

The benefits of this system are that it continually rejuvenates the tree and keeps tree size under control.

### Canopy management in Israel – Ehud Gafni

Ehud described the system developed in Israel that has been adopted and modified by the South Africans. He claims that the yield can be maintained between 18–25 t/ha every season with pruning every year.

**Figure 10. Israeli approach for reducing tree size whilst sustaining production, this system could result in wind damage in Australia.**



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## Pollination

### Dr Tom Davenport, University of Florida

Avocado pollen is not sticky.

It takes 24 hours for the pollen tube to reach the ovary and 48 hours to complete fertilisation of the ovary.

### Elizabeth Fetscher, University of California

A comparison of the pollination efficiency between the Italian honey bee and the Carniolan honey bee (of Yugoslav/Austrian origin) shows the Carniolan bee appears to be more efficient at pollinating avocados. Elizabeth was carrying out artificial insemination of queen bees with the Carniolan type on Reuben Hofshi's orchard.

### Reuben Hofshi's Orchard, Fallbrook, California

Reuben is giving significant attention to improving yield through the use of bees. On the 200 ha orchard he has 3000 hives as

well as polliniser varieties, and is attempting to convert his bees to the Carniolan type for better pollination. He runs his hives as a separate business, hiring them out when the avocados are not flowering, and is building a large honey extraction plant. He feeds his bees reject lollies (sweets) in an attempt to satisfy their nectar requirements so that they will forage in the orchard for pollen, avocados being known as a poor source of nectar.

### Other observations

The following comments were made during discussion at the pollination session at the University of California:

- Bees seem to get more nectar on humid days.
- Better fruit set on humid days.
- Seem to get better fruit set if bees can smell the avocado flower perfume.
- Flies only contributed 2% of daily pollination.

- Ben Faber's experience with bee attractants shows that at best they last for 2 days, and the bees must have just been introduced to the orchard.
- Prof Schmucl Gazit (Israel) has found that bee attractants are not effective in avocados.
- Dr Gad Ish-Am (Israel) says that bees are wise and not easily fooled—the scouts not only find potential food sources but also assess them.
- Research indicates that there needs to be about 20 pollen grains per stigma to get one to fertilise the ovary; however an average bee only deposits about 2 pollen grains per visit.
- The native bumble bee in Israel (*Bombus terrestris*) is regarded as being a more effective pollinator than honey bees. They are bigger and can carry 5 times more pollen.



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## 2001 Australian & New Zealand Avocado Growers Conference

Planning is well and truly under way for our joint conference with New Zealand following a combined steering committee meeting between Australia and New Zealand held in Bundaberg in March of this year. The committee is happy to announce the following details so you can mark your calendar and plan ahead.

**DATE** 2-7 June, 2001

**LOCATION** Bundaberg, Queensland

### PROGRAM

- June 2 **Pre-conference tour** leaving from the Sunshine Coast/Brisbane (optional).
- June 3 **Pre-conference tour** arrives in Bundaberg.  
**Registration and Cocktail Party** to commence at approximately 5.30 p.m.
- June 4 **Conference** begins in earnest.  
*Full day of technical sessions* at Moncrieff Theatre.  
*Evening - Free time.*
- June 5 *Morning - Technical sessions* at Moncrieff Theatre.  
*Afternoon - Visit* to properties in area.  
*Evening - Conference Dinner* to be held at the Bundaberg Civic Centre.
- June 6 *Morning - Technical sessions* at Moncrieff Theatre.  
*Afternoon - Visit* to properties in area.  
*Evening - BBQ* including a **night session** to be held at a nearby property. This will be the conference finale.
- June 7 **Post-conference Horticultural Tour** - This tour will be a full day's activity and will focus on the many other horticultural industries in the Bundaberg/Childers area.

Future editions of Talking Avocados will give further details in relation to attendance, accommodation, registration costs, pre-conference tour details and technical sessions program and guest speakers.

The 2001 Australia and New Zealand Avocado Growers Conference committee is planning this conference with growers in mind, and will cater for the interests and concerns of growers.



# Improving Avocado Quality At Retail Level

## “The *Avocare* Project”

By Peter Hofman, Maroochy Research Station, Queensland Horticulture Institute, QDPI

### History

Our report in the December issue of *Talking Avocados* outlined the background and objectives of this project. To refresh your memory, the project is developing and testing a method to measure avocado fruit quality on the retail shelf, and to determine how the fruit has been handled from grower all the way to the retailer. By comparing the quality on the retail shelf and the handling records for each line of fruit, we will be able to identify those commercial practices which cause loss of quality through the supply chain.

An essential part of the project is the records required to identify how the fruit was handled, and the fruit sampling procedures from the retail shelf. This is the most challenging part of the project, and the area where we have spent most of our project time over the last several months.

### Activities to date

We have had numerous discussions with key members of the supply chain, including growers, transporters, marketing groups, wholesalers and retailers. The

**Peter Hofman and Jason Cook (Queensland Horticulture Institute, Department of Primary Industries) placing colour coded dots on fruit stickers at a retail store before the fruit are placed on display. The coloured dot on each fruit can be related to the information on the carton, thereby providing the history of each fruit on the retail shelf.**



discussions have focussed on understanding the current procedures used at each step, and the feasibility of having sufficient records to ensure that we can get information on how the fruit was handled.

### What we have found

Co-operation at all levels has been high, with a general acceptance that improvements are required, and are feasible. This makes us confident that the project has real potential to achieve its objectives.

Most of the groups we have talked to either have adequate records in place, or are willing to implement slight changes to ensure adequate traceability for the duration of the project. Hence, with these changes and the records to be taken by the project team during the surveys, we are confident we will have sufficient records to determine how the fruit were handled.

### The proposed methods

We intend to use the following methods: One retail outlet from each of Woolworths, Franklins and Coles will be surveyed in one week, starting about Wednesday 14 June. This will be repeated in another area in Brisbane the following week, and at the Sunshine Coast in a third week. This will result in a total of three outlets from each of the three main retail stores being surveyed. This, and the fact that the stores will be selected to represent high, medium and low throughput stores, will provide a good representation of the range of retail outlets. We will also survey a top quality independent retailer during one of the weeks, which we expect would provide a good benchmark.

Each day, the project team will place a colour-coded dot on the fruit sticker when the fruit is delivered to the store, and before it is placed on the retail shelf. The team will record the colour used, and the information on the carton from which the fruit came (see photo).

Later each morning, the team will take about 15-20 of the colour coded fruit from the display shelf, and

transport the fruit to the DPI postharvest laboratory at Nambour. The quality of the ripe and over-ripe fruit will be assessed the same day, and the unripe fruit allowed to fully ripen before assessment.

The line will be sampled every day until completely sold. On the next day, another line will be coded, and so on.

### Records

Most of the large growers and marketing groups have agreed to place pallet numbers on every carton for the duration of the trial.

The wholesalers will place the date received and date dispatched from the wholesale floor on each carton. They will also record when each pallet is ethylene gassed etc.

We will record the information on the carton when we colour code each fruit. The information on the carton when it arrives at the retail store is crucial to tracing the handling history. In most cases this will include grower name or code, pallet number, date packed, and date received and dispatched from the wholesaler.

### Testing the method

This methodology will be tested during a trial run to be conducted from 10-20 May. One retail outlet from each of the chains will be visited daily. The main line of fruit delivered every day will be colour coded, and the sales of these lines will be monitored to determine how long fruit remain on the shelf before sale. No fruit samples will be taken during this period. In the second week, the colour-coded fruit will be assessed for quality to determine how to sample the fruit, the number of fruit we should purchase each day, and the impact of purchasing an additional 20-40 fruit each day on the flow of fruit, and the number of days the avocados remain on the shelf. Slight changes to the methods may be made after this trial.

In addition, growers, marketing groups and wholesalers will implement additional records from early May on, which will be evaluated before the start of the full survey in June, and refined if required. □



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# Effects Of Production Locality On 'Hass' Avocado Fruit Quality And Fruit Minerals

By Surachat Vuthapanich and David Simons, Dept of Plant Production, University of Queensland, Gatton College, Peter Hofman, Maroochy Research Station, Queensland Horticulture Institute, QDPI and Andreas Klieber, Department of Horticulture, Viticulture and Oenology, The University of Adelaide

Avocado fruit quality can be very variable and unpredictable. We have even observed this in fruit harvested from the same tree at the same time, where the fruit can take from 6-18 days to fully ripen. We have also noticed important variations in the severity of disease and flesh disorders in fruit from the same tree, and also between trees and production locations.

It is clear from local and international experience that one of the keys to industry profitability is the ability to market fruit that are of appropriate, and consistent quality (price and continuity of supply are the other important components to success). Therefore, variations in quality can be a major factor determining success in maintaining and expanding markets.

One of the programs of the Queensland Horticulture Institute involves identifying the causes of variation in quality, with the ultimate goal of manipulating quality to meet market expectations. The avocado component of this program was initiated through collaboration with The University of Queensland.

This article describes the results of the effects of production location and/or practices on 'Hass' avocado fruit quality. The study was not intended to prove that one production location was better than another but rather to indicate the potential impact production location or production practices can have on quality.

## Selected Areas

The experiment used six commercial 'Hass' orchards in southeast Queensland at Childers, Nambour, Maleny, Gatton and Toowoomba). The Gatton 1A and 1B trees were from the same farm, and were 6 and 12 years old, respectively. The two Toowoomba sites were on the same soil type and received the same management, except that A trees had one under-tree sprinkler and B trees had two under-tree sprinklers per tree. All the trees received normal commercial management.

Fruit were harvested from selected trees at early, mid and late maturity (early June for the early Childers harvest, to late

November for the late Toowoomba harvest). Fruit were dipped in 55 mL per 100 litres Sportak® for one minute within four hours of harvest.

Fruit were either ripened immediately after harvest (non-stored) at 22°C or stored at 7°C for 3 weeks. These storage conditions were chosen to stimulate the development of disorders so that the differences between fruit from the different locations could be studied.

## Results

Our results showed that fruit from the colder production districts of Toowoomba and Maleny were larger. Also, Toowoomba fruit were more pear-shaped, and fruit from the warmer areas were rounder and less 'necky'.

## Ripening

While the later-harvested fruit often ripened more quickly, in some locations and seasons they ripened more slowly. In general, fruit from Childers and from one of the Gatton locations, ripened more quickly than fruit from other locations. During cold storage at 7°C, fruit from orchards other than Childers and Maleny started to ripen

after about 7 days, indicating that these fruit had reduced storage life. There was no obvious relationship between production location and the number of days for the fruit to fully ripen after storage.

## Skin Colour

The skin colour of the ripe fruit is an important commercial consideration. In some instances, only 20% of the fruit reached an acceptable black skin colour when fully ripe, but there was no consistent relationship between harvest date or location and this percentage. This indicates significant variation in the skin colour between fruit at the eating soft stage, and may result in significant consumer confusion about how to determine when the 'Hass' fruit is ripe to eat. Following cold storage and ripening, most fruit had full black colour, irrespective of harvest or location.

## Flesh

Flesh (or mesocarp) discolouration due to physiological disorders occurred only in

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stored fruit. Generally, more severe mesocarp discoloration occurred in early harvested fruit from the warmer Childers and Gatton 2 locations (Figure 1). In contrast, fruit from the cooler Maleny and Toowoomba locations had higher mesocarp discoloration in the mid-harvests. This may indicate a potential to reduce these disorders by only storing fruit from locations and harvest times that have the lowest susceptibility to mesocarp discoloration.

### Anthracnose

Anthracnose severity generally increased in later harvested fruit (Figure 2), as observed in other studies. There was no consistent relationship between production location and disease over the two seasons. Stem end rot severity was not high, and there was no consistent relationship with date of harvest or production location.

### Nutrients

We noted that fruit calcium (Ca) and magnesium (Mg) concentrations declined with later harvests in most locations. Fruit from the Nambour orchard had the highest flesh Ca concentrations, but this would vary with production practices, soil type etc. within a production location. The Toowoomba orchards had higher soil Ca, Mg and K concentrations, but lower leaf Ca than other orchards (Figure 3 for the Ca results). The Toowoomba fruit Ca concentrations were in the middle to lower range in relation to concentrations from the other orchards.

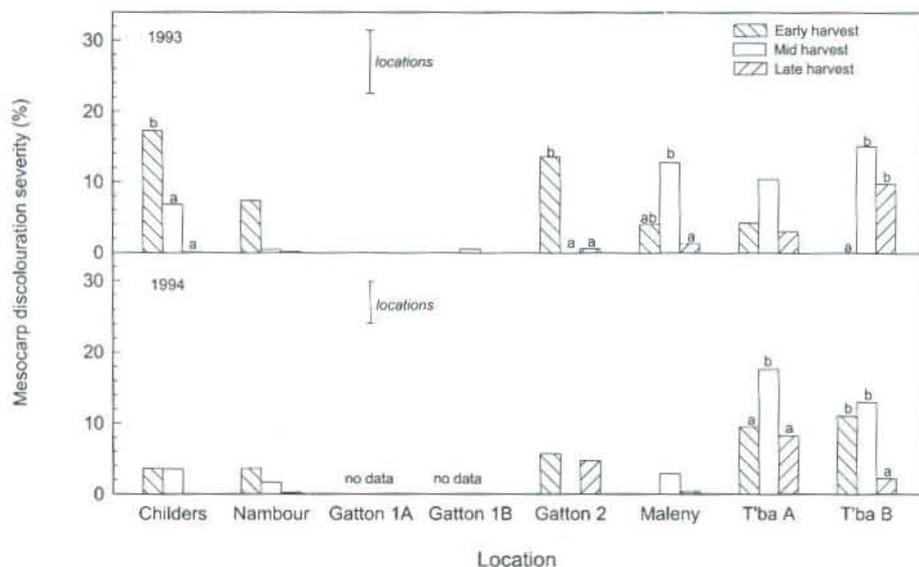
### Minerals

An indication of the influence of fruit minerals on fruit quality can be obtained by examining correlations between fruit minerals concentrations and fruit quality. A high negative correlation between, say, fruit Ca concentration and disease severity, means that fruit with high Ca will often have low fruit disease, and vice versa. However, a low correlation means that there is no obvious influence of Ca on disease.

Our results confirmed that fruit minerals affect the quality of avocado. High fruit Ca concentrations were associated with the fruit taking longer to ripen in some locations and seasons. This has also been observed in other fruits. More commonly, fruit with high Ca concentrations had less anthracnose severity in both non-stored and stored fruit (see Table 1 for the results with stored fruit). A similar result was also observed with Mg. In some cases, fruit with low potassium (K) concentrations also had less anthracnose. Fruit minerals

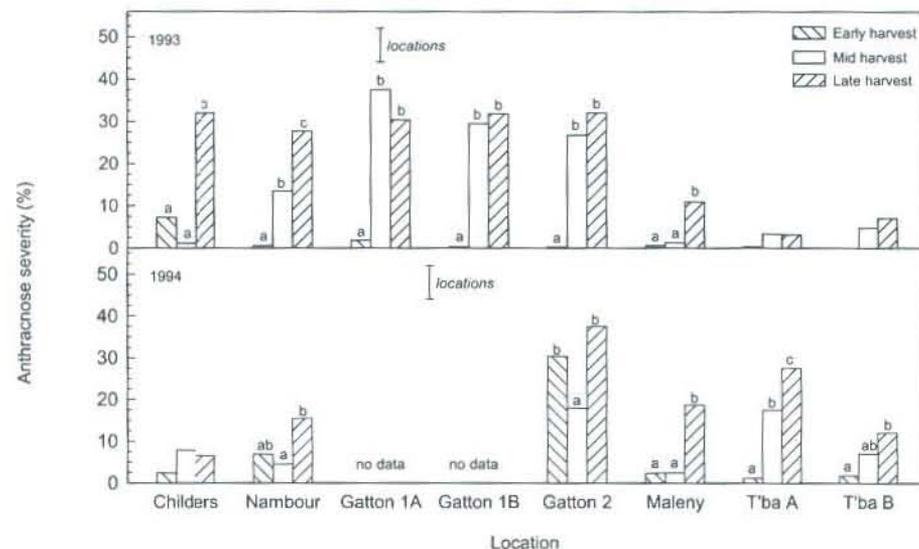
**Figure 1.** The severity of mesocarp discoloration in the flesh of ripe 'Hass' avocado fruit following three weeks storage at 7°C and ripening at 22°C. The fruit were harvested from several locations in south east Queensland, and at early, mid and late harvest relative to the standard commercial harvest times.

The severity was rated as the percentage of the cut fruit surface area with mesocarp discoloration. The bars with different letters are statistically different between harvests (within the same location). Bars with no letters are not statistically different between harvests. The height of the vertical line bars indicates the statistically significant differences between locations (within the same harvest). The absence of data in some harvests indicates that there was no detectable mesocarp discoloration.



**Figure 2.** The severity of anthracnose in the flesh of ripe 'Hass' avocado fruit following three weeks storage at 7°C. The fruit were harvested from several locations in south east Queensland, and at early mid and late harvest relative to the standard commercial harvest times.

The severity was rated as the percentage of the cut fruit surface area with anthracnose. The bars with the different letters are statistically different between harvests (within the same location). Bars with no letters are not statistically different between harvests. The height of the vertical line bars indicates the statistically significant differences between locations (within the same harvest).



generally were less related to the severity of flesh disorders.

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## Summary

To summarise, our results indicate that the production location and/or production practices can have a significant impact on most quality attributes. Probably one of the more interesting results is the fact that fruit mineral concentrations were associated with fruit quality, and especially that fruit with high Ca and Mg concentrations often had less anthracnose. Therefore, there is benefit in manipulating fruit mineral concentrations, especially Ca, to improve fruit quality.

Adequate soil Ca is important in maintaining fruit Ca, but there are other factors that may prevent Ca from reaching the fruit. For example, the Toowoomba orchard had high soil Ca, but low leaf Ca and below average fruit Ca, suggesting that other factors may prevent Ca from reaching the fruit.

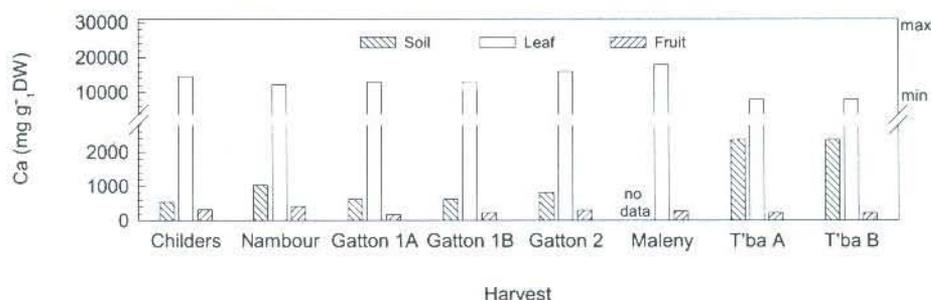
Results in other fruits indicate that high Mg and K concentrations in the soil may reduce Ca uptake by the roots. In addition, Ca moves from one part of the tree to another through the internal water stream. Therefore, those parts of the tree, such as the leaves, which lose (or transpire) a lot of water through the tissue, will accumulate larger concentrations of Ca through the water stream. Fruits generally do not transpire a lot of water, so they accumulate less Ca. Also, more leaves on the tree compared to fruits will reduce the relative amount of Ca going to the fruit. A shortage of water (not enough rain or irrigation) may also reduce the amount of Ca going to the fruit.

Therefore, it is important to get the right balance between soil minerals, water supply and the vegetative and reproductive growth in order to maximise fruit Ca concentrations. We are not sure what this balance should be, but there are indications that a consistent and high yield per tree is important in improving fruit Ca balance and quality. For instance, the South African experience suggests that fruit quality is poor during years of low yield.

Also, we have evidence that rootstocks can influence quality and fruit Ca concentrations, and this is being investigated further in the "Field management of avocado postharvest diseases" project (AV 9701).

Finally, we need a good system to measure fruit mineral concentration. Many studies have found that leaf and soil Ca concentrations are not good indicators of fruit Ca concentration, so fruit analysis may be the only reliable method. □

**Figure 3.** The calcium concentrations (mg Ca per g dry weight) in the soil, leaf and fruit of orchards and 'Hass' trees used in 1993. Soil and leaf sampling and analysis was conducted according to standard commercial practices, and the fruit mineral concentrations are the average of fruit from five trees over three harvests in 1993. The horizontal reference lines indicate the minimum and maximum leaf mineral concentrations recommended for avocado in southeast Queensland.



**Table 1.** The correlations between fruit mineral concentrations in 'Hass' avocado, and anthracnose severity after storage at 7°C for 3 weeks. The correlation values with "\*" and "\*\*\*" indicates significant and very significant statistical relationships. Significant negative values indicate that there was a good relationship between, for example, high fruit Ca concentration and low anthracnose, while significant positive values indicate a good relationship between high fruit K concentration and high anthracnose severity.

Location	Season	Ca and anthracnose	Mg and anthracnose	K and anthracnose
Childers	1993	-0.34	-0.40	-0.66 *
Childers	1994	-0.78 **	-0.65 *	0.19
Gatton 1A	1993	-0.52	-0.09	-0.09
Gatton 1B	1993	-0.13	-0.80 **	-0.25
Gatton 2	1993	-0.56 *	-0.26	0.29
Gatton 2	1994	-0.07	0.09	0.50
Maleny	1993	-0.64 **	-0.47	0.64 **
Maleny	1994	-0.77 **	-0.51	0.55 *
Nambour	1993	-0.53 *	-0.26	0.06
Nambour	1994	0.23	-0.08	-0.14
Toowoomba A	1993	-0.31	-0.15	0.47
Toowoomba A	1994	-0.57 *	-0.58 *	0.16
Toowoomba B	1993	-0.41	-0.50	-0.07
Toowoomba B	1994	-0.62 *	-0.73 **	-0.03

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# Little Evidence To Support The Use Of Foliar Applied Nutrients In Avocado

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## Introduction

Foliar fertiliser application is sometimes promoted as an effective means of supplying nutrients to avocado. On the market are various products being promoted as foliar nutrients for avocado, some proponents even suggest that their products do away with the need for soil applied nutrients. This article briefly reviews the literature relating to foliar feeding of avocado and examines the anatomy of the avocado leaf and flower in relation to nutrient uptake.

## The avocado leaf

The structure of plant leaves has evolved primarily to capture sunlight and exchange gases, roots have evolved to absorb nutrients and water and anchor the plant. Any absorption of nutrients by leaves is therefore likely to be more fortuitous than by design.

In some crops passive nutrient absorption by leaves is occasionally sufficient to supplement the supply of nutrients taken up by the roots. Most often this involves trace elements, which as their name suggests are required in very small amounts (eg. copper and zinc). However if non-mobile elements or elements with limited mobility in the plant (e.g. calcium, phosphorous, zinc, boron and iron) are absorbed when foliar sprayed they are not likely to make it down to the roots where they are also needed. Most nutrients will move freely in the water stream but the movement of many is restricted in the phloem, hence leaf applications don't meet the requirements of deficient trees.

Occasionally major elements (such as nitrogen and potassium) are applied to make up for a temporary shortfall or provide a boost at a critical time. Tomato is an example of a crop where some benefits from foliar applied nutrients have been reported (Fullelove, personal communication).

The ability of the leaf to absorb nutrients from its surface must depend to some degree on the permeability of its epidermis (outer layer) and the presence and density of stomates (pores for the exchange of gases).

Scanning Electron Microscope studies of mature leaves and floral structures in avocado show the presence of a waxy layer on both the upper and lower surfaces of mature avocado leaves (Whiley et al.

1988). On the upper surface the wax appears as a continuous layer and there are no stomates (Figure 1). On the lower surface the wax layer is globular and stomates are present (Figure 2). Blanke and Lovatt (1993) describe the avocado leaf as having a dense outer wax cover in the form of rodlets on young leaves and dendritic (branching) crystals on old leaves including the guard cells (guard cells surround stomates).

Tomato leaves by comparison (Figures 3) have no wax layers and stomates are present on the lower surface and often on the upper surface as well (Picken et al. 1986). The flower petals and sepals in avocado have stomates on their lower surfaces and no wax layers on either surface (Whiley et al. 1988), this may help explain why boron sprays in avocado are sometimes effective if applied when flower parts are present.

## Literature review

A literature search was conducted for information relating to foliar nutrition sprays in avocado.

### Nitrogen

Based upon total leaf nitrogen concentration, Embleton and Jones (unpublished) in a replicated trial in California in the early 1950's found no response to leaf sprays of urea on mature 'Fuerte' avocado trees in the field. Up to three sprays a year were applied.

Nevin et al (1990) reviewed urea foliar fertilisation of avocado and found only one study (Aziz et al., 1975) that reported positive results in terms of fruit yield. This trial by Aziz et al (1975) involved drenching sprays of significant amounts of urea four times a year (250 to 500 g of nitrogen per tree annually). It is unclear whether or not considerable amounts of the drenching spray reached the ground, nevertheless, the amounts applied were very high for foliar applications. No leaf analysis data was reported.

Galindo-Tovar (1983) was able to increase leaf nitrogen concentrations in 'Hass' avocado seedlings grown in a glasshouse with low concentrations of urea.

However similar treatments on 3-year-old 'Hass' in the field for each month during spring failed to increase leaf nitrogen in mature leaves sampled a week after spraying.

The author cited evidence for crops other than avocado suggesting that urea can penetrate leaf surfaces when grown in a greenhouse, but when grown in the field under full sun, leaf surfaces are different and resist movement of nitrogen into the leaf.

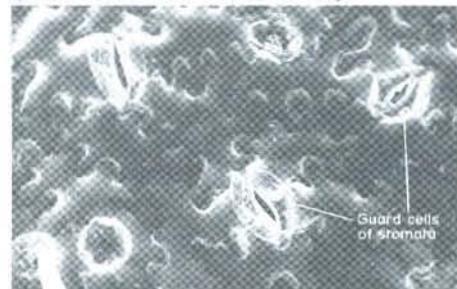
Figure 1. Cross section of upper surface of avocado leaf showing continuous wax layer and absence of stomates (pores) (X655) (from Whiley et al. 1988).



Figure 2. Cross section of lower surface of avocado leaf showing globular wax layer and stomates (X775) (from Whiley et al. 1988).



Figure 3. Cross section of tomato leaf showing absence of outer wax layers on either upper (adaxial) or lower (abaxial) surface (X300) (from Picken et al. 1986).



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## TECHNICAL REPORT

Klein & Zilkah (1986) reported substantial uptake of foliar urea-N when detached leaves of 'Fuerte' avocado were dipped in urea solutions. Zilkah et al. (1987) reported the translocation of  $^{15}\text{N}^*$  from foliar-applied urea to vegetative and reproductive sinks of both 'Fuerte' and 'Hass' avocado. Despite the apparent response achieved by Aziz et al. in Egypt, Klein & Zilkah, and Zilkah et al. in Israel, attempts at the University of California to demonstrate significant uptake of nitrogen from foliar sprays have not been successful (Nevin et al. 1990).

Research at the University of California, Riverside, provided evidence that the leaf nitrogen content of 'Hass' avocado was not increased by foliar application of urea at the same concentration that increased citrus leaf nitrogen content two-fold (Nevin et al. 1990). Maximum uptake of  $^{14}\text{C}$ -urea by 'Hass' avocado leaves was physiologically insignificant after 2 days. Over 96% of the  $^{14}\text{C}$ -urea applied was recovered from the leaf surface even after 5 days. Maximum uptake of  $^{14}\text{C}$ -urea by leaves of 'Gwen' and 'Fuerte' was less than 7%.

### Potassium

Sing and McNeil (1992) conducted a study on an orchard with a history of potassium

deficiency (rare in avocados) where high magnesium levels in the soil competed with potassium for uptake.

Foliar applications of 3.6% potassium nitrate were applied at half leaf expansion, full leaf expansion and one month after full leaf expansion. These foliar applications of potassium nitrate were effective in increasing the potassium level in the leaves of 'Hass' avocado trees; however two to three foliar applications per year were required to achieve the same result as one application of potassium sulphate (banded) to the soil once every 2 to 3 years. Accounting for labour and material costs the foliar sprays of potassium nitrate were estimated to be more expensive than soil applied potassium sulphate applied every three years. The foliar sprays also affected the levels of other nutrients in the leaf, some negatively.

### Calcium

Calcium is receiving attention as an element in avocado fruit associated with better quality and longer shelf life. Several different calcium products were tested during the 1980's as foliar sprays in South Africa in an attempt to raise fruit calcium levels but none were found to be effective (Toerien, personal communication).

Veldman (1983) reported that the treatment of avocado trees with one, three and six calcium nitrate sprays did not successfully control pulp spot in avocado fruit and there was no increase in fruit calcium levels on sprayed treatments.

Whiley et al. (1997) report that calcium foliar sprays during fruit growth have little effect on internal concentrations in most fruit due to poor absorption by fruit, and lack of translocation within the tree.

### Boron

Some benefits have been reported from foliar application of boron if applied at flowering. Timing is important because it appears that absorption takes place through flower structures and not leaves.

Jayanath and Lovatt (1995) reported on results of four bloom studies (two glasshouse and two field experiments) that demonstrated the efficacy of applying boron or urea sprays to 'Hass' avocado inflorescences during early expansion (cauliflower stage) but prior to full panicle expansion and anthesis.

Anatomical analysis of the flowers provided evidence that the boron prebloom spray increased the number of pollen tubes

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\*  $^{15}\text{N}$ ,  $^{14}\text{C}$ -urea and  $^{65}\text{Zn}$  are radioactive forms of nitrogen, urea and zinc respectively that are used to track their movement through the plant.

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that reached the ovule and also increased ovule viability, but to a lesser degree than urea. The urea prebloom spray increased ovule viability compared with boron-treated or untreated flowers. Urea also increased the number of pollen tubes that reached the ovule, but to a lesser degree than boron. However, combining boron and urea resulted in a negative effect even when the urea was applied 8 days after the boron.

Lovatt (unpublished) provided an update on this work at the World Avocado Congress in 1999. After 3 years of field trials the only treatment to have a positive effect on pollination was the boron in Year 2, the most likely reason why it didn't work in other years was thought to be low temperatures. There were only hardened leaves present at the time of foliar applications suggesting that uptake was through flower parts.

Whiley et al. (1996) report that despite an increase in fruit set with foliar sprays of boron during flowering there has been no convincing evidence that showed increased final yield.

Root growth has a requirement for boron and in deficient trees it is unlikely that sufficient nutrient from foliar applications would be translocated to the roots. Foliar applications have the advantage that specific organs can be targeted to enhance their boron concentrations, but with the disadvantage that insufficient boron can be absorbed through leaves to mediate chronic deficiency in trees.

Soil applications have been shown to dramatically improve the health of boron deficient trees. Smith (personal communication) reports no significant benefit to fruit set from foliar boron sprays at flowering when leaf boron concentration is already over 30 ppm.

Mans (1996) experimented with 'Hass' trees that had leaf levels of nitrogen and boron below the accepted norms (N was 1.71% and B was 23 ppm). The aim of this trial was to see if supplying nutrients directly on the flowers could increase the yield of 'Hass' trees growing in a cool environment. Mans (1996) found that if a multi-nutrient spray that included nitrogen and boron was applied as the first flowers started to open then he could increase yield and distribution of fruit size. The stage of flowering when spraying takes place was very important. Sprays that were applied pre-bloom, at fruitset or when fruitlets were present were not effective.

### Iron

Kadman and Lahav (1971-1972) reported that the only means to control iron chlorosis in already established avocado orchards is

soil application of iron chelates since applications of various iron compounds by foliar sprays have not been successful on a commercial scale. Gregoriou et al. (1983) found that the quickest and most successful treatment of trees suffering from iron chlorosis on calcareous soils (in terms of correcting chlorosis and improving yield) was obtained by incorporating Sequestrene 138 Fe-EDDHA (a type of iron chelate) in the soil.

### Zinc

Kadman and Cohen (1977) found that avocado trees have difficulties in absorbing mineral elements through their foliage. In spite of this, spraying of apparently zinc-deficient orchards was rather common in California and some other countries. In Israel, some growers spray their orchards, but as experiments have shown, no apparent improvement occurs in leaves or fruits following such treatment. The results presented in this paper indicate that the penetration of zinc through the leaves is so slight that there is practically no benefit through supplying it by foliar sprays.

Zinc deficiency is common in avocado and is particularly difficult to address on high pH (alkaline) soils. Crowley et al. (1996) evaluated methods for zinc fertilisation of 'Hass' avocado trees in a 2-year field experiment on a commercial orchard located on a calcareous soil (pH 7.8) in California. The fertilisation methods were:

- soil or irrigation-applied zinc sulphate
- irrigation-applied zinc chelate (Zn-EDTA)
- trunk injection of zinc nitrate
- foliar applications of zinc sulphate, zinc oxide, or zinc metalosate.

Among the three soil and irrigation treatments, zinc sulphate applied at 3.2 kg per tree either as a quarterly irrigation or annually as a soil application was the most effective and increased leaf tissue zinc concentrations to 75 and 90 mg/kg respectively.

Experiments with <sup>65</sup>Zn applied to leaves of greenhouse seedlings showed that less than 1% of zinc applied as zinc sulphate or zinc metalosate was actually taken up by the leaf tissue. There was also little translocation of zinc into leaf tissue adjacent to the application spots or into the leaves above or below the treated leaves. Given these problems with foliar zinc, Crowley et al. (1996) suggest that fertilisation using soil or irrigation applied zinc sulphate may provide the most reliable method for correction of zinc deficiency in avocado on calcareous soils.

Whiley and Pegg (1990) report that foliar applications of zinc have been found to be highly ineffective in Queensland orchards.

Price (1990) reports that zinc can be absorbed through the leaves (from foliar

sprays, e.g. zinc sulfate, zinc chelate) but that insufficient zinc can be absorbed in this manner to meet the plants requirements, especially in avocados. Since zinc is required at the growing points of new roots and shoots, it is essential that most zinc be taken up by the roots.

### Foliar fungicide sprays

If leaf applied nutrient sprays in avocado give inconsistent or nil effects why do copper fungicide sprays appear to prevent copper deficiency and why do foliar sprays of phosphorous acid work for the control of root rot?

Typically in Australia's eastern states copper fungicide sprays are applied about 12 times per season. These applications have been sufficient to effectively correct any copper deficiencies which may have occurred (Whiley, 1986). Whether this is attributable to uptake from the leaf surface or uptake from what finds its way into the soil when old leaves break down is not known. However, we do know that copper moves very slowly through the soil and that high levels are found in soils supporting avocado orchards, presumably accumulating following fungicide applications. Whiley (1986) reported that West Australian avocado growers, due to their dry environment did not have a significant anthracnose problem to warrant field spraying of trees. At that time leaf copper levels were low and deficiency symptoms could be found.

The amount of phosphorous acid uptake required for root rot control is small but even so, several applications per year are required to be effective and the canopy must be dense and healthy. The phosphonate concentration required in the roots for effective root rot control is in the order of 30 mg/kg. To achieve this level either three to four sprays of 0.5% phosphorous acid per year are required at strategic times (Leonardi et al. 2000) or alternatively six or more sprays of 0.16% phosphorous acid per year must be applied.

Another factor contributing to the effectiveness of leaf applied phosphorous acid is that, unlike many nutrients, it is extremely mobile in the plant (Whiley, personal communication). Note: phosphorous acid (fungicide) is not recommended as a soil application since it breaks down to phosphate (a plant nutrient) in the soil, is not considered cost effective and increases the potential for the selection of resistant strains of *Phytophthora cinnamomi* (Kaiser & Whiley, 1998).

Borys (1986) reports the dry matter distribution of roots to shoots in avocado



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seedlings average 26% and 74% respectively. Using these figures and some critical nutrient and fungicide levels in avocado we can get some perspective on the relative quantities required. In a tree consisting of say 100 kg of dry matter, about 26 kg would be in the roots and 74 kg in the shoots. This tree with a phosphonate root level of 30 mg/kg would contain a total of about 0.8 g phosphonate in the roots. With the optimal leaf levels of 50 mg/kg of boron and 2.5% of nitrogen, the tree would contain about 4 g and 1850 g of boron and nitrogen respectively in the canopy alone. It can be seen from these relative amounts that the fungicide required is substantially less than the nutrients.

## Summary

Several attempts to repeat the apparent success of foliar nitrogen application by Aziz et al. (1975) have not been successful.

In the only reference to foliar potassium applications, potassium nitrate was demonstrated to raise the leaf potash levels where a very high level of magnesium in the soil was suppressing potassium uptake; however even in this situation soil applied potassium was found to be more cost effective.

Foliar applications of calcium, iron and zinc have either been unsuccessful or have had a short-lived effect.

Several studies have shown a positive response to foliar boron sprays if applied at a critical time during the flowering process; uptake is thought to occur via flower parts and not leaves. However it is important to note that in circumstances where a foliar boron spray is beneficial it can only have a limited effect. Significantly, more boron than can be supplied by a foliar spray is required throughout the growing season for new root and shoot growth and young fruit development. The best way to get sufficient boron to the parts of the tree where it is needed is to apply carefully recommended rates to the soil.

A look at the structure of the avocado leaf provides some insight into the apparent failure of leaf-applied nutrients. Wax layers on both the upper and lower surfaces and absence of stomates on the upper surface are not conducive to good nutrient absorption.

Leaf analysis is a recommended tool to assist in the management of a nutrition program, but growers need to be aware that deposits of nutrients on the leaf surface can give high readings (eg. where copper fungicides are used) which could lead to erroneous conclusions.

## Conclusion

Apart from well-timed boron applications at flowering in situations where leaf boron

levels are deficient, there is no clear evidence to support the use of foliar nutrient sprays in avocado to correct nutrient deficiencies or to supply nutrients for growth. Occasionally a foliar nutrient spray may succeed in alleviating leaf deficiency symptoms; however, this type of application will not provide the tree's longer-term requirements for this nutrient which should be addressed through soil applications.

## Acknowledgments

I would like to thank Drs Chris Searle and Tony Whiley and Mr Garry Fullelove of the Queensland Horticulture Institute for their assistance in compiling this article. The literature search was conducted using the AVOINFO avocado reference database.

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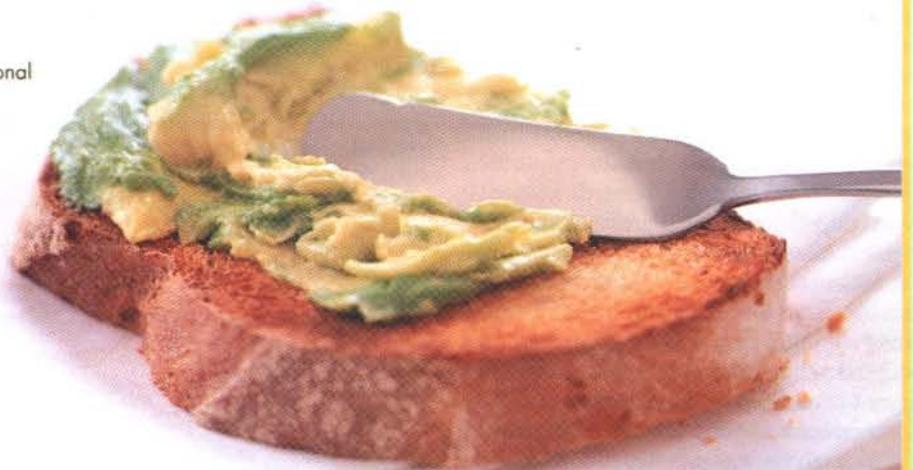
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Not only are avocados a delicious, easy to spread alternative to conventional butters and margarines, they are also rich in natural monounsaturated fats, which, unlike the saturated fats in dairy butter and the trans fats in margarine, actually lower your cholesterol. So now you know which side of your bread is buttered, 'ave an avo instead.



**'AVE AN AVO TODAY**



A magazine advertisement spreading the good news about avocados