

WESTERN AUSTRALIA AVOCADO STUDY GROUP
Minutes from 6th meeting, AVONOVA Warren orchard, Pemberton
9:30 am till 3:30 pm, Tuesday 25 May 2010

Aim of project

“Make Australian avocado production more internationally competitive”

Main topic of the day

“Avocado diseases”

Take home messages

- *Phytophthora* root rot control requires an integrated approach:
 - Select rootstocks with greater tolerance to *Phytophthora*
 - Healthy trees from the nursery
 - Good soil drainage and careful site selection
 - Good soil health which includes mulching of trees
 - Carefully managed nutrition and irrigation to reduce stress on the trees
 - Effective use of chemicals
- *Phytophthora* spores can survive for up to 6 years in the soil
- Avocado trees are particularly susceptible to *Phytophthora* when they are very young – special preparation and care is needed leading up to and for a year or two after planting
- Trees with an incompatible graft are likely to have a weakened root system
- Regularly inspect feeder roots for the presence of *Phytophthora* root rot
- Monitor root phosphonate levels to assist in phosphorous acid treatment decisions (see contact details etc for lab on pp.20)
- After pruning treat cut surfaces with copper fungicide paint or sprays to help prevent possible infection by species of *Trametes* fungi.
- An integrated approach for post harvest diseases is also needed
 - good tree husbandry
 - strategic use of fungicides
 - careful harvest
 - appropriate post harvest care including cool chain management.
- A half-hearted fungicide spray program for the fruit is worse than no program at all



Dudley Mitchell describing the practices used on young trees with Dave & Helen Duncan and others looking on

'Whilst every care has been taken in preparing these minutes, the Dept of Employment, Economic Development and Innovation (DEEDI) (previously known as DPI&F Qld) and DAFWA, accept no responsibility for decisions or actions taken as a result of any data, information, statement or advice, expressed or implied, contained in these minutes. The views and recommendations of the speakers are not necessarily endorsed or supported by DEEDI or DAFWA.'

Present: (82 + 4)

Sam Air, Kevin Anderson, Hes Anderson, Tim Backhouse, Bernadette Backhouse, Warrick Backhouse, Jim Baily, Joan Baily, Rod Bamess, Sue Bamess, Mark Bamess, Shane Booth, John Brealey, Anita Browne, Tod Burgess, Paul Burrill, Bill Castledon, Sam Castledon, Peter Cocking, Ron Cocking, Jeff Cocking, Joe Cooper, Ryan Cripps, Russell Delroy, Neil Delroy, Bev Dickons, Rob Dimitriou, Tom Dineen, Dave Duncan, Helen Duncan, Barry Dunnet, Wayne Edwards, Doug Edwards, Jason Edwards, Vin Farrell, Liz Farrell, Tony Fontanini, Jennie Franceschi, Joshua Franceschi, Carlton Freeman, Phil French, Wendy French, Dean French, Rob Gwynne, Ken Gwynne, Kay Gwynne, David Haynes, Jan Haynes, David Henderson, Lisa Henderson, Tracey Hutcheson, Stewart Ipsen, George Ipsen, Mitchell Ipsen, Chris Jones, Ron Kemp, Maria Kemp, Philip Lawe-Davies, Rosalind Lawe-Davies, Travis Luzny, Dudley Mitchell, Tony Mulligan, George Nicolaou, Ivan Panzich, Steve Poole, David Pottinger, Carey Riebau, Carmelo Russo, Andrew Scott, Quenton Seed, Anel Snyman, Lesley Stackhouse, Dave Stewart, Richard Stuart-Williams, Rory Tomlinson, Linda Viviers, Tom Wilkinson, Jocelyn Wilkinson, Kathy Williams, Mitchell Williams, Tom Winfield, Robin Winfield.

From Department of Agriculture and Food West Australia (DAFWA): Alec McCarthy,
From Queensland Dept of Employment, Economic Development & Innovation (DEEDI):
Dr Liz Dann, Dr Ken Pegg and Simon Newett

PROGRAM

- - MORNING TEA -
- Welcome and outline of the day – Alec McCarthy & Simon Newett
- Update on industry issues – Russell Delroy, AAL director for WA
- *Phytophthora* root rot management – Dr Ken Pegg
- Other soil borne diseases, postharvest fruit diseases and the “GrowHelp” diagnostic service – Dr Liz Dann
- Remote sensing – Jim Baily
- - LUNCH -
- Farm overview followed by farm walk – Dudley Mitchell
- Evaluation of the day
- “Positive Points” self assessment of avocado orchard management

Thanks to Alec McCarthy

During the outline of the day Simon Newett took the opportunity to thank Alec McCarthy for all his hard work often behind-the-scenes to help make these workshops a success.

Next project

Simon explained that this was the last workshop in the current 3 year project and that the next proposed project was going to focus on updating information products, establish a base-line for production costs, do a study of irrigation practices and perhaps some updates to the AVOMAN orchard management software.

Evaluation of project

Simon also pointed out that as well as the evaluation associated with each workshop there would be an **electronic-survey** sent out in the next month or so to conduct an overall evaluation of the 3 year study group workshop project, he asked growers to take the 10 minutes or so required to respond to this survey

INDUSTRY ISSUES – RUSSELL DELROY

Cercospora spot

Russell reported that the West Australian quarantine service suspected the presence of Cercospora spot on a consignment of fruit sent from the Bundaberg region in late April, so consignments of fruit were suspended from the particular packhouse until the presence of this disease could be confirmed or ruled out. To date this disease has only ever been reported from the Atherton Tablelands in Far North Queensland and neither fruit nor trees from this region are permitted to enter WA. Other areas of Australia to date have ‘area freedom’ status. The disease is quite easy to control with the standard copper spray program used for the control of anthracnose and Ken Pegg thinks that the cool dry conditions in the lower south west of WA would not favour the disease. Ken, Liz and Simon visited the DAFWA quarantine centre in Perth on Wednesday to speak to officials and discuss the suspect sample. Several orchards in the Bundaberg area have been scoured for evidence of the disease and the results have been negative. It was concluded that the presence of the disease in the consignment was a mis-diagnosis and consignments have since resumed.

Study group meetings

Russell Delroy said that he believed that the study group meetings had been of tremendous value, one of the best things for growers and very well attended. He asked for a show of hands for those who would like to see the workshops continued and there was very strong support.

Question about ICA

A question was raised – “If a packhouse in WA was sending fruit to the eastern states without full ICA, would that stop fruit being sent from WA as a whole to the eastern states?” The general feeling was that without ICA the consignments would not be accepted into the eastern states. If fruit was inadvertently sent that did not fully meet with the ICA protocols, then the offending packhouse would likely lose their accreditation. It is unlikely the ICA system would be stopped for all shippers unless an inherent flaw in the system was detected, though it is more likely that changes to the protocols would be made to resolve the flaw.



Left: lack of feeder roots under Phytophthora affected tree.

Right: long white feeder roots under a healthy tree not affected by Phytophthora root rot. Regular inspection of feeder roots under the mulch below the canopy will give you a much earlier warning of Phytophthora than waiting for visual symptoms to appear in the canopy. Brown lesions on the roots or a paucity of feeder roots will indicate that something is amiss.

‘PHYTOPHTHORA ROOT ROT MANAGEMENT’

Dr Ken Pegg

Please refer to copy of Ken’s MS PowerPoint presentation for details.

Here are some additional notes to emphasize parts of the presentation.

Phytophthora cinnamomi is not in fact a fungus but a more primitive organism more closely related to algae. For example fungi have cell walls made of chitin (like crustaceans) but the cell walls of *Phytophthora* are made of cellulose (like plants).

It is important to understand the life cycle of *Phytophthora* in order to understand how to control it.

***Phytophthora cinnamomi* spores**

In conditions that are unfavourable for the pathogen (e.g. very dry conditions) *Phytophthora* forms tough spores called **chlamydospores** that can survive in the soil for up to 6 years. These spores can be counted in soil samples and can number up to 40,000 in one cubic millimetre of soil. Chlamydospores are triggered to germinate when both wet conditions and root exudates return. The spores that are produced in wet conditions to spread the disease are called **zoospores**. Zoospores are mobile in free water – not unlike tadpoles in appearance but very small and with two tails to propel themselves with, not just one.

Ken showed the audience a video clip of zoospores being released from a *Phytophthora* sporangia and swimming away to infect fresh root tissue. Zoospores are attracted to the area just behind the root tip by exudates from the root. This area of the root tip is where small quantities of carbohydrates and nutrients are exuded by the root.

Within 16 hours of infecting fresh root material the disease can release a fresh generation of zoospores. This quick life cycle coupled with the very large number of spores produced can devastate the root system of an avocado tree within a very short period of time.



*Mulch plays a very significant role in combating *Phytophthora* root rot and in tree health in general. Use coarse free-draining material. Hardwood material, particularly if containing bark, needs to be aged or composted first to remove toxins.*

Trunk canker caused by *Phytophthora cinnamomi*

Phytophthora cinnamomi can also cause a trunk canker – usually when there has been some mechanical trunk damage and in the presence of waterlogging. Mexican rootstocks (e.g. Duke 7) are more susceptible to *Phytophthora* trunk canker. These trunk cankers should be scraped out and painted with a slurry of acrylic paint to which has been added some copper fungicide and phosphorous acid.

Drainage

It is essential that the area where you plant avocado trees is well drained. *Phytophthora* used to be called “water injury”. The zoospores of *Phytophthora* need water in which to travel to infect new roots, however they still require some oxygen. Well drained soils have the least time during which soil pores are filled with water. At least 1m of well drained soil is recommended for WA as well as planting on mounds. In parts of Queensland which can experience sustained torrential rain 1.5 to 2m of well drained soil is recommended as well as planting on mounds. Water logged trees with *Phytophthora* can collapse within 2 to 3 days whilst waterlogged trees without *Phytophthora* will last 10 to 15 days.

Season

The activity of root rot is strongly linked to seasons. Cooler weather suits *Phytophthora* more than it does avocado. The optimum temperature range for avocado is 21 to 33°C whilst the optimum range for *Phytophthora* is 19 - 25°C. Therefore *Phytophthora* is more likely to get the upper hand in autumn and spring when temperatures are cooler and soils are wetter.

Chemical control

It is important that you get your management right before using chemicals. For example good drainage, high organic matter and mulching, balanced nutrition including high calcium levels in the soil, well managed irrigation practices, tolerant rootstocks, disease free nursery stock.

Six months before planting out new trees

Treat the planting hole with fresh chook manure six months prior to planting.

*Note: In the sandy areas from north of Perth down through to Bunbury, you will not be allowed to use chicken manure from September 2011. Currently it may only be used in these areas from June to August. Make sure the chook manure is well mixed in to prevent smells and proliferation of flies. The manure will produce ammonia which is toxic to *Phytophthora*, however it is also toxic to avocado roots (hence the need to treat the planting the hole several months before the plants are established). Fumigants such as Metham sodium are not recommended because they destroy all organisms in the soil including beneficial ones so that *Phytophthora* will come back with a vengeance with no natural control organisms.*

At planting time

The night before planting drench the tree in the nursery bag with phosphorous acid.

At planting treat the site with Ridomil and apply coarse mulch to the site. Apply regular doses of gypsum (but monitor soil calcium levels to ensure that nutrients are kept in balance and that calcium levels do not become too high at the expense of other nutrients. Some trials have shown that painting stems with phosphorous acid (20% strength) at age 3 months is beneficial.

Mulching

Avocado evolved in Central America in well aerated soils rich in organic matter. Using plenty of coarse mulch attempts to replicate these conditions, raising organic matter levels improves soil aeration and makes soils more suppressive to *Phytophthora*. Woody mulches stimulate the production of the enzyme **cellulase** by micro-organisms to break down the

cellulose in the woody material, and since the cell walls of *Phytophthora* are made of cellulose they are also broken down. Some of the best mulches to use on avocados are the chips of avocado and those of aged hardwood chips.

Irrigation

It is essential to monitor soil moisture levels and use this information to make decisions about irrigation. Moisture stressed roots release more exudates and in doing so attract more *Phytophthora* zoospores. Also, sick trees use substantially less water than healthy ones so to avoid overwatering them (which would make them worse) the rate should be reduced – e.g. fit a lower rate sprinkler and install separate tensiometers under sick trees to guide you.

Carbohydrate storage levels in the tree

You need a good summer leaf flush to provide a good canopy that will manufacture (photosynthesize) plenty of carbohydrate which is needed amongst other things to produce a good root flush in autumn and winter. This good root flush will be better able to cope with the fight against *Phytophthora* in the cooler months when temperatures are optimum for root rot and provide for flowering and fruitset in spring.



Dudley Mitchell on the new thickly mulched mound with the new trees on improved rootstock. The rows run in the direction of the slope to improve drainage.

Resistant rootstocks

For avocado, *Phytophthora* is what is called a ‘new encounter disease’. This means that the avocado did not evolve in the presence of the disease and has therefore not developed any resistance (avocado evolved in Central America whilst *Phytophthora* is thought to have originated in New Guinea). It is very hard to get a high level of resistance in the plant to a new encounter disease.

When sourcing rootstock seed one should find out if the seed came from self-pollination as the seed will be more true-to-type to its mother tree, or cross-pollination in which case the seed will be more variable and may not give the *Phytophthora* tolerance you are expecting.

Compatibility of scion with rootstock

If there is an obvious incompatibility between the scion and the rootstock the graft union will show a different size between the two. When the diameter of the scion exceeds the diameter of the rootstock it means that the supply of carbohydrate to the roots is restricted and for this reason roots are starved of energy needed to replace roots destroyed by *Phytophthora*. Trees that show a clear incompatibility are usually much worse affected by *Phytophthora* root rot.



Due to incompatibility between the scion (Hass in this case) and the rootstock there is a constriction at the graft union which restricts the amount of carbohydrate that can reach the roots from the canopy. This makes it harder for the tree to re-generate roots after damage from *Phytophthora* root rot so trees showing incompatibility are often worse affected by this disease. This block of trees was staghorned two years previously in 2008.

Chemical control

1. Phosphorous acid

Phosphorous acid mode of action

Phosphorous acid doesn't actually kill *Phytophthora* but stops its growth and switches on the plants' own defence mechanisms (it is a plant defence activator).

Ken showed a picture of Petri dishes where *Phytophthora* was growing, when the *Phytophthora* culture was treated with phosphorous acid the growth stopped but the pathogen was not actually killed. This is why it is important to have the phosphorous acid already in the plant before *Phytophthora* arrives.

Phosphorous acid must be applied regularly because it doesn't kill *Phytophthora* or reduce its level in the soil.

Some rootstocks give a better response to phosphorous acid than others.

Phosphorous acid shouldn't be applied within 6 weeks of flowering.

Injecting 60% vs. 20% - since phosphorous acid does not move laterally but only to the roots directly below the injection site it is important to dilute the product down to 20% and inject a large number of sites evenly distributed around the circumference of the tree, in this way a greater proportion of the root system will be protected.

Phosphorous acid dilution rates

To dilute a 40% product to 20% add 1 part water to 1 part acid.
 To dilute a 60% product to 20% add 2 parts water to 1 part acid.

Question: How do you work out the injection rate for a very sick tree with virtually no canopy?

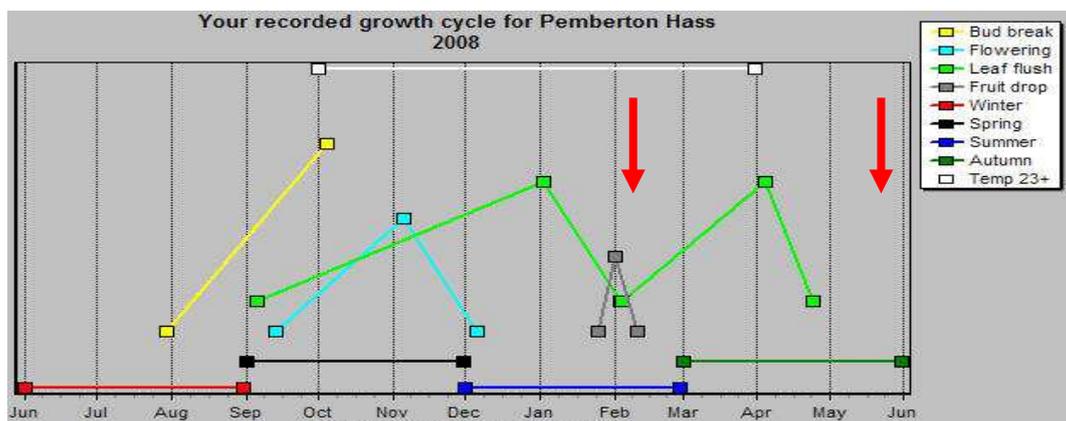
Response: Put injections a hand-spans apart around the circumference of the trunk &/or use Ridomil.

Foliar spray

Use 8.3mL of a 60% phosphorous acid solution per litre of water and buffer the final spray mixture to a pH of 7.2. Note that leaf burn associated with phosphorous acid sprays is usually caused by the combination of an acid pH and existing copper residues on the leaf, the acid releases a great amount of the copper ions and it is the copper that causes the burn. Copper oxide is the copper fungicide form least likely to cause leaf burn.

Where will the phosphorous acid go?

This will depend on which part of the tree is actively growing at the time of application and explains why the correct timing of application is so important. When something is applied it will go to that part of the tree which is actively growing at the time. Thus phosphorous acid applied at flowering time will go to the flowers (and not the roots where you want it). There are two main times in the year when the roots are actively growing, (a) root growth is strongest in late autumn because the rest of the tree has basically stopped growing – the leaf flush is over, fruit (if still present) growth has slowed right down and flower buds haven't started to develop yet, and (b) after the spring leaf flush has matured.



Typical Hass phenological cycle for the Pemberton area. The best times for applying phosphorous acid (see red arrows) are when leaf, flowers and fruit growth have either stopped or have slowed – this is the main time that roots get a chance to grow and this is when to apply phosphorous acid because this is when they are acting as a 'sink' and therefore attracting nutrients and chemicals.

Question: Can you put additives with phosphorous acid sprays?

Response: It is not recommended at this stage and can be dangerous however Liz Dann is investigating additives as part of the new diseases project.

Bark spraying

Research work shows that this only works on young trees (a grower in NSW has had success in larger trees spraying young branches), any mistake (e.g. an increase in concentration) can chemically cincture the tree.

Question: Is it better to spray or paint young trees?

Response: Either, but it is hard to get the level up in young trees.

Question: Is the optimum root level 25ppm or 40ppm?

Response: 25ppm is the minimum level. You need to keep it above this level for the whole year so to achieve this you may have to get it to about 100ppm to start with.

Phosphonate is not a fertiliser.

Relative efficiency of different application methods

Application method	ppm phosphonate in roots
Inject	75
Foliar	41
Bark spray	26
Control	6

Soil drenching is not effective, for example per square metre of canopy, only 1.25g of phosphonate is required by injection but 770g is required by soil drenching to reach the same level in the roots. That is, injection is 700 times more effective than soil drenching. Even more would be needed on a clay soil but probably a bit less on a sandy soil.

Question: What about resistance developing to phosphorous acid?

Response: After being used for about 40 years no resistance has been reported.

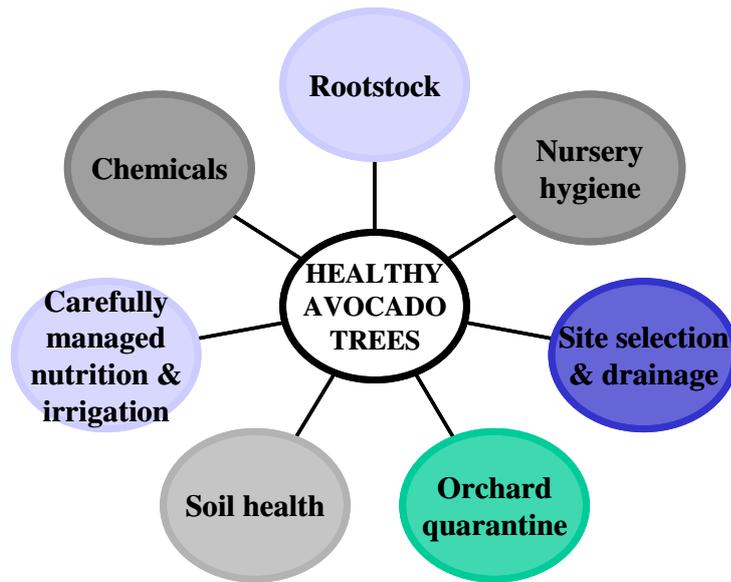
2. *Metalaxyl*

Metalaxyl is a very different chemical to phosphorous acid. It actually kills *Phytophthora* but its biggest problem is that it is susceptible to biodegradation in the soil i.e. micro-organisms in the soil use it as a food source and the more you use it the faster it is broken down and therefore the less it persists in the soil. At best the half life of metalaxyl once put out in the soil is about 12 weeks but once biodegradation starts it could be a little as 1 – 2 weeks. Therefore it is very important to try and get it straight to the roots for uptake before biodegradation.



These trees were pruned back, re-shaped and re-planted on mounds in 2006 and 2007, with a thick layer of mulch.

The keys to a healthy root system



The “Pegg Wheel” showing the 7 essential elements that must be integrated for effective root rot control. Note that chemicals are only one of the steps.

1. Rootstock – ones with greater tolerance to *Phytophthora* are becoming available
2. Nursery hygiene – ensure that trees are disease free from their source
3. Drainage – closely related to site selection
4. Soil health – this includes mulching of trees which contributes greatly to soil health
5. Carefully managed nutrition and irrigation – the less the trees are stressed the better
6. Effective use of chemicals
7. Quarantine – only in rare cases is an orchard free of *Phytophthora*

There are other species of *Phytophthora* that effect avocados, viz. *Phytophthora citricola*, *P. menzei*, *P. hevea* and *P. boehmeriae* but the only one that affects avocado in Australia is *Phytophthora cinnamomi*.

For more information on *Phytophthora* trunk cankers please refer to the article in “Talking Avocados” Summer 2009/2010.

Question: Organic growers aren’t permitted to use phosphorous acid so how can you fight Phytophthora?

Response: Use all the other measures on the “Pegg Wheel”. Before phosphorous acid was available growers placed great importance on the use of mulch.



Salt burn on leaves. Trees with Phytophthora-affected feeder roots are less able to exclude salt from uptake

INJECTION EQUIPMENT

Chemjet

Spring loaded syringe. Approx cost per unit = \$10.

Website: www.chemjet.com.au

Gus Gorinsen can be contacted at: chemjet@powerup.com.au



Avo-Ject (Aongatete)

Syringe that uses air pressure. Approximate cost per unit = \$3.

Website: www.coolstore.co.nz/products (NZ)

Email: Caron Rogers at caron@coolstore.co.nz



Side-winder

A drill/injector in one unit that works with the aid of an air compressor.

Website: www.treeinjectors.com

Geoff Eldridge can be contacted at: geoff@treeinjectors.com



OTHER SOIL BORNE DISEASES, POSTHARVEST FRUIT DISEASES AND THE “GROWHELP” DIAGNOSTIC SERVICE

Dr Liz Dann

Please refer to copy of Liz’s MS PowerPoint presentation for details.

Note: the hardcopy of the PowerPoint included with these minutes contain several more slides than were shown at the workshop, they start after the “Questions” slide and provide quite a lot of extra information.

Here are some additional notes to emphasize parts of the presentation.

OTHER SOIL BORNE DISEASES

- *Verticillium* wilt disease (*Verticillium dahliae*)
- “Cylindro” complex
 - *Cylindrocladium parasiticum*
 - *Cylindrocladiella parva*
 - *Cylindrocarpon destructans*
- Basidiomycete diseases
 - Brown root rot – *Phellinus noxius*
 - *Trametes* (?)

***Verticillium* wilt**

This disease is usually confined to one branch although in very young trees it can affect the whole tree. It has many alternate hosts including the Solanaceae family (e.g. potato and tomato), strawberries, cotton, peanut, and various weeds. Avocados growing in ground previously used for potatoes often show *Verticillium*. The symptoms include sudden wilting of the affected branch and once the branch dies the dead leaves remain on the branch, if the branch is sliced longitudinally the vascular tissue will appear stained brown.

Verticillium survives in the soil as microsclerotia which are stimulated to germinate by root exudates. The disease prefers cool (less than 25°C), acidic, wet soil. High summer temperatures arrest infection and trees can recover but re-occur when cool temperatures return. Affected material should be removed and burnt. Some variation in susceptibility exists, for example Mexican rootstocks have a lower incidence.

Trees get predisposed to *Verticillium* by things that stress or starve the root system. Save any radical pruning to when temperatures are warmer and therefore less conducive to the disease.

For more information on Verticillium wilt disease please refer to the article in “Talking Avocados” Summer 2009/2010.

“Cylindro” complex

These diseases are a type of damping off/seedling blight that can affect young trees before or after planting out. They are favoured by high humidity, wet conditions, shading, high temperatures. Nursery cloning rooms are perfect incubators for the disease complex. They can be exacerbated by transplant shock and over-irrigation.

Question: How can root symptoms caused by the “Cylindro” complex be distinguished from the root symptoms of Phytophthora?

Response: Only by detailed laboratory pathological analysis.

Brown root rot – *Phellinus noxius*

This disease is thought to be confined to the tropics and sub-tropics but there are other species found in WA forests. *Phellinus noxius* has a very wide host range which includes mango, fig, jacaranda and hoop pine. It survives on woody debris in the soil and is spread only in infected woody material. It is spread from tree to tree by root contact. Currently there is no chemical control. Control lies in removing affected trees (including all woody roots) and isolating healthy trees from potentially infected ones by using root barriers. Symptoms include sudden leaf wilt, the presence of an “infection” stocking which advances up the trunk from ground level and the presence of white mycelial growth under the bark.

In areas where it is known to occur when trees are cleared all woody material both above and below the ground should be removed. The disease tends to start on dead woody material in the ground then it spreads to live roots.

*For more information on *Phellinus noxius* please refer to the article in “Talking Avocados” Winter 2009.*

Suspected *Trametes*

A section of the AVONOVA Warren Rd farm is declining quite fast and the trees are covered in bracts which are the fruiting bodies of fungi. The identity of the fungus is yet to be confirmed but it is thought to belong to the genus *Trametes*. The spores of the pathogen may be airborne and may have entered the tree through open wounds such as pruning cuts but possibly also through sunburn damaged branches.

Until the disease can be positively identified the recommendations are as follows:

- Treat all cut surfaces with a fungicide
- Apply a copper fungicide spray immediately after mechanically pruning

Liz mentioned that the new avocado pathology project will investigate this disease further.



*Typical fruiting bodies (bracts) appearing on the trunks of dying from what is thought to be a *Trametes* species*

POST HARVEST DISEASES

Anthracnose

It is important to note that infection occurs in the field but then remains dormant and symptoms don't develop until the fruit ripens – usually well after the fruit leaves the orchard.

Stem end rot

Many species of fungi can cause Stem end rot (SER), and like anthracnose symptoms don't develop till the fruit ripens.

Grower comment: Some years these diseases are a problem but others they aren't.

Response: Fruit rots are generally worse in wetter years. However stem end rot (SER) behaves differently and tends to be more severe in water stressed (dry) years.

The strobilurin group of fungicides e.g. Amistar® have some “reach back” control, that is, they can be applied a couple of days after a suitable set of climatic conditions for fungal infection and still have a reasonable controlling effect.

Effect of rootstock

Rootstocks produce anti-fungal chemicals such as dienes that reduce the susceptibility of the fruit to diseases such as anthracnose. For example fruit from Hass on the Velvick rootstock have a lower incidence of anthracnose than on Duke 7 rootstock. Liz is analysing the effect of different rootstocks on anthracnose susceptibility. The level of anti-fungal chemicals in the fruit drops as the fruit ripens after harvest.

Effect of nitrogen level and nitrogen:calcium ratio on anthracnose susceptibility

As the nitrogen level increases the susceptibility of the fruit to anthracnose increases. The same is true for the N:Ca ratio, the higher the N the greater the anthracnose susceptibility. These levels are influenced by the rootstock as well as the fertiliser program used.

How to control these diseases

Control measures include field control and post-harvest control measures.

Field control measures include rootstock selection, fungicide sprays, the nitrogen and calcium fertiliser program and minimising insect damage to fruit.

NB: a half hearted copper spray program is worse than having no copper spray program at all. This is because copper more easily destroys the beneficial fungi that attack anthracnose than the anthracnose itself.

Post-harvest measures include careful handling of fruit, keeping fruit out of the sun, removing field heat as soon as possible, the use of post harvest chemicals such as prochloraz and careful control of fruit temperatures at different stages of ripeness.

New disease project

Part of the new project will be to investigate new approaches to disease management including new products and other existing protectant fungicides.

In summary

Liz explained the need to use an integrated approach for control of fruit diseases including:

- good tree husbandry
- strategic use of fungicides
- careful harvest
- appropriate post harvest care including cool chain management.

‘Grow Help’ diagnostic service

The diagnostic service offered by ‘Grow Help’ was outlined. Liz pointed out that as well as including dead material in the sample it is very important to also include alive (but affected) plant material. Refer to details on the MS PowerPoint slides for details and the web site.

AIR AGRONOMICS – Jim Baily

Jim explained an aerial service that provided images that could be useful in agricultural property management. Aerial photographs were taken using infra red signals to a resolution of 1 pixel per square metre of ground area. In fields of wine grapes the service has been used to differentiate different areas within the same block so that the grapes from different areas can be harvested separately and used for different quality wines. It has potential application for disease management, irrigation management and nutrition management. Costs range from about \$50/ha including interpretation. Enquiries should be directed to Jim at 08 9853 1038



Liz pointing out a dead tree that may have been killed by Trametes, and (right) the fruiting bodies of the fungus

OVERVIEW OF ORCHARD AND FARM WALK

Dudley Mitchell gave us a comprehensive overview of the orchard before we headed out in the field.

This orchard consists of approximately 8,000 trees on 16 to 17 hectares of which 6 ha are in mature production. Until 1987 the property grew potatoes, the first avocados were planted in 1988.

Soil types

One of the most difficult things to manage about this orchard is that there are 6 different soil types on the property, ranging from shallow clay loams to deep sandy soils. Each soil type needs to be managed differently especially when it comes to irrigation.

Rootstocks

Historically too they have 10 different rootstocks including different sources of ‘Velvick’, Duke 7 and Topa Topa which also complicates management of the property. New plantings are using SHSR-02 and Dorrian Velvick. Note: The mother trees for Dorrian Velvick are grown in isolation and therefore the seed are self pollinated and true-to-type.

***Phytophthora* management**

Phytophthora root rot has been a big issue on this orchard and for this reason the farm is currently undergoing a renewal process involving the removal of old trees, changing row direction, mounding up rows to improve drainage, replanting on improved rootstocks and

managing irrigation more carefully. Since installing moisture monitoring devices Dudley says that they have been able to manage soil moisture better and turn around *Phytophthora* control. *Phytophthora* control is being approached from a whole rhizosphere (root environment) concept which attempts to create a *Phytophthora* suppressive root environment with high oxygen content. Phosphorous acid injections and sprays are also used.

Canopy management

Young trees

The Chilean system is being tried which involves cincturing one limb per year per tree to improve the yield on that limb the following season then cutting it off after harvest. In this way they are starting a process of selective limb removal at an early age to control tree size and shape. Sunny® is also used.

Older trees

Selective limb removal is used. This is timed for early in the season so there is a full season of growth ahead for enough leaf to re-grow to prevent sunburn. Some staghorning has been carried out on the sandy block but it takes an extra year to come back into production.

Leaf tip burn

This is caused by salt. Dudley quoted the fact that every year 40 kg of sea salt is dumped per hectare here (a distance of 15 km from the ocean). Ken Pegg pointed out that trees with *Phytophthora*-affected feeder roots lose the ability to exclude salt from uptake, thus making the leaf burn worse.

Over-irrigating?

The first block we visited is now 21 years old and the yield last year was 16 t/ha. The soil is heavy clay and irrigation has been cut back to once every 3rd day.

Dudley pointed out another block that is due to be replaced. The decision to remove the trees was made last year and the irrigation was switched off in spring, two months later in December the trees were the best they had ever looked which suggested that they were being over-watered previously.

Renewed block

The next block we visited was one that had had the original trees ripped out, rows mounded up, replanted and mulched. An additional benefit of the thick layer of mulch is weed control, in this way it is unnecessary to go near the trees with weedicide. Weedicide is now only used in a narrow strip where the interrow grass meets the edge of the mulched area.

The central leader or another vigorous branch is the one selected for cincturing and subsequent removal after harvest. A budding knife is used for the cincturing process. Last year a saw was used but proved too wide for these young trees because sometimes the cinctured limbs snapped off in the wind.

Older block

An older block was visited on the other side of the dam. The soil is heavy clay and irrigation has been cut back here to about 10-15 minutes per day with a longer one to flush out any salt build up at the weekend. Total irrigation applied per year now is about 5 ML/year.

In this block we saw some examples of scion overgrowth of the rootstock which makes it harder for the tree to cope with and recover from root rot damage because the constriction in the “plumbing” at the graft union prevents sufficient carbohydrate from reaching the root system from the canopy to provide energy for root re-growth.

Youngest block

The final block visited had been very recently re-shaped (rows mounded) and re-planted and also incorporated were a percentage of 'Edranol' variety for cross-pollination purposes.

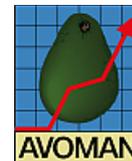
Some trees have suffered from the "Cylindro" complex. Affected trees have been drenched with Prochloraz.



Above: The most recent block of land to be re-modelled was replanted on significant mounds for improved drainage. The rootstock is SHRS-02.

Left: The "Cylindro" complex of diseases had affected a percentage of trees (50 out of 1200) causing some die-back of branches and some loss of trees.





AVOMAN APPLICATIONS FOR AVOCADO *PHYTOPHTHORA* MANAGEMENT

The AVOMAN avocado management software includes the following features that support *Phytophthora* control.

- Illustrated Help files (see some of topics in 1st screen grab below)
- Database containing details of pesticides registered for use against *Phytophthora* root rot
- Record keeping and reporting for soil phosphonate testing results
- Record keeping and reporting for root rot control management practices used such as injections, foliar sprays, spreading of Ridomil, applying mulch etc
- Recommendations for injections (see 2nd screen grab below)
- Numerous reports, including the spray diary

Integrated root rot management

Judicious use of chemicals Carefully managed nutrition and irrigation

Mulching with organic materials

Figure 1: The seven elements of an Integrated program to manage root rot disease

Some of the elements of *Phytophthora* root rot management, viz. tolerant rootstocks, disease-free nursery trees and careful selection of the site to ensure free drainage have been addressed in the orchard establishment section. Once trees reach bearing age, root rot management then involves judicious chemical use and various cultural measures.

Click on any of the following links for more details on each of these 7 elements

- [Soil drainage](#)
- [Tolerant rootstocks](#)
- [Disease free nursery trees](#)
- [Orchard quarantine](#)
- [Chemical control](#)
- [Mulching and cover cropping](#)
- [Fertiliser and irrigation management](#)

Other useful practices

Another useful practice to help minimise the impact of root rot disease is to remove the fruit from unthrifty trees, particularly young trees. This helps the tree cope with the disease by removing a significant source of competition for resources, thereby facilitating replacement root growth.

See also:

- [Root rot information](#)
- [Rootrot symptoms](#)
- [Rootrot Source of infection and spread](#)
- [Understanding root rot injection recommendations](#)

Recommendations

Jobs Tools Options Pest & disease guidelines Help

Week 48 [26/11/2007 to 02/12/2007] 12 4 < Today > 4 12

Block Alstonvl Fuerte [New job] [Edit job] [Delete job] [Symbol legend] [Rootrot details]

	Month	Nov	Nov	Nov	Dec	Dec	Dec	Dec	Dec	Jan	Jan	Jan	Jan
	Week	46	47	48	49	50	51	52	1	2	3	4	5
Sunny®	Due												
	App												
Rootrot inject	Due	*	*	97.50*	*	*	*	*	*	*	*	*	*
	App			97.50									
				0.00									

N P & K / B and Zn / Fe, Mn and Cu / Ca, Mg, pH and S Sunny® & Rootrot

Jobs this week	Date	Operation	Product	Amount (L/Kg)
	26/11/2007	Inject	Fungi-Fos 400 pH 7.2 (Rutec)	4.9

AVOMAN APPLICATIONS FOR POST HARVEST FRUIT DISEASE MANAGEMENT

- Illustrated Help files (see examples in the screen grabs below)
- Database containing details of pesticides registered for use against fruit diseases
- Record keeping and reporting for fungicide sprays
- Broad description of recommendations for fruit diseases

AVOMAN crop information

Hide Back Forward Home Print Options

Contents Index Search Favorites

- ▣ Pest and disease information and management
 - ▣ Pest management
 - ▣ Algal spot
 - ▣ Anthracnose
 - ▣ Anthracnose information
 - ▣ Understanding anthracnose
 - ▣ **Symptoms and damage**
 - ▣ Source of infection and spread
 - ▣ Management of the disease
 - ▣ Future management of anthracnose
 - ▣ Avocado sunblotch viroid
 - ▣ Bacterial soft rot
 - ▣ Basidiomycete
 - ▣ Bug - Bathrus
 - ▣ Bug - Tea mosquito (Helopeltis bug)
 - ▣ Bugs - Fruitspotting and Banana spotting
 - ▣ Cercospora leaf and fruit spot
 - ▣ Fruitborer - Avocado
 - ▣ Fruitborer - Orange
 - ▣ Fruit fly - Mediterranean
 - ▣ Fruit fly - Queensland
 - ▣ Leaf-eating beetles (Monolepta beetle & Swar)
 - ▣ Leafrollers
 - ▣ Looper - Bizarre
 - ▣ Looper - Brown
 - ▣ Looper - Ectropis
 - ▣ Looper - Grey
 - ▣ Mite - Broad
 - ▣ Mite - Six spotted
 - ▣ Mite - Tea red spider
 - ▣ Moth - Light brown apple
 - ▣ Moth - Saunders case
 - ▣ Moth - Tussock
 - ▣ Moth - Yellow peach
 - ▣ Nematode
 - ▣ Pepper spot
 - ▣ Planthopper
 - ▣ Rootrot

Symptoms and damage of anthracnose

Three types of preharvest symptoms are commonly found:

- Small dark spots which occur around the fruit breathing pores or lenticels. Often a teardrop pattern of spots can be observed as the infection runs from the top to the base of the fruit. This occurs when fungal spores are carried down the fruit by water during extended rainfall periods. All varieties are susceptible to this type of infection. The spots rarely penetrate the ripened flesh, but downgrade the cosmetic appearance of the fruit.
- Large, circular, sunken brown spots. These occur when the fungus infects fruit through damaged areas such as insect feeding, egg-laying punctures or mechanical injury to the skin (for example, hail and wind rub). This type of infection is most commonly seen on the more susceptible varieties such as Fuerte, Rincon and Wurtz).
- Another pre-harvest symptom caused by the anthracnose pathogen *Glomerella cingulata* (*Colletotrichum gloeosporioides*) has recently been reported on Hass and has been referred to as 'speckle' in South Africa and 'pepper spot' in Australia.



Figure 1: The rot penetrates deeply into the flesh in a hemispherical pattern.



Figure 2: Spots are initially small, light brown and circular. These darken with age, centres become sunken, and in moist conditions pinkish spore masses may form on the spots.

Postharvest development of anthracnose disease is mainly due to what are known as latent infections. These are essentially field infections, which develop in the skin as fruit begins to ripen. Before fruit ripen, naturally occurring antifungal compounds (dienes) are present at sufficient levels to prevent disease development. However, when the fruit begins to soften, these compounds dissipate and anthracnose is able to develop.

Initially, small, light brown spots develop on the skin. These rapidly enlarge and change colour to dark brown or black. Centres of the spots may be slightly sunken. If a fruit is kept in a moist atmosphere, pink spores will develop on the spots. The smaller spots may rapidly coalesce and spread into large areas of rot that may cover the entire fruit surface. The dark rot usually penetrates deeply into the flesh in a hemispherical pattern.

See also:
[Anthracnose information](#)
[Understanding anthracnose](#)
[Source of infection and spread](#)
[Management of the disease](#)
[Future management of anthracnose](#)

Use of Amistar®

[Top](#) [Previous](#) [Next](#)

Amistar® is a Strobilurin fungicide that was registered for use in avocados in July 2003 to assist in the management of Anthracnose and Stem end rot. Concurrently it is also effective against Sooty blotch and Pepper spot.

Advantages:

- Locally systemic (copper fungicides are protectants only)
- Active against established latent infections
- Reduced visible fruit residues at harvest
- Does not contribute to the build up of copper levels in the soil
- Has a 'greening' effect on the tree canopy
- IPM friendly
 - Non-toxic to predatory mites
 - Low toxicity to bees
 - Low mammalian toxicity
 - Breaks down readily in soil

Disadvantages:

- Expensive
- Resistance may develop if used incorrectly
- Highly toxic to aquatic life

Directions for use:
 Amistar® has a highly specific mode of action. An anti-resistance strategy must be employed in its use, viz:

- Use no more than three Amistar® sprays per season
- No more than 1/3 of sprays during the season should be Amistar®
- Use in conjunction with copper fungicide sprays
- Do not start a season with Amistar®

Click here for more information on [Anthracnose spray guidelines](#).

See also:
[Anthracnose information](#)
[Understanding anthracnose](#)
[Symptoms and damage](#)
[Source of infection and spread](#)
[Management of the disease](#)
[Future management of anthracnose](#)

NEXT MEETING

This was the 6th and final workshop in the current study group project. No more workshops are planned for the time being.

ACKNOWLEDGEMENTS

Very many thanks to Dave and Helen Duncan and Dudley Mitchell and Ryan Cripps for hosting the day, opening up their orchard to the big group and conducting a very interesting farm walk. Thanks also to Drs Ken Pegg and Liz Dann for travelling over from Queensland as our guest speakers and to Jim Baily for telling us about the remote sensing service.

APPENDICES & ATTACHMENTS

- Appendix I: Grower feedback from the meeting
- MS PowerPoint presentations:
 - *Phytophthora* root rot management – Dr Ken Pegg
 - Other soil borne diseases, postharvest fruit diseases and the “GrowHelp” diagnostic service – Dr Liz Dann

Simon Newett,
Agri-Science, Queensland
Department of Employment, Economic Development and Innovation
(formerly Qld DPI&F)
PO Box 5083 SCMC
NAMBOUR QLD 4560
Email: simon.newett@deedi.qld.gov.au
Phone: 07-54 535 926 Fax: 07-54 535 901

Alec McCarthy
Development Officer
Department of Agriculture and Food, WA
PO BOX 1231, Bunbury WA 6231
email: alec.mccarthy@agric.wa.gov.au
Phone: 08-9780 6273 Fax: 08-9780 6136

CONTACT DETAILS FOR MONITORING ROOT PHOSPHONATE LEVELS

The laboratory SGS in Toowoomba Queensland and Graeme Thomas of GLT Horticultural Services P/L have developed a service for monitoring the phosphonate levels in feeder roots (as a result of phosphorous acid applications to the trees) to help growers make decisions on re-treatment. Information from monitoring phosphonate levels in feeder roots has proved invaluable to growers in helping them to make decisions about root rot treatments. We are also learning more about optimum treatment times and application methods from the results.

Testing kits are available from:

SGS, PO Box 549, 214 McDougall St, TOOWOOMBA QLD 4350

Phone: 46 33 0599, Fax: 46 33 0711

Email: au.agritech.twb@sgs.com

They can forward you a kit or the instructions via email. The current price per sample is: \$92.40, this includes analysis by the lab and interpretation by Graeme Thomas.

RESULTS FOR FEEDBACK SHEET – West Australia

(Avocado diseases 25/5/10)

Your current farm practice:

- Do you specify root rot tolerant rootstocks when you order new trees?
YES 28 NO 6
- For sick trees do you apply phosphorous acid by injection on a regular basis?
YES 20 NO 18
- Do you monitor phosphorous acid levels in roots?
YES 10 NO 27
- Do you schedule irrigation based on soil moisture monitoring devices?
YES 25 NO 13
- Do you reduce the irrigation water applied to trees affected by root rot?
YES 17 NO 21
- Do you spray fruit with protectant fungicides every 2 to 4 weeks?
YES 3 NO 35
- Is Amistar included in your pre-harvest fungicide program?
YES 0 NO 38
- Do you, or your packer, use a post harvest fungicide treatment (Prochloraz/Sportak) to minimise anthracnose development on fruit?
YES 22 NO 16

Today's workshop:

1. How useful did you find this workshop? Please circle the most appropriate description.

Not useful Fairly useful Useful 3 Very useful 22 Extremely useful 16

2. List the 3 most useful things that we did today and why?

- **Fungi growing in dead wood, Phytophthora session, use of mulch**
- **Phytophthora lifecycle presentation, anthracnose/stem & rot presentation.**
- **Discuss injection process, discuss spray programs, look at other diseases.**
- **Ken Pegg's talk, field walk.**
- **How PC moves about in the soil, the importance of pre plant measures, importance of a fungicide program and its timing.**
- **In situ examples of all problems, very competent speakers, very well organised.**
- **Learning about PC & prevention, farm walk: cincturing, mulching, staghorning etc, learning about other pathogens.**
- **Orchard walk to see what we learnt, cincturing & mulching, excellent speakers Ken & Liz.**
- **Ken Pegg session, field walk.**
- **Talk on PC, irrigation practices, other diseases.**

- Understanding the diseases, cultural management practices, chemical management practices.
- Explained die back very well, use lots of chook poo, mulch = coarse pine not composted.
- Fellowship with fellow growers, locational interest, different management issues.
- PC presentation, farm walk, interaction.
- Better understanding of phytophthora cycle, identify nursery based fungal diseases, look at cincturing & pruning.
- Phytophthora session Ken Pegg: many lessons to be learnt again, field walk: use of mulch-plan to reintroduce this management tool, inspired update our growth/management plan again.
- Phytophthora management.
- Talk by Ken Pegg, talk by Liz Dann, lunch & field walk.
- Farm walk, practical PC management advice, talking to other growers.
- See irrigation management technique, good management technique.
- Phytophthora management.
- Field walk: seeing different pruning & growing methods, Ken Pegg: very interesting report on phytophthora-well presented, Liz Dann: information about different diseases-well presented.
- Both Ken & Liz talks were very informative, covering a wide range of root problems, Ken especially on knowledge of phytophthora life cycle.
- Saw first hand results of good management, learnt about the benefits of mulch, learnt about fungi.
- Injection practices, more info on mulching, more info on cincturing.
- Ken Pegg's talk was excellent, farm walk was also good, general openness to questions & friendly crowd.
- Reminded on very useful avo management, PC control: more than phosphite, mulching: do it heavy.
- Action of mulches, disease control, farm management & water application.
- Other fungi: have not had info on them before, field walk: see what others are doing in new plantings, PC: good refresher.
- Phytophthora presentation, soil borne disease presentation.
- Interaction of growers, different farming methods, variation of soils.
- Ken Pegg's talk was very informative, exposure to diseases other than Phytophthora, observation of onsite problems & management practices.
- PC management & life cycle, verticillium wilt management.
- Mulch & root stocks.
- Identify diseases, identify post harvest diseases, farm walk identify diseases.

3. Did you feel able to participate? Please circle most appropriate description.

No A little 1 Some 13 Many chances 19 Every chance 8

4. Have you established new contacts today and/or had beneficial discussions with others?
 YES 37 NO 4

5. Have you learnt something new about avocado production and/or fruit quality today? ...
 YES 38 NO 3

6. Has what you learnt today made you question your current farm practices?.....
 YES 36 NO 5

7. Do you think, from what you learnt today, you will make a change to your farm practice?
 YES 31 NO 4

If yes briefly describe:

- **Mulch.**
- **Apply mulches, water management.**
- **Go back to annual mulching.**
- **Different pruning methods and type of mulch used.**
- **A multitude of things. Really an overall integrated approach.**
- **Phytophthora & root management, knowledge from Liz on other fungal diseases.**
- **Root monitoring.**
- **Monitoring our irrigation practices.**
- **Inject every year instead of alternating with bark sprays, mulch more.**
- **Back to mulching-wood chip this time, review water use: are we overwatering?**
- **Better mulching regime, re-examine irrigation control.**
- **Irrigation.**
- **Mounding, staghorning.**
- **Mulching, root analysis.**
- **Will look at trying to control risk of infection on major pruning wounds and sunburn on major limbs.**
- **Further monitoring throughout season particularly phosphorous acid levels.**
- **Disease and mulch management.**
- **More mulch applied and also increase water monitoring and chicken manure.**
- **Ca/N ratio, oxygen levels.**
- **Cincturing, injecting then staghorning.**
- **Soil nutrition.**
- **Better mulching, focus on getting planting correct, better irrigation.**
- **Lots of things including mulching & mounding, also water management.**
- **Water and spraying and mulch.**
- **Irrigation.**
- **Be more observant.**
- **Monitor irrigation process better.**
- **Mulching and removing dead stumps to prevent fungi growth.**
- **Regular sprays for dieback. (Editors note: dieback trees need to be injected, trees with dieback haven't the canopy to absorb sufficient phosphorous acid from sprays)**

8. In running the day, what could we do better?

- **Nothing it is all good.**
- **It was all good.**
- **Not a lot.**
- **Not much.**
- **Start on the soil.**
- **Avocados for lunch.**
- **Excellent as it was.**
- **Not interested in sales pitch from 3rd speaker.**
- **Seems about right to me.**
- **It was all good.**
- **Well done.**
- **Nothing.**

9. Any other comments:

- **First talk was very good. Second talk a bit too technical, print on slides could be larger & less detail.**
- **Good day.**
- **A very useful activity.**
- **Keep them going 2 to 3 times p.a.**
- **Sorry it is the last one. Would like to keep these meetings coming.**

- **Thanks!**
- **Let's keep doing them.**
- **Thanks for the opportunity to participate.**
- **More avocados for lunch.**
- **Great day, good tucker, great speakers.**
- **Australian industry or state by state standards on soil levels.**
- **Hope that some kind of meetings can continue.**
- **Ken Pegg was excellent speaker.**
- **Thanks to the organisers Dudley & Duncan's.**
- **Please push to continue with having field days, they are the only chance I get to meet other growers.**

Minutes of last meeting

1. Did you receive minutes of the last meeting? YES 28 NO 8
2. Did you read them? YES 23 NO 12
3. What did you like about them?
 - **Can use and an excellent refresher.**
 - **Summary of main points.**
 - **Very comprehensive.**
 - **Very detailed.**
 - **Have on file for constant reference and re-reading, reinforced messages from field day.**
 - **Complete & informative.**
 - **Great to refresh what was discussed during meeting and used as a reference in the field.**
 - **Easy to read and remember since we have done the workshop.**
 - **Comprehensive, well documented. It is good to be able to save to our computer.**
 - **Revision on field day topics.**
 - **Very comprehensive.**
 - **Very informative.**
 - **Excellent.**
 - **Many pictures and explanations.**
4. Any suggestions to improve them?
 - **Please send out a little earlier if possible.**
 - **Probably a little more text.**
 - **Perhaps some references could be given if we want to follow up.**