ASSESSING THE IMPACTS OF ENVIRONMENTAL COVERS IN ORCHARDS

AUGUST 2014

REPORT PREPARED BY THE APPLE & PEAR GROWERS ASSOCIATION OF SOUTH AUSTRALIA

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Contents

INTRODUCTION

The Adelaide Hills is a major region for apple and pear production in South Australia, with approximately 85% of all apples and pears grown within the Adelaide and Mt Lofty Ranges NRM region. In recent years, apple and pear orchardists within the Adelaide Hills have begun to invest in environmental covers (permanent netting infrastructure), primarily as a means of protection against hail damage to fruit, but also against damage from birds.

The environmental covers are extremely costly to install and also require additional planning submissions, therefore most of the installations to date have been in areas that are at higher risk of hail events or that are under significant bird pressure. However local anecdotal evidence and peer reviewed research in other states is that there are significant additional benefits from environmental covers.

The objectives of this project were to:

1. Quantify the impact that environmental covers have on local growing conditions and the sustainable use of land and water resources for apple and pear production within the Adelaide Hills.
2. Communicate the findings to orchardists to enable them to make informed decisions about the use of environmental covers
3. Educate the wider community, including natural resource managers and planners about the role that environmental covers can play in sustainable production of apple and pear orchards

METHODOLOGY

The intent of this project was that it be a demonstrative trial to showcase the impacts of environmental covers on fruit trees and their growing environment in the central Adelaide Hills. It was well beyond the scope of this project to install fully replicated scientific trials.

SITE SELECTION AND DESCRIPTION

Two different trial sites were selected, to cover different growing regions within the central hills and also the two main types of netting that are typically used in Australia.

At each property areas were selected that had the same variety and age of tree, on similar soil types and aspects and under identical management regimes. One site was selected under netting with the other site selected outside of netting.

LENSWOOD SITE

The Lenswood trial site was situated on Stafford Road, Lenswood at Oakwood Orchards. It was positioned on a westerly facing slope on the upper reaches of a hill. Monitoring was conducted in two separate blocks, which were situated approximately 400 metres apart.

The soils comprised of loamy topsoil, rich in organic matter, overlying clay to clay loam subsoil, with weathered rock underneath.

IMAGE 1. IMAGE FROM GOOGLE MAPS SHOWING TRIAL SITE LOCATIONS AT LENSWOOD.

The first monitoring site, apgasa001 was positioned under netting. The second monitoring site, apgasa002 was positioned in a block with no netting.

MONITORING SITE 1 – APGASA001

The orchard block was planted to the Pink Lady™ strain Rosy Glow on M26 rootstock in 2002, so the trees are well established and at full maturity and production.

The orchard trellis is part of the overall netting structure and the netting is positioned 4.5 metres above the ground surface at the highest part in the tree-line. It drops approximately half a metre in height mid-row. Trees are trained on the trellis to virtually the full height of the net.

The netting is white in colour and is a G2 netting system by JA Grigson Trading Pty Ltd. The netting can be opened up between tree rows if required. The ends of the rows are open and not enclosed in netting.

The block is watered with drip irrigation, using Amiad Supertiff emitters, with one emitter per tree. The watering system is completely automated, with the irrigation program developed around an ET model.

The monitoring site is situated approximately mid-block, slightly toward the northern end.

Monitoring Site 2 – APGASA002

As with monitoring site 1, this orchard block was planted to the Pink Lady™ strain Rosy Glow on M26 rootstock in 2002, so the trees are well established and at full maturity and production.

The orchard support structure consists of wooden trellis posts with the top trellis wire at a height of approximately 2 metres. Although they are the same age as the trees in monitoring site 1, the trees in this block are generally more stunted and the tops are not well supported.

The block is watered with drip irrigation, using Amiad Supertiff emitters, with one emitter per tree. The watering system is completely automated, with the irrigation program developed around an ET model.

The monitoring site is situated approximately 10 rows from the northern end, approximately two-thirds of the way into the row.

Image 2. Monitoring site 1 APGASA001

Image 3. Monitoring site 3 APGASA002

The above images show the visual contrast in trees, with significantly stronger and more even growth under netting.

Both sites are under very similar watering regimes.

Echunga Site

The Echunga monitoring site was located at 118 Church Hill Road, Echunga, at Ceravolo Orchards. The sites were positioned on the upper slopes near a gentle ride line, with the rows running north-south and gently sloping down to the north. The soils comprised loamy topsoil overlying fairly shallow clay to clay loam subsoil which transitioned into weathered rock and then solid rock.

Image 4. Image from Google Maps showing site locations at Echunga

The third monitoring site, apgasa003 was positioned under netting. The fourth monitoring site, apgasa004 was positioned in an immediately adjacent block with no netting.

Monitoring Site 3 – APGASA003

The trees in monitoring site 3 were planted in 1996 and as such are well established and mature trees. They are Fuji variety (type Nagafu 2) on M106 rootstock, trained to a traditional central leader at 4.5 metre row spacing and 1.8 metre tree spacing.

They are covered with grey "Netpro" netting at 6 metres above the ground on a permanent support structure that is separate from the trellis system. The sides and ends of the block are also enclosed in netting. The netting roof is permanently installed and cannot be opened up. The ends can be opened for tractor access.

This netting has only been in place for 12 months, so for most of their life the trees have not been under cover.

Irrigation is with Waterbird minisprinklers with a specified output of 69 litres per hour.

Monitoring Site 4 – APGASA004

As with monitoring site 3, the trees in monitoring site 4 were planted in 1996 and are well established and mature trees. They are Fuji variety (type Nagafu 2) on M106 rootstock, trained to a traditional central leader at 4.5 metre row spacing and 1.8 metre tree spacing.

This site is not under permanent net. Temporary, throw-over net was put over the trees a few weeks prior to harvest to help alleviate bird damage.

Irrigation is with Waterbird minisprinklers with a specified output of 69 litres per hour.

Image 5. Monitoring Site 3 - APGASA003

Image 6. Monitoring Site 4 - APGASA004

Both sites are under very similar watering regimes.

Moisture Monitoring

Soil water monitoring equipment was installed at all four monitoring sites. The equipment was provided in-kind by Sentek Technologies and comprised of their EnviroSCAN™ PLUS monitoring system. One capacitance-based probe was installed at each of the monitoring sites. Special PVC tubing was carefully installed using appropriate equipment into a slightly undersized, pre-drilled hole to ensure no disturbance of the soil to be measured. The tube was cleaned and then sealed at the bottom and an access cap fitted to the top. The capacitance probe consisted of a rod with sensors positioned at 10 cm increments along the spine and an interface card at the top.

At Lenswood, (Sites APGASA001 and APGASA002) the probe was inserted into the tubing and positioned such that the sensors were placed 10 cm, 20 cm, 30 cm, 50 cm and 80 cm below the ground surface.

At Echunga, (Sites APGASA003 and APGASA004) where hard rock was encountered during installation, the plastic tubes were cut shorter and the probe was inserted such that the sensors were placed at 10 cm, 20 cm, 30 cm, 40 cm and 60 cm below the ground surface.

The probe housing was sealed so that water could not enter and they were then connected via cable to a GPRS telemetry unit. Each sensor took a reading every 10 minutes and the data was collected by the GPRS unit and then transmitted every 3 hours to the internet. Data was stored online and downloaded into the software viewing package IrriMAX™ as needed.

The sensors used a capacitance based technology to determine soil water content and measured approximately 10 cm into the soil profile from the outside wall of the access tube. The sensor output was a volumetric output in millimetres of water per 10 cm of soil depth based on a factory calibration. It was not calibrated to soil type.

IMAGE 7. INSTALLING ACCESS TUBE

IMAGE 8. COMPLETE ENVIROSCAN PLUS SYSTEM

Image 7 above shows the access tube being installed. The tube was held in place using a tripod system. An auger was inserted into the tube and a slightly undersized hole augered beneath the tube. The tube (with a sharpened cutting edge fitted) was then gently hammered into the hole.

Image 8 shows the completely installed probe with sealed top cap fitted on the right hand side, with a short length of cable connecting it to the solar powered GPRS system on the left.

Irrigation System Check

At each site, the amount of water being output by the emitter closest to each soil moisture probe was measured. At Monitoring Sites 1 and 2 at Lenswood, this was done by placing a cup under the dripper for one minute and measuring how much water was captured. This was done when the system was operating at full pressure.

At Monitoring Sites 3 and 4 at Echunga, 3 cups were placed around the access tube (as shown in Image 9) and the amount of water captured by each cup was measured in a 30 minute period and the average between the 3 cups calculated.

Image 9. Measuring sprinkler output at Echunga

Weather evaluation

It was beyond the scope of this project to supply equipment in order to measure weather conditions under the netting. In order to compare moisture data with general weather conditions, weather data was imported from the on-farm weather station at Lenswood. At Echunga, weather data was imported from the nearest Bureau of Meteorology station at Mount Barker.

Ground cover assessments

With a different micro-climate under the net compared to outside the net, it is reasonable to expect that there may be some differences in the growth of the ground cover (orchard sward). Therefore the ground cover adjacent to each soil moisture probe was assessed for height, thickness and type of grass. Measurements were taken in spring as a benchmark and a visual assessment was also carried out in autumn, just prior to harvest.

Assessments were made in 10 x 10 cm transect, within a 50 cm by 50 cm square. This was replicated 3 times in the wheel track and 3 times in the mid-row, as shown in the Figure 1 below.

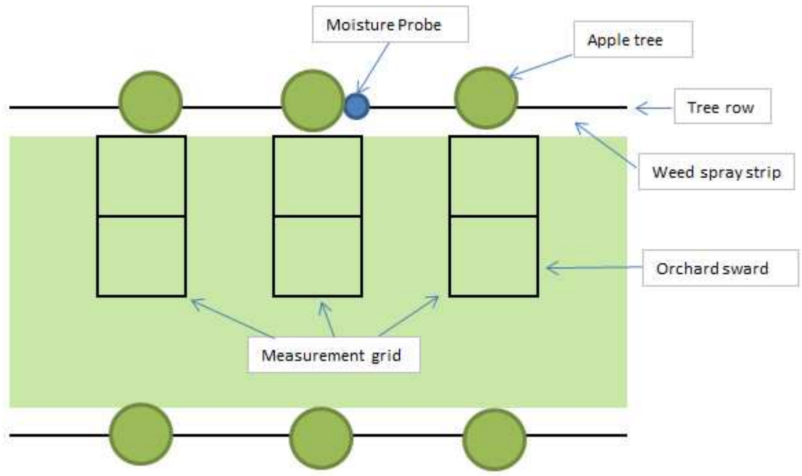

FIGURE 1. GROUND COVER ASSESSMENT GRID

IMAGE 10. SPRING GROUND COVER ASSESSMENT 50 CM X 50 CM GRID AT LENSWOOD

FRUIT AND TREE VISUAL ASSESSMENTS

Just prior to harvest, trees were visually assessed for vigour and growth. Fruit numbers were counted and a visual assessment of fruit quality and damage was made. Type of damage was recorded and percentage of fruit affected was estimated.

Further to that, yield data was collected from each site, in tonnes per hectare of fruit picked into bins.

Final packout figures (amount of first grade fruit) are not available at the time of this report as the fruit is still in storage and has not yet been packed.

RESULTS

SOIL MOISTURE AND WEATHER DATA

There were only small observable differences in soil moisture and water uptake patterns between the netted and non-netted sites at both Lenswood and Echunga. Generally over the course of the season, the dynamics of change in soil water content were very similar at both sites, as shown in Figure 2 below. This graph shows a sum of the water content measured by each sensor within the profile. The bottom pane shows the site under net and the top pane shows outside the net.

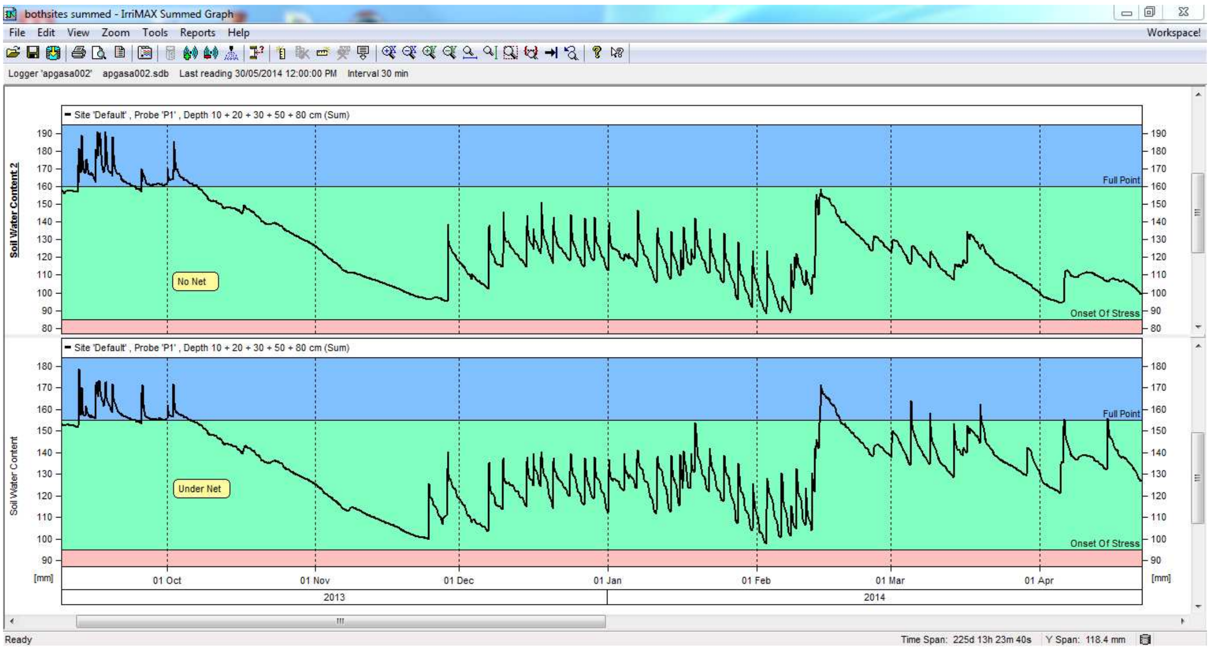

FIGURE 2. CHANGING MOISTURE DYNAMICS OVER THE SEASON AT LENSWOOD

Slight differences were however, observed in subsoil moisture extraction patterns during spring. Figure 3 below shows a separate level graph, with soil moisture data from sensors positioned at 30 cm, 50 cm and 80 cm below the ground surface. The top panel shows the site outside of the net and the bottom panel shows the site under net.

The “stepping” or staircase pattern observed on the graph is indicative of plant water uptake by roots, with water extraction occurring during the day time and no water use at night time. It can be seen that there was water extraction occurring from 50 cm and 80 cm depth earlier in the spring time (prior to the first irrigation) where there was no net than under net. This is an indicator that the trees have to extract moisture from deeper in the profile to meet their evapotranspiration demand earlier where there is no net.

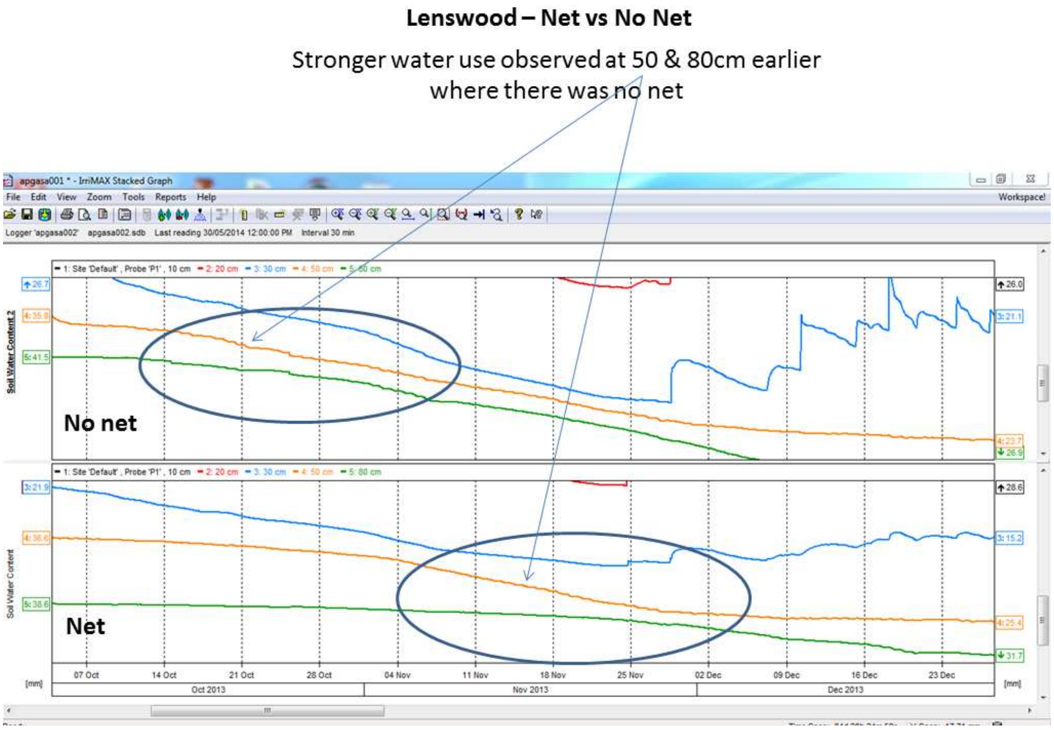

FIGURE 3. SPRING SUBSOIL MOISTURE EXTRACTION AT LENSWOOD

There were some extreme heat conditions experienced through January and February. Figure 4 shows that moisture levels within the top 30 cm of the soil profile decreased during this period, with irrigation not replenishing the soil water content at the same rate as water losses. At Lenswood, both sites responded similarly, with netting not appearing to have an observable impact on soil water content.

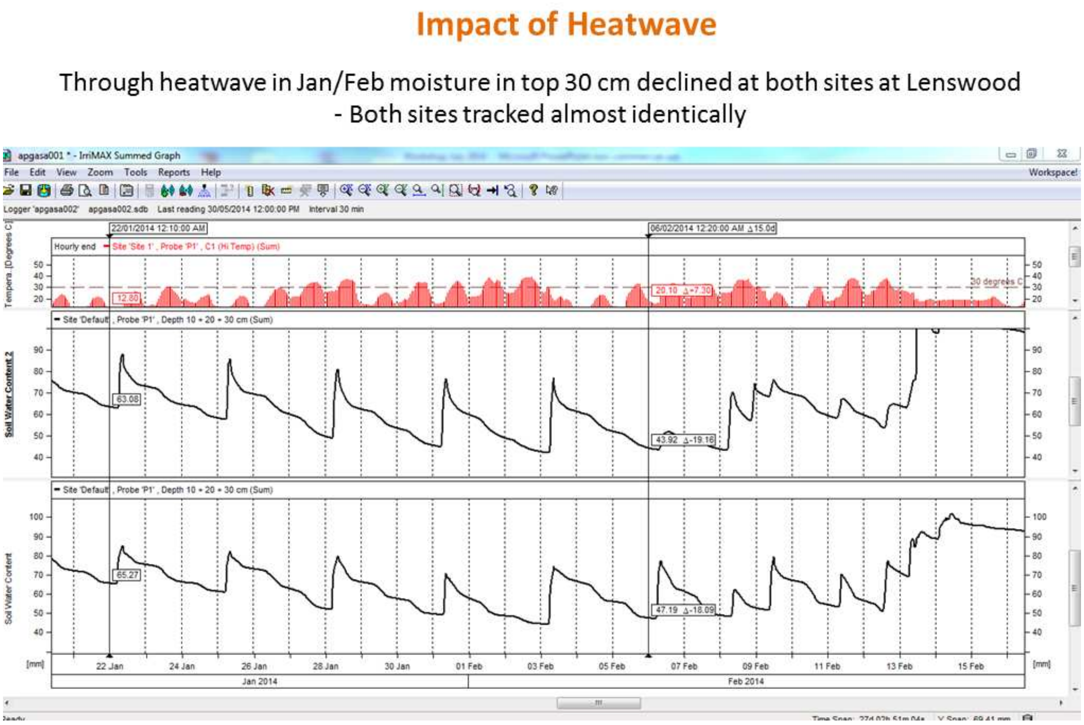

FIGURE 4. IMPACT OF SUMMER HEAT WAVE OF SOIL MOISTURE AT LENSWOOD

At Echunga however, there was an observable difference in water losses through the heatwave, with greater water loss observed from the profile where there was no net than recorded at the site under the net. This is shown in Figure 5 below.

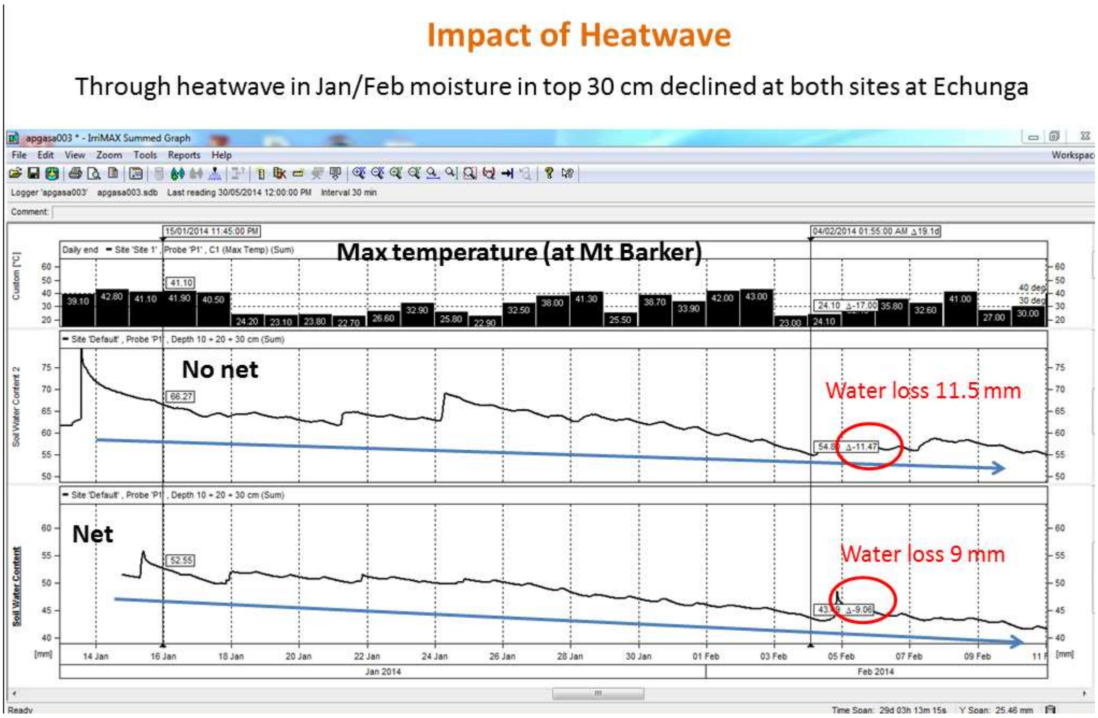

FIGURE 5. IMPACT OF HEATWAVE ON SOIL MOISTURE AT ECHUNGA

Immediately following on from the heatwave, in which some differences in soil moisture were begun to be observed at Echunga, there was a significant rainfall event on the 16th February, which completely replenished the soil moisture profile. The rainfall also filled profiles at Lenswood. This meant that with follow up irrigation and rainfall through February, March and April, the soil profile remained quite full, which was very unseasonal. Usually through late summer and early autumn, rainfall is very minimal and the soil profile is very dry, with the greatest amount of pressure on irrigation systems.

If we were to predict a time during which there may be differences in water uptake between netted and non-netted blocks, it would be through this period. However, the unseasonal rainfall masked any likely impacts.

These results are not typical of what has been observed anecdotally at these sites in previous years and also what has been observed elsewhere. Recent research from netting trials currently being undertaken by the Department of Agriculture and Food in Western Australia is showing 15-20% water savings under netting (personal communications).

While the current Sustainable Industry Grants trial is formally completed, moisture monitoring probes will be left in the ground for another season to informally compare ongoing data with this year's outcome.

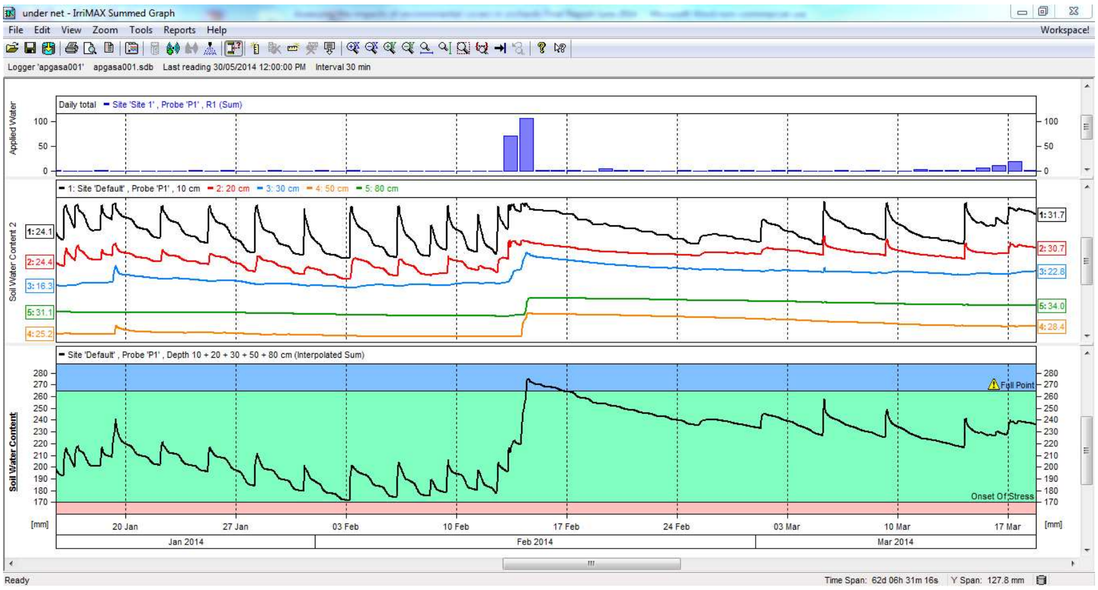

Figure 6. Impact of large rainfall event on soil moisture content at Lenswood in February

Ground Cover Assessments

There were no observable or measurable differences in the ground cover when measurements were made in either spring or autumn at either site.

The significant rainfall event in February had a major impact on ground cover, as normally the grass in the inter-row during March-April period would have dried off, particularly at drip irrigation sites. However, this did not occur in 2014 and the grass remained lush and green throughout the growing season.

The following tables show the average spread of ground cover observed at each site. There was high variability recorded between each measurement grid, such that the differences seen below are non-significant.

	Grass	Weed	Total Cover	Bare Ground
Netted	54%	41%	95%	5%
No Net	55%	43%	98%	4%

Table 1. Ground Cover at Echunga

	Grass	Weed	Clover	Total cover	Bare ground
Netted	54%	13%	15%	82%	18%
No Net	16%	7%	50%	74%	26%

Table 2. Ground cover at Lenswood

 

Image 11. Inter-row ground cover at Echunga in February on the left and at Lenswood in April on the right

Fruit and Tree Visual Assessments

Ceravolo site assessment – 24/2/14

Site 3: Under net

There was thick, lush, green ground cover, with no observable difference from spring assessment.

The trees were looking very healthy and the fruit was also very healthy, of good size and with very little sign of damage. There was no bird damage to the fruit and no visible signs of sunburn, even in the tops of the trees.

Image 12. Healthy tree growth & undamaged fruit under net

Site 4: No net

A throw-over net had been applied to these trees a few weeks prior in response to extremely high numbers of rainbow and musk lorikeets.

The ground cover was thick and lush. Visually it appeared slightly more stunted in growth than under the net; however the measured differences were not significant.

It was estimated that the top one quarter of the trees has lost approximately 90% of the fruit load to birds. There was an estimated 20% of fruit damage on the remainder of trees through sunburn, bird damage and hail damage. There was an estimated 30% fruit damage overall.

Fruit size was also observed to be slightly smaller than under the net, although this may be more tree-specific and related to the amount of thinning that occurred.

Image 13. Throw-over net to protect from bird damage - orchard access is difficult

Image 14. fruit damaged from birds

IMAGE 15. BLEACHING FROM SUNBURN AND MARKS FROM HAIL DAMAGE

IMAGE 16. FIELD DAY DEMONSTRATING TRIAL RESULTS TO GROWERS AND NRM STAFF

LENSWOOD SITE ASSESSMENT - 14/4/14

SITE 1: UNDER NET

The tree health and fruit quality was very good. There were approximately 140 apples on each tree, with no visible signs of bird damage or sunburn damage.

Reflective matting was in place to assist with the development of fruit colour. Underneath the matting the ground cover was thick, green and lush.

IMAGE 17. TREES JUST BEFORE HARVEST

IMAGE 18. VERY GOOD QUALITY FRUIT WITH NO SIGNS OF DAMAGE

SITE 2: NO NET

The tree health and fruit quality was also very good. The tops of the trees were not as well supported us with the higher trellis system under net, however there was still a very good crop load. There were approximately 150 apples on each tree and the ground cover was thick, lush and green. There was no reflective matting in place. There were some signs of damage from birds and sunburn. Overall fruit damage was estimated to be < 5%.

IMAGE 19. GOOD CROP LOAD WITH VERY LITTLE DAMAGE

YIELDS

LENSWOOD – SITES 1 & 2

The yields (tonnes per hectare of harvested fruit) from both sites at Lenswood were very similar, with almost no differences. At the time of this report the fruit is still in storage and has not yet been packed.

Yield data:	
Site 1: Block 2 (under net)	84.5T/Ha
Site 2: Block 6	83.5T/Ha

TABLE 3. YIELD DATA FROM LENSWOOD

ECHUNGA – SITES 3 & 4

The overall yields at Echunga from both blocks averaged at 25 tonnes per hectare. The differences in harvested yields between the netted and non-netted trees were not recorded.

The fruit that was picked from the non-netted site has had some problems during storage, with additional losses during storage due to rots and fruit breakdown. It is estimated that the final losses from the non-netted site were approximately 60% of the initial crop potential. Losses from the netted site were less than 5%.

These differences are very significant.

Summary

The impact of netting on water use is inconclusive in this trial. It is highly likely that the significant rainfall event in February masked some of the potential impacts through what is typically the driest part of the season. While this trial is formally completed, monitoring of soil moisture content will continue for another year to observe differences over a longer period of time.

Netting had significant benefits on fruit quality and yield, particularly in the Fuji block, through:

- Reduced hail damage
- Reduced sunburn
- Reduced bird damage
- Reduced susceptibility to resultant storage breakdown

Netting generally provided a much more favourable growing environment.