Role of Polyacrylamides (PAM) in Drip Irrigated Vineyards in the Riverland of South Australia.

By Shane Phillips and Tim Smythe
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Picture 1: Century Orchard October 2008

Introduction

The Riverland of South Australia is the largest producer of wine grapes in Australia, providing the bulk of the popular premium varieties for both domestic and international markets. As a warm inland growing region its advantages lie in the ability to produce fruit with low disease pressures at economically viable tonnages for the market. The drought in the Murray Darling Basin has placed wine grape growers under extreme water restrictions that have resulted in many growers being required to lease in water to enable crops to produce at productive levels. As a result of this extreme drought this project aims to extend the outcomes of published research into the role of polyacrylamides (PAM) in irrigation systems to increase crop water use efficiency.

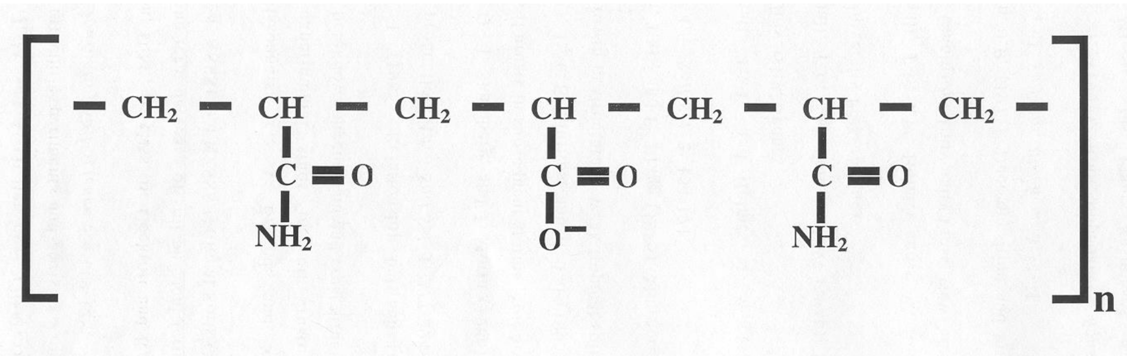
The project has been generously funded by GWRDC through the RITA program and the Riverland Wine Industry Development Council, with product

and technical support by Biocentral Laboratories. The aim of the project is to extend published research in PAM into practical field management for irrigators. As a result the field trials have evaluated a commercially available PAM product (AquaboostAG30 a patented liquid formulation). The aim is to show irrigators the advantage that the use of PAM provides in terms of irrigation and nutrient management opportunities.

Literature Review

The Murray Darling Basin has been in the grip of severe drought with restricted water allocations and increasing pressure on water resources. The pressure to produce better crops with less water is becoming more apparent as the basin faces unprecedented ongoing below average years of inflows to the storages

The aim of this project is to extend the research that has been conducted into PAM in Australia into a practical application for irrigators in the region. The role that the use of PAM can play in reducing infiltration rates in light textured soils and surface runoff as a function of reduced infiltration rates in the heavier soils offers significant benefits to drip irrigators across the region. The potential that this could have in increasing water and nutrient use efficiency
and therefore production per applied mega litre of water is significant as the focus is not on only increasing water use efficiency but that returns to full water allocations in the near future are unlikely. The focus of much of the world's research into PAM has been in increasing infiltration rates in flood and sprinkler irrigated soils. This projects shows that AquaBoostAG30 can play a significant role in decreasing water infiltration rates in soils, but more significantly the adoption of AquaBoostAG30 use in the drip irrigated vineyards of regional Australia.



Picture 2: The 'PAM' molecule, a long carbon chain.

Varying the length of the chain and the attached functional groups will alter the behaviour of the molecule in water and soil.

Influence of PAM on soil physical properties

Infiltration

Flood and or furrow irrigation is still a major main mean by which water is applied to irrigated crops in the world. However in the Riverland of South Australia the majority of vineyards are irrigated using drip irrigation. The initial conversion from flood based systems then to overheads and finally to drip has been as a result of changes in water quality and availability and the move to larger mechanised operations over the past 30 years.

Phillips (2007) noted that applications of PAM at very low concentrations had significant effects on reducing infiltration rates of water in light textured soils. PAM could be seen to reduce infiltration rates in these light textured soils. Husein and Trout (2006) produced some studies showing how PAM decreased infiltration rates in sandy loam soils in field trials in Fresno, California. Rates of high molecular weight PAM were between 5-20ppm of applied water volume. The reduction in infiltration rates when PAM was applied was less in Ca containing water than Na water. Permeability tests of PAM solutions through uniform sands showed a decrease of permeability with increased concentrations. For vineyards in sandy soils the ability to reduce deep percolation losses of water is a significant benefit to increase water use efficiency in drip irrigation practices.

For drip irrigators this has the potential to reduce the negative effect of water percolating through the soil and having minimal lateral spread through the soil profile. This was the opposite to what was being seen in heavier soil types where PAM via irrigation was being seen to increase infiltration rates as a result of the flocculation and stabilization of clay soil types thus increasing infiltration rates.

Sojka and Lentz (1994) showed how applications of PAM improved soil aggregate stability from 54 to 80% in 1993 and 63 to 84% in 1994. In the case of drip irrigation where the point source application of water is in a relatively small part of the soil profile the importance of maintaining aggregate stability to ensure that water infiltrates the soil and does not runoff. Many growers have noted that infiltration rates under drip irrigation alter over time and that soil physical and chemical conditions are constantly changing and as such new approaches to management of the soil need to be considered. The role of PAM in drip-irrigated vineyards is one such approach. Trout *et al.* (1995) reported that 0.7 kg /ha of a high molecular weight PAM reduced furrow induced erosion by 85-99%. PAM was also seen to increase net infiltration by 30%. It was postulated that this was the result of reduced sediment movement and furrow surface sealing. Infiltration was also inversely related to the maximum sediment concentration in the flowing water. The Murray and Darling Rivers are regarded internationally as being high in colloidal material. Growers using PAM in drip irrigation systems have recorded increased infiltration and lateral spread of moisture via moisture monitoring equipment and observing changes to flow patterns as a result of increased flocculation of this colloidal material. The flocculating nature of PAM used in drip irrigation systems can be seen to remove colloidal material from within the drip line. This may therefore increase flows (increasing pipe size or reducing friction losses). Alternatively as sediment is reduced in the water flow, infiltration and subsequent lateral spread of moisture is increased. The number of flushing valves in drip-irrigated enterprises highlights the amounts of impurities that still get past the primary filtration systems whether they be sand or disc filter systems.

Soil sodicity, structure and mechanical strength.

The use of PAM offers an interesting opportunity in the battle against salinisation. In the Murray Darling Basin of Australia increasing salinity is a major problem facing the rural community. The increasing extraction of water from the river system is raising real concern over potentially dramatic increases in long term river salinity levels.

Highly sodic water is used for irrigation in parts of the Middle East. High sodium concentration water creates problems with long term infiltration, reduced hydraulic conductivity and surface crusting. Gardiner and Shainberg (1996) investigated the use of PAM and or gypsum to overcome the effects of sodium. Soil was exposed to PAM at 0,10,25 and 40 mg/L and then to weekly applications of wastewater over a period of eight weeks. In each soil an application of PAM resulted in hydraulic conductivity being improved significantly. In this experiment PAM performed better than gypsum in increasing infiltration rates. It was concluded that PAM has the potential to facilitate irrigation with high sodium wastewater. For grape growers along the lower reaches of the Murray River system where salinity levels have reached high levels, evidence would suggest that the use of PAM is at least worth considering. Aly and Letey (1989) also showed that PAM ameliorated soil hardness with water with EC 0.05 and 0.7 dS /m.

Levy *et al.* (1995) added small amounts of anionic PAM to montmorillonitic soils with exchangeable sodium percentages greater than 12. Levy (1995) studied the impact that PAM had on runoff and erosion from sodic soils. In both soils studied PAM was seen to control runoff at low ESP (<4) but was inefficient at high ESP levels. However PAM applications to the irrigation water reduced soil erosion in moderate and high ESP soils. The addition of PAM at low rates can have a significant impact on water viscosity. It is possible that the reduction in erosion is due to the increased viscosity of the water slowing water movement across the soil surface. On some of the heavier soils of the Riverland the potential of PAM in these soils cannot be easily dismissed.

Levy and Rapp (1999) added synthetic polymers to crusting soils and found that seedling emergence was improved. However, moisture content for a given cumulative drying time was higher in the polymer treatments than in the control. This observation has been replicated in field studies (Phillips 1999,2007) where the use of PAM was seen to increase soil moisture levels in neutron probe, enviroscan and tensiometer monitoring systems. This result indicated that the polymer application delayed crust formation and maintained a crust with a lower mechanical strength for a longer period of time. The ability of the polymers to increase aggregate stability at the soil surface and prevent clay dispersion could prove beneficial in high crusting soils exposed to overhead irrigation or rainfall. Even in drip irrigation systems dispersion of clays could prove a problem with regards to infiltration rates as soils develop a pond of clay under the dripper influencing soil water infiltration rates over time.

Impact of PAM on plant growth and development

Plant and soil nutrient levels

The application of PAM to soil has been shown to have an impact on plant and soil nutrient levels. Leaching of nutrients through the soil profile can contribute to ground water contamination and runoff from furrows can lead to nutrient losses from paddocks.

Wallace *et al.* (1986) grew wheat and tomatoes in soils containing amounts of anionic polymers than would be in excess of those required for soil stabilisation. The 1% rate increased the vegetative growth rate over the controls. The anionic polymer decreased the accumulation of phosphate and silicon in both wheat and tomatoes and decreased manganese and boron in wheat only. Applying 5% polymer was seen to depress accumulation of some of the macroelement cations.

Assessment of furrow runoff reveals water containing organic matter, sediments and nutrients. The addition of PAM with the water was seen to markedly reduce furrow runoff losses of sediment, orthophosphate, total phosphorus and chemical oxygen demand. The use of PAM did not appear to influence nitrate runoff Lentz *et al.* (1998a). PAM applied at 10mg/L during the furrow advance had 5-7 lower phosphate loads than the control areas (Lentz *et al.* 1998b).

Applications of polymers to soil have been observed to affect the nitrogen surface area of soil. Willams *et al.* (1966) used polyvinyl alcohol to change surface area and pore distribution of a clay soil. The amount of this polymer absorbed by aggregated material was less than the maximum absorbed by a dispersed soil. The data shows significant differences in nitrogen absorbed between controls and polymer treated soils at differing partial pressures. The addition of polymer revealed reduced absorption of nitrogen onto particles in montmorillonite soil.

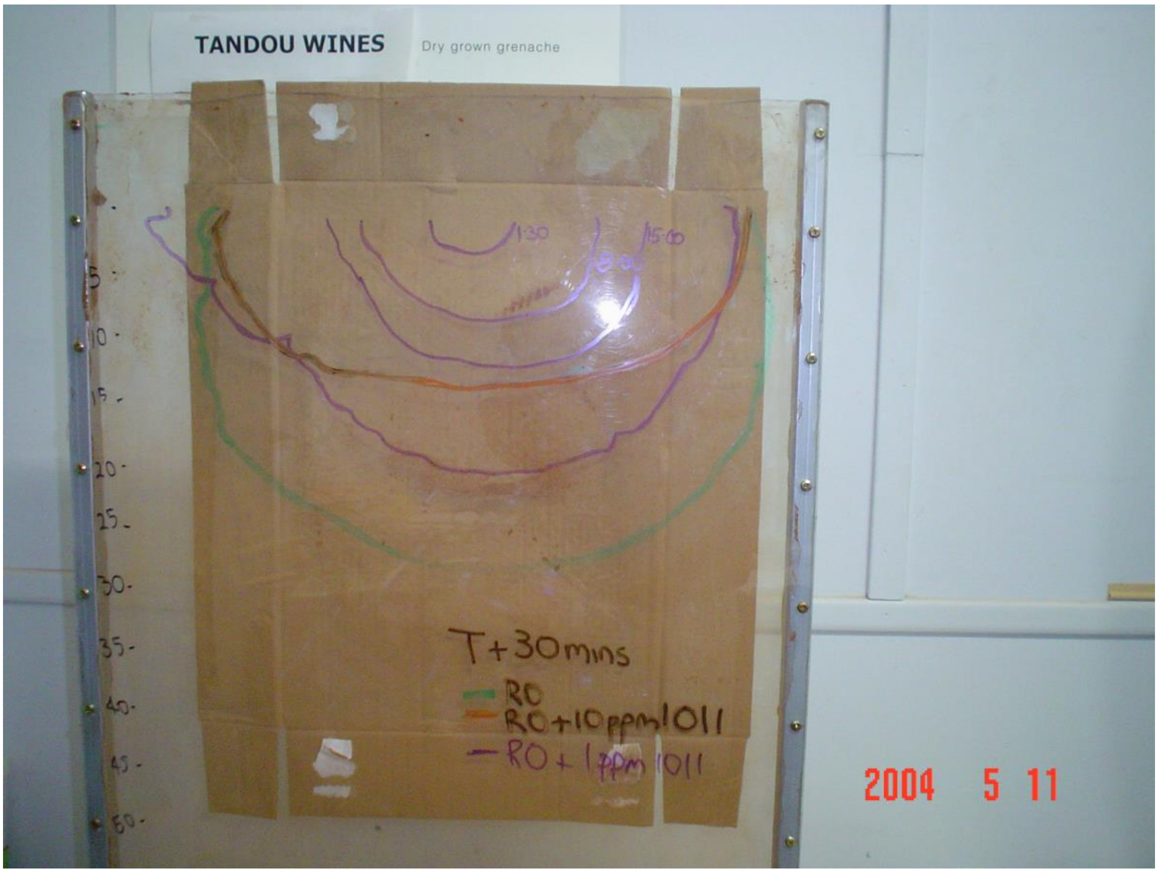
Water absorbent PAM gels have been observed not only to absorb water but reduce leaching losses of nitrogen in soilless medium (Bres and Watson 1993). PAM (HydroSource and Agri-gel) were incorporated into the growing medium at 1,2 and 3 g/L with 88g of ammonium nitrate. Water retention by the growth medium increased linearly with gel application. Nitrate N and ammonium N was higher when 3 g/L of PAM was added to the growth media. Total foliar nitrogen concentration in the tomato leaves was significantly higher in the HydroSource PAM than in either the control or Agri-gel treatments.

PAM has been used in coating urea (Abraham *et al.* 1995). N,N' methylene bisacrylamide crosslinked polyacrylamide was coated onto urea. The coated urea was found to have a greater slow release characteristic than when uncoated. There were differences in release of urea depending upon the PAM used in coating. In nutrient application the use of PAM treated fertiliser may be useful in reducing leaching losses and groundwater recharge.

With the high cost of fertiliser and low prices for wine grapes the potential for PAM to increase nitrogen efficiency in the vineyard may have a significant impact of economic practices in the vineyard.

Implications of research into effect of PAM on the physical properties of some light textured soils

Phillips (2007) documented how AquaBoostAG30 applied in irrigation water reduced the infiltration rate of that water in some light textured Mallee soils. In Pictures 2 and 3 the impact of AquaBoostAG30 on soil hydraulic properties can be seen in resulting in reduced movement of water through the soil profile in a 2-dimensional model.



Picture 3: The Gardner Model was made to investigate the impact that AquaBoostAG30 would have on water movement through the soil profile with 2.3l/hr drip irrigation. What is noticeable is that the addition of PAM such as AG30 significantly reduced water movement through the profile for equal irrigation events and that the more AG30 that was added to the irrigation water resulted in a decrease in infiltration rates

Picture 4: When increased salinity of the irrigation water was used the impact of AG30 in reducing infiltration rates was also reduced. To decrease infiltration rates where saline water is being used would require higher AG30 rates than what would be required in better quality irrigation water.

One of the key aspects of the work by Phillips (2007) and I quote from the thesis (pg 72-73):

- The reduced rates of infiltration caused by PAM-1011 in the laboratory suggest that less water would be required in the field and that the time between irrigation cycles on coarse sands could be extended or at least be more flexible.
- The effects of sodium and calcium in irrigation water clearly reduced the viscosity of PAM-1011, but sodium and calcium are not the only cations in irrigation water (iron is seen to have a major influence on the behaviour of many commercially available PAM products.
- In coarse sands water tends to finger its way down the soil profile, so water contents are rather variable in the root zone.
- The utility of PAM-1011 (and equivalent charged products) covers a wide range of sands but higher concentrations are required to reduce infiltration rates as the particle size distribution becomes coarser and finally,
- The potential for changes in soil biology as a result of greater water retention near the soil surface needs to be at least considered.

These considerations from the work conducted through Adelaide University suggest enormous practical applications for increasing water use efficiency at an irrigator level.

The aim of this trial is to investigate the role of AquaBoostAG30 in drip irrigation systems, and the ability to have an impact on soil hydraulic conductivity, nutrient uptake by the plant, crop yield and quality parameters and water retention in soils. In Australia, which suffers from variability of flows in its rivers and severe droughts, AquaBoostAG30 may have great potential in future irrigation scheduling practices.

PAM has been shown to alter water infiltration rates. As a result there have been significant changes to soil nutrient levels, changes to microbial populations and impacts on plant growth and development. In Australia the emerging crisis in soil water management in the Murray Darling Basin makes the investigation into AquaBoostAG30 applications worthy of more detailed attention for drip-irrigated wine grapes.

Field Sites

The sites chosen for these field studies were in Renmark (Angoves vineyard) and Loxton (Century Orchards Loxton). The Renmark vineyard was devoted to the production of cabernet sauvignon on own roots on a shallow clay loam soil, whereas the Loxton vineyard was devoted to growing chardonnay on ramsey on sandy soils of various depths (dunal system) overlying limestone.

The application of AquaBoostAG30 was to coincide with periods of peak plant growth and development. For the wine grapes this was determined to be in the following periods:

- Early shoot development – first irrigation (late August to late September according to variety),
- Bunch hook (October - November),
- Pre-veraison (late December)
- Pre-harvest (late January according to weather conditions, crop load and water allocation remaining)

AquaBoostAG30: This product is a high molecular weight anionic PAM liquid. AG30 is a patented liquid PAM solution that is soluble in water. It requires no agitation to mix with water and is easy to handle and mix. The AG30 requires a rate (50ppm of actual flow or 50L/ML of irrigation water).

Once the product is mixed in the fertigation tank the solution is quite viscous. AquaBoostAG30 fertigation should commence at the start of the irrigation shift as it is the flow of water through the soil profile that is being addressed. Even at rates as low as 1ppm through the dripper the increased viscosity of the water can be seen in how the water droplet comes out of the dripper emitter. AquaBoostAG30 being quite powerful flocculants will also remove colloidal material from within the drip diaphragm and along the drip line wall that are not necessarily moved by increased flushing velocities. As such the initial

AquaBoostAG30 application should also coincide with a flushing of the system.

Picture 6: Water droplet as influenced by addition of PAM AG30 (increased length of water droplet)

AquaBoostAG30 was used at the Angoves Renmark vineyard with application rates at 10L/ha which is the label rate where flow rates are uncertain. The reason for looking at the label rate of 10L/ha was to make an easy form of PAM application for growers with either very small fertigation systems or where isolation of sections and valves was going to be difficult.

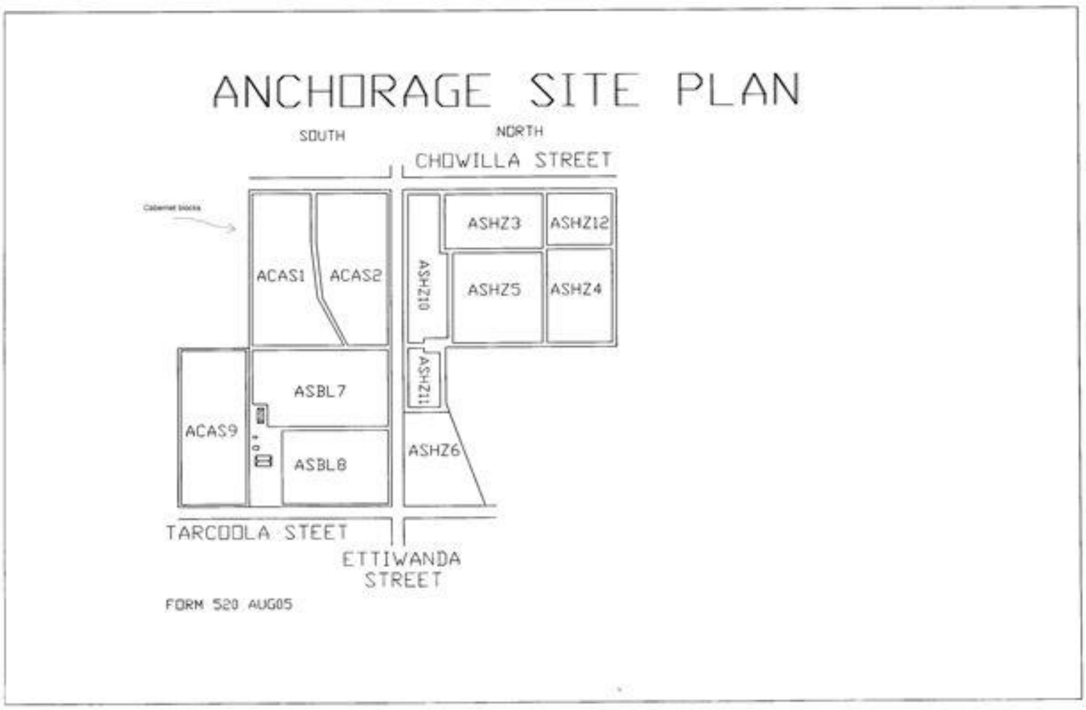
Case Studies: Practical Use of AquaBoostAG30 in the Drip Irrigated Vineyards

1: Angoves Anchorage Vineyard, Renmark South Australia

The trial was conducted at the Angoves Renmark property. The trial was conducted in ACAS2 (AquaBoostAG30) and ACAS1 (control no PAM). The property is all irrigated with 2.3L x 0.6m drippers and has extensive soil moisture monitoring via the Sentek Enviroscan. Irrigation was conducted in accordance to the soil moisture status from the Enviroscan soil moisture monitoring. Both ACAS 1&2 are the same clone of cabernet on similar soils from dug soil pits prior to the commencement of the trial.

AG 30 was applied at the rate of 10L/ha via fertigation in the following events:

- First irrigation (Late September)
- Bunch hook (Late October)
- Veraison (Late December)



Picture 7: Site Map Angoves Anchorage Vineyard

Blocks 1: ACA S1= control
Block 2: ACA S2 = AG30

Angove's Anchorage Vineyard Cabernet Polymer trial season detailed data

block	ha	Tons	Tons/ha
Block 1 control	3.65	82.48	22.6
Block 2 trial	3.53	80.80	22.9

CabSav Color scores 2009

GROWER NAME	B/P	PICK DATE	VARIETY	COLOUR SCORE	BAUME	DIFF. FROM AVE.
ANCHORAGE	ACAS2	25-Mar	CAB CAB SAUV	1.25	14.0	-0.03
ANCHORAGE	ACAS1	25-Mar	CAB SAUV	1.08	13.3	-0.21

Winery received CabSav color score range 2009

AVERAGE	**1.29**
MAX	**2.00**
MIN	0.51

Water usage block specific 2008/2009

South	Month / KL												Vintage 2009					
Block	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	Apr	May	June	Total KL	Ha	ML / Ha	Total T	T/Ha	ML / T
ACAS 1			446.85	1638.90	2143.35	3126.60	7258.50	5341.50	2205.00	1305.00			23465.70	3.65	6.429	82.48	22.60	0.28
ACAS 2			548.94	1174.74	1621.20	2748.06	5754.00	4559.94	1638.00	1344.00			19388.88	3.53	5.493	80.80	22.89	0.24

Nick Bakkum 7th May 2009
Angove Family Winemakers

Table 1: 2008/09 Yield and Water Use Data for Anchorage Vineyard

From the details in Table 1 and past records the site has consistently yielded between 20-25t/ha. The difference in water use from the AG30 and control treated blocks was approximately 1.0ML of water. This equated to 17% less water being applied in the AG30 treated section than the control. From the initial soil pits dug on site, the soil profile for both sections was very similar and little can be attributed to soil variance in this field study.

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The colour score was significantly higher in the AG30 treated section than the control with 1.25 to 1.01 colour score. With similar yields in terms of t/ha it raises some interesting questions that water alone is not responsible for fruit colour but that distribution of water in time and space must also be a consideration. What was noticeable early during the growing season was that the untreated section had considerably more iron deficiency than the treated area. While iron deficiency is commonly associated with overly wet soils it can also be found in soils that are excessively dry where the availability of iron does not occur as a function of soil dryness. From water applications in the early part of the growing season (no significant difference) the variance in plant growth could be reasonably given to the movement of water within the soil profile.

It is widely regarded that increased fruit colour is attributed to lower crop yields and reduced irrigation practices. In this instance the yields from both treated and untreated sections were similar but the AG 30 treated section was able to obtain similar yields with 17% less water over the control.

Soil Moisture Monitoring

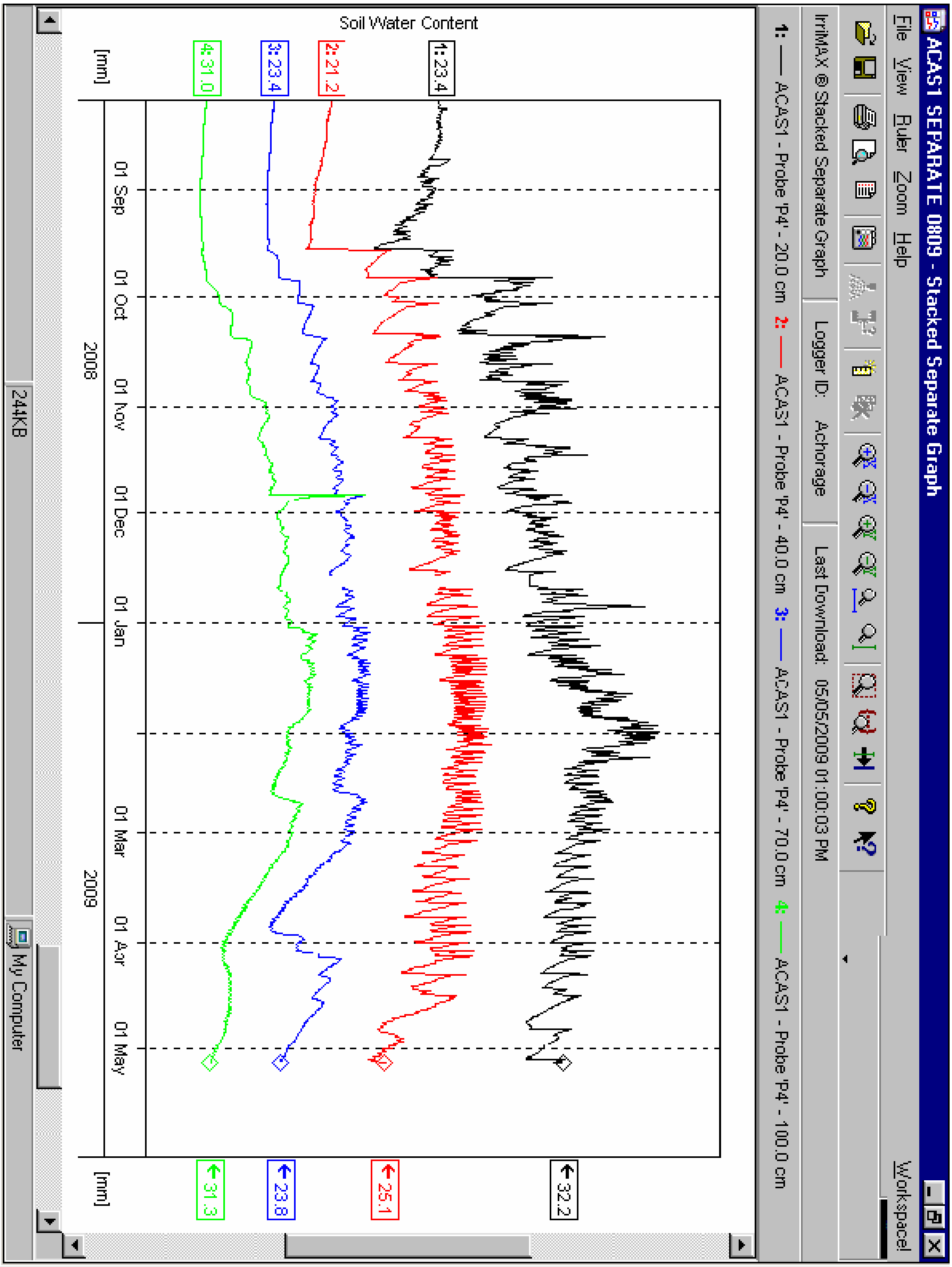
Sentek Environscans were installed in both sections to record soil moisture levels over the growing season. Irrigation was undertaken according to Enviroscan data.

The graphs shown below highlight the soil moisture monitoring for the 2008/09 irrigation season. What is noticeable is that the AG30 treated section has considerably soil water content readings in comparison to the untreated control in the summed histograph.

When looking at the separate graphs what becomes quickly apparent is that soil water content levels at depth (100cm) are significantly lower in the treated area than the untreated. This recorded observation supports the work done by Phillips (2007) in Gardner models that showed that PAM treated water moved more slowly to depth than water without PAM. More importantly soil water content readings were higher in the rootzone where PAM was applied in comparison to where PAM was not applied. This would tend to suggest that even under drip irrigation deep percolation losses of water are a concern when aiming to maximise water use efficiency.

Soil moisture monitoring also shows considerable more movement in soil moisture levels at both the 70 and 100cm sensors in the untreated area. This again confirms deep percolation movement of water even under drippers in the Renmark clay soils.

ACAS1: Control
ACAS2: +AG30



ACAS1 SEPARATE 0809 - Stacked Separate Graph
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Workspace
IrriMAX ® Stacked Separate Graph
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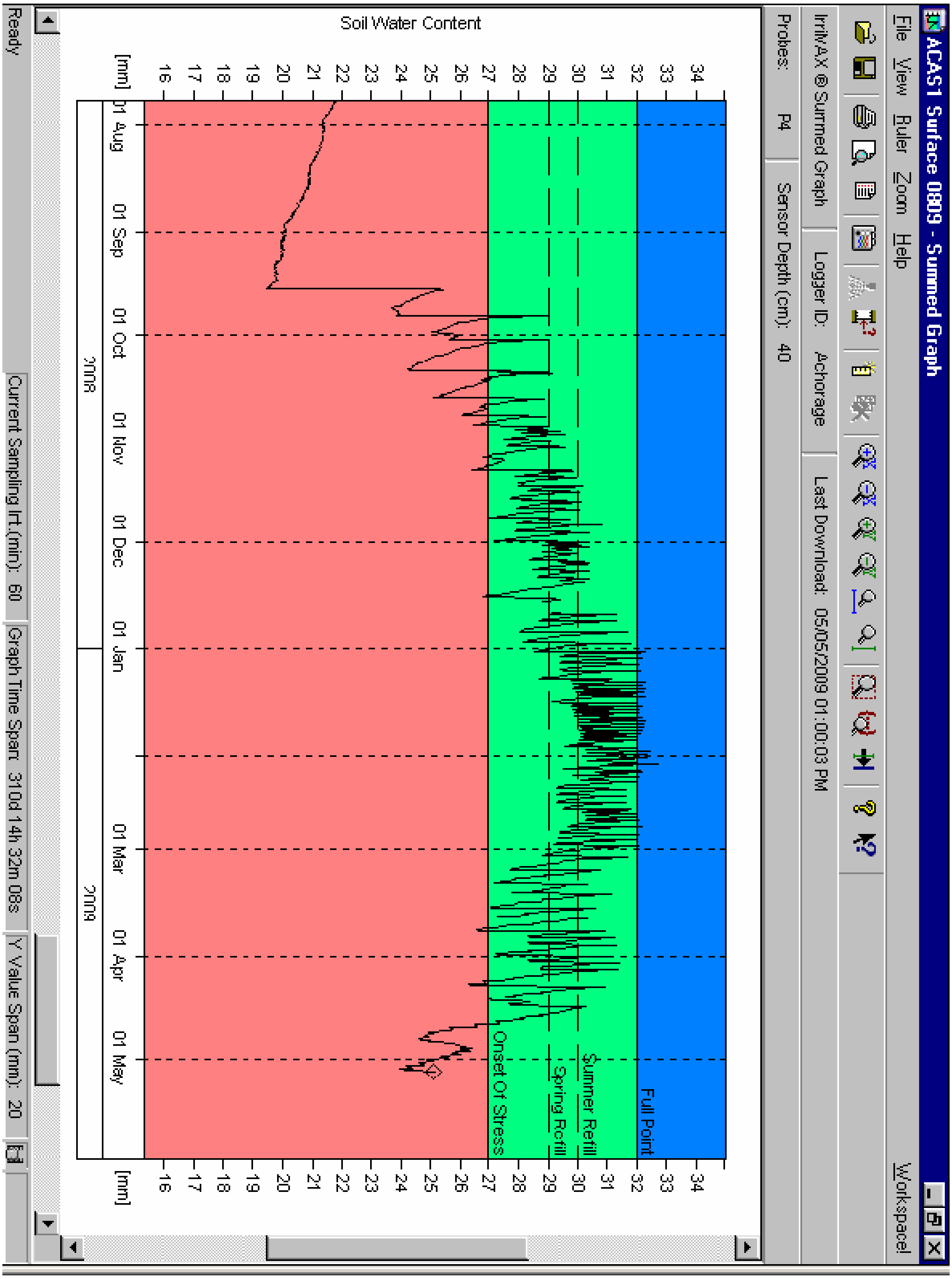
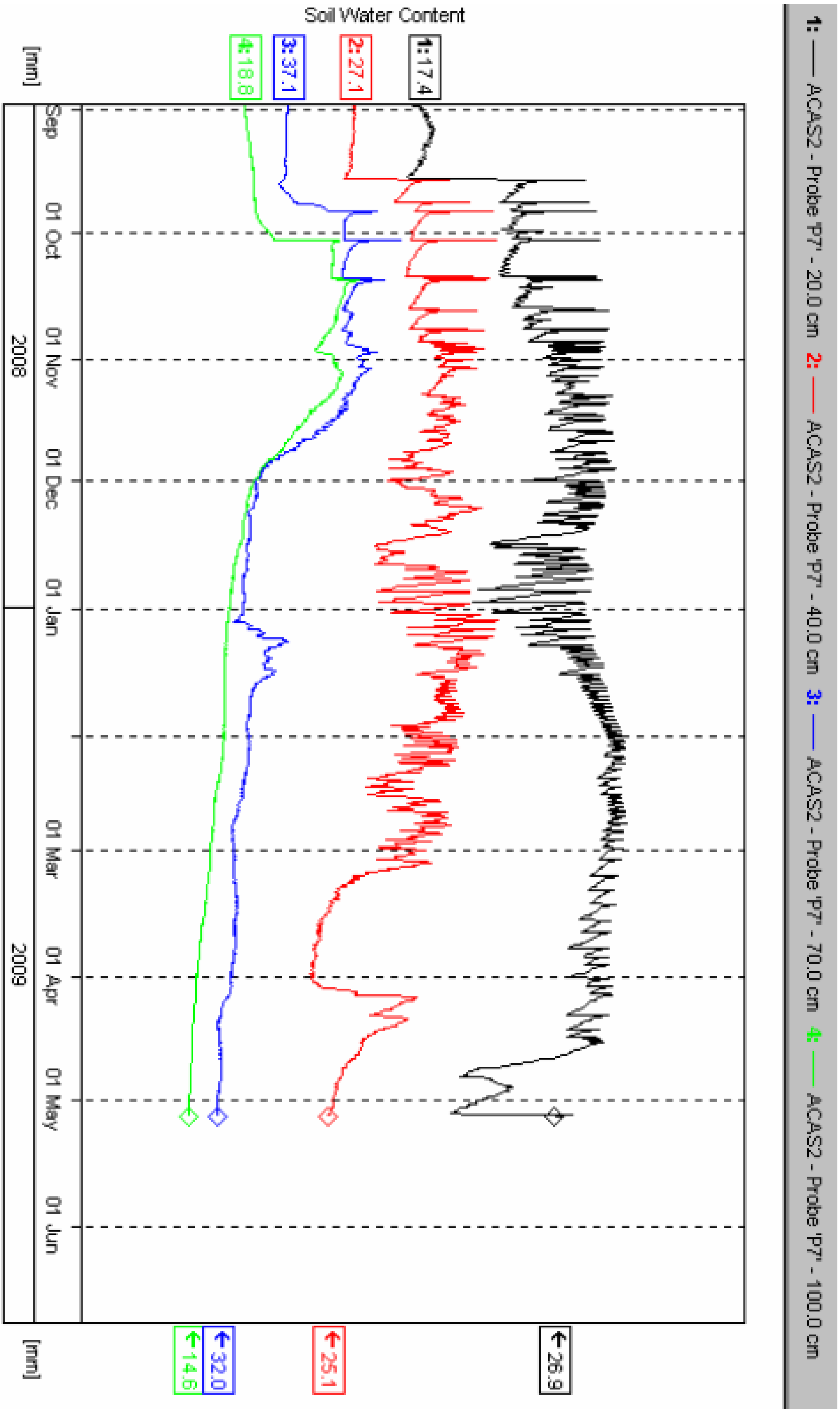
1: — ACAS1 - Probe 'P4' - 20.0 cm 2: — ACAS1 - Probe 'P4' - 40.0 cm 3: — ACAS1 - Probe 'P4' - 70.0 cm 4: — ACAS1 - Probe 'P4' - 100.0 cm
Soil Water Content
1: 23.4
2: 21.2
3: 23.4
4: 31.0
[mm]
32.2
25.1
23.8
31.3
[mm]
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
01 Mar
01 Apr
01 May
2008
2009
244KB
My Computer


ACAS1 Surface 0809 - Summed Graph
File View Ruler Zoom Help
Workspace
IrriMAX ® Summed Graph
Logger ID: Achorage
Last Download: 05/05/2009 01:00:03 PM
Probes: P4
Sensor Depth (cm): 40
Soil Water Content
[mm]
Full Point
Summer Refill
Spring Refill
Onset Of Stress
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
01 Mar
01 Apr
01 May
2008
2009
Ready
Current Sampling Int.(min): 60
Graph Time Span: 310d 14h 32m 08s
Y Value Span (mm): 20


1: — ACAS2 - Probe 'P7' - 20.0 cm
2: — ACAS2 - Probe 'P7' - 40.0 cm
3: — ACAS2 - Probe 'P7' - 70.0 cm
4: — ACAS2 - Probe 'P7' - 100.0 cm
Soil Water Content
1: 17.4
2: 27.1
3: 37.1
4: 18.8
[mm]
Sep
01 Oct
01 Nov
01 Dec
01 Jan
01 Mar
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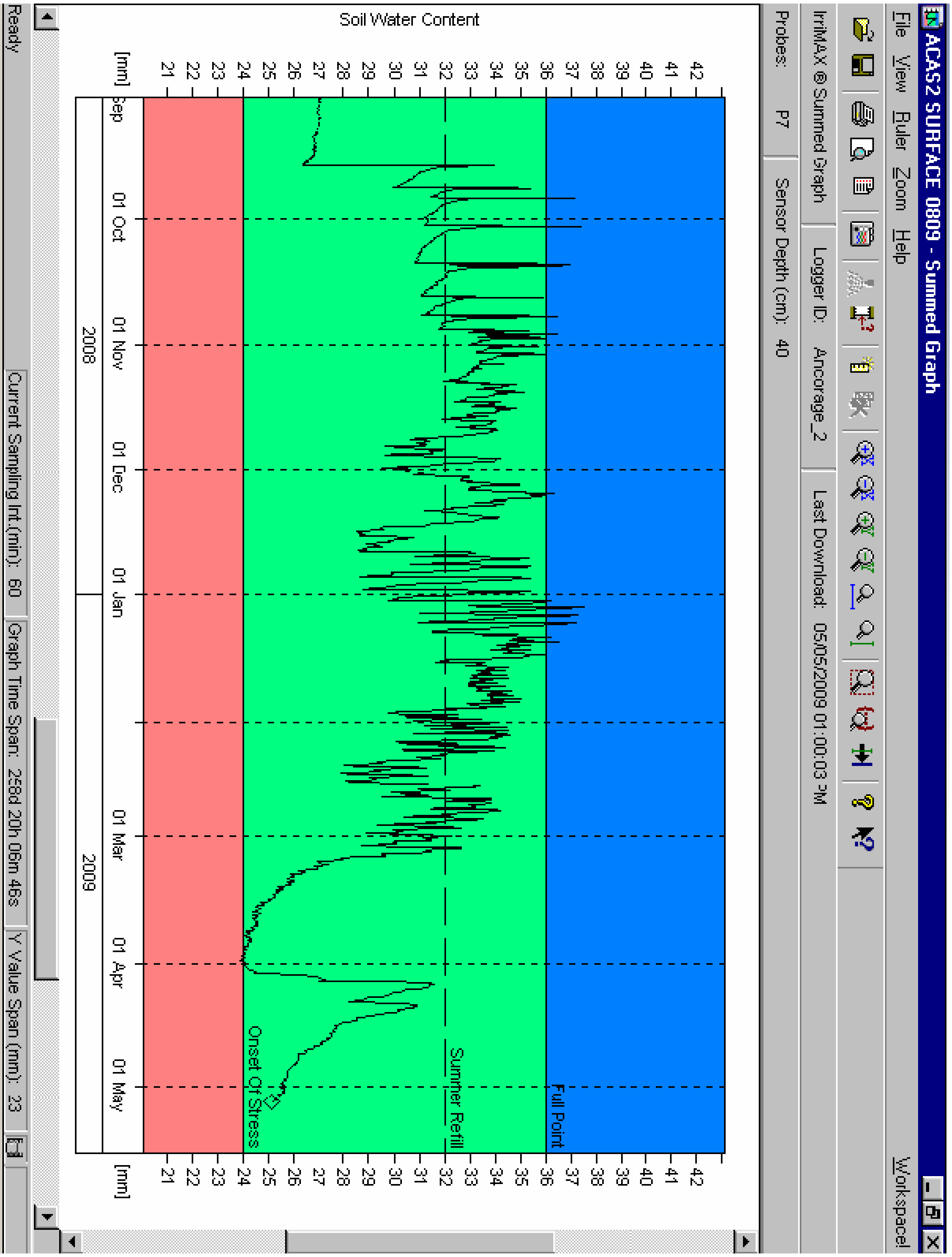
2009
26.9
25.1
32.0
14.6
[mm]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Soil Water Content
[mm]
21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
Sep
01 Oct
01 Nov
01 Dec
01 Jan
01 Mar
01 Apr
01 May
2008
2009
Full Point
Summer Refill
Onset Of Stress
Ready
Current Sampling Int.(min): 60
Graph Time Span: 258d 20h 06m 46s
Y Value Span (mm): 23

Plant physiology over the growing season

The influence of different spacial positioning of water within the rootzone could be seen to have an effect on early shoot development and bunch elongation.

Picture 8: AG30 treated Cabernet at flowering

Picture 9: Untreated PAM treated Cabernet at flowering

The influence of the AG30 PAM formulation could be seen in initial shoot and bunch development at this site. The AG30 treated section had better initial canopy growth and greater bunch elongation.

Picture 10: Control Section: November 08

Picture 11: AG30 treated section November 2008

Picture 12: Comparison of bunches between treated and untreated sections January 2009.

Overall the AG 30 treated vines had larger bunches than the untreated section. However this was not seen in overall yield at harvest.

2: Century Orchards Loxton

Century Orchards is located in Loxton South Australia and is devoted to the production of almonds with smaller plantings of wine grapes (chardonnay and some red varieties).
In previous seasons Century Orchards has had difficulty in obtaining sufficient canopy to ensure that fruit is adequately protected from sunburn and potential downgrading issues. As a result the program implemented at Century Orchards was to grow as much canopy as possible to protect the fruit from over exposure in the January February period. Part of the objectives from Century Orchards perspective was to see what impact that AquBoostAG30 would have on the vine for the same quantity of applied water in adjacent blocks on similar soil types.

The trial was undertaken on Chardonnay/Ramsey with 2.3L x 0.6m drippers.

2009 Harvest Information

Treatment	Be	pH	Ta	Yield t/ha
+ AG 30	12.21	3.47	7.43	26.17
Control	12.18	3.55	7.56	24.59

Monthly Water Use Figures mm/ha

September	21.1
October	39.7
November	75.5
December	96.0
January	141.4
February	108.6
March	36.5
April	5.1

Total Irrigation Applied = 5.24ML/ha

Picture 12: Control and AG3 treated vines at Century Orchards December 2008. Note greater canopy growth in the bottom picture which was treated with AG 60. The treated section had greater cane growth at the end of the cordons. Heavy topping removed most of this growth. It would have been preferable to control this vegetative growth through irrigation management rather than heavy topping late in the season.

Picture 13: Untreated vines January 2009. Note lack of canopy at the end of the cordons.

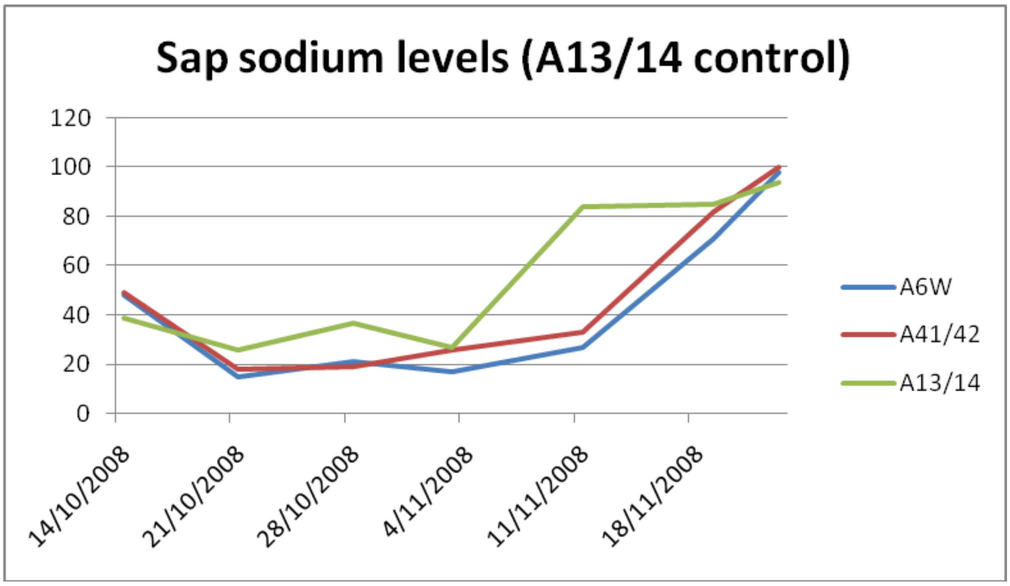
Plant Sap Analysis

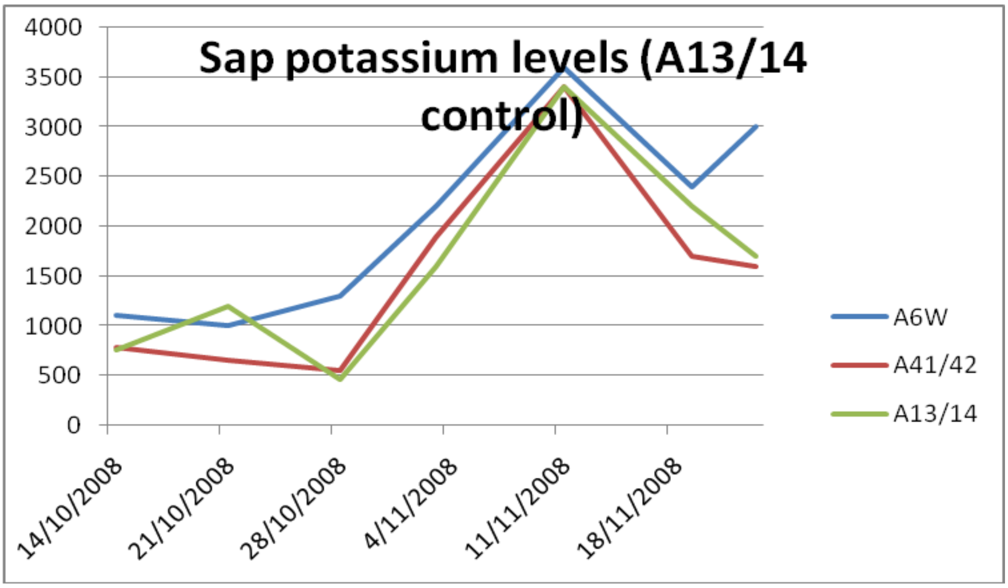
Sap analysis data was collated through use of the Horiba Cardy Meters. These meters are used for taking readings of nitrate nitrogen, potassium and sodium. Petiole samples were taken from leaves opposite the flowering bunch for information on trends within treatments over the growing season.

Samples were taken from the same rows over the season to minimize potential site variances. Samples were also taken at the same time to reduce the potential for differences associated with dehydration of plant tissue.

Century Orchards

Samples were taken from 2 PAM treated sites (top of the sand dune and flat). This accounted for 2 soil types within the valve. The control sample (13/14) was directly opposite PAM (43/42) on similar light textured sandy soils.





Graph 1: sap analysis data from Century Orchards

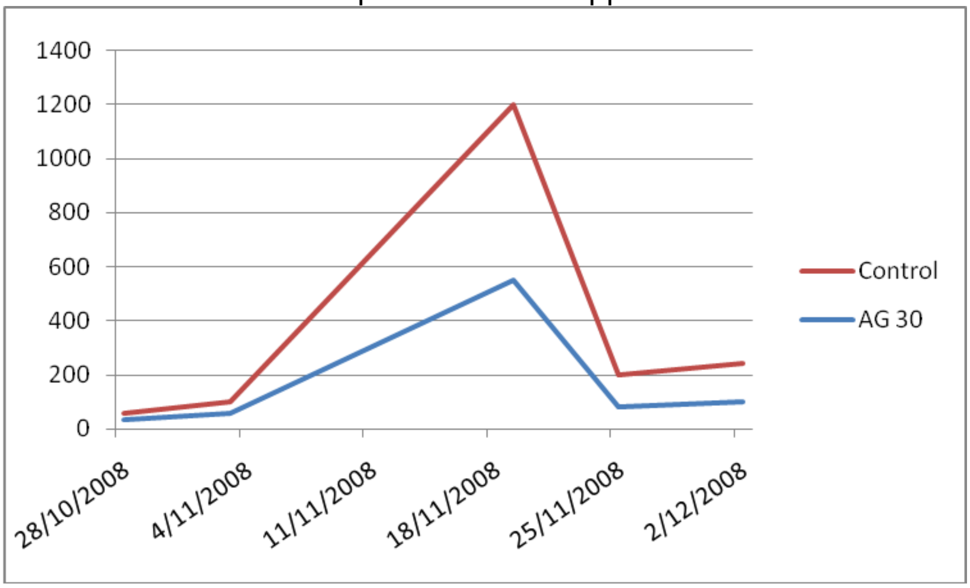
Slightly higher potassium levels could be seen in the A6W sample. This is not surprising as this location is on soils with higher clay content and available soil potassium levels than the other sampling sites. The site in the past has been seen to have drying of the bunch on the lighter soil types consistent with low potassium levels at the bunch developing stages. In soils with fluctuating soil moisture levels and poor wetting patterns can result in soil potassium levels becoming unavailable and deficiencies as a function of soil hydraulic conditions can occur. Under very saline conditions and poor irrigation practices, sap sodium levels have been seen to be as high as 700ppm sodium. At these levels salinity in juice can be tasted. The levels in these samples were well below levels where salinity damage can be noticed

Nitrate Nitrogen levels can be seen to decline over the season. This is in line with normal nitrate nitrogen levels within the plant. Significant declines in sap nitrate levels are seen during the bunch hook and flowering stage with some recovery post fruit set but under normal management conditions a general decline over the rest of the season from the initial peaks during early shoot development. Overall similar trends in petiole nitrate nitrogen levels were seen over the growing season.

Sap sodium levels tend to rise over the season and data seen in this sampling is consistent with trends seen in many other crops around the district. The salinity spikes in the control areas were sharper than the treated vines. From historical monitoring using this equipment, salinity spikes are often associated with drying soils and plant dehydration, as the plant is rehydrated sap sodium levels are seen to decline.

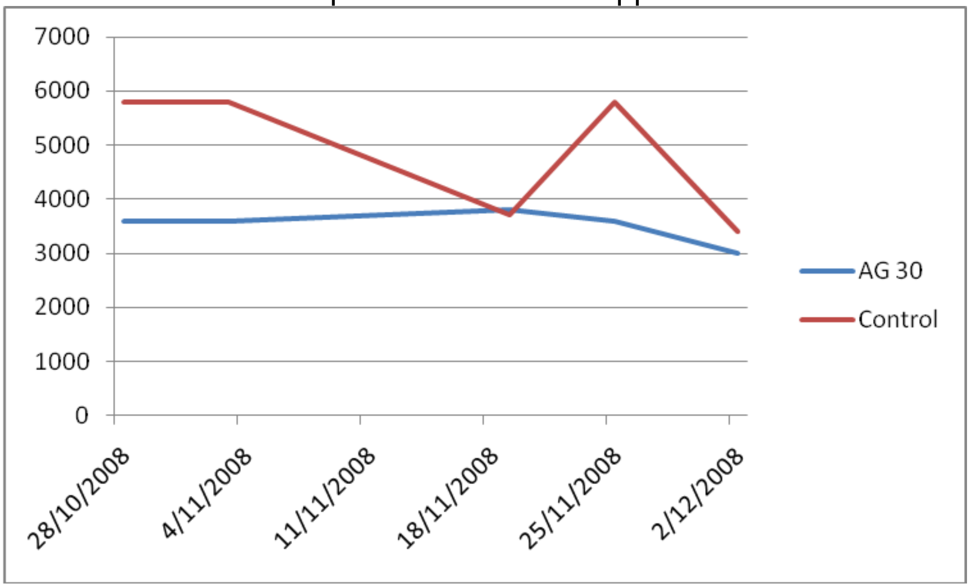
Sap Analysis Results Angoves Anchorage Vineyard

Sap Nitrate Levels ppm

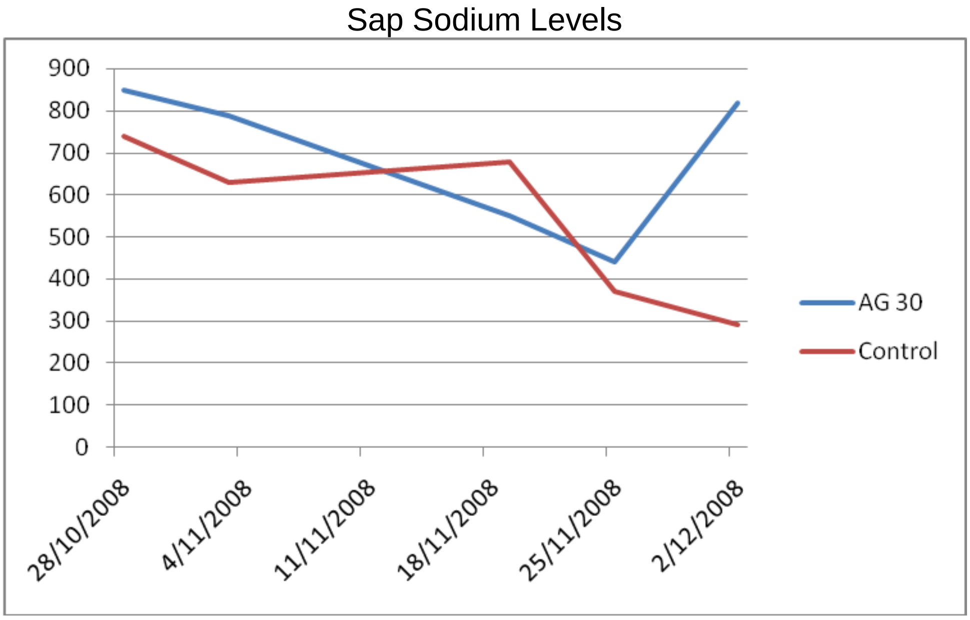


Similar trends in sap nitrate levels can be seen between the treated and untreated areas. The post flowering spike in nitrogen levels was significantly higher than in the control section.

Sap Potassium Levels ppm



Sap potassium levels can be seen to be significantly higher than those at Century Orchards. While some varietal considerations can be drawn the soil type variance is the major reason for the high potassium levels seen in these samples. The Renmark clay flats are very high potassium soils (>450mg/kg Colwel K) whereas the sand dunes at Century Orchards are quite low (<200mg/kg). The varietal significance is that Chardonnay has significantly easrlier shoot growth than Cabernet sauvignon and in cooler soils the availability of soil potassium is less due to cooler weather and in many cases lower applied water volumes (to aid the solubility of potassium). In some of the cooler growing regions early season potassium deficiencies are often seen as a result of the plant out growing the roots ability to supply these nutrients due to short term unavailability of soil potassium. In most years once the weather warms up and solubility of potassium in the soil increases the deficiency symptom dissapears.



Higher salinity levels are seen in this sample in comparison to that at Century Orchards. This is a reflection of the reduced irrigation practices and the use of RDI practices to increase fruit colour in this variety. One of the consequences of reduced irrigation and some drying out of the vine is that the sap sodium levels tend to increase.

The management of plant nutrition is closely linked to irrigation practices, soil type, varieties and winery requirements. As such sap analysis results can be looked as trends for each site and not necessary valid for comparisons between soil types and varieties. With differing irrigation practices wide variances between sites are expected and the performance of rootstocks has a major influence on the recorded levels of nitrate nitrogen, potassium and sodium.

References

Aase J.K.,Bjourneborg D.L.,Sojka R.E. (1986) Sprinkler Irrigation Runoff and Erosion Control with Polyacrylamide – Laboratory Tests
Soil Sci. Soc. Amer.J. 62, 1681-1686

Abraham J.,Rajasekharan Pillai V.N. (1990). N,N' – methylene bisacrylamide crosslinked polyacrylamide for controlled release urea fertiliser formulations.
Comm. Soil Sci. Plant Anal. 26, 3231-3241

Aly S., Letey J.(1989). The effect of two polymers and water qualities on dry cohesive strength of three soils.
Soil Sci. Soc. Amer. J. 53, 255-259

Bjorneberg D.L. (1998). Temperature, Concentration and Pumping Effects on PAM Viscosity. Amer. Soc. Ag. Engin. 4, 1651-1655

Bres W.,Weston L.A.(1993). Influence of gel additives on nitrate, ammonium and water retention and tomato growth in a soilless medium.
HortScience 28, 1005-1007

Carter, D.L,Brockway C.E.,Tanji K.K. (1993). Controlling erosion and sediment loss from furrow irrigated cropland.
J. Irrig. and Drainage Engineering 119, 975-987

Gardiner D., Shainberg I. (1996). Effects of PAM on infiltration of high sodium water.
Institute of Soils and Water, The Volcani Centre, PO Box 6, Bet Dagan Israel. 1996

Husein A.A.,Trout T. (2006). Polyacrylamide and water quality effects on infiltration in sandy loams soils. J. Soil Sci. Soc. Am. 70:643-650

Levy G.J., Rapp I., (1999). Polymer effects on surface mechanical strength of a crusting loessil soil.
Aust. J. Soil Res. 37, 91-102

Levy G.J.,Levin J.,Shainberg I. (1995). Polymer effects on runoff and soil erosion from sodic soils. Irrig. Sci. 16, 9-14

Levy G.J.,Levin J.,Gai M.,Ben-Hur M.,Shainberg I. (1992). Polymer Effects on Infiltration and Soil Erosion during consecutive Simulated Sprinkler Irrigations. J. Soil Sci. Soc. Amer. 56, 902-907

Phillips S. (2007); Effect of polyacrylamides on the physical properties of some light textured soils. Thesis The University of Adelaide School of Earth and Environmental Sciences Waite Campus August 2007.

Sojka,R.E., Lentz,R.D., Westermann D.T. (1998). Water and erosion management with multiple applications of polyacrylamide in furrow irrigation. Soil Sci. Soc. Amer. J. 62, 172-1680

Trout T.J., Sojka R.E., Lentz R.D. (1995). Polyacrylamide effect on furrow erosion and infiltration. Amer. Soc. Agricultural Engin. 38, 761-765

WallaceA.,Wallace G.A.,Abouzamzam A.M.(1986). Effects of excess levels of a polymer as a soil conditioner on yields and mineral nutrition of plants. Soil Sci. 141, 377-380

Zahow M.F.,Amrhein C.(1992). Reclamation of a saline sodic soil using synthetic polymers and gypsum. Soil Sci. Soc. Amer. J. 56, 1257-1260 (1992)