Department of **Employment, Economic Development and Innovation**

Plant based monitoring for irrigation scheduling in vegetable horticulture:

A case study in South Australian onions

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Direct measurement of plant water status for irrigation scheduling may be more sensitive, and promote better horticultural crop quality, than indirect methods such as soil moisture monitoring. In our research project, we sought to identify instances where direct methods of plant-water status previously used in horticultural crops in Australia. We present the outcomes, suitability or obstacles for adoption by horticultural producers. This report presents a case study from the point of view of researcher Mr Michael Cutting of the Murray-Darling Basin Natural Resources Management Board of South Australia. He used a stem and bulb diameter sensor (Phytech Monitoring System – Phytech Limited) with several South Australian onion growers. The purpose was to identify the potential of the Phytech system as a more accurate method for irrigation scheduling in onions than soil moisture monitoring. After four seasons of data collection, Mr Cutting and the growers involved had a better understanding of the water relations of the onion plant. They were also able to manipulate irrigation scheduling to achieve desirable crop quality outcomes ($/ML). In this report, Mr Cutting explains the suitability of the Phytech equipment for horticultural production. The Pytech system is a viable alternative to soil moisture and clear growth trends identified to be responsive to management practices. He discusses the problems overcome during the experiment. Some of the problems occurred in the communication between the sensors and the data collection device or with the loggers themselves; the location of technical support and maintenance was also an issue. Finally, he talks about some of the issues that could prevent its adoption in horticultural production. These issues include the cost of the Phytech system and the need for multiple bulbs and planting monitoring to make irrigation management decisions.

Figure 1: The Phytech monitoring system in an onion crop (Photograph supplied by M. Cutting)

Introduction

In the pursuit to grow more food with more consistent quality, there has been a re-evaluation of past and recent research into plant-based monitoring for irrigation management. Many current grower-adopted methods of irrigation scheduling use evapotranspiration or soil moisture monitoring. However, these are indirect measurements of plant water status. They do not completely describe the status of the plant-soil interface, nor the plants internal environment. Monitoring of the plant's water status directly may give a more detailed and accurate picture of the plant's ability to continue it's productive processes (Jones 2004). Numerous plant-based devices have potential for irrigation management. However, few are investigated for their ability to be integrated into an actual production system regarding their performance, ease of use and ease of interpretation.

In our project, we sought to identify the current state of knowledge in plant-based water sensing for irrigated vegetable production and develop priority areas for ongoing research and development. Part of this role is to validate case studies where plant-based sensing technology is used in irrigation management in vegetable crops. However, instances where these devices are tested or incorporated into commercial vegetable production in Australia (rather than as research tool) are limited.

We developed this case study after we found that a researcher, Mr Michael Cutting (Murray-Darling Basin Natural Resource Management Board of South Australia) had several years experience with a plant monitoring system developed by an Israeli company, Phytech Limited. A number of Phytech systems [seen here in **Figure 1**] were set up to monitor onion crops in South Australian with several growers involved. The purpose was to identify an alternative, more responsive method of crop monitoring for irrigation scheduling, compared to soil moisture monitoring. The following interview documents Mr Cutting's experience, thoughts and concerns, identified through the monitoring onion crops with this tool. A detailed description of this research can be found in "Plant Based Monitoring and Irrigation Management in Vegetable Crops: An Overview of Trials Conducted in the SA Murray-Darling Region" (Cutting 2008).

The monitoring tool

What kind of monitoring tool was utilised in the onion crop?

"Phytech Limited an Israeli Company, with Australian distributor trading as Isis Phyto Monitoring (www.phytech.com). The tool's components monitored "in canopy air temperature and relative humidity; soil moisture (single depth); stem diameter and 15-70 mm fruit (bulb) growth sensors [**Figures 2** and **3** display the stem and fruit sensors in crops]. Data was downloaded using a portable concentrator that extracts data from the field sensors (via radio link) and is then plugged into a computer and downloaded into specialised PhytoGraph software. In 2008 we purchased a field radio that automatically extracted data from the field sensors into which a laptop directly plugs to download the data."

Figure 2 left: Photograph of the Phytech stem diameter sensor monitoring a capsicum plant and **Figure 3** below: a fruit (or bulb) diameter sensor in greenhouse tomatoes. (Photographs supplied by VP Marketing, PhyTech Ltd.)

Desired outcomes

What was the desired outcome of utilising this monitoring tool?

"The first trial commenced in 2004 purely to see if the plant based system was an alternative to traditional soil moisture monitoring. The initial work focused on interpreting what the data was telling us rather than rigorous record keeping however, in recent times we have incorporated the data into more detailed trial works. We endeavoured to provide access to the equipment to as many growers as we could so that a range of different management practices could be captured.

Now that we have four seasons of data we do believe we have gained a much improved understanding of plant water relations and how to manipulate irrigation to generate desirable outcomes."

The achievement of outcomes

Was the monitoring tool successful in achieving this outcome?

"The product certainly did prove a viable alternative to standard soil moisture based systems and almost all growers involved in the work were impressed by the outputs of the system. Results did vary between growers and were largely a function of how willing the grower was to react to the information the system was showing them. Many growers involved in the trial continued with normal irrigation management practices and therefore any changes that were observed could not be solely accredited to the system. The benefit of this however was that clear growth response trends (both positive and negative) were observed between the different management regimes.

One particular grower was very reactive to the data and implemented significant changes to his management practices in response to the observed data trends. This grower utilised the strong correlation between onion bulb growth and humidity and scheduled irrigations to prolong humidity levels [this bulb vs. humidity relationship can be seen in **Figures 4** and **5** below]. It should be noted that this is largely at odds with standard industry practices due to the increased disease pressure that such practices create however the resultant increases in yield and quality generated by this grower more than paid for the additional costs associated with enhanced disease control.

In summary improved yields and quality (and hence $$/ML) were observed rather than significant reductions in water use (ML/ha)."

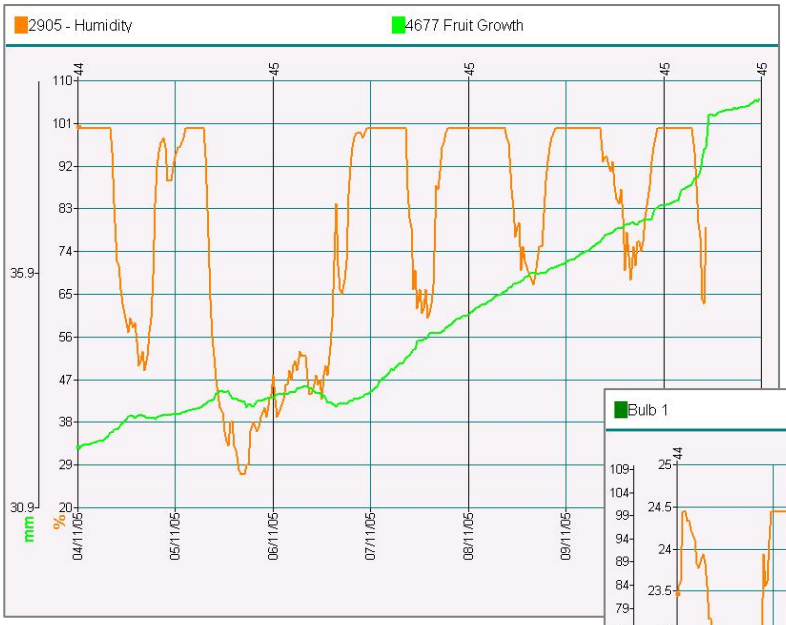

Figure 4 (left) and 5 (below): Graphs showing bulb growth response to humidity (Output of the Phytech monitoring system). **Figure 4** shows a consistent upward trend in bulb growth response from management practices that aim to keep the canopy humid and **Figure 5** shows bulb "stop-start" growth of an onion crop with the "standard" irrigation management. (Supplied by M. Cutting)

The potential use in horticultural production in Australia

In light of the monitoring tool's success, would you consider it as 'cost effective' in the long term?

"The Phytech system is not cheap, approximately $12-$15,000 for a system with a field radio and in reality unless the cost reduces, wider uptake is likely to be low. However if you were to speak with growers that made good use of the system they would likely say that the tool is cost effective.

From a Natural Resources Management Board perspective I feel our investment in two of these systems has been very worthwhile as we have been able to provide growers with exposure to a new system and learnt collectively about how the plant responds to different management practices."

How did you (or those working with you) find the monitoring tool's ease of use?

"The system does take a bit of work to set up but assuming communication is reliable this is relatively seamless after you have done it a few times. Downloading from the field is also simple but the portable concentrator model requires that all the sensors be close together otherwise

issues with communication can arise. In general, communication issues have been an endless source of frustration particularly now that the sensors are a few years old. This issue can dampen the enthusiasm of growers very quickly.

On-going issues with communication drove us to purchase a field radio station in 2008 at a significant cost (approximately $2,000) however; it did largely overcome the communication problems. Sensors have also stopped logging in the field at critical times during the growth cycle, which again disheartens growers when data gaps appear. On-going maintenance is likely to overcome many, if not all of the above issues however technical support is in Brisbane, Queensland so any time something needed to be sent away it was not a simple exercise. Having said this, the Australian representative was always available by phone to guide us through any technical issues we encountered meaning the large majority were quickly resolved."

What is your opinion on the monitoring tool's adoption in a commercial production system?

"Personally I believe the tool is suitable for broader adoption across the commercial onion growing industry however costs would need to reduce before this would happen. Obviously, the representativeness of the site being monitored is critical as the response of one or two onion bulbs is being used to guide irrigation management. With staggered planting dates, it would be beneficial to have systems across all plantings but the cost of this would be very high. However in this day and age and with access to the latest technological advances I would suspect that similar plant based monitoring tools could be developed at a much lower cost.

One comment we have had from growers is that they may use the system for one or two seasons and monitor the crops response before settling on a management practice that achieves the desired production but without validation from the system. Personally, I do not support this, as I strongly believe that good management is a product of good monitoring but that is only an opinion.

Note: This same system was also trialled on two potato crops but was largely unsuccessful as the sub surface nature of the tuber does not allow for the growth to be accurately measured."

Acknowledgements

Thank you Michael Cutting for taking the time out of your schedule to provide us with your experience and views on the Phytech system Thank you also for the personalised guided tour of your management region and imparting your expertise about the issues facing irrigated horticultural production in the Lower Murray region of South Australia. Thank you also to Craig Henderson, who, as always, is there to bounce ideas off and give a helpful critique.

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