Integrated Crop And Soil Management Software

Abstract

Objective measurements are essential for informed decisions about the behaviour of soils and plants. A software package is described that allows users to record, view and graph data from soil moisture sensors; weather stations; data loggers; mainframe computers; and manually entered crop growth data. The software smoothly integrates data from a wide range of sources, allowing comparisons to be made on a routine basis from site-to-site and year-to-year.

The system gives users insights into the actual behaviour of the soil profile, enabling the detection of problems such as hard-pans, through-drainage, rising water table and surface run-off; the calculation of actual crop water use, irrigation efficiency, and rooting depths; and correlation between other factors that affect crop growth such as weather. The system allows growers, agronomists and water managers to use techniques, on a routine basis, usually thought of as appropriate for researchers or agricultural extension officers.

The software is described with case studies from commercial growers.

The data is analysed, displayed and graphed on MSDOS or Macintosh microcomputers, and is in use on many crops and soils throughout Australia, New Zealand, Europe, Africa and North America.

Introduction

Objective measurements are essential for informed decisions about the behaviour of soils and plants. A microcomputer is the ideal tool to make this data available to a grower on a routine basis, but the software needs to have a straightforward user interface and to present the data in a consistent manner, whatever its source.

A software package has been developed, running on DOS PC's and Macintosh, that can display and graph data from:

- portable data loggers, such as the neutron probe or time domain reflectometers
- fixed data loggers, such as weather stations or soil moisture loggers
- manual entry of measurements taken in the field, such as crop growth
- mainframe computers, such as weather data or insect counts
- portable, hand-held units with data entered in the field
- crop predictive models

With the software users can:

- view and edit the data
- draw profile and time graphs of all or selected items
- overlay graphs to compare site-with-site or year-with-year
- calculate, for example, the daily water use of the crop, root penetration and cumulative total water usage

- schedule irrigations (by predicting the date of the next irrigation)

The software is best described using case studies. It should be stressed that these studies have all been conducted by commercial growers as a routine part of their management practice.

Land Disposal Of Waste, Dubbo, NSW, Australia

The city of Dubbo, NSW, has set up a waste water re-use woodlot, with the water applications being monitored with various soil moisture sensors, including a neutron probe. Initially, the automatic irrigation system was set to apply water for 1 hour/day.

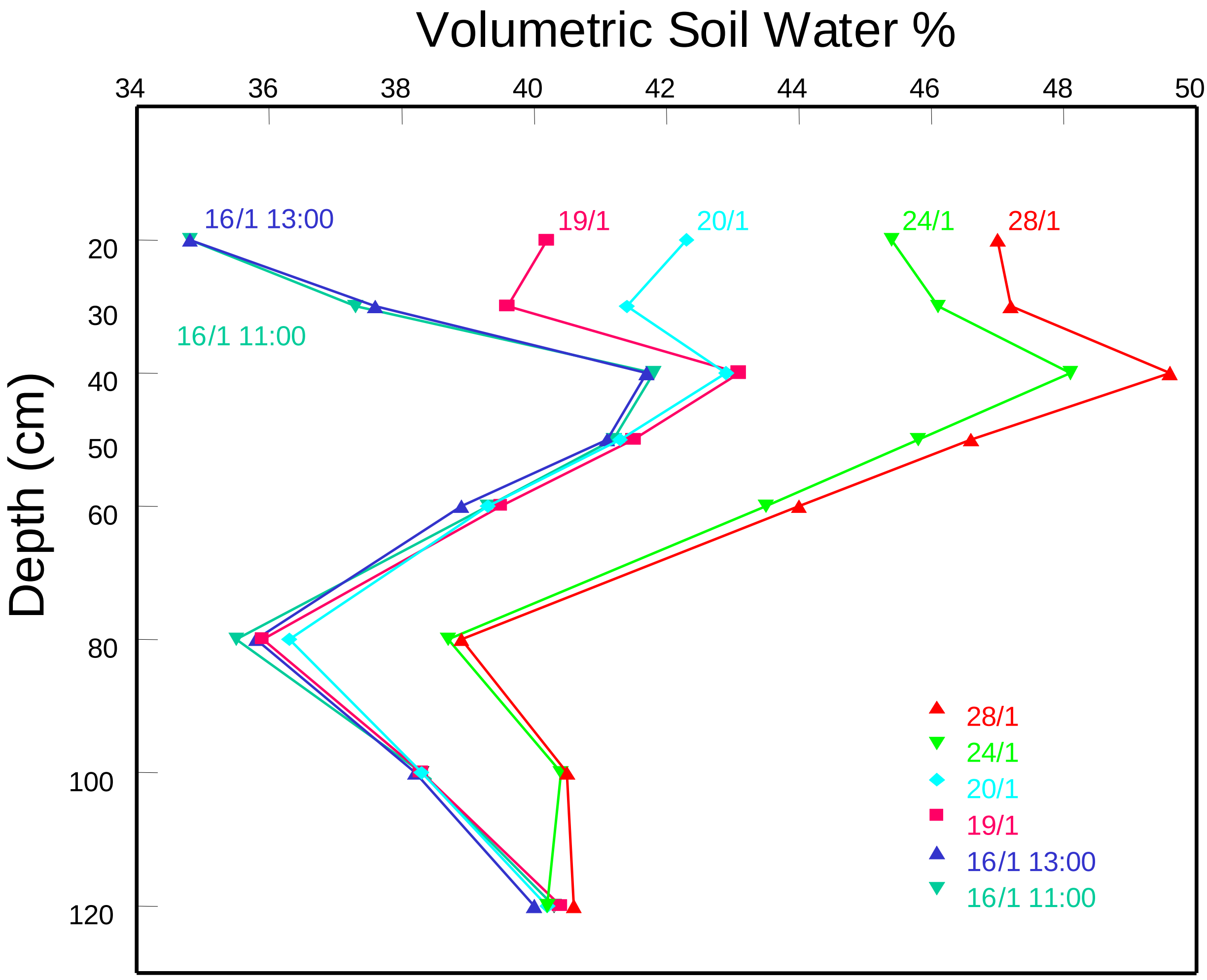


Figure 1. Soil moisture profiles after application of waste water

The two readings on 16/1 were taken before and after the 1 hour irrigation - note that there is almost no change in the profile water content indicating surface evaporation of the effluent. The irrigation time was increased to 3 hours/day and the water profiles started to increase, with infiltration down to 40 cm by 19/1 and to 120 cm by the 24/1. There is a possibility that effluent water may be draining through the profile.

The same data can be plotted as a time graph, with the through-drainage showing as a progressive increase in water content with depth, with an increase at 100cm by 22/1.

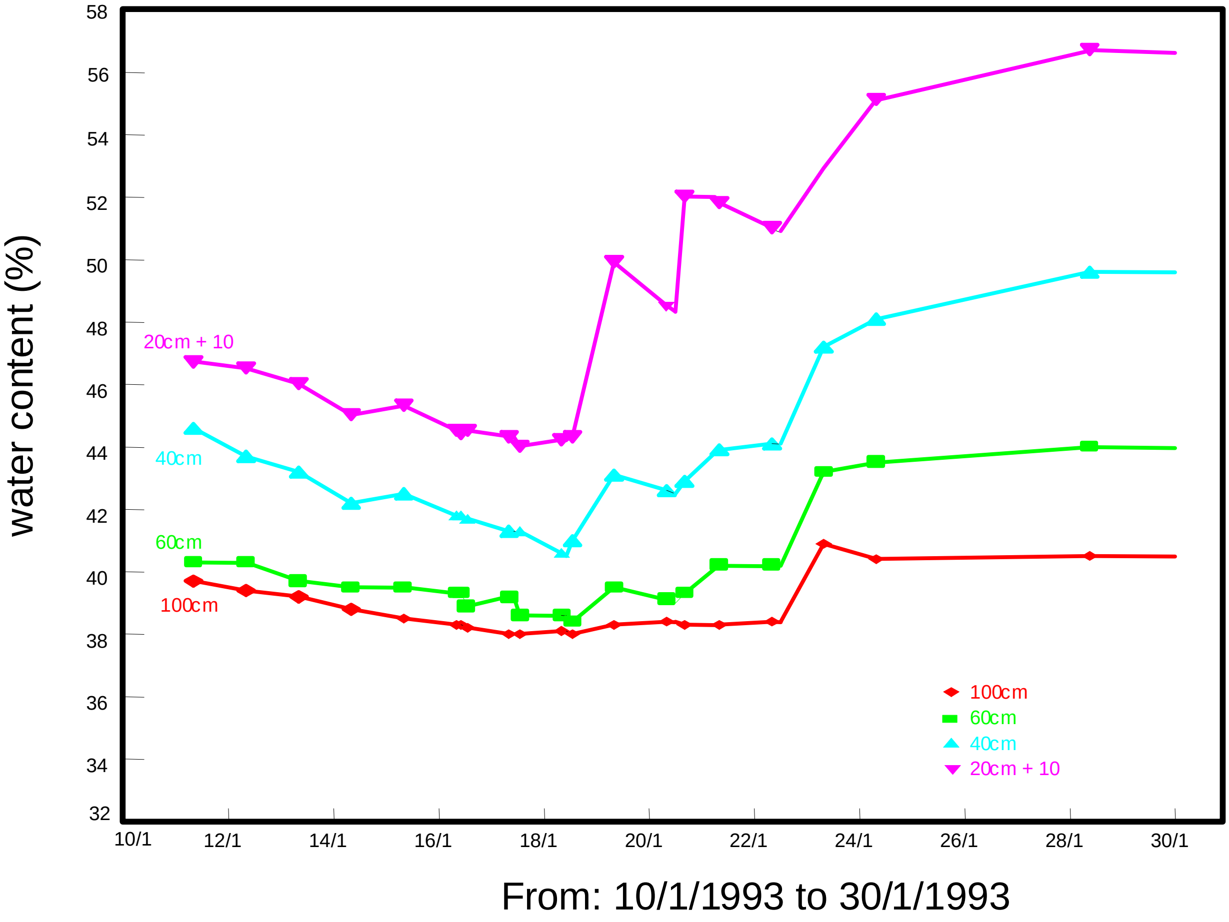


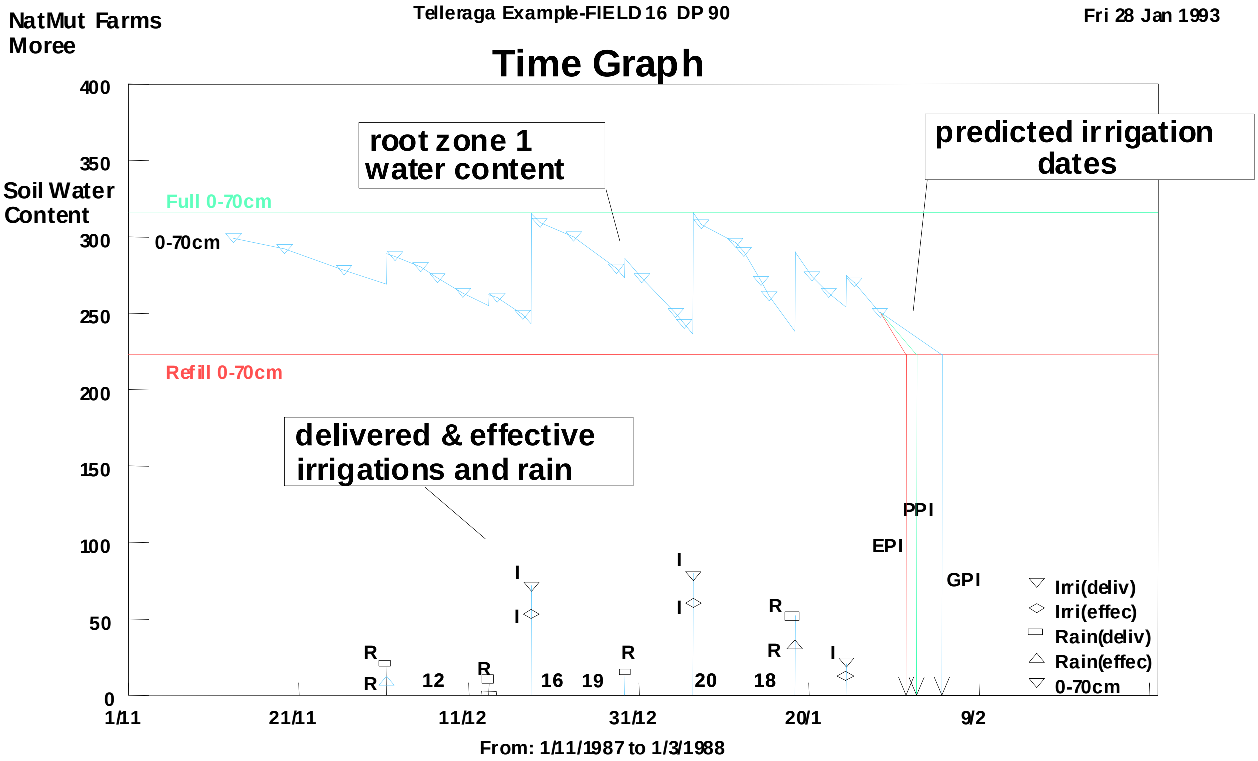
Figure 2. Changes in soil moisture with time at different depths

Quantitative measurement of soil moisture, combined with appropriate software, allows for routine monitoring of the woodlot. The irrigation schedule can now be adjusted to optimise tree production, while at the same time ensuring that effluent does not contaminate the aquifer. Routine monitoring can be specified as part of the design, allowing for optimum use of land, and minimising capital outlay.

Solid waste disposal using landfill can also result in through-drainage of contaminants. California environmental protection regulations are now calling for environmental monitoring to *guarantee* that through-drainage is not occurring. This results in a very different design problem, as the assumption that isolated monitoring is indicative of overall behaviour is no longer appropriate. Some landfill sites have had impervious liners installed, with several horizontal access tubes below the liners for neutron probe monitoring of possible leaks.

Irrigation Scheduling, Moree, NSW, Australia

Measurement of soil moisture status on a regular basis allows the actual crop daily water use to be calculated, and the date of the next irrigation predicted.



Depth	Full	Refill	Previous	Current	Defct	PDWU	Date	EDWU	Date	Volume
0-70cm	316	223	270	250	93	6.4	1/2	9.0	31/1	127 Ml

Figure 3. Irrigation scheduling

Three dates are predicted by the software - one based on the actual crop water use (6.4 mm/day), a second on a user estimated daily water use (9.0 mm/day), and a third based on long-term historical data. The graph also shows the water management through the season - any rises above the full point (water logging) or dips below the refill point (crop stress) can be noted, and general trends such as a decrease in soil moisture become clear.

Deep Drainage At Biloela, Queensland, Australia

A common problem encountered when irrigating light textured soils is through drainage. In this case cotton is being grown at Biloela in Central Queensland on alluvial soils and water is applied by furrow irrigation. However it was taking too long for water to run the length of the field down the furrows.

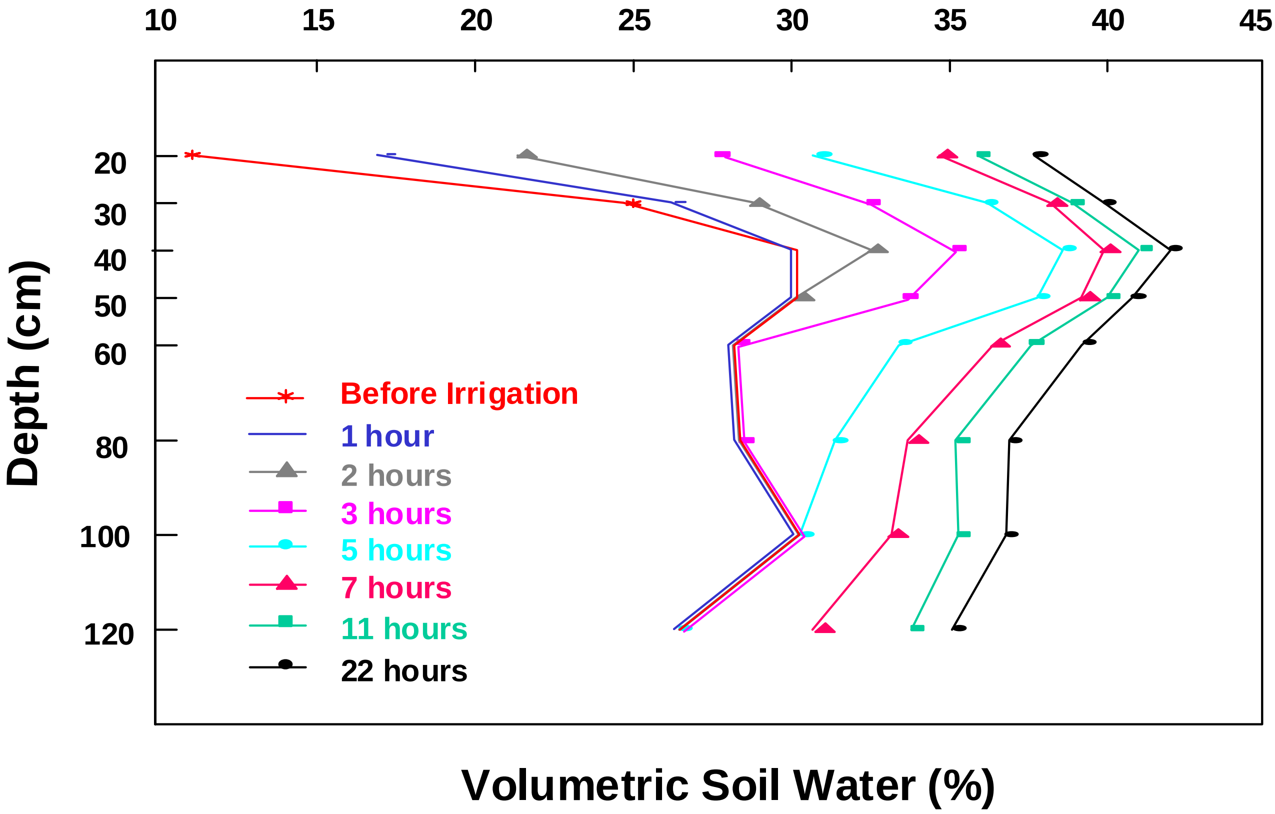


Figure 4. Deep drainage of irrigation water.

Three hours after the irrigation had started water had already reached the 50cm depth, and 56mm of water had been added to the root zone. By five hours the water had reached 80cm, and by seven hours the soil water content had increased at all depths. After five hours a large quantity of water was going well beyond the crops usual root zone and was being lost to deep drainage. After twenty-two hours 119mm had been delivered, 48mm of water had been lost to deep drainage, with only 71 mm being retained in the root zone.

Deep drainage is a serious problem with furrow irrigation on this alluvial soil - large volumes of water can be wasted. To minimise losses runs need to be short with a relatively steep slope and water needs to be put on in large volumes to push water down the rows as quickly as possible to minimise downward movement. The data shows that the ideal time to get from head ditch to tail drain is five hours.

Monitoring Plant Growth Rates

The relationship between cotton plant height and the number of nodes affects the yield - plants growing too quickly will lose productive lint yield, and if too slowly (possibly because of soil compaction problems) will also loose yield. Tony Cush of Pechelba, Moree, NSW has measured plant height and the number of nodes, and an overlaid cross-correlation graph shows which fields are under or over the Vigour Index line.

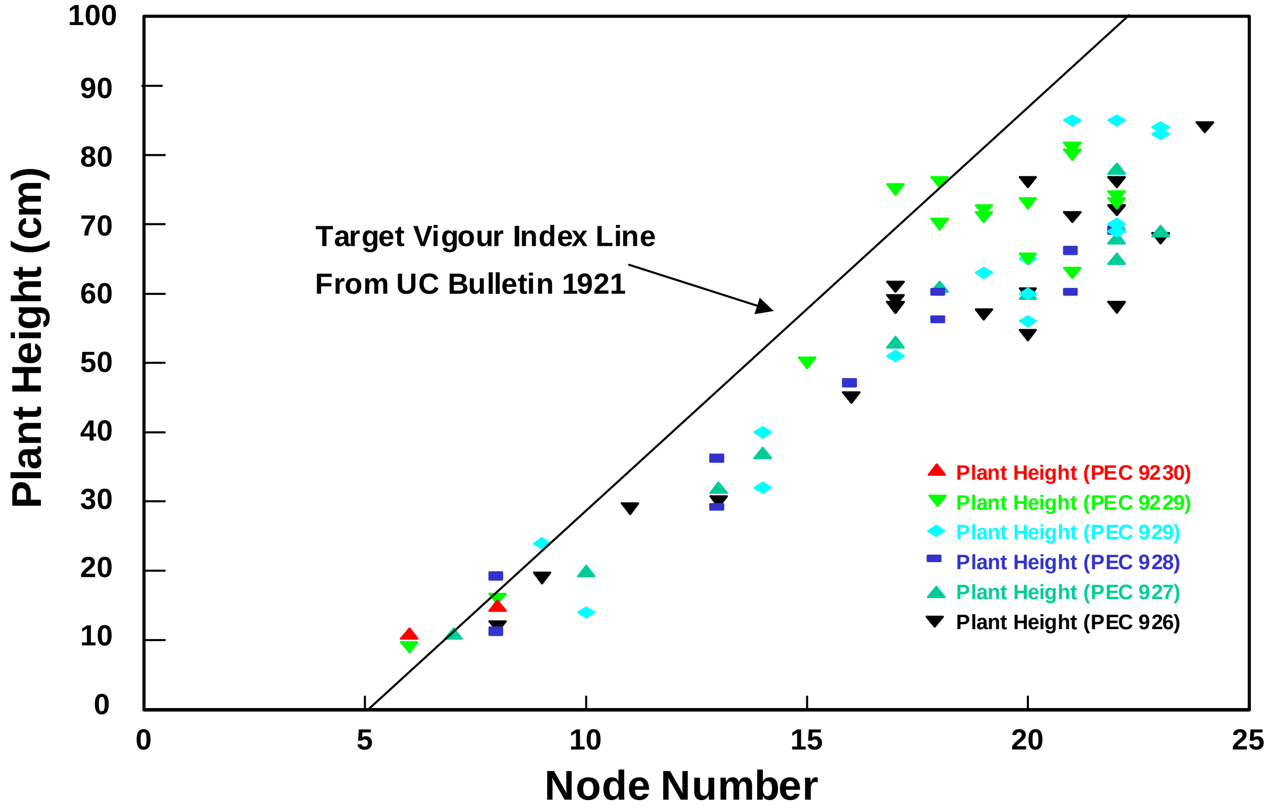


Figure 5. Relationship between plant height and nodes

Actual plant water use patterns using depth graphs can then be examined to further investigate the different behaviours. The measurements are continuing, with all fields being monitored throughout the growing period tracking the height/node relationship.

Apples At Cape Town, South Africa

Monitoring the size of apples, together with the actual and predicted crop daily water use, allows growers to control fruit size and quality.

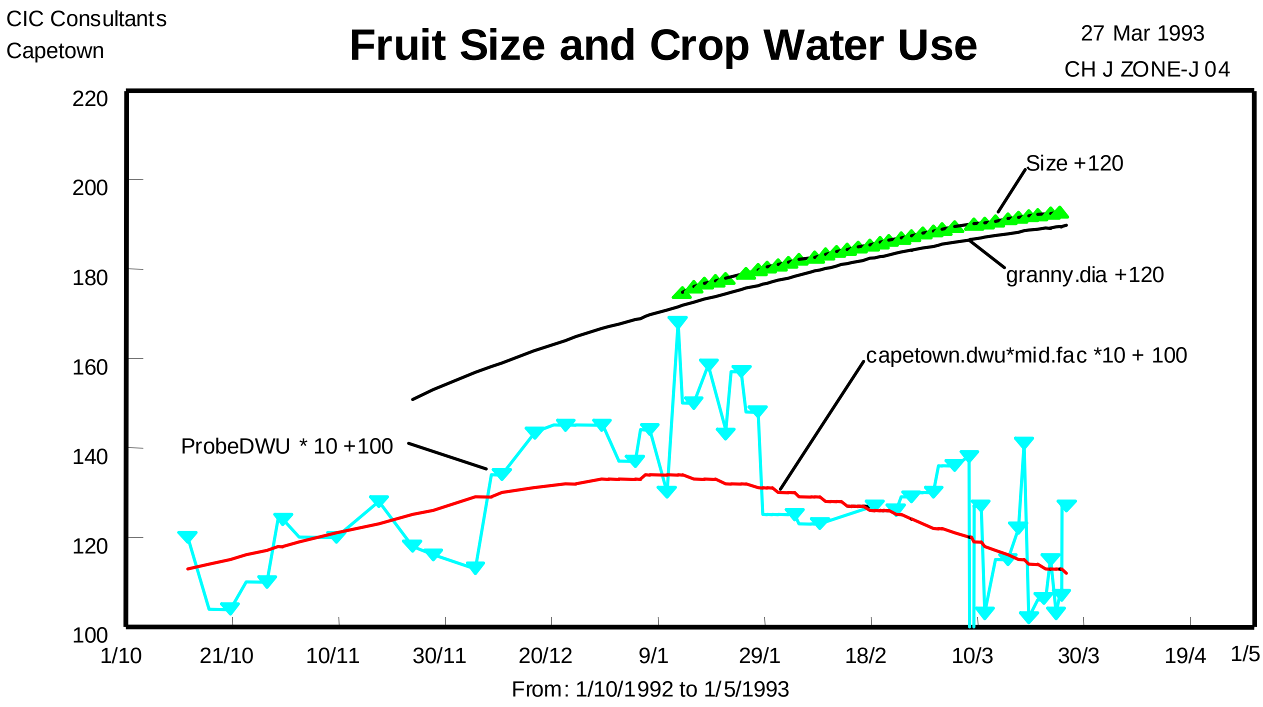


Figure 6. Actual and predicted apple size and daily water use

The apple size has been manually entered from direct measurements using a hand calliper, and is compared with 'ideal' growth data. The actual daily water use is being compared with 40 year average pan evaporation data for Cape Town, multiplied by a varying crop factor. The graphs have been scaled for clarity.

Soil, Weather And Plant Behaviour In California, USA

Grape growers at Napa, California are using the software to control the yield and quality of table and wine grapes. The University of California maintains an extensive network of weather stations (CIMIS), and weather data is downloaded to the software and compared with actual soil moisture and crop behaviour.

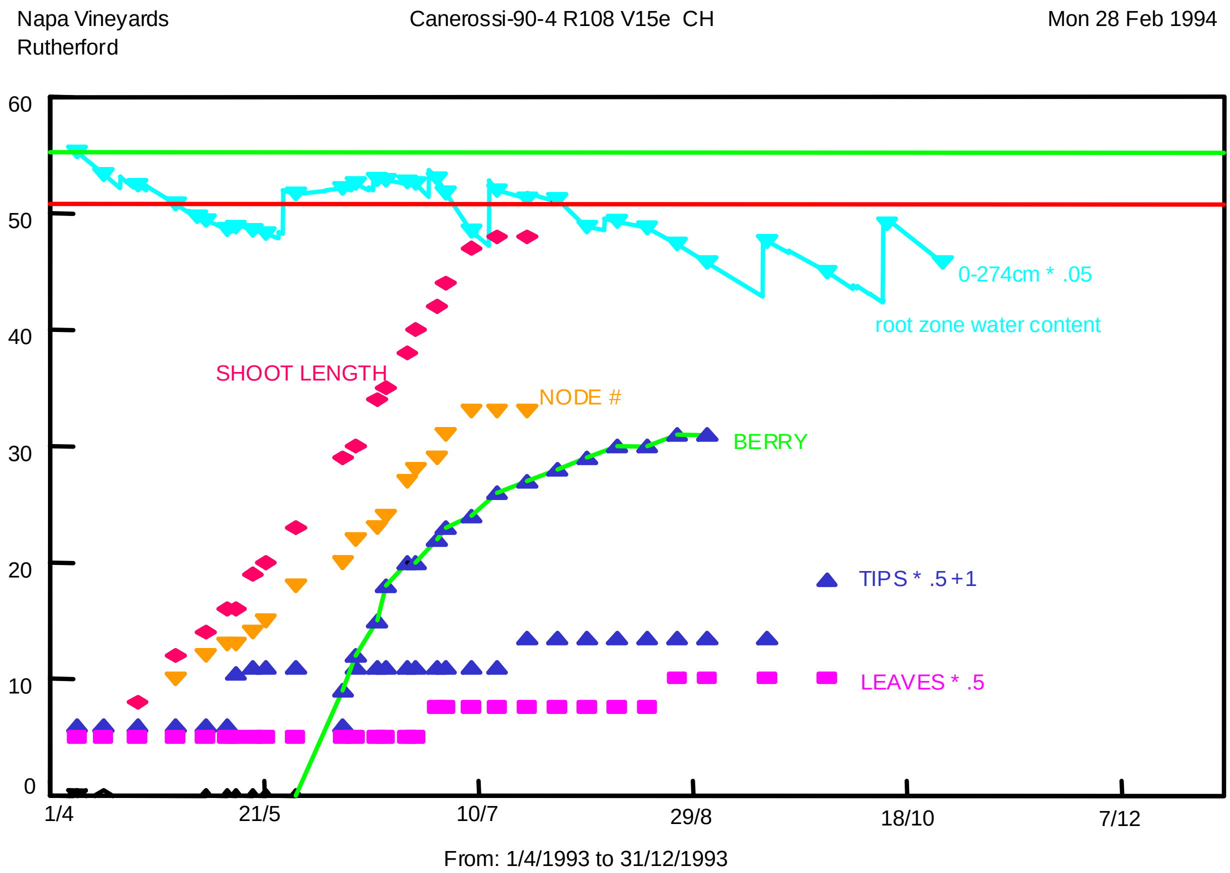


Figure 7. Overlaid soil moisture and plant data from Napa, California.

The grower is recording berry size, tendril score (tips), node number and cane length; and graphing the data with the root zone water content. This will allow an understanding of the relationship between moisture content and crop growth, and of any variation between sites and varieties. The grower is developing the methodology to be able to control crop quality by manipulating soil water content, using data from their own crops and soil types.

Weather data and crop growth models are available from CIMIS, and this data could also have been overlaid onto the graph, allowing users to confirm the accuracy of theoretical models and compare their predictions with the actual performance of the crop.

Long Term Weather Trends

Data from a weather data base on a mainframe computer can be downloaded and imported into the software.

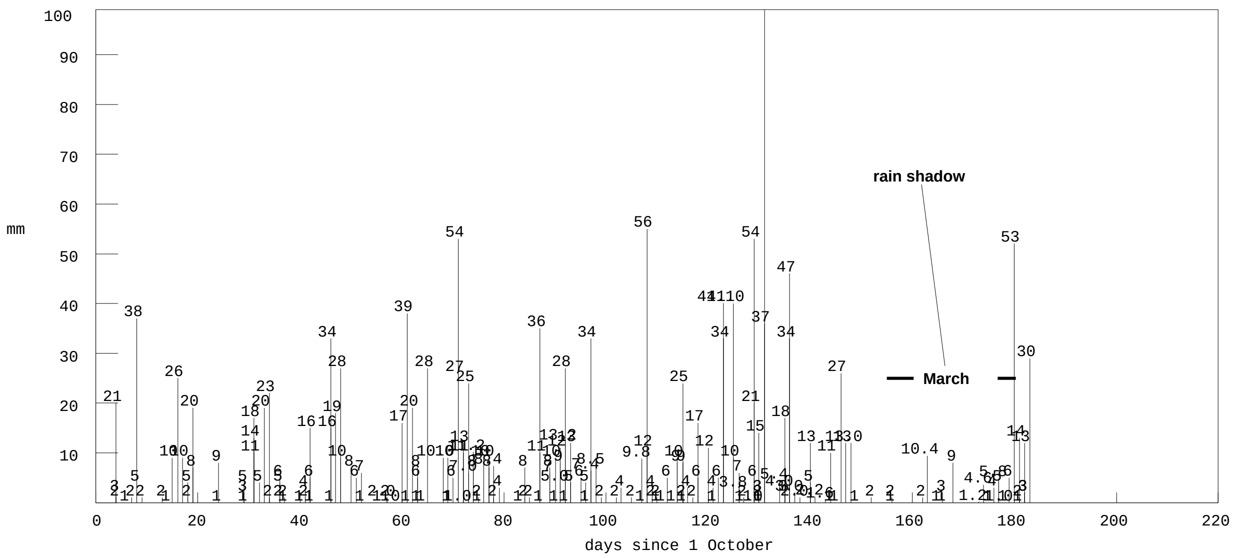


Figure 8. All rainfall events 1987-92 Myall Vale

The graph shows all rainfall events in the years 1987-1992 for Myall Vale, Moree NSW, plotted against days-since-1 October (the crop planting date). The rain shadow at approximately 160 days (corresponding to March) is readily apparent.

Summary

The software is in routine use by growers and agronomists throughout the world. The software presents objective measurements of soil, crop and weather behaviour to the user in a consistent manner, enabling them to routinely monitor and control crop growth. Problems with through-drainage, over-irrigation and soil compaction; and plant/fruit growth and soil moisture relationships can all be routinely analysed as part of normal management practice.

ICT International Pty Ltd
PO Box 503, Armidale NSW 2350, Australia
Ph: [61] 2-6772-6770 Fax: [61] 2-6772-7616
sales@ictinternational.com.au
www.ictinternational.com.au