RESEARCH BULLETIN

Managing fertigation technologies in citrus orchards

New technologies for growing citrus

With recent advances in technology irrigators can now more precisely control delivery of mineral nutrients and water to the roots of perennial tree crops. These technologies, collectively referred to as "fertigation", provide the opportunity to adopt and implement highly technical management programs, such as open hydroponics, that use drip irrigation to deliver a balanced mixture of nutrients and water. Irrigators are currently using a variety of management programs to suit their circumstances, but many current practices may be leading to lower returns and undesirable on-farm and off-farm effects. This is due to the use of practices developed in other countries and/or applying fertiliser at rates developed for less advanced delivery systems. With the increasing popularity of fertigation it is important that irrigators get the most from these technologies that potentially could deliver greater productivity and profitability, and cause less on-farm and off-farm impacts. The project aims to investigate some of the issues specific to using fertigation in Australia, and work with irrigators to upgrade their knowledge and skills to get the most from the new technologies.

The project team will be investigating:

- the effects of common high-intensity fertigation regimes on salt, water and nutrient movement within and below the root zone and the linkage of those losses with management of water and nutrients to trees,
- mineral nutrient uptake by commonly used citrus rootstocks, and
- the long-term impacts of fertigation practices.

Citrus producers are increasingly using new technologies to deliver water and nutrients to tree roots, but knowledge and skills to use those technologies effectively in Australian soils is limited.

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The project team is also developing tools to help citrus producers predict water and fertiliser needs and to plan more appropriate supply programs. Workshops are also being conducted to assist growers upgrade their skills and knowledge in relation to the use of these technologies.

Current issues with using fertigation technologies in Australia

As part of assisting growers to upgrade their skills and knowledge to effectively use these technologies, the project team is investigating some of the issues associated with fertigation in an Australian environment. These issues include:

- the effects of high frequency drip irrigation,
- movement of solutes past the root zone,
- nutrient uptake by different rootstocks, and
- assessing tree nitrogen status.

Using high frequency drip irrigation

The cornerstone of fertigation in citrus orchards is the tight control of the wetted soil volume using high frequency drip irrigation, either continuously throughout the day or pulsed for short periods. These approaches use water efficiently (i.e. nil drainage), but the effects on tree growth and productivity are unknown. A trial being conducted at Dareton on young navel orange trees is comparing these two approaches with conventionally scheduled drip irrigation. The limited data available confirm that the wetted soil volume is greatly reduced by applying smaller volumes of water more frequently, and that the crop coefficients used by the industry for young trees are inadequate, resulting in poor growth and stress of young trees. This trial site is also being used to road test spreadsheet-based frameworks that integrate soil moisture measurements and web-based weather data and predictions to predict irrigation requirements.

Movement of water and solutes past the root zone

With fertigation delivering specific amounts of water and solutes to the trees roots, any water (and solutes) moving past the root zone can be considered a loss. It is difficult to measure these losses and link them directly to management practices. To directly link movement of water and nutrient down the soil profile with inputs, the project team is growing trees in large (ca. 1 m^3) pots, and tightly controlling the inputs and measuring the movement of water and solutes through the soil profile to more confidently link water and nutrient management to water and nutrient movement down the soil profile. This information will enable the team to validate a framework for estimating the likelihood of water and solute movement beneath the root zone in citrus orchards, and be the basis of growers being able to identify such losses and modify management accordingly.

Nutrient uptake by different rootstocks

Rootstocks for citrus production are chosen on the basis of tolerance to soil-borne pathogens and effects on tree growth and productivity. It is widely assumed that all citrus rootstocks behave similarly in relation to nutrient uptake. This assumption is being tested in a series of sand culture experiments that aim to strongly control the concentration of important nutrients around the roots. The aim is to identify specific concentrations of important nutrients beyond which additional uptake is unlikely. This knowledge will assist growers to reduce production costs by matching nutrient supply with the capacity of the rootstock being used to take up those nutrients.

Managing crop nitrogen

Nitrogen is generally the most limiting nutrient in Australian soils and large amounts are applied to address the shortfall between crop demand and what the soil can supply—citrus is no exception. Assessing crop nitrogen status is important to ensuring that demand is satisfied. Citrus producers currently lack the means to readily assess tree nitrogen status, and therefore have difficulty precisely managing nitrogen inputs. The project team is aiming to develop an easy method for growers to assess tree nitrogen status by using an indirect measurement of plant tissue nitrogen status. When there is insufficient nitrogen in leaves to support new growth the level of a group of compounds called polyphenols, which occur naturally in plants, tend to be higher. These compounds absorb UV light, and so measuring the absorbance of UV light by leaves can be an indirect measure of the nitrogen status of those leaves. Current data indicate that the uptake of nitrogen is different between the various rootstock types and there are also differences in the way nitrogen is used within the tree (i.e. directed toward new growth or to existing leaves) as nitrogen levels rise in response to supply. With a real-time, on-site measurement of tree nitrogen status, growers can make more informed and timely decisions regarding management of this important nutrient in their orchards.

Getting fertiliser supply programs correct is important as the effects of any changes in fertiliser management may take more than a season to become obvious. This is particularly so for nitrogen because 70% of the nitrogen used by spring growth is sourced from nitrogen taken up by the tree in the previous season. It is therefore important to consistently impose particular fertiliser supply regimes to measure long term responses. To address this need, the project team is also setting up a commercial-scale research/demonstration site using citrus varieties and rootstocks currently grown by citrus producers. The team aims to assess the long term effects of fertigation technologies, and ensure that the results are relevant to commercial enterprises.

Training

An important part of this project is working with growers to assist them to get the most from the fertigation technologies that are available by providing the knowledge needed to implement effective management practices. Workshops have been developed based on a combination of an extensive review of existing knowledge and the new knowledge being generated by the research being undertaken.

The project team is delivering workshops covering soil solution sampling and the mineral nutrition of citrus trees to citrus producers in the major producing regions of south east Australia.

The workshops take a strong hands-on approach, providing expert help, to ensure that participants can carry out the appropriate sampling needed to assess management and use the tools being presented. The workshops are split over a number of sessions to allow growers an opportunity to reflect on the applicability of the content and seek clarification on specific issues at subsequent sessions.

These workshops form a documented platform of knowledge that can be continually updated to ensure relevance to future citrus producers and industry circumstances.

These workshops are advertised via the regional marketing boards and the CITTgroup network, and citrus producers wishing to participate need to register.

Additional workshops are being developed on:

- the physiology of citrus trees,
- crop water use and estimating needs (including use of the irrigation scheduling spreadsheet),
- soil fertility and its measurement and
- fertigation.

Hands on workshops are being used to transfer the knowledge and skills needed to get the most from the fertigation technologies being increasingly used by citrus producers.



For more information

Details of upcoming workshops can be obtained from Steven Falivene, NSW Department of Primary Industries at the Dareton Primary Industries Institute, Silver City Highway, Dareton, NSW; phone, 03 5019 8400; fax, 03 5027 4319; email, Steven.Falivene@dpi.nsw.gov.au

Suggested reading

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Photos courtesy of New South Wales Department of Primary Industries.

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About the Program

The National Program for Sustainable Irrigation defines and invests in research on the development and adoption of sustainable irrigation practices in Australian agriculture. The aim is to address critical emerging environmental management issues, while generating long-term economic and social benefits that ensure irrigation has a viable future.

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