FACTSHEET

Friday, 22 November 2013

Contact
Mark Skewes
Loxton Research Centre
PO Box 411, Loxton, SA, 5333
Phone: 08 8595 9149
Fax: 08 8595 9199
Email: mark.skewes@sa.gov.au

SOUTH AUSTRALIAN RESEARCH & DEVELOPMENT INSTITUTE
PIRSA

Citrus Drought Information Package

Introduction

This information package provides relevant information to assist citrus growers to manage the impacts of severe reductions in irrigation allocations should they occur again.

The information presented arises from a research program conducted in the Southern Murray Darling Basin between 2006 and 2011 by the South Australian Research and Development Institute (SARDI), and funded by the South Australian state government and Horticulture Australia Limited (HAL).

Data presented was collected from research trials conducted near Loxton in South Australia, and from an extensive on-farm monitoring exercise across the Riverland (SA) and Sunraysia (NSW & Vic.) districts.

Figure 1 Citrus tree under severe drought stress

PREMIUM FOOD AND WINE FROM OUR CLEAN ENVIRONMENT

SOUTH AUSTRALIA

Government of South Australia
Primary Industries and Regions SA

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

The Impact of Drought on Citrus Orchards

Citrus trees respond poorly to insufficient irrigation. Responses (ranked by increasing water deficit) include:

- Reduced transpiration: reduced photosynthesis, fruit growth rate and fruit maturation;
- Leaf drop: reduced transpiration, photosynthesis and fruit development;
- Fruit drop: partial or complete loss of crop;
- Dying-off: dead twigs and branches;
- Tree death.

In addition, water deficit during flowering and fruit set can dramatically reduce fruit number, even if sufficient water is applied subsequently.

Drought can also severely restrict subsequent crops, and/or cause wide fluctuations in crop size from season to season (biennial bearing).

Data collected from 130 citrus plantings across the Riverland and Sunraysia are presented in Figure 2, illustrating significant reduction in yield as the total amount of water applied per season (irrigation plus rainfall) declined below the recommendation for these regions of around 1000 mm (10 ML/ha).

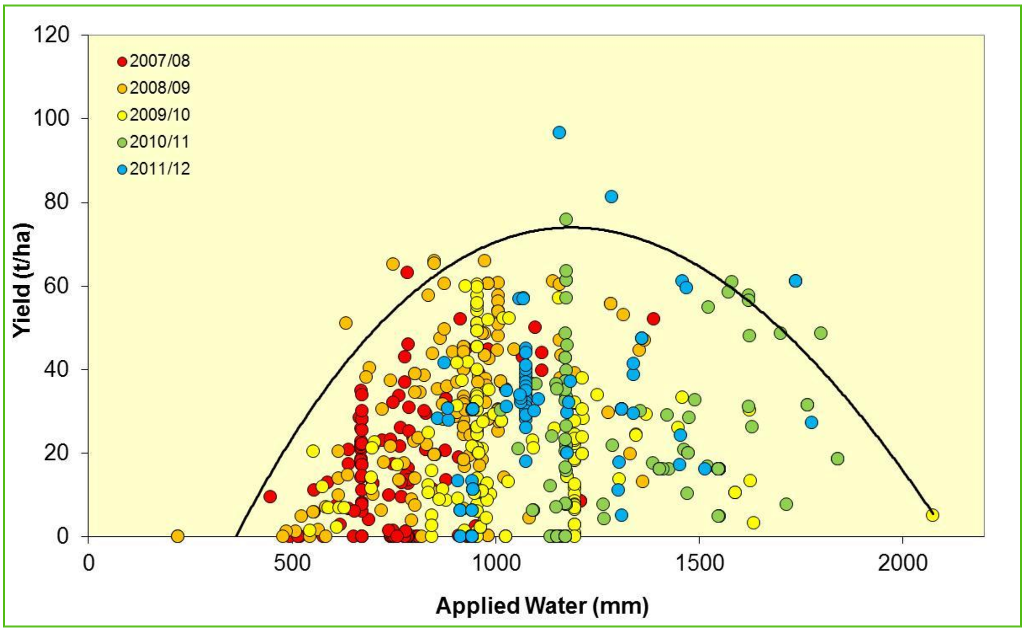

Figure 2 Relationship between water applied (irrigation and rainfall) and yield in citrus

Establishing a Resilient Citrus Orchard

A little care in setting up an orchard can result in an orchard which is inherently more resilient to drought than would otherwise be the case.

Planting Material

The recent research trials at Loxton confirm previous findings that Cleopatra Mandarin is more drought tolerant than most other citrus rootsotcks, and therefore suitable for establishing citrus orchards in virgin soil.

The most common rootstocks used in replant soils in Australia are Troyer Citrange and Carrizo Citrange. Swingle Citrumelo is also suitable for replanting. All of these rootstocks demonstrate a similar degree of drought tolerance, being almost as tolerant as Cleopatra Mandarin.

Irrigation System Configuration

Wetted Area

When irrigation volumes are reduced as a result of water shortage, any limitations or deficiencies in the irrigation system are revealed. Research results indicate that inadequate wetted area of drip irrigation systems can increase tree water stress under these conditions.

Drip irrigation systems should seek to achieve at least 30% below ground wetted area coverage, to guard against this phenomenon.

Partial Root-zone Drying

Partial Root-zone Drying (PRD) is an irrigation management technique which uses hormonal signals within the plant to reduce transpiration by more than the reduction in water availability, therefore saving water whilst minimising the degree of stress experienced by the crop.

PRD requires specific irrigation system configuration, which therefore needs to be installed well before drought conditions are encountered.

Further information about PRD is available from Kriedemann and Goodwin (2003).

Managing Drought Stress in Citrus Orchards

Yield reduction in citrus under drought is driven by the degree of stress experienced by trees. In turn, the degree of stress experienced is reflective of the balance between water availability and water demand; the greater the difference, the greater the stress.

There are 2 broad options for managing water stress; increasing water availability, or reducing water demand.

Increasing Water Availability

Purchase or Lease of Water (External Source) – High Potential

Additional water can be sourced from outside the property, via the water market, as lease (temporary trade) or purchase (permanent trade).

Consolidation of Water (Internal Source) – Moderate Potential

Water can be reallocated within the business, by sacrificing some plantings in favour of others, taking into account current and future earning potential (including tree age, variety, rootstock, disease, markets etc.). Also, water loss through irrigation system leaks cannot be tolerated during drought, this water should be supporting crop production.

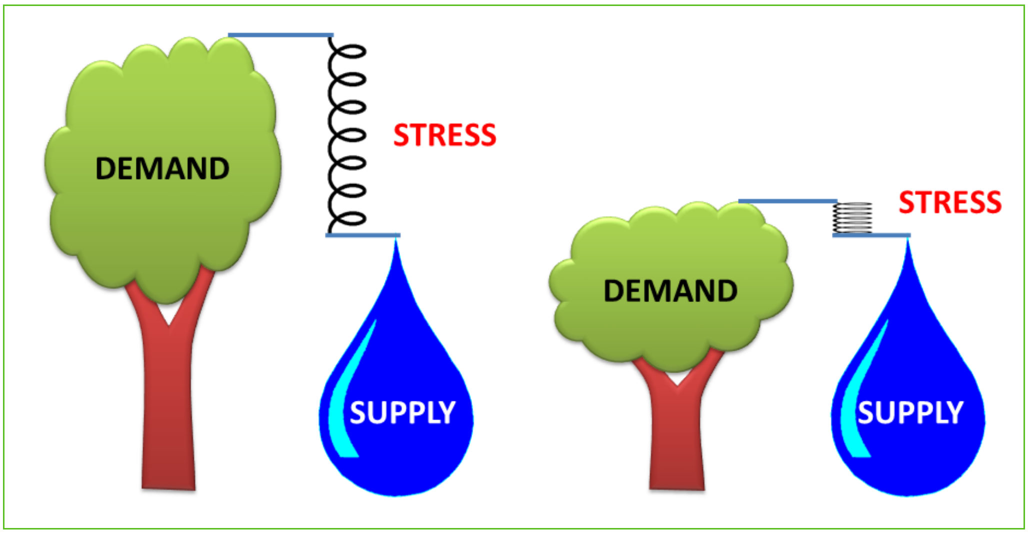

Figure 3 Decreasing tree stress, by reducing water demand to more closely match water supply

Decreasing Water Demand

Canopy Reduction – High Potential

Leaf surface area is a key determinant of tree water demand. Reducing canopy size can result in significant reductions in water demand, thus greatly reducing the stress experienced by trees when water supply is limited (Figure 3).

Figure 4 Hedging citrus trees to reduce water demand

A number of canopy reduction strategies are available (see Falivene, Giddings, Hardy et al. (2006) for more information):

- Hedging – mechanised, and therefore quick and cheaper than hand pruning (Figure 4), but the amount of canopy reduction is limited.
- Hand Pruning – may be combined with hedging to clean out tree centres. Care should be taken to avoid sunburn of limbs.
- Skeletonising – useful where water is in extremely short supply (Figure 5), sacrifices medium term production in favour of long term survival. Trunk and limbs must be whitewashed to avoid sunburn.
- Topworking – also known as reworking, facilitates more rapid varietal renewal, but also results in a significant medium term (3-5 years) reduction in canopy size, and therefore water demand (Sanderson, Falivene, & Hardy, 2007).

Figure 5 Citrus trees skeletonised to dramatically reduce water demand (yet to be whitewashed for sunburn protection)

Crop Load Reduction – Moderate Potential

Developing fruits demand nutrients and water, increasing the overall demand for water. Reducing water applications slows fruit growth rate, resulting in smaller fruit in the current crop, and creating residual impacts on flowering and fruit set in the following season.

Crop load reduction reduces the impact of drought on fruit growth, and may enable the production of a lower yield of economically viable sized fruit. For further information see Bevington, Hardy, Melville et al. (2003).

Under severe stress, trees naturally drop fruit. In a field trial near Loxton, SA, there was no demonstrable difference in fruit number or yield over 2 seasons between crop removal treatments and a control, at low irrigation applications (33% of normal).

Orchard Management – Limited Potential

Small water savings are possible through reduction of transpiration by off-target plants, such as weeds and cover crops.

Cultural treatments trialled at Loxton, including mulching along the drip-tube, soil polymer application through the irrigation system, and application of kaolin clay particle film to tree foliage, did not result in any significant increase in yield under drought.

Recovery from Drought

Citrus trees are quite resilient, and quickly recover from very severe water deficit.

Trees at Loxton Research Centre receiving 33% of full irrigation for 1 ½ seasons, returned to full cropping in the second season following resumption of full watering (Figure 6), whilst trees subjected to 90% irrigation reduction took longer, but eventually made a full recovery (Figure 7 and Figure 8).

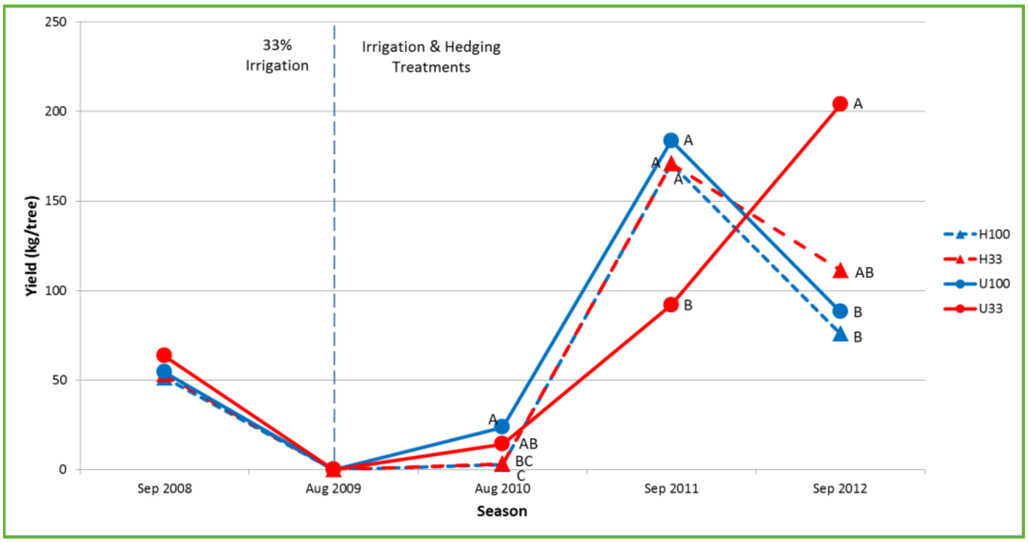

Figure 6 Annual yield recovery of citrus trees irrigated at 33% for 1½ seasons (letters indicate groups of no significant difference within each season)

Rootstocks influence citrus drought survival and recovery (Figure 7). The commonly used replant rootstocks Swingle Citrumelo and Troyer Citrange performed well in the trial above.

However, there are some issues to consider when bringing trees back from a prolonged period of less than optimal irrigation:

- Dead twigs in the canopy lead to fruit rub damage, resulting in downgrading of quality and reduced financial returns. A light hedging, and possibly hand pruning, may be required to remove this dead wood, and this will also stimulate new growth;
- Drought stress exacerbates the natural tendency of citrus to biennial bearing, where crop load alternates widely from year to year. The resultant shift in fruit size range (a large crop of small fruit followed by a small crop of large fruit)

does not promote optimal financial returns. Pruning, flower suppression and crop thinning are all strategies that can be used in heavy crop years to dampen biennial bearing cycles.

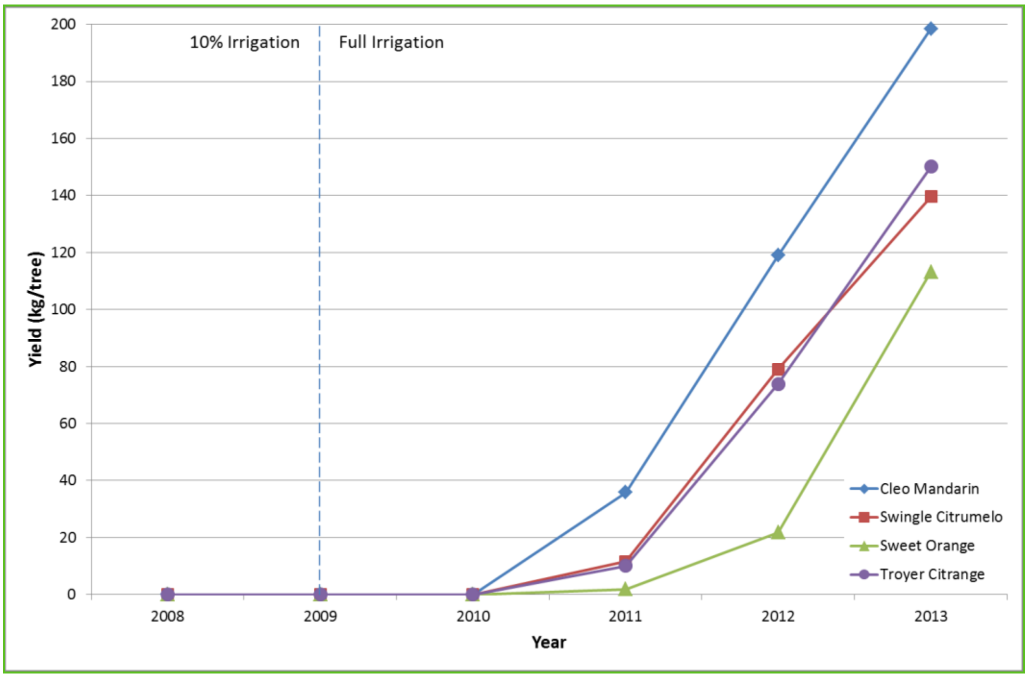

Figure 7 Cumulative yield of citrus trees on different rootstocks given 10% irrigation for 1½ seasons (no significant differences due to large between-tree variation)

Figure 8 Visual comparison of 10% irrigation tree in July 2009 (l), and the same tree in July 2013 (r)

Further Reading

Bevington, K. B., Hardy, S., Melville, P., Thiel, K., Fullelove, G., & Morrish, P. (2003). Fruit Size Management Guide - Part 1 (pp. 16). Mildura, Victoria: Australian Citrus Growers. http://www.dpi.nsw.gov.au/agriculture/horticulture/citrus/management/other-information/fruit-size.

Falivene, S., Giddings, J., Hardy, S., & Sanderson, G. (2006). Managing Citrus Orchards with Less Water Primefact (Vol. 427, pp. 10). Orange, NSW: NSW Department of Primary Industries. http://www.dpi.nsw.gov.au/agriculture/emergency/drought/managing/crop-hort/managing-citrus-orchards-with-less-water.

Kriedemann, P. E., & Goodwin, I. (2003). Regulated Deficit Irrigation and Partial Rootzone Drying. In A. Currey (Ed.), Irrigation Insights (Vol. No. 4, pp. 102). Canberra, Australia: Land and Water Australia. http://npsi.gov.au/products/pr020382.

Sanderson, G., Falivene, S., & Hardy, S. (2007). Reworking Citrus Trees Primefact (Vol. 756, pp. 5). Orange, NSW: NSW Department of Primary Industries. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0010/136675/Reworking-citrus-trees.pdf.

Know-how for Horticulture™

This project has been facilitated by HAL (Horticulture Australia Limited) in partnership with The SA Drought Response Team of the Premier's High Level Drought Task Force. The Australian Government provides matching funds for all HAL's R&D activities.

View publication stats