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Water and crop management strategies for temperate fruit orchards during drought

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Water is a critical input in any fruit production system. It plays a vital role in plant processes including nutrient transport, cell turgor and growth, photosynthesis and temperature regulation. Modern temperate fruit orchards use irrigation systems to ensure adequate water supply to the soil and crop as required. These systems rely on stored or pumped water being available. In severe drought, on-farm water resources can reach critically low levels, placing crop and tree performance at risk.

Efficient water use in the orchard is always a high priority, but even more so when rainfall and water resources reach potentially limiting levels. During droughts, orchardists must implement all possible management strategies to maximise water use efficiency and minimise the negative effects of reduced water on crops and trees.

The following are some strategies growers can consider implementing to help mitigate the effects of drought.

Water management strategies

Pre-season planning and irrigation system checks

A pre-season water plan might include estimating the water requirements per block, expected irrigation period (i.e. October–April), scheduling, frequency, run times and prioritising blocks if water becomes limited. Planning ahead for blocks that will be placed on tree survival irrigation if necessary will be easier than during the season.

System checking usually involves a test run before the irrigation season to assess system output and identify any problems such as breakages, blockages or off-target water losses.

Plan well ahead for new orchard blocks and aim to have irrigation water available to young trees from the day of planting.

Prioritise young blocks

Newer blocks are often the most valuable because they contain high value varieties and represent the future of the orchard (Figure 1). Water stress on young developing trees can result in stunted growth and poor block establishment.

Figure 1. Young orchards are a high priority for irrigation in drought because of their shallow root systems and high value.

When developing your irrigation plan, prioritise young blocks more highly than older blocks and those which do not perform well. In extreme circumstances, you may need to walk away from some blocks and focus on those with the highest known value and returns.

Another option may be to chemically remove the crop early in the season to reduce the risks associated with normal cropping and stress. This is discussed in more detail in the section 'Crop and tree management strategies' on page 3.

Drought can also be a strong motivator to remove those old orchard blocks that have been under-performing for some time.

Soil moisture monitoring

Using irrigation water efficiently during water shortages is paramount. Monitoring the fate of water applied to the soil is the only way to properly understand if is meeting crop needs whilst not resulting in waste and nutrient loss via leaching. To efficiently use irrigation water requires knowledge of how the water applied affects soil moisture levels and how far the moisture travels in the soil. There are two main types of soil moisture probes; those measuring soil water tension (i.e. tensiometers or gypsum blocks; Figure 2) and those measuring volumetric soil moisture (i.e. capacitance probes; Figure 3).

Tensiometers measure how hard a plant must work to extract the available moisture at a given time, whilst capacitance probes measure total water in the soil and indicate how this changes over time. Typically, tensiometer probes have a single sensor meaning multiple probes are required to track soil moisture at various depths. Capacitance probes usually include sensors at multiple depths built into one probe.

Estimating crop water use

A crop water budget provides a method for estimating crop water needs based on crop evapotranspiration (ETc), irrigation efficiency, rainfall, soil type and crop coefficient (Kc). There are a number of online resources for water budgeting in temperate tree fruit crops. The publication 'Guide to best practice in water management: orchard crops' (2009) by Dr Anne-Maree Boland is a useful document that covers all aspects of temperate tree fruit irrigation including estimating crop water needs across a range of crops using the budgeting method described above.

Figure 2. An example of a gypsum block probe.

Figure 3. An example of a capacitance probe.

This document is available (along with many other useful publications) via the Apple and Pear Australia Limited Future Orchards Library (https://apal.org.au/programs/future-orchards/future-orchards-library/).

Water wisely

Wise water use includes practices such as avoiding irrigating during the hottest part of the day (if possible). This will reduce losses due to surface evaporation. Depending on your irrigation system capacity, this may not be practical as many systems need to be run almost constantly in summer to cycle around your blocks in a 24 hour period. In these situations, consider scheduling daytime irrigations on blocks that are least likely to be affected by evaporation. For example, those covered with protective netting and those in areas less exposed to drying winds. Leave the exposed and windy sites for night time irrigating.

Always aim to use shorter more frequent irrigation intervals (i.e. pulse irrigation). This helps to keep valuable water and fertigated nutrients in the active root zone and is less likely to result in leaching. This is particularly important in shallow rooted dwarf orchards on drip irrigation as the main root systems are usually quite shallow and can be concentrated around dripper zones.

Take advantage of stone fruit growth patterns

Apple and pear fruit grow at a fairly constant rate throughout the season and therefore generally require adequate soil moisture throughout the fruit growth phase. Conversely, stone fruits exhibit rapid fruit growth following fruit set and in the lead-up to harvest, but in the middle of the season (when the pit or stone is hardening), fruit diameter growth is minimal and any water applied is more likely to result in vegetative shoot growth. The 'pit hardening' period in stone fruits is an opportunity to reduce irrigation inputs without negatively affecting fruit growth or tree health. Reducing irrigation during this phase saves valuable water and reduces the likelihood of excessive vegetative growth. Regular fruit growth monitoring can help to identify when pit hardening starts and finishes.

Reducing moisture loss

Ensuring good weed control, particularly near the effective root zone, will minimise moisture losses due to competition. Weed control can be physical or chemical.

Applying organic mulches where practical will help reduce evaporation, retain soil moisture and increase soil carbon, thus improving long-term soil water holding capacity and general soil health. Mulches can provide the added benefit of suppressing weeds, provided the depth of the mulch is sufficient to block out light and prevent seed germination and growth (Figure 4).

Studies have shown that protective hail netting over orchards reduces the level of solar radiation, evaporation and crop water requirements. Monitoring soil moisture in netted and un-netted blocks may help growers to take advantage of reduced water demand in netted blocks.

Figure 4. Organic mulches can help retain soil moisture in the profile by reducing evaporation and competition from weeds.

Crop and tree management strategies

Start your crop load planning in winter

Have a plan for the optimum fruit size (weight) and number per tree that will deliver your desired yield per hectare. The target number of fruit per tree can then be used to guide winter pruning. Removing excess fruit buds at pruning (either by snipping

or spur removal) will reduce the spring bud load and potential hand thinning costs. Note: when counting buds to retain, it is important (particularly in varieties that are prone to biennial bearing) to plan to retain sufficient buds so that some will be free of fruit and resting in the current season to develop buds for next season.

In drought years, consider reducing the number of fruit buds retained at pruning. This will take some pressure off your primary and secondary thinning programs in the spring.

Adjust thinning regimes

During drought, aim to reduce crop load early and by more than usual. Plan for aggressive blossom thinning and early fruit thinning. Also be prepared to sacrifice some yield to achieve the desired fruit quality and average size.

Be prepared to carry out additional hand fruit thinning if required (Figure 5). Use fruit size monitoring and fruit size curves (trend lines) to help you to decide when additional fruit thinning is needed.

Figure 5. Fruit thinning programs may need to be adjusted to ensure the target fruit size is achieved. It may be necessary to accept a lower overall yield in drought years.

In apples, complete crop removal is an option when the block is to receive tree maintenance irrigations only. Certain registered products with the active constituent ethephon include label recommendations for aiding complete removal of apple fruit.

Monitor fruit size

Establish fruit size monitoring plots in each orchard block and measure the same 20 fruit per block weekly starting when fruit reach 20 mm in diameter and continue until harvest. Comparing the weekly average fruit growth rate can help identify any slow-down in growth that might be due to water stress and/or over cropping. Comparing the seasonal fruit growth curve with past seasons can also help identify if the crop is on track to reach the target fruit size. Accurate fruit size monitoring involves returning to the same fruit each week and recording the growth rate and progressive fruit size. The online program OrchardNet (https://www.hortwatch.com/orchardnet/) has a good tool for recording and graphing fruit size and comparing seasons based on growth from full bloom. OrchardNet also includes target fruit growth trend lines for the key varieties.

An excel spreadsheet could also be used to track fruit growth data.

Re-think timing of pruning

Historically, most temperate fruit trees are pruned in winter. This typically results in a strong spring growth response, which creates a high demand for water and nutrients in the early part of the growing season. Conversely, summer pruning will suppress vigour and reduce canopy area, resulting in more efficient use of available water and nutrient resources to help support satisfactory fruit growth.

Summary

Water is a critical input in any fruit production system, but especially during drought. Water management strategies including pre-season planning, prioritising young blocks, monitoring soil moisture, estimating crop water use, watering wisely, taking advantage of stone fruit growth patterns and reducing moisture loss can be implemented to help. Additionally, crop and tree management strategies such as planning in winter for crop loads, adjusting thinning regimes, monitoring fruit size and considering different times to prune can also help with efficient water use in orchards.

Useful resources

Australian Cherry Production Guide: https://www.cherrygrowers.org.au/assets/australian_cherry_production_guide.pdf

Dry Season Information for Stone Fruit: http://agriculture.vic.gov.au/agriculture/horticulture/fruit-and-nuts/stone-fruit/dry-season-information-and-cstone-fruit

Future Orchards Library: https://apal.org.au/programs/future-orchards/archive-library/

Irrigation Requirements for Peach and Nectarine Orchards: http://agriculture.vic.gov.au/agriculture/horticulture/fruit-and-nuts/stone-fruit/irrigation-requirements-peach-and-nectarine-orchards

Support for drought affected farmers

Department of Agriculture: http://www.agriculture.gov.au/ag-farm-food/drought

DroughtHub: https://www.dpi.nsw.gov.au/climate-and-emergencies/droughthub

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