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Converting mature citrus from full cover to drip irrigation

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DPI Agriculture Water and Irrigation Unit

Drip irrigation is a popular method of water application for citrus growers, particularly in new developments, but also when converting established plantings. Converting mature citrus trees to drip irrigation creates a series of challenges that can be overcome if appropriate management practices are adopted. Where an established orchard is converted to drip, the change in wetting pattern can 'shock' the tree and result in poor tree health and reduced productivity in the first year after conversion. However, converting existing trees can be successful if growers follow a few simple guidelines.

Poor tree health following conversion is most commonly observed on older trees or trees growing on shallow soil. It is often due to a poor understanding of the different management practices the new system requires. The most common problem is that irrigators unfamiliar with drip systems often do not initially recognise that more frequent irrigations are required.

Two key aims when converting existing trees from full-cover to drip irrigation are to:

1. Quickly encourage new root growth in the soil volume wetted by the drippers to support the tree during periods of peak water demand.
2. Leach salts from the soil volume wetted by the drippers.

Full-cover irrigation systems encourage root development over the entire wetted area. They also tend to result in salt build-up beneath the tree row, particularly in furrow and overhead systems, and also in un-skirted under-tree sprinkler situations. These zones of high salinity are commonly within the dripper-wetted profile and needs to be quickly leached. As drip irrigation applies water to a relatively small area compared with full-cover systems, the system's leaching power is considerable.

To leach salts away from the tree row, the first few irrigations under drip should be reasonably heavy, taking into account crop water requirements, water tables and problem areas. Subsequent irrigations need to be scheduled to ensure under-watering does not occur. Soil salinity testing before and after the conversion can provide a guide to the degree of leaching required. If a previously existing full cover system is retained, be aware that using this system regularly could move salts back into the dripper-wetted profile.

Rootstock

Some rootstocks are more sensitive to system conversion than others. Rough lemon and sweet orange in particular have shown problems when converting to drip. This is likely to result from the sensitive root systems of these rootstocks being weakened by existing root diseases such as Phytophthora. In this situation, installing an extra dripline (three driplines per row) is often recommended.

Existing orchard health

The success of the conversion can be related to tree health at the time. The conversion process can reveal some pre-existing problems that might have been tolerated or masked under sprinklers. These problems are discussed below.

Soil

Soil compaction significantly reduces citrus root growth and root health. Therefore, assessing compaction before conversion is recommended. In Mallee soils for example, compact layers or hard pans commonly occur below the shallow surface cultivation layer, at depths of 20–40 cm, although deeper compact layers can, in some situations, be a problem (contact your local agronomist for specific advice regarding compaction and appropriate management). With very poor root growth in the compact layer, citrus trees commonly lose vigour at a much younger age than expected. In these situations, citrus trees are likely to have difficulty establishing an adequate root system in the wetted profile of a new drip system, resulting in conversion shock as the tree cannot access adequate moisture.

Digging several backhoe trenches across the orchard before converting to drip irrigation is advisable to examine the root system and assess the soils for compaction. If available, a penetrometer is excellent to determine compaction levels. However, a rule of thumb for sandy citrus soils is that compaction is not a major problem if it is reasonably easy to push a finger in the sides of the backhoe trench when the soil is moist. If it is virtually impossible to push a finger into moist soil in the sides of the trench, the soil is likely to have significant compaction and root growth will probably be severely restricted.

Soil compaction can be treated, but it is not an easy task and the process can add further stress to plantings if not done carefully. It can also have some downsides such as suckers growing along the rip line and/or water shoots growing from the rootstock.

A suitable method to break up compaction layers is to rip along the skirt line on one side of each tree row with a parabolic style ripper in winter, preferably after harvest for navels. It is preferable to have a small wing on the boot of the ripper to give some soil lift. The ripper tine at the tree skirt should have a balancing second tine in the mid-row to stop the tractor swinging sideways. The tines should have a large coulter disc immediately in front of it to cut the roots with which the tine connects to avoid large roots being pulled from the tree. It is unwise to rip both sides of the tree in one winter; hence compaction assessment should be done a year before conversion so that conversion occurs after the second rip operation has been carried out.

Nematodes and Phytophthora

A nematode test in the orchard is also recommended. If existing root systems are unhealthy due to nematodes, rootrot or compaction, conversion to drip irrigation will not correct these problems. Correcting these problems might be required before the irrigation upgrade.

If Phytophthora, nematodes or other root diseases exist, consider redevelopment to tolerant rootstocks rather than converting to drip, as the symptoms could significantly worsen under a restricted wetting pattern (see Rootstock section).

Ideally, redevelopment should be preceded by resting, establishing cover crops to build up organic matter, deep ripping and possibly mounding.

Irrigation management in the first season

Ample water supply is usually recommended in the first year after conversion. Growers should not be too concerned about consciously overwatering in the first year. A healthy orchard that successfully overcomes the conversion to drip irrigation has the opportunity to be efficiently drip-irrigated for many years to come. Ample water application in this first season also encourages greater lateral spread of water, which helps minimise the significant change in the new wetting pattern produced when drip irrigation is installed. For some lighter soil types, additional water will simply leach below the rootzone and, in this situation, pulsing irrigations should be considered.

Drip irrigation is often hastily adopted by managers during periods of water shortage to reduce water use. If this is the case, care should still be taken to avoid under-irrigating in the first year in order to ensure that trees are not stressed. Trees can easily become stressed due to the shock of the new system, and adding water deficit on top of this, during drought conditions, is likely to lead to significant stress.

Fertigation

It is important to apply soluble fertiliser through the irrigation system (that is, fertigate) early in the season to encourage root growth within the wetted strip. Applying sufficient levels of phosphorus and nitrogen will encourage roots to develop within the wetted strip. Ample phosphorus could already exist in the mid-row area from previous fertiliser programs, but under drip irrigation, much of this becomes unavailable to the tree. Side banding fertiliser along the driplines might also be an option. If the conversion to drip irrigation is well planned, side banding phosphorus could be a consideration in the seasons before the upgrade, acknowledging that it still might take a season to move into the rootzone.

When fertigating, time the application over the whole irrigation period, allowing time to flush it from the irrigation system. It is generally recommended to apply split applications of nitrogen and phosphorus fertilisers weekly throughout the first season of conversion. Applying phosphoric acid products at label recommended rates should also be considered to encourage root growth.

Irrigation scheduling

It is highly recommended that soil moisture monitoring be adopted at the same time as the new drip system. This will readily help to identify the new irrigation management program required under the new system. It is very important that good soil moisture be constantly maintained in the smaller wetted volumes created by drip irrigation. This moisture must be maintained in a similar location below the tree. If driplines move to the edge of the wetted zone they can push salt into the establishing rootzone. This rootzone location must be kept consistent to adequately develop in the first season. Staking the dripline might be necessary in some situations.

Dual systems

If converting from a reasonably well-maintained overhead or under-tree sprinkler system, consider retaining this system in combination with drip irrigation to take advantage of the options they deliver. A full cover system can provide the ability to establish a mid row cover crop, some level of frost protection and tree cooling.

Figure 1. Overhead sprinklers are retained in a recently installed drip orchard.

Dripline location

Mature drip irrigated orchards generally have two driplines installed, one each side of the tree row, usually 0.5–0.75 m from the butt. If a third dripline is introduced in between these laterals along the butt line (or the outside laterals are located too close to the butt), problems such as rootrot can occur in citrus. For double row planting systems (tramline), three lines might be possible, one down the middle of the double rows, and one line on either side of the double row.

If extra lines are installed, it is recommended that you check with your irrigation designer to determine your system capabilities. If a third line is installed, it should be located on the northern side of rows running east–west (along with the scheduling tool location), and the western side of rows running north–south. Ensure that this extra line is not located too close to the butt of the tree.

Figure 2. Conversion to drip in an interplant situation. Young trees have a small rootzone requiring the dripline to be located close to the butt for tree establishment. The mature trees require the dripline 0.5–0.75 m from the butt, resulting in the dripline being looped along the tree line for three seasons. When young trees are mature, the dripline will be straightened and positioned 0.5–0.75 m either side of the tree row.

Timing the conversion

The best period for conversion to drip irrigation is normally straight after harvest, particularly for citrus varieties harvested in autumn, winter or early spring, as this gives the tree extra time to adapt to the new system before the onset of summer and without a crop to support. In Australia, the July–August period is ideal. Successful conversions have occurred during less than ideal periods, with trees carrying heavy crop loads. However, the risk of problems occurring is much higher, particularly if early heatwaves occur.

It is recommended to harvest spring/summer varieties (such as Late Lane navels and Valencias) as early as possible before conversion.

Using existing pipework

In some situations, existing sprinkler irrigation pipework could be used for the drip system. An irrigation designer should assess the system as sometimes it is more efficient and/or cost effective to install new pipework. Existing asbestos cement (AC) submains are unsuitable for drip conversions due to their tendency to flake and block emitters once disturbed during installation, and once fertigation and acid injection begins. AC mainlines might be more acceptable if backup filters are installed at all valves, and the pH of the water is not lowered below 4.5 if acid is injected.

Silt and clay build-up in existing pipework can cause massive emitter blockage problems, making a drip system useless. If this is the case, it is again important to install backup filters at each irrigation valve, and fully flush the system following installation. Existing pipework might also be oversized for the new drip system, resulting in lower flow rates and water velocities, which tend to exacerbate algal growth and subsequent silt and clay build-up.

Conclusion

Before conversion, careful consideration is necessary to determine that conversion is indeed appropriate for a particular patch. For some older patches growing on a rootstock that does not readily adapt its root system to the wetted area of drip, or if Phytophthora problems exist, replanting might be a better option.

For patches that are suitable for conversion to drip irrigation, the following tips will minimise the problems associated with converting sprinkler irrigated orchards to drip irrigation:

1. Schedule irrigations more frequently and be guided by soil moisture monitoring devices.
2. Apply a slight excess of irrigation to maximise lateral spread and leach accumulated salts.
3. Adopt a regular fertigation program.

More information

Primefact 427 *Managing citrus orchards with less water*

Drip Irrigation – a citrus growers guide

Acknowledgments

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