

Fodder & Cash Crops - Irrigation Requirements

WISE WATERING Irrigation Management Course

These materials are part of the Wise Watering Irrigation Management Program, developed in part from the NSW Agriculture WaterWise on the farm education program and The Mallee Wells Irrigators manual.

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The Wise Watering project is part of the Tasmanian Irrigation Partnership Program, funded jointly by the State Government and Natural Heritage Trust.



5 November 2001

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Introduction

Plant species vary in their sensitivity to water stress, and their response to irrigation.

This module aims to identify the requirements of the main plant species irrigated in Tasmania, as the basis for developing an irrigation regime.

Where possible, the irrigation requirements have been based on criteria that indicate;

- ∅ When to start irrigating.
- ∅ How to manage the irrigation during the season.
- ∅ When to stop irrigating.

The notes for this module have been prepared by a number of specialists with experience in each of the specific crop and pasture species.

Pastures

Basil Doonan, DPIWE

Overview

Perennial pastures are most commonly irrigated for dairy cattle. The aim is to maintain growth of the pasture species in a vegetative phase, and minimize water stress during the irrigation season.

Pastures should comprise a mix of perennial species that will be productive. This includes for example white clover, perennial ryegrass and cocksfoot .

It is important to ensure that the fertiliser regime provides an adequate supply of nutrients; irrigation is expensive and plant response to the water should not be limited by low levels of phosphorus and potassium, in particular. Use soil tests to make sure levels are adequate.

The root zone of perennial pastures typically extends to about 15-30 cm depending on a number of factors such as soil pH, soil fertility status, rainfall, irrigation level and strategy and aluminum and manganese levels.

When to start irrigating

Pasture irrigators generally start too late. The reasons for this are many but in general it is due to irrigation start-up coinciding with other important tasks such as silage making, fertiliser application and mating . In addition to this pastures do not exhibit any visible signs of moisture stress when this is occurring.

Irrigation start-up is one of the most important aspects of irrigation management. Pasture production can fall by 50% over a 30-40 day period if irrigation start-up is delayed by just 7 days. This highlights the importance of correct irrigation start-up date.

Irrigation start-up can be calculated in a number of ways based around available soil moisture (ASM) in the soil. This is calculated by subtracting daily evapotranspiration from soil moisture holding capacity of the soil. When this reaches half field capacity it is time to irrigate.

While it is possible to determine the optimum start-up time for dairy pasture irrigation using evaporation and rainfall figures, field located tensiometers are less complicated and labour intensive. Tensiometers can be set up in the field, and depending on the type used, monitored on a daily basis while conducting other farm work.

Tensiometers are generally limited to ranges of 0-80 kPa. This does not pose a problem with respect to their usefulness in irrigation scheduling as the normal

range is 20-50 kPa, which accounts for levels of -50% of ASW. Tensiometers do not measure ASW directly but can be calibrated to give an indication of it.

The depth at which tensiometers are placed is a function of root growth and soil buffering capacity to avoid large daily variations. On most soils in Tasmania this would be around 300 mm. The most appropriate time to irrigate was when the vacuum level of the tensiometer reaches 35 kPa. Start-up time needs to be somewhat earlier than this in practice because it takes time to complete the irrigation round.

Irrigating during the season

After start-up regular monitoring of the soil tension is advised to make adjustments to the amount of irrigation applied as evaporation rates rise or rainfall occurs. The lower the soil's water holding capacity the quicker the tensiometer reading can be expected to rise, and a more rapid irrigation round must be adopted to deliver the required water. Soil tensiometers are therefore applicable to any soil type, as are the trigger ranges or points for commencing watering.

While most farmers start irrigation too late, there is a tendency to restart too early after rainfall events resulting water and nutrient wastage. This is particularly so where large storage's of water are not available and the extra days spent not watering result in additional days as the storage's are allowed time to refill from either run-off or from bores.

When to stop

Although there are no published datum on the most appropriate determination of irrigation shut-down it may be possible to use tensiometers and/or water budgets. As the end of the season approaches and temperatures and day length decline, the irrigation round lengthens and the likelihood of rainfall events increases as autumn/winter approaches. Farmers are able to predict relatively accurately when the next round will be completed, and as such the occurrence of a significant rainfall event might end irrigation for the season.

The use of this information, with historical rainfall data allows informed decisions to be made on the likelihood of obtaining benefit from further irrigation. Rainfall data can be used to determine the likelihood of rainfall in the coming irrigation round, and the amount that is likely to fall. This, combined with the current tensiometer readings, would allow a more informed decision on whether water is required, than that based on historical data alone.

Fodder Crops

Basil Doonan, DPIWE

Overview

The most commonly irrigated fodder crops are brassica's sown in spring ,oats and short-tem ryegrass varieties/clover mixes. These are generally sown to target a specific pasture deficit, and generally benefit from irrigation. On many dairy farms the use of effluent can result in substantial increases in the yield of fodder crops.

There are a number of commonly grown brassica fodder crops with turnips being the most common for a number of reasons. Turnips out yield both rape and pasja under both dryland and irrigated conditions, in addition to this they are more water efficient. Turnips yield around 40 kgDM/ha /mm, rape 20 kgDM/ha/mm and pasja 15 kgDM/ha.

When to start irrigating

Some differentiation needs to be made here between grass based fodder crops such as annual pastures and oats, and brassica's. Annual pasture and oat based fodder should be irrigated in the same way as for "Pasture" section of the manual.

Brassica fodder crops respond poorly to irrigation prior to bulb initiation (usually the first 6 weeks of growth) and as a result there is a large potential to waste a lot of water in this period. Crops that successfully germinate can be expected to go without water for the first 6 weeks unless conditions are extremely dry.

Irrigating during the season

Again there is a difference between the grass and brassica based fodder crops. Pastures respond best to scheduled watering and major decreases in water use efficiency result from pastures that become moisture stressed. As a result they should be monitored closely throughout the growing season. This is covered in the "Pastures" section of the manual

Once the bulb initiation is complete brassica's will respond to irrigation with the same efficiency whether they have been water stressed or not. This allows some flexibility in irrigation management as they can be irrigated as water and time permit without a major decline in water use efficiency. Decreases in total yield however will result from the decrease in applied water. To achieve maximum yields brassica crops need to be managed in a similar fashion to grass based fodder crops.

When to stop

Generally the productive life of fodder crops is shorter than the irrigation period. This means that it is the reduction in the crop rather than favorable moisture conditions that determine the most appropriate time to stop irrigating.

If the productive life of a fodder crop extends beyond the irrigation period then strategies similar to those outlined in the "Pasture" section of the manual should be implemented.

Lucerne

David Armstrong, Armstrong Agricultural Services

Overview

Lucerne is a very deep rooting crop, and in most of Tasmania it will survive without irrigation. For maximum production however, irrigation is generally needed over the period December till March.

The deep rooting system means that irrigation applications can be widely spaced (eg., several weeks or more). The period between irrigations will depend on the soil characteristics and the age of the planting (younger crops have shallower root depth).

The root zone of a mature stand of irrigated lucerne will be at least 1 metre in friable, well structured alluvial soils and Krasnozems. It will be less where there are hardpans or water-logged subsoils. This rooting depth can be used to calculate Readily Available Water (RAW), and thus develop an irrigation schedule.

A well irrigated lucerne stand will use water at about the same rate as the evaporation from an evaporimeter; so the Crop Factor during the summer can be assumed as 1.

Remember, for the first week after mowing transpiration will be reduced, although there will be evaporation from the soil surface.

When to start irrigating

Starting time will often depend on when the first hay-cut is taken. Daily water use in November is likely to be about 4.3 mm/day (Cressy average daily pan evaporation in November is 4.3 mm). Therefore, a period of about 16 days after heavy rain would generally be sufficient to reduce the level of Available Water in the rootzone to a level where irrigation is required.

Maintaining a simple water balance would allow the starting to be established with confidence. Remember, that after your start it will take some time to irrigate the whole paddock, so irrigation should start before the RAW is fully depleted.

Irrigating during the season

In the peak of summer average daily pan evaporation, and this daily water use, will be about 6 mm. A Krasnozem profile with 0.4 metres of Clay Loam over Medium Clay will have RAW of about 70 mm. The interval from one irrigation to the next, without effective rainfall will therefore be about 12 days.

When to stop

The growth of lucerne slows as temperatures fall, as does water use.

It is desirable to enter the cooler months with the moisture content of the rootzone below Field Capacity. This reduces the chances of water-logging after heavy autumn rains. Irrigations applied in late March or early April should therefore be less than the estimated soil moisture deficit. This allows some capacity for the soil to absorb rainfall without becoming waterlogged.

Cereals

David Armstrong, Armstrong Agricultural Services

Overview

Cereals such as spring sown barley commonly suffer moisture stress in December. At this time a number of factors work together to make this a critical period;

- € Weather conditions are becoming warmer and dryer, and water demands peak.
- € Crop leaf areas are high, so there is potential for high rates of water use.
- € Yields are very susceptible to water stress at flowering; in spring sown barley for example flowering occurs in early December.

As a result of these influences, yields of barley in many districts are strongly related to the amount of rainfall in the first 2 weeks of December. You might think, therefore, that this is the best time to irrigate, and in some years this is true. A complicating issue is that if conditions are dry earlier in the season, and the crop is stressed for water before ear emergence, then irrigation at this time is very likely to cause “second growth”.

Second growth delays harvesting, and carbohydrate demands for these late filling ears reduces the size of grains developing from the first tillers. As a result, overall grain size is therefore reduced.

A further complication is that the economic returns from barley, and the yield improvements available from irrigation, are insufficient to justify the capital costs of irrigation equipment. But if equipment is available, then it will usually be worthwhile irrigating cereals; in this circumstance the only costs are those of labour, water and pumping.

When to start irrigating

In most circumstances it is not economic to water barley early in the season (normally the irrigation facilities will be used on more valuable crops).

However, if the crop is dense and well developed before flowering, and there is a prolonged dry spell at this time, and you have water, and you have facilities to irrigate, then irrigation will be worthwhile.

Irrigating at this time will increase the number of grains per ear. Subsequent irrigations will improve grain size.

Green peas (Pisum sativum)

Sue Hinton, Glaxo Smith Kline/ Hinton Agricultural Consulting

Overview

The root system of peas consists of a taproot and extensively branched laterals. The lateral roots can extend horizontally for reasonable distances.

Peas are moderately deep rooted, with roots extending to 900 + mm, if soil conditions permit. The majority of the root system will be in the top 300 to 400 mm of soil.

Peas require moderate soil moisture to germinate. It is important to have soil moisture to encourage even germination and emergence of the pea crop.

When to start irrigating

Starting time will depend on soil moisture conditions. If conditions are dry a pre-plant watering is sometimes applied. With centre-pivot irrigators it is possible to start watering after planting, if required, to ensure an even germination and emergence.

The soil does not need to be at field capacity at this early stage. Excessive soil moisture during or immediately after germination, may lead to damping-off (root rot).

During the season

It is important to ensure soil moisture is maintained from the commencement of flowering until harvesting of the crop.

A pea crop will normally require between 1 and 2 megalitres per hectare.

When to stop

Irrigation will be stopped just prior to harvesting of the crop.

Poppies (Papaver somniferum)

Sue Hinton, Glaxo Smith Kline/ Hinton Agricultural Consulting

Overview

The depth of poppy root systems will depend on the depth of top soil available. Generally most poppy plant root systems concentrate in the top 300 to 400 mm of the soil. In deeper soil types the roots will extend further, and in areas with less depth of top soil the root system will be more shallow.

When to irrigate

Irrigation is required at running up, through the hook stage and until after flowering.

Irrigation of poppy crops has traditionally been applying between 1 and 1.5 ML of irrigation per hectare. The trend is for increased quantities of irrigation to be applied to the crop. Irrigation strategies are also changing with the expansion of centre pivot irrigators and the use of raised beds in some areas.

When to stop

Stop irrigation when the crop water use falls. This is somewhere between post-flowering and the stripey capsule stage.

A Glaxo newsletter reports that the water use of 10 top-yielding crops in 1999/2000 was 2 MI/ha, equivalent to eight 25mm irrigations.

Potatoes – commercial & seed crops

Sue Hinton, Hinton Agricultural Consulting

Overview

Profitable potato production depends on an adequate supply of water to the roots throughout the growing season. Water is a major constituent of potato plants, making up 90 –95 % of green tissues and 75 – 85% of tubers.

A growing potato crop uses a lot of water. In average conditions a well growing potato crop will use 6+ mm of water per day. Crop water use is generally expressed as evapotranspiration. This is the sum of evaporation from the soil and transpiration from the plants.

Evapotranspiration is affected by climatic conditions and plant characteristics. This will vary with temperature, humidity, wind conditions, and the level of solar radiation.

Water stress, from too little or too much water, can have significant impact on the health of a potato crop, and the quality of the tubers produced. Several tuber disorders that reduce the marketability of the crop are associated with excess, deficient, or fluctuating soil moisture.

Early in a crop **excess water** can promote seed piece decay. Excessive soil moisture, particularly during tuber bulking and maturation, can cause lenticels on tubers to become enlarged. Enlarged lenticels can be significant entry sites for organisms such as soft rot bacteria. Excess water during tuber maturation favours the development of pink rot and late blight tuber rot. Excess moisture at harvesting, increases the tuber susceptibility to shatter bruise and cracking.

Deficient soil water, during tuber initiation may favour the development of common scab and some tuber disorders such as irregular shape. During tuber bulking deficient soil moisture may favour the development of common scab, and favour tuber disorders such as internal brown spot, irregular shape, and growth cracks (with intermittent dry). Dry conditions during tuber bulking may initiate premature senescence and lead to increased early blight and early dying. During tuber maturation deficient soil water may result in dehydrated tubers, and may cause stem-end vascular discolouration. Dry conditions at harvesting, increases tuber susceptibility to bruising. Dry conditions (soil cracks in moulds) may allow damage to tubers from potato moth.

Fluctuating soil moisture can lead to growth cracks, poor tuber shapes (dumbbell, pear shape, pointed end), and knobby tubers.

When to Start

This will be different each season, depending on soil moisture conditions. It is better to start early, during tuber initiation (starts about 4 weeks after planting) and to maintain regular soil moisture levels throughout the growing period of the crop. Soil moisture levels start to become critical for potato crops when the readily available water levels go below 60-65%. This means that in most soil types a water deficit develops in potato plants when 35-40% of available soil water has been used. Potato plants that have water deficits, have darker green leaves (often seen before irrigation is started in crops). Prolonged dry will result in wilting of the crop.

Irrigating During the Season

The aim of irrigation management in potato crops should be to maintain adequate soil moisture throughout the growth of the crop, avoiding extremes and excessive fluctuations.

Crop water use is at its highest when the crop has a full canopy and tuber bulking has commenced, Water use starts to reduce during the tuber maturation stage.

Irrigation to minimise the fluctuation in soil moisture during the growth of the crop is recommended

Broccoli

Dave O'Donnell, DPIWE

Overview

Summer planted Broccoli is particularly sensitive to soil drying during crop establishment ; this is the case for both direct seeded and transplanted crops.

Summer grown Broccoli has a high irrigation demand; the crop often requires greater than 40mm of irrigation per week.

During warm, moist weather excessive irrigation can be associated with the disease 'head rot'.

Broccoli crops with the root disease 'club root' are often excessively irrigated to compensate for the poor water uptake of diseased roots.

When to start irrigating

Adequate soil moisture at transplant of seedlings is required for even crop establishment.

The crop root activity is shallow during early crop development and if possible, regular low volume irrigations are the most efficient practice.

Irrigating during the season

It is critical to all stages of broccoli crop development that soil moisture is not limited at any time.

As general rule 30mm to 45 mm of irrigation is required per week throughout summer.

In heavier soils, and during later stages of crop development (buttoning onwards) a single large volume irrigation per week may be adequate.

When to stop

Irrigation should be continued until just prior to harvest as the Broccoli head will continue to gain weight and develop.

Onions

Dave O'Donnell, DPIWE

Overview

Onions, during early stages of development, are a shallow rooted crop generally extracting soil moisture from only the upper 25 cm of topsoil.

Onions need for irrigation is difficult to detect by 'eye' as the plant stops being productive in dry soils but does not show drought stress due to the bulbs' capability to store water.

When to start irrigating

Irrigation volumes early in crop development may be low as the water and nutrient uptake is only occurring in upper 20cm of the soil profile .

Irrigating during the season

Irrigation trial data suggests that irrigation should be applied when a tensiometer at a soil depth of 15cm reads about 40 kpa. Tensiometer values approaching 70 kpa result in yield and quality loss.

From bulb initiation onwards water demand rises (estimated at 4 – 5 mm/day). Regular high volume irrigations are required to maintain crop water requirements from the early bulbing stage onwards.

In late stages of crop development onion roots have been observed to extract soil moisture down to a soil depth of 50 to 80cm.

When to stop

Irrigation late in bulbing may delay maturity and decrease bulb quality. Ceasing irrigation at least 14 days prior to harvest allows complete drying of the crop.

Pyrethrum

Dave O'Donnell, DPIWE

Overview

Pyrethrum is adapted to dry climates and is capable of surviving dry conditions whilst showing very little sign of water stress; this can be a difficulty when managing irrigation. Although the production of pyrethrins may have slowed down the crop may not appear dry - for this reason irrigation management based upon direct measurement of available soil moisture may be a key in yield management.

Pyrethrum is a crop that is very sensitive to excessive soil moisture.

Early crop establishment from seed is another critical time of irrigation management because at this stage the crop has a very shallow root system.

When to start irrigating

Under typical summer condition pyrethrum yield often benefits from one irrigation applied in the early stages of flower development; often around mid November.

Irrigating during the season

A total of 2 to 3 irrigations is a standard practice in optimal yielding crops.

The need for irrigation is best based on monitoring soil moisture depletion and irrigating "as required".

This can be achieved several ways:

- € Irrigating to maintain soil moisture content above 'refill point' on a Gopher.
- € Irrigating to ensure a tensiometer, at 30cm soil depth, does not exceed 70 kpa.
- € Irrigating at an evaporation pan deficit of 40 – 45 mm

When to stop

A final irrigation is often applied prior to the flowers drying off if soil moisture levels are becoming low. The crop is then dried off for a fortnight prior to harvest.

Stone fruit, cherries and apricots

Wayne Boucher, DPIWE

Overview

Water is essential for all stages in the growth and development of fruit trees. Growth of shoots and leaves is reduced, especially in young trees, if soil moisture falls below certain levels during the four to five months following bud break and bloom.

Flower bud formation, bloom and fruit set can all be affected by low soil moisture. Flower buds of stone fruits are initiated in late spring to summer, develop slowly through summer and autumn and bloom in spring, eight to nine months after bud initiation.

Apricot flower buds are most sensitive to water shortage during summer. When the soil is dry for the entire summer apricot trees produce little or no bloom the following spring. Other stone fruits are less sensitive than apricots. Cherries are least affected, in terms of flower bud development, by lack of summer irrigation. However, lack of water following harvest greatly reduces the ability of the tree to accumulate nutrients and carbohydrates, necessary for flower and initial leaf/shoot development the following spring.

Large fruits are obtained when trees are irrigated regularly throughout the growing season. Frequent irrigations also make more nutrients available from the soil, further contributing to large fruit size and reducing the annual fertiliser requirement of the tree.

Fruit quality (flavour, firmness and colour) is best when trees receive sufficient but not excessive irrigation.

A variety of irrigation systems are suitable for stone fruits (under tree sprinklers, mini-sprinklers, microjets and drip) Mini-sprinklers/microjets and drip are preferred. Correct irrigation design is essential to ensure systems deliver the appropriate amount of water to trees.

Irrigation scheduling based on soil moisture monitoring is strongly recommended. A variety of soil moisture monitoring devices are available commercially. Most will have a soil moisture range that is recommended to be maintained.

Tensiometers are the simplest and cheapest soil moisture monitoring device.

When to start irrigating

Irrigation will commence early to late spring depending on district. For tensiometers, irrigation will commence once readings reach 40 centibars. Frequency and duration of irrigations will depend on irrigation system employed.

Irrigating during the season

Irrigation is maintained throughout the season for young non fruiting trees. For fruiting trees that have attained full size, a full irrigation schedule is maintained till the end of harvest. Following harvest irrigation should be stopped for two to three weeks to stop current seasons shoot growth. Following cessation of growth (hardening of terminal tissue and setting of terminal bud) continue irrigating. Frequency of irrigating can be reduced but must be sufficient to maintain tree health and ensure that post harvest nutrition is effective.

When to stop

Cease irrigating young non fruiting trees at the end of April to ensure trees have hardened off prior to onset of frosts.

Maintain adequate soil moisture levels for fruiting trees up to the commencement of leaf fall. Once leaf fall has commenced, cease irrigating.

Pome fruit, apples and pears

Predo Jotic, DPIWE

Overview

Apples and pears have a large demand for water to support all physiological processes required for fruit and tree development and to ensure good bud formation for the return crop. Water has a direct impact on yield and quality parameters - fruit size, colour, soluble solids and keeping quality.

One tonne of fruit contains 850L of pure water. To grow this crop the trees need 85000L of water during the growing season. This means that only 1% of water is retained in the crop, while the tree parts hold less than 0.5%. In high producing intensive plantings a 50t/ha crop will require 4.25 megalitres of water.

At the start of the growing season good fruit set is dependent on adequate soil moisture, however, in Tasmania quite regular winter rainfall provides satisfactory water reserves for the early part of the spring.

Another crucial stage of fruit development occurs during the six weeks interval following the fruit set. A rapid rate of cell division takes place in young fruitlets and this is essential for good fruit size and storage. Any moisture stress during this period will influence the final fruit size and keeping quality.

Between the completion of fruit cell division and harvest apple diameter increases at a constant rate.

The moisture regime affects the overall rate of fruit growth but not at the same level during the season. As the diameter gets larger constant increase in diameter is reflected in much larger gain in fruit volume. Therefore, the impact of water stress will be more pronounced during the latter stages of fruit growth. This is a very important point in irrigation management. In seasons when irrigation water storage is limited we must make sure that adequate water volume is reserved for the period four to six weeks prior to harvest. The next most critical phase is during the six weeks of rapid cell division after fruit set. The water storage needed to meet these demands can be estimated from average Class A pan evaporimeter readings for a given location. In Tasmania a fully developed orchard at peak demand during the six weeks prior to harvest may require 1.26 megalitres of water per hectare. This is based on 0.6 of average Class A pan data (0.6 x 5mm x 42 days) ÷ 100.

To ensure optimum current and return crop and tree development we must ensure good orchard soil moisture regime throughout the growing season.

The estimate of orchard water demand is based on the relationships between Class pan measurements and the maximum water use by the tree. When an orchard canopy fills half of the orchard space (50% ground cover) than its water

demand is similar to that evaporated from Class A tank. At the start of the season due to small leaf area the trees will use only a small proportion of the water evaporated from the tank. The tree water use will rise with the increase in leaf area. These proportions will range from 0.1 at flowering to 0.6 in midsummer. The figure will rise above 0.6 four to six weeks before harvest especially if the trees are carrying a heavy crop load.

Irrigation scheduling is essential to minimise and prevent soil moisture stress. There are three basic approaches to determine irrigation levels:

∄ Evaporation (E) data - Class A pan readings.

Evapotranspiration (ET) data provided by the Bureau of Meteorology. ET values are calculated by the Penman formula which takes into account temperature, relative humidity, solar radiation and wind speed.

∄ Soil moisture monitoring sensors - tensiometers, gypsum blocks, Neutron probe, EnviroSCAN, Aqua-Tel, Aqua-Flex etc. Tensiometer is perhaps the most user-friendly device. Vacuum gauge is calibrated in kilopascals (0 - 100kPa). Tensiometer function satisfactorily up to 75kPa. The optimum moisture range for medium to heavy textured soils will indicate tensiometer reading between 20 and 50kPa.

∄ A combination of soil moisture monitoring instruments and E and or ET data is the best method of irrigation scheduling. A soil moisture device tells us when water should be applied and E or ET information provide an estimate of irrigation required by the orchard.

Various water saving measures have been tried in pome fruit orchards:

∄ Regulated Deficit Irrigation (RDI) has not been successfully adapted for apples. RDI decreased fruit size.

∄ Partial Rootzone Drying (PRD) is being tested on apples in New Zealand and Washington State. It may offer considerable water savings without loss of yield and fruit quality. Compared with 100% (control) and 70% irrigation volumes applied to the entire root zone, 50% water quantity restricted to half of the root zone (PRD treatment) did not affect fruit yield and quality parameters. The three irrigation regimes applied on fully cropping mature trees during the last seven weeks prior to harvest produced similar results in terms of total crop, final fruit size, fruit firmness and soluble solids.

∄ According to US experience Alfalfa mulches on tree lines reduced irrigation needs to by to 30%.

Micro irrigation systems based on various trickle designs and to an extent mini sprinklers are the most common methods of irrigation in Tasmanian apple orchards. They are well suited for intensive plantings, particularly on duplex sandy loams where most of the apple plantings are located.

When to start irrigation

Growers should be ready for irrigation during the early calyx stage of fruit development to ensure a maximum rate of cell division essential for optimum fruit size and keeping quality.

Irrigating during the season

In Tasmania irrigation is normally required between October and late April. Irrigation scheduling should be carried out throughout the growing season to provide for optimum fruit growth, tree development and fruit bud formation for the return crop. On typical sandy loam duplex apple soils in Tasmania tensiometer readings should be maintained within the 20-50kPa range.

When to stop

For late apple cultivars (Braeburn, Fuji, Pink Lady, Sundowner) irrigation should be terminated at the end of harvest. For early to mid-season cultivars for example, Gala, Jonagold and Golden Delicious watering can continue post harvest until leaf fall to assist in fruit bud development for the following season.

Vines

Duncan Farquhar, DPIWE

Overview

Water use in vines ranges from 250mm to over 800mm per season. 500mm or 5MI per hectare is used by DPIWE as a Tasmanian rule of thumb. Vegetative growth and yield are determined by vine water use. Vines can survive under very low moisture conditions. Tasmanian vineyards on deep ferrosol soil have reported no signs of leaf stress starting to appear until 800 Kpa soil tensions. Problems with moisture stress generally occur with vines in sandy and shallow soils. Yield response has been reported to vary between 0.16 and 0.7T/10mm irrigation (Coombe and Dry, 1992). Much or all of a vineyard's annual water requirement can come from rainfall.

Abscisic acid is produced by drying roots and leaves and its chief function is to control the closing of stomata. ABA accumulation under rootzone drying is also associated with cytokinin decreases. PRD (Partial Rootzone Drying) works by swapping the volume of drying vine rootzone from side to side. Consideration of the rate of attenuation of the transient abscisic acid effect shows a 12-15 day cycle time works best. Experiments in with this technique showed

- € reduced stomatal conductance
- € reduced vegetative growth
- € a 39% reduction in water received over the season
- € open canopy and greater bunch exposure
- € harvest a week earlier at the same sugar concentration
- € no effect on yield or any component of yield
- € increased water use efficiency of 7.2t/MI vs control 4.9t/MI

It is possible to separate the biochemical responses of water stress from the physical effects of reduced water availability using PRD. "A reduction in canopy density from PRD appears to be a likely cause of the changes in fruit quality components" (e.g. increases in total anthocyanin) (Dry et al 2000). Soil type and regional rainfall obviously have a large effect on the applicability of this technology.

Tensions greater than 60kPa can be applied to reduce vegetative growth of grapevines. Berry size can be reduced by applying soil moisture stress conditions between 200 and 400 k Pa after set and before veraison. Small berries increase the skin to juice ratio. As many of the grape's fruit flavours and colours are just below the skin this increases the intensity of the wine and the concentration of wine quality components. An estimate of the amount of moisture between 60 and 600 kPa in the vine root volume is a useful indicator for consideration in assessment of soil quality for vines.

Root growth in vines occurs early and late in the season when fruit is not on the vines and soil moisture tensions are often high. Thus, generally, roots will fill the soil volume of a vineyard over time. In sandy or shallow soils some concentration

around the drip zones can occur. Compaction zones are likely to restrict root development. Feeder roots concentrate in upper or nutrient rich horizons.

Drip irrigation is the most common application method of application of water in Tasmanian vineyards. This treatment of irrigation practice is restricted to drip irrigation.

When to start irrigating

For Growth including root growth	at 60kPa
For Deficit	at 400kPa
For PRD	after 12-14 days

Irrigating during the season

For implementation of PRD twin drippers must be installed with emitters spaced to allow for independent irrigation of the different sides of the vine.

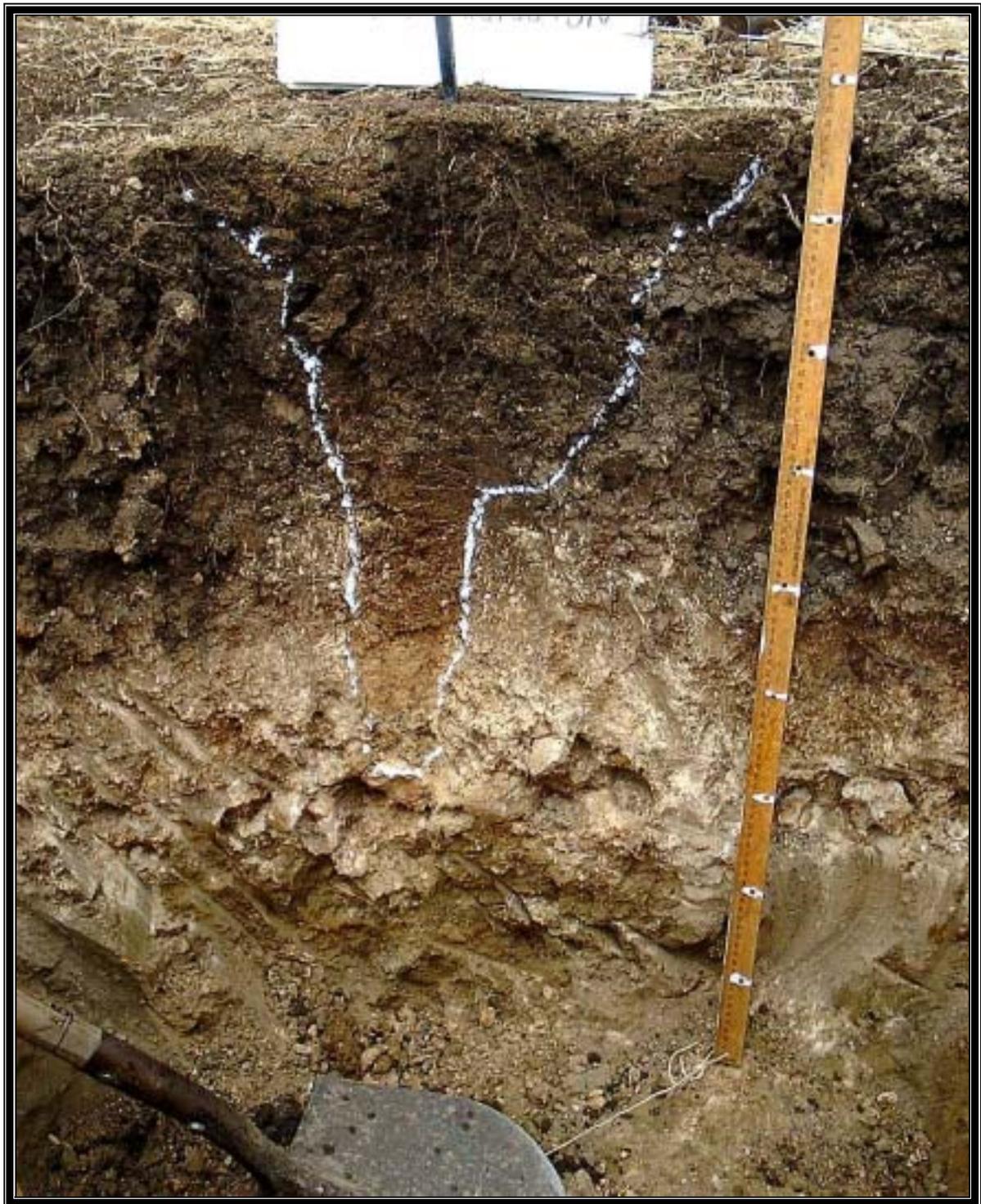
Continuous monitoring of plant appearance and soil moisture status will enable fine tuning of vineyard water applications. A wide range of soil moisture monitoring devices are used in vineyards with tensiometers often the cheapest method available. Gypsum blocks last longer in high pH soils are very cost effective and can be combined with a continuous logging device.

After veraison vines photosynthesis is necessary to accumulate sugars to ripen fruit. As water is the cost of photosynthesis good water status is important. Sudden increases in water availability can however induce berry splitting.

When to stop

Stop irrigating when the wetting front reaches the limit of the rootzone. To determine this volume drippers can be arranged in a row in the vineyard to drip different volumes. For example 3, 6, 9 and 12 litres for heavy clay soil. Then use a backhoe to dig a soil pit along this row. Inspect the soil profile and note the extent of the wetting front and the distribution of vine roots.

Dormant vines will not benefit from irrigation.



Profile of a Black Vertisol on Dolerite showing 6 litre dripper wetting pattern.