

Irrigation Management

This manual has been written for the Rubus industry with the aim of providing current irrigation practices for new growers to the industry, and support the improvement of 'best practice' irrigation techniques for existing growers.

Water management is critical in the production of crops especially under conditions when water supply may be limited or in the management of potential extreme events.

There are a range of tools that can be used to schedule irrigation and manage your crops water needs. These may be stand alone and can be used in isolation or may be used in combination to provide more effective management. Soil moisture monitoring is one such tool which can be used as stand alone or combined with evapotranspiration and crop growth stages. This manual will provide an example of a range of methods that can be used to schedule irrigation and increase productivity, quality and potentially better manage limited water supplies.

To determine how much water to apply, consider the following thought process....

Irrigation thought process

Do you know your soil type?

Step 1 Determine soil texture

What is your soils' infiltration rate?
(RAW mm/rainfall equivalent)

Step 2 Calculate Readily Available Water

How much water does your dripper irrigation
system deliver?

Step 3 Dripper Application Rate (mm/Hour)

How much water do you need to apply?

Step 4 Calculate required length of irrigation (Hours)

Do you know when to irrigate and how much?

Step 5 Determine your Irrigation Schedule



Know-how for Horticulture™



Department of
Primary Industries

This irrigation manual is intended for the purpose of providing information on ways to improve farm irrigation practices. It is by no means a full comprehensive manual and so it is suggested that growers also seek advice from profession irrigation service providers.

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Texture is an important soil property which influences water and nutrient availability to the plant.

Section 2

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Step 2: Calculate the Readily Available Water

The depth of the rootzone and the depth of each layer of soil are very important for determining the soil's capacity for holding moisture. Readily available water is the water that a plant can extract from the soil easily.

Section 3

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It is important to know how much water per hour your drip irrigation system is applying to your soils.

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Step 4: Calculate length of irrigation for your Raspberry plant beds

*Determine how long you need to irrigate you plants with your drip irrigation system
This is the key step to Water Use Efficiency!*

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Step 5: Determine when to irrigate and how much.

Scheduling is the process of determining how much water to put on and when. This enables you to keep Readily Available Water in your soil.

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Moisture monitoring is an important tool for any grower reliant on a water supply.

Types of Moisture monitoring equipment

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These examples give new growers an idea of irrigation requirements.

Example 1: Irrigation requirements for floricanes in the Yarra Valley

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Advanced approaches to irrigating:

Regulated Deficit Irrigation, Partial Root Zone Drying, Subsurface Drip Irrigation

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Section 1 Do you know your soil type?

Soil Texture

Soil is a fundamental resource on which your crop production depends. Soil contains nutrients and stores water which will be available to plants between rainfall or irrigation events. The amount of water a soil will store is determined by the particular soil characteristics, so it is important to understand your soil type.

Texture is an important soil property which influences water and nutrient availability to the plant. Changes in texture with depth is one of the main characteristics used to define topsoil versus subsoil.

The texture of a soil is determined by the relative amounts of sand, silt and clay that it contains. The texture of each layer will determine how much water it can make available to plants. [¹J. Vargas]

Using the ribboning technique:

- Carry out a ribbon test on a sample from each layer identified in your soil profile.
- Take a sample of soil sufficient to comfortably fit into the palm of the hand. The soil is moistened with water, a little at a time, and kneaded until the ball of soil just fails to stick to the fingers. More soil or water may be added to attain this condition which is known as the sticky point, and approximates **field capacity** for that soil, which is the greatest level of moisture the soil can hold.
- Kneading and moistening, if necessary, is continued until there is no apparent change in the soil ball, usually a working time of 1 to 2 minutes. Using the thumb and forefinger from one hand, squeeze out a ribbon of soil into the palm of the other hand.
- Measure the length of the ribbon from the tip until it breaks naturally, do this several times for confirmation and compare the average ribbon length with those of the Table 1.



Photo 1: Soil ball or bolus ready for manipulation

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Table 1 Determining soil texture using the ribboning technique

(S) SAND – Will not ribbon.	Coherence nil to very slight, cannot be moulded; single grains adhere to fingers; nil to slight turbidity when puddled.
(LS) LOAMY SAND – Will form ribbon to 5mm	Slight coherence; definite turbidity when puddled in palm of hand.
(CS) CLAYEY SAND – Will form ribbon 5 to 15mm	Slight coherence, sticky when wet; many sand grains stick to fingers, discolours fingers with clay stain.
(SL) SANDY LOAM – Will form ribbon of 15 to 20mm	Bolus just coherent and very sandy to touch; sand grains visible.
(LSCL) LIGHT SANDY CLAY LOAM – Will form ribbon of 20 to 25mm	Bolus moderately coherent but sandy to touch; sand grains easily visible.
(L) LOAM – Will form ribbon of about 25mm	Bolus coherent and spongy; smooth feel and no obvious sandiness; may be somewhat greasy as organic matter is usually present.
(SCL) SANDY CLAY LOAM – Will form ribbon 25 to 40mm	Bolus strongly coherent, sandy to touch; sand grains visible.
(CL) CLAY LOAM – Will form ribbon 40 to 50mm	Bolus strongly coherent and plastic; smooth to manipulate.
(SC & LC) SANDY CLAY and LIGHT CLAY – Will form ribbon 50 to 75mm	Plastic bolus, slight resistance to shearing. SC - can see, feel and hear sand grains. LC - smooth to touch.
(LMC) LIGHT MEDIUM CLAY – Will form ribbon 75 to 85mm	Plastic bolus smooth to touch; moderate resistance to shearing between thumb and forefinger.
(MC) MEDIUM CLAY – Will form ribbon 85 to 100mm	Smooth plastic bolus; handles like plasticine and can be moulded into rods; moderate resistance to ribboning.
(HC) HEAVY CLAY – Will easily form a ribbon over 100mm	Smooth plastic bolus; handles like stiff plasticine; can be moulded into rods without fracture; has firm resistance to ribboning shear

Step 1: What soil types do you have?

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Section 2 What is your soils' infiltration rate? Water Infiltration

Water infiltrates the soil and is held in the spaces between soil particles. These spaces are called 'soil pores'. Once the soil has taken up enough water to fill all the pores, the soil is said to be at 'field capacity'. There is no benefit in applying more water once the soil profile is at field capacity, as watering at this point will cause saturation of the soil resulting in runoff or subsoil drainage.

Roots remove water from the soil pores by creating suction. Water drains downwards in the soil due to gravity until a balance is reached with large soil pores holding the remaining water at field capacity. As plants remove water from soil pores, the remaining water is held more tightly in the smaller pores or adsorbed onto the soil particles. When the plant begins to have difficulty drawing up water, the '**refill point**' has been reached. Irrigation should occur at this point to avoid water stress. The '**permanent wilting point**' occurs when the remaining water is held so tightly by the soil particles that plants cannot remove it. [2 P. Wilk]

Between the refill point and the permanent wilting point, plants can experience increasing water stress. Stressed plants use their energy to extract soil moisture at the expense of growth and fruit production.

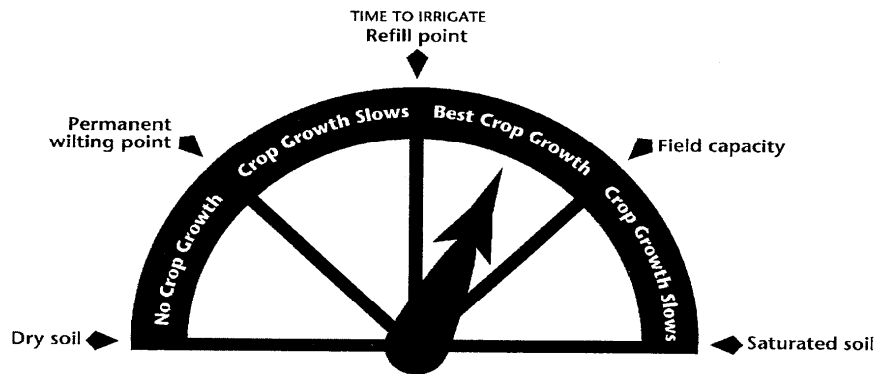


Figure 1 Total soil:water 'fuel gauge'

Water stored in the soil is easiest for the plants to access when it lies between the field capacity and the refill point. This is called '**readily available water**' (RAW) .

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Readily Available Water

Readily Available Water or RAW is soil moisture that is easy for plants to absorb - plants don't have to work hard to get it. We talk about RAW in a similar manner as rain fall. If you have a RAW of 35mm, this means that 35mm of rainfall is needed to completely refill your RAW.

A couple of days after a full irrigation or heavy rain fall, the amount of water the soil is "holding" is called Field Capacity.

As soil dries out, eventually, plants struggle to take up water, reaching Wilting Point. The plant can be revived by irrigating, but the crop has lost productivity. To maximise crop yield it is important to avoid reaching the point where there is water stress. To do this you need to find the level of dryness that does not reduce yield. This tipping point (known as refill point) can be different for different crop species, and cultivars.

You can determine 'readily available water' using soil moisture monitoring equipment such as tentimeters. RAW lies between the field capacity (0 kPa) and the refill point (40 kPa). This water is easy for the plants to access. [3 A. Buzza]

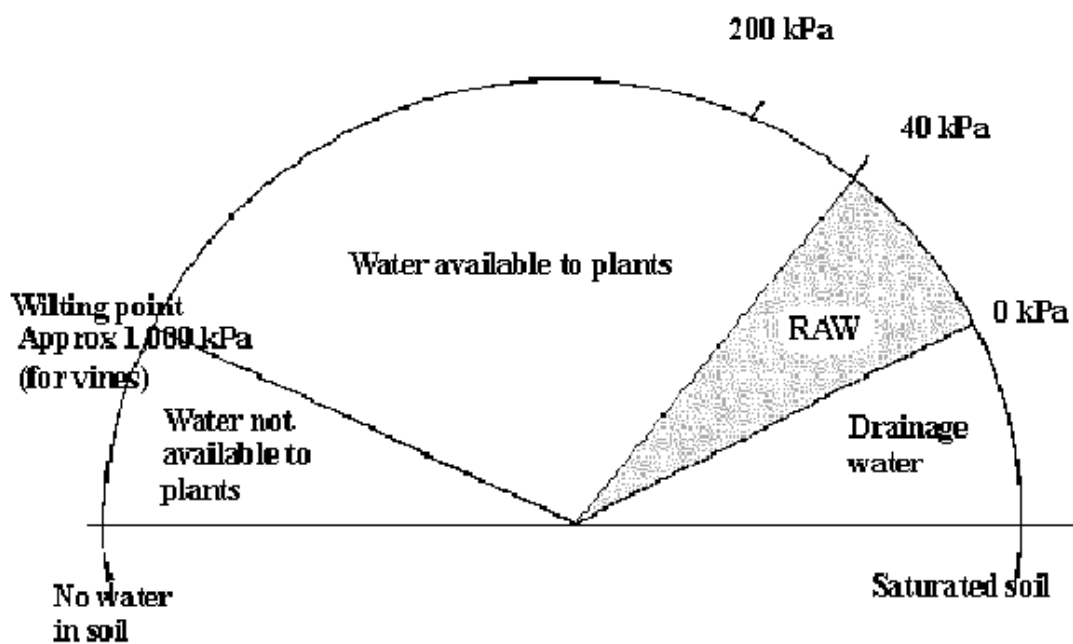


Figure 2 Total soil:water 'fuel gauge' with pressure values from a tensiometer (See page 19 for details on tensiometers). RAW is the amount of water between Field Capacity, and your tipping point (most often 40kPa).

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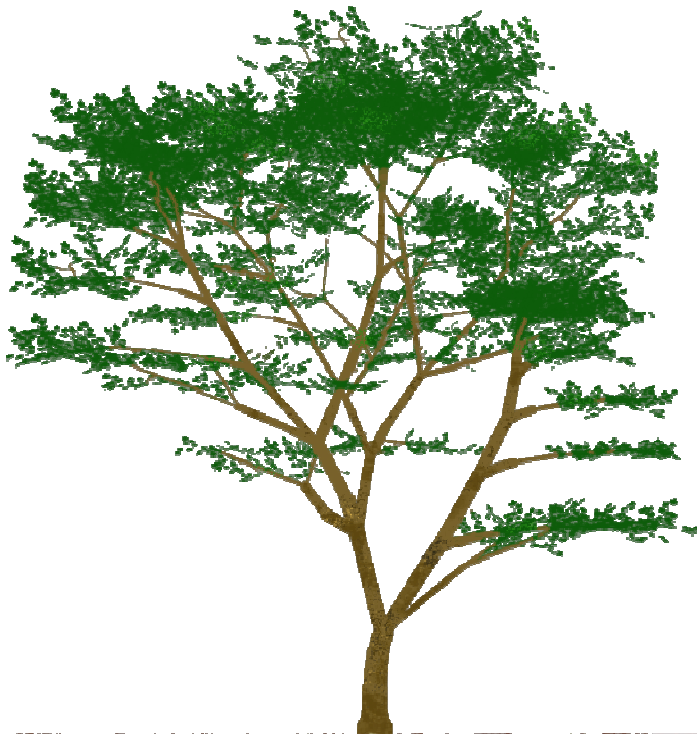
Calculate your Readily Available Water

To find your RAW, you first need to dig several holes to find out:

- The root depth
- The distinct soil layers

Why is this important?

- The deeper the roots the more water is available to the plant.
- Different soils give up different amounts of water.



Example RAW calculation:

As an example, let's assume that you dug some holes and found three distinct layers.



- } 1st Layer: **15cm**, soil texture is **Loam**
- } 2nd Layer: **35cm**, soil texture is **Sand**
- } 3rd Layer: **50cm**, soil texture is **Heavy Clay**
Roots end here. No need to measure deeper.

⁴Using Soil Texture Tables (See Table 2), we can look up the different types of soil, and find the total readily available water for this example. Note the water deficit is the depth of water in mm needed to bring a one centimetre depth of a soil at 40kpa dryness back to field capacity. [⁴ A. Buzza, J. Vargas]

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Soil Texture Table 2: The figures in this table represent the depth of water easily available to the plant for every centimetre depth of soil. For example, for sand there is 0.36mm depth of water available for every centimetre depth of sand in the soil profile.

Readily Available Waterholding Capacity (RAW) of Field Textures in mm/cm	
Texture Grade	Water mm/cm
Sand (S)	0.36
Loamy Sand (LS)	0.52
Clayey Sand (CS)	0.55
Sandy Loam (SL)	0.59
Light Sandy Clay Loam (LSCL)	0.65
Loam (L)	0.69
Sandy Clay Loam (SCL)	0.61
Clay Loam (CL)	0.53
Clays (SC, LC, LMC, MC)	0.46
Heavy Clay (HC)	0.25

Remember: The drier the soil, the more water that needs to be added to bring the soil back to field capacity.

TABLE 3 : RAW CALCULATION Results

A. Soil Layers	B. Depth (in cm)	C. Soil Texture	D. Water Deficit mm/cm (to - 40kPa)	E. Readily Available Water (B x D)
1	15 cm	Loam	0.69	10.35mm
2	35 cm	Sand	0.36	12.6mm
3	50 cm (roots ended)	Heavy Clay	0.25	12.5mm
Total	100 cm			35.45 mm

If you apply more than **35.45mm** (approx. 35mm) of water in the example above, then you are pushing water deeper than the plant can reach it, so it is lost to drainage and/or the water table. However when measuring soil moisture levels it is important to measure below the root zone so that you can assess that the irrigation has wetted to the desired depth.

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Explaining RAW CALCULATIONS from Table 3:

To calculate rootzone RAW, multiply the thickness of each layer (in centimetres) by the RAW of that layer (Table 2). Then add the values for each soil layer in the rootzone to get the total rootzone RAW. Using the following equation:

$$\begin{array}{rcl} \text{Readily Available} & \text{Deficit in mm/cm} & \text{Depth of soil} \\ \text{Water} & = \text{(loam)} & \text{X} \quad \text{(loam)} \end{array}$$

Calculating RAW per each layer from Table 3

Soil Layer 1. Measuring 1st layer thickness at 0 to 15cm = **15cm** depth
'Loam' soil water deficit = **0.69 mm/cm** (from Table 2)

We can call this layer RAW 1:
15cm x 0.69 mm/cm = **10.35 mm**

Soil Layer 2. Measuring 2nd layer thickness 15cm to 50cm = **35cm** depth
'Sandy' soil water deficit = **0.36 mm/cm**

We can call this layer RAW 2:
35 cm x 0.36 mm/cm = **12.6 mm**

Soil Layer 3. Measuring 3rd layer thickness 50-100 cm = **50 cm** depth
'Heavy Clay' soil water deficit = **0.25 mm/cm**

We can call this layer RAW 3:
50 cm x 0.25 mm/cm = **12.5mm**

$$\begin{array}{rcl} \text{Total RAW} & = & 10.35 + 12.6 + 12.5 \\ & = & \mathbf{35.35mm} \end{array}$$

Assuming that all the water in each of the 3 layers requires complete refilling then a total of 35.35mm of water will be required.

Note: Raspberry roots go to a depth of 20-30cm, consequently for raspberries this is the critical depth to measure to. By measuring below this it can be assessed whether or not the irrigation has reached the required depth. If for example water levels in the soil below 30cm for raspberries have not risen when soil moisture is being assessed then it is unlikely that the profile above has been completely refilled.

The next steps of the irrigation thought process are:

- to determine how much water to apply through your irrigation system

Step 3 Application Rate for Drip Irrigation Section 3,

Step 4 Calculating length of irrigation Section 4.

- to determine when to apply it,

Step 5 Irrigation Scheduling Section 5

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Step 2: What is your soil's RAW?

Insert your own soil's RAW values (Raspberries root depth is 20-30cm)

Soil Texture	Depth	Thickness of layer	mm/cm	Calculation	RAW
Example: Sand	0 to 30cm	30cm	0.36	30 x 0.36	10.8
Total soil profile RAW					

Insert your own soil's RAW values

Soil Texture	Depth	Thickness of layer	mm/cm	Calculation	RAW
Total soil profile RAW					

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Section 3

How much water does your Drip Irrigation system deliver?

Application Rate for Drip Irrigation

Do you know your dripper rate?

Before calculating the 'Application Rate', the amount of water you need to apply to your plants, you must know how much water comes out of the drip system.

Catch can approach:

This technique will

- determine your dripper rate
- tell you if you need to change the pressure to the drip line
- give you an idea of the variation in volume of water that comes from your drip irrigation system, especially important if you grow produce down a slope

Place a large can at the top and the bottom of a row and capture water from the dripper hole. Pick a dripper that is, at minimum, 5 metres from the mains line.

Place a twist tie around the pipe, just below the dripper. Have the ends of the twist tie directed into the can. The aim is to capture any water that travels along the dripper pipe.

Run the irrigation for an hour. Measure the water from the cans, and then calculate the average of the two cans.

Example:

Can 1= 3.9 L Can 2= 4.1L

$$\text{Dripper rate} = \frac{3.9 + 4.1}{2}$$

4 Litres per hour

This is your dripper rate.

How often do you calibrate your system?

Whether you are changing pipes or changing pumps it is good practice to check the drip rates using this technique.

Test your pressure.

- It is good practice to test the delivery pressure regularly.
- Install a 'Pump tank valve' at the outlet of your pump. A pressure gauge can be attached when you want to check the pressure for your line.
- Perform the 'catch can' test if you have adjusted your pressure.

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Calculating the Application Rate for a dripper system

It is important to know how much water per hour your drip irrigation system is putting out every time you apply an irrigation. For drip irrigators, the amount of water you are applying can be calculated using the bed width as follows:

$$\text{Application Rate (mm/hr)} = \frac{\text{Dripper Rate (l/hr)}}{\text{Dripper spacing (m)} \times \text{Width of bed (m)}}$$

For example:

$$\text{dripper rate} = 4 \text{ L/hr}$$

$$\text{dripper spacing} = 0.5 \text{ m}$$

$$\text{bed width} = 0.5 \text{ m}$$

$$\text{Application rate (mm/hr)} = \frac{4}{0.5 \times 0.5}$$

$$= 16 \text{ mm per hour}$$

Conversion Note:

$$1 \text{ Litre/hr per m}^2 = 1 \text{ mm /hr}$$

The reason is:

$$1 \text{ litre} = 1\text{mm} \times 1\text{m}^2$$

and therefore:

$$\frac{(1\text{mm} \times 1\text{m}^2)}{\text{m}^2 \cdot \text{hr}} = 1\text{mm/hr}$$

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Step 3: What is your application rate?

Dripper Rate ^{mm}

Dripper spacing ^m

Width of wetted zone ^m

$$\text{Application Rate (mm/hr)} = \frac{\text{Dripper Rate (l/hr)}}{\text{Dripper spacing (m)} \times \text{Width of wetted zone (m)}}$$

Application rate ^{mm}

Things to consider with drip systems:

- Drip systems should be flushed regularly to ensure that sediment or algae does not build up and block drippers. This should be done at least three times during the season. In some areas, where water is of very poor quality, flushing may need to be more frequent.
- Fertigation/fertiliser injection can be an effective way of applying fertiliser. As it is being applied directly to the rootzone alone, little fertiliser is wasted and can be applied more regularly compared to broadcasting fertiliser. This is especially beneficial to young trees, vines and fast growing crops like vegetables, which require small amounts of fertiliser regularly.

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Section 4 How much water do you need to apply?

Calculating length of irrigation

Example:

Using the RAW (**Readily Available Water**) value of **35.45** mm (as calculated in the Readily Available Water Section page 9) and the application rate of 16mm/hr (from page 13), we can find the hours of irrigation:

$$\text{Hours of irrigation} = \frac{\text{RAW}}{\text{Application Rate}}$$

$$\begin{aligned} \text{Hours of irrigation} &= \frac{35.45 \text{ mm}}{16 \text{ mm/hour}} \\ &= \text{approx } 2 \frac{1}{4} \text{ hours} \end{aligned}$$

In this example, 2 1/4 hours of irrigation are needed to replenish the soil water content for that soil profile to its field capacity. The total depth of the soil profile is 100cm and therefore requires a long irrigation to fill that profile. Remember that this assumes that the total soil profile is dry. [⁵ A. Buzza, J. Vargas]

Step 4 How many hours do you need to irrigate?

RAW **—**

Application Rate **—**

HOURS of irrigation **—**

Note: Soil moisture monitoring helps us determine when we should irrigate. and how much water we should apply (scheduling).

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Example: Raspberry Irrigation Calculation

A 4 hectare block of raspberries, with a crop rootzone depth of 30cm, growing on medium clay, is under drip irrigation with an emitter spacing of 50cm, a dripper rate of 3.8 L/hr, on 50cm wide beds (wetting zone).

Use Steps 1 to 4 to determine the length of time you need to irrigate to fill soils with water to 'full capacity'.

1. Determine Soil Texture: Medium Clay

2. Calculate Readily Available Water (RAW):

Medium Clay (MC) – Water Deficit (Table 2 page 9): 0.46mm/cm

Root zone depth: 30cm (Approximate Raspberry Root Depth)

$$\text{Readily Available Water} = \text{Soil Deficit in mm/cm} \times \text{Depth of soil}$$

$$\begin{aligned} \text{RAW} &= 0.46\text{mm/cm} \times 30\text{cm} \\ &= 13.8 \text{ mm} \end{aligned}$$

3. Dripper Application Rate

Dripper Rate = 3.8 L/hr

Dripper spacing = 50cm (0.5m)

Bed Width = 0.5m

$$\text{Application Rate (mm/hr)} = \frac{\text{Dripper Rate (L/hr)}}{\text{Dripper spacing (m)} \times \text{Bed Width (m)}}$$

$$\begin{aligned} \text{Application rate} &= \frac{3.8\text{L/hr}}{0.5\text{m} \times 0.5\text{m}} \\ &= 15.2 \text{ mm/hr} \end{aligned}$$

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4. Calculate required length of Irrigation (Hours)

Raw = 13.8mm

Application Rate = 15.2mm / Hr

$$\text{Hours of irrigation} = \frac{\text{RAW}}{\text{Application Rate}}$$

$$\begin{aligned} \text{Irrigation time} &= \frac{13.8 \text{ mm}}{15.2 \text{ mm/hr}} \\ &= 0.91 \text{ hr} \end{aligned}$$

Irrigation time is approximately **1 hour**

However we need to ensure that the soil profile is full to 30cm so we would need to irrigate to the point that soil dryness below 30cm is reduced without leaching nutrients. We can do this by monitoring soil moisture levels and consequently we need to monitor soil moisture levels in the top 30cm and below that as well.

Key Questions?

- How do you take rainfall into consideration before you irrigate?
- What if your soils already have water still available from the last irrigation?
- How do you stop your plants from suffering from water stress?

Step 5: See Section 5 “IRRIGATION SCHEDULING” for answers!

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Section 5 Do you know when to irrigate & how much? Determine your Irrigation Scheduling

⁶Why is **Scheduling** important?

Scheduling is the process of determining how much water to put on your soils and when you need to apply this water to support a crop and maximise its productive potential.

Irrigation can be scheduled using a range of methods either alone or in combination. Scheduling takes into account

- soil readily available water holding capacity (RAW),
- application rate,
- current soil water content, and
- rate of crop water use.

Crop Water Requirement is explained below:

$$\text{Hours of operation} = \frac{\text{crop water requirement (mm)}}{\text{application rate (mm/hr)}}$$

Scheduling systems

There are a number of methods irrigators use to know when to irrigate and what and amount to apply. Each system has strengths and weaknesses, so it is recommended to use more than one system. The most accurate methods are using soil based measures of actual soil moisture levels or weather based assessments of water use and loss which can be used as stand alone or together. The use of visual symptoms is not reliable or accurate and if the plant is showing signs of water stress it has usually been under stress for some time. [⁶ A. Buzza, J. Vargas]

a) Plant based	1. Crop growth stage 2. Plant symptoms
b) Soil based	Shovel, feel the soil Soil moisture monitoring
c) Weather based	Weather station data and/or Evaporation pan

a) Plants require a different amount of water at different stages of growth. See the irrigation example in Sections 7 and 8: Irrigating Primocanes and Floricanes.

b) Soil moisture monitoring is a tool to manage what is happening in the soil at that point in time. See the section 5.1 on soil moisture monitoring.

c) **The water use of crops is closely related to evaporation.** Weather based methods can use weather data to estimate crop water use, either using **Pan Evaporation** or **Evapotranspiration (ET_o)** calculated from a weather station.

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Section 5.1 Are you over-watering or under-watering?

Soil Moisture Monitoring

For Soil based irrigation scheduling

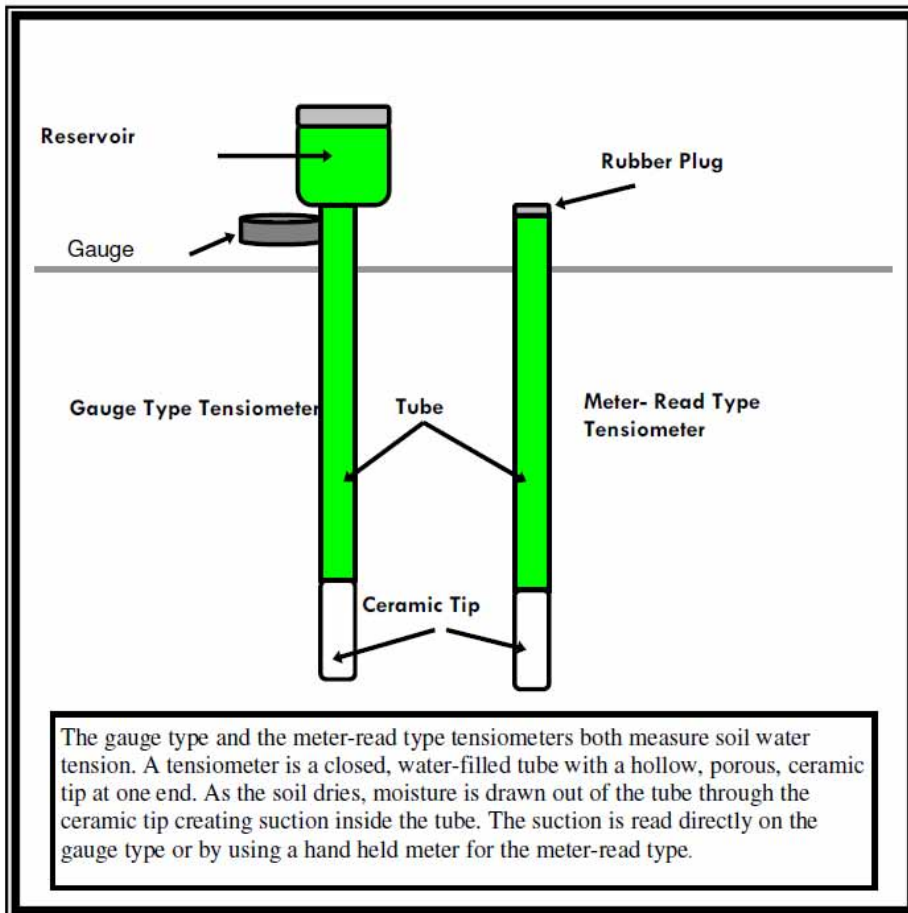
⁷Moisture monitoring is an important tool for any grower reliant on a water supply. Irrigation Scheduling requires a combination of growers knowledge, such as signs of water stress on plants, weather based data and moisture monitoring. This approach is considered 'best practice' for 'Water Use Efficiency'.

The advantages of using moisture monitoring tools is that they can give you a quick indication of the status of the soil, reducing the risk of stressing the plants to the point that production is reduced. A dry soil can become hydrophilic, i.e. it is less accepting of water than a damp soil. This means that water may run off before it can be absorbed, wasting more water than is normally required to get it to level that the plant can readily uptake the water.

The most common types of soil-based monitoring equipment used are soil probes, gypsum blocks, tensiometers and soil capacitance probes. [⁷J. Vargas]

Diagram 1

Tensiometers (for example SoilSpec[®], Irrrometer[®])



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Advantages

- Simple operation
- No calibration needed
- Easily read
- Soil suction directly measured
- Indicate effectiveness of leaching irrigations in light-textured soils.

Disadvantages

- Small suction range (0 to 70 kPa)
- In drier soil suction range not sufficient
- Regular maintenance is essential
- Best in sand-loam soils
- Amount of water in soil not measured
- Frost prone
- Obstruction for farm machinery

Using Tensiometers

Tensiometers are used to provide an easily interpreted guide to soil moisture levels. A tensiometer is a closed tube filled with water, a ceramic tip at one end and a vacuum gauge at the other. As the soil dries out water is drawn out through the ceramic tip and creates a vacuum in the tube. When an irrigation or rainfall occurs and this water reaches the tensiometer tip, water is drawn back into the tube decreasing the vacuum. A high vacuum reading on the gauge indicates that the soil is dry and a low reading shows that the soil is moist. With regular maintenance they will provide years of reliable service.

Common tensiometer sizes are 30, 60 and 90 cms, other sizes are also available. Tensiometers should be installed in the rootzone. Covering tensiometers helps to prevent frost and physical damage and reduces algal growth in them. An upturned bryce bucket is a suitable cover.

Resistance Blocks (Gypsum Blocks)

Gypsum blocks measure soil water tension. This tension reflects the forces a plant must overcome to extract water from the soil. Two electrodes are embedded in a block of gypsum and connected by wires to a meter. These blocks are placed in the soil at various depths. Electrical Resistance is measured between the electrodes in the gypsum block. This resistance varies depending on the amount of water in the gypsum block. See diagram 2.

Gypsum block

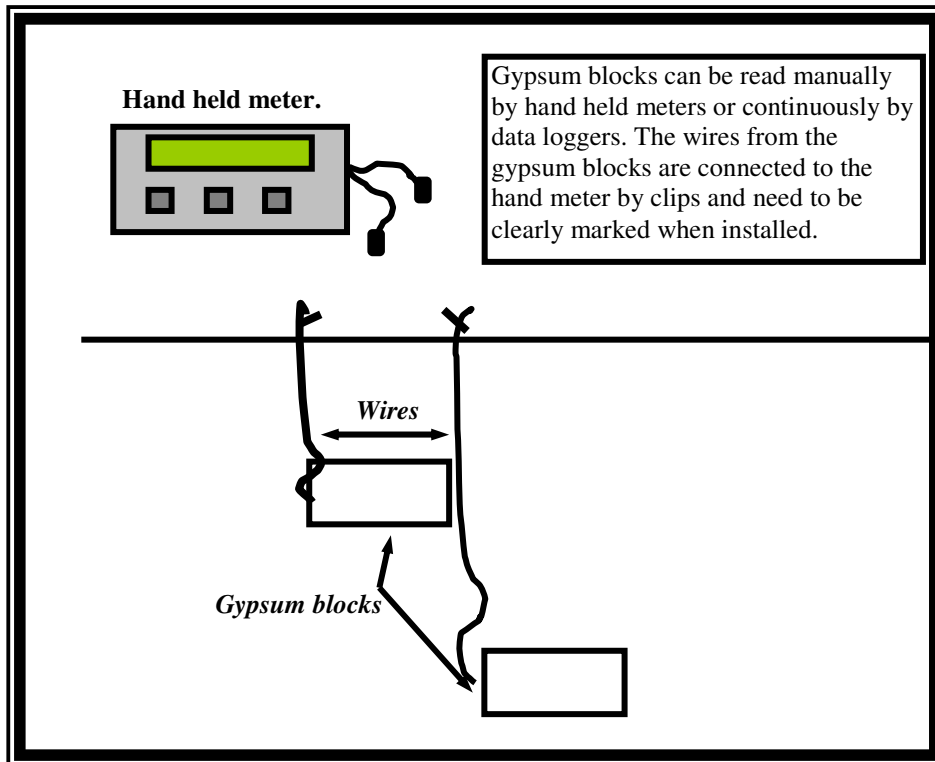
The GBug is a mini data logger in which four gypsum blocks, in any combination of GBHeavy and GBLite, may be attached. The GBug logs the sensor readings every two hours and can store up to 20 days worth of readings. The data stored in the G Bugs is then collected using the MEARetriever, which talks to the GBug using a wireless connection. The MEARetriever will hold data from up to 100 G Bugs. Readings can be retrieved on the MEARetriever or downloaded into supplied software for analysis.

Installation: Use the GBLite in sandy soils and the GBHeavy in loam or clay soils.

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Diagram 2

Resistance Blocks (for example GBLite/Heavy[®], Watermark[®])



Advantages

- Quick and easy to read
- Minimal maintenance
- Effective up to wilting point (depending on soil type)
- Can be placed in drier top part of the soil
- Can be automated and used with/without a computer

Disadvantages

- Some types tend to be inaccurate at the “wet end”
- Calibrations varies slightly between blocks
- Life-span of 1-8 years, depending on soil pH, the amount of rainfall & irrigation and type of gypsum block. As they dissolve their calibration properties change
- In sandy soils, blocks can dry out rapidly
- Contact with soil critical
- Affected by temperature and salinity

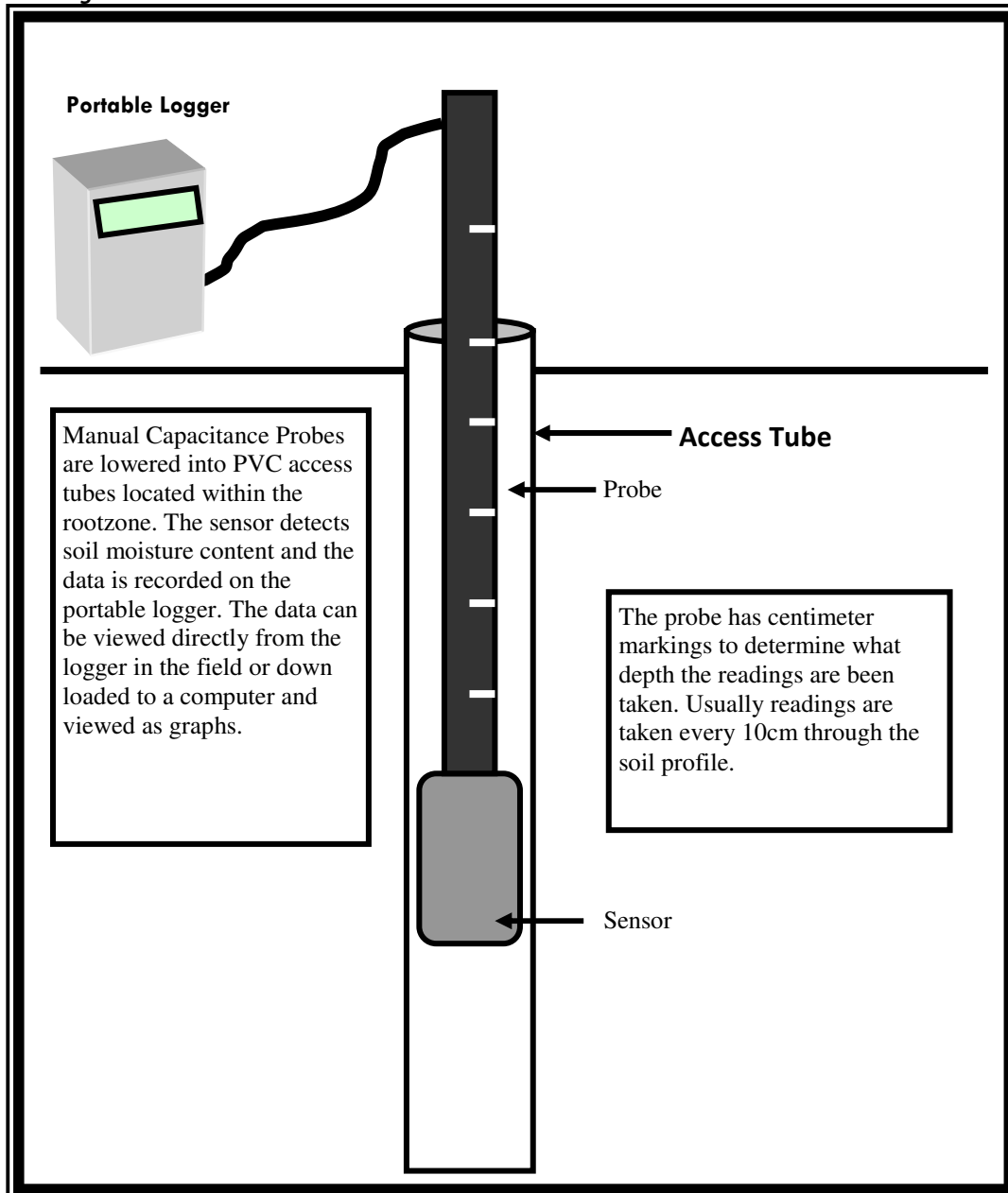
Capacitance Sensors

Capacitance sensors use an oscillator to generate an AC field which is applied to the soil. The sensor detects changes in this field because of changes that occur in the soil water content. One approach measures changes in the operating frequency of this field which varies depending on the amount of water in the soil. Another approach measures that amplitude of the frequency which is a measure of the soils electrical conductivity. Examples of manual and continuous logging capacitance sensors are shown in diagrams 3 and 4 consecutively.

Irrigation Management

Capacitance Sensors (Manual Logging) (for example Gopher[®], Diviner 2000[®])

Diagram 3



Advantages

- Accurate .
- Automatic readings.
- Suitable for a wide range of soil types.
- Can be read manually with or without a computer.
- Multiple sites with one probe.

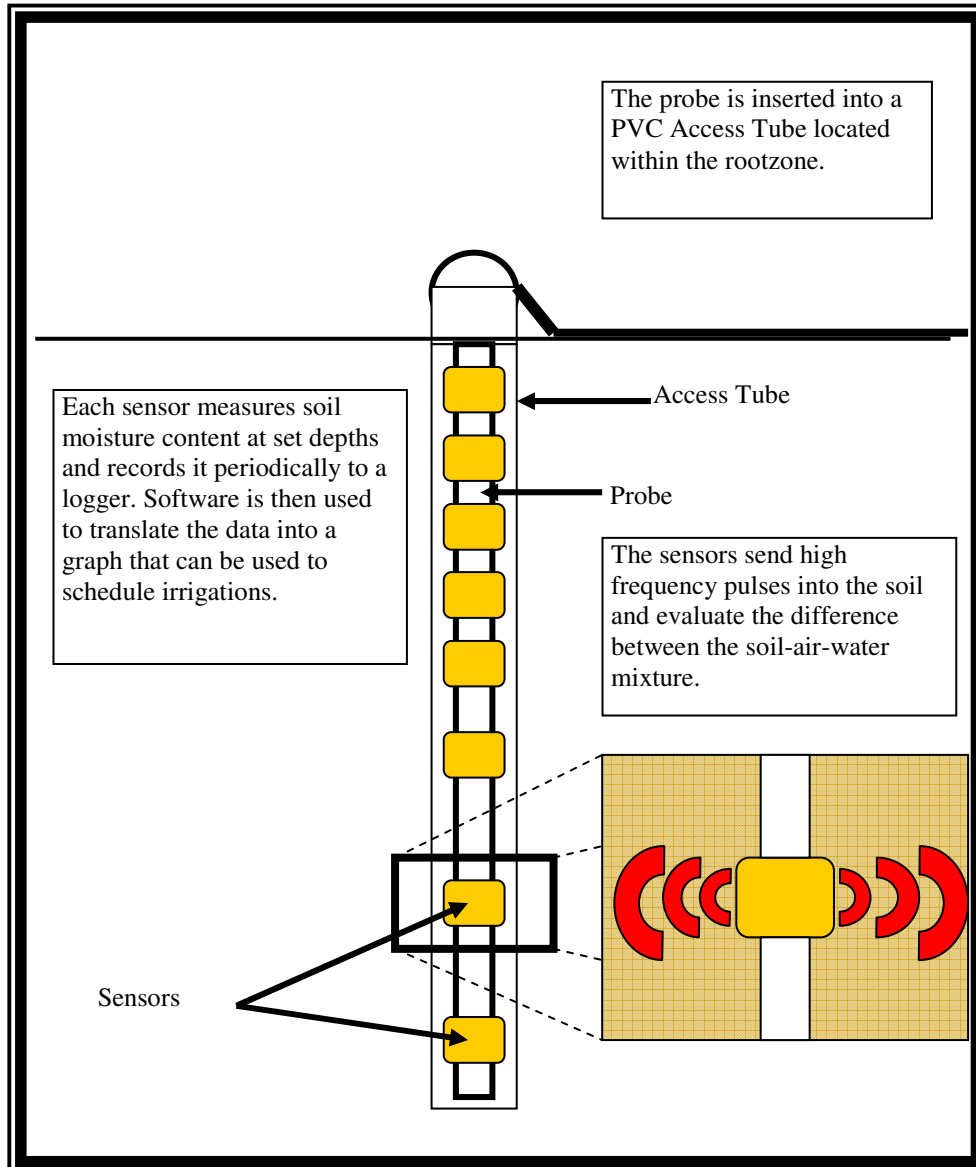
Disadvantages

- On some soil types calibration needed.
- May be affected by temperature.

Irrigation Management

Capacitance Sensors (Continuous Logging) (for example EnviroSCAN[®], C-Probe[®])

Diagram 4



Advantages

- Accurate
- Automatic readings
- Suitable for a wide range of soil types.
- Can give continuous data

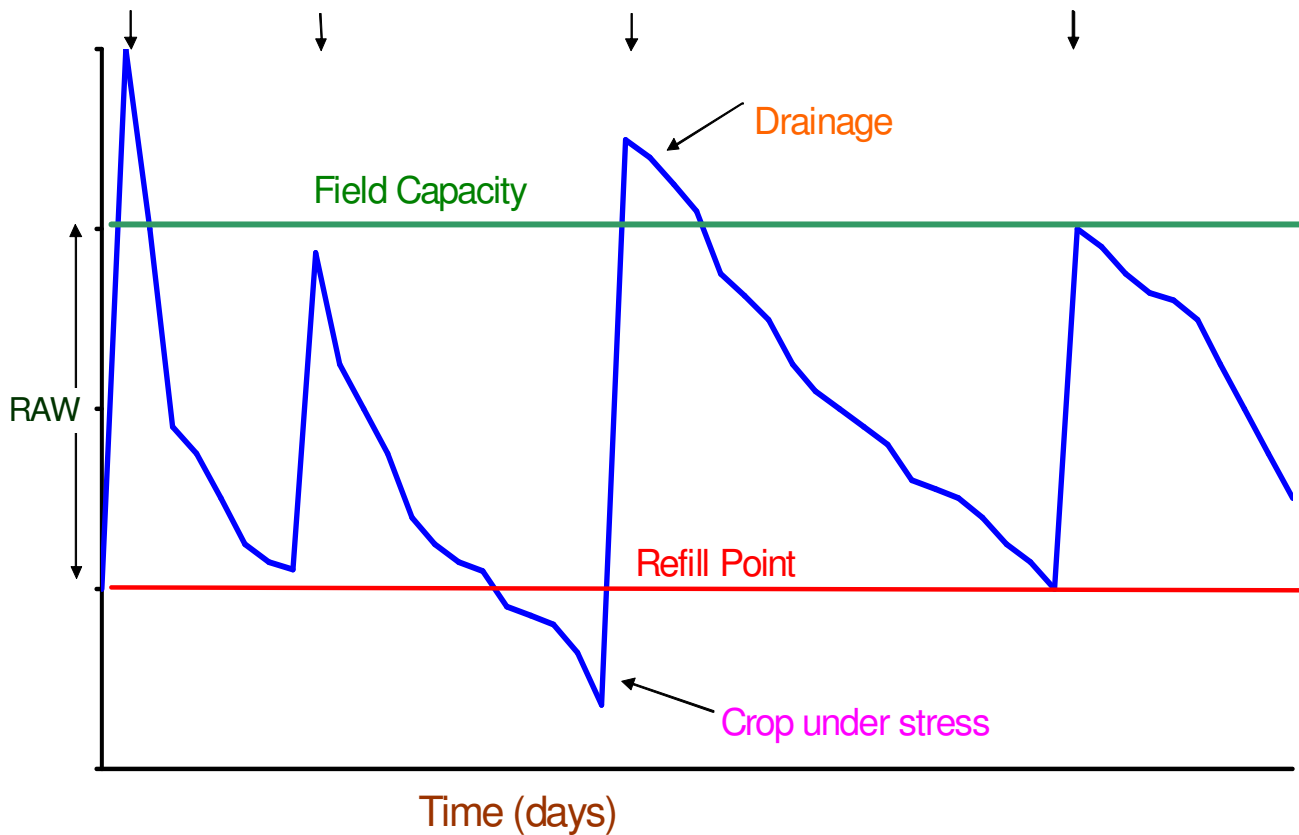
Disadvantages

- Calibration on some soil types needed
- In situ probes
- Computer access needed for EnviroSCAN[®]

Irrigation Management

Soil water monitoring graph

Diagram 5



The soil water monitoring graph provides an example of output from continuous soil monitoring using a data logger. The aim is to keep soil moisture between refill and full points. In the above graph irrigations 1 and 3 produced drainage, irrigation 2 was too light and irrigation 4 about right. Additionally irrigation 3 was too late as crop stress occurred.

For more information on moisture monitoring sensors see 'Soil Water Monitoring' an information package on the ARGA website www.arga.com.au.

What sort of soil moisture monitoring equipment will you use?

Irrigation Management

Section 5.2 Weather based irrigation scheduling

Example of irrigation scheduling using two weather based methods:

Soil types, crop types and water requirements vary between properties, so it is not possible to provide irrigation programs that will suit every situation. However, with careful monitoring of the soil, crop and weather conditions, growers can develop good scheduling programs for their properties.

Evapotranspiration (ET) is the process of water moving to the atmosphere through plant use (transpiration) and evaporation from the earth's surface.

ET can be used by growers to determine how much water is lost in a paddock through crop growth and evaporation and therefore needs to be replaced through irrigation. Et is available from weather stations as a calculated value if there is one nearby.

The term Crop Evapotranspiration (ET_c) is the daily withdrawal figure from the soil water balance in the effective root zone. It is estimated from weather and crop information.

Example 1 determining irrigation scheduling using *Evapotranspiration (ET_o)* data

In this example *Evapotranspiration (ET_o)* will be used to estimate crop water use. Daily Evapotranspiration data is required along with the appropriate crop coefficients.

A raspberry crop is under drip irrigation at peak water use development/growing stage, with an **application rate of 3.6 mm/hr**, in the middle of January. A single **crop coefficient (ET_c)** for raspberry at mid season stage is **1.2**. (See table 5)

Calculate the hours of operation required for the system to supply water requirements for the crop.

a) Collect ET_o figures for the days since the last irrigation and add them up (assuming the last irrigation was done 4 days ago). The total ET_o values of the last 3 days were:

$$2.5 + 3.1 + 6.0 = \mathbf{11.6 \text{ mm}} \quad \mathbf{\text{Total } ET_o \text{ (mm)}}$$

b) Multiply ET_o by the appropriate crop coefficient, ET_c , to calculate water requirement.

$$ET_c = \mathbf{1.2}$$

Irrigation Management

Crop water requirement is:

$$\text{Crop water requirement (mm)} = \text{Total } ET_o \text{ (mm)} \times ET_c$$

$$11.6\text{mm} \times 1.2 = \mathbf{13.92 \text{ mm}}$$

- c) The system application rate is **16 mm/hr**
- d) Therefore the hours of operation **required** to supply estimated crop water requirements are:

$$\text{Hours of operation} = \frac{\text{crop water requirement (mm)}}{\text{application rate (mm/hr)}}$$

$$= \frac{\mathbf{13.92 \text{ mm}}}{\mathbf{16 \text{ mm/hr}}}$$

$$\text{Hours of Operation} = \mathbf{0.87 \text{ hrs.}}$$

Approx. 1 hour is the amount of time that the drip irrigation system needs to be operating to supply crop water needs at that particular time of year.

Where do Evapotranspiration (ET_c) figures come from:

The formula for estimating ET_c is:

$$ET_c = K_c \times ET_o$$

Where:

K_c = the crop coefficient which expresses the difference in Evapotranspiration between the cropped and reference grass surface.

ET_o = a grass reference crop Evapotranspiration (mm per day).

ET_o is calculated using radiation, air temperature, air humidity and wind speed data. A number of automatic weather stations with sensors for these measurements calculate ET_o using this method.

Crop Stage of Development

Table 5 taken from 'Water Conservation FACTSHEET' British Columbia, Ministry of Agriculture, Food and Fisheries

Stage	Indicators	Crop Coefficient
Initial	Planting date (or the start of new leaves for perennials) to 10% ground cover.	$K_{c_{mi}}$
Crop development	10% ground cover to effective full cover, about 60-70% coverage for tree crops and 70-80% for field and row crops.	$K_{c_{mi}} - K_{c_{mid}}$
Mid season	Effective full cover to maturity, indicated by yellowing of leave, leaf drop, browning of fruit. This stage is long for perennials but relatively short for vegetables crops that are harvested for their fresh fruit.	$K_{c_{mid}}$
Late Season	Maturity to harvest: the K_c value could be high if the crop is irrigated frequently until fresh harvest or low if the crop is allowed to dry out in the field before harvest.	$K_{c_{mid}} - K_{c_{end}}$

Table 5 explains when each Crop Coefficient (K_c) should be used during the growing season.

Irrigation Management

Crop Coefficient (Kc) Figures for Raspberries:

$K_{C_{ini}} = 0.4$ (Figure used at the start of the season)

$K_{C_{mid}} = 1.2$ (Figure used during peak harvest)

$K_{C_{end}} = 0.75$ (Figure used at the end of the season)

Crop Coefficients for Forage, Vegetables and Berries

Table 6 taken from 'Water Conservation FACTSHEET' British Columbia, Ministry of Agriculture, Food and Fisheries

Crop	$K_{C_{ini}}$	$K_{C_{mid}}$	$K_{C_{end}}$
alfalfa	0.4	1.2	1.15
asparagus	0.3	0.95	0.3
beans, green	0.5	1.05	0.9
beets	0.5	1.05	0.95
blueberries	0.4	1.0	0.75
broccoli	0.7	1.05	0.95
cabbage	0.7	1.05	0.95
cabbage -local	0.7	1.05	0.95
carrots	0.7	1.05	0.95
cauliflower	0.7	1.05	0.95
cranberries	0.4	0.9	0.50
celery	0.7	1.05	0.95
cereal	0.3	1.15	0.25
corn	0.3	1.15	0.4
cucumber	0.6	1	0.75
green onions	0.7	1.05	0.95
lettuce	0.7	1	0.95

Crop	$K_{C_{ini}}$	$K_{C_{mid}}$	$K_{C_{end}}$
onions	0.7	1.05	0.95
pasture (grass)	0.4	1.0	0.85
peas	0.5	1.15	1.1
potato	0.5	1.15	0.75
pumpkin	0.5	1	0.8
radish	0.7	0.9	0.85
raspberries	0.4	1.2	0.75
small vegetables	0.70	1.05	0.95
spinach	0.7	1.05	0.95
strawberries	0.4	1.05	0.7
squash	0.5	0.95	0.75
sweet corn	0.3	1.15	0.4
sweet peppers	0.7	1.05	0.85
tomato	0.7	1.05	0.8
tubers	0.5	1.05	0.95
watermelon	0.4	1	0.75

Photo 2: Weather station providing E_{t_0}



Note: The Bureau of Meteorology now provides E_{t_0} data from weather stations throughout Australia

See their website: www.bom.gov.au

Irrigation Management

Example 2 determine irrigation scheduling using Pan Evaporation data

In this example **Pan Evaporation data** will be used to estimate crop water use.

Pan evaporation is the most commonly used and simplest method for calculating the crops' water use. Daily Pan evaporation data is taken from a 'Class A pan'. However these require daily checking and maintenance and one will be required in reasonable proximity to the crop.

The evaporation from a pan is generally higher than the transpiration loss from a plant. Therefore a 'Crop factor' is used in the calculation to adjust for the crops' water requirements.

$$\text{Crop water requirements (mm)} = \text{Crop Factor} \times \text{Pan Evaporation (E}_{\text{pan}})$$

For example, if pan evaporation is 8 mm/day and the raspberry peak growing season is December. At this mid season stage the crop factor might be 0.36 (taken from calculations on page 31).

$$\begin{aligned} \text{The plant water requirements would be} \\ &= 8 \text{ mm} \times 0.36 \\ &= 2.9 \text{ mm} \end{aligned}$$

Example Calculation

A raspberry crop is under drip irrigation at peak water use development/growing stage, with an **application rate of 3.6 mm/hr**, in the middle of January. A single **crop factor** for raspberry berry at mid season stage is **0.36** (Crop factor determined by calculations on farm is **0.36**. See 'Determining Crop Factors' on page 31).

Calculate the hours of operation required for that system to supply water requirements for that crop.

a) Collect E_{pan} figures for the days since the last irrigation and add them up (assuming the last irrigation was done 4 days ago). The total ET_0 values of the last 3 days were:

$$6.7 + 8.1 + 9.0 = \mathbf{23.8 \text{ mm}} \quad \text{Total } E_{\text{pan}} \text{ (mm)}$$

Note: E_{pan} figures need to be adjusted by multiplying this figure by **0.8**. The reason for this is that water evaporation is higher than plant evapotranspiration.

$$23.8 \times 0.8 = \mathbf{19.04 \text{ mm}} \quad \text{Total } E_{\text{pan}} \text{ (mm)}_{\text{Adjusted}}$$

b) Multiply E_{pan} by the appropriate Crop Factor, E_{pan} , to calculate water requirement

$$\text{Crop Factor } C_f = \mathbf{0.36}$$

Irrigation Management

Crop water requirement is:

$$\text{Crop water requirement (mm)} = \text{Total } E_{\text{pan}} \text{ (mm)} \times \text{Cf}$$

$$19.04 \text{ mm} \times 0.36 = \mathbf{6.9 \text{ mm}}$$

- c) The system application rate is **16 mm/hr**
- d) Therefore the hours of operation **required** to supply estimated crop water requirements are:

$$\text{Hours of operation} = \frac{\text{crop water requirement (mm)}}{\text{application rate (mm/hr)}}$$

$$= \frac{\mathbf{6.9 \text{ mm}}}{\mathbf{16 \text{ mm/hr}}}$$

$$= \mathbf{0.43 \text{ hrs approx.}} \text{ (or 26 minutes)}$$

Approximately 1/2 hour is the amount of time that the drip irrigation system needs to be operating to supply crop water needs at that particular time of year.

*Where do you get your evaporation data?

Class A Pan Evaporation data

If you have a 'Bureau of Meteorology' weather station in your area, check the website www.bom.gov.au for information provided by that station. Look up 'daily weather observations' and locate a weather station near you.

The weather station at Coffs Harbour provides Evaporation data that can be used to determine plant water needs.

Figure 2 'Evap' (mm): "Class A" pan evaporation in the 24 hours to 9am

Evaporation data is shown in the fifth column under the heading 'Evap'. Measurements are given in millimetres (mm).

Coffs Harbour, New South Wales March 2010 Daily Weather Observations

Date	Day	Temps		Rain	Evap	Sun	Max wind gust			9 am				3 pm							
		Min	Max				Dir	Spd	Time	Temp	RH	Cld	Dir	Spd	MSLP	Temp	RH	Cld	Dir	Spd	MSL
		°C	°C	mm	mm	hours	km/h	local	°C	%	g th	km/h	hPa	°C	%	g th	km/h	hPa			
1	Mo	21.4	24.5	0	4.0	1.0	SSE	54	22:45	23.2	79	8	WSW	17	1014.2	21.9	92	8	SSW	30	1013
2	Tu	18.0		59.0	8.6					18.8	70	8	SW	28	1014.6						
Statistics for the first 2 days of March 2010																					
Mean		19.7	24.5		6.3	1.0				21.0	74	8		22	1014.4	21.9	92	8		30	1013
Lowest		18.0	24.5	0	4.0	1.0				18.8	70	8	WSW	17	1014.2	21.9	92	8	SSW	30	1013
Highest		21.4	24.5	59.0	8.6	1.0	SSE	54		23.2	79	8	SW	28	1014.6	21.9	92	8	SSW	30	1013
Total				59.0	12.6	1.0															

IDCJDW2030.201003 Prepared at 23:36 GMT on Monday 1 March 2010

Source: Bureau of Meteorology website www.bom.gov.au

Irrigation Management

Class A Pan: evaporation data

If you don't have a 'Bureau of Meteorology' weather station near you, the other option is to build or buy a 'Class A Pan'. See 'Construction of an evaporation pan for irrigation scheduling' (Ag0293) from the Victorian Department of Primary Industry website www.dpi.vic.gov.au.

Class A Pans:

- Measurements must be taken every day and the pan refilled.
- Rainfall data must be collected as well.

Photo 3: Class A Pan – measures evaporation



Important Note:

Pan evaporation and Evapotranspiration methods are both valid approaches to scheduling. Choose one approach and use it consistently.

Do not get these mixed up. Confusing 'crop factor' and 'crop coefficient' in your calculations will differ your irrigation requirements as much as 30%.

'Crop factors' – number used with Pan Evaporation calculations. 'Cf'

'Crop coefficients' – number used with Evapotranspiration calculations. 'Kc'

Irrigation Management

Determining Your Crop Factors (Cf) for Pan Evaporation Irrigation Scheduling:

In order to do this you will need to determine the effective shade area of the crop.

Step 1 Guide for determining Effective Shade Area (EAS)

Direct sunlight striking a canopy is difficult to measure. Effective area of shade (EAS) is based on the percentage of area shaded across the orchard row. This represents the direct sunlight striking a canopy. [8 H. Adem]

Photo 3: Measuring Effective Area of Shade



A monthly average effective area of shade (EAS) is determined by taking a number of measurements on a clear day during that month.

AEST 9am 12:30, 4pm. During summer (Daylight savings) 10am, 1:30pm, 5pm.

Example:

The row width is 2.75m (standard width).

The shaded area across the row at 9am is 1.4m

Therefore at	9am	50% Shade
	Midday	10% Shade
	4pm	30% Shade

Calculate the average %shade for the day.

$$\begin{aligned} \text{Average (EAS)} &= \frac{50\% + 10\% + 30\%}{3} \\ &= 30\% \end{aligned}$$

This figure can be used for the month. Daylights saving will require the measurements to be taken at an hour later i.e. 10am, 1:30pm, 5pm

Step 2 Determining Your Crop Factors (Cf)

$$\begin{aligned} \text{Crop factor (Cf)} &= \frac{1.2^{\#} \times (\text{EAS}) \text{ Shade}\%}{100} \\ &= \frac{1.2 \times 30}{100} \\ \text{Cf} &= 0.36 \end{aligned}$$

(#1.2 is a crop coefficient (refer to Kc mid - table 6) for berries used to calculate the crop factor using effective area shade)

*The Class A Pan Water Budget Model is an excel spread sheet that will calculate crop factors for you based on Effective Area of Shade. See Section 6.

Irrigation Management

Section 6

Water Budgeting Tool

Action: Watch the DVD and install the Excel spreadsheet.

The Excel spreadsheets are located in the irrigation section of the IFP manual.

They will help you to:

- Monitor crop water use on a daily basis.
- Download weather data from the Bureau of Meteorology website.
- Compare different watering run times and see figures calculated automatically.
- Graph actual against the theoretical water use.

Two spreadsheet versions are available – For ‘Pan evaporation’ Data (Class A Pan Water Budget Model.xls); For ‘Evapotranspiration’ Data (ETO Water Budget Model.xls). [9 H. Adem]

Example spreadsheet ‘Irrigation Scheduling Plan’. Source: Harold Adem – DPI Vic.

Irrigation Scheduling Plan									
Tatura - micro									
Location	Knoxfield			Plant Spacing (m)					1
Block				Row Spacing (m)					3.5
Variety	Raspberries			Emitter Output (litre/hour)					2
Clone				Emitter Spacing (m)					0.3
Rootstock				Laterals per Row					1
Month	Irrigation Run Time (hours)	Irrigation Amount (litre/tree)	Class A Pan Adjusted (mm/day)	Crop Coefficient	Stress Coefficient (RDI)	Tree x Row Spacing (square m)	Daily Water Use (litre/tree)	Irrigation Frequency (day)	
		A	B	C	D	E	F=BxCxDxE	G=Ax%IAE/F	
September	4.4	29	2.1	0.1	1.0	3.5	1	33	
October	4.4	29	3.2	0.3	1.0	3.5	4	7	
November	4.4	29	4.5	0.6	1.0	3.5	9	3	
December	4.4	29	5.5	0.6	1.0	3.5	11	2	
January	4.4	29	5.9	0.6	1.0	3.5	11	2	
February	4.4	29	5.4	0.6	1.0	3.5	10	3	
March	4.4	29	3.8	0.6	1.0	3.5	7	4	
April	4.4	29	2.3	0.3	1.0	3.5	2	12	
May	4.4	29	1.2	0.2	1.0	3.5	1	30	

Example spreadsheet ‘Irrigation Recording Sheet’ Source: Harold Adem – DPI Vic.

Irrigation Recording Sheet													(Actual Daily)	
Drip														
Location	Knoxfield					Tree Spacing (m)	1		Minimum Effective Rainfall (mm)	10				
Block						Row Spacing (m)	3.5		Percent Effective Rainfall (%)	100				
Variety	Raspberries					Emitter Output (litre/hour)	2							
Clone						Emitter Spacing (m)	0.3							
Rootstock						Laterals per Row	1							
Date	Rainfall (mm)	Effective Rainfall (mm)	Evaporation Class A Pan (mm)	Class A Pan Adjusted D=0.8xC (mm/day)	Effective Area of Shade (%)	Crop Coefficient	Stress Coefficient (RDI)	Tree x Row Spacing (square m)	Daily Water Use (litre/tree)	Soil Water Deficit (litre/tree)	Predicted Irrigation Run Time (h)	Irrigation Run Time (hour)	Effective Irrigation Amount (litre/tree)	
	A	B	C	D	E	F=1.3xE/100	G	H	I=DxFxGxH	J=SumH-C-L	K=J/%IAE	L		
9/11/2008	0	0.0	5.2	4.2	25	0.3	1.0	3.5	4.0	4.0	0.7		0	
10/11/2008	0	0.0	5.8	4.6	25	0.3	1.0	3.5	4.5	8.5	1.4		0	
11/11/2008	0	0.0	6.6	5.3	25	0.3	1.0	3.5	5.1	13.6	2.3		0	
12/11/2008	0	0.0	8.4	6.7	25	0.3	1.0	3.5	6.5	20.0	3.3	3.0	18	
13/11/2008	0	0.0	8.8	7.0	25	0.3	1.0	3.5	6.8	8.8	1.5		0	
14/11/2008	1.4	0.0	4.6	3.7	25	0.3	1.0	3.5	3.5	12.3	2.1		0	
15/11/2008	2.5	0.0	7.6	6.1	25	0.3	1.0	3.5	5.9	18.2	3.0	3.0	18	
16/11/2008	0	0.0	6.8	5.4	25	0.3	1.0	3.5	5.2	5.4	0.9		0	
17/11/2008	0	0.0	6.8	5.4	25	0.3	1.0	3.5	5.2	10.7	1.8		0	
18/11/2008	0	0.0	5.0	4.0	25	0.3	1.0	3.5	3.9	14.5	2.4		0	
19/11/2008	9.6	0.0	4.9	3.9	25	0.3	1.0	3.5	3.9	18.3	3.0	3.0	18	
20/11/2008	56.4	46.4	0.6	0.5	25	0.3	1.0	3.5	0.5	0.0	0.0		0	
21/11/2008	0	0.0	5.2	4.2	25	0.3	1.0	3.5	4.0	4.0	0.7		0	
22/11/2008	2.2	0.0	5.7	4.6	25	0.3	1.0	3.5	4.4	8.4	1.4		0	
23/11/2008	1.8	0.0	5.7	4.6	25	0.3	1.0	3.5	4.4	12.8	2.1		0	
24/11/2008	0.0	0.0	5.7	4.6	25	0.3	1.0	3.5	4.4	17.2	2.9	3.0	18	
25/11/2008	0.0	0.0	3.8	3.0	25	0.3	1.0	3.5	2.9	2.9	0.5		0	
26/11/2008	0.0	0.0	7.1	5.7	25	0.3	1.0	3.5	5.5	8.4	1.4		0	
27/11/2008	5.4	0.0	6.6	5.3	25	0.3	1.0	3.5	5.1	13.5	2.2		0	
28/11/2008	3.6	0.0	7.0	5.6	25	0.3	1.0	3.5	5.4	18.9	3.1	3.0	18	
29/11/2008	4.0	0.0	6.5	5.2	25	0.3	1.0	3.5	5.0	5.9	1.0		0	
30/11/2008	0.0	0.0	6.5	5.2	25	0.3	1.0	3.5	5.0	10.9	1.8		0	
1/12/2008	0.0	0.0	6.7	5.4	25	0.3	1.0	3.5	5.2	16.0	2.7	3.0	18	
2/12/2008				0.0	25	0.3	1.0	3.5	0.0	0.0	0.0		0	
3/12/2008				0.0	25	0.3	1.0	3.5	0.0	0.0	0.0		0	

Irrigation Management

Section 7

Waterwise Berries II summary

For more detail, see 'WWBII Raspberries' report in the irrigation section of the IFP manual.

Background

This project aimed to address gaps in research and knowledge of the true water needs of local berry crops during fruiting season and harvest.

In 2007-08, WaterWise Berries collected data on how 6 different berry irrigation practices react across different soil types and root depths. Waterwise Berries II aimed to expand on this cross industry project to examine the water requirements of strawberries, raspberries and blueberries with respect to yield and quality parameters such as brix and fruit size. In addition, it also investigated different irrigation practices to see how they impacted on productivity with the aim of determining how efficient irrigation practices can be achieved. [¹⁰ C. Brunt]

Results

- Raspberry plants suffered both heat and water stress in the summer 08-09.
- Leaf temperatures of up to 46.7C were recorded resulting in leaf loss.
- Fruit was badly damaged through desiccation and sunburn, resulting in crop of up to 50% and crumbly fruit.
- The root zone varied for crops according to site with a range of 30-50cm deep.
- Where three 'Easy Ags[®]' (soil moisture capacitance sensor) were placed along a gradient, the top of the slope was drier than the bottom
- Cane diameter varied very little between sites and showed no relationship to fruit quality in this study during the season. However, other studies have shown that following drought stress, productivity and cane growth will be reduced in the following year (Irrigationworld2000.com, Hess et al., 1997).

Stress tests

- Fruit from deficit plots were smaller than fruit from the control plots during January and February, but size recovered later in the season.
- The highest sugar content (% brix) was associated with the smallest berries.

Recommendations

- Base irrigation scheduling on long term crop water balance (evapotranspiration x crop-coefficient) data and fine tune with soil moisture monitoring equipment.
- Weed matting and canopy cover makes the bed relatively impermeable to rainfall events. Less than 20mm will have very little effect on the plant's water balance.
- Therefore, irrigation needs to continue after small to moderate rainfall events.
- Organic mulches may be beneficial in conserving soil moisture, keeping roots cool and increasing soil carbon.
- Subsurface drippers or dripper placement below the mulch may be beneficial.
- Windbreaks may help to minimise plant stress from hot winds and reduce evapotranspiration.

Irrigation Management

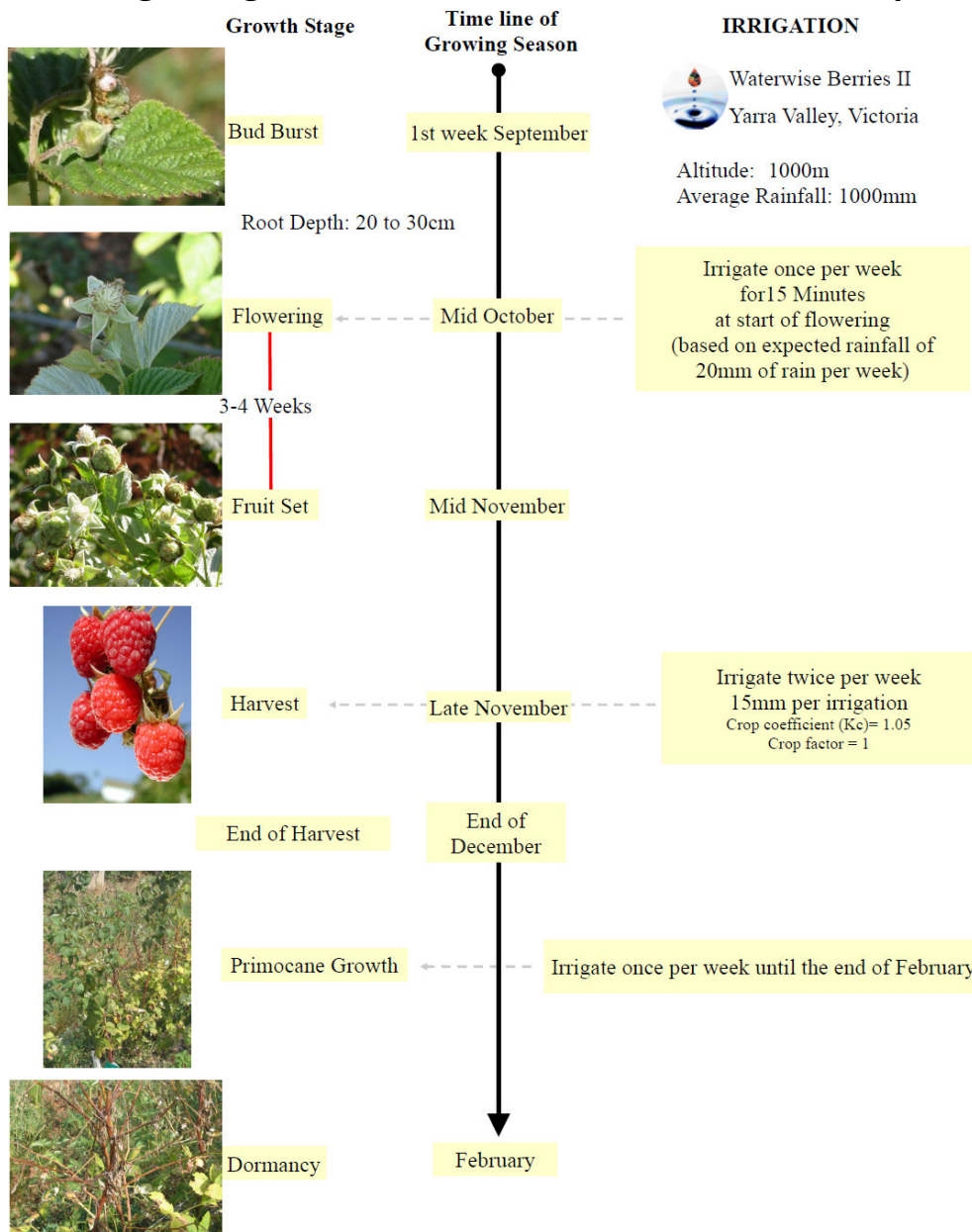
Section 8 Irrigation Posters

The Waterwise Berries project captured the irrigation requirements of raspberry floricanes (summer) and primocanes (autumn) grown in the Yarra Valley.

The growing location for Rubus in the Yarra Valley has an average rainfall of 1000mm, at a height above sea level of about 200m. The raspberry variety represented in the primocane poster is 'Bogong', and the florican variety is 'Chilliwick'.

Each poster contains a timeline with the growth and fruiting stages, along with irrigation requirements. This information can be adapted to your growing situation based on the latitude, altitude and rainfall of your farm. [¹¹ A. Brinson]

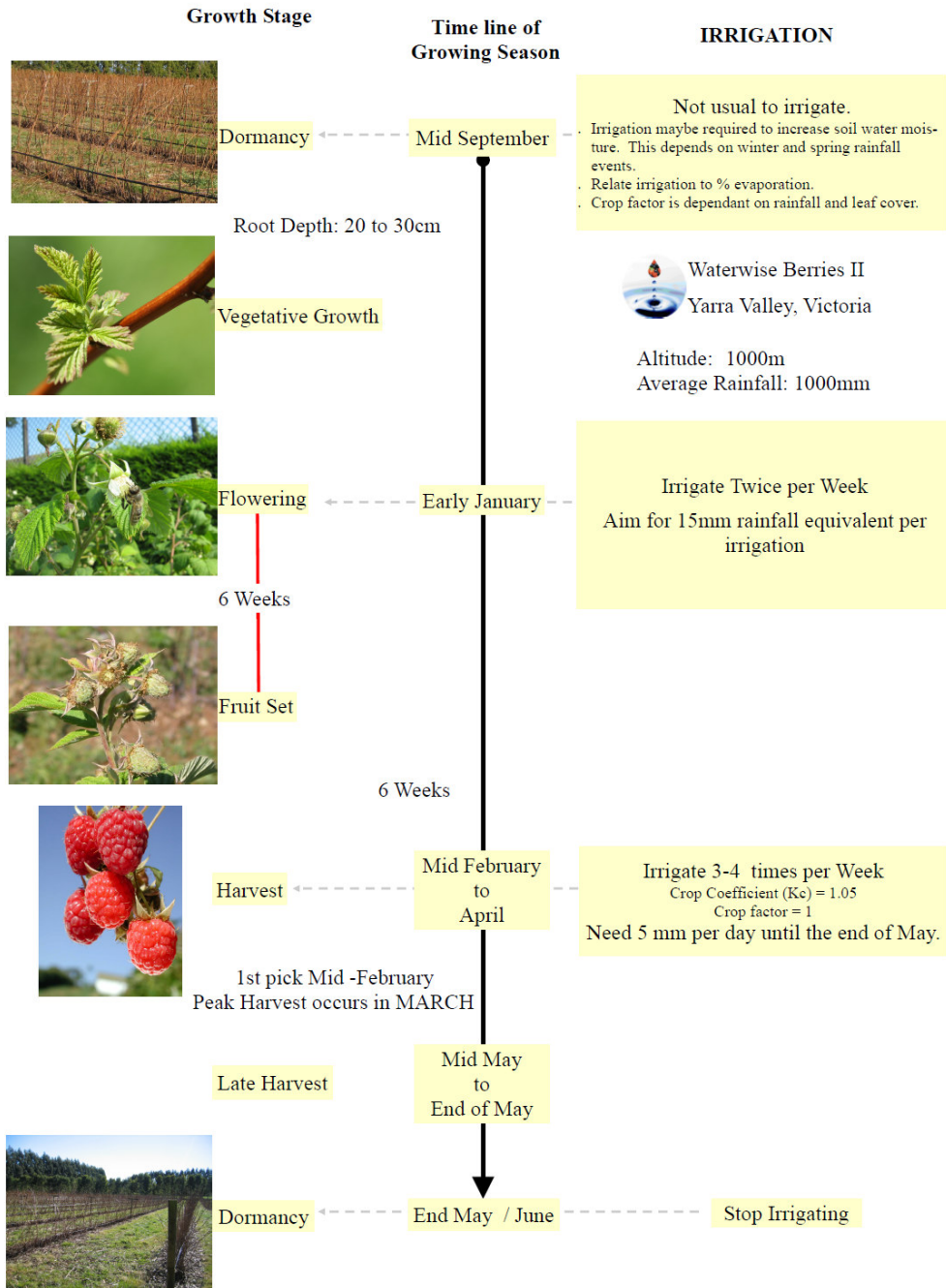
Poster 1 Irrigating Floricanes in the Yarra Valley



Irrigation Management

Poster 2

Irrigating Primocanes in the Yarra Valley



A2 posters are provided, separate from this document.



Waterwise Berries II. Yarra Valley, Victoria

Irrigation Management

Section 9

Advanced approaches to irrigating.

These approaches are methods used for produce other than Rubus. Growers should consider trials on a small section of their farm to determine the relevance of these approaches to their crops.

Regulated Deficit Irrigation

Irrigation is generally associated with minimising moisture stress. Under such conditions trees grow quickly and are very vigorous. Until a tree has reached its desired size it should not be stressed for water. Once the tree has grown to its desired size, however, vigorous growth not only increases the need for pruning but can reduce yield. Irrigation needs to be managed in such a way as to control the growth of shoots. Such management is known as regulated deficit irrigation (RDI) and in experimental plots has maintained yields of pears and peaches, and reduced irrigation by about 30 %.

For more information see Irrigation Scheduling for Regulated Deficit Irrigation (RDI) produced by the Victorian Department of Primary Industries www.dpi.vic.gov.au. The fact sheet 'AGO299' is located in the irrigation section of your IFP manual.

Partial Root Zone Drying

Partial Root Zone drying is a technique predominantly used with fruit trees. The approach creates wet and dry root zones around each plant. Reduced water to half the root system stresses the plant sending a message to the leaves to close the stomata and reduce evaporation from the leaf surface. Fruit development still occurs and is not significantly effected because half the root system still has water.

For more information see Partial Root Zone Drying fact sheet produced by the National Program for Sustainable Irrigation from the NSW Department of Primary Industries (website www.dpi.nsw.gov.au). This fact sheet is located in the irrigation section of your IFP manual - 'prdfactsheet.pdf'.

Subsurface Drip Irrigation

Sub-surface drip irrigation (SDI) is the placement of permanent drip tape (trickle) below the soil surface, usually at a depth of between 20 and 40cm. However, the strawberry industry runs drip tape just under the soil surface along raised beds. Emitters along this drip tape emit water during irrigation. Some of the advantages are distribution uniformity, reduced water use, and reduced evaporation loss.

For more information see the Sub-surface drip irrigation fact sheet produced by the Queensland Department of Primary Industries and Fisheries (website www.dpi.qld.gov.au). This fact sheet is located in the irrigation section of your IFP manual - 'sdi_advantges.pdf'.

Irrigation Management

Appendix 1

Farm Name	
Location	
Varietal Type	
Soil Type	
RAW	
Dripper Application Rate	
Crop requirement (mm)	
Hours or irrigation	

Farm Name	
Location	
Varietal Type	
Soil Type	
RAW	
Dripper Application Rate	
Crop requirement (mm)	
Hours or irrigation	

Irrigation Management

For more information:

www.arga.org.au

Australian Government

www.bom.gov.au

State Government websites

Victoria

www.dpi.vic.gov.au

New South Wales

www.dpi.nsw.gov.au

Queensland

www.dpi.qld.gov.au

Tasmania

www.dpiw.tas.gov.au

Western Australia

www.agric.wa.gov.au

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- Waterwise Berries Workshops and information developed by Adam Buzza and Julio Vargas DPI Victoria.
- Blueberry document 'Irrigation and soil moisture monitoring in Blueberries'. P. Wilk, G. Carruthers, C. Mansfield and V. Hood.
- Water Budget Workshop and information presented by Harold Adem, DPI Victoria
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- Charlotte Brunt, Project Officer for Water Wise Berries
- Australian Rubus Growers Association Committee
- Victorian Department of Primary Industries and Horticulture Australia Limited
- Robert Dimsey, DPI Bairnsdale

Irrigation Management

References

- ¹ Soil Texture Information provide by Julio Vargas DPI-Vic Bacchus Marsh
- ² Irrigation and soil moisture monitoring in Blueberries P. Wilk, G. Carruthers, C. Mansfield and V. Hood
- ³ Information adapted from 'RAW Deal?', Adam Buzza DPI-Vic Bacchus Marsh
- ^{4,5,6} Information adapted from the Water Wise Berries project, produced by Adam Buzza and Julio Vargas, DPI-Vic Bacchus Marsh
- ⁷ Information adapted from 'Soil moisture monitoring', presentation, Julio Vargas DPI-Vic Bacchus Marsh.
- ⁸ Information adapted from Irrigation budget presentation produced by Harold Adem DPI Tatura
- ⁹ Irrigation budget tool produced by Harold Adem DPI Tatura. DVD produced by Harold Adem DPI-Vic, Mark Hincksman DPI-Vic, Kieran Murphy DPI-Vic and Production VIDEO for the ARGA, the ABGA and the Horticulture Industry Network Victoria
- ¹⁰ Waterwise berries II report provided by Charlotte Brunt
- ¹¹ Posters produced from information gathered in the Waterwise Berries projects

Irrigation Management

Conversions:

To Convert From	To	Multiply by
AREA		
acres (ac)	hectares (ha)	2.49
hectares (ha)	square metres (m ²)	10,000
hectares (ha)	acres (ac)	0.4047
FLOW		
gallons per minute (gpm)	litres per minute (l/m)	4.546
litres per minute	gallons per minute	0.22
cubic metres/hour (m ³ /h)	litres per hour (l/h)	1,000
cubic metres/hour	gallons per minute	3.666
PRESSURE		
kilopascals (kPa)	pounds per square inch (p.s.i.)	0.145
pounds per square inch (p.s.i.)	kilopascals (kPa)	6.895
bar (kg/cm ²)	kilopascals (kPa)	100
VOLUME		
litre (l)	gallon (gal)	0.22
gallon (gal)	litre (l)	4.546
gallon (imperial)	U.S. gallon	1.201
cubic metre (m ³)	kilolitre (kl)	1
cubic metre (m ³)	gallon (gal)	220
cubic metre (m ³)	litre (l)	1,000
DEPTH		
millimetre (mm)	inch	0.0394
inch	millimetre (mm)	25.4

Irrigation Management

Familiarize yourself with terms often used to discuss irrigation.

Glossary

Aquifer	A water-bearing layer of permeable rock, sand, or gravel capable of yielding significant quantities of water to bores or springs.
Available water	The difference between the water content of a soil at field capacity and at wilting point, that can be used by the crop.
Bolus	A bolus is a ball of soil.
Bore	A hole of uniform diameter (usually 15 to 60 cm) drilled vertically in the ground to tap an aquifer, and containing a pipe through which ground water can be pumped.
Carbonate layer	A layer of the soil profile that has a very high concentration of calcium carbonate, known locally as the lime layer which can restrict root growth.
Clay	Mineral particles in soil with a diameter less than 0.002 mm; a soil in which clay particles constitute more than 30 per cent of the mass.
Consistency	The degree of cohesion between soil particles.
Electrical conductivity (EC)	The capacity of a medium to pass an electric current. In an aqueous solution, it increases with the concentration of ions and hence the concentration of total dissolved salts. It is measured in micro Siemens per centimetre ($\mu\text{S}/\text{cm}$).
Evapotranspiration	A composite term expressing the loss of water resulting from both transpiration by plants and evaporation from soil.
Farm planning	The process of developing a property management plan by matching landholder's goals with the resources of the property to achieve sustainable and profitable land use by minimising risk.
Fertiliser	Any substance, manufactured or naturally occurring, added to the soil to supplement its nutrient level. The most commonly applied fertilisers contain nitrogen, potassium and phosphorus, three of the most essential elements for plant growth.
Field capacity	the water content of a soil after free drainage has ceased.
Groundwater	All free water found in the subsurface layers of the earth's crust.
Head loss	Head loss in farm channels, if the channel cross-section and the speed of water flow remain fairly uniform, head loss can be taken to be the difference in water level between any two points.
Heavy soil	A soil that requires considerable mechanical power for cultivation; usually a clay soil.
Hydrogeology	The study of water and its movement through soils. Such studies are important when trying to understand soil salinity, water erosion and waterlogging.
Infiltration rate	The rate at which water enters the soil.
Ion	An electrically charged particle that is released on dissociation of an electrolyte (eg. sodium chloride) in aqueous solution.
Leaching	The washing of soluble material from soil by the passage of water through the soil.
Leaching requirement	The amount of water passing through the root zone that is required to wash excess salt through the profile.
Light soil	A soil that is easy to cultivate, requiring less power than a heavy soil; usually a sandy soil.
Lime	The common name for Calcium Oxide or Calcium Carbonate, an alkaline material applied to soil with acidity problems or applied to provide calcium for plant growth.

Irrigation Management

Loam	25% clay and 25% silt. Bolus coherent and spongy; smooth feel and no obvious sandiness; may be somewhat greasy if a large amount of organic matter is present.
Organic matter	The substance of plants, animals, and micro-organisms. The decomposition of organic matter in soil produces further substances that can link soil particles to form aggregates.
Percolation	The downward movement of water through the soil.
Permeability	This refers to the capacity of a substance (eg. soil or rock) to allow water to pass through it. Sand, for example, is said to have high permeability.
pH	pH is the measure of how acid or alkaline your soil is, and this in turn affects the soil's ability to supply or make available the nutrients contained within the soil. Scale 0 – 14 < 7 = Acidity 7 = Neutral > 7 = Alkalinity
Photosynthesis	The formation by plants of carbohydrates from carbon dioxide and water through the agency of light.
Pitot tube	Instrument for measuring the velocity or pressure of a gas or liquid. It is a tube with two openings, one into the moving fluid and one away from it. The difference in pressure between ends of the tube is related to the velocity of the fluid.
Readily Available Water	The amounts of water held within each layer in the rootzone, relating to the amount of water held in the soil between -8 kPa field capacity and 40 kPa.
Soil profile	A vertical section of a soil.
Root zone	The depth of soil in which most (about 90 per cent) of the roots of a plant occur.
Salinity	The content of salts in soil or water, measured in units of electrical conductivity (EC's).
Salinisation	The accumulation of salts in the soil or part of a landscape to an extent which causes degradation of vegetation, soil structure and soil fertility. It is typically caused by hydrogeological changes following human land use.
Salts	Soluble mineral substances present in soil and water. The salts most commonly observed in Victoria are common salt (NaCl), gypsum Calcium SO ₄ and lime Calcium CO ₃ .
Salt tolerance	The capacity of a plant to tolerate salts in the soil solution.
Sand	Mineral particles in soil with a diameter in the range 0.02 to 2.0 mm; a soil in which sand particles constitute more than 85 per cent of the mass.
Saturation	The condition of a soil in which nearly all of the pores are filled with water.
Silt	Mineral particles in soil with a diameter in the range 0.002 to 0.02 mm.
Soil structure	Soil structure is vital to the soil's long term stability, fertility and suitability for rural production. Structure depends on the aggregation of clay, silt and sand, and on the pore spaces between the aggregates. A well structured soil will allow the entry of water, air and plant roots into the soil profile without causing such problems as waterlogging. Well structured soils tend to be more resistant to erosion and degradation.
Tensiometer	An instrument for measuring the soil moisture.
Texture	The relative proportions in a soil of the different sized soil particles; the coarseness or fineness of a soil.
Total dissolved salts	The total salt content of water, expressed in milligrams per litre (mg/l); it may be determined by multiplication of the electrical conductivity of the water by 0.6.
Transpiration	The loss of water from plants by evaporation.
Turbidity	The cloudy condition, caused by suspended solids and soil sediment in a liquid, usually water.
Watertable	The upper surface of the zone of soil saturation by groundwater.
Wilting point	The water content of a soil at which indicator plants growing in that soil wilt and fail to recover when placed in a humid chamber.

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