Drip Irrigation Management

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DRIP IRRIGATION MANAGEMENT

- System specifications
  - Definitions
  - Interpreting manufacturers charts and design descriptions
  - Application rate
- System Monitoring
  - Measure system pressure & discharge
  - Calculate variation
  - Drip drainage
  - Alternative monitoring methods
- System maintenance
  - Flushing
  - Chlorine / hydrogen peroxide
  - Acid injection

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DEFINITIONS

EMITTER TYPES

- On-line drippers
- In-line drippers
- Non pressure compensating drippers (NPC)
- Pressure compensating drippers (PC)
  - Non drain (non leak) drippers (ND)
  - Anti suck back drippers (AS)
  - Root intrusion protection

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DRIP SYSTEM DEFINITIONS

SPECIFICATIONS

- Nominal flow rate for NPC drippers

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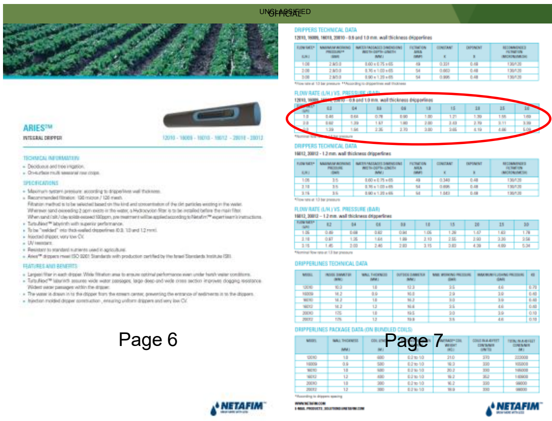

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Nominal flow rate for non-PC drippers

FLOW RATE (L/H.) VS. PRESSURE (BAR)

12010, 16009, 16010, 20010 – 0.9 and 1.0 mm. wall thickness dripperlines

100 kPa

FLOW RATE* (L/H)	0.2	0.4	0.6	0.8	1.0	1.5	2.0	2.5	3.0
1.0	0.46	0.64	0.78	0.90	1.00	1.21	1.39	1.55	1.69
2.0	0.92	1.29	1.57	1.80	2.00	2.43	2.79	3.11	3.39
3.0	1.39	1.94	2.35	2.70	3.00	3.65	4.19	4.66	5.09

*Nominal flow rate at 1.0 bar pressure

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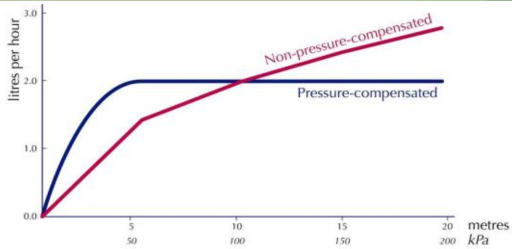
Both 2 L /Hr drippers



Drip specifications – PC drippers

→ DRIPPERS TECHNICAL DATA

FLOW RATE* (L/H)	WORKING PRESSURE RANGE (BAR)	WATER PASSAGES DIMENSIONS WIDTH-DEPTH-LENGTH (MM)	FILTRATION AREA (MM²)	CONSTANT K	EXPONENT* X	RECOMMENDED FILTRATION (MICRON)/(MESH)
0.7	0.5 - 4.0	0.70 x 0.65 x 40	110	0.7	0	130/120
1.0	0.5 - 4.0	0.83 x 0.74 x 40	130	1.0	0	130/120
1.6	0.5 - 4.0	1.07 x 0.79 x 40	130	1.6	0	200/80
2.3	0.5 - 4.0	1.26 x 0.95 x 40	130	2.3	0	200/80
3.5	0.5 - 4.0	1.59 x 1.10 x 40	150	3.5	0	200/80

* Within working pressure range

DRIP SYSTEM DEFINITIONS

SPECIFICATIONS

- Nominal flow rate
- Spec. sheet exercise

1.3 Activity 1: Understand specification sheets and ordering parts

Work through the following questions by referring to Figures 1a and 1b: Aries Integral Dripper specification sheet.

1. What is the wall thickness of Dripperline model 16009? **0.9** mm
2. What are the 3 nominal flow rates available for 16009? **1.0,2.0,3.0**
3. What would be the joiner size required for 16009? **14** mm
4. What would be the clamp size required for 16009? **16** mm
5. Using the table below, determine the number of coils of dripperline 16009 is required to irrigate a 2 ha vineyard with 2.74 m row spacings: **3,650 × 2 ÷ 500 = 15 coils**

Table 3: Dripline length required for 1 ha at various row spacings

Row spacing (m)	Approx. dripline length for 1 ha (m)
3.35 (11 ft)	2986
3.00 (10 ft)	3334
2.74 (9 ft)	3650
2.44 (8 ft)	4099

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DRIP SYSTEM DEFINITIONS

SPECIFICATIONS

- Nominal flow rate
- Spec. sheet exercise
- Application rate (mm/h)

APPLICATION RATE

- On design as full cover equivalent

$$= \frac{\text{Discharge (L/hr) x lateral number}}{\text{Emitter spacing (m) x row spacing (m)}}$$

Eg. 2 laterals of 2 L/hr drippers, at 0.5 m emitter spacings and 6 m rows

$$= \frac{2 \times 2}{0.5 \times 6.0}$$

= 1.33 mm/hr

1.5 Activity 2: Calculate mean application rate (MAR)

Worked example

Dripper discharge = 2.0 L/h
Dripper spacing = 0.5 m
Row width = 3.0 m
Driplines (laterals) per row = 1

Mean Application Rate (mm) $= \frac{2.0 \times 1}{0.5 \times 3.0}$

= 1.3

= 1.3 mm/h

1.3 mm is applied in 1 hour

Determine the mean application rate of your drip system by entering your system specifications (dotted lines) into the equation below.

Mean Application Rate (mm) =

$$\frac{\text{.......... dripper discharge (L/h)} \times \text{......... lateral number}}{\text{........ emitter spacing (m)} \times \text{....... row spacing (m)}}$$

= .... mm/h

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Application rates (mm/h)

Discharge (L/h)	Emitter spacing (m)					
	0.2	**0.3**	**0.4**	**0.5**	**0.6**	**0.75**
0.7	1.17	0.78	0.58	0.47	0.39	0.31
1	1.67	1.11	0.83	0.67	0.56	0.44
1.6	2.67	1.78	1.33	1.07	0.89	0.71
2.3	3.83	2.56	1.92	1.53	1.28	1.02
3	5.00	3.33	2.50	2.00	1.67	1.33
3.5	5.83	3.89	2.92	2.33	1.94	1.56

Row spacing 6.0m x 2 laterals

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Design description

IRRIGATION DATA TABLE

Description	Units		
Crop		Almonds	Almonds / Pistachio
Irrigation Area (Net)	Ha		
Rows\Beds Spacing	Mtr.	7.25	
Plants Spacing	Mtr.	5.0	
Irrigation System		In-Line Drip	
Emitter Type		Uniram CNL 20012 & 23010	
Minimum Emitter Pressure	Mtr.	13.00	
Emitter Discharge	L/H	1.60	
Emitter Spacing	Mtr.	0.44	
Laterals Average Spacing	Mtr.	7.25	
No. of Laterals per Row\Bed	No.	2	
Application Rate	mm/h	1.00	
Max. Daily Consumption	mm/day	12.00	
Irrigation Cycle	Days	1	
Duration of one Operation	Hrs.	11.96	
Number of Operations	No.	2	
Max. Daily Operation Duration	Hrs.	23.93	
Available Daily Duration	Hrs.	24	
Max. Flow Variation	%	0.0	
Mainline Flexibility		Maximum	
Max Number of Laterals per Flush Tap	No.	Uniram 20012 = 36 Laterals Uniram 23010 = 28 Laterals	
Pump Duty (Excludes Backflush Requirements)		Stage 2 & Stage 3 North Pump Station	Stage 3 South Pump Station
Maximum Discharge Required	m3/h	4580.0	3600.0
Maximum Discharge Required	lps	1272.2	1000.0
Required Pressure at Water Source	Mtr.	57.0	57.0
Required Pressure After Filtration	Mtr.	47.0	47.0
Assumed Water RL:	Mtr.	51.9	51.9

Following losses have been allowed for in the calculation of the pump TDH: Suction Line=3.0m, Misc/headworks=2.0m, Filtration=7.0m, In-Field losses=2.0m

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Trend towards lower application rates

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DRIP SYSTEM DEFINITIONS

SPECIFICATIONS

- Nominal flow rate
- Spec. sheet exercise
- Application rate (mm/h)
- Maximum number of shifts

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MAXIMUM NUMBER OF SHIFTS

EXAMPLE

Max daily water use = 12 mm/d

Application rate = 1.3 mm/hr

Max. hrs pumping avail. = 18 hr/d (25% downtime)

1. Hours req./day = max. daily water req. (mm/d) / Application rate (mm/hr)

= 12 mm/day / 1.3 mm/hr

= 9.2 hr/d

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MAXIMUM NUMBER OF SHIFTS

2. Max. no. shifts/d = Max. hrs pumping avail. (hr) / Hours req. per day (from 1.)

= 18 hr / 9.2 hr/d

= 1.9

= 2 shifts

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Activity 10: Calculate maximum number of shifts

Use your system application rate and your chosen maximum number of pumping hours to calculate the maximum number of shifts that can be run from your pump.

For example, if your maximum daily crop water use was 12 mm/day:

Step 1. Hours req. per day = 12 mm/day (from page 12) / ....Applic. rate (mm/h) (from Activity 2 on page 9) = ...

Step 2. Max. no. shifts per day = 18 (max. no. pumping hrs) / ....(hours required per day) (from Step 1 above) = ...

This is the maximum number of shifts you can safely run from your pump. It is a 'design calculation' and is unrelated to scheduling and does not suggest you should run this number of shifts each day.

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Application rate & peak demand determines shift number

IRRIGATION DATA TABLE

Description	Units	Almonds	Almonds / Pistachio
Crop		Almonds	Almonds / Pistachio
Irrigation Area (Net)	Ha		
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Plants Spacing	Mtr.	5.0	
Irrigation System		In-Line Drip	
Emitter Type		Uniram CNL 20012 & 23010	
Minimum Emitter Pressure	Mtr.	13.00	
Emitter Discharge	L/H	1.60	
Emitter Spacing	Mtr.	0.44	
Laterals Average Spacing	Mtr.	7.25	
No. of Laterals per Row/Bed	No.	2	
Application Rate	mm/h	1.00	
Max. Daily Consumption	mm/day	12.00	
Irrigation Cycle	Days	1	
Duration of one Operation	Hrs.	11.96	
Number of Operations	No.	2	
Max. Daily Operation Duration	Hrs.	23.93	
Available Daily Duration	Hrs.	24	
Max. Flow Variation	%	0.0	
Mainline Flexibility		Maximum	
Max Number of Laterals per Flush Tap	No.	Uniram 20012 = 36 Laterals Uniram 23010 = 28 Laterals	
Pump Duty (Excludes Backflush Requirements)		Stage 2 & Stage 3 North Pump Station	Stage 3 South Pump Station
Maximum Discharge Required	m3/h	4580.0	3600.0
Maximum Discharge Required	lps	1272.2	1000.0
Required Pressure at Water Source	Mtr.	67.0	67.0
Required Pressure After Filtration	Mtr.	47.0	47.0
Assumed Water RL	Mtr.	51.0	51.0

Following losses have been allowed for in the calculation of the pump TDH: Suction Line=3.0m, Misc/headworks=2.0m, Filtration=7.0m, In-Field losses=2.0m

IRRIGATION SYSTEM DETAILS

DRIPLINE:	20ND Dripline (minimum ID 17,4mm)
SPECIFICATION:	1,6 LPH @ 0,65m Emitter Spacing (SDR 2,462 Lph/m) 2 Laterals per row
SYSTEM:	1 Shift System
ROW SPACING:	7,0m
TREE SPACING:	3,5m
APPLICATION RATE:	0.703mm/hr
PEAK APPLICATION RATE:	13,0mm/Day in 18,5hrs
MIN. EMITTER PRESSURE:	12m

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Irrigation drainage plans (IDPs)

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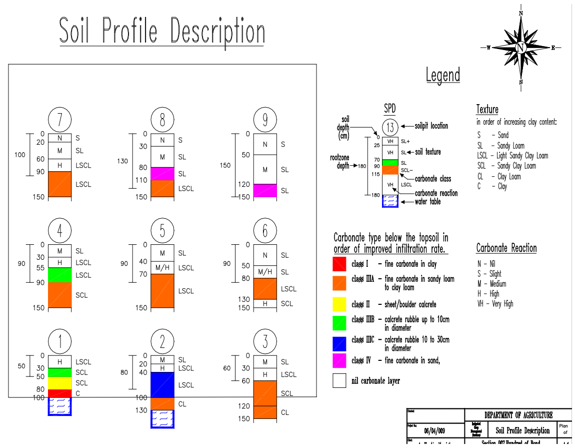
1



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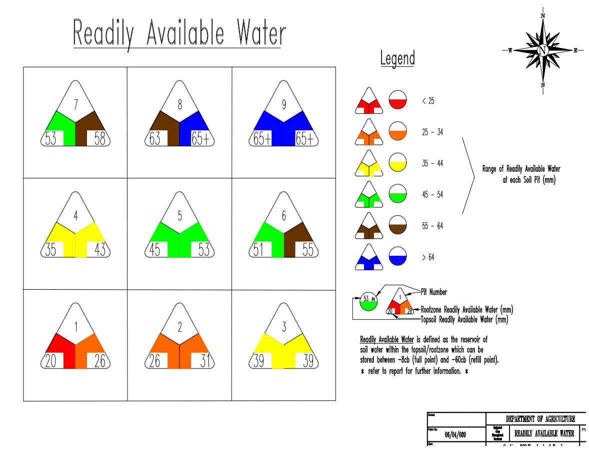

3

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BENEFITS OF SOIL SURVEYS IN THE MALLEE

- Suitable crop selection
- Variety and rootstock selection
- Produce even growth, maturity, yield and quality throughout a patch
- Assist with irrigation management
- Locate soil moisture monitoring tool with confidence
- Isolate or avoid drainage problems
- Provide answers to poor crop performance
  - ***Cost of soil survey vs system up-grade***

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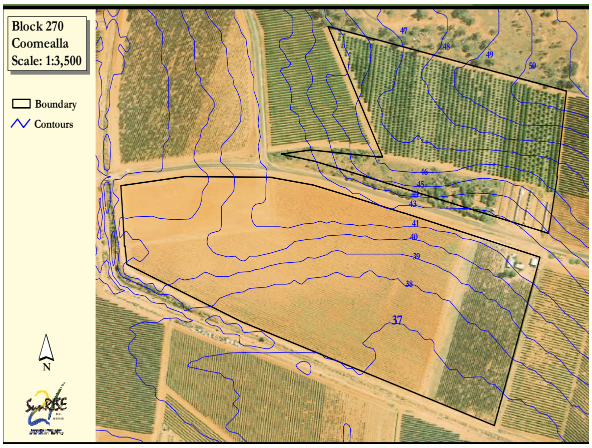
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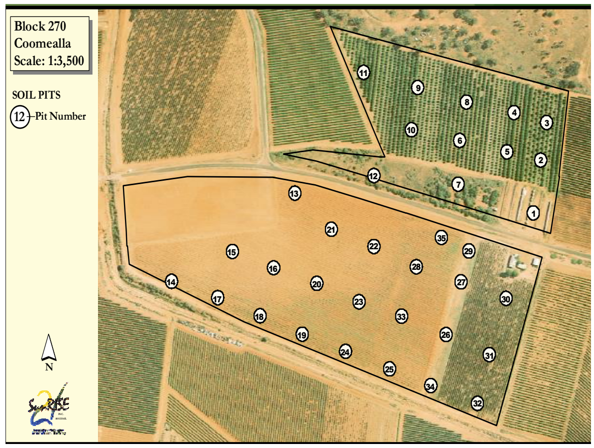
Boundary
Contours
N

8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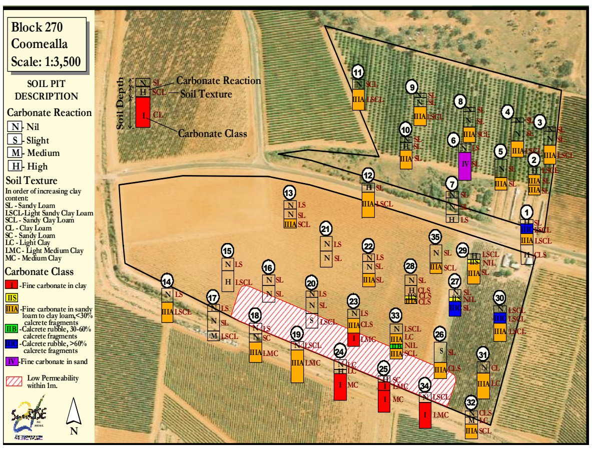
SOIL PITS
12 Pit Number
N

9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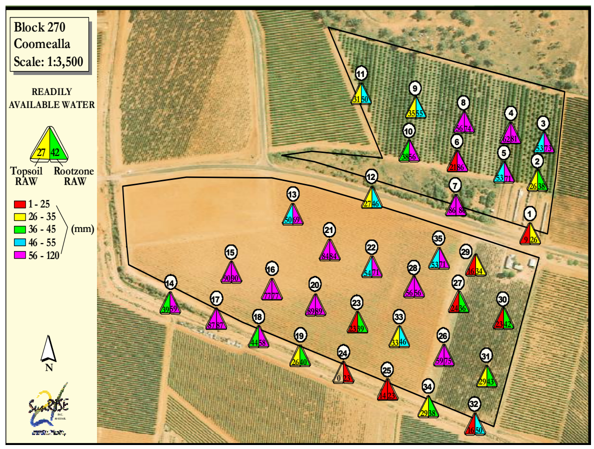
Coomealla
Scale: 1:3,500
SOIL PIT DESCRIPTION
Carbonate Reaction
N - Nil
S - Slight
M - Medium
H - High
Soil Texture
In order of increasing clay content:
SL - Sandy Loam
LSCL - Light Sandy Clay Loam
SCL - Sandy Clay Loam
CL - Clay Loam
SC - Sandy Loam
LC - Light Clay
LMC - Light Medium Clay
MC - Medium Clay
Carbonate Class
I - Fine carbonate in clay
IIS
IIIA - Fine carbonate in sandy loam to clay loam, <30% calcrete fragments
IIIB - Calcrete rubble, 30-60% calcrete fragments
IIIC - Calcrete rubble, >60% calcrete fragments
IV - Fine carbonate in sand
Low Permeability within 1m.
Soil Depth
Carbonate Reaction
Soil Texture
Carbonate Class
N

10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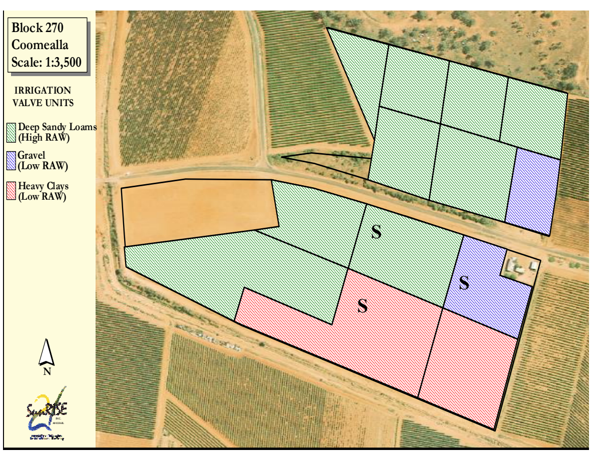
READILY AVAILABLE WATER
Topsoil RAW
Rootzone RAW
1 - 25
26 - 35
36 - 45
46 - 55
56 - 120
(mm)
N

11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Coomealla
Scale: 1:3,500
IRRIGATION VALVE UNITS
Deep Sandy Loams (High RAW)
Gravel (Low RAW)
Heavy Clays (Low RAW)
S
S
S
N

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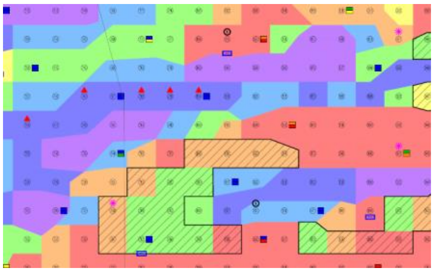
Examples



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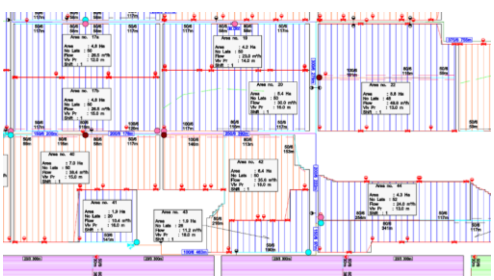

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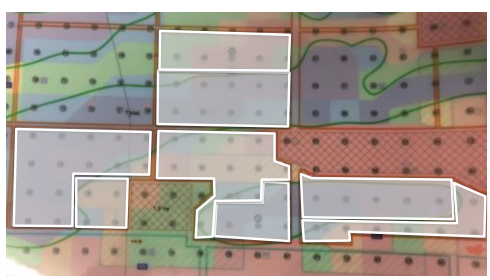
System design



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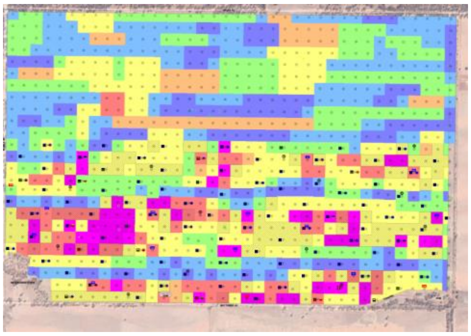

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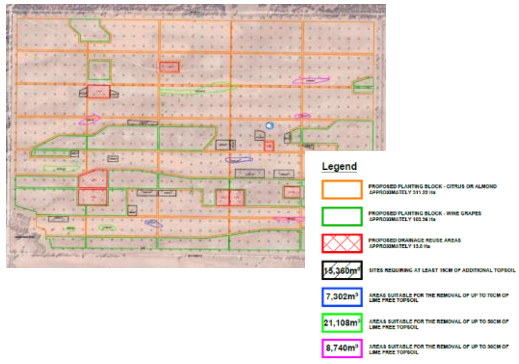

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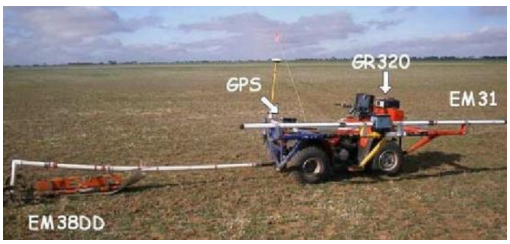
EM 38 mapping?



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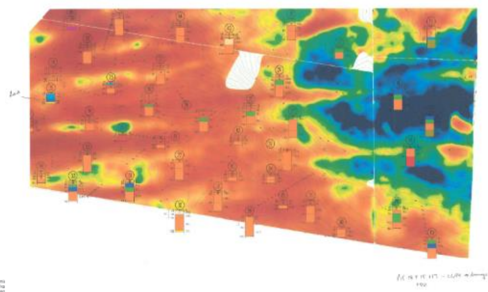

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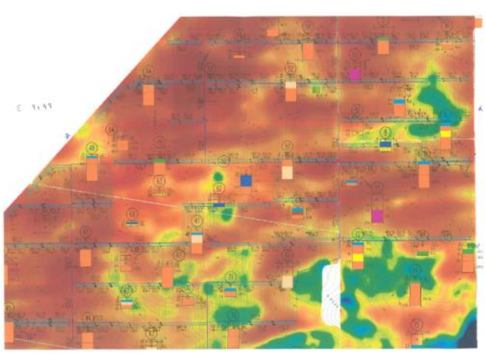

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Summary

- Many soil maps exist ‘somewhere’
- Simple to understand
- Worth reviewing
- Soil variability in wet years
- Re-developing or replacing dripline?

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Topsoil depths

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Irrigation scheduling

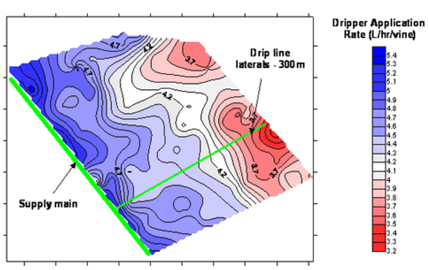
1

To achieve efficient water use and healthy crops:

- Apply water evenly

2

Dripper uniformity



3

To achieve efficient water use and healthy crops:

- Apply water evenly
- Apply no more than the soil can hold - **RIGHT AMOUNT**

4

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To achieve efficient water use and healthy crops:

- Apply water evenly
- Apply no more than the soil can hold - **RIGHT AMOUNT**
- Apply water at the **RIGHT TIME**

6

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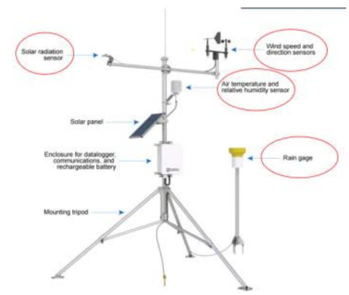
Private weather stations



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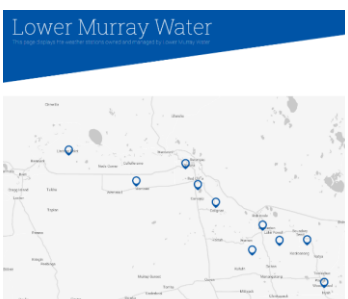
District weather stations



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Climate based scheduling

- Evapotranspiration (ET_o) figures represent daily water use (mm) of a healthy, uniform, actively growing crop completely covering the ground (eg. grass, lucerne)
- Almond crops do not have full ground cover
- Reduce the ET_o by the crop's percentage ground cover (CROP COEFFICIENT - Kc)

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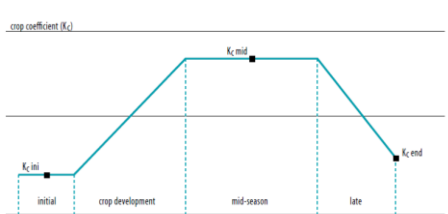
Standard crop coefficient curve



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Climate based scheduling

- Estimate crop water use

Etc = Eto x Kc

Estimated crop water use

Reference crop WU - from weather station

Crop coefficient

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Climate based scheduling

- Almonds in October cover approx. 65% of the ground (crop coefficient = 0.65).
- Av. ETo in October is 5.8
- **Crop water use = 5.8 x 0.65 = 3.8 mm/day**

- Almonds in December crop coefficient = 0.9
- Av. ETo in December is 8.6
- **Vine water use = 8.6 x 0.9 = 7.8 mm/day**

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DECEMBER - GRAPEVINES - RAW = 30 mm (Date: 10th December)
30mm APPLIED 30th NOVEMBER, PROFILE FULL

DATE	ACTUAL ET (a)	CROP COEFFICIENT (b)	WATER USE (mm) (a X b)	CUMULATIVE DEFICIT (mm)	IRRIGATION (mm)
1	8	0.5	4.0	26.0	
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

14

DECEMBER - GRAPEVINES - RAW = 30 mm (Date: 10th December)

DATE	ACTUAL ET (a)	CROP COEFFICIENT (b)	WATER USE (mm) (a X b)	CUMULATIVE DEFICIT (mm)	IRRIGATION (mm)
1	8	0.5	4.0	26.0	
2	8.4	0.5	4.2	21.8	
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

15

DECEMBER - GRAPEVINES - RAW = 30 mm (Date: 10th December)

DATE	ACTUAL ET (a)	CROP COEFFICIENT (b)	WATER USE (mm) (a X b)	CUMULATIVE DEFICIT (mm)	IRRIGATION (mm)
1	8	0.5	4.0	26.0	
2	8.4	0.5	4.2	21.8	
3	8.7	0.5	4.4	17.5	
4	9.1	0.5	4.6	12.9	
5	10.1	0.5	5.1	7.9	
6	10.5	0.5	5.3	2.6	
7	8.9	0.5	4.5	0	
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

16

DECEMBER - GRAPEVINES - RAW = 30 mm (Date: 10th December)

DATE	ACTUAL ET (a)	CROP COEFFICIENT (b)	WATER USE (mm) (a X b)	CUMULATIVE DEFICIT (mm)	IRRIGATION (mm)
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2	8.4	0.5	4.2	21.8	
3	8.7	0.5	4.4	17.5	
4	9.1	0.5	4.6	12.9	
5	10.1	0.5	5.1	7.9	
6	10.5	0.5	5.3	2.6	
7	8.9	0.5	4.5	0	30
8	8.4	0.5	4.2	25.8	
9	8	0.5	4.0	21.8	
10	8.2	0.5	4.1	17.7	
11					
12					
13					
14					
15					
16					
17					

17

DECEMBER - GRAPEVINES - RAW = 30 mm (Date: 10th December)

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4	9.1	0.5	4.6	12.9	
5	10.1	0.5	5.1	7.9	
6	10.5	0.5	5.3	2.6	
7	8.9	0.5	4.5	0	30
8	8.4	0.5	4.2	25.8	
9	8	0.5	4.0	21.8	
10	8.2	0.5	4.1	17.7	
11	AV. FOR DEC = 8.6	0.5	4.3	13.4	
12					
13					
14					
15					
16					
17					

18

DECEMBER - GRAPEVINES - RAW = 30 mm (Date: 10th December)

DATE	ACTUAL ET (a)	CROP COEFFICIENT (b)	WATER USE (mm) (a X b)	CUMULATIVE DEFICIT (mm)	IRRIGATION (mm)
1	8	0.5	4.0	26.0	
2	8.4	0.5	4.2	21.8	
3	8.7	0.5	4.4	17.5	
4	9.1	0.5	4.6	12.9	
5	10.1	0.5	5.1	7.9	
6	10.5	0.5	5.3	2.6	
7	8.9	0.5	4.5	0	30
8	8.4	0.5	4.2	25.8	
9	8	0.5	4.0	21.8	
10	8.2	0.5	4.1	17.7	
11	AV. FOR DEC = 8.6	0.5	4.3	13.4	
12	8.6	0.5	4.3	9.1	
13	8.6	0.5	4.3	4.8	
14	8.6	0.5	4.3	0.5	30 REQUIRED
15	8.6	0.5	4.3	25.7	
16	8.6	0.5	4.3	21.4	
17	8.6	0.5	4.3		

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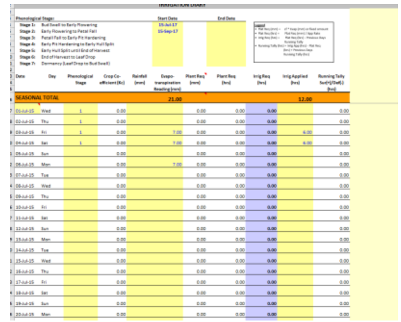

https://australianalmonds.com.au/topic/irrigation

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Weekly notices

Evapotranspiration (Eto) for the last 7 days was 48 mm (6-12 Jan) at Robinvale.

For moderate vigour almonds with a Kc value of 1.09, this results in an approximate water requirement of 52.1 mm for this period. This is 7.8 mm less than the previous week. This figure may be influenced by any effective rainfall for your property.

Cumulative Eto for the next 7 days is forecast to be 59.2 mm (Jan 13-19), which relates to an approximate water requirement of 60 mm.

These figures are approximate only and should be adjusted based on variety, crop load and canopy and vineyard/orchard floor management.

For further information please contact Maxine Schache.

irrigation@agriculture.vic.gov.au

AGRICULTURE VICTORIA

https://australianalmonds.com.au/topic/irrigation

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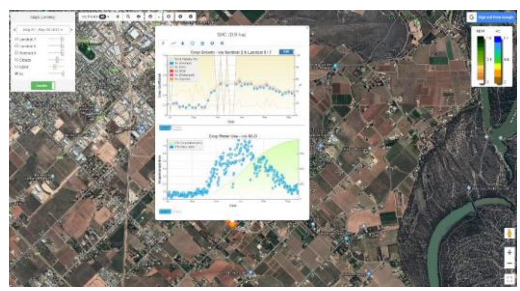
IrriSAT



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IrriSAT

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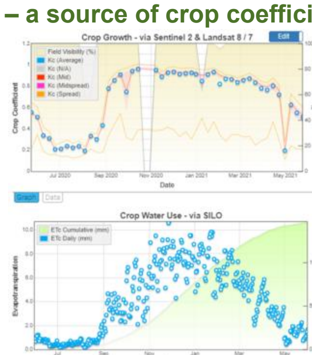
IrriSAT – a source of crop coefficients



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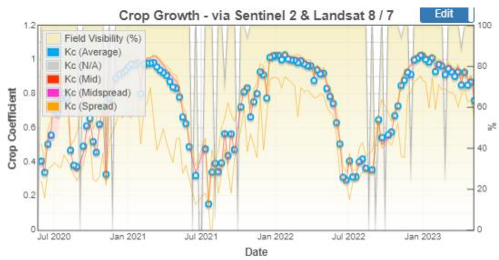

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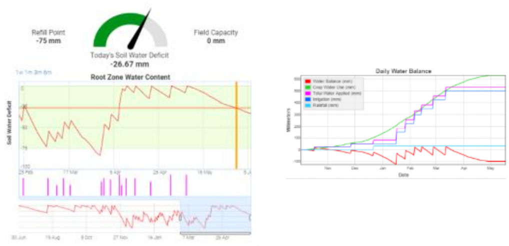
IrriSAT – forecasting ETo

26

IrriSAT – scheduling potential



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IrriSAT – crop variation

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Aspects to consider when selecting a sensor

- After sales service and agronomy
- Data presentation

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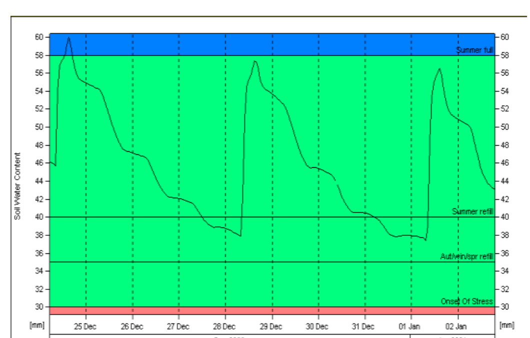

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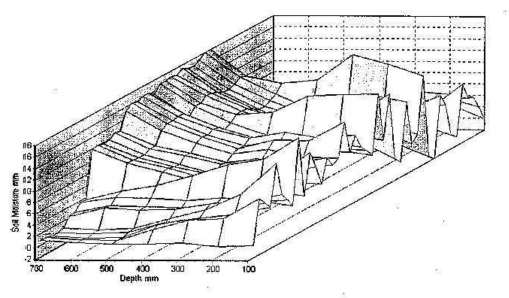

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Aspects to consider when selecting a sensor

- After sales service and agronomy
- Data presentation and integration
- Case studies / examples / history
- Data delivery / time input available

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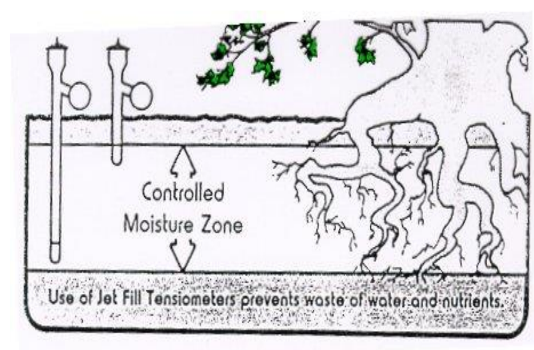

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High tech. scheduling tools

- Continuously logged capacitance probes
  (EnviroSCAN, Green Brain, AquaCheck)
- Neutron Probe
- Gypsum block
- Plant based sensors
  (Dendrometers, sap flow sensors, psychrometers, canopy temperatures)
- Remote sensing (satellites/drones)

Higher accuracy, greater cost

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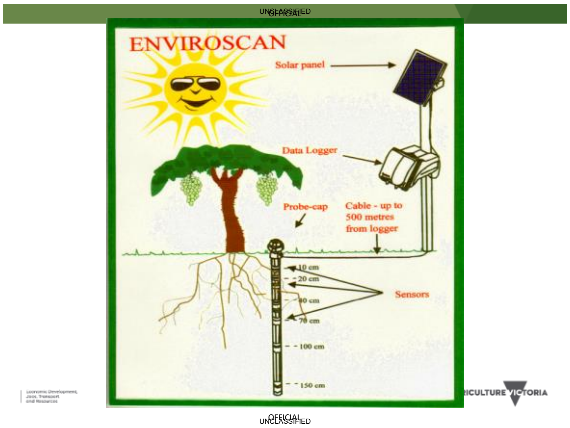

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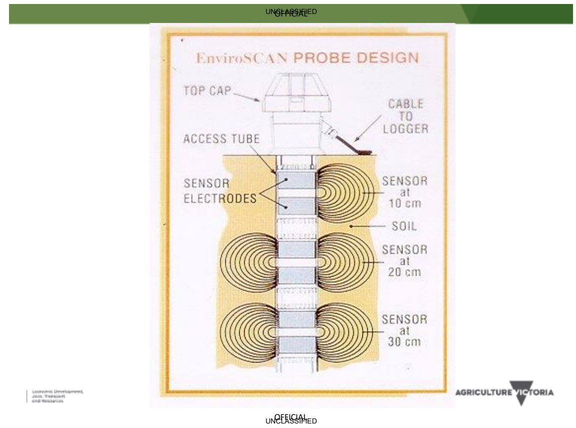

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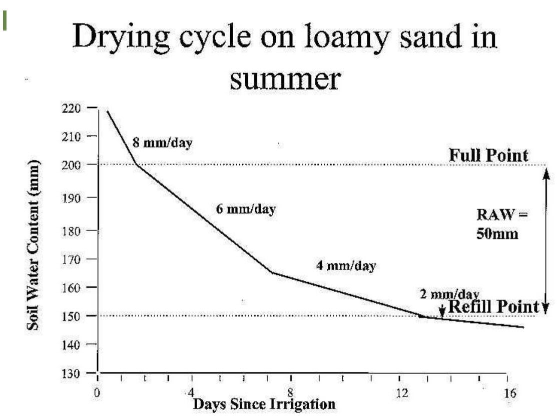

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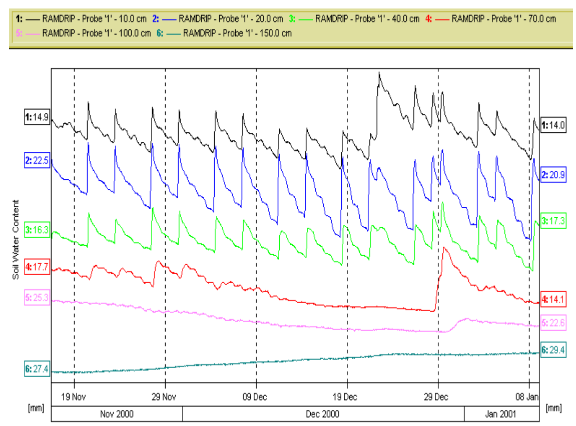

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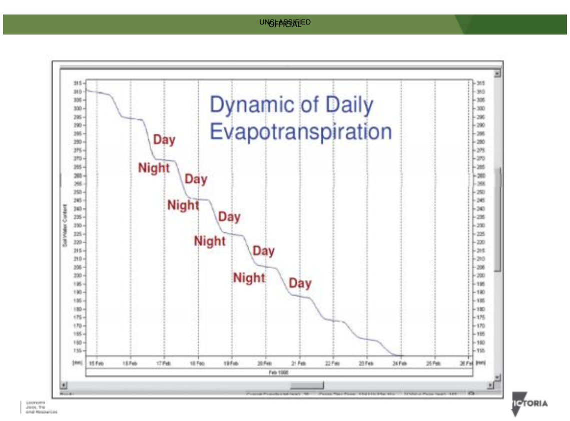

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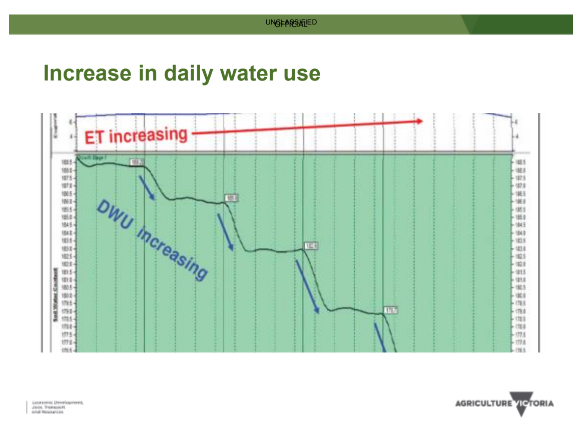

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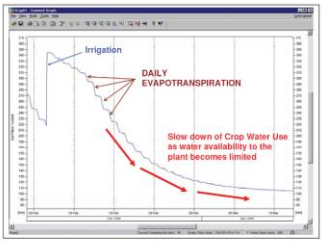
Slowing of daily water use



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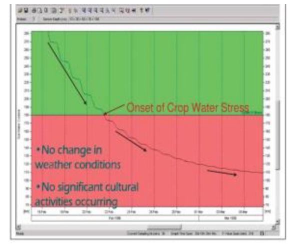
Setting refill points



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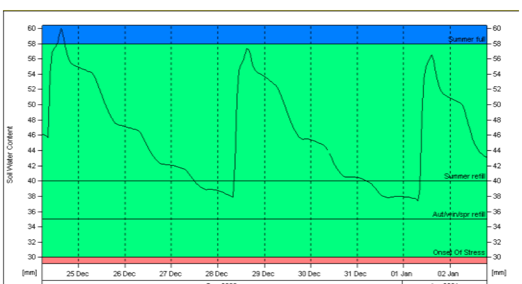
SUMMED GRAPH

(10, 20, 40, 70, 100cm)



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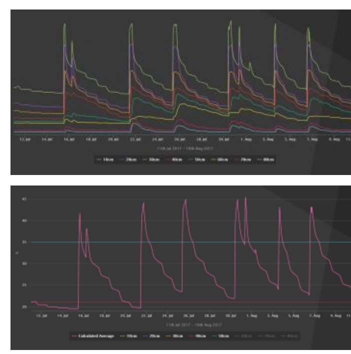
Split level & summed graphs



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Neutron probe

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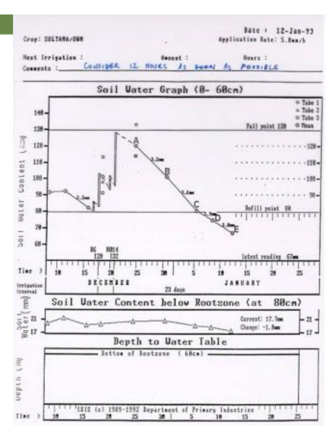

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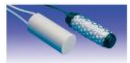
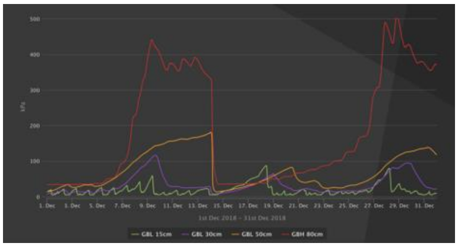
Gypsum block





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G Dot

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Gypsum blocks

- Can be slow to respond
- Soil water tension data is supported by industry soils data. E.g. drying before harvest
- More instant, understandable results

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Plant based scheduling - dendrometer

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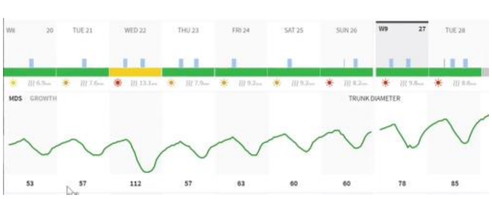
Dendrometer data



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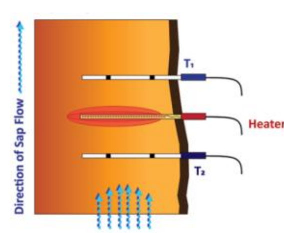
Sap flow sensors



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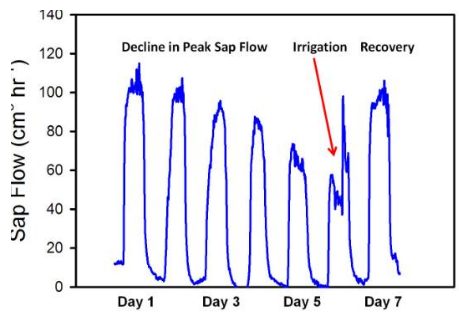

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Plant-based sensors for irrigation management

INTRODUCTION

SAP FLOW SENSORS

PRINCIPLES OF PLANT-BASED SENSORS

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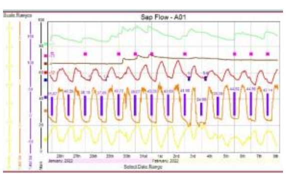
Data integration



- Soil moisture
- Soil oxygen
- Eto
- Ambient temp – cooling
- Trunk dendrometer
- Fruit dendrometer
- Sap flow
- VPD

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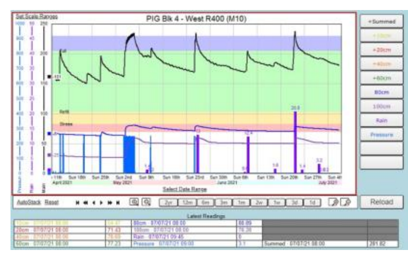
Soil moisture, rainfall and irrigation events integrated



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Soil moisture monitoring observations

- Day vs night
- Gypsum application
- Effective rainfall
- Ignoring graph

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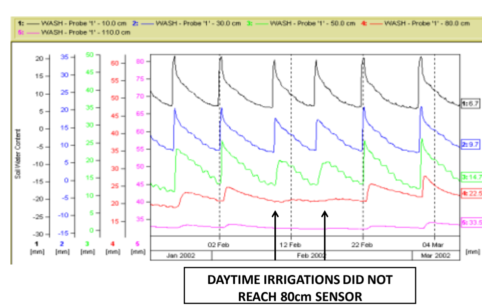
DAY vs NIGHT IRRIGATIONS



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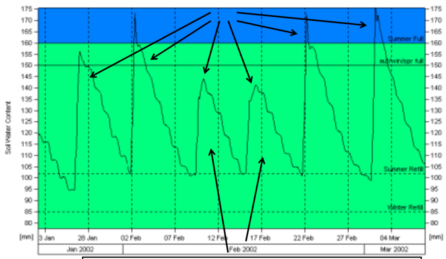
50 mm APPLICATIONS



DAY TIME IRRIGATIONS 30% LESS EFFECTIVE, MEANING THE FOLLOWING IRRIGATIONS MUST BECOME MORE FREQUENT

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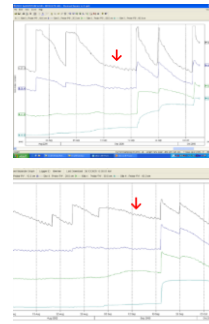
SOIL MANAGEMENT – GYPSUM APPLICATION



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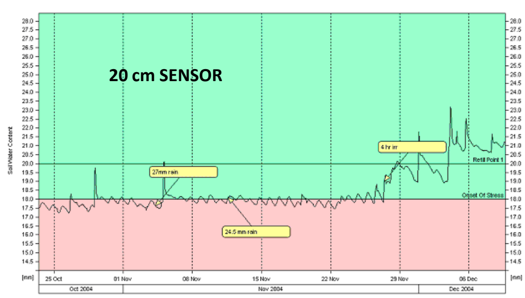
EFFECTIVE RAINFALL



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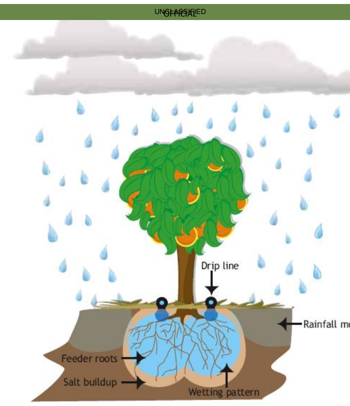

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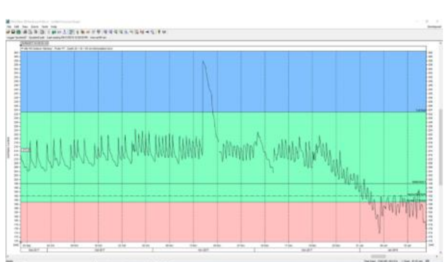
Need to monitor daily irrigations?



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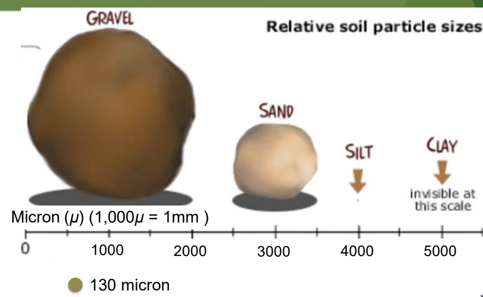
DRIP SYSTEM MAINTENANCE

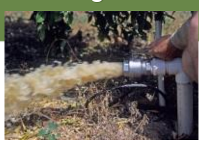
- Flushing
- Sanitation
  - Chlorine
  - Hydrogen peroxide
  - Acid injection

1



2

Flushing order



3

4

Flushing arrangements

5

Flushing frequency

- Historically not often enough
- Water quality & visual inspection of discharge determines frequency

6

Cut and inspect emitters

7

Flushing velocity (water speed)

- Is adequate velocity achieved ?
- Water speed influenced by number of laterals open

8

Open up a lateral to measure flow

9

Drip manufacturer	Drip model	Pipe size (ID mm)	Flow rate required (L/min) to achieve 0.5 m/sec
Netafim	Dripnet PC AS 12	10.6	2.6
Rivulis	D2000 / Hydrogol / D5000PC/AS / HydroPC 16	13.8	4.5
Toro	16mm Drip-in Classic	14	4.6
Netafim	Aries HWD / UniRam AS 16 / Dripnet PC AS 16	14.2	4.8
Rivulis	D2000 / D5000PC/AS / HydroPC 17	15.3	5.5
Toro	Neptune PC	15.4	5.6
Netafim Rivulis	Aries HWD / UniRam AS 20 Dripnet PC AS 20 R2000 / GR dripline / NGR / D4500 R5000PC	17.5	7.2
Rivulis	D2000 / Hydrogol / D5000PC/AS HydroPC 20	17.6	7.3
Toro	20mm Drip-in Classic	18	7.6
Netafim Rivulis Toro	UniRam AS 23 / Dripnet PC AS 23 D2000 / D5000PC/AS Neptune PC	20.8	10.2
Netafim Rivulis Toro	Typhoon Plus D5000PC Neptune PC	25	14.7

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Worked example of flushing velocity for Toro Neptune PC (ID 15.4mm)
For Neptune PC (ID 15.4mm) from Table 8, the flow rate cannot be less than **5.6 L/min** to be sure of achieving a flushing velocity of 0.5 m/s.
No. of laterals open: 1. Discharge (L/min): 15.5
No. of laterals open: 2. Discharge (L/min): 10.1
No. of laterals open: 4. Discharge (L/min): 5.8
In this situation 4 laterals can only be opened at any one time.

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11

IRRIGATION DATA TABLE

Description	Units		
Crop		Almonds	Almonds / Pistachio
Irrigation Area (Net)	Ha		
Rows\Beds Spacing	Mtr.	7.25	
Plants Spacing	Mtr.	5.0	
Irrigation System		In-Line Drip	
Emitter Type		Uniram CNL 20012 & 23010	
Minimum Emitter Pressure	Mtr.	13.00	
Emitter Discharge	L/H	1.60	
Emitter Spacing	Mtr.	0.44	
Laterals Average Spacing	Mtr.	7.25	
No. of Laterals per Row\Bed	No.	2	
Application Rate	mm/h	1.00	
Max. Daily Consumption	mm/day	12.00	
Irrigation Cycle	Days	1	
Duration of one Operation	Hrs.	11.96	
Number of Operations	No.	2	
Max. Daily Operation Duration	Hrs.	23.93	
Available Daily Duration	Hrs.	24	
Max. Flow Variation	%	0.0	
Mainline Flexibility		Maximum	
Max Number of Laterals per Flush Tap	No.	Uniram 20012 = 36 Laterals Uniram 23010 = 28 Laterals	
Pump Duty (Excludes Backflush Requirements)		Stage 2 & Stage 3 North Pump Station	Stage 3 South Pump Station
Maximum Discharge Required	m3/h	4580.0	3600.0
Maximum Discharge Required	lps	1272.2	1000.0
Required Pressure at Water Source	Mtr.	57.0	57.0
Required Pressure After Filtration	Mtr.	47.0	47.0
Assumed Water RL:	Mtr.	51.9	51.9

Following losses have been allowed for in the calculation of the pump TDH: Suction Line=3.0m, Misc/headworks=2.0m, Filtration=7.0m, In-Field losses=2.0m

12

Need to increase flushing velocity?

13

14

15

16

SYSTEM SANITATION

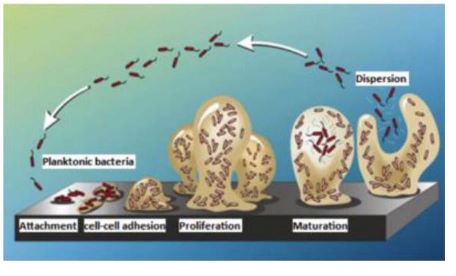
1. Chlorine
2. Hydrogen peroxide

Both control organic matter

Becoming a more common practice

17

Biofilm development



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1. Chlorination

- Traditional chemical used for sanitation
- Purchase for short term use only
- 10-15 mg/L (ppm) injected
- 0.5-2 mg/L detectable at end of system (intermittent treatment)
  - Sodium hypochlorite 12.5% (liquid)
  - Calcium hypochlorite 65% (solid)

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Calculating injection rate
(intermittent treatment)

NEED TO KNOW THREE THINGS

1. System (shift) flow rate (e.g. 80 L/s, from system design or flow meter)
2. Concentration of active ingredient
   - e.g. 12.5% liquid chlorine
3. Concentration of peroxide required for injection
   - Usually 10 mg/L (ppm) for intermittent treatment

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Calculating chlorine injection rate

$$= \frac{\text{Sys flow rate (L/s) x Req. conc. (mg/L) x 0.36}}{\text{Active ingredient \%}}$$

$$= \frac{\text{80 L/s x 10 mg/L x 0.36}}{12.5}$$

$$= 23 \text{ L/h}$$

Rule of thumb: 1-1.5 L/hr per Hectare to be irrigated
(for systems with an application rate approx. 1 mm/h)

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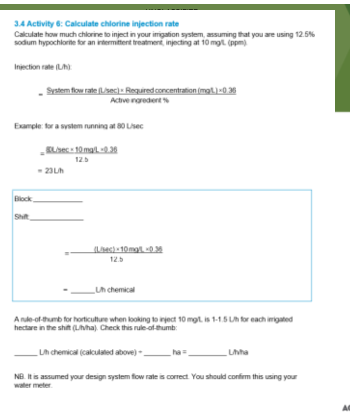

3.4 Activity 6: Calculate chlorine injection rate

Calculate how much chlorine to inject in your irrigation system, assuming that you are using 12.5% sodium hypochlorite for an intermittent treatment, injecting at 10 mg/L (ppm).

Injection rate (L/h):

$$= \frac{\text{System flow rate (L/sec)} \times \text{Required concentration (mg/L)} \times 0.36}{\text{Active ingredient \%}}$$

Example: for a system running at 80 L/sec

$$= \frac{\text{80L/sec} \times \text{10 mg/L} \times 0.36}{12.5}$$

= 23 L/h

Block:____________

Shift:____________

$$= \frac{\text{\_\_\_\_\_\_ (L/sec)} \times \text{10 mg/L} \times 0.36}{12.5}$$

= ______L/h chemical

A rule-of-thumb for horticulture when looking to inject 10 mg/L is 1-1.5 L/h for each irrigated hectare in the shift (L/h/ha). Check this rule-of-thumb:

______ L/h chemical (calculated above) ÷ _______ ha = __________ L/h/ha

NB. It is assumed your design system flow rate is correct. You should confirm this using your water meter.

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Chlorination to reduce dripper output variation

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2. Hydrogen peroxide

- Is **VERY** corrosive – safety procedures needed
- Stronger oxidising agent than chlorine
- Effective in high pH (Darling River)
- Can be stored long term, but separately in shade
- Can be used by organic growers**
- Various concentrations available – 35 or 50% recommended
- Test strips available
- **30-50 mg/L** injected; **8-10 mg/L** detectable at end of system (test strips)

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Calculating injection rate
(intermittent treatment)

Same calculation as chlorine

$$= \frac{\text{Sys flow rate (L/s) x Req. conc. (mg/L) x 0.36}}{\text{Active ingredient \%}}$$

$$= \frac{\text{80 L/s x } \mathbf{30} \text{ mg/L x 0.36}}{\mathbf{50}}$$

= 17.3 (say 18) L/h

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What does 18 L/h mean?

- This is an injection rate
- Flush the system if dirty
- If injector pumps 1,000 L/hr, add 18 L of peroxide to 922 L water and inject for 1 hour
- Determine that peroxide has reached the furthest point (test strips)
- Leave in system overnight
- Flush again

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3.5 Activity 7: Calculate hydrogen peroxide injection rate – intermittent treatment

Calculate how much hydrogen peroxide to inject in your irrigation system, assuming that you are using 50% for an intermittent treatment, injecting at 30 mg/L (ppm).

Injection rate (L/h):

$$= \frac{\text{System flow rate (L/sec)} \times \text{Required concentration (mg/L)} \times 0.36}{\text{Active ingredient \%}}$$

Example: for a system running at 80 L/sec

$$= \frac{\text{80 L/sec} \times \text{30 mg/L} \times 0.36}{50}$$

= 17.3 (say 18) L/h

Block:__________

Shift:__________

$$= \frac{\_\_\_\_\text{(L/sec)} \times \text{30 mg/L} \times 0.36}{50}$$

= ________L/h chemical

A rule-of-thumb for horticulture when looking to inject 30 mg/L is 0.5 L/h for each irrigated hectare in the shift (L/h/ha). Check this rule-of-thumb:

______ L/h chemical (calculated above) ÷ ______ ha = __________ L/h/ha

NB. It is assumed your design system flow rate is correct. You should confirm this using your water meter.

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Sanitation (cont.)

Important to inject correct amount of chemical

TOO MUCH

- Corrosion of low-grade stainless-steel components; eg solenoids
- Effects diaphragm of older drippers
- Waste of money

TOO LITTLE

- Ineffective sanitation

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Calculating <u>continuous</u> injection rate

Same calculation

Peroxide injection rate (L/h)

$$= \frac{\text{Sys flow rate (L/s) x Req. conc. (mg/L) x 0.36}}{\text{Active ingredient \%}}$$

$$= \frac{\text{80 L/s x } \mathbf{2} \text{ mg/L x 0.36}}{50}$$

= 1.2 L/h

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Continuous injection - mobile

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Continuous injection - permanent

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Continuous injection

- Becoming popular for larger systems
- Must be professionally designed
- Generally using peroxide rather than chlorine
- Typically injecting 2-5 ppm
- Fertigation / peroxide interaction?

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Injection spreadsheets available

Peroxide Injection rates

NETAFIM

Peroxide injection rates L/H

Area Hect.	Required Peroxide concentration ppm						
	2	5	10	30	50	100	200
1	0.04	0.09	0.18	0.53	0.88	1.77	3.53
5	0.18	0.44	0.88	2.65	4.41	8.83	17.66
10	0.35	0.88	1.77	5.30	8.83	17.66	35.31
20	0.71	1.77	3.53	10.59	17.66	35.31	70.62
50	1.77	4.41	8.83	26.48	44.14	88.28	176.55
100	3.53	8.83	17.66	52.97	88.28	176.55	353.10
150	5.30	13.24	26.48	79.45	132.41	264.83	529.66
200	7.06	17.66	35.31	105.93	176.55	353.10	706.21
250	8.83	22.07	44.14	132.41	220.69	441.38	882.76
300	10.59	26.48	52.97	158.90	264.83	529.66	1,059.31

Based on 1mm/h system

- Utilising 50% concentration
- Injection concentration
  - Periodic inj.-30 – 50 ppm
  - Continuous inj.-2 – 5 ppm
- Make sure injection system components are compatible
  - Seek professional help

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Filtration issues prior to continuously injecting peroxide

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Filters following peroxide program

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Emitters before and after peroxide injection

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Bryozoa on disc filter

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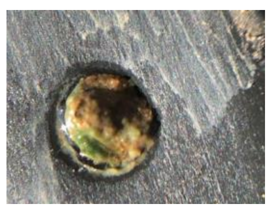

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Fertiliser residue

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ACID INJECTION

- Used to dissolve **mineral** deposits
- Rarely used in Mallee. Possible use in;
  - Error in fertiliser mixing / poor cleaning
  - Groundwater
  - Certain water sources (Lake Cullulleraine, upper Darling River)
- Carryout acid titration to drop water to pH 2 – 4 (usually pH 3)
- Different types of acid
  - Organic
  - Mineral
- Observe OH & S issues

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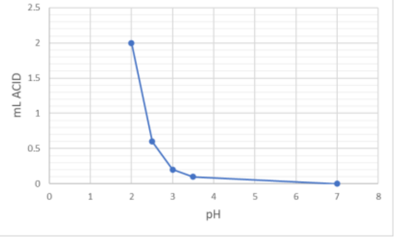
Acid titration



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Calculating acid injection rate – small system

Example
System flow rate 18 L/s
Titration found 0.2 ml/L needed to drop pH to 3

0.2 x 18 L/s x 3.6 = 13 L/h

Adjust for injection time (eg 15 min)

$$\frac{13 \text{ L/h} \times 15}{60} = 3.3 \text{ L (say 5 L)}$$

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If injector pumps 1,000 L/hr, and acid is to be injected for 15 minutes (1/4 hr);

¼ full tank 250 L (15 minutes worth)

245 L water, 5 L acid
Always add acid to water

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3.8 Activity 10: Calculate acid injection rate

Use the results of the acid titration and your system flow rate to determine the amount of acid to inject.

1. Required acid injection rate (L/h) = titration acid level (ml) × system flow rate (L/s) × 3.6
2. Required quantity of acid = $\frac{\text{Injection rate (L/h from above)} \times \text{injection time (mins)}}{60}$

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Peroxide & acid program to reduce flow variation

Dripper maintenance			
Dripper No.	No Treatment	Hydrogen Peroxide	Nitric Acid
1	2.7	2.4	2.3
2	2.5	2.5	2.3
3	2.4	2.4	2.3
4	2.4	2.6	2.3
5	2.3	2.5	2.3
6	2.5	2.4	2.3
7	2.9	2.5	2.3
8	2.6	2.4	2.3
9	2.8	2.6	2.3
10	2.2	2.5	2.3
11	2.4	2.5	2.3
12	3	2.9	2.4
13	2.6	2.5	2.3
Sum	33.3	32.7	30
Average	2.56	2.52	2.31
Variation ± %	15.38	9.43	2.13

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CONCLUSION

- Use the right chemical for the problem
- Record system flow rate before and after maintenance program to determine effectiveness
- Local contractors may be available to carryout chlorine and acid injection
- Observe OH & S issues
- Correct container disposal

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Monitoring drip irrigation systems

1. Conventional method of monitoring performance
2. Drip drainage
3. Alternative monitoring methods

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1. Conventional drip monitoring

- Pressure (kPa)
- Dripper flow rate (L/hr)
- Calculate variation
- Compare results to manufacturers charts and design description

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Measuring drip pressure and discharge

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3

Measuring micro pressure and discharge

Pressure

Discharge

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4

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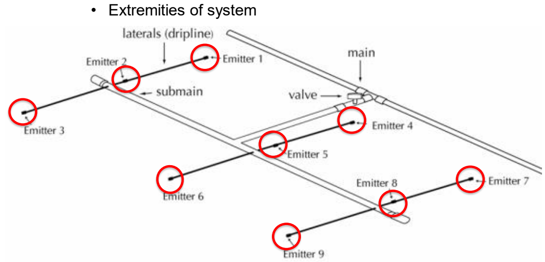
Pressure & discharge variation

- Measure
  - Extremities of system



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Pressure & discharge variation

- Where?
  - Extremities of system
  - High and low points
  - Weak area
- When?
  - new system
  - after maintenance program such as chlorination
- Measure pressure and flow at the same location

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	ml in 36 seconds					
Dripper no.	Discharge 1	Discharge 2	Discharge 3	Average discharge	Discharge (L/hr) × 100	Pressure (kPa)
1						
2						
3						
4						
5						
6						
7						
8						
9						

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2.4 Activity 4: Calculate your pressure and discharge variation

Enter your data collected in the field in the following table. Follow the instructions in the left hand column to determine your pressure and discharge variation.

Emitter	Pressures (kPa)	Discharge (L/hr) Volume (ml in 36 sec × 100)
1		
2		
3		
4		
5		
6		
7		
8		
9		
Firstly add up all the pressures and discharge	Total pressure =	Total discharge =
To calculate the average pressure and discharge rate divide the totals by the number of emitters measured	Average = Total pressure / ……… (No. of emitters) = ……kPa	Average = Total pressure / ……… (No. of emitters) = ……L/hr
To calculate the Midpoint, select and add together the Maximum and Minimum and divide the result by two.	Midpoint = Max + Min / 2 = ………	Midpoint = Max + Min / 2 = ………
To calculate variation subtract the Minimum from the Midpoint, divide this by the Midpoint and multiply by one hundred to get a Percentage.	Variation = (Mid - Min) × 100 / ………Mid = ± ………% **Acceptable is < ± 10%**	Variation = (Mid - Min) × 100 / ………Mid = ± ………% **Acceptable is < ± 5%**

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IRRIGATION DATA TABLE			
Description	Units		
Crop		Almonds	Almonds / Pistachio
Irrigation Area (Net)	Ha		
Rows\Beds Spacing	Mtr.	7.25	
Plants Spacing	Mtr.	5.0	
Irrigation System		In-Line Drip	
Emitter Type		Uniram CNL 20012 & 23010	
Minimum Emitter Pressure	Mtr.	13.00	
Emitter Discharge	L/H	1.60	
Emitter Spacing	Mtr.	0.44	
Laterals Average Spacing	Mtr.	7.25	
No. of Laterals per Row\Bed	No.	2	
Application Rate	mm/h	1.00	
Max. Daily Consumption	mm/day	12.00	
Irrigation Cycle	Days	1	
Duration of one Operation	Hrs.	11.96	
Number of Operations	No.	2	
Max. Daily Operation Duration	Hrs.	23.93	
Available Daily Duration	Hrs.	24	
Max. Flow Variation	%	0.0	
Mainline Flexibility		Maximum	
Max Number of Laterals per Flush Tap	No.	Uniram 20012 = 36 Laterals Uniram 23010 = 28 Laterals	
Pump Duty (Excludes Backflush Requirements)		Stage 2 & Stage 3 North Pump Station	Stage 3 South Pump Station
Maximum Discharge Required	m3/h	4580.0	3600.0
Maximum Discharge Required	lps	1272.2	1000.0
Required Pressure at Water Source	Mtr.	57.0	57.0
Required Pressure After Filtration	Mtr.	47.0	47.0
Assumed Water RL:	Mtr.	51.9	51.9

Following losses have been allowed for in the calculation of the pump TDH: Suction Line=3.0m, Misc/headworks=2.0m, Filtration=7.0m, In-Field losses=2.0m

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EMITTER		PRESSURES (kPa)	FLOW RATES (l/hr)
1		95	3
2		87	3
3		70	3
4		82	3.05
5		70	2.8
6		70	2.9
7		100	3.05
8		90	3
9		85	2.95
	Totals =	**749**	**26.75**
AVERAGE =	To calculate the **average** pressure and flow rate divide the totals by the number of emitters measured	83.2	3.0
MIDPOINT =	To calculate the **Midpoint**, select and add together the Maximum and Minimum and divide the result by two	85.0	2.9
VARIATION % =	To calculate **variation** subtract the Minimum from the Midpoint, divide this by the Midpoint and multiply by one hundred to get a Percentage	17.6	4.3

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Why measure PC dripper operating pressure?

- Are they operating within acceptable limits (50 - 400kPa)?
- Are DNL's an option?
- Is adequate flushing possible?
- Does excessive pressure exist? – energy efficiency

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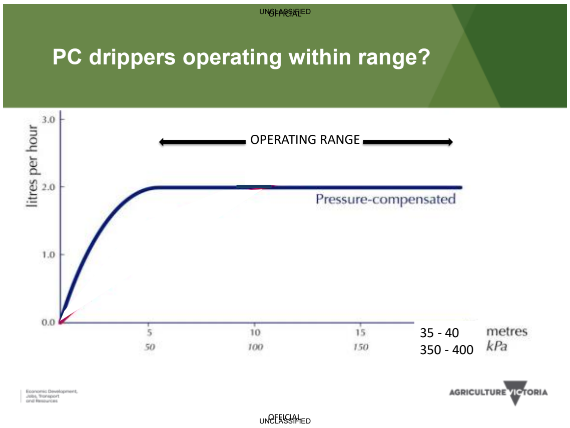

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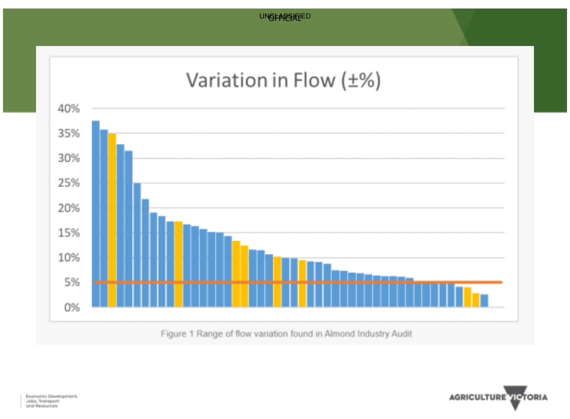

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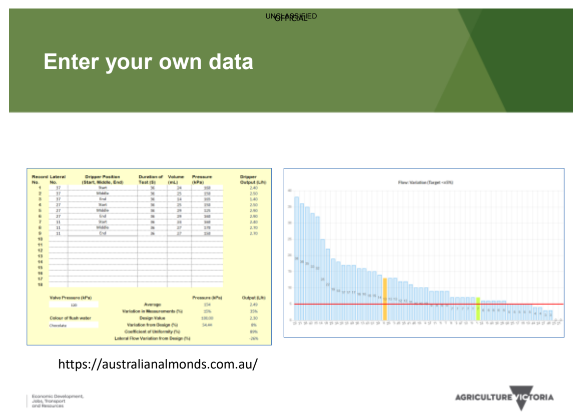

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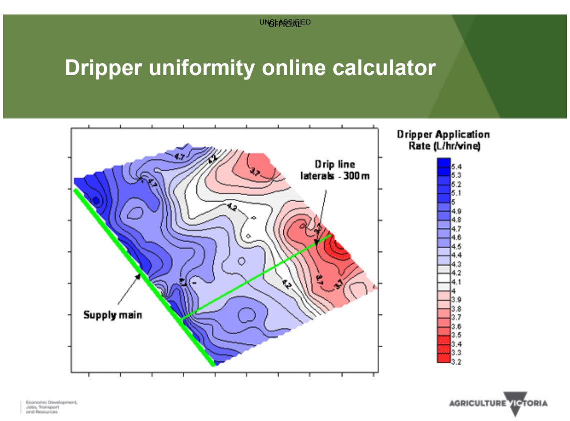

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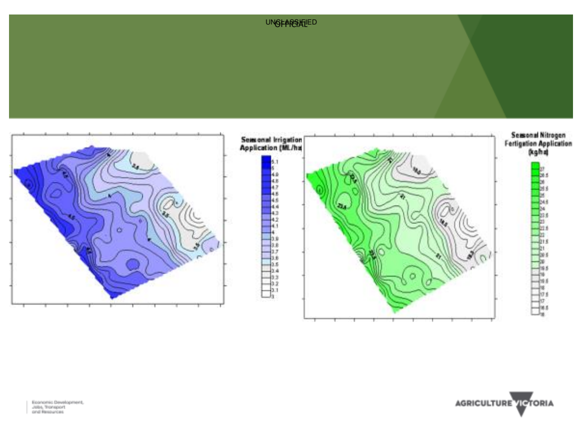

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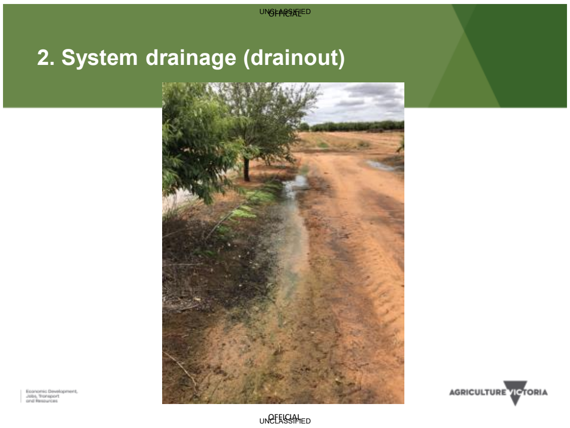

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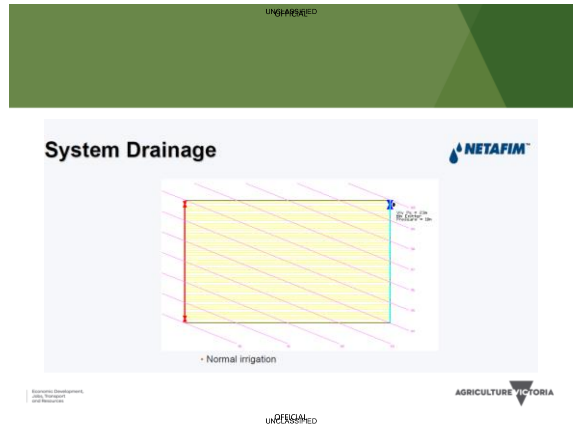

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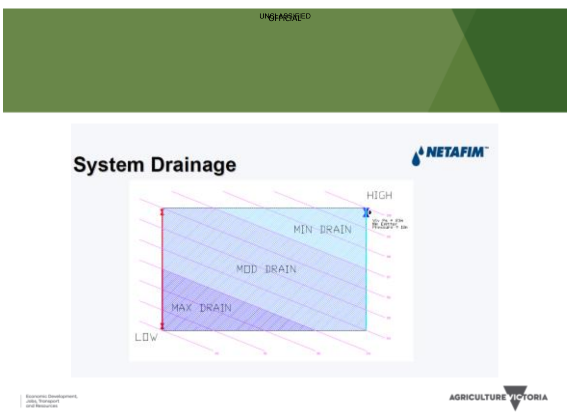

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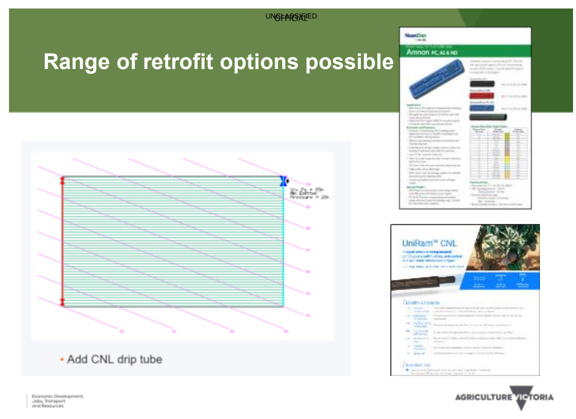

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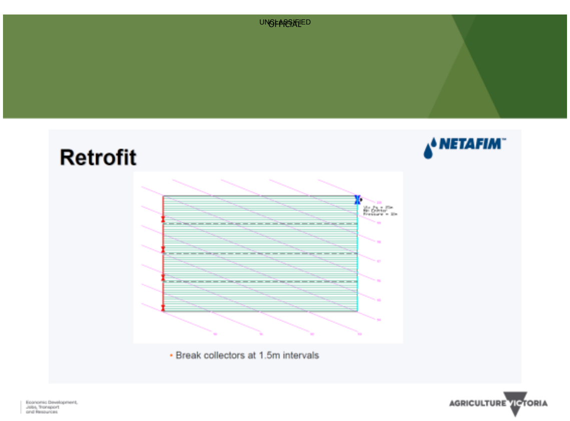

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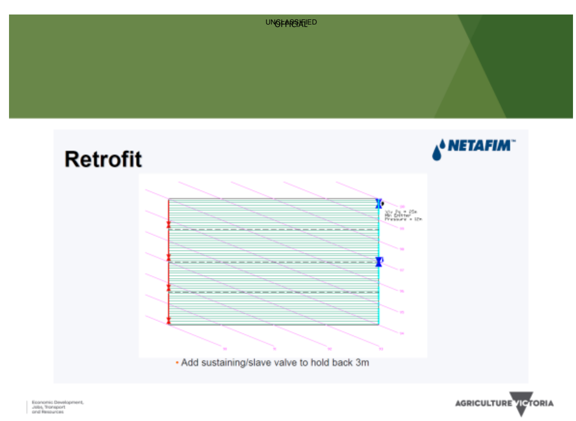

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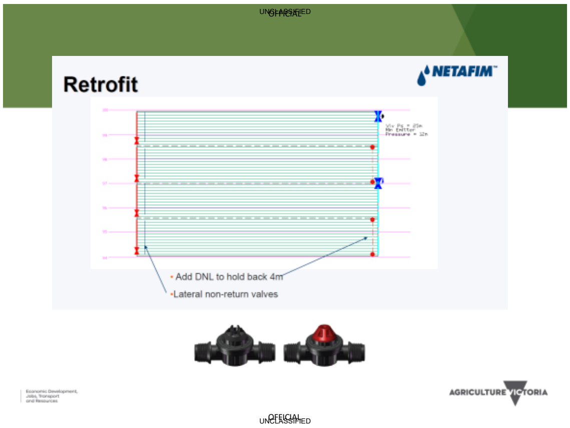

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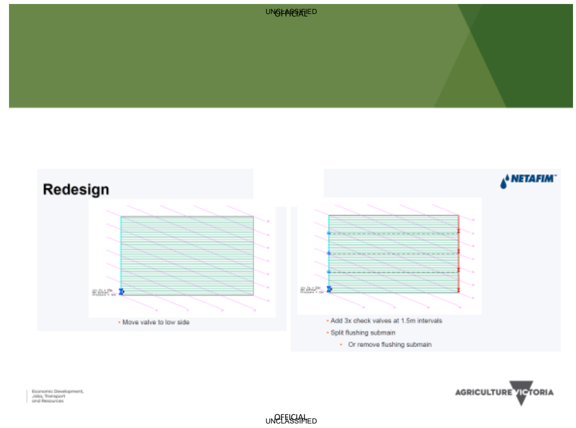

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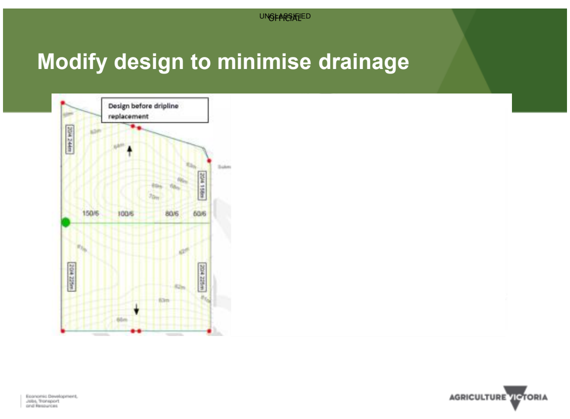

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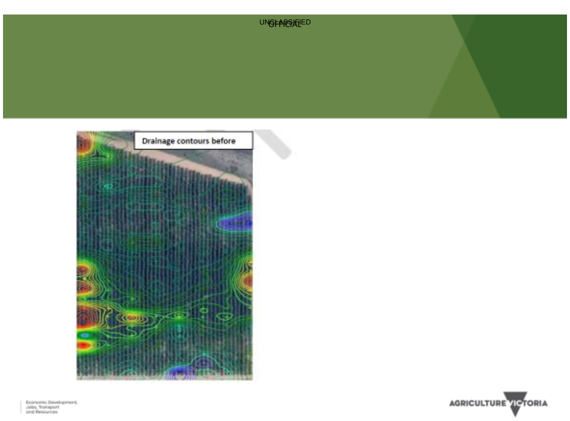

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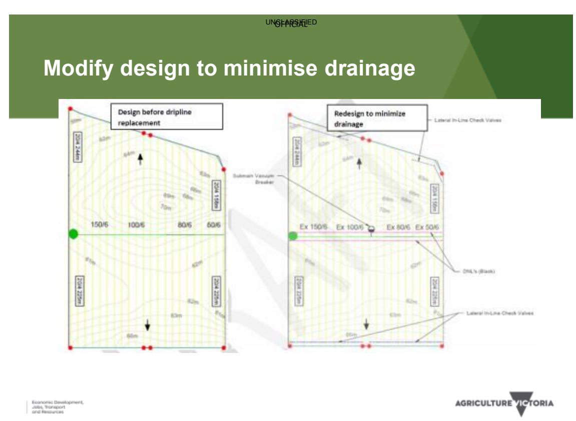

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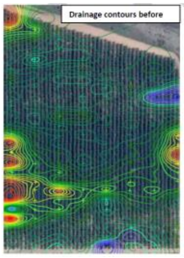

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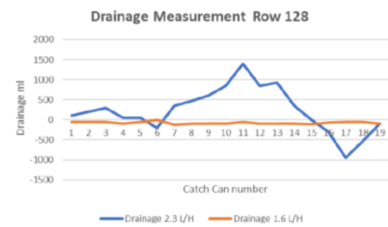

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Agriculture Victoria fact sheet:

https://australianalmonds.com.au/topic/irrigation


Minimising drip system drainage

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3. Alternative monitoring methods

- Flow meters
- Satellite imagery – uniformity?
- In-line sensors – water delivery

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Using flow meters

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Satellite imagery - IrriSAT

https://irrisat.app/

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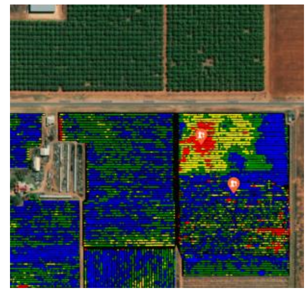
Satellite imagery - Ceres Imaging



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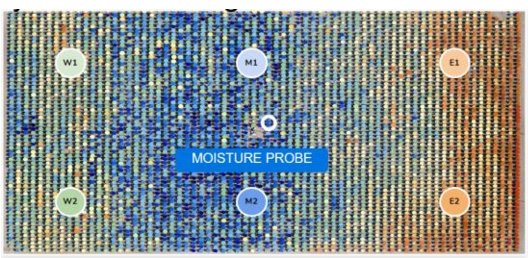
Satellite imagery - Aerobotics



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In-line sensors - Phytech

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In-line sensors - Greenbrain

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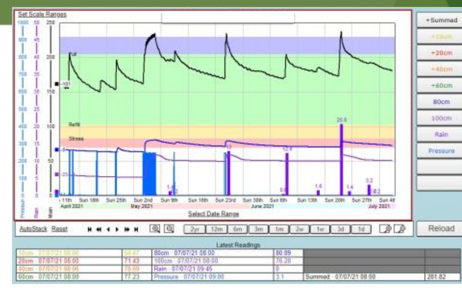
In-line sensors - Mait Industries



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Take home messages

- Good irrigation management assumes uniform water application
- Drip drainage starting to be considered
- Conventional and modern methods of determining variability and system performance exist.

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