Troubleshooting Techniques for Efficient Drip Irrigation Systems

Khaled M. Bali
Statewide Irrigation Water Management Specialist- Kearney REC
and
Andre Biscaro
Irrigation and Water Resources Advisor- UCCE Ventura County
kmbali@ucanr.edu

UC Agriculture and Natural Resources
University of California

2025 Irrigation and Nutrient Management Meeting
For Vegetable and Berry Crops- Ventura 8/21/2025

Goals

- Simple and quick approach to evaluate drip irrigation system performance

- Connecting distribution uniformity (DU) to flow rate (Q)

- Practical examples based on data from Ventura and other locations in CA

Irrigation Water Management:

What you need to know to Design a Drip System

- Crop, farm size, soil type, water source, water quality, water availability, etc
- Max. Crop water use (units, gallons/tree per day, in/day)
- Flow rate (gpm, gph, or cfs)
- Design Pressure (1 psi=2.31 ft, typically 10-20 psi)
- Variation in elevation if any
- Other considerations (example leaching, etc)

Irrigation Water Management

- Applying the right amount of water to meet crop water requirements (in/irrigation)

- Timing of irrigation events (frequency, days between irrigations)

- **Applying the water uniformly (efficiency)**

Irrigation Scheduling

- **Simple approach (Water budgeting using ETo and crop coefficients)**

- Soil moisture measurement (requires extra work, soil sampling, soil moisture sensors, dataloggers, etc)

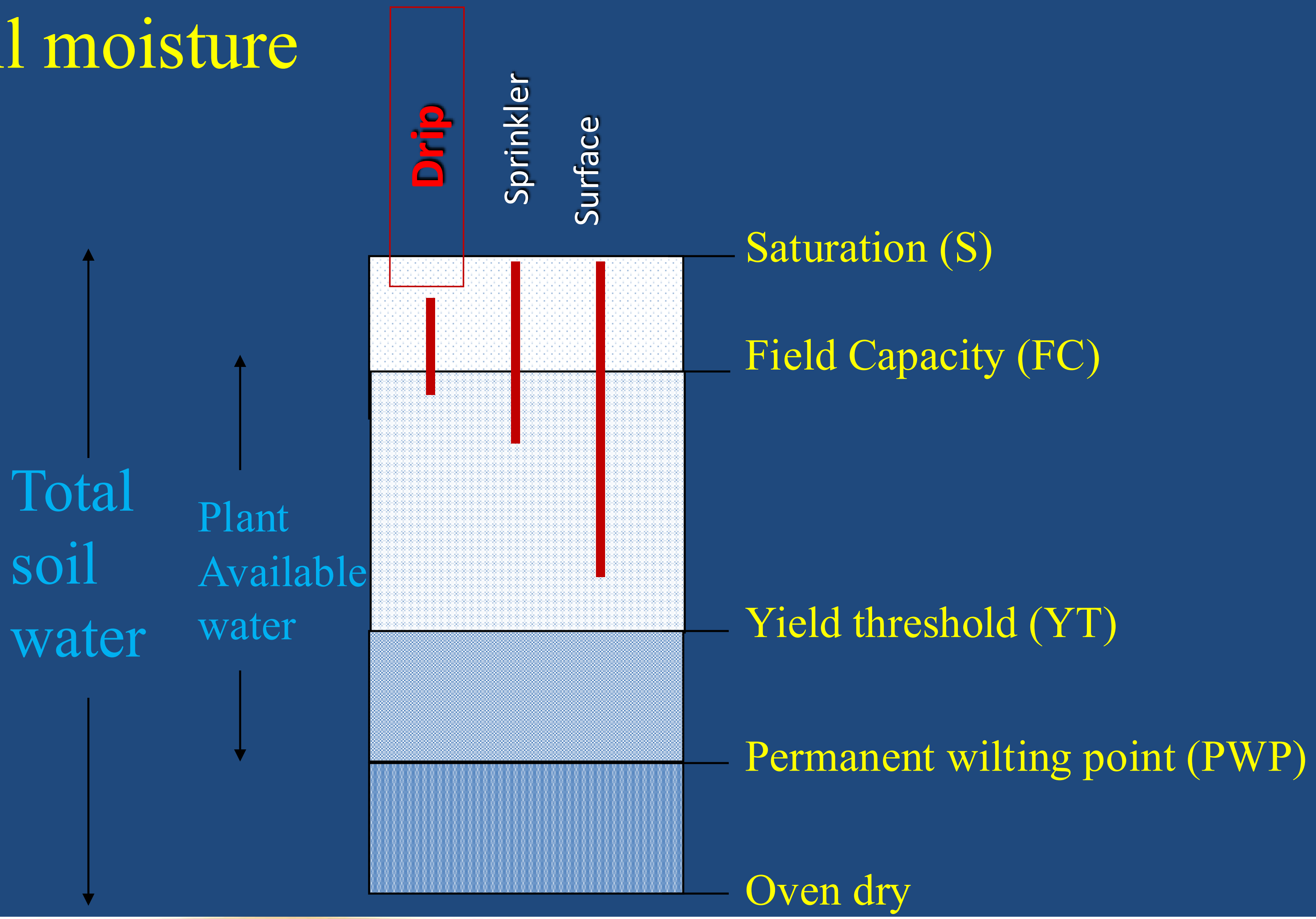
- A combination of the above two (and technologies to help in making irrigation decisions)

How Much Water do I need to Apply?

- Need to know crop water use (crop evapotranspiration, ETc) since last irrigation
- ETc from (ETo and crop coefficient)

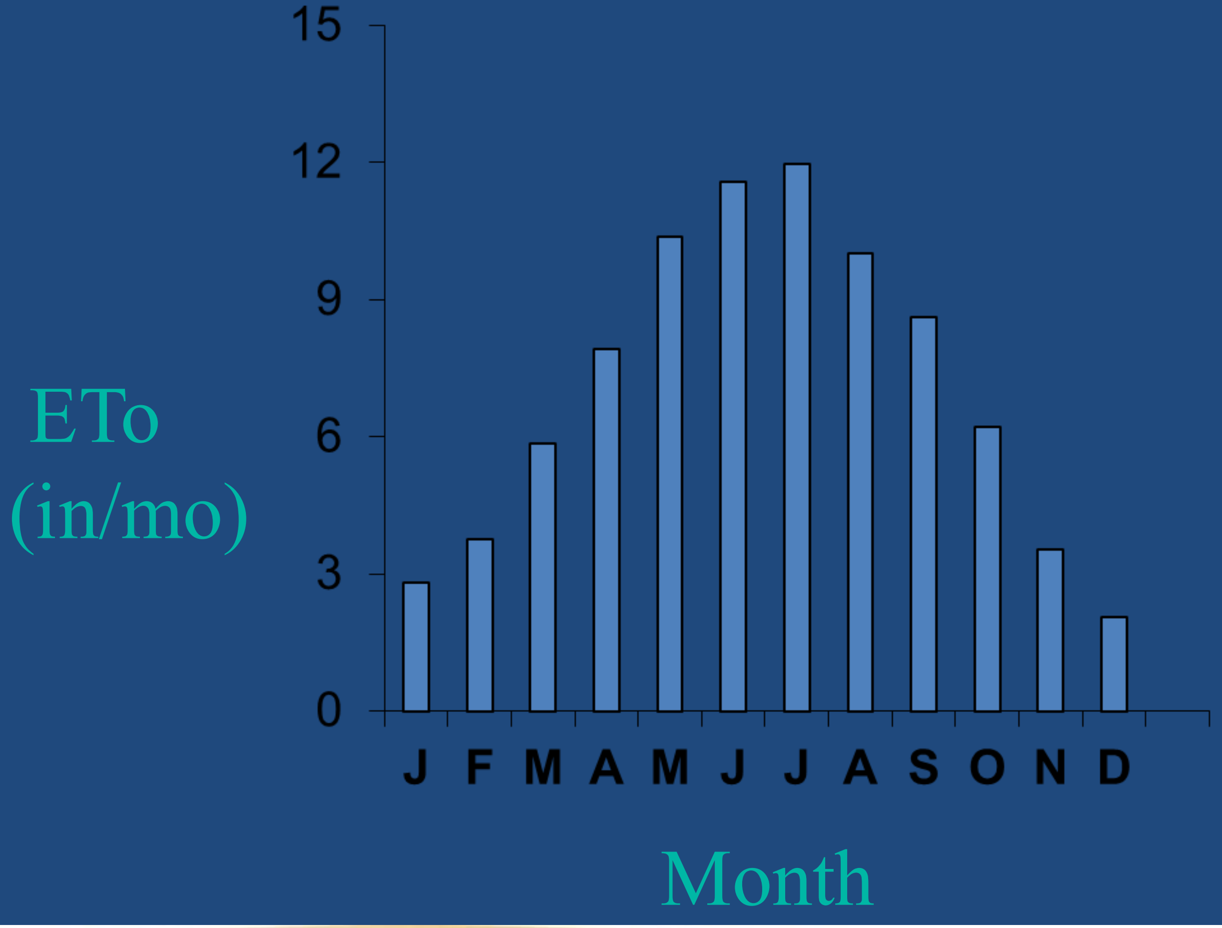
- Application rates (depends on the irrigation system and soil type):
- Surface: ~ 3-5 in/irrigation (a lot more for lighter soils)
- Sprinkler: ~ 0.5-1.5 in/irrigation
- **Drip: ~ 0.25-1 in/irrigation**

Soil moisture



Water use (ET based scheduling)

1 in= 25.4 mm



On-Farm Water Conservation
=Higher Application Efficiency (AE)

IRRIGATION =Root zone storage (ETc) + DEEP PERCOLATION + Runoff

A + B + C

Application Efficiency (AE)= A/(A+B+C)

To achieve higher efficiency, reduce B and/or C

BUT

Need to have a balance,

Deep Percolation sometimes is needed for salinity control

(700 ppm ~ 0.96 tons of salt/ac-ft but NOT with every irrigation)

Runoff is needed for Uniformity (100% AE means under irrigation)

On-Farm Water Conservation
=Higher Application Efficiency (AE)

IRRIGATION =Root zone storage (ETc) + DEEP PERCOLATION + Runoff

A + B + C

Application Efficiency (AE)= A/(A+B+C)

Deep Percolation Ratio= B/(A+B+C)

Runoff Ratio= C/(A+B+C)

Irrigation Water Requirements (IR)

IR= Crop ET/AE

For drip IR= Crop ET/DU

Distribution Uniformity (DU)

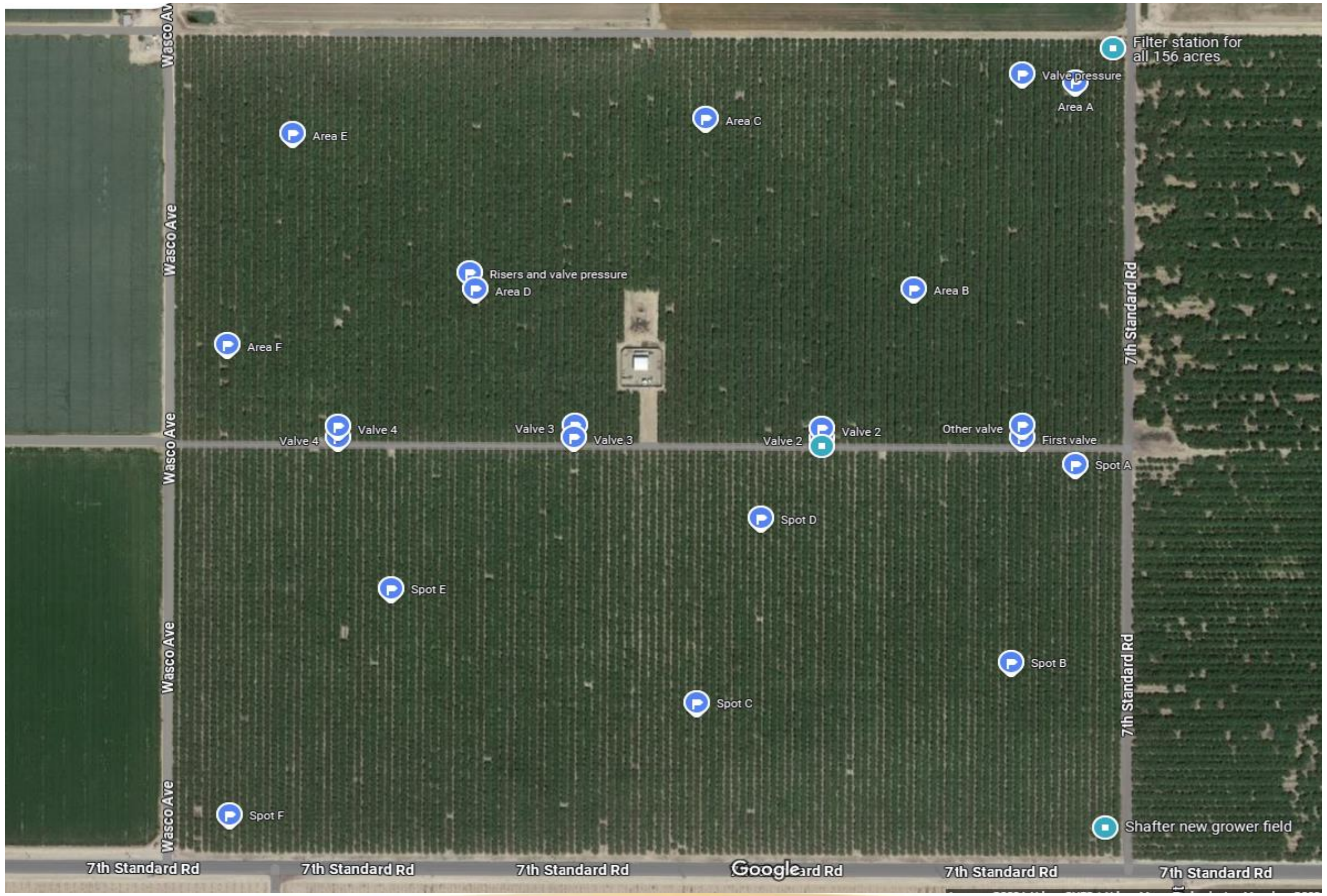
DU= Average depth in low quarter/Average depth infiltrated

Many other efficiency parameters
BUT

KEEP IT SIMPLE, AE and DU are all you need
AE could be 100% for a given drip system but the system could be completely inefficient
More focus on DU for drip systems

For drip systems, IR= Crop ET/DU

Example: Almond, Kern County, CA. Sep 2024



Example: Almond, Kern County, CA. Sep 2024

Area=Irrigation set

Water collected in 3 mins (mL)		Area A	Area B	Area C	Area D	Area E	Area F
	1	77	72	75	77	74	77
	2	76	71	75	77	72	76
	3	74	70	65	75	68	75
	4	71	65	64	75	68	74
	5	65	63	60	75	67	70
	6	65	63	57	74	66	65
	7	62	63	56	74	61	63
	8	50	61	51	67	50	58
Total Average		67.5	66	62.875	74.25	65.75	69.75
Lowest Quarter Avg.		56	62	53.5	70.5	55.5	60.5
DU		0.83	0.94	0.85	0.95	0.84	0.87
Global DU		0.88					

	Area A	Area B	Area C	Area D	Area E	Area F
PSI	13	13	19	18	16	18
Total amount of water (mL) collected per tree in 3 minutes	540	528	503	594	526	558
Drip emitter discharge rate (gph)*	0.4	0.3	0.3	0.4	0.3	0.4
Drip emitter (gph) Per tree	2.9	2.8	2.7	3.1	2.8	2.9

Calculate average application rate

Example:

Application rate 0.1 in/hr

Area irrigated 80 acres

Q=Volume/time

80 acres*0.1 in/12= 96 ac-ft (volume)

1 ac-ft= 325,850 gallons

Volume: 325,850*1.2= 391,020 gallons

Q=V/Time

Q=391,020/(60 min)=6,500 gpm

Flow meter reading 6,000 gpm

Flow meter reading: 7,200 gpm

Ventura County
Celery field August 2025

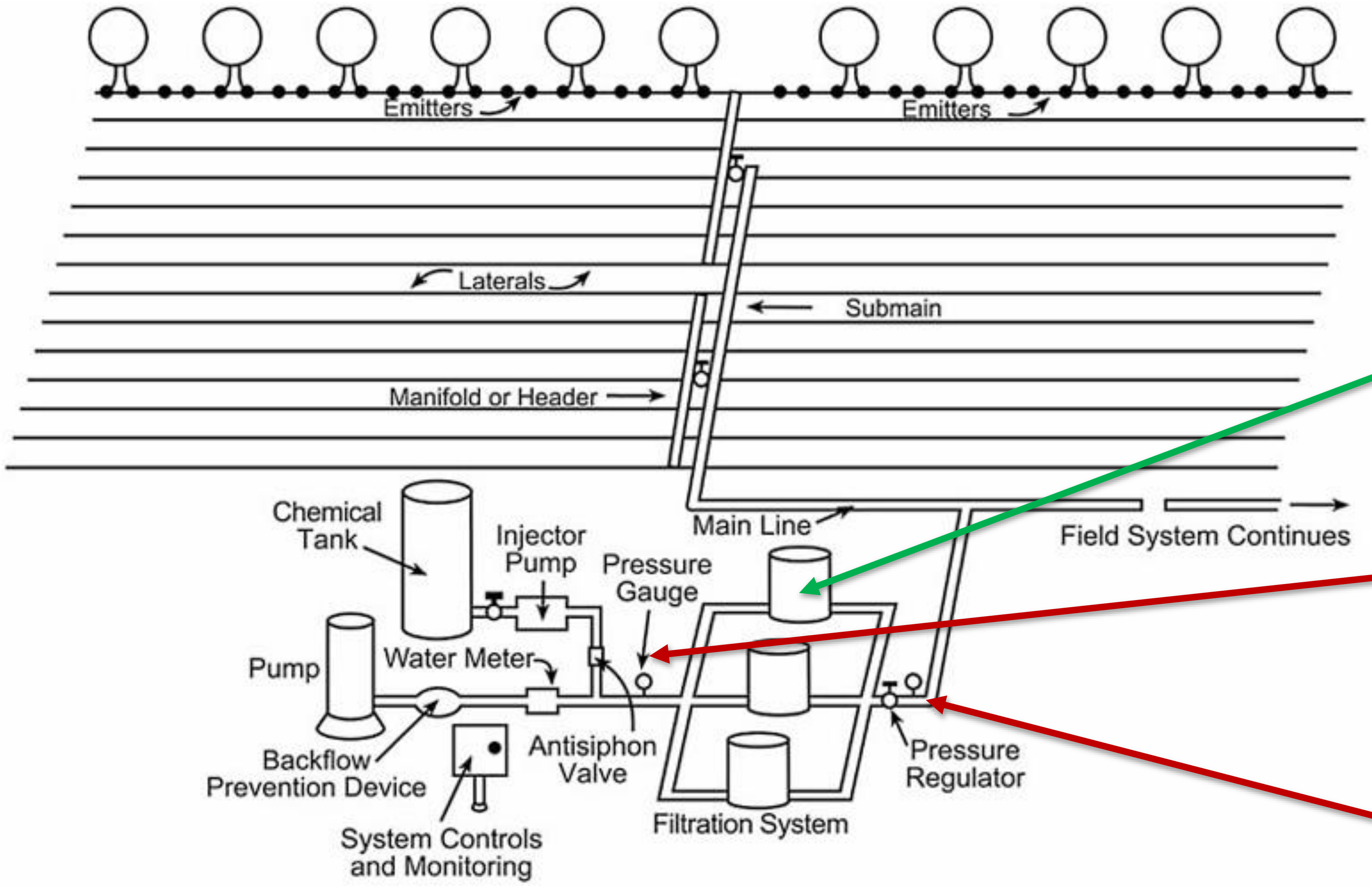
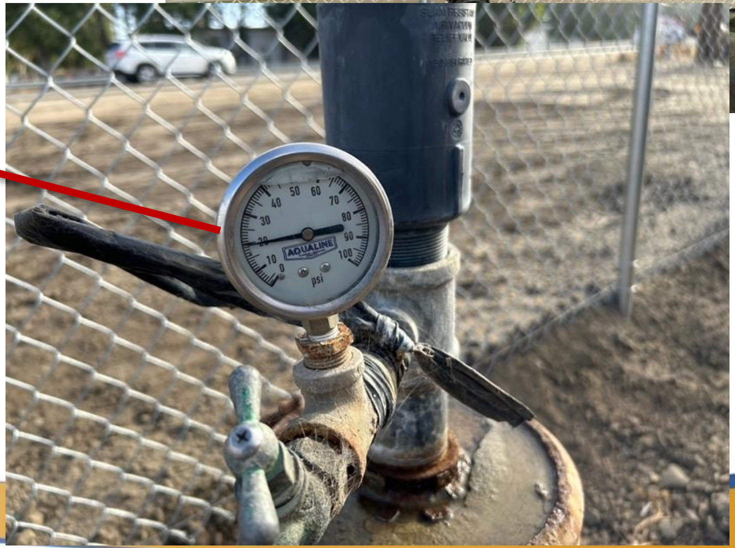


FIGURE 1.7 An example of a basic microirrigation system. *Courtesy of Kansas State University.*



Source: Microirrigation for Crop Production, 2023, Ayars, Zaccaria, and Bali

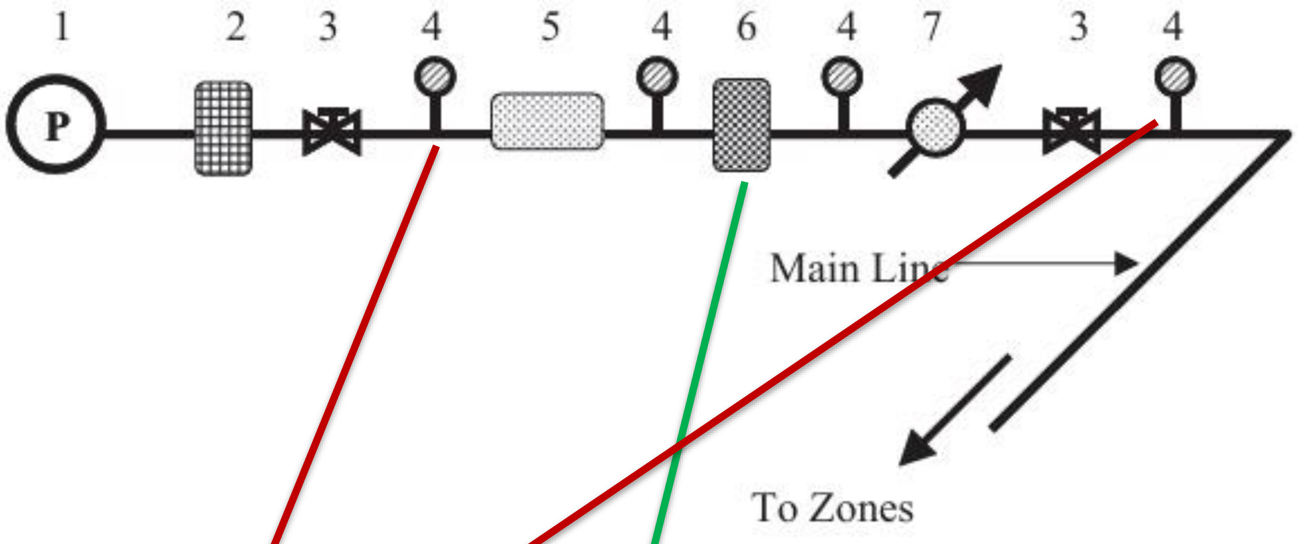


FIGURE 6.3 Example arrangement of the water supply and control head for a microirrigation system.

1. Pump or Pressurized Water Supply
2. Initial Filter for Large Particles & Sand (if needed)
3. Flow Control Valve
4. Pressure Gauge
5. Chemical Injection Station – Backflow Prevention
6. Main Filter Station
7. Flowmeter

Source: Microirrigation for Crop Production, 2023, Ayars, Zaccaria, and Bali

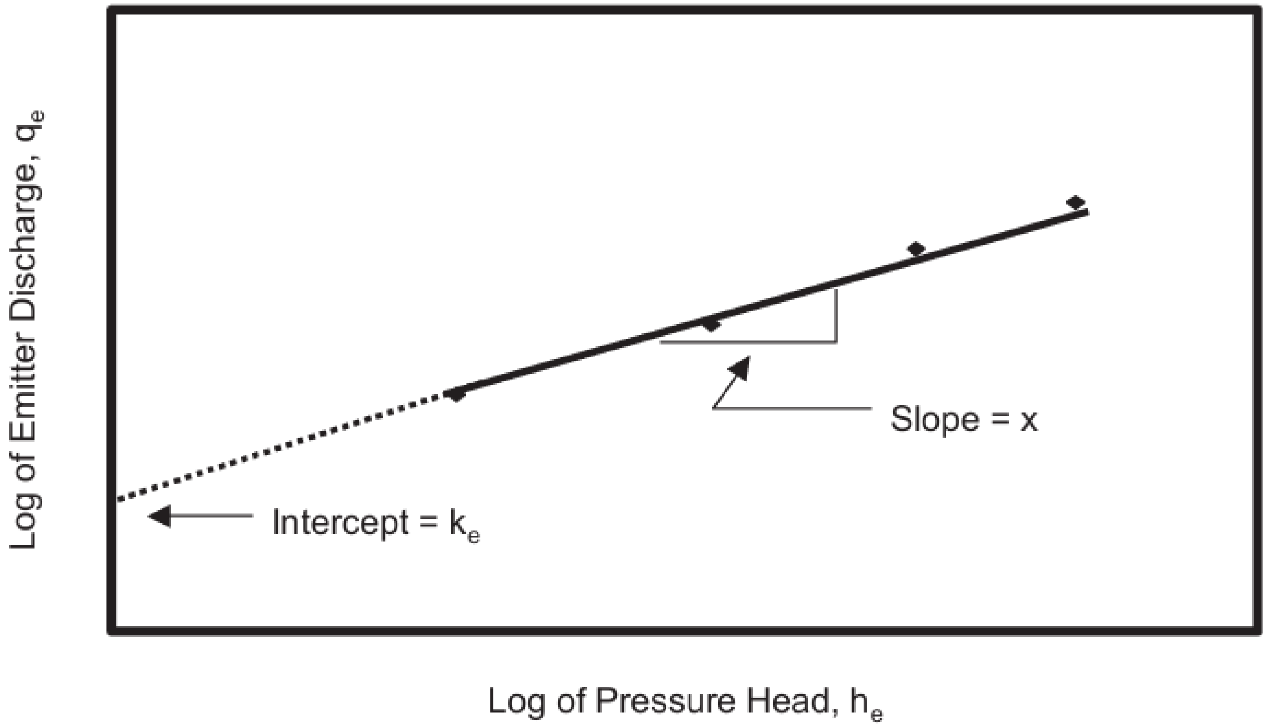
Ventura County
Celery field August 2025

P before filters =52 psi, great

Filters
Need to know Design pressure at field =10 psi

Head losses: 8 psi
P at lowest pressure location in field 12 psi

P after filters = 20 psi, great (greater than 10+8)



Source: Microirrigation for Crop Production, 2023, Ayars, Zaccaria, and Bali

Emitter flow rate (Q) is a function of Pressure (P)

Example if design P is 10 psi, Q=0.5 gpm
If P drops to 8 psi, Q ~ 0.45 gpm

Variation in flow rate due to P losses

(0.5-0.45)/0.5 or 10%

Simple goal for efficient drip system is to have no more than 10% in flow differences between emitters

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(0.45-0.5)/0.5 or 10%
Simple goal for efficient drip system
Is to have no more than <u>10% in flow</u> differences between emitters

Catch can method:
Volume over time
Close to main line
Example 100 ml in 10 minutes

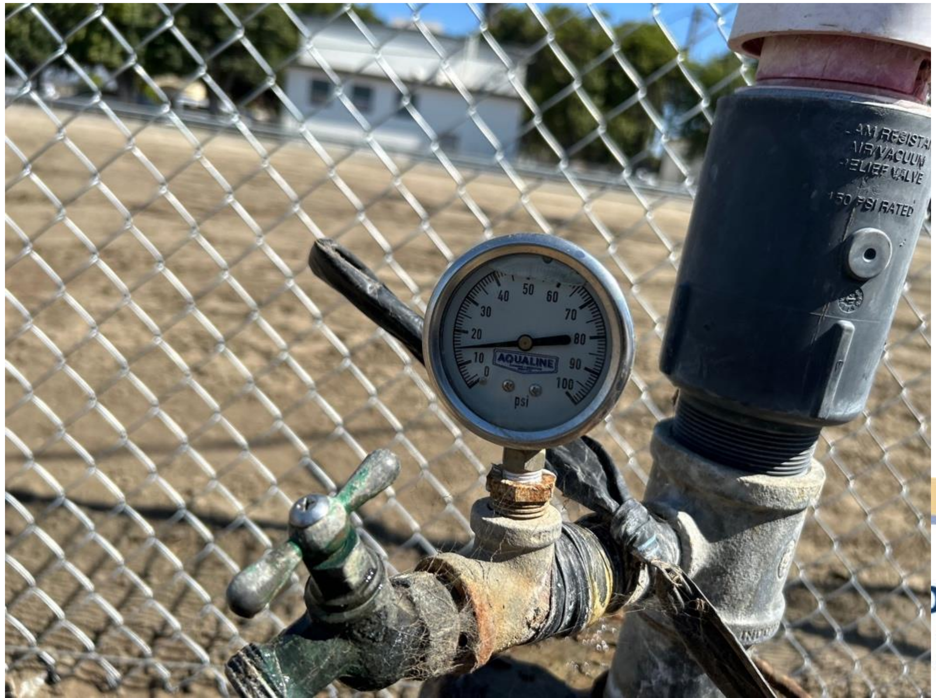
Check pressure at the potential lowest pressure location in the field/set
Example 10 psi, great

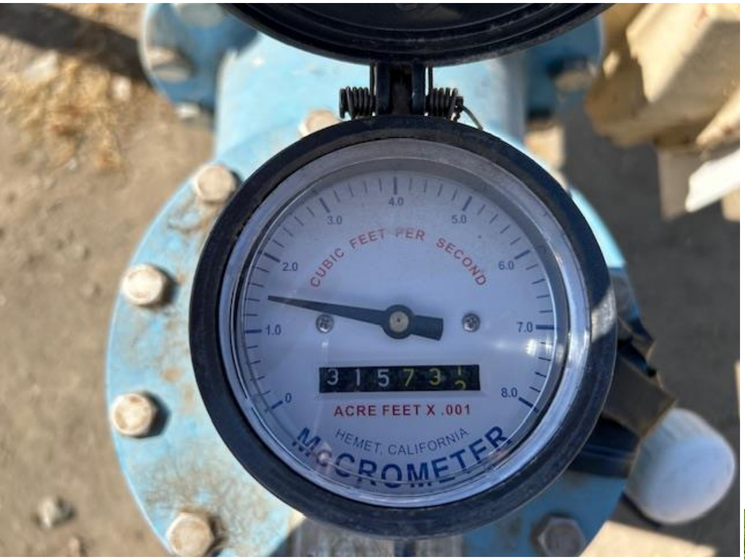
Volume over time
Close to lowest P in field/set
Example 90 ml in 10 minutes (Variation is 10%)

Check pressure again at the pumping station ☺
And talk to the irrigator (could be better than automation ☺
You could have the most advanced and efficient system, but the irrigator could increase the set size; average application rate, P, and DU will all go down (Q is constant from irrigation district)

FIGURE 1.9 Automated microirrigation controls. *Photo courtesy of Blake Mccullough-Sanden, University of California.*

Source: Microirrigation for Crop Production, 2023, Ayars, Zaccaria, and Bali





Check Q again

Q: 1.5 cfs (448*1.5= 672 gpm)

Most flow meter have cumulative volume (ac-ft)

Check the cumulative volume at different times (1-2 hrs)

Example: at 8 am V: 5.700 ac-ft, at 10 am, V: 5.900 ac-ft

Area: 800 ft*2* 94 lines (40”)

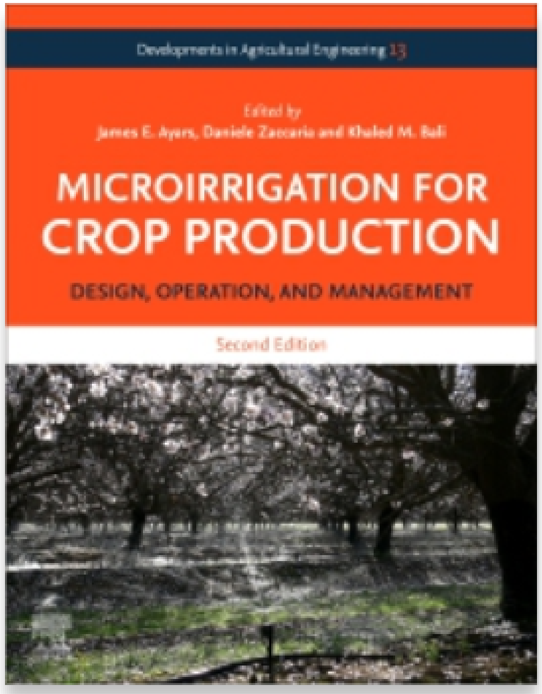
Area of irrigation set: 11.5 ac

Depth applied in 2 hrs: 0.2”

- Application rate: 0.1”/hr
- Irrig. Time: 6 hrs
- Depth applied: 0.6”
- good for 2-3 days
- if ET crop is 0.2”/day

Check soil moisture to let you know the soil moisture status

Drip Irrigation System Design



Microirrigation for Crop Production

Design, Operation, and Management

2nd Edition - November 21, 2023

Editors: James E. Ayars, Daniele Zaccaria, Khaled M. Bali

Language: English

Hardback ISBN: 9780323997195 • eBook ISBN: 9780323997201

Thank you

Q & A