Tools and Approaches for Assessing and Improving Irrigation Efficiency in Drip Irrigated Row Crops

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What is irrigation efficiency?

Comparison of the volume of water **applied** to the crop **to** the volume of water **required** by the crop for **consumptive** use (*irrigation requirement)*

- Evapotranspiration
- Salinity control (leaching of salts from the root zone)
- Climate modification (crop cooling, frost protection)

Irrigation Requirement = 13 inches

Applied Water = 15 inches

$$\text{Irrigation Efficiency} = \frac{13\ in\ \times 100}{15\ in}$$

$$= 87\%$$

Benefits of a high Irrigation Efficiency

- **Conserve water**
- **Fertigate uniformly**
- **Minimize nutrient losses**
- **Save Money**

Steps to achieving a high irrigation efficiency

- **Design**– irrigation system is designed to apply water uniformly to the crop (high Application Uniformity)
- **Operation and Maintenance**— maximize application uniformity of the irrigation system
- **Scheduling of irrigations** –match applied water with crop water needs (Irrigation Requirement)

Identify problems and fix them

Use appropriate filtration for water quality

Screen

Sand Media

Disk

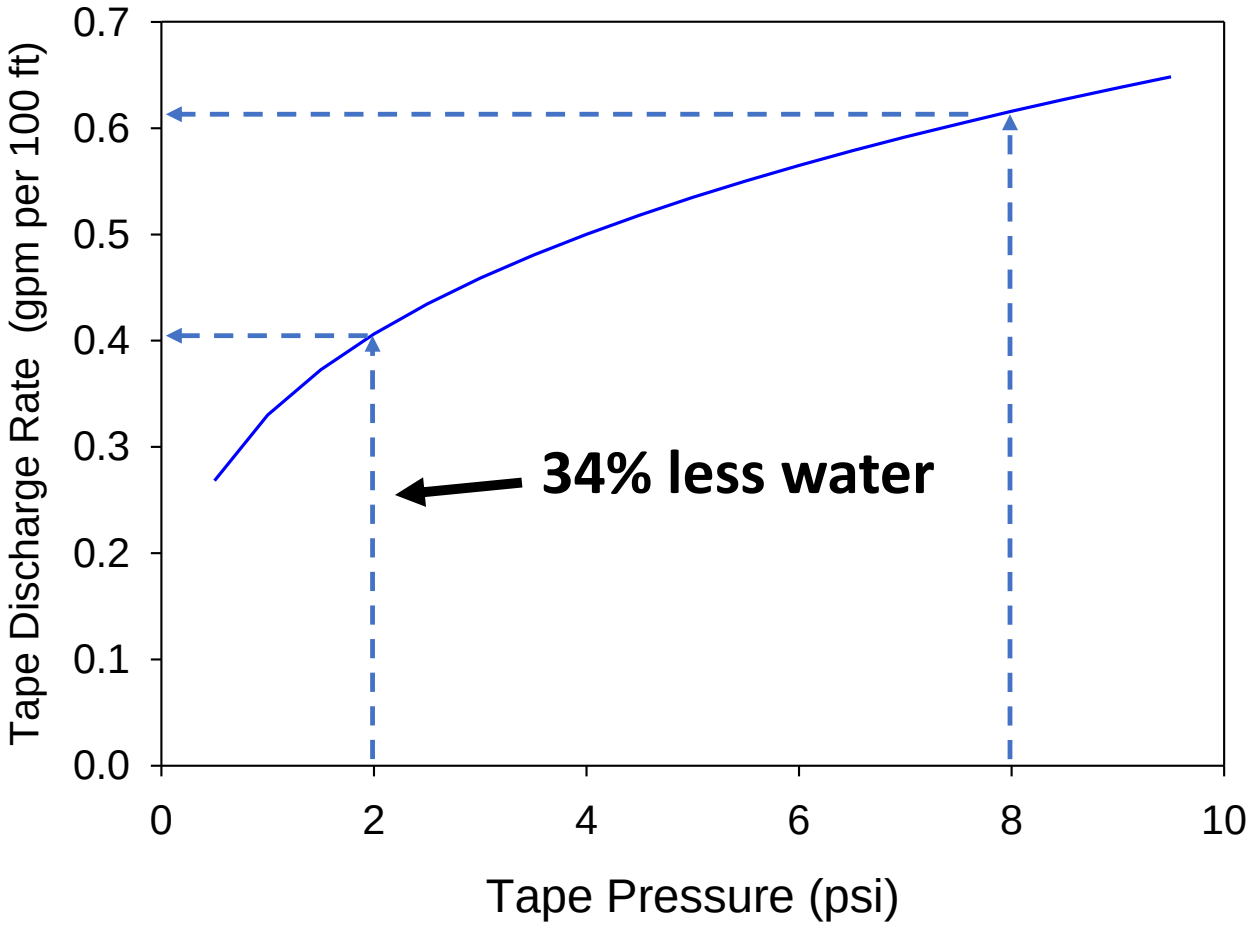
Evaluate Application Uniformity

Measure volume of water discharged from 30 or more emitters for 10 to 15 minutes: eg. 8 emitters × 5 locations in the field

$$\text{Lowest quarter} = \frac{Average\ volume\ of\ lowest\ 25\%\ of\ the\ emitters}{Average\ volume\ of\ all\ emitters}$$

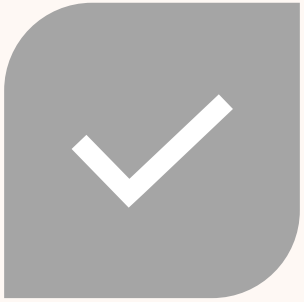
Management of Pressure is Key to Achieving a High Application Uniformity with Drip

Discharge rate of drip tape varies with pressure



Factors that increase pressure variation

ELEVATION CHANGE



UNDERSIZED FITTINGS AND PIPE

DRIP LINES ARE TOO LONG


2.3 feet of elevation change = 1 psi

Pressure Loss in Mains and Submains (psi loss per 100 ft)

Pipe Diameter (inches)	flow rate (gal/min)										
	25	50	75	100	125	150	175	200	300	400	500
1.5	3	13	27	--	--	--	--	--	--	--	--
2.0	1	3	7	11	17	24	--	--	--	--	--
2.5	0	1	2	4	6	8	11	14	29	--	--
3.0	0	0	1	2	2	3	4	6	12	20	31
3.5	0	0	0	1	1	2	2	3	6	10	14
4.0	0	0	0	0	1	1	1	1	3	5	8
5.0	0	0	0	0	0	0	0	0	1	2	3
6.0	0	0	0	0	0	0	0	0	0	1	1

Undersized connections between the main and submain can cause excessive pressure loss

Assure that the pressure loss along the length of the drip lines is not excessive

Monitor and Record Pressure

Monitoring pressure is more complicated than it seems

- Mechanical pressure gauges on an irrigation system are often inaccurate, in the wrong location, or broken.
- New mechanical pressure gauges may be inaccurate by as much as 1 to 2 psi (10% to 20% error for tape at 10 psi).

Best practices for monitoring pressure of drip systems

- Install Schrader valves where you want to check the pressure of the drip system (submain, ends of drip tape, middle of field, etc.
- Add a Schrader adapter to an accurate mechanical gauge
- Use the same gauge to check pressures
- Periodically check the calibration of the pressure gauges and note if they are above or below the calibrated gauge
- Use a gauge with 0 to 30 psi range for the drip system and a gauge with 0 to 100 psi range for pressures greater than 30 psi
- Take care of your pressure gauges. They are more fragile than you might think.

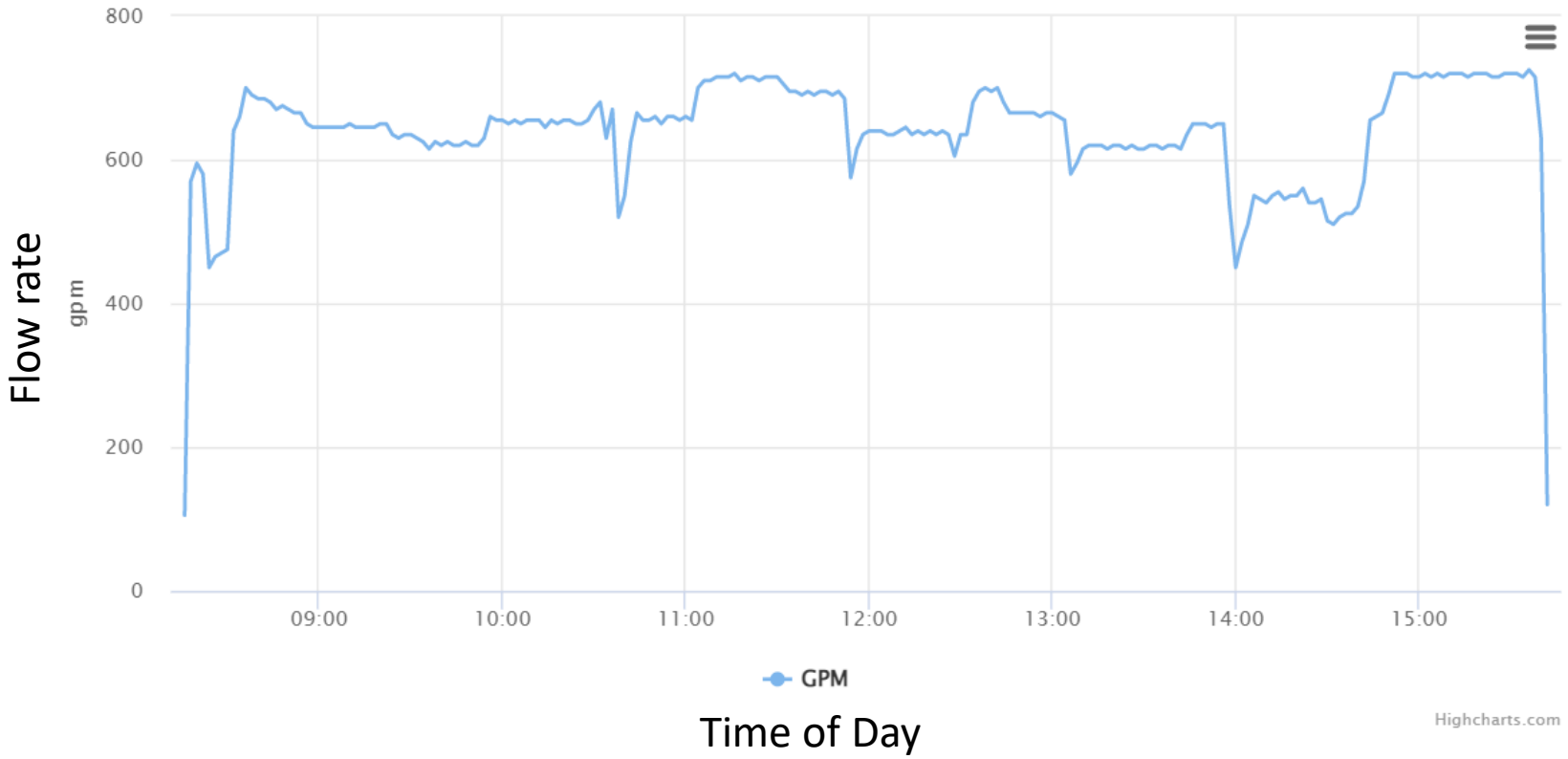

PSI PR WATER AT


GONZALES
Irrigation Systems

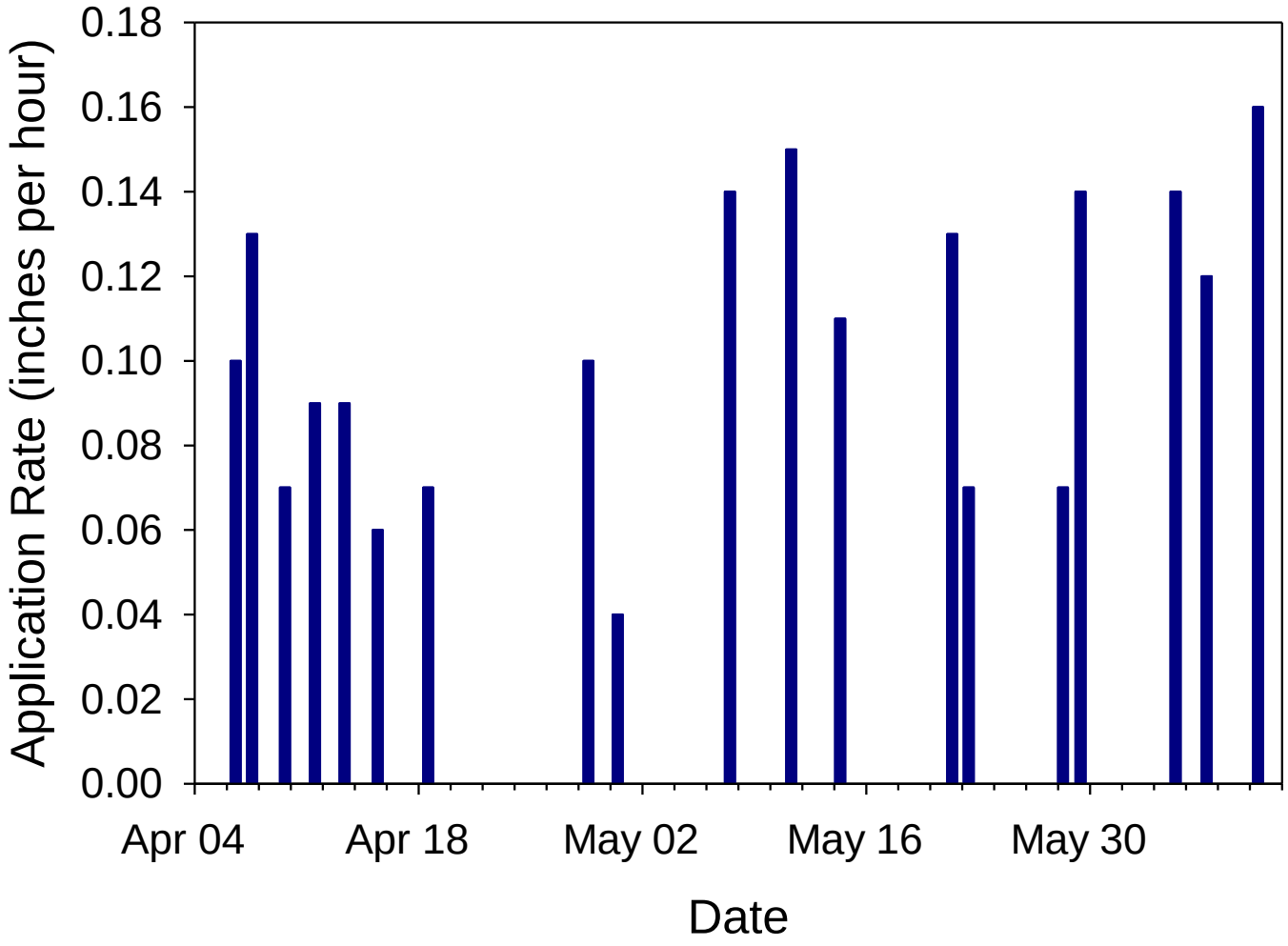
Periodically check the calibration of all pressure gauges

Many irrigators regulate pressure of drip systems using a valve

If pressure varies at the pump, then the flow rate of the drip system will vary



The application rate of this drip system varied 33% during the season



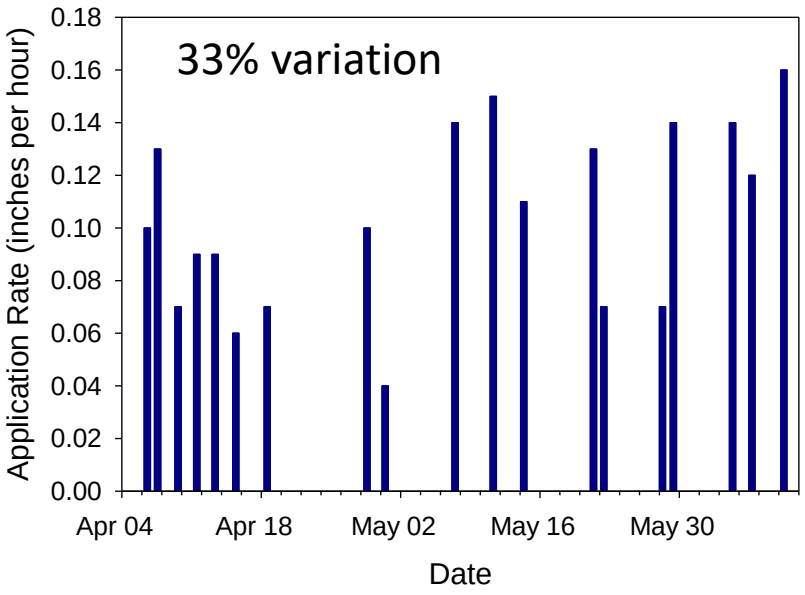

BERMAD

Adjustable pressure reducing valves are becoming simpler to use

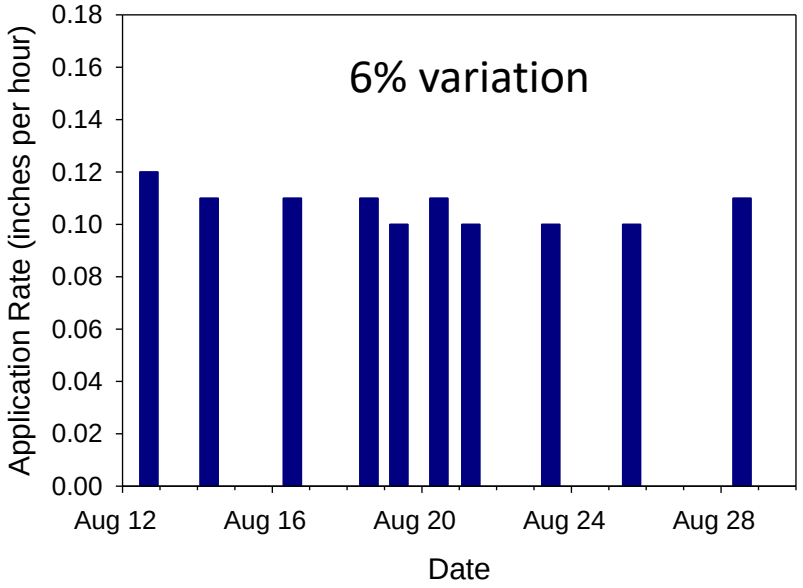
- ✓ 2, 3, 4- inch diameter
- ✓ Accommodate flow rates from 100 to 500 gpm
- ✓ Easy to adjust downstream pressure

Pressure regulating valve minimized variability in the application rate of the drip system

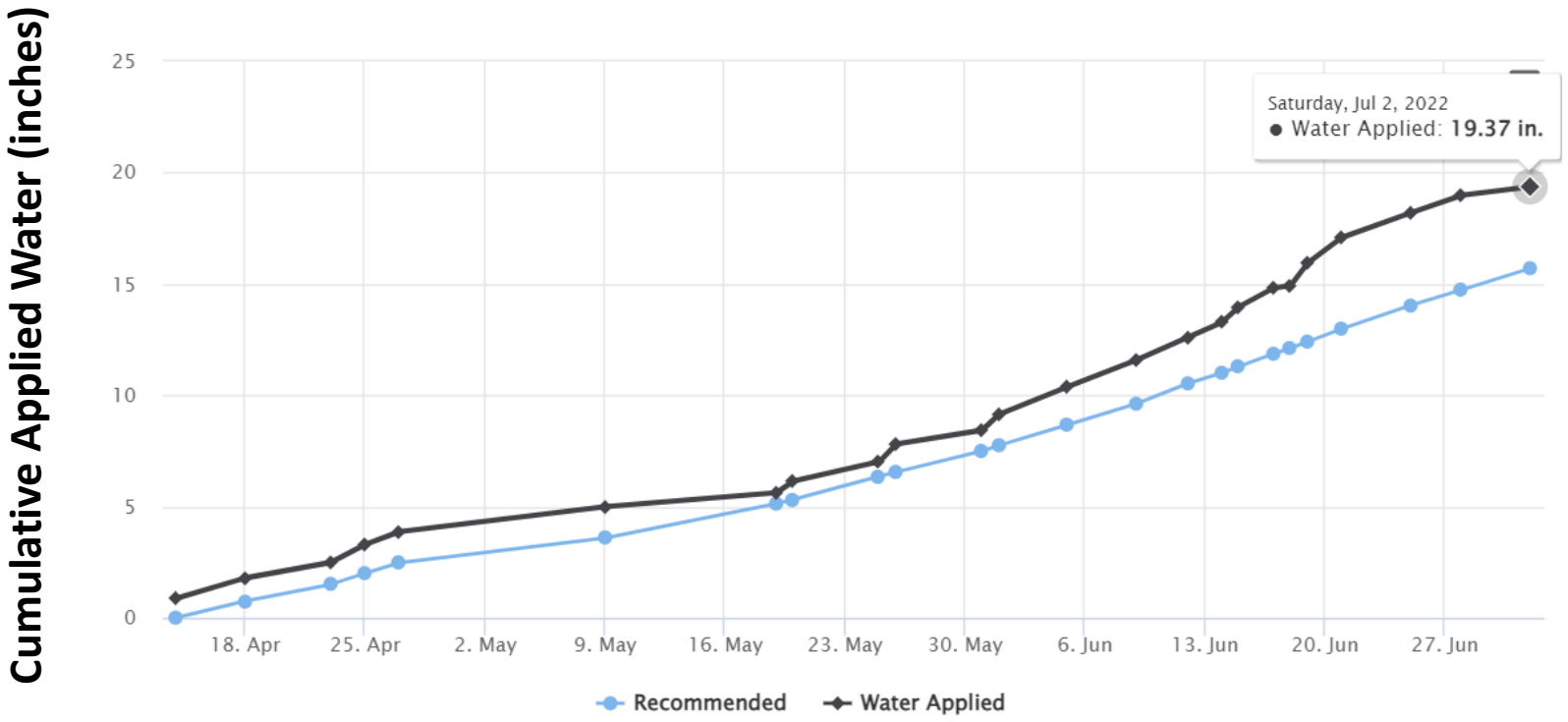
No regulating valve



Regulating valve



Matching Irrigations with Crop Water Requirements



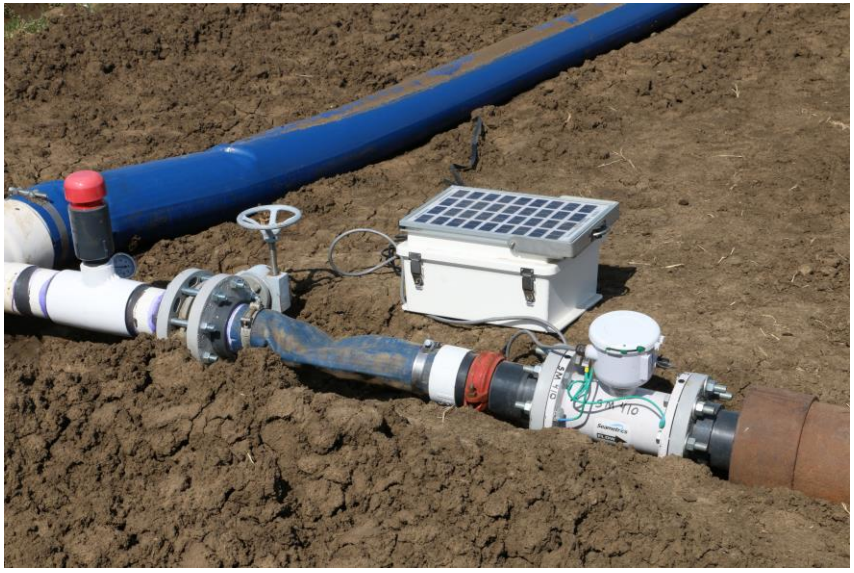
Various Approaches to Irrigation Scheduling

Weather (ET)-based

Plant-based

Soil-based

Flowmeters are useful tools for irrigation scheduling

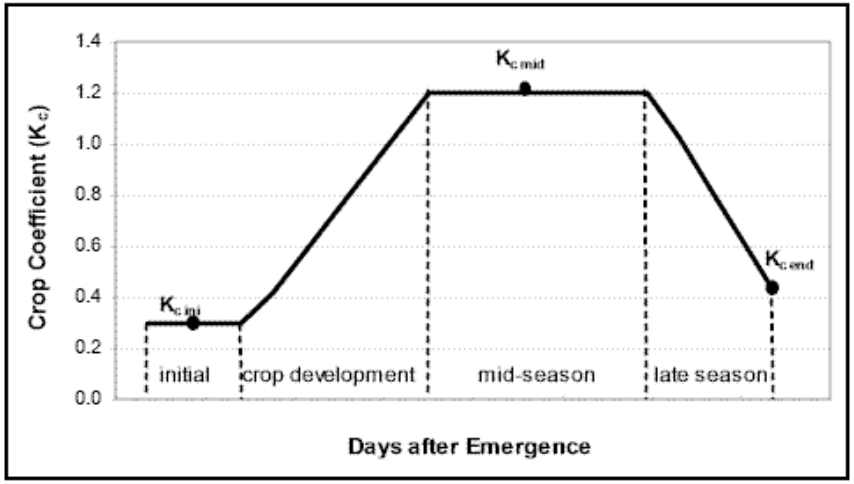


Weather-based irrigation scheduling

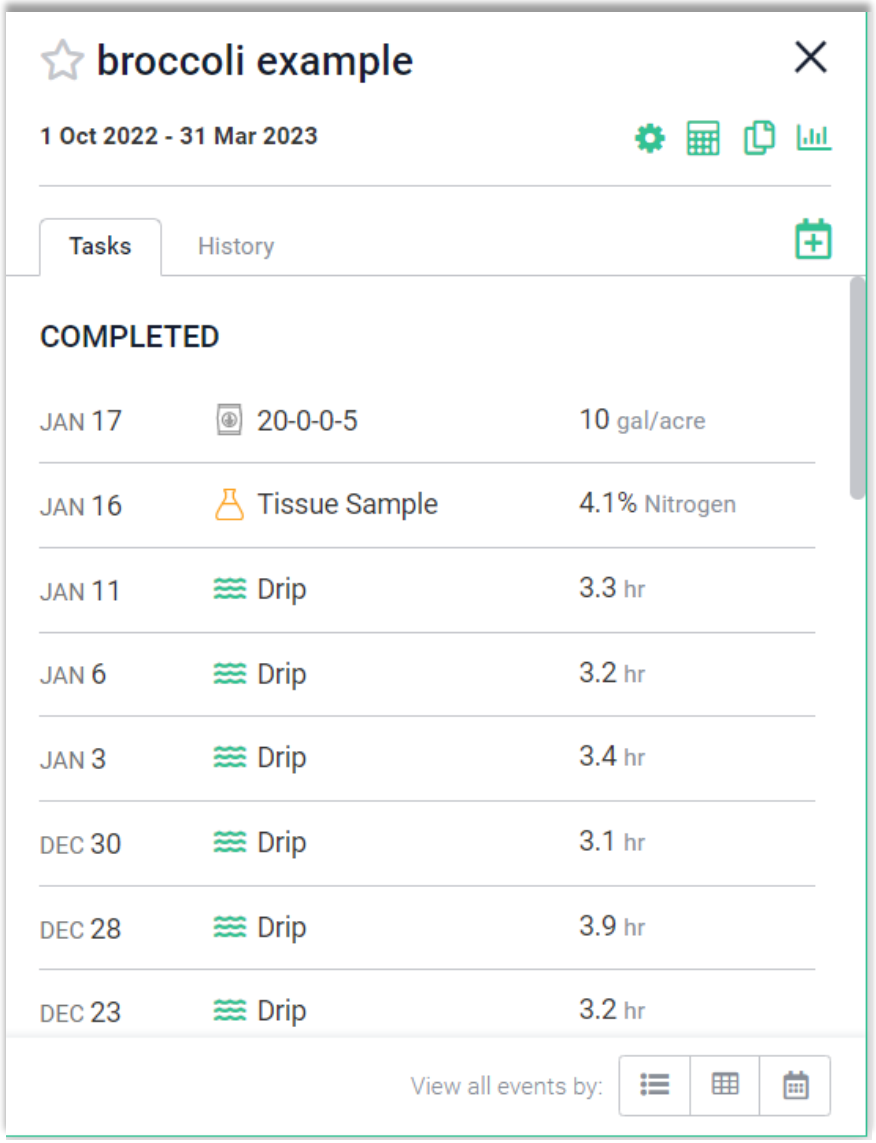
Converting Reference ET to Crop ET:

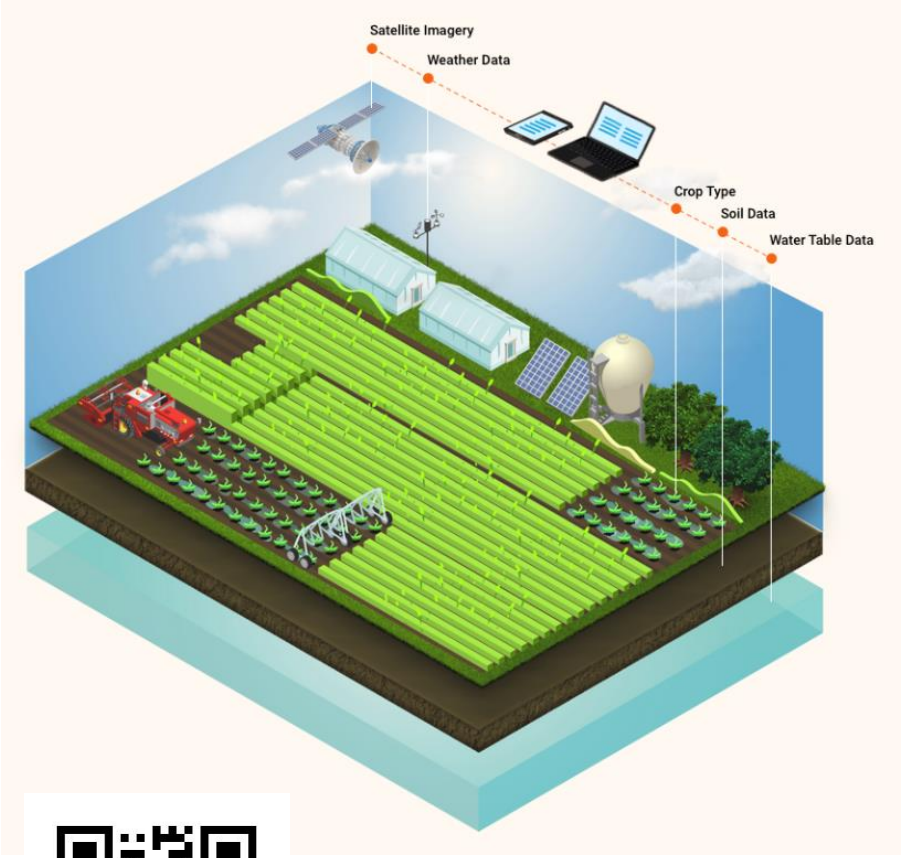
$$ET_{crop} = ET_{ref} \times K_{crop}$$

K_c can vary from 0.1 to 1.2



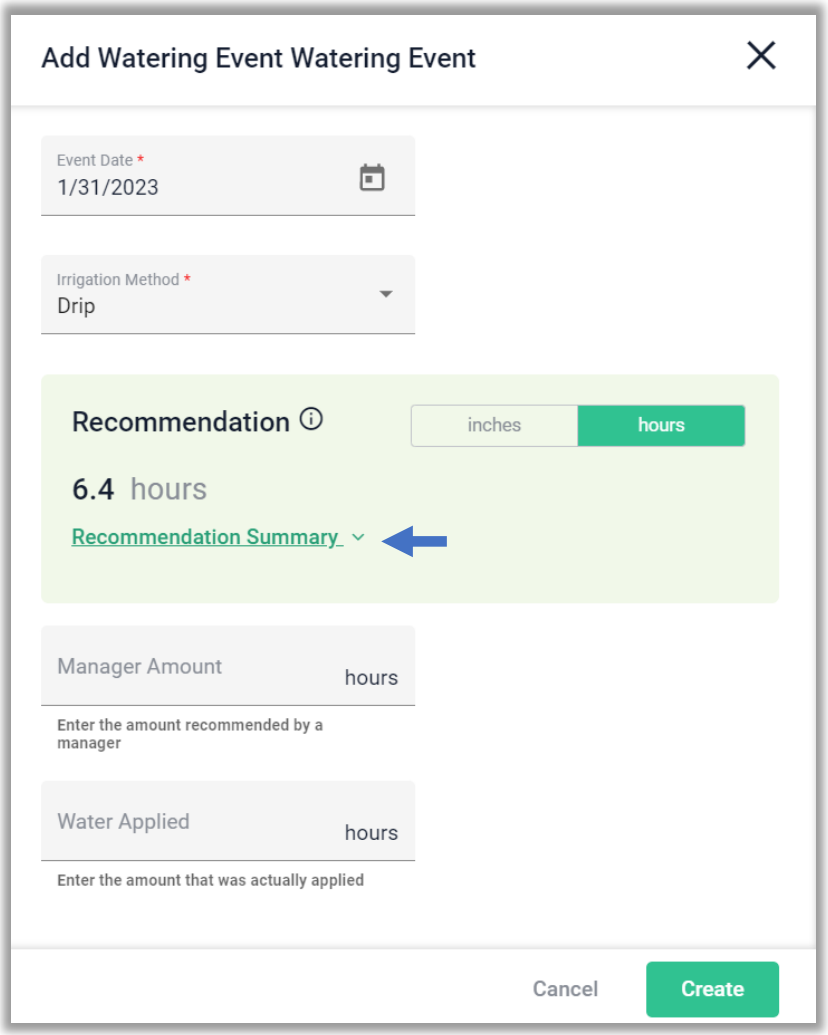
CropManage: Online irrigation and nitrogen management decision support

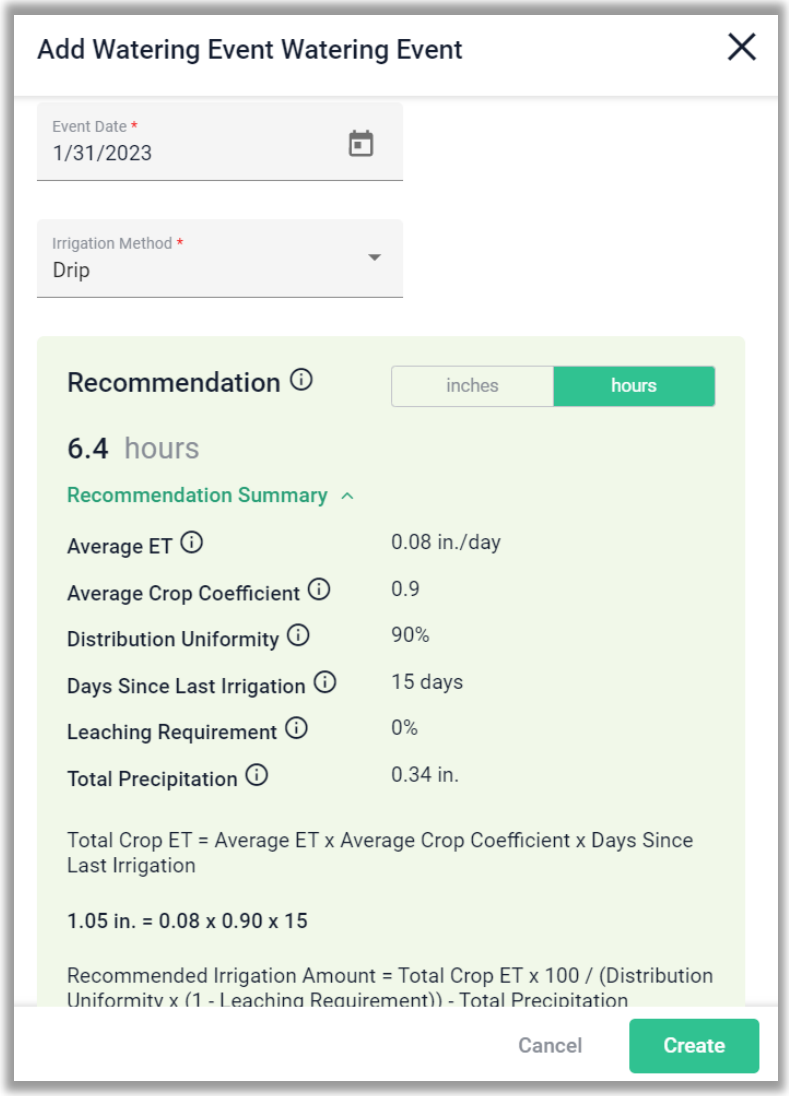




cropmanage.ucanr.edu

Using CropManage for Weather-based Irrigation Scheduling





When to irrigate?

Soil Moisture Sensors

Tension

Volumetric


1"CS 1/2" SCH


600PSI @73F

Summary

- Achieving a high irrigation efficiency can maximize yield and quality as well as save water, fertilizer, and money.
- Both application uniformity of the drip system and scheduling affect irrigation efficiency.
- The design, operation and maintenance of the irrigation system will affect how uniformly the drip tape applies water to the crop.
- Tools such as flowmeters, soil moisture sensors, CropManage, and calibrated pressure gauges can help you assess if you are applying water uniformly and matching irrigation applications with crop water needs.