Using weather-based irrigation scheduling for optimizing red cabbage production

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UCCE Irrigation & Nutrient Management Meeting
23 February 2021

CropManage testbed at USDA Spence Ranch Research Farm, Salinas

Series of experiments:

- head lettuce, broccoli (2012-13)
- romaine, green cabbage (2015-16)
- cauliflower, celery (2018-19)
- artichoke, red cabbage (2020-21)

control, replication, repeatability

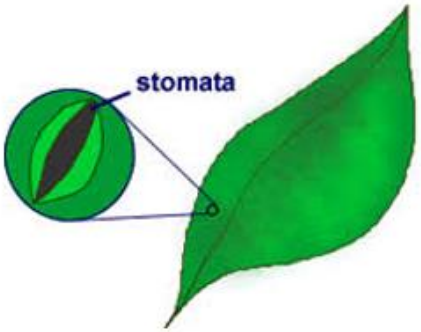
Study rationale

- Water sensitive crop
- Water supplies may become more limited in Salinas Valley (Sustainable Ground Water Management Act)
- Better water management may help improve nitrogen use efficiency (Ag Order)
- Demonstrate weather-based irrigation scheduling
- Evaluate CropManage for decision-support

What is Evapotranspiration?

Water Vapor
Oxygen

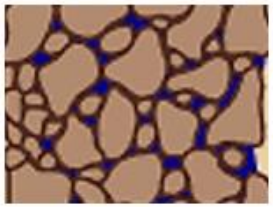
Carbon dioxide
Net Radiation (Sunlight absorbed)
Air Temperature
Wind
Humidity



Transpiration

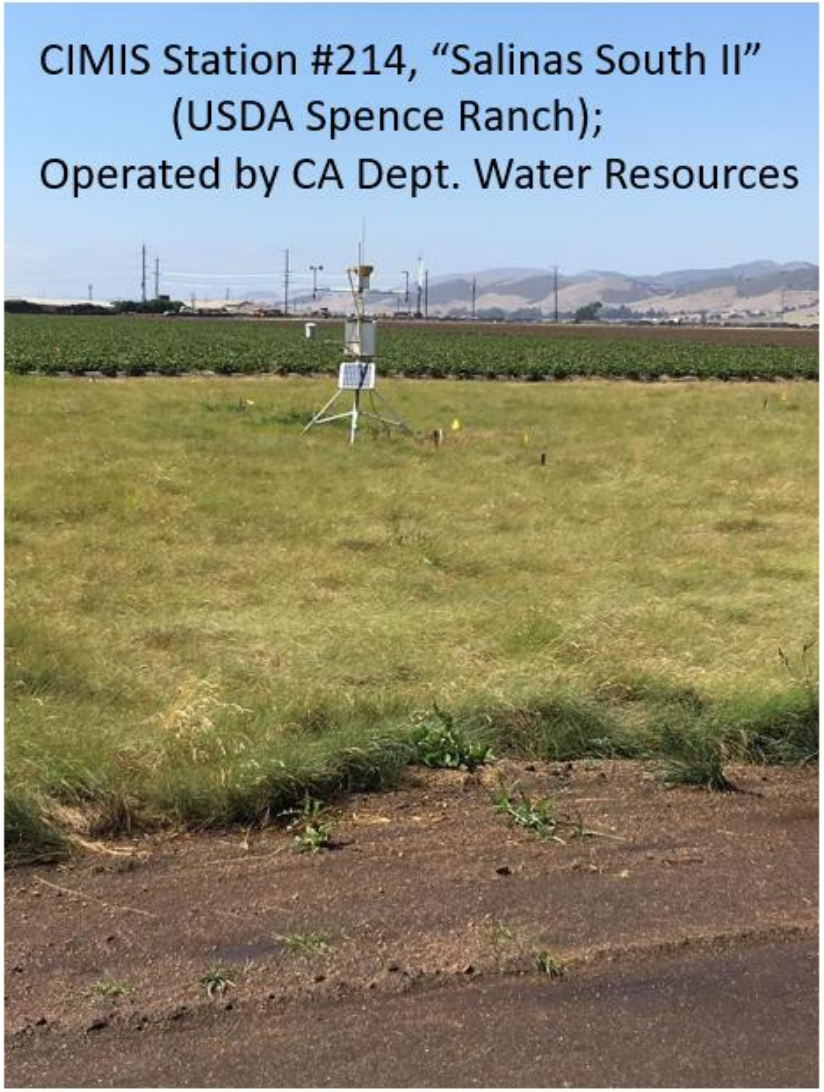
+

Soil Evaporation



Soil Moisture

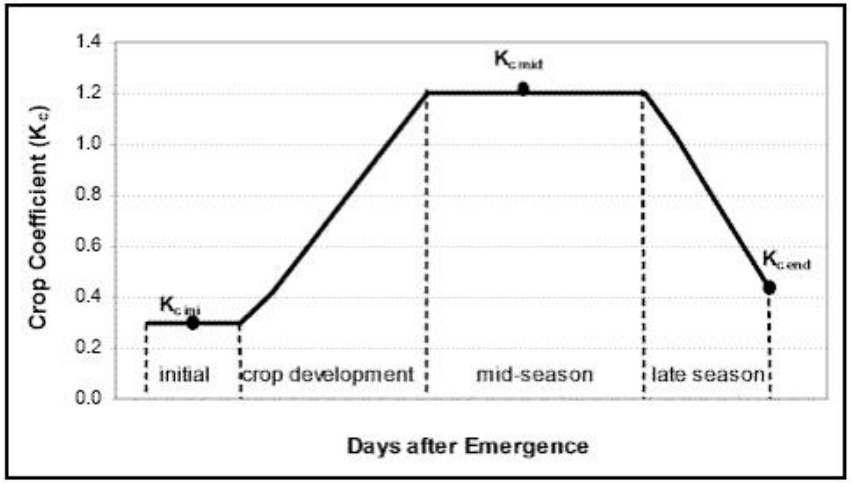
Weather-based irrigation scheduling
(aka, 'ET-based')



Converting reference ET* to crop ET*:

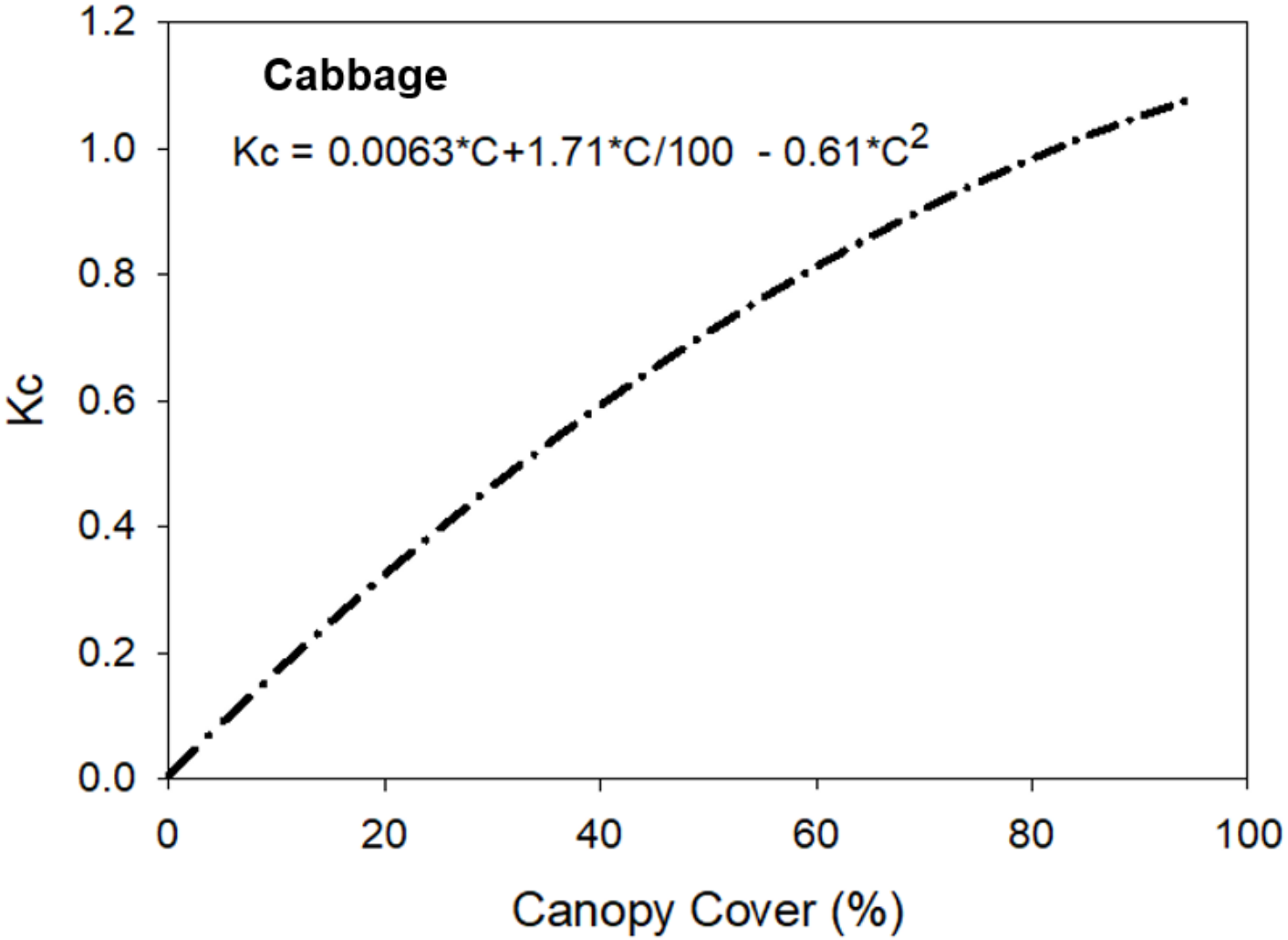
$$ET_{crop} = ET_{ref} \times K_{crop}$$

K_c can vary from 0.1 to 1.2

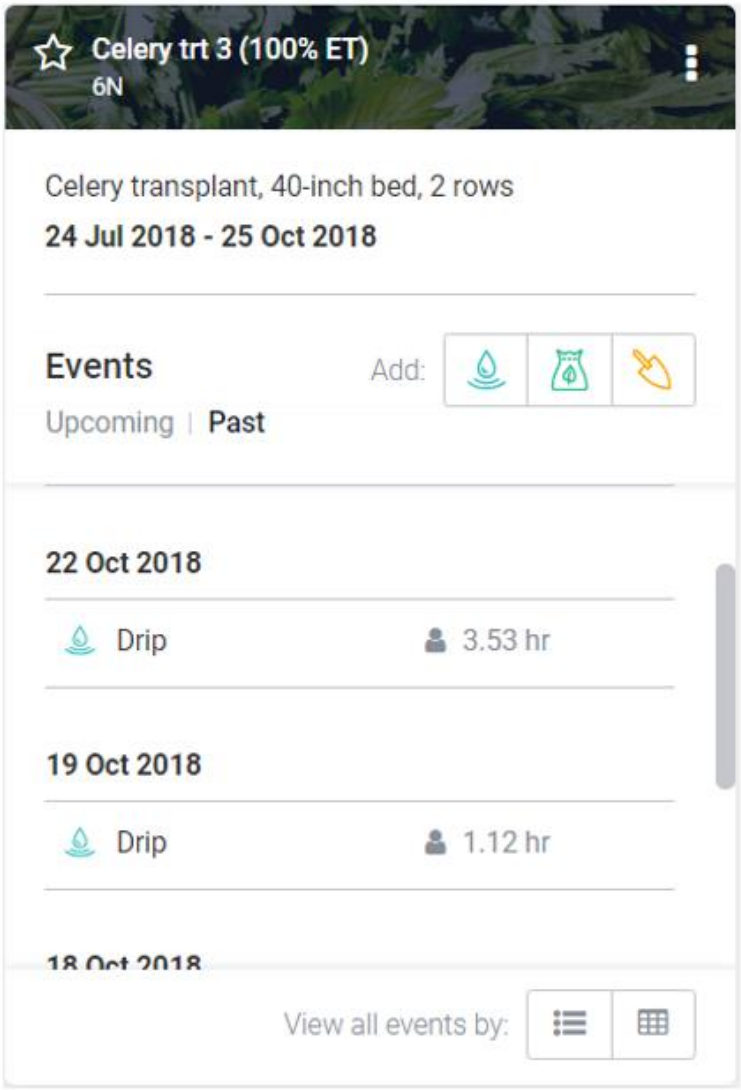


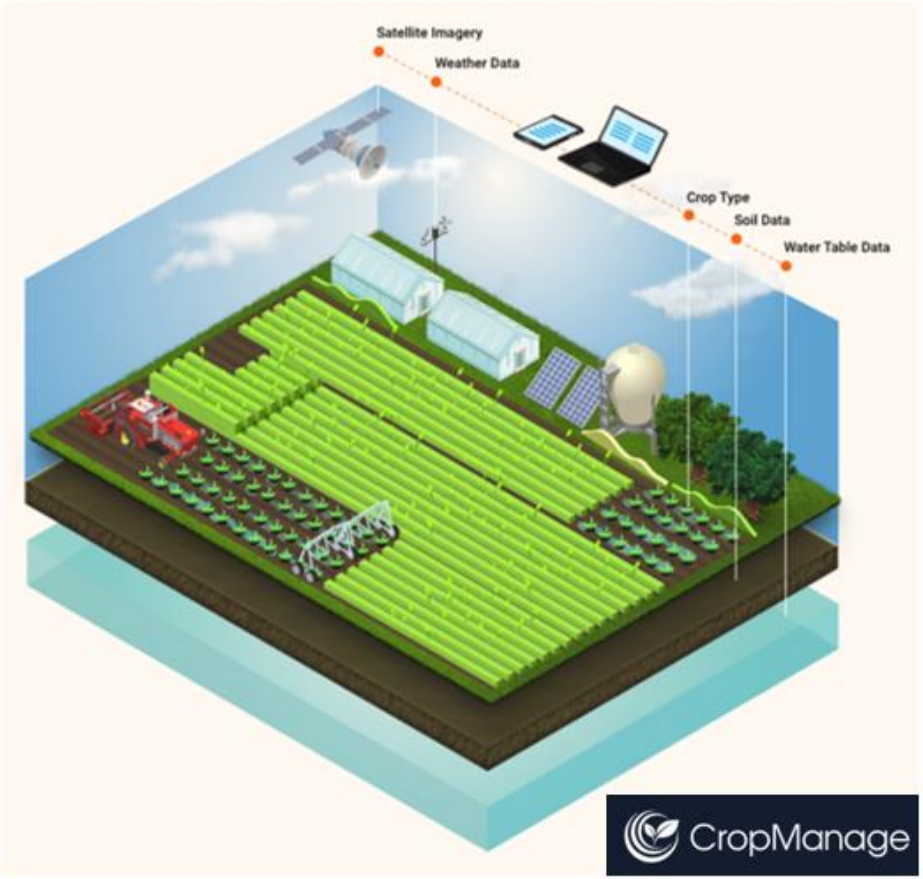
(*evapotranspiration}

Crop Kc is related to canopy cover



CropManage can be used for ET-based irrigation scheduling





Objectives

- Determine water requirement of drip irrigated red cabbage for optimizing yield and quality
- Determine if a crop coefficient based approach for estimating cabbage ET is effective

Experimental Approach

- Apply different water volumes based on guidance from CropManage ET model
- Evaluate yield, quality, soil moisture, crop development vs. applied water

Procedures

- Site: USDA Spence Ranch, Salinas
- Soil: Chualar sandy loam
- Cultivar: Rondale
- Transplanted April 29, 2020
- 2 rows on 40-inch wide beds, 12-inch plant spacing
- Transplants established with sprinklers (~4 inches of water)
- Fertilizer: preplant 300 lbs/acre 6-20-20, by drip 322 lbs N/acre as UAN32

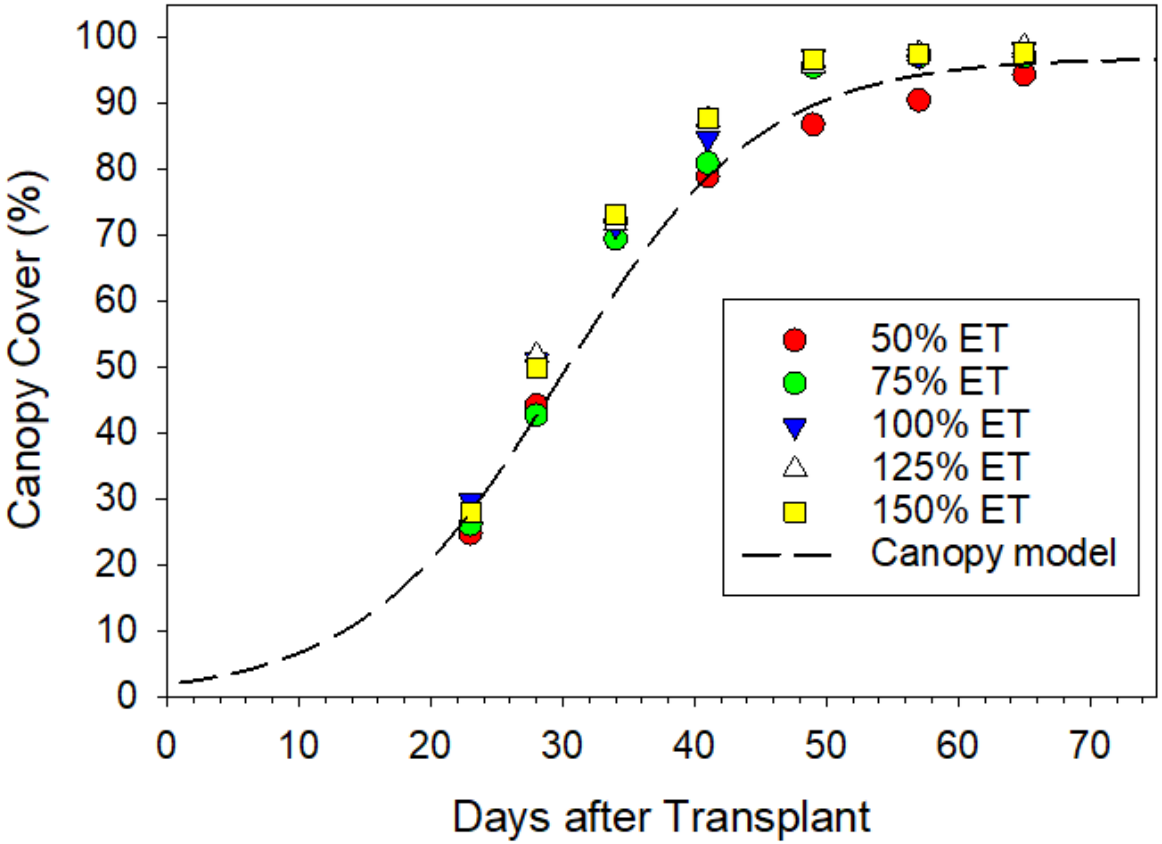
Procedures continued

- **Randomized Complete Block Design:**
  - **-5 drip irrig tmts: (50,75,100,125,150% ET)**
  - **-6 replications**
  - **-Plots measured 135 ft x 5 beds**
- **Drip irrigation treatments began on 5/21**
  - **-3 times per week**
  - **-assumed 85% distribution uniformity**
- **Sub plots (10 ft x 30 ft) commercially harvested by Dole on 7/22 (carton) and 8/5 (bulk) [84 and 98 DAP]**
- **Above ground biomass evaluated on 7/29 [91 DAP]**

Manifold for applying irrigation treatments

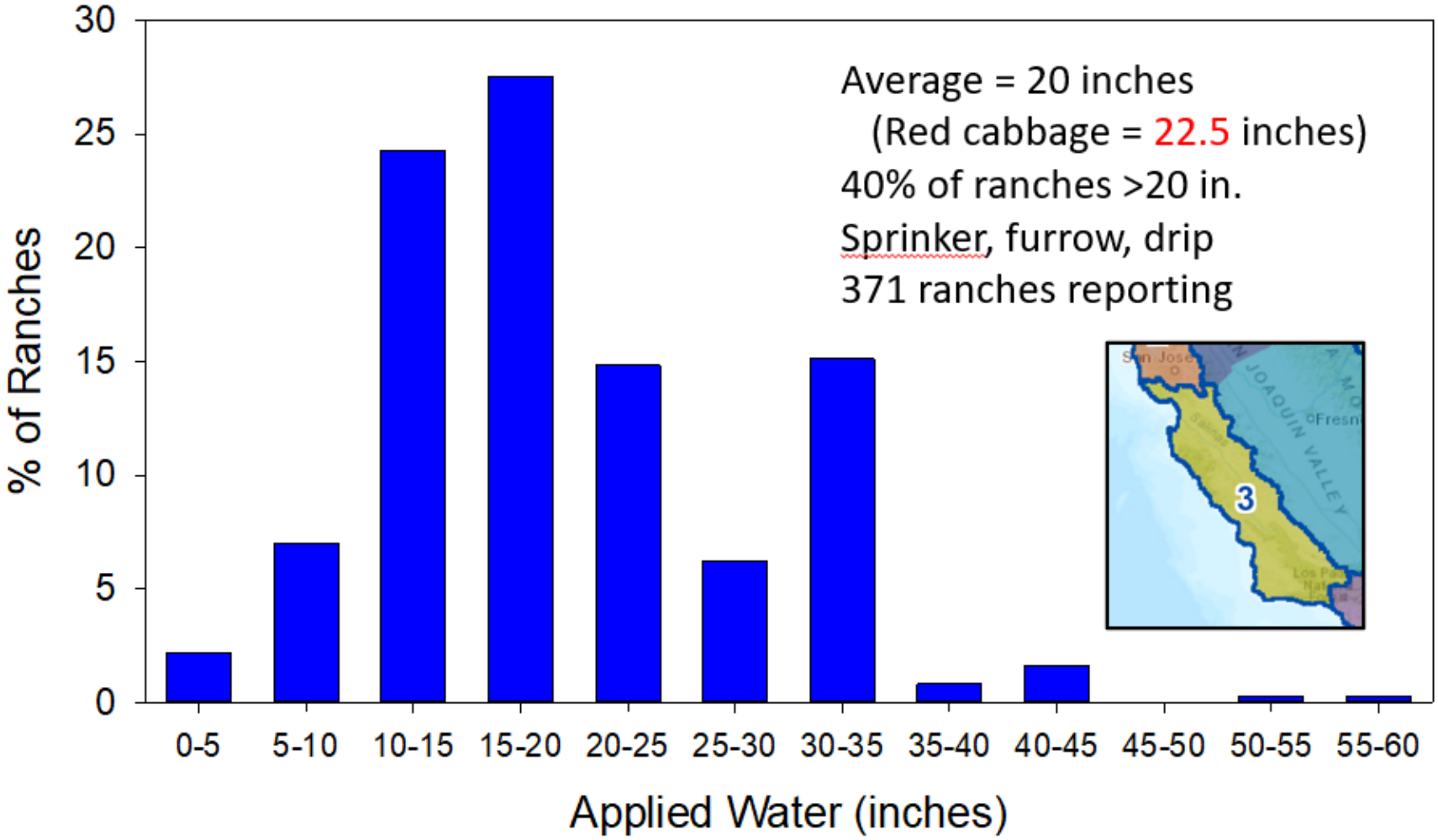
Results

Canopy cover was measured and compared with a theoretical curve used by CropManage



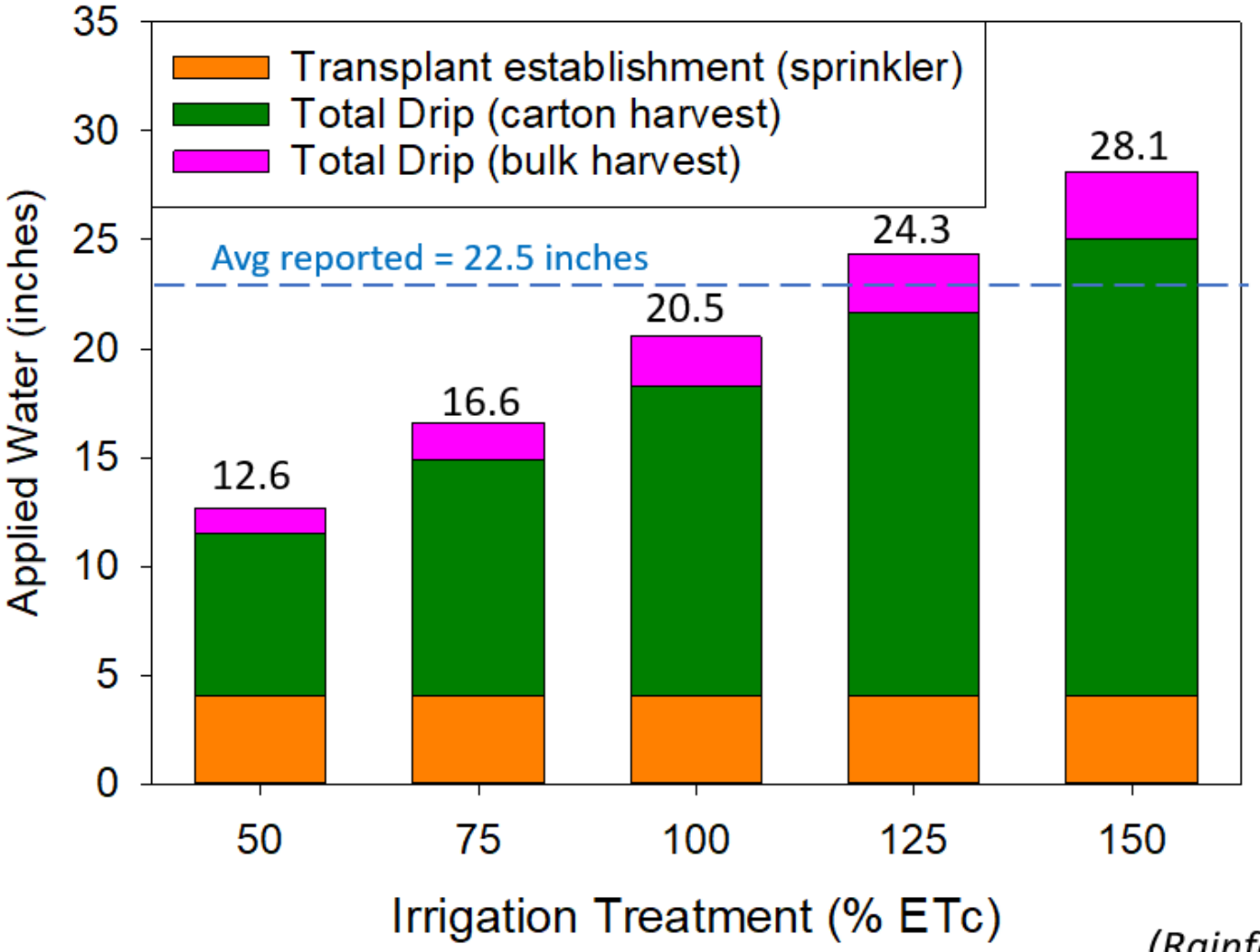
Canopy cover is a key determinant of ET

Reported water use of cabbage in Region 3 (2014-17)



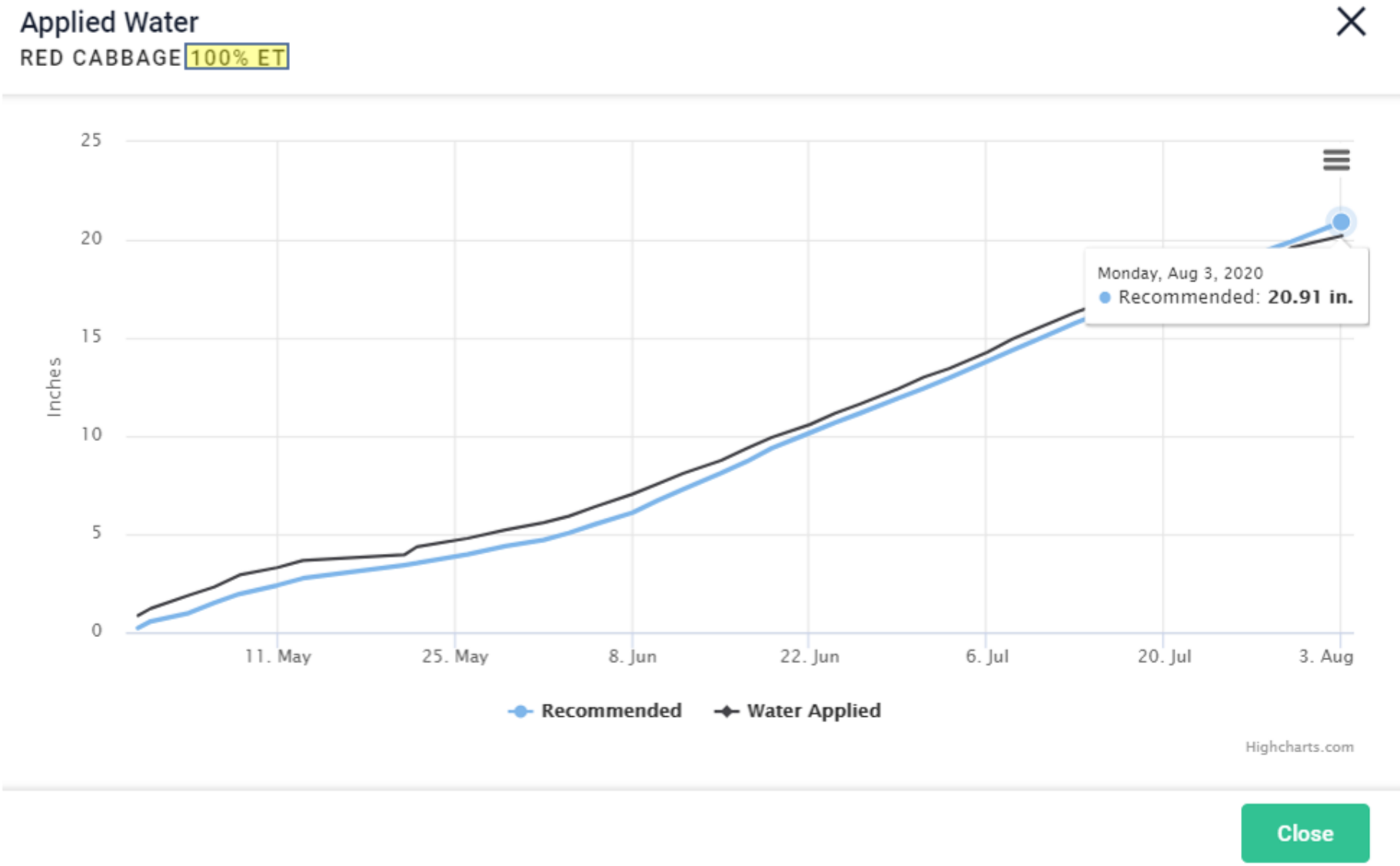
Source: Central Coast Regional Water Quality Control Board

Total water applied to 100% ET treatment was 18.3 inches to carton harvest and 20.5 inches to bulk harvest



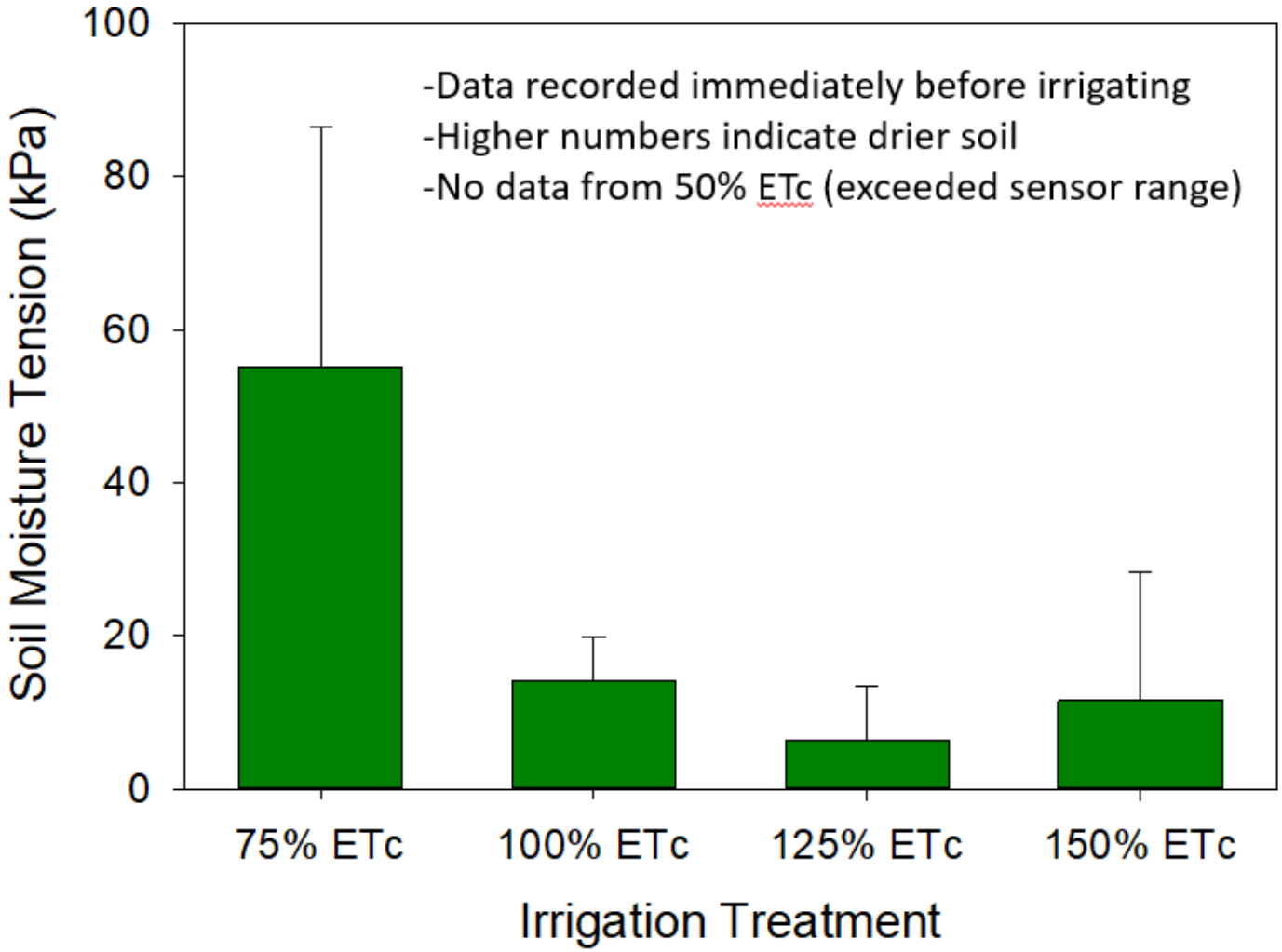
(Rainfall negligible)

Water volumes were applied using CropManage



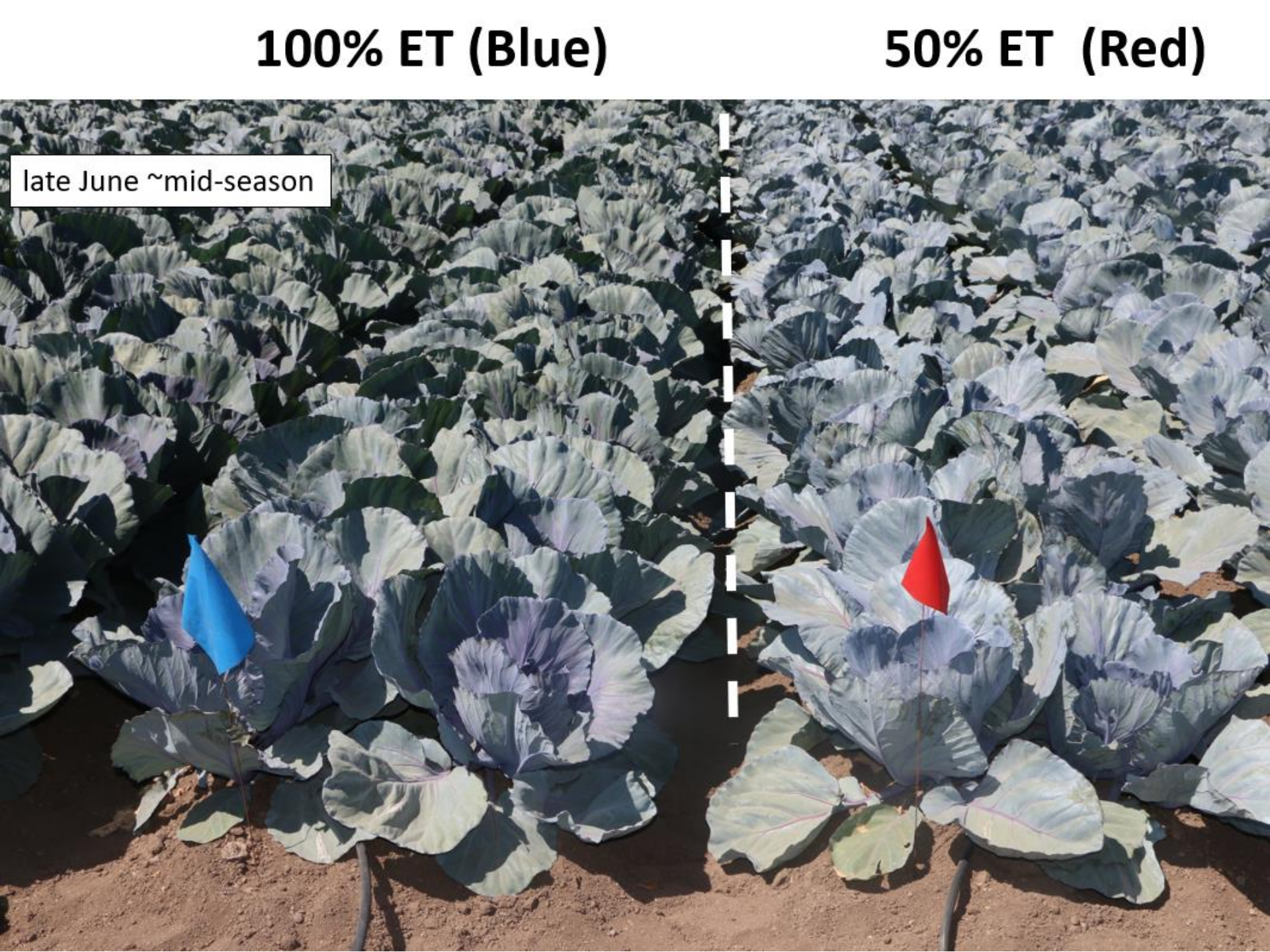
Includes sprinkler + drip

Average soil moisture tension of irrigation treatments at 18-inch depth (6/10 – 7/3)

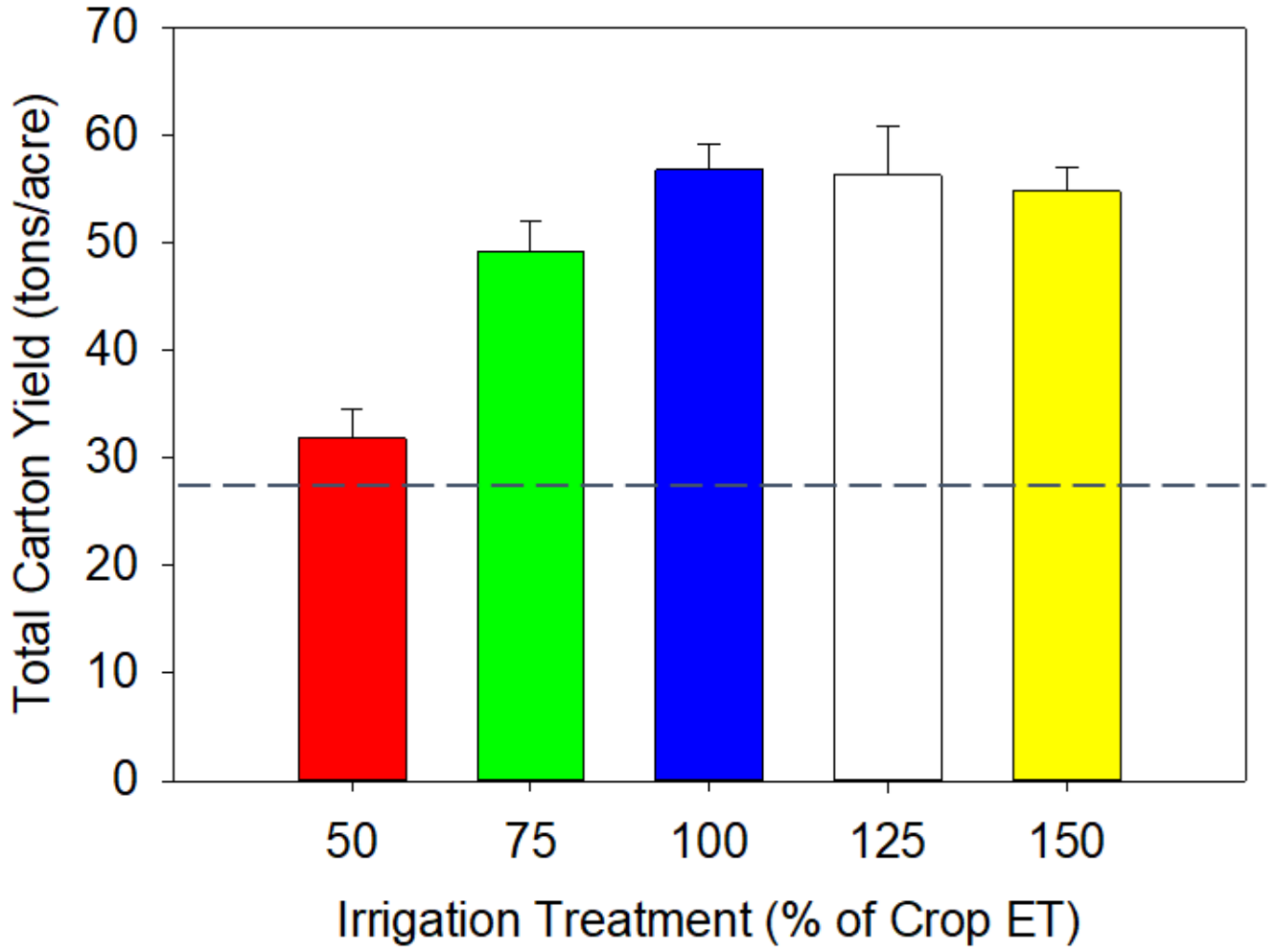


Tests for statistical significance are pending

100% ET (Blue) 150% ET (Yellow)

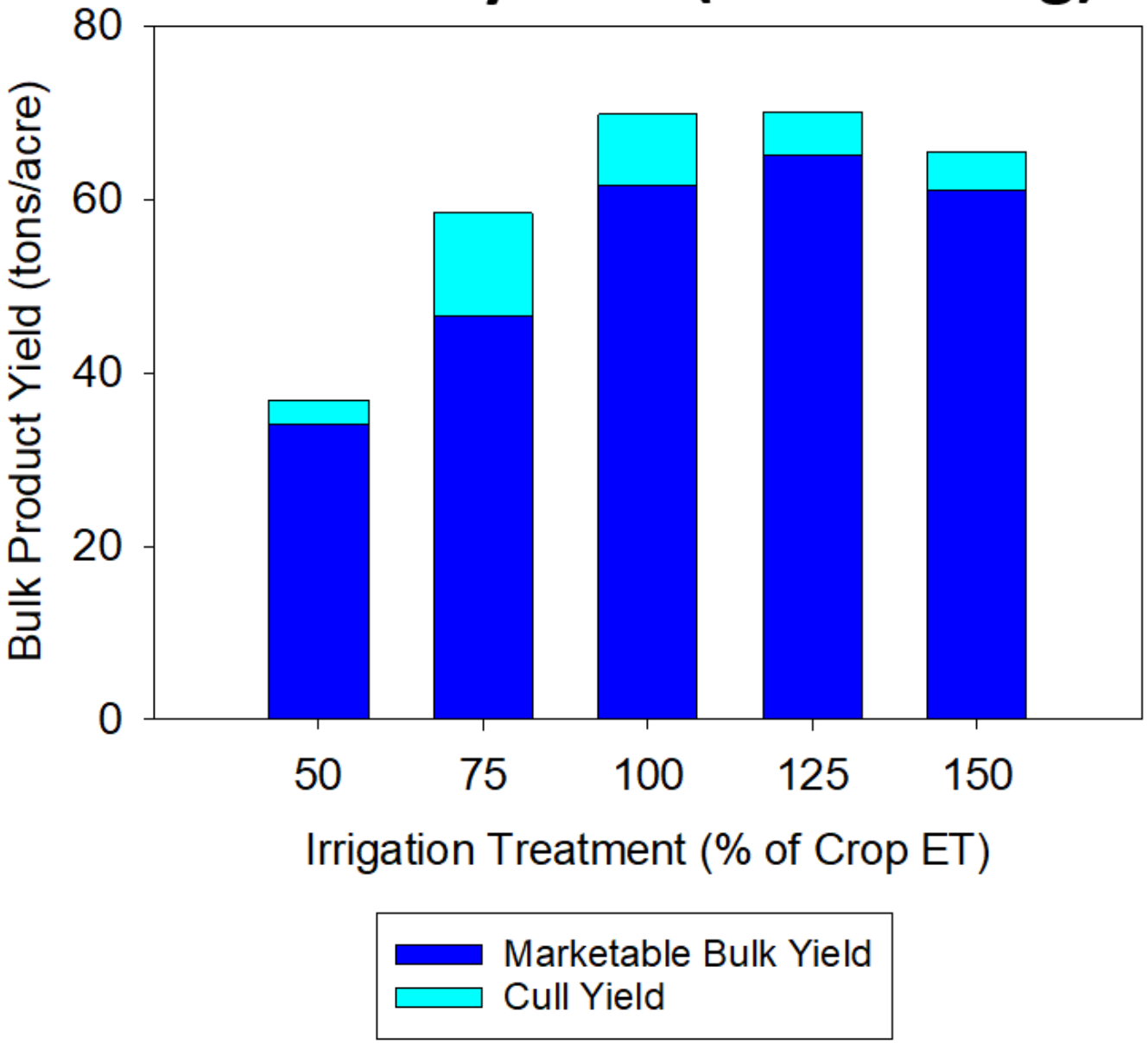

100% ET (Blue)
50% ET (Red)
late June ~mid-season

Carton yield was highest in the 100% ET treatment

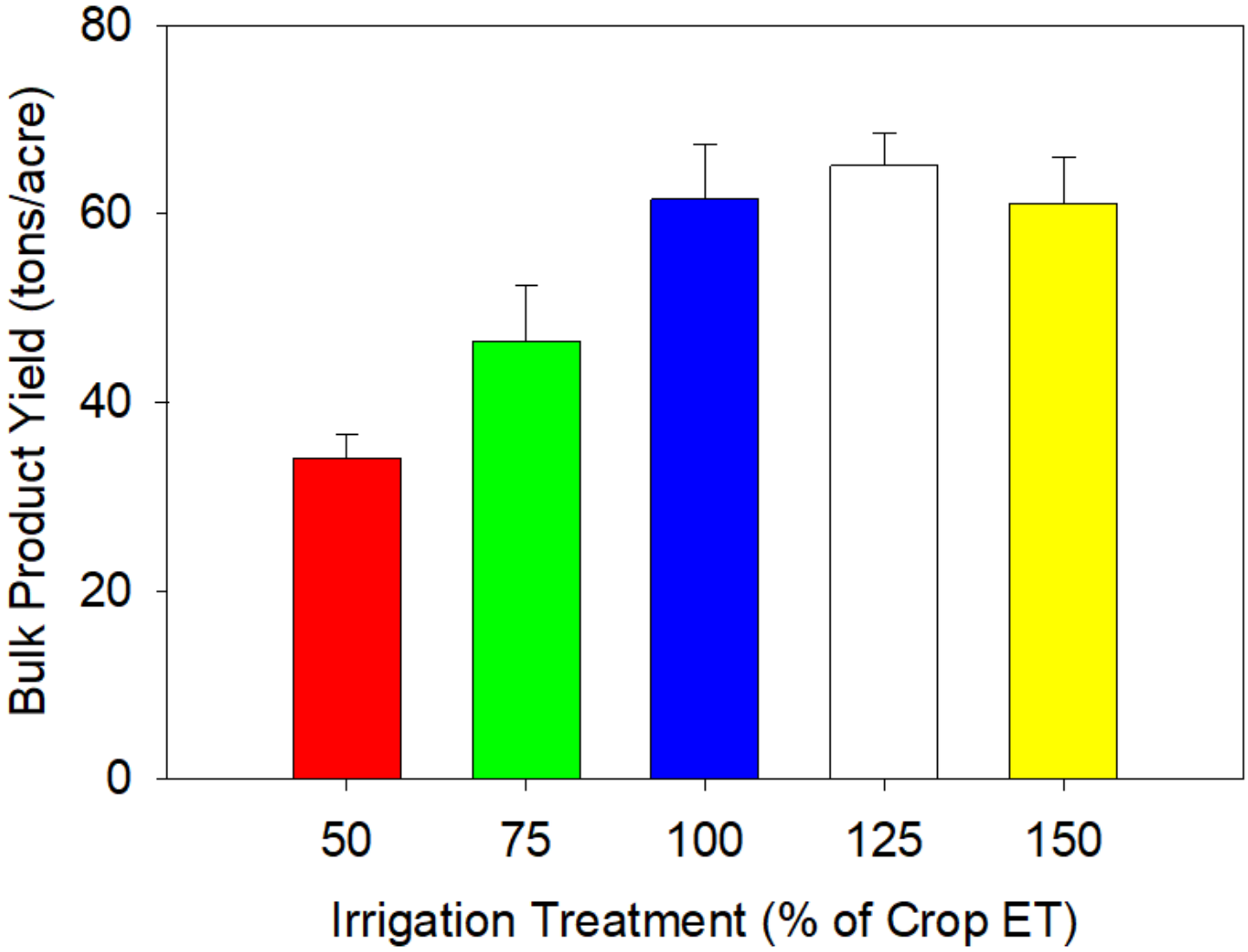


(Significance test pending…)

Bulk product yield of 100% ET treatment was reduced by culls (sunburning)

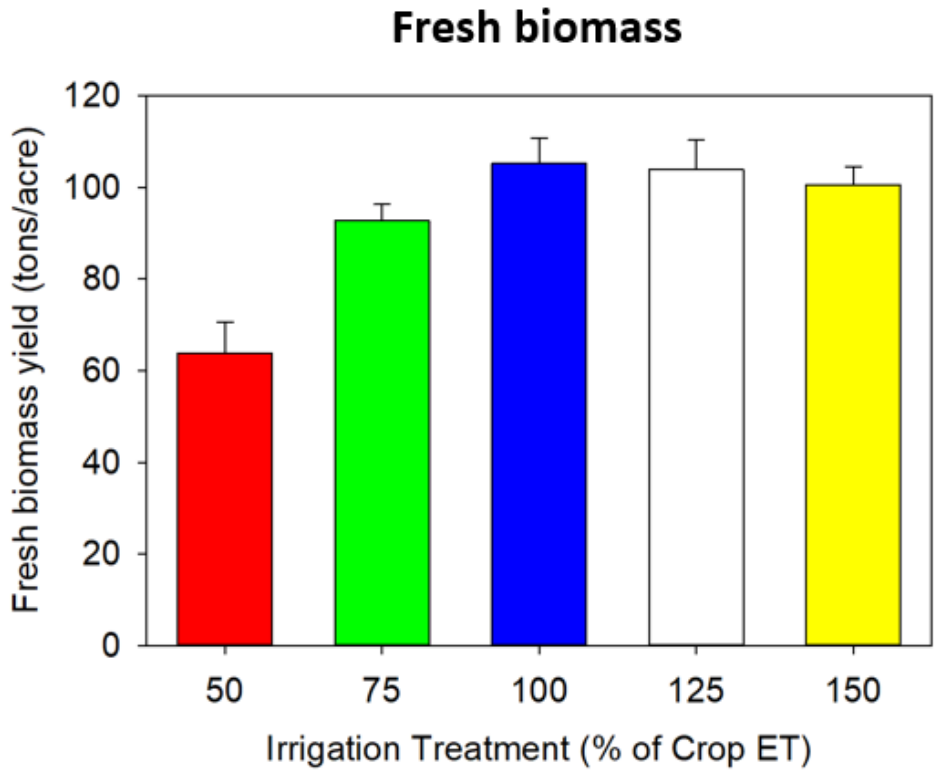


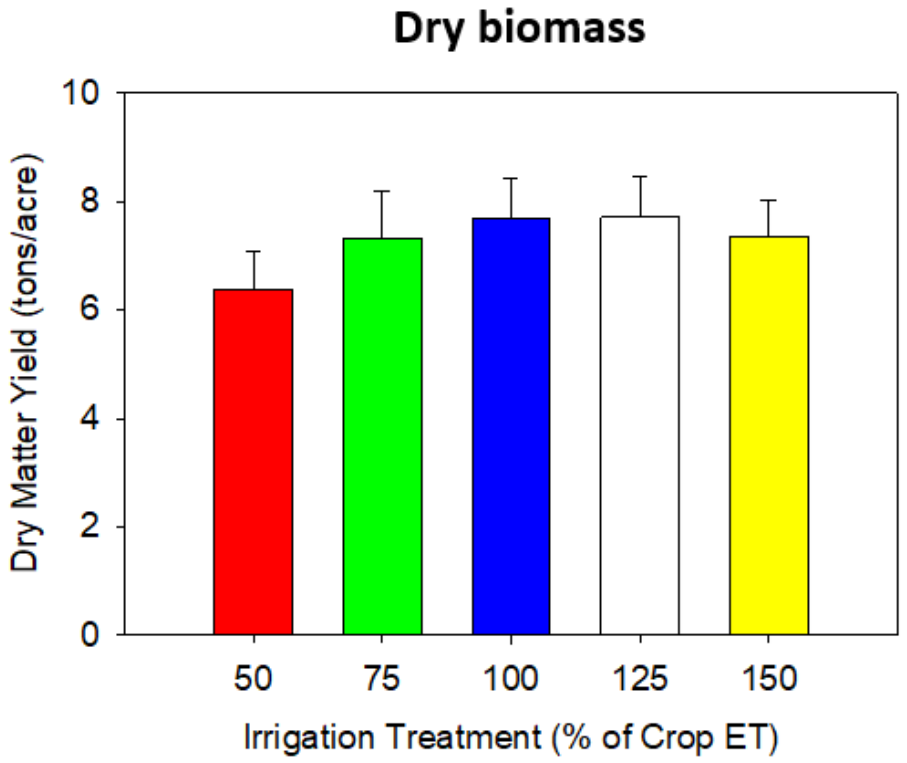
Bulk yield was highest in the 125% ET treatment



(Significance test pending…)

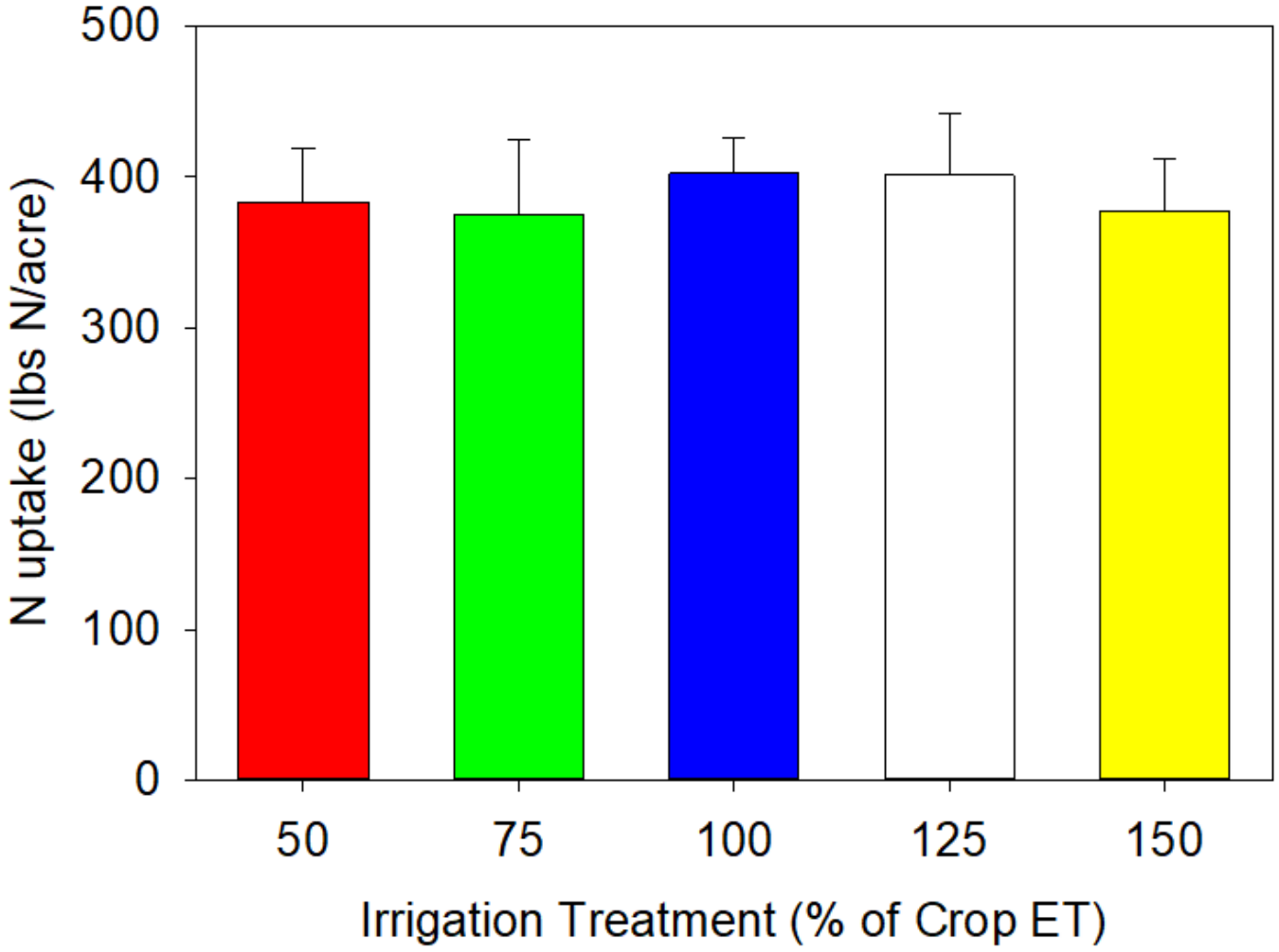
Fresh and dry biomass yield was highest in the 100% ET treatment





(Significance test pending…)

Highest N uptake was 400 lbs N/acre in the 100% and 125% treatments



(Significance test pending…)

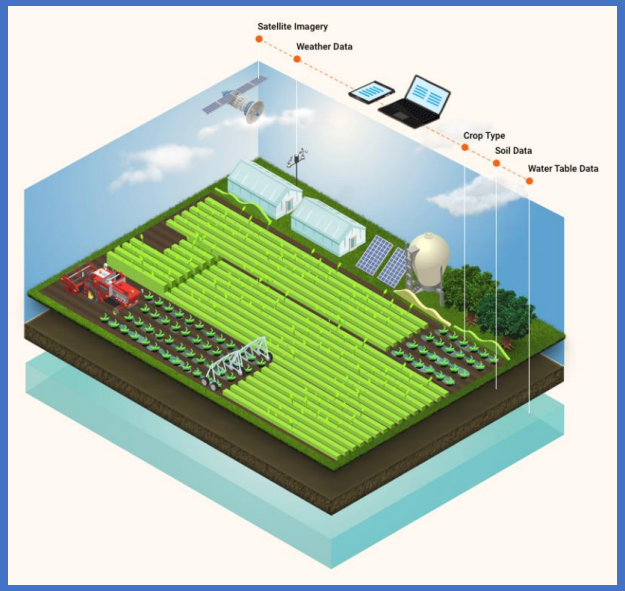
Preliminary findings*

- Yield and quality targets for red cabbage can be met with drip irrigation. (Irrigate 2-3x/wk to avoid moisture stress in sandy textured soils)
- CropManage was used to determine crop water requirement based on weather (ET) and canopy cover.
- 18 inches of water (100% ETc treatment) maximized carton yield, at a level well above county average. This water volume is about 20% below industry mean.
- 20-24 inches maximized bulk yield (100%,125% treatments).
- Yields from 50% tmt were appx half of the 100%, and displayed occasional afternoon wilting.

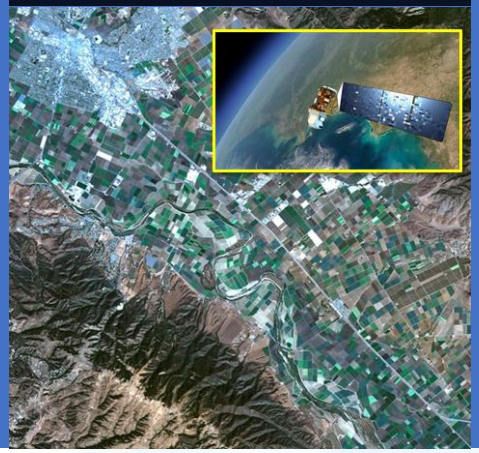
*Subject to trial repeat in 2021.

Future…

CropManage



OPENET



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Acknowledgments

Guillermo Jimenez, Alejandro Palmas (Dole Fresh Vegetables)

Joel Wiley (Wilbur Ellis)

David Chambers, Tom Lockhart (UCCE)

Javier Lopez (CSUMB)

Noe Cardenas Cabrera (Hartnell)

Gerry Spinelli, Angie Carreras (RCD Santa Cruz County)

Gerry Ochoa, Armando Lopez Tayum, Valeriano Hernandez (USDA-ARS)

Funding was made possible by the U.S. Department of Agriculture's (USDA) Agricultural Marketing Service through grant AM190100XXXXG008. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of USDA.

Questions?