

Opportunities of Water and Nitrogen Management for Processing Tomato with CropManage

2025 UCCE NSJV Tomato Meeting

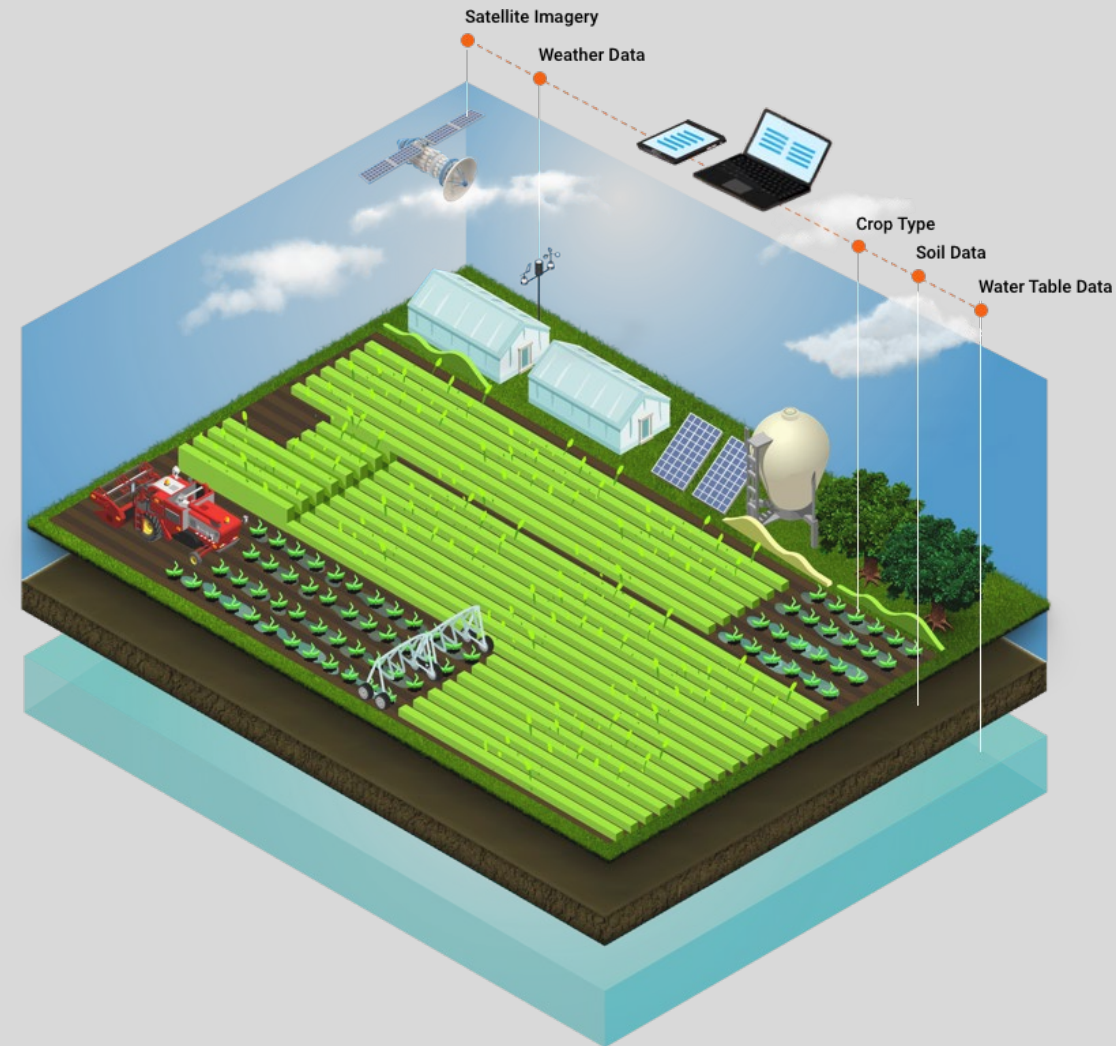
Zheng Wang

University of California Cooperative Extension

February 12, 2025

CropManage is an ET-based online decision support tool to assist farmers and ag professionals in managing irrigation and nutrient application for various crops.

- <https://cropmanage.ucanr.edu/>
- Developed and operated by UCCE.
- Started on cool season vegetables in Central Coast since 2011.
- Expanded to berry, nut, agronomic, and warm season vegetables.
- Optimize water and N fertilizer use with the goals of improving crop yield, reducing environmental impact, and saving costs.



Key features: Irrigation scheduling

Edit Watering Event

Event Date * 6/14/2022

Irrigation Method * Drip

Provides recommendations on when and how much to irrigate.

Recommendation ⓘ inches hours

0.64 inches

Recommendation Summary ▾

Manager Amount inches

Enter the amount recommended by a manager

Water Applied 0.6002 inches

Enter the amount that was actually applied

Flow Meter Information:
0.6 in. = 1010620 gals over 62 acres
Last updated by CropManage 6/18/2022 - 6:05 PM

Delete Cancel Save

Edit Watering Event

Recommendation ⓘ inches hours

0.64 inches

Recommendation Summary ^

Average ET ⓘ 0.29 in./day

Average Crop Coefficient ⓘ 1

Distribution Uniformity ⓘ 90%

Days Since Last Irrigation ⓘ 2 days

Leaching Requirement ⓘ 0%

Total Precipitation ⓘ 0 in.

Recommendations are made based on crop type, soil, weather conditions, and others.

Total Crop ET = Average ET x Average Crop Coefficient x Days Since Last Irrigation

0.57 in. = 0.29 x 1.00 x 2

Recommended Irrigation Amount = Total Crop ET x 100 / (Distribution Uniformity x (1 - Leaching Requirement)) - Total Precipitation

0.64 in. = (0.57 in. x 100 / (90.00 * (1 - 0))) - 0.00 in.)

Date	ET	Source ⓘ	Last Modified
6/13/22	0.335	Averaged from Station...	7/13/23, 6:22 PM
6/12/22	0.235	Averaged from Station...	7/13/23, 6:22 PM
Total	0.57		

Delete Cancel Save

Key features: Nutrient management (Nitrogen)

Add Fertilization Event [Close]

Event Date * 7/22/2023 [Calendar]

Fertilizer Type * 17-0-0-8 - Wet [Dropdown] **Fertilizer Details**

Days To Next Fertilization * 5

Soil Sample * No Soil Sample [Dropdown]
Choose the soil sample date used to calculate this recommendation

Recommendation lbs N/acre Fertilizer Unit

14.46 lbs N/acre

Recommendation Summary [Dropdown]

Include N Contribution From Water in Recommendation

Delete [Cancel] **Save**

Offers guidance on proper amount and timing of fertilizer applications to match crop needs and reduce over-application and nutrient run-off.

Add Fertilization Event [Close]

Recommendation lbs N/acre Fertilizer Unit

14.46 lbs N/acre

Recommendation Summary [Dropdown]

Crop N Uptake ⓘ	16.07 lbs N/acre
N Fertilizer Factor ⓘ	1.00
Total Mineralized N ⓘ	1.61 lbs N/acre

Fertilizer N Recommendation = (Crop N Uptake / N Fertilizer Factor) - Total Mineralized N

14.46 = (16.07 / 1.00) - 1.61

Include N Contribution From Water in Recommendation

Manager Amount lbs N/acre Fertilizer N Applied 17.55 lbs N/acre

Enter the amount recommended by a manager

Last updated by Zheng Wang 7/27/2023 - 3:02 PM

Delete [Cancel] **Save**

Key features: Crop specific

Planting Settings

Planting Name

Commodity
Tomato

Crop Type
Processing tomato transplanted 60-inch bi

Wet Date * 5/5/2022
Harvest Date * 9/7/2022

Planting Area
CropManage tomato

Acres
61

Coordinates
37.419014,-121.132246

Delete

Irrigation Settings

Blending of Water from Various Water Sources ⓘ

Water Source	N Concentration	% Used for Planting
Canal	3 ppm	100
Average N Concentration	3 ppm	100% ✓

Sprinklers

Sprinkler Application Rate ⓘ
0.3 in./hr

Sprinkler Distribution Uniformity ⓘ
75 %

Germination Sprinkler Distribution Uniformity ⓘ
65 %

Drip

Drip Application Rate ⓘ
0.04 in./hr

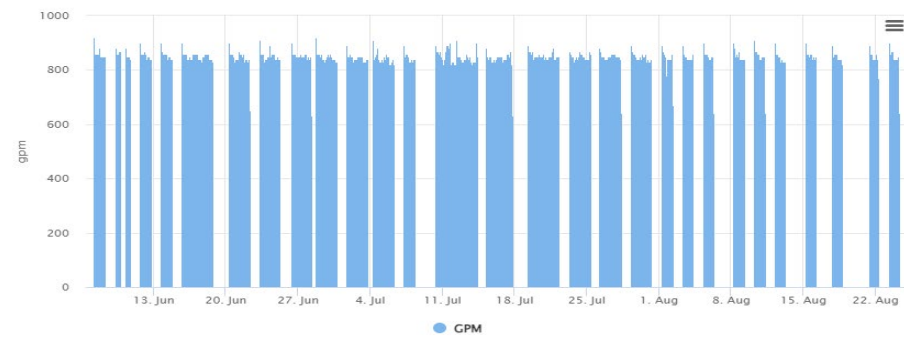
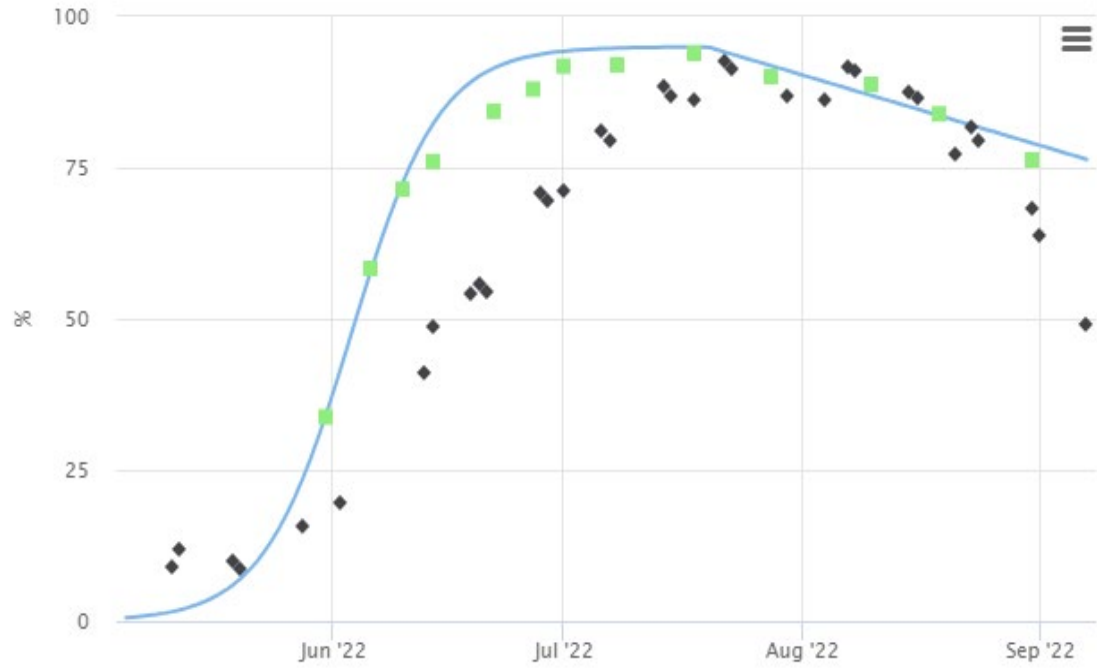
Drip Distribution Uniformity ⓘ
90 %

Leaching Requirement ⓘ
0 %

Cancel Save

CropManage currently supports a variety of crops with specific recommendations tailored to each crop's growth pattern and stages.

Key features: Data integration (weather stations and sensors)



Start	End	Average Flow Rate (gpm)	Gallons	Time	Applied Flowmeter Water (in.)	Application Rate (in/hr)	Flowmeter Area (acres)
06/07/2022 04:55	06/08/2022 06:00	674	1,014,890	25.08	0.60	0.02	62.00
06/09/2022 07:36	06/09/2022 17:52	690	425,260	10.27	0.25	0.02	62.00

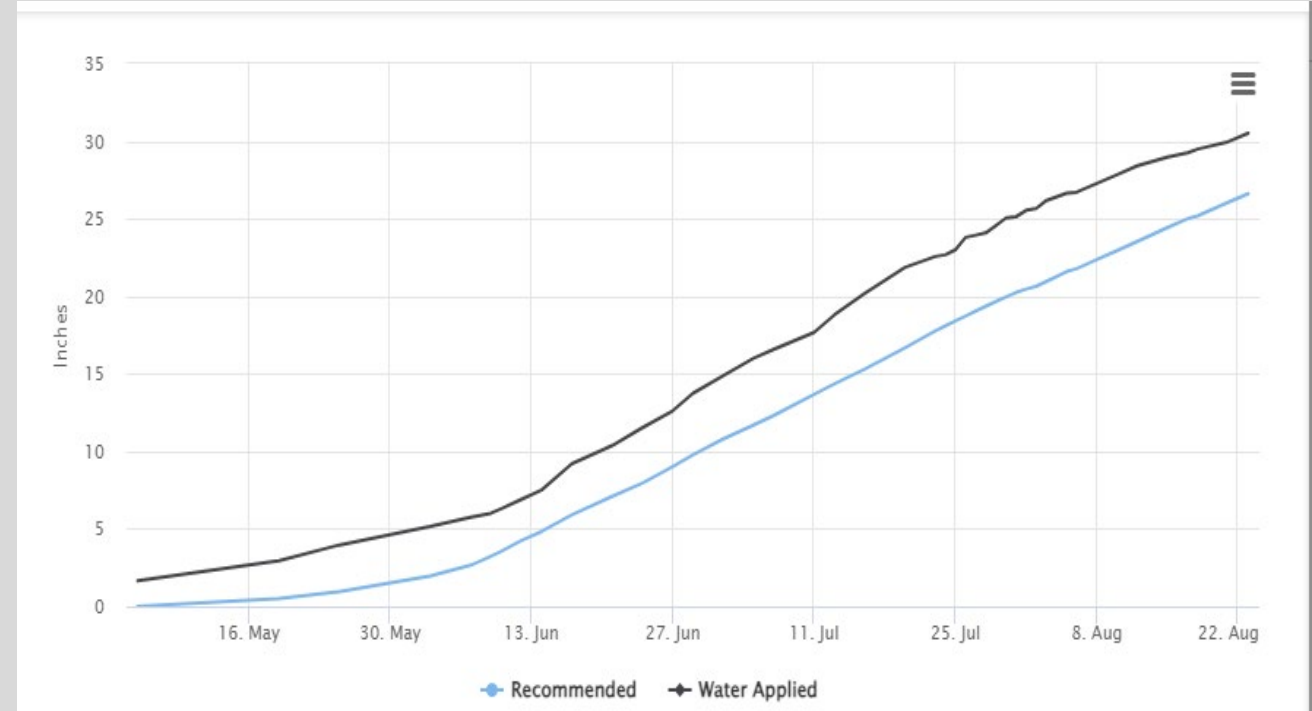
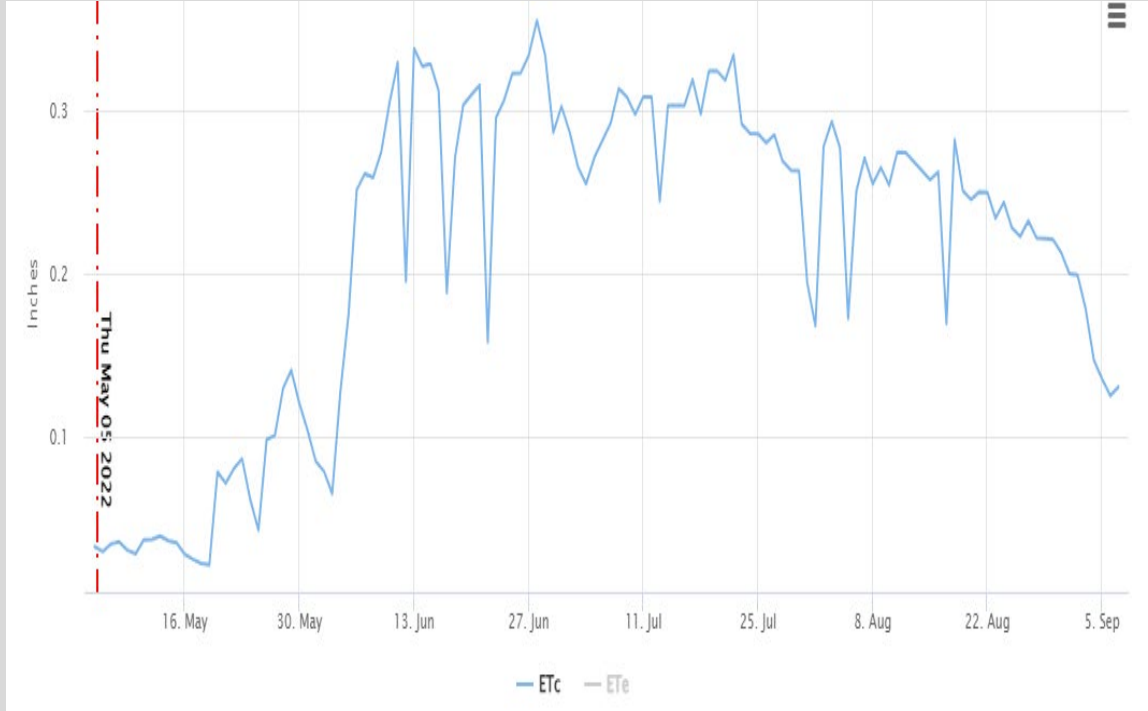
Settings

ET Data

8/3/2022	0.28	Averaged from Stations: 206,071	0.3	0.26
8/2/2022	0.265	Averaged from Stations: 206,071	0.28	0.25
8/1/2022	0.16	Averaged from Stations: 206,071	0.17	0.15
7/31/2022	0.185	Averaged from Stations: 206,071	0.2	0.17
7/30/2022	0.25	Averaged from Stations: 206,071	0.26	0.24
7/29/2022	0.25	Averaged from Stations: 206,071	0.26	0.24
7/28/2022	0.255	Averaged from Stations: 206,071	0.26	0.25
7/27/2022	0.27	Averaged from Stations: 206,071	0.28	0.26
7/26/2022	0.265	Averaged from Stations: 206,071	0.28	0.25
7/25/2022	0.27	Averaged from Stations: 206,071	0.28	0.26
7/24/2022	0.27	Averaged from Stations: 206,071	0.28	0.26
7/23/2022	0.275	Averaged from Stations: 206,071	0.28	0.26

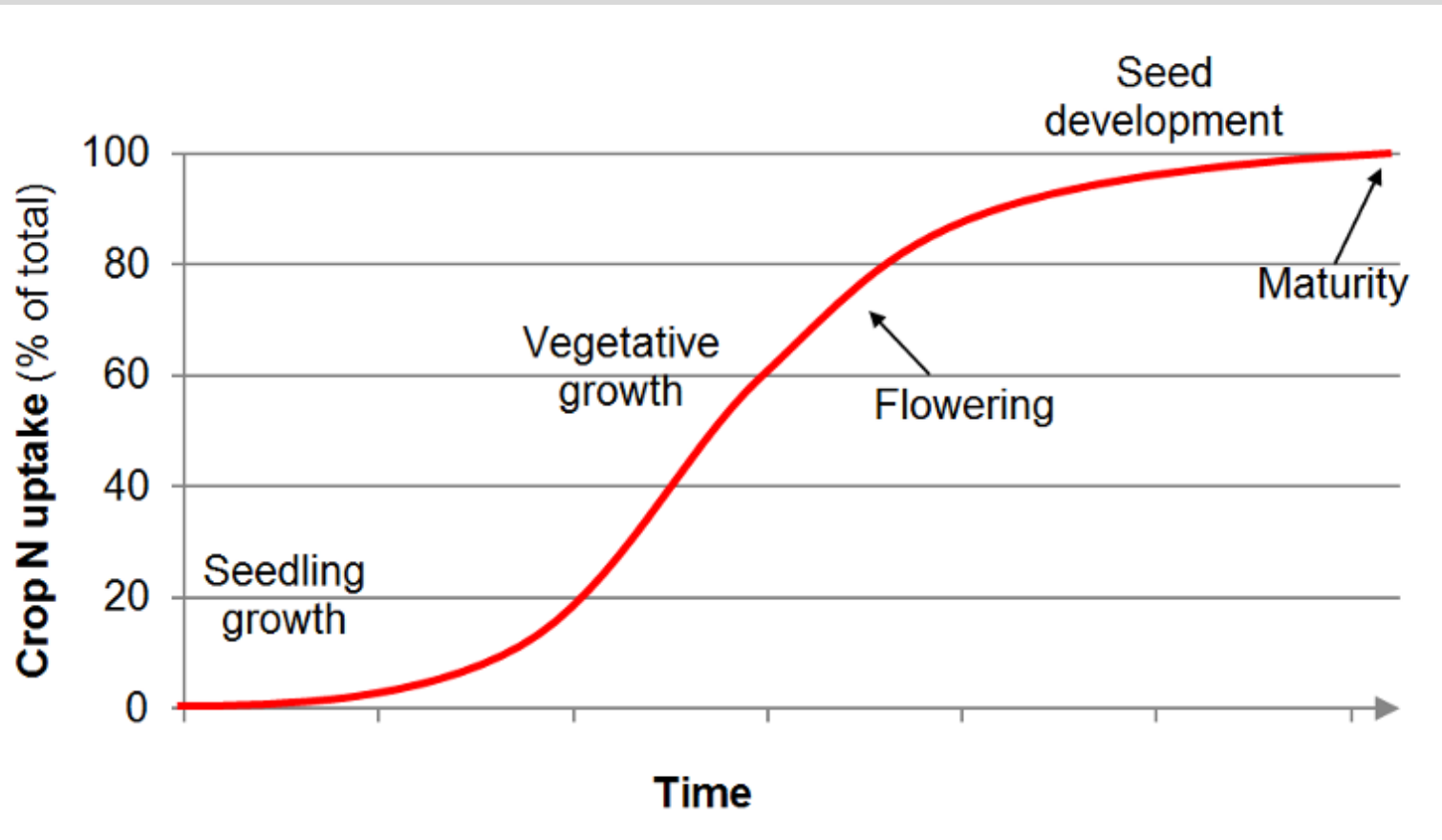
Close

Key features: Record keeping



The tool helps users keep detailed records of irrigation and fertilization practices, which can be useful for compliance with regulations and for analyzing effectiveness of different management strategies.

General shape of the N uptake curve for annual crops

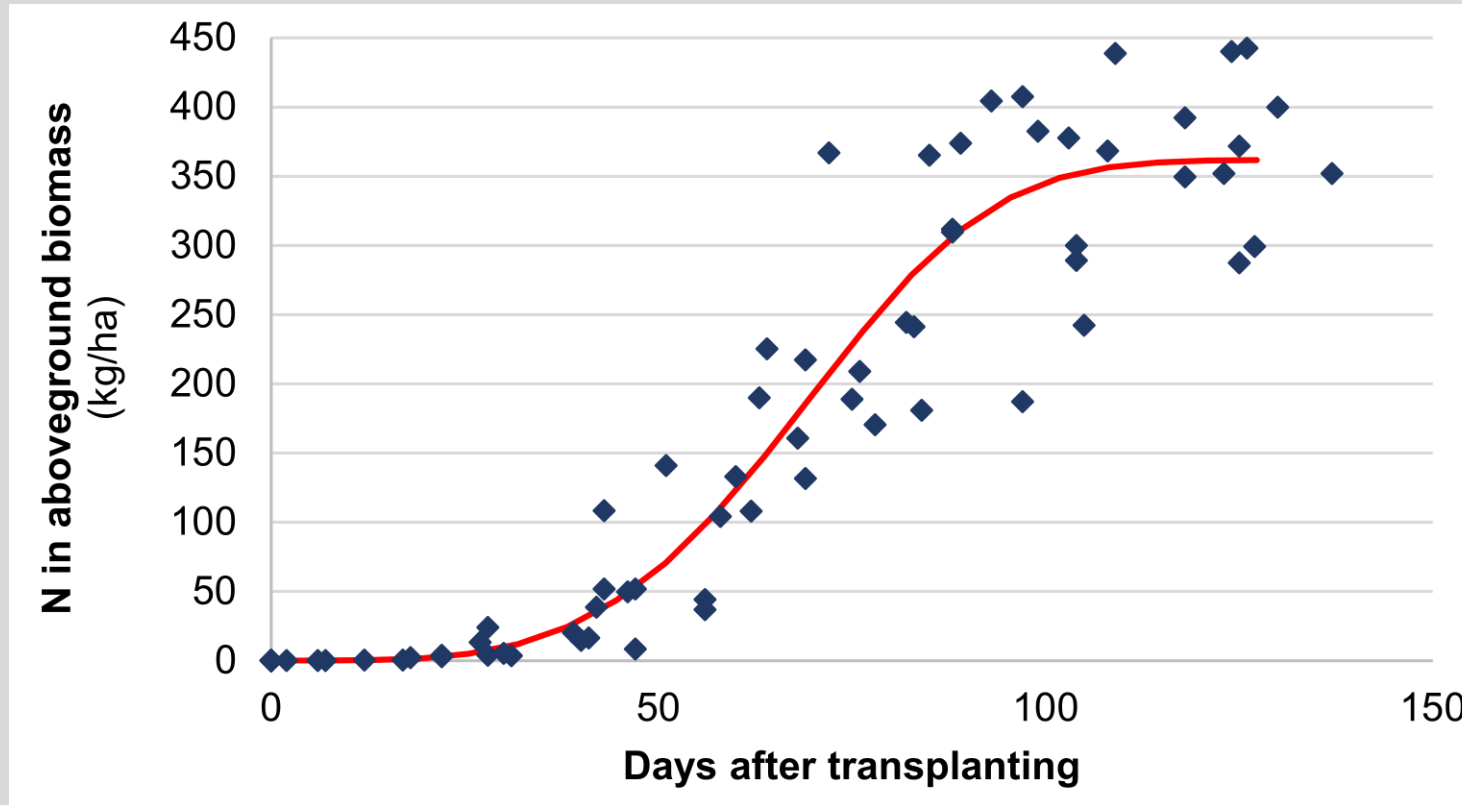


S-shaped N uptake for annual crops

- **Early season: slow uptake**
- **Sharp increase during shoot, leaf, and root expansion (when fertigation is needed).**
- **Level off prior to harvest – N translocation from vegetative components to fruiting reproductive structures.**

Retrieved from Geisseler and Horwath (online resource)

The general pattern of cumulative seasonal N uptake by processing tomatoes



Geisseler et al. (2020)

Required seasonal N application = Total plant N requirement – N contributions already in the soil

Soil test for soil residual NO₃-N as total N, sourced from mineralization of OM, decomposition of soil microorganisms, left over residues, and contribution from cover crops. This tells you the directly available site-specific Nitrate at sampling.

Irrigation water, especially well water.

Seasonal tomato N uptake pattern and % nutrient removed with harvest

Ranch Members

Sort

Planting Areas

Lots, blocks, fields, orchards, etc.

Sort

CROPMANAGE TOMATO

61 acres

Fertilizers

Sort

0-0-25 Wet Used
0% Nitrogen 3
12 Lbs/gal (liquid) Times

2-17-17 Wet Used
2% Nitrogen 0
11.6 Lbs/gal (liquid) Times

7-21-1 HUMIPLUS Wet Used
7% Nitrogen 1
10.25 Lbs/gal (liquid) Times

8-24-6 Wet Used
8% Nitrogen 0
10.6 Lbs/gal (liquid) Times

Weather Stations

ET data from weather station(s)
Average mode

1 DENAIR (#206)
Denair, Stanislaus - 21
miles away

2 MODESTO (#071)
Modesto, Stanislaus - 18
miles away

Water Sources

Includes Wells and Canals
(dS/m) - Electrical Conductivity
(ppm) - Nitrate-N Concentration

1 CANAL
0.3 dS/m - 3 ppm

Commodities

TOMATO

Edit Soil Sample

Event Date *
4/8/2022

Sample Type *
Lab Test

Depth *
0 to 1 ft

Crop Stage

Nitrate-N *
18.7 ppm

B (boron) ppm	Calcium 2353.3 ppm
Iron ppm	Magnesium 652.7 ppm
Manganese ppm	Na (sodium) 72.3 ppm

Delete Cancel Save

5 May 2022 - 7 Sep 2022

Tasks History

JUN 7	Drip	15.1 hr
JUN 7	Intelliphos 0-24-8	7.5 gal/acre
JUN 3	Drip	29.7 hr
JUN 3	UAN32	10 gal/acre
MAY 25	Drip	25.3 hr
MAY 19	Drip	32.7 hr
MAY 19	Intelliphos 0-24-8	7.5 gal/acre
MAY 5	Drip	41.3 hr
MAY 5	7-21-1 Humiplus	8 gal/acre
APR 8	Lab Test	18.7 ppm

View all events by: [List] [Calendar] [Calendar]

Seasonal N uptake and harvest removal of annual vegetables in CA

Crop	Seasonal crop N uptake (kg/ha and lbs./acre)		% Nutrient removed with harvest
Broccoli	280-392	250-350	25-35
Brussels sprout	392-560	350-500	30-50
Cabbage	314-426	280-380	50-60
Cantaloupe	168-224	150-200	50-65
Carrot	168-247	150-220	55-65
Cauliflower	280-336	250-300	25-35
Celery	224-336	200-300	50-65
Head or romaine lettuce	135-180	120-160	50-60
Baby lettuce	67-78	60-70	65-75
Onion	168-200	150-180	60-75
Pepper (bell)	270-392	240-350	55-65
Potato	190-280	170-250	65-75
<i>Processing tomato</i>	247-358	220-320	55-65 (avg. of 3 lbs. N removed per ton of fresh fruit harvested)
Spinach	100-145	90-130	65-75

Add Fertilization Event



Event Date *
7/22/2023



Fertilizer Type *
17-0-0-8 - Wet



Fertilizer Details

Days To Next Fertilization *
5

Soil Sample *
No Soil Sample



Choose the soil sample date used to calculate this recommendation

Recommendation

lbs N/acre

Fertilizer Unit

14.46 lbs N/acre

Recommendation Summary ▾

Include N Contribution From Water in Recommendation

Delete

Cancel

Save

Add Fertilization Event



Recommendation

lbs N/acre

Fertilizer Unit

14.46 lbs N/acre

Recommendation Summary ▾

Crop N Uptake ⓘ 16.07 lbs N/acre

N Fertilizer Factor ⓘ 1.00

Total Mineralized N ⓘ 1.61 lbs N/acre

Fertilizer N Recommendation = (Crop N Uptake / N Fertilizer Factor) - Total Mineralized N

14.46 = (16.07 / 1.00) - 1.61

Include N Contribution From Water in Recommendation

Manager Amount

lbs N/acre

Fertilizer N Applied

17.55

lbs N/acre

Enter the amount recommended by a manager

Last updated by Zheng Wang 7/27/2023 - 3:02 PM

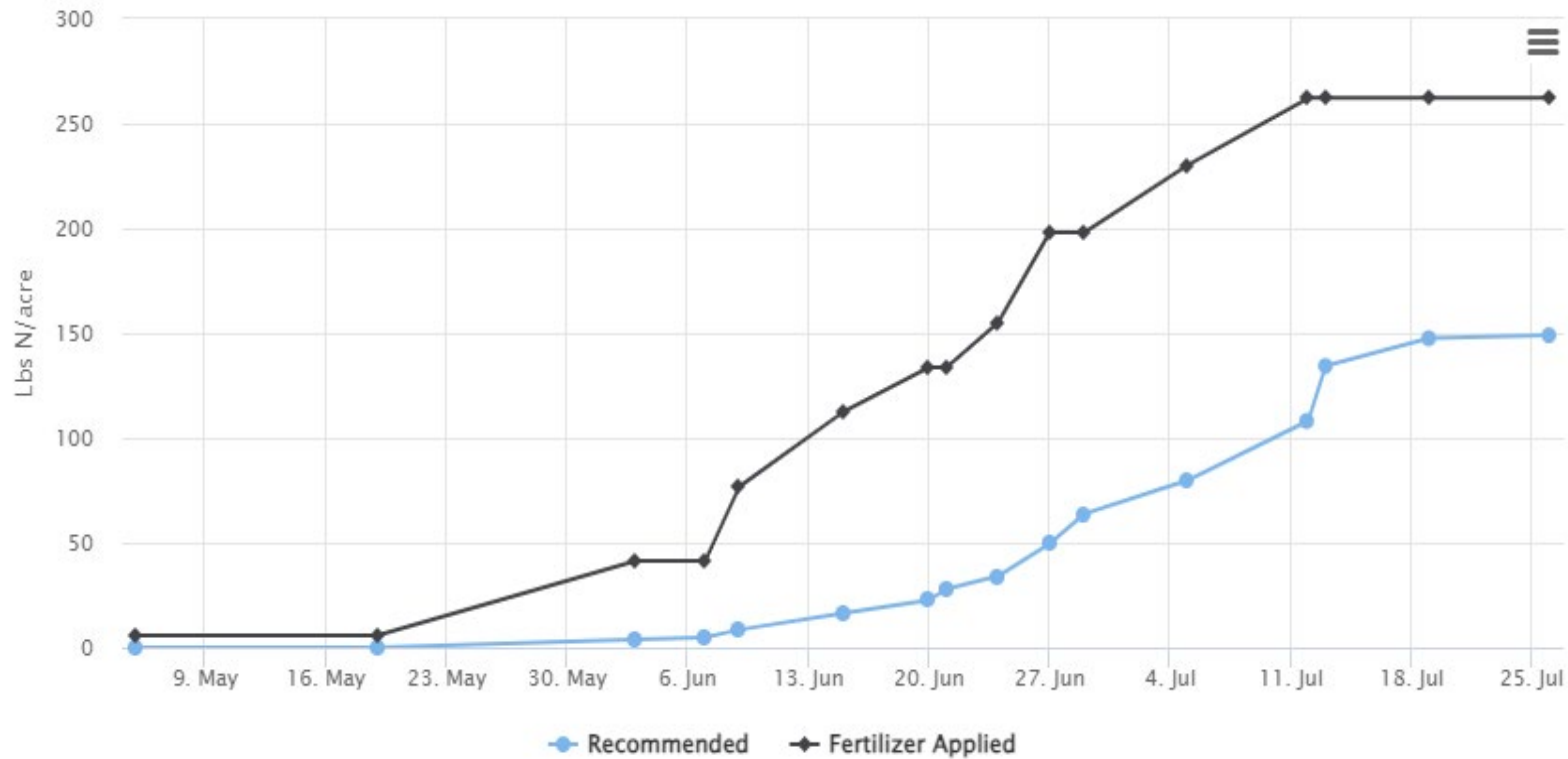
Delete

Cancel

Save

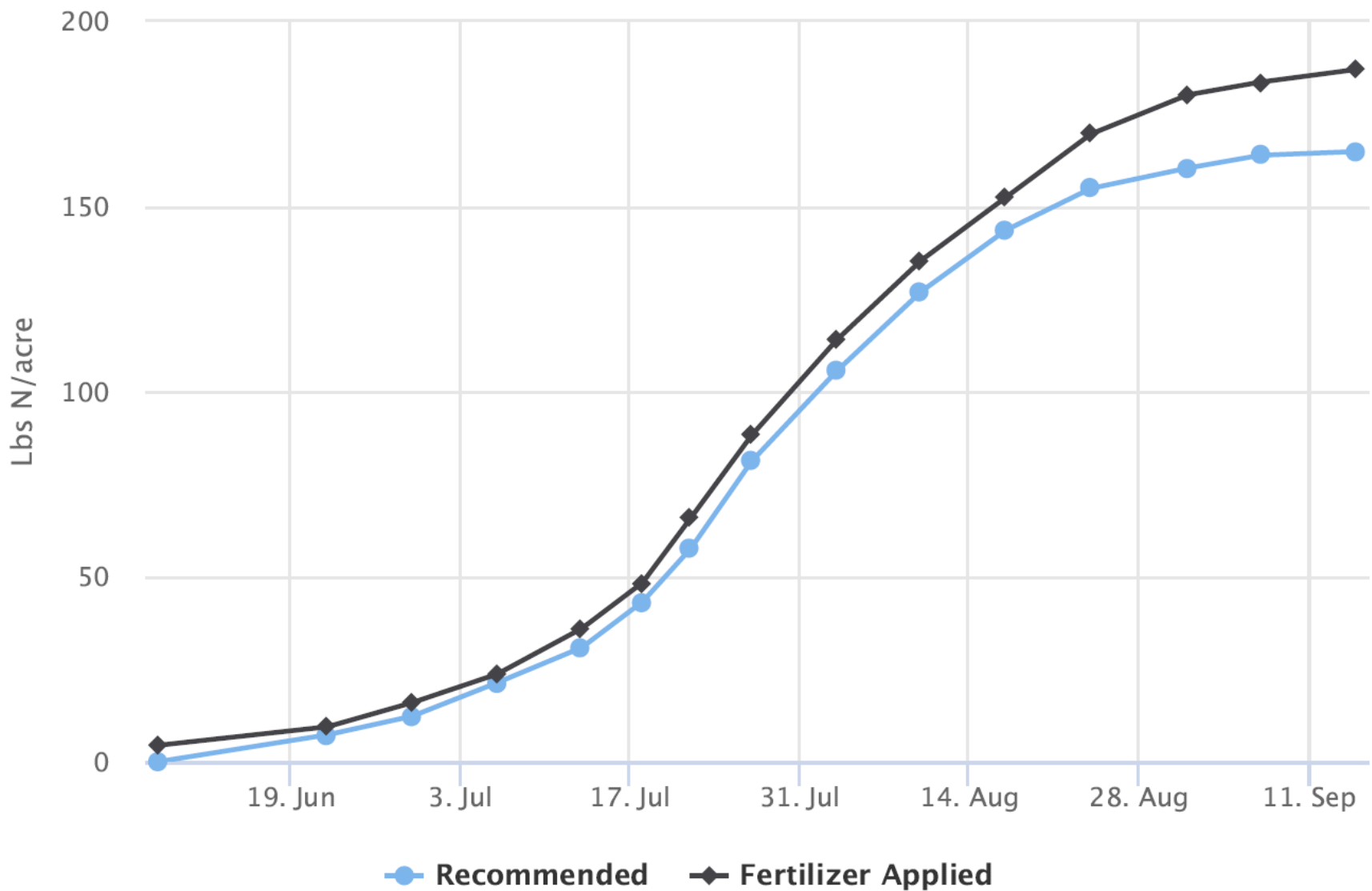
Cumulative N application and comparison with CM recommendation

Applied Fertilization Chart



2022

- Grower application: 260 lbs./acre
- CM recommendation: 150 lbs./acre
- Yielded 56 tons per acre.



2023

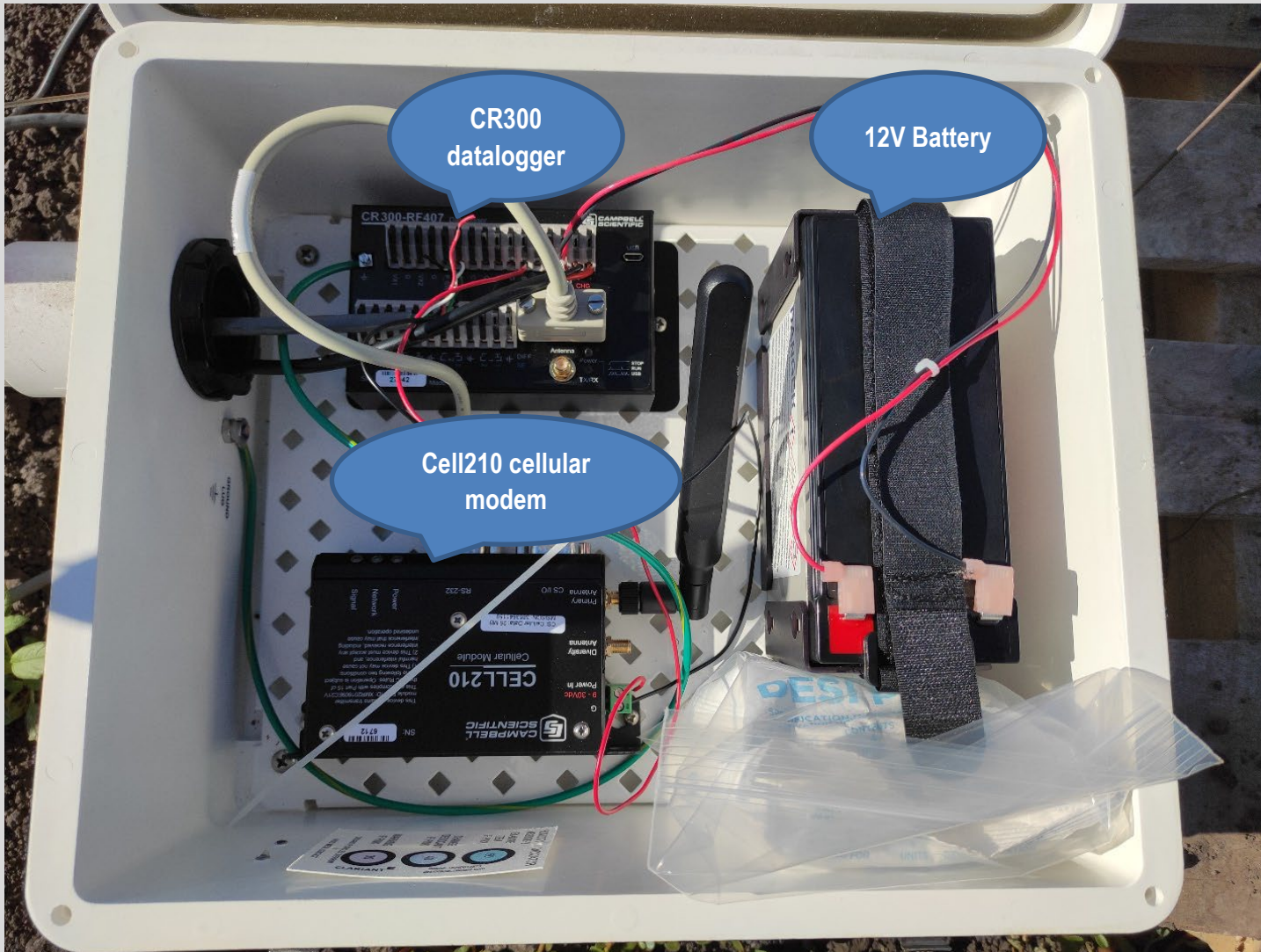
- 165 lbs./acre N recommended
- 186 lbs./acre N actually applied
- Yield: 58 tons/acre

Irrigation monitoring setup and system programming



- Trials located in Crows Landing (2022) and Stockton (2023).
- Clay loam
- Machine transplanted on May 6, 2022 and May 24, 2023.
- Variety: 9013 in 2022 and 9016 in 2023
- Machine harvests Sept. 26, 2022 and October 10, 2023.
- Field size: 61 acres (2022) and 30 acres (2023) – We monitored the whole field.

Tomato



- Monitored area: 61 (2022) and 30 (2023) acres
- Single line sub-surface drip (10-12 inches below)
- No sprinkler
- Drip rate 0.04-0.05 in/hr

ET-based irrigation...

$$ET_{\text{tomato}} = ET_{\text{ref}} \times K_{\text{tomato}}$$

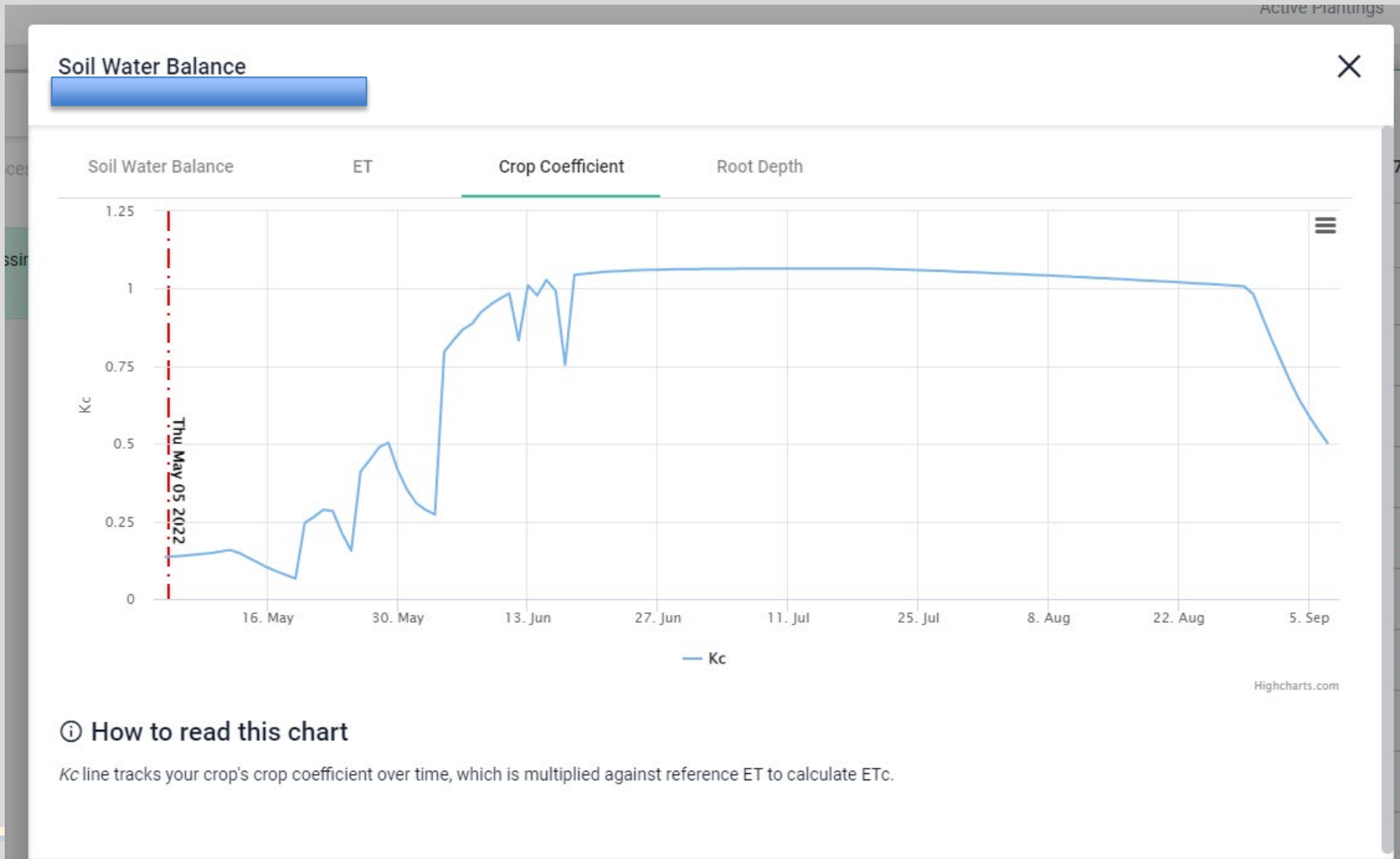
$$\text{Recommendation (inch of water)} = \text{Avg. } ET_{\text{ref}} \times K_{\text{tomato}} \times \text{days since last irrigation}$$

ET_{tomato} : actual ET of tomato (water demand)

ET_{ref} : reference ET near the field, access through California Irrigation Management Information System (CIMIS)

K_{tomato} : crop coefficient for tomato- relates to canopy development over the crop cycle.

Processing Tomato Crop Coefficient (Kc)



Daily ET reference: CIMIS

ET Data ✕

8/3/2022	0.28	Averaged from Stations: 206,071	0.3	0.26
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7/24/2022	0.27	Averaged from Stations: 206,071	0.28	0.26
7/23/2022	0.275	Averaged from Stations: 206,071	0.28	0.26

Close

Irrigation recommendation: with a flow meter and communication devices

Edit Watering Event

Event Date * 6/14/2022

Irrigation Method * Drip

Recommendation inches

0.64 inches

Recommendation Summary

Manager Amount inches

Enter the amount recommended by a manager

Water Applied 0.6002 inches

Enter the amount that was actually applied

Flow Meter Information:
0.6 in. = 1010620 gals over 62 acres
Last updated by CropManage 6/18/2022 - 6:05 PM

Delete Cancel Save

Edit Watering Event

Recommendation inches

0.64 inches

Recommendation Summary

Average ET 0.29 in./day

Average Crop Coefficient 1

Distribution Uniformity 90%

Days Since Last Irrigation 2 days

Leaching Requirement 0%

Total Precipitation 0 in.

Total Crop ET = Average ET x Average Crop Coefficient x Days Since Last Irrigation

0.57 in. = 0.29 x 1.00 x 2

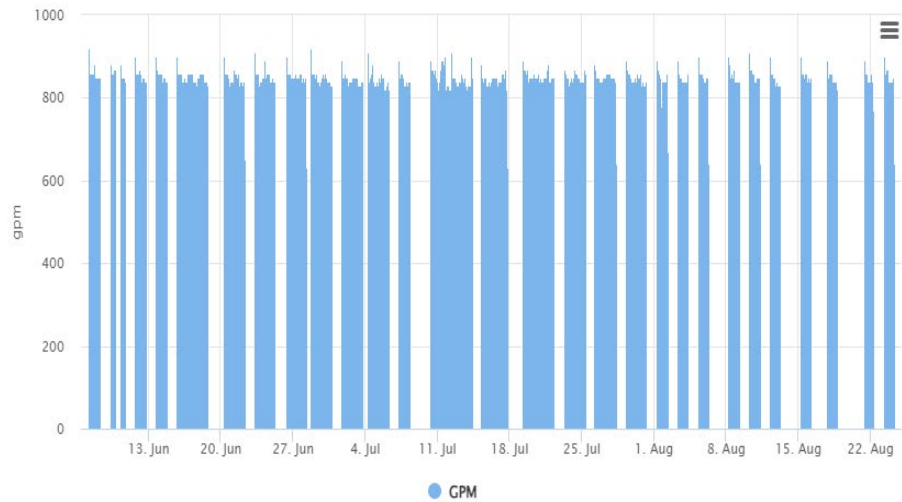
Recommended Irrigation Amount = Total Crop ET x 100 / (Distribution Uniformity x (1 - Leaching Requirement)) - Total Precipitation

0.64 in. = (0.57 in. x 100 / (90.00 * (1 - 0))) - 0.00 in.)

Date	ET	Source	Last Modified
6/13/22	0.335	Averaged from Station...	7/13/23, 6:22 PM
6/12/22	0.235	Averaged from Station...	7/13/23, 6:22 PM
Total	0.57		

Delete Cancel Save

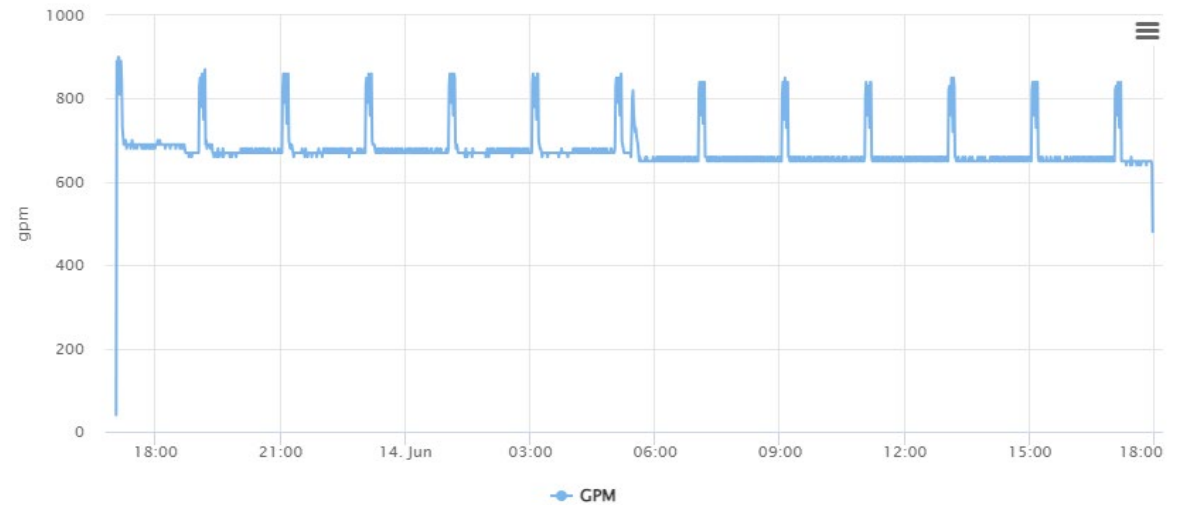
At a specific irrigation event



Highcharts.com

Start	End	Average Flow Rate (gpm)	Gallons	Time	Applied Flowmeter Water (in.)	Application Rate (in/hr)	Flowmeter Area (acres)
06/07/2022 04:55	06/08/2022 06:00	674	1,014,890	25.08	0.60	0.02	62.00
06/09/2022 07:36	06/09/2022 17:52	690	425,260	10.27	0.25	0.02	62.00

Settings



Highcharts.com

[← Back to Summary](#)

Date and Time	Average Flow Rate (gpm)	Cumulative Gallons	Applied Flowmeter Water (in.)	Application Rate (in/hr)
06/13/2022 17:02	0	0	0.00	0.00

Settings

Irrigation recommendation: without devices

Event Date *
7/18/2023

Irrigation Method *
Drip

Recommendation ⓘ inches hours
0.31 inches
Recommendation Summary ▾

Manager Amount inches
Enter the amount recommended by a manager

Water Applied inches
0.375
Enter the amount that was actually applied

Delete Cancel Save

Recommendation ⓘ inches hours
0.31 inches
Recommendation Summary ^

Average ET ⓘ 0.27 in./day
Average Crop Coefficient ⓘ 1.04
Distribution Uniformity ⓘ 90%
Days Since Last Irrigation ⓘ 1 day
Leaching Requirement ⓘ 0%
Total Precipitation ⓘ 0 in.

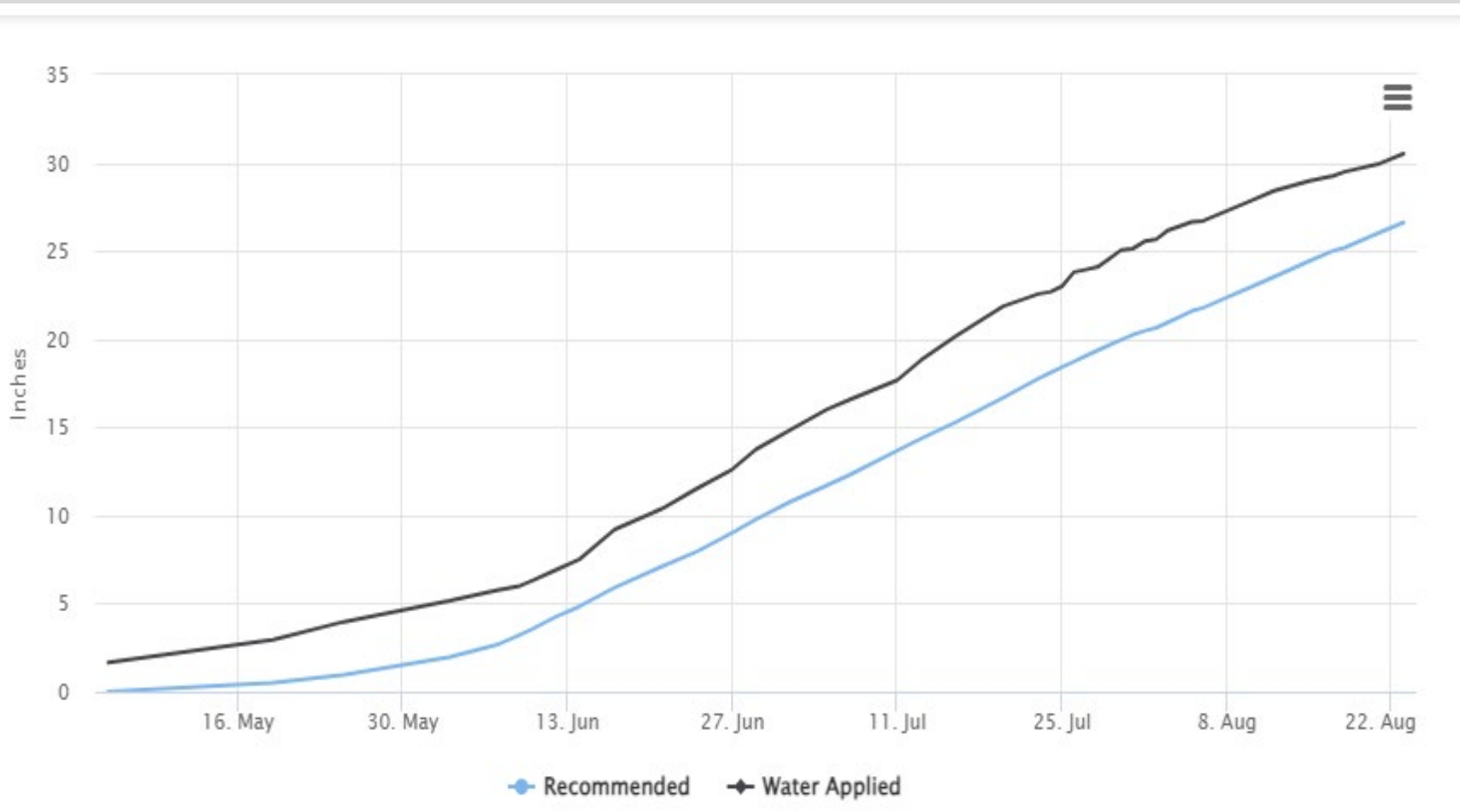
Total Crop ET = Average ET x Average Crop Coefficient x Days Since Last Irrigation
0.28 in. = 0.27 x 1.04 x 1

Recommended Irrigation Amount = Total Crop ET x 100 / (Distribution Uniformity x (1 - Leaching Requirement)) - Total Precipitation
0.31 in. = (0.28 in. x 100 / (90.00 * (1 - 0))) - 0.00 in.)

Date	ET	Source ⓘ	Last Modified
7/17/23	0.27	CIMIS Station: 262	10/10/23, 10:36 AM
Total	0.27		

Delete Cancel Save

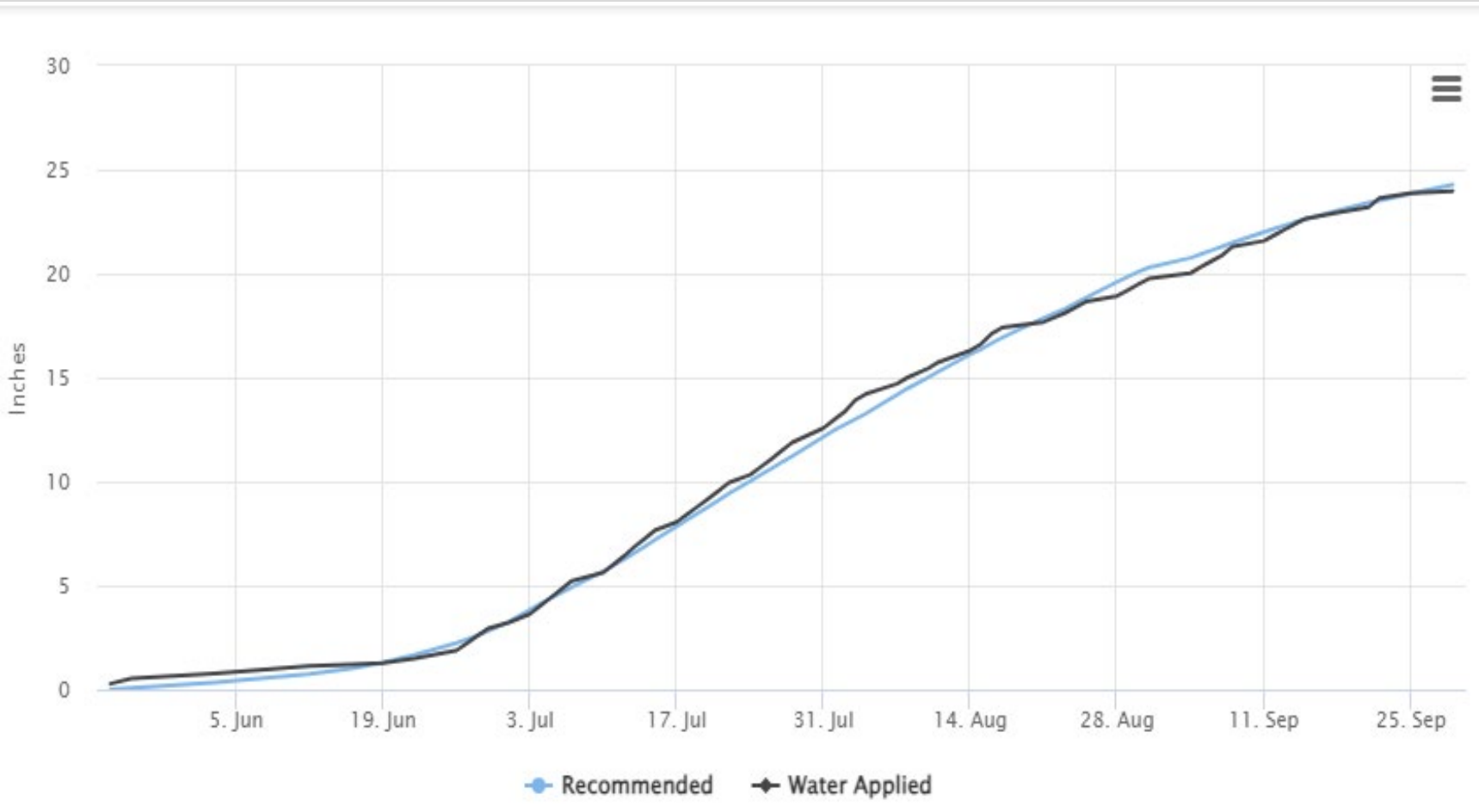
Cumulative irrigation and comparison with CM recommendation



2022

- Grower application: 30.5 inches
- CM recommendation: 26.6 inches
- Last irrigation made on August 23, 2022 – harvested on Sept. 26, 2022.
- Yielded 56 tons per acre.

Cumulative irrigation and comparison with CM recommendation



2023

- Highly overlapped
- Grower application: 24 inches
- CM recommendation: 24.3 inches
- Last irrigation made on September 26, 2023 – harvested on Oct. 10, 2023.
- Yielded 58 tons per acre.

Current adoption in the norther SJ Valley and future plans

- About 300 acres of tomatoes are now using CropManage for referencing irrigation and N in the valley. There were zero acres before 2021.
- Recommendation of N application will be further tested.
- Collaboration with other irrigation organizations/boards on promoting the use of decision-support tools.
- Training and train-the-trainer workshops are underway
- In-person and Zoom-based trainings are being offered.
- Key point: we will work together!



KAGOME



UC UNIVERSITY OF CALIFORNIA
CE Agriculture and Natural Resources UC Cooperative Extension

Thank You!
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