

# CropManage 3.0: Bringing water and nitrogen management decision support to the field



Michael Cahn  
Irrigation and Water Resources Advisor  
UC Cooperative Extension, Monterey County



## **Acknowledgements:**

- **UCCE Advisors/Specialists**
- **UC ANR and Breyta programming staff**
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- **CA Dept of Water Resources**
- **UC Division of Agriculture and Natural Resources**
- **Growers and Shippers**



# Tools for making water and nitrogen fertilizer decisions at the field level

- Soil nitrate quick test

- Weather-based irrigation scheduling



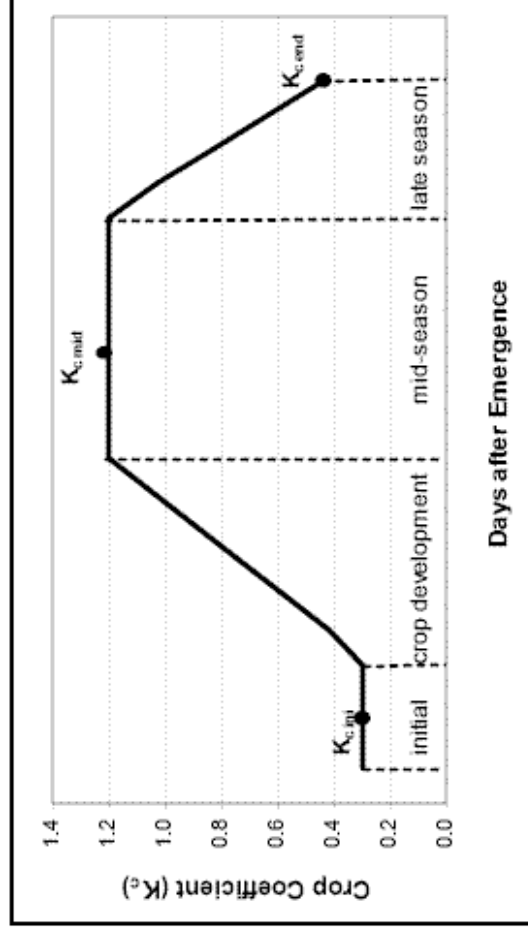
# Weather-based irrigation scheduling

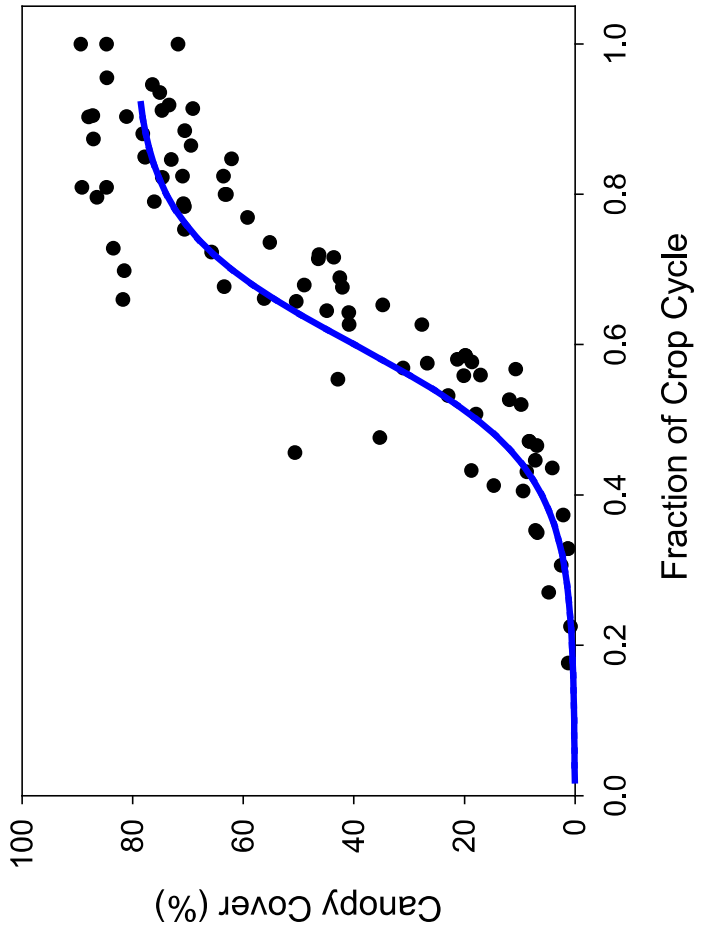
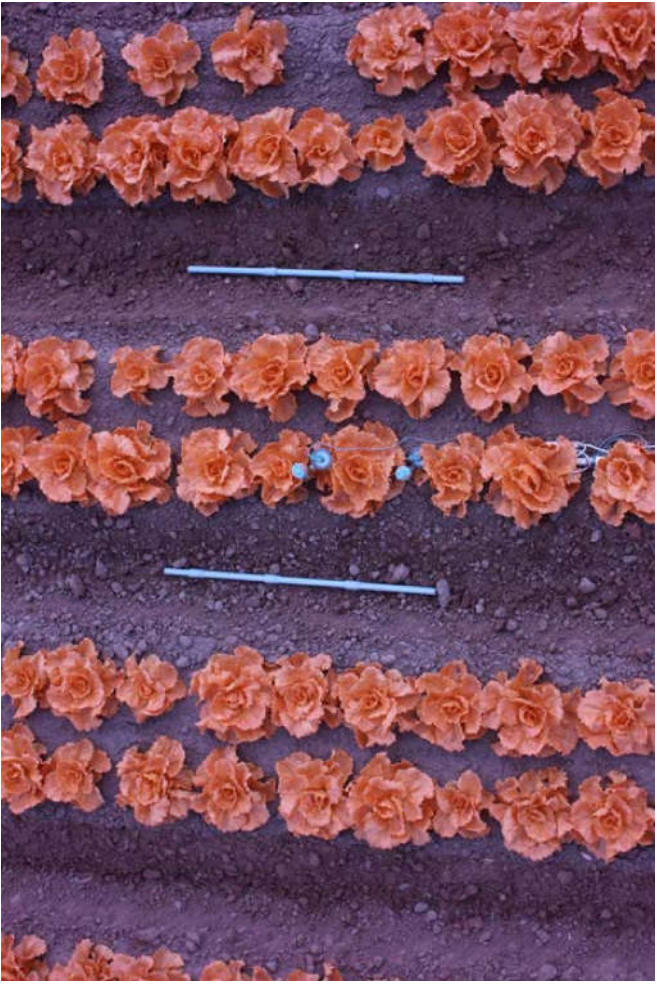


Converting Reference ET to  
Crop ET:

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

$K_c$  can vary from 0.1 to 1.2





# Other information needs to be considered

Rooting Depth



Irrigation System Uniformity and Application Rate



Soil Type

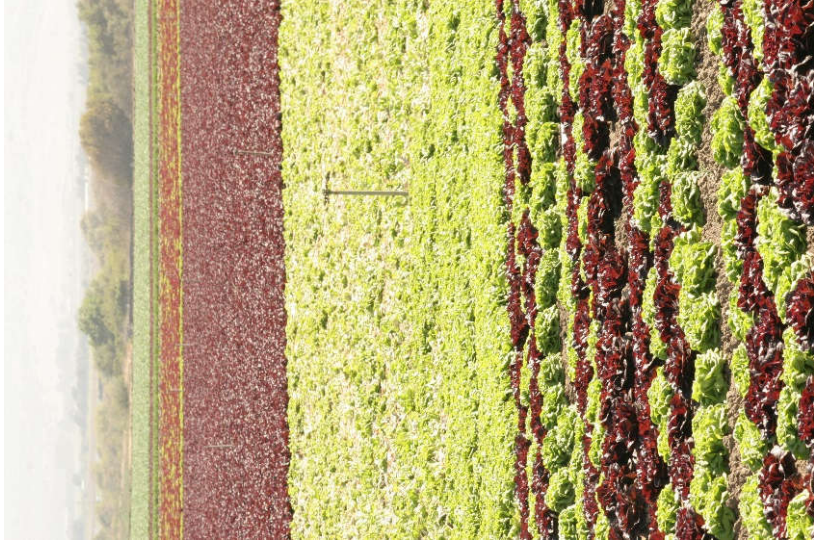


Salinity of Water Source



# **On-farm challenges in implementing tools for managing water and fertilizer:**

- ✓ **Multiple fields to manage and track**
- ✓ **Other decisions and activities to coordinate**
- ✓ **Calculations involved for N and water management decisions are time consuming**
- ✓ **Communication between decision maker and field staff can be challenging**





# CropManage: Online irrigation and nitrogen management decision support tool

The screenshot displays the CropManage mobile application interface. At the top, a header bar shows a star icon, the plot name "Romaine Trt 2 (CropManage)", and "Lot 22". Below the header, the plot details are "Lettuce-Romaine, 2 row, 40-inch bed" and the date range "27 Mar 2017 - 31 May 2017". A central section titled "Events" has tabs for "Upcoming" and "Past". To the right of the "Events" title are three icons: a water drop, a fertilizer bag, and a hand holding a tool. Below this, the "Upcoming" events are listed:

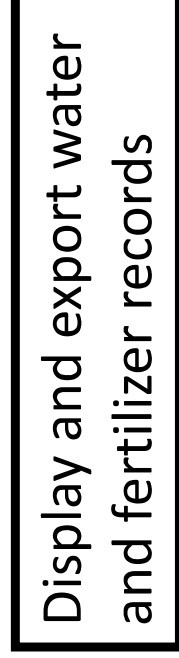
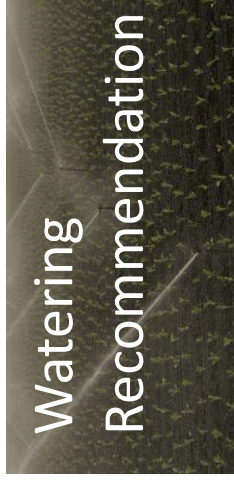
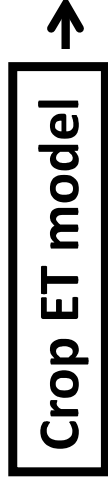
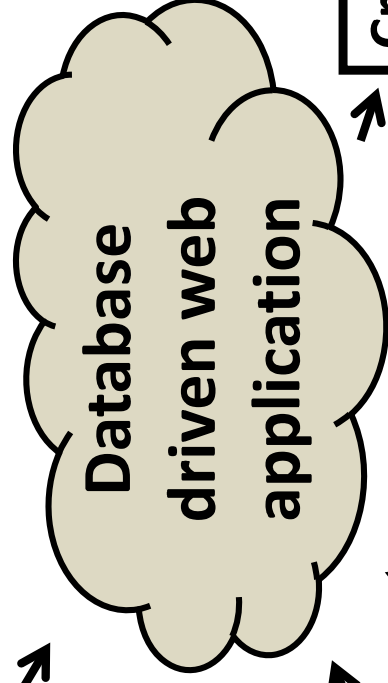
- 23 May 2017**
  - Drip: 6.58 hr
  - 20-0-0-5: 11.90 gal/acre
- 19 May 2017**
  - Drip: 4.84 hr

At the bottom, there is a "View all events by:" section with three icons: a list, a calendar, and a grid.

[v3.cropmanage.ucanr.edu](http://v3.cropmanage.ucanr.edu)



# Integrate information from multiple sources



# Decision support using crop models

## **Crops currently supported**

### **Vegetables:**

**Romaine lettuce**

**Iceberg lettuce**

**Leaf lettuce**

**Baby lettuce (red, green)**

**Broccoli**

**Cauliflower**

**Cabbage (red and green)**

**Celery**

**Spinach (baby, teen, bunch)**

**Mizuna**

**Cilantro**

**Berries**

**Strawberry (UC and proprietary varieties)**

# How is N fertilizer rate determined from the soil nitrate quick test?

Recommended

Fertilizer N = Future Crop N uptake

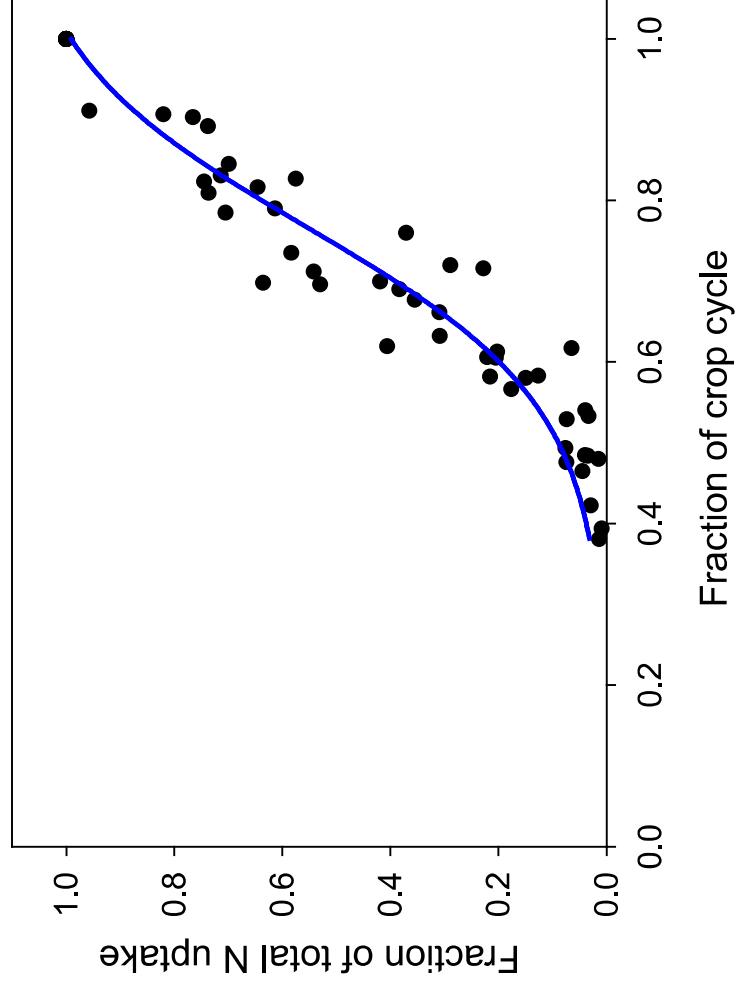
– (Quick Test N - threshold  $\text{NO}_3\text{-N}$ )

– Soil mineralization N

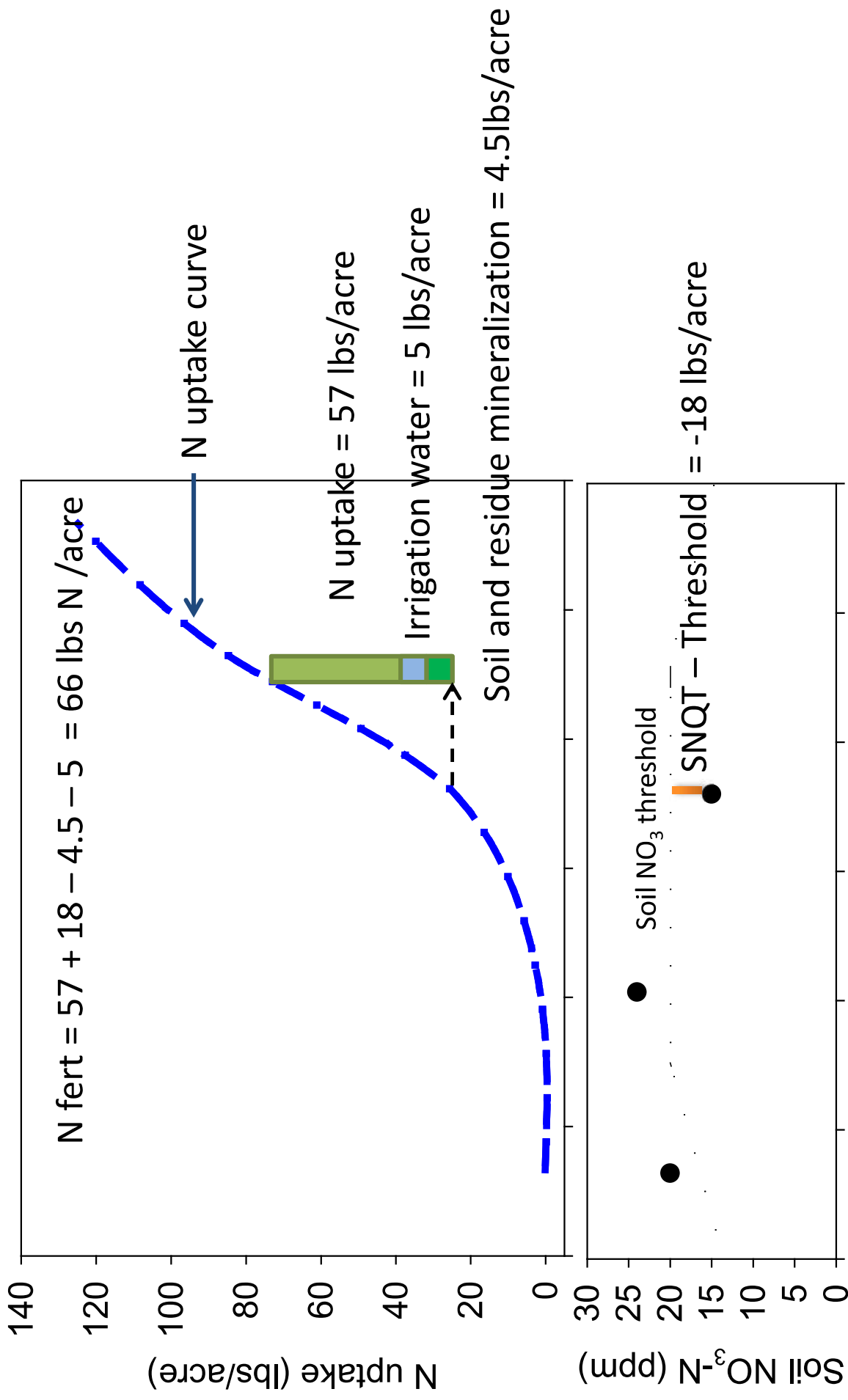
– Plant residue N

– N in irrigation water\*

# Crop N uptake models



# Nitrogen Fertilizer Recommendation for Vegetables



Jan 20 Feb 04 Feb 19 Mar 06 Mar 21 Apr 05 Apr 20

# CropManage Evolved

## 2005 spreadsheet

**1.1** sprinkler irrigation system  
**1.2** drip irrigation system  
**2.1** Field Application Rate (inches/hour) =  
**2.2** Distribution Uniformity (%) =  
**3.1** Leaching Fraction (%) =  
**3.2** evapotranspiration  
**4.1** Actual irrigation interval (days) =  
**4.2** Actual irrigation interval (days) =  
**5.1** Rooting Kc x 100 or Allowable  
**5.2** Rooting Kc x 100 or Allowable  
**5.3** Rooting Kc x 100 or Allowable  
**5.4** Rooting Kc x 100 or Allowable  
**5.5** Rooting Kc x 100 or Allowable  
**5.6** Rooting Kc x 100 or Allowable  
**5.7** Rooting Kc x 100 or Allowable  
**5.8** Rooting Kc x 100 or Allowable  
**5.9** Rooting Kc x 100 or Allowable  
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**5.97** Rooting Kc x 100 or Allowable  
**5.98** Rooting Kc x 100 or Allowable  
**5.99** Rooting Kc x 100 or Allowable  
**6.00** Rooting Kc x 100 or Allowable

## 2011 V1.0 launched

| Water Date              | Irrigation Method | Irrigation Interval (days) | Recommended Irrigation Interval (days) | Recommended Irrigation Time (hrs) | Recommended Irrigation Amount (in) |
|-------------------------|-------------------|----------------------------|--|-----------------------------------|------------------------------------|
| <a href="#">6/8/11</a>  | Sprinkler         | 0                          | N/A                                    | N/A                               | N/A                                |
| <a href="#">6/10/11</a> | Sprinkler         | 2                          | 2.3                                    | 0.70 hrs                          | 0.21 in                            |
| <a href="#">6/12/11</a> | Sprinkler         | 2                          | 2.5                                    | 0.63 hrs                          | 0.19 in                            |
| <a href="#">6/22/11</a> | Sprinkler         | 10                         | 7.2                                    | 1.11 hrs                          | 0.33 in                            |
| <a href="#">7/2/11</a>  | Sprinkler         | 10                         | 8.1                                    | 0.33 hrs                          | 0.10 in                            |
| <a href="#">7/8/11</a>  | Drip              | 6                          | 5.8                                    | 4.15 hrs                          | 0.42 in                            |
| <a href="#">7/12/11</a> | Drip              | 4                          | 12.8                                   | 1.45 hrs                          | 0.14 in                            |
| <a href="#">7/18/11</a> | Drip              | 6                          | 7.3                                    | 3.90 hrs                          | 0.39 in                            |

## 2013 V1.1

| Water Date | Irrigation Method | Recommended Irrigation Interval (days) | Recommended Irrigation Amount (inches) | Recommended Irrigation Time (hours) | Irrigation Water Applied (inches) | Canopy Cover (%) | Kc | Average Reference ET (inches/day) | Total Crop ET (inches) |
|------------|-------------------|--|--|-------------------------------------|-----------------------------------|------------------|----|-----------------------------------|------------------------|
| 7/8/12     | Sprinkler         | 1.6                                    | 0.48 in                                | 1.59 hrs                            | 0.60 in                           | 0.48             | 0  | 0.25                              | 0.36                   |
| 7/13/12    | Sprinkler         | 2.8                                    | 0.47 in                                | 1.57 hrs                            | 0.51 in                           | 0.80             | 1  | 0.24                              | 0.35                   |
| 7/20/12    | Drip              | 6.3                                    | 0.41 in                                | 2.70 hrs                            | 0.45 in                           | 0.23             | 3  | 0.22                              | 0.34                   |
| 7/24/12    | Drip              | 9.4                                    | 0.19 in                                | 1.25 hrs                            | 0.22 in                           | 0.16             | 5  | 0.25                              | 0.16                   |
| 7/29/12    | Drip              | 11.2                                   | 0.23 in                                | 1.56 hrs                            | 0.15 in                           | 0.18             | 11 | 0.22                              | 0.20                   |
| 8/4/12     | Drip              | 8.2                                    | 0.46 in                                | 3.03 hrs                            | 0.60 in                           | 0.27             | 24 | 0.24                              | 0.39                   |
| 8/7/12     | Drip              | 7.6                                    | 0.26 in                                | 1.76 hrs                            | 0.30 in                           | 0.40             | 33 | 0.19                              | 0.22                   |
| 8/10/12    | Drip              | 4.9                                    | 0.44 in                                | 2.95 hrs                            | 0.30 in                           | 0.50             | 43 | 0.25                              | 0.38                   |
| 8/14/12    | Drip              | 4.3                                    | 0.73 in                                | 4.90 hrs                            | 0.80 in                           | 0.64             | 56 | 0.25                              | 0.62                   |
| 8/18/12    | Drip              | 4.1                                    | 0.62 in                                | 5.49 hrs                            | 0.00 in                           | 0.77             | 67 | 0.23                              | 0.70                   |
| Totals     |                   |  | 5.36 in                                | 29.70 hrs                           | 6.03 in                           |                  |    |                                   | 4.38 in                |

## 2015 V2 launched

| Date           | Soil Sample - ppm Nitrate-N   | Fertilizer - Fertilizer Units | Water - in.    |
|----------------|---|-------------------------------|----------------|
| 8/31/2015      | 1 ft depth: 12.5 ppm Nitrate-N  |                               |                |
| 9/2/2015       |   |                               | Drip 0.6 in    |
| 9/3/2015       |   |                               | Drip 0.0 in    |
| 9/4/2015       |   | UAN28 22.5 gal/acre           | Drip 0.4 in    |
| 9/7/2015       | 1 ft depth: 12.5 ppm Nitrate-N  |                               |                |
| 9/9/2015       | 1 ft depth: 18.8 ppm Nitrate-N  |                               | Drip 0.5 in    |
| 9/10/2015      |   |                               | Drip 0.6 in    |
| 9/14/2015      | 1 ft depth: 0.0 ppm Nitrate-N<br>1.2 ppm Organic Matter<br>50.0 ppm Phosphorus<br>120.0 ppm Potassium |                               |                |
| <b>TOTALS:</b> |   | <b>88.20 lbs N/acre</b>       | <b>7.41 in</b> |

# CropManage 3.0

## *Bringing CropManage to the field*

breyta

- Simplify user interface
- Easy to read on smart phones and tablet computers
- Intuitive to navigate
- Simple for field staff to use (irrigators, foremen)
- Designed better for communicating between decision makers and field staff



# Ranch List (all)

## Ranches

My Ranches Favorite Ranches Public Ranches

+ Create Ranch

Search My Ranches

### Filter Ranches by Name

|     |   |   |   |
|-----|---|---|---|
| All | A | B | C |
| D   | E | F | G |
| H   | I | J | K |
| L   | M | N | O |
| P   | Q | R | S |
| T   | U | V | W |
| X   | Y | Z | # |

|   |   |   |
|---|---|---|
| <p>☆ <b>ALBA student demo plot</b><br/>Laura Murphy</p> <p>0 Active Plantings</p> | <p>☆ <b>Aptos</b><br/>Michael Cahn</p> <p>0 Active Plantings</p>    | <p>☆ <b>Arts Ranch - UC trial</b><br/>Andre Biscaro</p> <p>0 Active Plantings</p> |
| <p>☆ <b>Backus</b><br/>michael cahn</p> <p>0 Active Plantings</p>                 | <p>☆ <b>Bird</b><br/>Michael Johnson</p> <p>1 Active Plantings</p>  | <p>☆ <b>Blanco</b><br/>Manuel Mercado</p> <p>0 Active Plantings</p>               |
| <p>☆ <b>Bondenson</b><br/>Michael Cahn</p> <p>0 Active Plantings</p>              | <p>★ <b>Bondesen</b><br/>Kyle Pollock</p> <p>8 Active Plantings</p> | <p>★ <b>Borchard</b><br/>Michael Cahn</p> <p>0 Active Plantings</p>               |
| <p>☆ <b>Broome Ranch</b><br/>richard smith</p>                                    | <p>☆ <b>Bruscia</b><br/>Michael Johnson</p>                         | <p>☆ <b>Bryon's Test</b><br/>Bryon Noel</p>                                       |

# Ranch List (favorites)

MENU

CropManage

Hello Michael Cahn

English (United States) ▾

+ Create Ranch

Ranches

[My Ranches](#)
[Favorite Ranches](#)
[Public Ranches](#)

**Filter Ranches by Name**

|     |   |   |   |
|-----|---|---|---|
| All | A | B | C |
| D   | E | F | G |
| H   | I | J | K |
| L   | M | N | O |
| P   | Q | R | S |
| T   | U | V | W |
| X   | Y | Z | # |

★

**Bondesden**  
CropManage

8
Active Plantings

★

**Borchard**  
CropManage

0
Active Plantings

★

**Celery BMP**  
CropManage

0
Active Plantings

★

**D'Arrigo Ranch 15**  
CropManage

0
Active Plantings

★

**D'Arrigo Ranch 22**  
CropManage

4
Active Plantings

★

**Driscoll's Balich**  
Marino Hernandez

0
Active Plantings

★

**Molera Boutonnet**  
Laura Murphy

0
Active Plantings

★


**UCCE Ranch 3**  
CropManage



2
Active Plantings

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# Ranch Settings



 Hello Michael Cahn
 
 English (United States)

Active Plantings
Favorite Plantings
All Plantings
+ Add Planting




UCCE Ranch 3 

36.6277435996739,-121.57244205242  100 Acres  [Michael Cahn](#) Edit Ranch

SETTINGS

**Ranch Members** 4

Sort ▼

|                |   |
|----------------|---|
| Bryon Noel     |    |
| Michael Cahn   |  |
| Michael D Cahn |  |

**Lots** 6

Sort ▼


|   |          |   |          |
|---|----------|---|----------|
| 1 | 10 acres | 2 | 10 acres |
| 3 | 8 acres  | 4 | 10 acres |
| 5 | 12 acres | 7 | 12 acres |

**Fertilizers** 18

Sort ▼

|                                      |              |
|--------------------------------------|--------------|
| 0-0-50 Dry                           | Used 0 Times |
| 0% Nitrogen<br>0 Lbs/gal (liquid)    |              |
| 0-14-14 Wet                          | Used 2 Times |
| 0% Nitrogen<br>11.3 Lbs/gal (liquid) |              |
| 10-20-10 Dry                         | Used         |

**Weather Stations** 3



ET data from Spatial CIMIS  
CIMIS Data Sequential mode 


|                           |                                     |
|---------------------------|-------------------------------------|
| 1 SALINAS SOUTH II (#214) | Salinas, Monterey<br>- 2 miles away |
| 2 SALINAS NORTH (#116)    | Salinas, Monterey<br>- 9 miles away |


**Wells** 2


(dS/m) - Electrical Conductivity (ppm) - Nitrate-N Concentration

|          |                   |
|----------|-------------------|
| 1 W2     | 0.5 dS/m - 30 ppm |
| 2 WELL 1 | 0.5 dS/m - 10 ppm |

 Help
 
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 Privacy

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# Planting Summary

Search Active Plantings 

**Filter Plantings**


All Plantings

**Lots**


- 1
- 2
- 3

**Crop Type**

- Broccoli
- Lettuce
- Strawberry



**Broccoli test**  
Lot 3



Broccoli 2 row, 40-inch bed, summer, sprink...




**13 Jul 2017 - 9 Oct 2017**

---

**Events**


Upcoming | Past 1


Add:


---



**15 Aug 2017** Today


 Drip 10.00 hr

 28-0-0-5 15.00 gal/acre


**14 Aug 2017** Yesterday

 Quick Nitrate Strip 16.7 ppm

View all events by:  



**lettuce test**  
Lot 2



Lettuce-Romaine, 6 row, 80-inch bed




**15 Jun 2017 - 27 Aug 2017**

---

**Events**

Upcoming | Past 1



Add:






---


**15 Aug 2017** Today

No Events Today

View all events by:  



**strawberry test**  
Lot 1



Strawberry-Albion, 2 row, 52-inch bed




**30 Nov 2016 - 31 Oct 2017**

---

**Events**

Upcoming | Past 4



Add:

---

**15 Aug 2017** Today

No Events Today

View all events by:  

# Planting Summary



## Filter Plantings

All Plantings

Lots

Crop Type

Active Plantings

Favorite Plantings

All Plantings

+ Add Planting

**★ Broccoli test**  
Lot 3

Broccoli 2 row, 40-inch bed, summer, sprink...

**13 Jul 2017 - 9 Oct 2017**

**Events**  
Upcoming | Past **1**


Add:

**15 Aug 2017** Today

No Events Today

View all events by:

# Planting Summary




 **Broccoli test**  
Lot 3

Broccoli 2 row, 40-inch bed, summer, sprink...

**13 Jul 2017 - 9 Oct 2017**



**Events**

Upcoming | Past **1**

Add:   

**15 Aug 2017** Today

No Events Today

View all events by:  

## Edit Watering Event



08/15/2017 

Irrigation Method

Drip 

### Recommendations

CropManage

5.40 hours

[Recommendation Summary](#) 

inches 

Manager

hours

### Water Applied

hours

Delete

Cancel

Save 

# Edit Watering Event



## Recommendations

inches hours

CropManage

5.40 hours

Manager

hours

[Recommendation Summary](#) ^

Average ET ⓘ

0.20 in./day

Average Crop Coefficient ⓘ

0.33

Distribution Uniformity ⓘ

90.00%

Days Since Last Irrigation ⓘ

11 Days

Leaching Requirement ⓘ

0%/100

Total Precipitation ⓘ

0.01 in.

Base Amount = (Average ET x Average Crop Coefficient x Days Since Last Irrigation x 100) / Distribution Uniformity

0.82 = (0.20 inches x 0.33 x 11 x 100) / 90.00

Recommended Irrigation Amount = Base Amount / (1 - Leaching Requirement) - Total Precipitation

0.81 = (0.82 in. / (1 - 0) - 0.01 in.)

Delete

Cancel

Save





Broccoli test

Lot 3



Broccoli 2 row, 40-inch bed, summer, sprink...

13 Jul 2017 - 9 Oct 2017

### Events

Upcoming | Past **1**

Add:



15 Aug 2017

Today



Drip



5.40 hr

View all events by:



## Edit Watering Event



08/15/2017 

Irrigation Method

Drip ▼

### Recommendations

CropManage

5.40 hours

[Recommendation Summary](#) ▼

inches **hours**

Manager

5 hours

### Water Applied

hours

Delete

Cancel

Save



Broccoli test  
Lot 3



Broccoli 2 row, 40-inch bed, summer, sprink...

13 Jul 2017 - 9 Oct 2017

### Events

Upcoming | Past **1**

Add:



15 Aug 2017

Today



Drip



5.00 hr

Michael Cahn 8/15/2017 - 10:07 AM

View all events by:





Broccoli test

Lot 3



Broccoli 2 row, 40-inch bed, summer, sprink...

13 Jul 2017 - 9 Oct 2017

### Events

Add:



Upcoming | Past **1**

15 Aug 2017

Today



Drip

10.00 hr

richard smith 8/15/2017 - 10:40 AM

04 Aug 2017



Sprinkler

2.00 hr

25 Jul 2017

View all events by:



# Summary Table

| All Events<br>Broccoli test   3 |                       | All                                    | Water      | Fertilizer   | Soil Samples |
|---------------------------------|-----------------------|--|------------|--|--------------|
| Date                            | Water                 | Fertilizer                             | Fertilizer | Soil Sample  |              |
| 8/15/2017                       | Drip<br>10.0 hr       | 28-0-0-5<br>15.00 gal/acre             |            |  |              |
| 8/14/2017                       |                       |  |            | 1.00 ft depth<br>16.67 ppm Nitrate-N<br><b>Michael Cahn 8/15/2017 - 10:53 AM</b> |              |
| 8/4/2017                        | Sprinkler<br>2.0 hr   |  |            |  |              |
| 8/1/2017                        |                       |  |            | 1.00 ft depth<br>23.81 ppm Nitrate-N   |              |
| 7/25/2017                       | Sprinkler ⚠<br>1.5 hr |  |            |  |              |
| <b>Totals</b>                   | 4.50 in.              | 46.45 lbs N/acre<br>Fertilizer Applied | 2 Events   |  |              |

# Summary Table (Water)

**Water Events**  
Broccoli test | 3

[Irrigation Data](#) | [Additional Water Data](#)

[All](#) | [Water](#) | [Fertilizer](#) | [Soil Samples](#)

Units ▾ Add:

| Date          | Irrigation Method     | Irrigation Interval | Recommended Max Irrigation Interval | Recommended Water             | Applied Water             | Rainfall             |
|---------------|-----------------------|---------------------|-------------------------------------|-------------------------------|---------------------------|----------------------|
| 8/15/2017     | Drip                  | 11 days             | 8.4 days                            | 5.0 hr                        | 10.0 hr                   | 0.00 in.             |
| 8/4/2017      | Sprinkler             | 10 days             | 6.3 days                            | 1.6 hr                        | 2.0 hr                    | 0.00 in.             |
| 7/25/2017     | Sprinkler             | 8 days              | 4.4 days                            | 1.5 hr                        | 0.0 hr                    | 0.00 in.             |
| 7/17/2017     | Germination Sprinkler | 2 days              | 1.1 days                            | 1.8 hr                        | 2.0 hr                    | 0.00 in.             |
| 7/15/2017     | Germination Sprinkler | 2 days              | 1.3 days                            | 2.0 hr                        | 2.0 hr                    | 0.00 in.             |
| <b>Totals</b> |                       |                     |                                     | 2.82 in.<br>Recommended Water | 4.50 in.<br>Applied Water | 0.00 in.<br>Rainfall |

**4.50 in.** (4.50 in. + 0.00 in.)  
[Rainfall Data](#) | [Flowmeter Data](#)

# Flowmeters can be used to evaluate irrigation application

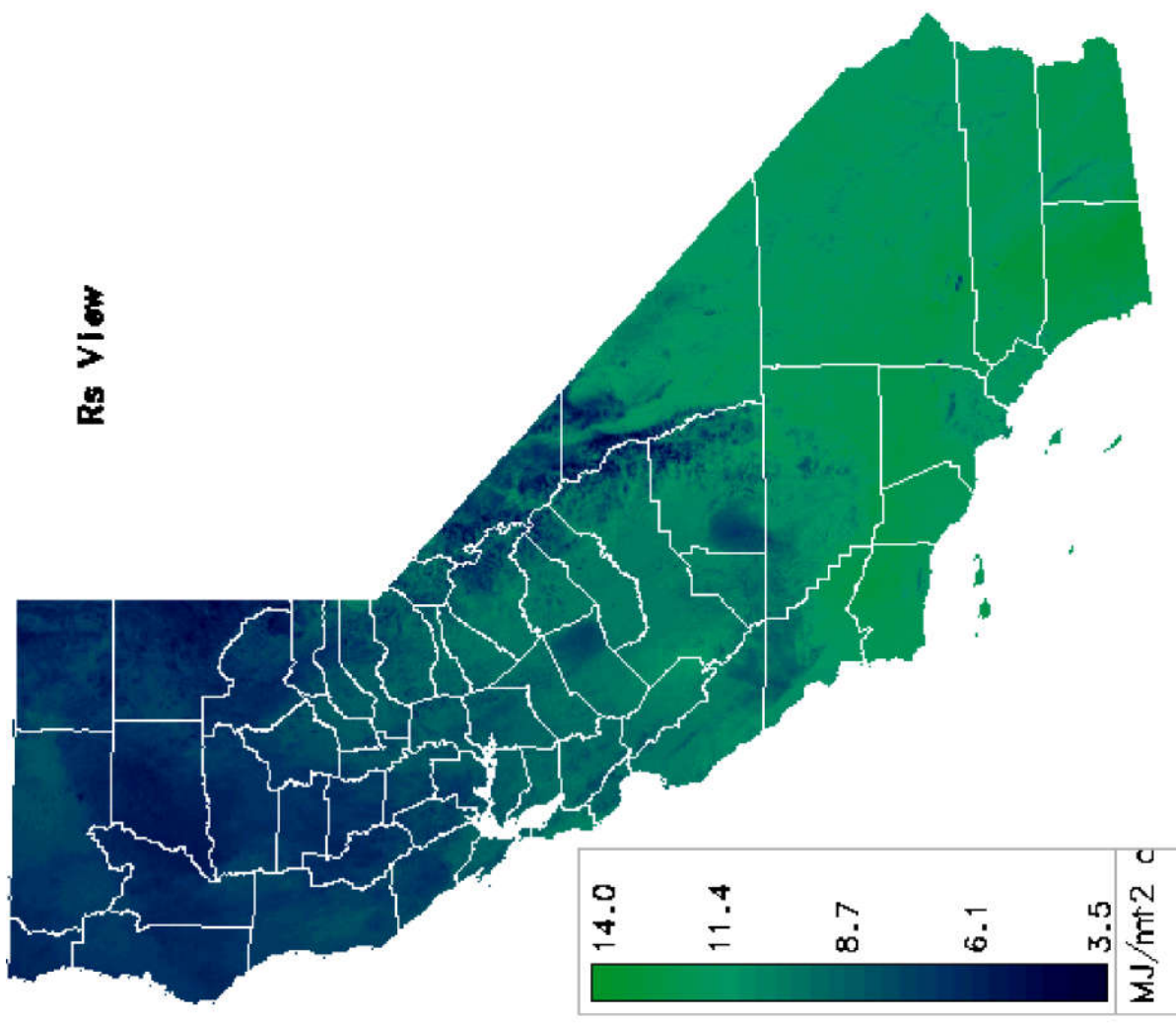


## Flowmeter Data

Crop Manage Pink Flowmeter Data Detail



# Spatial CIMIS ETo Reporting





# Future developments...



# Summary

- **Web applications can be useful for repackaging research into simple to use decision support tools**
- ***CropManage* is designed to help growers improve water and N management practices**
- **UC will continue to adapt CM to more commodities and add new features**
- ***CropManage* hands-on workshops will be scheduled for winter**

**CropManage 2.0:**

**cropmanage.ucanr.edu**

**CropManage 3.0:**

**v3.cropmanage.ucanr.edu**

**CropManage API:**

**api.cropmanage.ucanr.edu**