Improving Irrigation and Nutrient Management

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Objectives

• Fill gaps in nutrient and water management data
• Devise CropManage for onions
CropManage

database driven web application

Crop ET model

Crop N model

Soil and Ranch

CIMIS ET0

Soil nitrate test

Field sensors

Watering Recommendation

N fertilizer Recommendation

Crops:
Lettuce, broccoli, cauliflower, cabbage, celery, salad greens, peppers, caneberries

ucanr.org/cropmanage
How is irrigation rate determined?

- Allowable depletion
- Irrigation system application rate
- Irrigation system application uniformity
- Leaching fraction (water salinity)
- And more
\[ E_{\text{crop}} = E_{\text{T}_o} \times K_c \]

\( K_c \) can vary from 0.1 to 1.2
How is N fertilizer rate determined?

Fertilizer N = Crop N uptake – Soil N

Soil N:
- Quick Test N (ppm NO₃-N)
- Soil mineralization N

Crop uptake???
Nitrogen and Water Management in Onion Production

✓ Successful water and nitrogen management = maximum yields and quality of onions

✓ Proposed changes in water quality regulations in California in recent years = increasing efficiency of nitrogen fertilizer use
N Uptake Information

• Nutrient uptake information for onion production in California is very limited

• Information created for the Pacific Northwest
Nutrient Management for Onions in the Pacific Northwest

Dry matter

N uptake

N uptake rate
Measurements

• 3 onion fields; 3 varieties (A, B and C)
• 4 sampling locations per field/variety

Weekly:

• **Biomass** samples
• **Nutrient content** (NPK) for uptake curves
• **Canopy coverage** (%)
• **Root depth**
• Growth state
• Number of plants
• Yield
Biomass sampling

- 3ft of the bed
Laboratory analysis - NPK
Canopy Cover

- Infra-red camera
Infra-Red Pictures
Yield
Results

Biomass (bulbs and leaves)

*Average of 4 locations
Lab Analysis

<table>
<thead>
<tr>
<th>Lab ID</th>
<th>N (% Total)</th>
<th>P (% Total)</th>
<th>K (% Total)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>4.65</td>
<td>0.472</td>
<td>5.97</td>
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<tr>
<td>2</td>
<td>4.66</td>
<td>0.497</td>
<td>5.51</td>
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<td>3</td>
<td>4.44</td>
<td>0.47</td>
<td>5.33</td>
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<tr>
<td>4</td>
<td>4.49</td>
<td>0.381</td>
<td>4.74</td>
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<tr>
<td>5</td>
<td>3.94</td>
<td>0.336</td>
<td>4.83</td>
</tr>
<tr>
<td>6</td>
<td>4.66</td>
<td>0.438</td>
<td>5.48</td>
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</table>
Total Nutrient Uptake

- Average of 3 varieties, 4 sampling locations each
- Average of 4 locations;
- $P = 0.0313$
- Error bars = 2 std. dev. = 95% conf. inter.
Phosphorus

(Average of 4 sampling locations; P<0.001)
Potassium

(Average of 4 sampling locations; P=0.001)
And more data analysis...

<table>
<thead>
<tr>
<th>DAP</th>
<th>time fraction</th>
<th>Time fraction harvest</th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>fraction N</th>
<th>Fraction P</th>
<th>Fraction K</th>
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<tbody>
<tr>
<td>68</td>
<td>0.41</td>
<td>0.41</td>
<td>14</td>
<td>1</td>
<td>17</td>
<td>0.08</td>
<td>0.03</td>
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<td>81</td>
<td>0.49</td>
<td>0.49</td>
<td>32</td>
<td>3</td>
<td>38</td>
<td>0.17</td>
<td>0.06</td>
<td>0.14</td>
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<td>95</td>
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<td>0.58</td>
<td>62</td>
<td>10</td>
<td>80</td>
<td>0.33</td>
<td>0.19</td>
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<td>109</td>
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<td>0.66</td>
<td>97</td>
<td>19</td>
<td>131</td>
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<td>0.36</td>
<td>0.47</td>
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<td>116</td>
<td>0.70</td>
<td>0.70</td>
<td>103</td>
<td>21</td>
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<td>0.40</td>
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<td>128</td>
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<td>0.78</td>
<td>151</td>
<td>33</td>
<td>213</td>
<td>0.81</td>
<td>0.63</td>
<td>0.76</td>
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<td>136</td>
<td>0.82</td>
<td>0.82</td>
<td>145</td>
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<td>198</td>
<td>0.78</td>
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<td>143</td>
<td>0.87</td>
<td>0.87</td>
<td>168</td>
<td>41</td>
<td>246</td>
<td>0.90</td>
<td>0.80</td>
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<td>151</td>
<td>0.92</td>
<td>0.92</td>
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<td>52</td>
<td>279</td>
<td>1.00</td>
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The graph shows the relationship between N uptake fraction and time fraction, with the equation:

\[ \text{N uptake (lbs/acre)} = 1.263 \times \text{Nmax} / (1 + \exp\left(-\frac{(\text{day}/\text{Maxday}) - 0.769}{0.494}\right)) \]

\[ R^2 = 0.88 \]
Results – N Uptake Curve

N uptake (lbs/acre) = \( 1.263 \times N_{\text{max}} / (1 + \exp\left[ \frac{-(\text{day}/\text{Maxday})-0.769}{0.494} \right]) \)

\( R^2 = 0.88 \)
Results -
Canopy Cover (%)
Canopy Cover (%)

Variety A

DAP

0 25 50 75 100 125 150
Canopy Cover (%)
Predicted Canopy =
Max Canopy / (1 + EXP(coef_A + coef_B * Ni * fc))

<table>
<thead>
<tr>
<th>Ni</th>
<th>In(Gx/Gi)</th>
<th>Ni Calc</th>
<th>ln(Gx/Gi) 1 calc</th>
<th>Canopy coef A</th>
<th>Canopy coef B</th>
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</thead>
<tbody>
<tr>
<td>0.40</td>
<td>2.04</td>
<td>0.40</td>
<td>2.04</td>
<td>6.5646</td>
<td>-14.477</td>
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<tr>
<td>0.47</td>
<td>1.20</td>
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<td>1.20</td>
<td>6.5646</td>
<td>-14.477</td>
</tr>
<tr>
<td>0.52</td>
<td>0.76</td>
<td>0.52</td>
<td>0.76</td>
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<td>-14.477</td>
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<td>0.55</td>
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<td>0.60</td>
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<td>0.63</td>
<td>-1.06</td>
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<td>0.67</td>
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<td>0.74</td>
<td>-2.37</td>
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</tr>
</tbody>
</table>

To Peak Canopy

y = -10.366x + 7.3639
R² = 0.8838
Canopy, Measured vs. Predicted

\[ y = 0.9032x + 0.0751 \]

\[ R^2 = 0.9392 \]
Summary

• Data created with this study will allow more accurate decisions of fertilizer and water management

• Data shows the importance of developing local information – differences with Pacific Northwest

• Onion growth (biomass, nutrient uptake, root and canopy cover) are better understood and can be more accurately predicted based on DAP
Summary

• Total N, P and K uptake amounts and patterns
• Right Rate and Right Time of fertilizers
• Next: validate the information on test plots.
Thank you:

- John Calandri
- Jorge Nuniz
- Mark Proctor
- Michael Cahn