Surfactant vs. Nutrient Use Efficiency and Yield of Tomato

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Most Soils in Florida Are Sandy in Nature

Hastings

Live Oak

Belle Glade

Parrish
Problems associated with water repellent soils

1. Rapid leaching of fertilizers
2. Poor water and nutrient holding capacity
3. Uneven distribution of nutrients and water
4. High soil evaporation
5. Severe runoff
6. Soil erosion
7. Low productivity
Vegetation shift caused by high P levels in water

Vegetation shift in the Everglades

Sawgrass

Cattail
Sandy Soils Are Water Repellent

Wet soil
Weak bonding of hydrophilic surfaces

Dry soil
Strong bonding of hydrophobic surfaces

Courtesy of P. Hallett
Why do surfactants work?

Sandy soil particle

Water repellent

Surfactant

Tail

Head

Water friendly
Hypothesis

Surfactants:
• Lower the surface tension
• May act as
  1. Detergents; Emulsifiers; Foaming agents; and Dispersants
  2. Wetting agents: help better hold water and nutrients in root zones
Objectives

To evaluate the surfactant effects on:

- N, P, K use efficiency
- Yield of tomato grown on sandy soil
Materials and Methods

- Trial time: Fall 2012
- Location: Citra, Florida
- Fertilization: N (urea), 160; P$_2$O$_5$(TSP), 83; K$_2$O (MOP), 250 lb/acre
- Irrigation: drip and plastic mulch
- Variety: Phoenix
- Surfactant: Stockosorb 660, 30 lb/acre
- Plot size: 135 square feet
- Number of replication: 3
- Nutrient use efficiency:

\[
NUE(lb/lb) = \frac{TY_f - TY_0}{F}
\]

$TY_f$ = tuber yield with N fertilizer
$TY_0$ = tuber yield without N fertilizer
$F$ = fertilizer
Plant size
(8 weeks after planting)

Surfactant: 30 lb/acre      0 lb/acre
The graph shows the relative plant size (%) of two treatments: 30 lb/acre and 0 lb/acre. The treatments are compared for height and diameter.

- For height, the 30 lb/acre treatment is significantly higher than the 0 lb/acre treatment, indicated by the bar labeled 'a'.
- For diameter, the 30 lb/acre treatment also shows a significant increase compared to the 0 lb/acre treatment, indicated by the bar labeled 'a'.

The p-value for both comparisons is less than 0.10, indicating a statistically significant difference.
Fruit yield

![Bar charts showing the effect of surfactant rate on tomato yield and number of tomatoes.](image)
NPK use efficiency

- **N**: 30 lb/acre (A), 0 lb/acre (B)
- **P**: 30 lb/acre (A), 0 lb/acre (B)
- **K**: 30 lb/acre (A), 0 lb/acre (B)

Significance: P < 0.05
Summary

The surfactant significantly increased:

- Tomato growth and yield
- N, P, and K use efficiency
How about other crops?
Materials and Methods

- Trial time: Spring 2013
- Location: Hastings, Florida
- Fertilization: N (NH₄NO₃), 200; P₂O₅ (TSP), 100; K₂O (MOP), 250 lb/acre
- Irrigation: seepage
- Variety: Atlantic
- Surfactant: Stockosorb 660, 30 lb/acre
- Treatment: (1) 200 lb/acre AN N. Two applications, (2) N mixed with SF, one application, (3) control, no N
- Plot size: 533 square feet
- Number of replication: 4
- Fertilizer use efficiency (FUE):

\[
FUE(lb / lb) = \frac{TY_f - TY_0}{F}
\]

\(TY_f\) = tuber yield with N fertilizer
\(TY_0\) = tuber yield without N fertilizer
\(F\) = fertilizer
Results
Surfactant vs. Potato Yield

Potato yield (lb/acre)

200 lb AN N + 30 lb SF
100% pre-plant

200 lb AN N
50% pre-plant + 50% side-dress

0 lb N
Control

Nonmarketable
Marketable

2738
24244
2511

26674
2736
17422

0 lb N
200 lb AN N
200 lb AN N + 30 lb SF

Potato yield (lb/acre)

0 5000 10000 15000 20000 25000 30000 35000

2738
24244
2511

26674
2736
17422
Surfactant Increases Tuber Specific Gravity

Comparison of tuber specific gravity across different treatments:

- **200 lb AN N + 30 lb SF**
  - 100% pre-plant

- **200 lb AN N**
  - 50% pre-plant + 50% side-dress

- **0 lb N**
  - Control

The chart shows that the specific gravity increases with surfactant treatment compared to the control.
# Potato Tuber Quality

<table>
<thead>
<tr>
<th>Application method</th>
<th>N treatment</th>
<th>HH</th>
<th>BR</th>
<th>CRS</th>
<th>IHN</th>
<th>L</th>
<th>M</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% pre-plant</td>
<td>200 lb AN N + 30 lb SF</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>50% pre-plant + 50% side-dress</td>
<td>200 lb AN N</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Control</td>
<td>0 lb N</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

HH = Hollow Heart  
BR = Brown Rot  
CRS = Corky Ringspot  
IHN = Internal Heat Necrosis
# Fertilizer Use Efficiency (lb/lb)

<table>
<thead>
<tr>
<th>Application method</th>
<th>N treatment</th>
<th>Fertilizer use efficiency (lb/lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>100% pre-plant</td>
<td>200 lb AN N + 30 lb SF</td>
<td>47.4a</td>
</tr>
<tr>
<td>50% pre-plant + 50% side-dress</td>
<td>200 lb AN N</td>
<td>35.2b</td>
</tr>
<tr>
<td>Control</td>
<td>0 lb N</td>
<td>-</td>
</tr>
</tbody>
</table>

The formula for Fertilizer Use Efficiency (FUE) is:

\[
FUE(lb/lb) = \frac{TY_f - TY_0}{F}
\]

- \(TY_f\) = tuber yield with N fertilizer
- \(TY_0\) = tuber yield without N fertilizer
- \(F\) = fertilizer
Summary

The surfactant significantly increased:

- Potato growth and yield
- N, P, and K use efficiency
Acknowledgements

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- Superior Plant Co. provided tomato seedlings
Thank You!