SUPPLYING PLANT NUTRIENTS VIA FERTIGATION: PRINCIPLES AND EXAMPLES IN TRIPLOID WATERMELON

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What is Fertigation?

- Application of fertilizer materials via the irrigation system.
- Commonly via trickle irrigation
- Also via center pivot and micro-sprinklers

Benefits of Fertigation

- Controlled application of nutrients and water
- Increased flexibility of fertilizer application
- Allows better timing of application correlated with crop growth stage
- Allows small dosage application
- Minimizes leaching and negative environmental impacts

Benefits of Fertigation

- Increased water use efficiency
- Increased fertilizer use efficiency
- Potential to reduce fertilizer inputs, reducing production costs
- Reduce foliar disease-minimizing leaf wetness
- Reduce weeds- fertilizer only applied to crop

Fertigation Concerns

- Increased management required
- Investment in appropriate injection equipment
- Potential for emitter clogging
- Fertilizer source must be water soluble
- Be cautious of precipitation reactions with fertilizer components

Fertigation Concerns

- Over-irrigation leaches nitrogen out of effective root zone, thus unavailable to crops
- Environmental contamination possible w/o appropriate devices- i.e. backflow preventer
- Fertilizer uniformity dictated by irrigation uniformity
- Unnecessary water application- i.e. field at full water capacity, but program is calling for fertilizer application.
Fertilizer Injection

- Injector Selection:
  - type of irrigation system (flow rate/pressure etc.)
  - crop
  - chemical to be injected
  - source of power
  - expansion possibilities
  - safety considerations
- 2 main types: Passive and Active

Fertilizer Injection

- Passive: utilizes the energy supplied by the irrigation system
- Ex. Venturi, pitot tube, use of pressure differentials
- Venturi: operates by creating a vacuum when irrigation water is forced through a constriction.

Fertilizer Injection

- Active: utilizes external energy or mechanical moving part to create pressure exceeding the mainline pressure to inject the fertilizer.
- Ex. Pumps, compressors, water powered
- Water powered (dosatron): energy of pressurized water in the irrigation to drive the piston
Background

- Midwest Vegetable Production Guide (ID-56) – 80 lbs N/Acre
- Common in SW Indiana – 170 lbs N/Acre
- Production guides for University of Florida and Ohio State University – 150 lbs N/Acre
- Major crop for SW Indiana growers – extra fertilizer viewed as insurance
- Critical to have sufficient N to ensure good yields
- Economically viable – fertilizer relatively inexpensive input

- Nitrogen fertilizer produced with fossil fuels and cost is increasing
- Poor fertilizer management has negative impacts regardless of application method:
  - Environmental contamination of aquatic ecosystems and ground water
  - Waste of economic input
  - Potential to increase foliar diseases and attack by other arthropod pests

Research Questions for 2010 and 2011 Experiments

- Is 80 lbs N/acre enough for good triploid watermelon production?
- Is there a benefit to adding additional N above the current recommended rate for Indiana?
- Does timing of N application affect yield and quality?

Production Methods 2010

- Plasticulture – black plastic mulch and drip tape
- Pre-plant fertilizer: 100 lbs – 0-0-60
  - 200 lbs – pelletized lime
- Watermelon plots: 8’ centers, 40’ rows, 48” in-row, 10 plants/plot, 5 pollinators/plot (SP-5)
- RCBD with 6 replicates
- Variety: Tri-X 313 (Rogers/Syngenta)
- Treatments applied using Linear Bed Foot Method as opposed to Broadcast method
Linear Bed Foot Method

- “Per Acre” expression – derived from row crops where most of acre is planted to crops.
- LBF is the linear distance of 1 foot measured along a mulched bed.
- Based on the premise that the entire area in a given acre is not planted in a plasticulture system.
- Focuses fertilizer application in the area of the field where crops are actually planted.

(Hochmuth and Hanlon, 2009)

Treatments 2010 - LBF

- 80 lbs N/Acre pre-plant
- 80 lbs N/Acre 25% pre-plant, 75% throughout growing season via fertigation
- 160 lbs N/Acre pre-plant
- 160 lbs N/Acre 25% pre-plant, 75% throughout growing season via fertigation

Production Methods 2011

- Plasticulture – black plastic mulch and drip tape
- Pre-plant fertilizer: 100 lbs – 0-0-60
  200 lbs – pelletized lime
- Watermelon plots: 8’ centers, 48’ rows, 48” in-row, 12 plants/plot, 6 pollinators/plot (SP-5)
- RCBD with 4 replicates
- Variety: Tri-X 313 (Rogers/Syngenta)
- 9 total treatments using both Broadcast and LBF methods

Treatments 2011 – Broadcast and Linear Bed Foot Method

- 80 lbs N/Acre pre-plant (LBF)
- 80 lbs N/Acre 25% pre-plant, 75% throughout growing season via fertigation (LBF)
- 160 lbs N/Acre pre-plant (LBF)
- 160 lbs N/Acre 25% pre-plant, 75% throughout growing season via fertigation (LBF)
- 80 lbs N/Acre pre-plant (B)
- 80 lbs N/Acre 25% pre-plant, 75% throughout growing season via fertigation (B)
- 160 lbs N/Acre pre-plant (B)
- 160 lbs N/Acre 25% pre-plant, 75% throughout growing season via fertigation (B)
- 0 lbs N/Acre

Fertilizer Materials and Application 2010 and 2011

- Pre-plant material 46-0-0 (Urea)
- Fertigation material 9-0-0-11 (Calcium nitrate)
- Fertigation treatments applied 1x per week for ten weeks May 26th – July 28th
- In-season application with Dosatron proportional injector

Data Collection

- Yield: fruit number, total weight/acre, average fruit weight
- Internal quality: size, firmness, soluble solids, and rind thickness
- Internal quality sampled from 12 melons per treatment
Table 1. Yield of triploid watermelon as affected by nitrogen fertilization, 2010.

<table>
<thead>
<tr>
<th>Description</th>
<th>Weight per Acre (lbs)</th>
<th>CWT/Acre (lbs)</th>
<th>Tons/Acre</th>
<th>Average Weight (lbs)</th>
<th>Number per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 lbs N, all preplant</td>
<td>74,842</td>
<td>748.4</td>
<td>37.4</td>
<td>16.0</td>
<td>4,673.6</td>
</tr>
<tr>
<td>160 lbs N (25% pre, 75% drip)</td>
<td>68,759</td>
<td>687.5</td>
<td>34.3</td>
<td>15.9</td>
<td>4,333.3</td>
</tr>
<tr>
<td>80 lbs N (25% pre, 75% drip)</td>
<td>67,950</td>
<td>679.5</td>
<td>33.9</td>
<td>16.1</td>
<td>4,242.6</td>
</tr>
<tr>
<td>160 lbs N, all preplant</td>
<td>65,736</td>
<td>657.3</td>
<td>32.8</td>
<td>15.5</td>
<td>4,242.6</td>
</tr>
</tbody>
</table>

Significance: NS* NS NS NS NS NS

Table 2. Internal quality of triploid watermelon as affected by nitrogen fertilization, 2010.

<table>
<thead>
<tr>
<th>Description</th>
<th>Soluble Sugars (%)</th>
<th>Firmness (lbs-force)</th>
<th>Rind Thickness (lbs-force)</th>
<th>Overall Length (in)</th>
<th>Overall Width (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 lbs N, all preplant</td>
<td>11.9</td>
<td>2.6</td>
<td>1.9</td>
<td>28.1</td>
<td>22.2</td>
</tr>
<tr>
<td>160 lbs N (25% pre, 75% drip)</td>
<td>11.6</td>
<td>2.8</td>
<td>1.8</td>
<td>29.5</td>
<td>22.9</td>
</tr>
<tr>
<td>160 lbs N, all preplant</td>
<td>11.3</td>
<td>2.6</td>
<td>1.7</td>
<td>27.7</td>
<td>22.5</td>
</tr>
<tr>
<td>80 lbs N (25% pre, 75% drip)</td>
<td>11.1</td>
<td>2.7</td>
<td>2.0</td>
<td>28.4</td>
<td>22.6</td>
</tr>
</tbody>
</table>

Significance: NS* NS NS NS NS NS

Table 3. Yield of triploid watermelon as affected by nitrogen fertilization, 2011.

<table>
<thead>
<tr>
<th>Nitrogen Application(a)</th>
<th>Fruit Number per Plot(b)</th>
<th>Weight per Plot (lbs)</th>
<th>Average Weight (lbs)</th>
<th>Fruit Number per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>80% preplant (LBF)</td>
<td>28.3</td>
<td>452.8</td>
<td>16.4</td>
<td>51,366</td>
</tr>
<tr>
<td>80% split (LBF)</td>
<td>28.0</td>
<td>462.0</td>
<td>14.7</td>
<td>52,411</td>
</tr>
<tr>
<td>160% preplant (LBF)</td>
<td>29.0</td>
<td>481.4</td>
<td>17.3</td>
<td>54,695</td>
</tr>
<tr>
<td>160% split (LBF)</td>
<td>29.8</td>
<td>480.7</td>
<td>14.5</td>
<td>54,533</td>
</tr>
<tr>
<td>80% preplant (B)</td>
<td>27.0</td>
<td>462.1</td>
<td>16.8</td>
<td>52,423</td>
</tr>
<tr>
<td>80% split (B)</td>
<td>28.0</td>
<td>450.5</td>
<td>14.6</td>
<td>51,100</td>
</tr>
<tr>
<td>160% preplant (B)</td>
<td>28.0</td>
<td>459.0</td>
<td>16.2</td>
<td>52,062</td>
</tr>
<tr>
<td>160% split (B)</td>
<td>29.5</td>
<td>474.8</td>
<td>15.1</td>
<td>53,862</td>
</tr>
<tr>
<td>0% N</td>
<td>26.5</td>
<td>432.6</td>
<td>15.7</td>
<td>49,073</td>
</tr>
</tbody>
</table>

Significance: NS NS NS NS NS NS

\(a\) LBF = Linear Bed Foot Method, B = broadcast application
\(b\) Plot size = 384 ft
* NS = no significance, means separated by Fisher’s least significant difference test (P ≤ 0.05)

Table 4. Internal quality of triploid watermelon as affected by nitrogen fertilization, 2011.

<table>
<thead>
<tr>
<th>Nitrogen Application(a)</th>
<th>Rind Thickness (lbs-force)</th>
<th>Brix(b)</th>
<th>Firmness (lbs-force)</th>
<th>Fruit Length (in)</th>
<th>Fruit Width (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80% split (B)</td>
<td>11.0</td>
<td>3.3</td>
<td>74.4</td>
<td>61.2</td>
<td></td>
</tr>
<tr>
<td>160% split (B)</td>
<td>10.5</td>
<td>3.2</td>
<td>72.6</td>
<td>61.2</td>
<td></td>
</tr>
<tr>
<td>80% split (LBF)</td>
<td>10.9</td>
<td>3.1</td>
<td>72.9</td>
<td>61.0</td>
<td></td>
</tr>
<tr>
<td>160% split (LBF)</td>
<td>10.1</td>
<td>3.2</td>
<td>74.4</td>
<td>61.5</td>
<td></td>
</tr>
<tr>
<td>80% preplant (B)</td>
<td>11.0</td>
<td>3.0</td>
<td>74.7</td>
<td>60.7</td>
<td></td>
</tr>
<tr>
<td>80% preplant (LBF)</td>
<td>10.8</td>
<td>3.2</td>
<td>73.4</td>
<td>62.2</td>
<td></td>
</tr>
<tr>
<td>0% N</td>
<td>10.6</td>
<td>3.1</td>
<td>73.4</td>
<td>60.2</td>
<td></td>
</tr>
<tr>
<td>160% preplant (LBF)</td>
<td>10.2</td>
<td>3.1</td>
<td>72.4</td>
<td>62.5</td>
<td></td>
</tr>
<tr>
<td>80% preplant (LBF)</td>
<td>11.0</td>
<td>2.7</td>
<td>77.5</td>
<td>62.2</td>
<td></td>
</tr>
</tbody>
</table>

Significance: * NS NS NS NS NS

\(a\) LBF = Linear Bed Foot Method, B = broadcast application
\(b\) Brix: percent soluble solids, Higher values related to higher sugar content in the fruit.
* Means in columns separated by Fisher’s least significant difference test (P ≤ 0.05), means with same letter are not significantly different, NS=not significant

Summary

- Initial results indicate no statistical differences for any parameter for any treatment with the exception of rind thickness in 2011.
- Preliminary study indicates:
  - 80 lbs N/acre is sufficient for triploid watermelon production
  - No added benefits of increased nitrogen rate
  - Timing of N application does not affect yield or internal fruit quality under southwestern Indiana conditions
- Control in 2011 is confounding as no nitrogen was applied. Potential movement of fertilizer with excessive rains
- Larger demonstration plot to observe any differences in yield planned for 2012 field season

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