Irrigation Management Effects on Soil Fertility and Environmental Impacts

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Water Management Needs to be Factored into Soil Fertility Management

- Costly to build up soil fertility in organic systems
- Poor water management can lead to loss of nutrients (mostly N and P)
- Potential water quality impairments from sediment and nutrients in run-off and leachate from organic fields
Organic Liquid Fertilizers*
(0.1 – 7% N)

Activate, Micronized
Aqua Power Liquid Fish
Azomite
Biolink Organic 0/5/5

Fertall Liquid Iron
Fertall Liquid MB
Fertall Liquid Zinc
HFPC Hydrolyzed Fish Powder

• **5-1-1** liquid costs $9.6 per lb of N
• **13-0-0** dry costs $4 per lb of N

Earth Juice Bloom 0/3/1
Earth Juice Catalyst
Neptune's Harvest Liquid Fish
Nutra Min

• **A substantial amount of the N could be in mineral form** (12-50%)

Feather Tea
Sulfate of Potash, Diamond K Soluble
Fertall Liquid Chelate Calcium

*Organic Material Research Institute, National Organic Program*
Compost sources of Nitrogen

- $1.5 - $2 per lb of N (1.4% N product)
Cover Crops as a Source of Nitrogen

- 100 – 150 lb of N/acre in above ground Biomass
- Production costs of $150 – $200/acre for a winter cover crop
- $1-2 per lb of Nitrogen
- Roughly 30% of cover crop N becomes available for subsequent crop
Comparison of Organic and Conventional Onions (Hollister, 1996)

Soil ppm NO3-N

Conventional

Organic

20 ppm PSNT threshold

Smith, 1996
Mineral Nitrogen in an Organic Processing Tomato Field (Sutter Co, 2001)

Date

3/1/01 4/1/01 5/1/01 6/1/01 7/1/01 8/1/01

Mineral Nitrogen (ppm)

0 2 4 6 8 10 12 14 16

Winter Grain/Legume Cover Crop
Winter Legume Cover Crop
Winter Fallow

Mineral Nitrogen (ppm)

3/1/01 4/1/01 5/1/01 6/1/01 7/1/01 8/1/01

Winter Grain/Legume Cover Crop
Winter Legume Cover Crop
Winter Fallow
How susceptible is nitrate to leaching?
## Estimated Nitrogen Losses due to Leaching
*(King City July 25-July 29)*

<table>
<thead>
<tr>
<th>Management Treatment</th>
<th>Applied Water¹</th>
<th>Crop ET</th>
<th>Soil Moisture Storage</th>
<th>Percolation</th>
<th>NO3-N concentration in leachate</th>
<th>Nitrogen loss by leaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMP</td>
<td>0.8</td>
<td>0.6</td>
<td>0.0</td>
<td>0.3</td>
<td>173.9</td>
<td>11.2</td>
</tr>
<tr>
<td>Grower</td>
<td>1.4</td>
<td>0.6</td>
<td>-0.1</td>
<td>0.9</td>
<td>178.4</td>
<td>37.3</td>
</tr>
</tbody>
</table>
Irrigation Management is Key to Maintaining N in the Rootzone

- High Distribution Uniformity
- Schedule irrigations to match water requirements of crop
- Minimize scheduling and operational errors
Is drip irrigation the answer to minimizing nitrogen losses?

• Possible to irrigate more frequent and less per irrigation
• Possible to fertigate some liquid fertilizer materials
Potential Leaching of Nitrate Under Drip Irrigation

- Bed Width (inches): 0 2 4 6 8 10 12 14 16
- Depth (inches): 2 4 6 8 10 12 14 16 24 28 32 36 40 44 48

%H₂O

- Seed line
- Drip Tape
- Seed line
Residual Nitrate in Soil Profile of a Conventional Vegetable Field before and after 3 irrigations

![Graph showing the residual nitrate in soil profile](image)
Management of Drip in Romaine Lettuce

**Amount of Applied Water (inches)**

- 0.0
- 0.5
- 1.0
- 1.5
- 2.0
- 2.5

**Number of Irrigations**

- 0
- 2
- 4
- 6
- 8
- 10
- 12
- 14

**Irrigation Interval (days)**

- 1
- 2
- 3
- 4
- 5
- 6
- 7

- **n = 66**
- **n = 59**
Additional Challenge with Drip: Dry bed shoulders and furrows may reduce N mineralization and crop use of nutrients

Depends on:
• Bed width
• Number and depth of drip lines
• Soil type
• Irrigation scheduling
Environmental Impacts of Water Management
Run-off Carries Sediment and Nutrients into Surface Water
Eutrophication of Surface Water

Possible TMDL Concentration targets:
- $P < 0.1$ ppm
- $NO_3^{-}-N < 10$ ppm
Total P concentration in Run-off is linked to the Sediment concentration

$R^2=0.77$
Soil P can be at high levels in Organic Fields

Hartz 2008
Phosphate loss by run-off and leaching

Hartz 2008
Irrigation management is critical to minimizing surface water impairments.

Minimize run-off in sprinkler and furrow systems.

Drip irrigation is ideal for minimizing surface run-off.
Other measures to treat irrigation run-off

Vegetated Ditches

Retention Ponds

Vegetated Treatment Systems
Managing Storm Water Run-off
Reduced Biomass Cover Crops
## Nutrient and Sediment Concentration in Storm Run-off

<table>
<thead>
<tr>
<th>Winter Treatment</th>
<th>Total Suspended Solids (ppm)</th>
<th>Turbidity (NTU&lt;sup&gt;x&lt;/sup&gt;)</th>
<th>Total-P (ppm)</th>
<th>Total Kjeldahl N (ppm)</th>
<th>NO&lt;sub&gt;3&lt;/sub&gt;-N (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>bare (control)</td>
<td>1419</td>
<td>4449</td>
<td>4.4</td>
<td>8.0</td>
<td>7.48</td>
</tr>
<tr>
<td>full cover crop</td>
<td>342</td>
<td>917</td>
<td>1.9</td>
<td>3.0</td>
<td>0.37</td>
</tr>
<tr>
<td>furrow bottom cover crop</td>
<td>841</td>
<td>2377</td>
<td>3.3</td>
<td>5.7</td>
<td>2.29</td>
</tr>
</tbody>
</table>

<sup>x</sup>: low NTU (Nephelometric turbidity units) indicate less turbidity
Nitrogen is often a limiting and a costly nutrient that can be lost through leaching.

Sediment, phosphorus, and nitrogen carried in irrigation run-off can impair the quality of surface water.

Controlling storm run-off is a more difficult challenge than reducing irrigation run-off, but cover crops and vegetation can be effective strategies for minimizing impacts to water quality.

Water management is critical to maintaining soil fertility and minimizing water quality impacts from organic farms.
Thank you!