Nitrogen management for organic potatoes

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Hermiston Farm Fair
Potato Seminar
Nov. 30, 2011
Organic Nitrogen Leaching

Nitrate $\text{NO}_3^-$

Ammonium $\text{NH}_4^+$

Plant Uptake

Ammonia $\text{NH}_3$

Denitrification $\text{N}_2$ or $\text{N}_2\text{O}$

Leaching

Organic Nitrogen
## Organic potato case study, WVValley

<table>
<thead>
<tr>
<th>Farm ID + field history</th>
<th>Input Total N</th>
<th>Input (available N)</th>
<th>Crop N uptake (target)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lb N/ac</td>
<td>lb N/ac</td>
<td>lb N/ac</td>
</tr>
<tr>
<td><strong>Farm 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fallow after 20 yr</td>
<td>400 compost; 100 chicken</td>
<td>80</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Farm 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Org 15+ yr</td>
<td>200 chicken</td>
<td>90</td>
<td>200</td>
</tr>
</tbody>
</table>

From: John McQueen M.S. thesis, OSU. [http://ir.library.oregonstate.edu/xmlui/handle/1957/20524](http://ir.library.oregonstate.edu/xmlui/handle/1957/20524)
Days after planting

Soil nitrate-N (ppm)

grower N fert practice

zero N

Farm 1
2007
Days after planting

Soil nitrate-N (ppm)

grower N fert practice

Farm 2 2007

zero N

Days after planting
Organic potato case study, WValley 2007

<table>
<thead>
<tr>
<th></th>
<th>Farm 1</th>
<th>Farm 2</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to harvest</td>
<td>90</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>N adequate?</td>
<td>probably not</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Tuber yield</td>
<td>14</td>
<td>18</td>
<td>ton/acre</td>
</tr>
<tr>
<td>Tuber N</td>
<td>69</td>
<td>137</td>
<td>lb/acre</td>
</tr>
<tr>
<td>Vine N</td>
<td>30</td>
<td>71</td>
<td>lb/acre</td>
</tr>
<tr>
<td>Vine +tuber N</td>
<td>99</td>
<td>208</td>
<td></td>
</tr>
</tbody>
</table>

fertilized by growers, 2007
## Organic potato case study, WVValley: 2007

<table>
<thead>
<tr>
<th></th>
<th>Farm 1</th>
<th>Farm 2</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>N adequate?</td>
<td>no</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Petiole N 45 days</td>
<td>11,300</td>
<td>25,900</td>
<td>ppm</td>
</tr>
<tr>
<td>Petiole N 60 days</td>
<td>2,155</td>
<td>15,300</td>
<td>ppm</td>
</tr>
<tr>
<td>Nitrate-N in soil 45 days</td>
<td>14</td>
<td>52</td>
<td>ppm</td>
</tr>
<tr>
<td>Nitrate-N in soil 60 days</td>
<td>12</td>
<td>42</td>
<td>ppm</td>
</tr>
<tr>
<td>Net N min lab summer soil rate (9 week incubation)</td>
<td>0.3</td>
<td>0.6</td>
<td>ppm/day</td>
</tr>
</tbody>
</table>

fertilized by growers, 2007
Monitoring N sufficiency in organic system?

• Soil tests and petiole test interpretations not totally straightforward

• When nitrate-N is slowly being “dribbled out” by mineralization, petiole values and soil nitrate values can remain lower than “standard values” used for conventional potato all season long

• Most indications are that nitrate-N petiole standards for conventional potato production are too high for organic production
Monitoring N sufficiency in organic potatoes?

- Early season (up to tuber set) monitoring of soil nitrate-N recommended for w. Oregon. Target = 30 ppm nitrate-N at tuber set.

- Petiole analysis can diagnose N excess, but deficiency diagnosis more difficult.

- Dan guesstimate (limited w OR data): keep petioles above 5000 ppm nitrate-N during tuber bulking
New Decision Tool for Organic Farmers
OSU Organic Fertilizer & Cover Crop Calculator

Contact: Nick Andrews
(503) 678-1264 x 149
Nick.andrews@oregonstate.edu
OSU Organic Fertilizer & Cover Crop Calculator

Free online tool compares nutrient value and cost of cover crops, organic and synthetic fertilizers and compost.

Research Background: Gele et al. (2008) and Sullivan et al. (2010). These papers describe the research basis for PAN estimates. In this webinar, we describe cover crop sampling methods, explain the research, and demonstrate the calculator. This slide show describes the research that validates the cover crop PAN model.

- Organic Fertilizer & Cover Crop Calculator (per acre calculations for cover crops and fertilizers).
- Small Farm/Garden Calculator (square foot calculations for fertilizers only).

This work was sponsored by the Western Sustainable Agriculture Research and Education (project FW06-301), Oregon Tilth, Inc., and the Oregon State University Organic Cropping Research program.

We also thank Stubman Environmental Products, Concentrates Inc., Wilbur-Ellis Company, and Bridgwell Resources for supporting this work with their donations.
## Relative Costs of Plant-available Nitrogen (PAN)

<table>
<thead>
<tr>
<th>Product</th>
<th>$/ton</th>
<th>Total % N</th>
<th>Est’d % PAN</th>
<th>$/lb PAN</th>
<th>$/100lbs PAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea (not organic)</td>
<td>$500</td>
<td>46%</td>
<td>100%</td>
<td>$0.54</td>
<td>$54</td>
</tr>
<tr>
<td></td>
<td>$1000</td>
<td>46%</td>
<td>100%</td>
<td>$1.09</td>
<td>$109</td>
</tr>
<tr>
<td>Processed chicken manure</td>
<td>$200</td>
<td>4%</td>
<td>50%</td>
<td>$5.00</td>
<td>$500</td>
</tr>
<tr>
<td></td>
<td>$250</td>
<td>4%</td>
<td>50%</td>
<td>$6.25</td>
<td>$625</td>
</tr>
<tr>
<td>Legume cover crops</td>
<td>$1-3.00/lb PAN</td>
<td>All costs attributed to PAN</td>
<td>$0.50-$1.50/lb PAN Seed and inoculum only</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All costs attributed to PAN
OSU Organic Fertilizer & Cover Crop Calculator

This free online tool compares the nutrient value and cost of cover crops, organic and synthetic fertilizers and compost. Use this Excel Calculator to develop well balanced and cost effective nutrient management programs for your farm. Developed by Nick Andrews, Dan Sullivan, Jim Julian and Kristin Pool.

Quick Guide & Records Sheet The Quick Guide describes the main steps used to sample cover crops in the field, list the laboratory analyses required and describe how to use the Calculator.

Cover Crop Sampling Instructions These instructions describe the recommended method for sampling and analysing cover crops in more detail than the Quick Guide.

Research Background: Gale et al. 2000, Sullivan et al. 2010. These papers describe the research basis for PAN estimates. In this report, we describe cover crop sampling methods, explain the research, and demonstrate the Calculator. This slide show describes the research that validates the cover crop PAN model.

Organic Fertilizer & Cover Crop Calculator (per acre calculations for cover crops and fertilizers).

Small Farm/Garden Calculator (square foot calculations for fertilizers only).

This work was sponsored by Western Sustainable Agriculture Research and Education (project FW06-301), Oregon Tilth, Inc, and the OSU Oregon Organic Cropping Research program.

We also thank Sutzman Environmental Products, Concentrates Inc., Wilbur-Ellis Company, and Bridgewell Resources for supporting this work with their donations.
- Equations predict PAN from fertilizers, compost and cover crops
- Calculate the cost and value of each amendment
- Helps develop cost effective & balanced fertilizer programs
# RECORDS SHEET: OSU COVER CROP CALCULATOR

## Information needed to use the Calculator

<table>
<thead>
<tr>
<th>Information</th>
<th>Source of information</th>
<th>Units &amp; accuracy</th>
<th>Your values</th>
<th>Calculator Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer cost</td>
<td>Supplier</td>
<td>$/lb</td>
<td></td>
<td>Cost comparisons</td>
</tr>
<tr>
<td>Seed cost</td>
<td>Supplier</td>
<td>$/lb</td>
<td></td>
<td>Your costs</td>
</tr>
<tr>
<td>Inoculant cost</td>
<td>Supplier</td>
<td>$</td>
<td></td>
<td>Your costs</td>
</tr>
<tr>
<td>Labor cost</td>
<td>Farm records</td>
<td>$/hr</td>
<td></td>
<td>Your costs</td>
</tr>
<tr>
<td>Fuel Cost</td>
<td>Supplier</td>
<td>$/gal</td>
<td></td>
<td>Your costs</td>
</tr>
<tr>
<td>Tractor size</td>
<td>Farm records</td>
<td>hp</td>
<td></td>
<td>Your costs</td>
</tr>
<tr>
<td>Implement or broadcast width</td>
<td>Farm records: seeders, fertilizer spreaders and tillage equipment</td>
<td>ft</td>
<td></td>
<td>Your costs</td>
</tr>
<tr>
<td>Speed travelled</td>
<td>Tractor manual (gear, rpm and wheel size conversion)</td>
<td>mph</td>
<td></td>
<td>Your costs</td>
</tr>
</tbody>
</table>
Sampling Cover Crops to Estimate N
Submit sample to lab

NUTRIENT MANAGEMENT guide

Laboratories Serving Oregon
Soil, Water, Plant Tissue, and Feed Analysis
J. Hart

Total percent N
Percent dry matter
Nitrate $\text{NO}_3^-$ or $\text{N}_2$ or $\text{N}_2\text{O}$

Ammonium $\text{NH}_4^+$

Organic Nitrogen

Leaching

Plant Uptake

Denitrification

Ammonia $\text{NH}_3$

Immobilization

Mineralization
Total N (% dry wt) can be used as a predictor of Plant-Available Nitrogen or PAN

- N mineralization rate of new inputs is controlled by the “quality” of organic input
- Amendment “quality” a function of C:N ratio
- Carbon (%) in fresh organic materials is relatively constant at 35 to 45%
- Total N (%) in fresh organic materials varies from 0.5 to 12%
Prediction Equations in the OSU Calculator (2011)

Based on regression:

- input = total N analysis of organic fertilizer
- output = estimated plant-available N (PAN)
- time-steps = 4 wk and approx 10 wk (“full season”)

Categories of organic inputs:

- Organic fertilizers: “fresh” seed meals, solid fish, solid animal manure etc. (2006)
- Cover crops (2010)
Organic Fertilizers
Lab vs. full-season field PAN (4-site yr.)

Gale et al., 2006. JEQ 35:2321
Incubations to measure plant-available N

Cut cover crop or “amendment”

Add to 0.9 L (1-qt) freezer bag

Mix with moist soil (200 to 250g H₂O/kg)

Incubate at room temperature (22 °C or 72 °F); extract soil; measure nitrate-N
OSU Calculator is a planning tool

1. Predict crop N need (crop uptake)
2. Estimate soil N mineralization in absence of new inputs
3. Estimate N from irrigation water
4. Calculate N inputs required:
   - OSU Organic Fertilizer and Cover Crop Calculator
5. Monitor soil nitrate-N; assess N sufficiency
6. Adjust N for next crop based on monitoring data (experience)
Calibration data for PAN estimate for organic fertilizers (OSU Calculator)

Regression eqn based on: Gale et al., 2006. JEQ 35:2321

Calculator at: http://smallfarms.oregonstate.edu
Specialty product “calibration data”


Specialty Products included:

<table>
<thead>
<tr>
<th>Fish meals</th>
<th>Alfalfa meal</th>
<th>Fish bone meal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean meal</td>
<td>Blood meal</td>
<td>Meat &amp; bone meal</td>
</tr>
<tr>
<td>Corn gluten meal</td>
<td>Kelp meal</td>
<td>Bone meal</td>
</tr>
<tr>
<td>Feather meal</td>
<td>Seaweed Extract</td>
<td>Seabird guano</td>
</tr>
</tbody>
</table>
## OSU Calculator: compost PAN prediction

<table>
<thead>
<tr>
<th>Compost analysis total N</th>
<th>PAN prediction (28 d)</th>
<th>PAN prediction (70 d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% dry wt</td>
<td>% of total N</td>
<td>% of total N</td>
</tr>
<tr>
<td>Less than 1%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1-2 %</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>2+ %</td>
<td>5</td>
<td>10</td>
</tr>
</tbody>
</table>
Hermiston example: Mustard cover crop preceeding potato

Mustard biomass (crop residue)

Chopped, then incubated in moist soil at 72 °F

http://eorganic.info/sites/eorganic.info/files/images/Caliente%20blooming.smaller.JPG

Measured nitrate-N accumulated during incubation ➔
Decomposition of mustard residue in soil (incubation at 72 °F)

Soil incubation Days at 72 °F

Carbon dioxide-C loss (% of residue C)

Mustard residue harvested Oct 10, 2005
Hermiston, OR
Flowering growth stage
C:N = 24
1.8% total N (36 lb N/dry ton)

Sullivan, McQueen and Horneck, OSU
Mustard Residue in soil decomposes, releasing nitrate-N

Decomposition

Nitrate release

Sullivan, McQueen and Horneck, OSU
Plant-available (NO$_3$-N) from mustard decomposition

Mustard cover crop N uptake = 88 lb N/acre
Nitrate-N produced at 72 d = 40% x 88 lb N/acre = 35 lb NO$_3$-N/acre

Mustard residue
harvested Oct 10, 2005
Hermiston, OR
Flowering growth stage

Field harvest = 2.4 ton./acre mustard DM
= 35 lb NO$_3$-N/acre

Sullivan, McQueen and Horneck, OSU
More soil N mineralized under “Organic” management

Soil nitrate-N (lb/acre-ft)

Soil incubation Days at 72 °F

Soil nitrate-N (mg/kg)

Soil sampled (0-12 in)
Oct 10, 2005
Hermiston (loamy sand)
soil only incubated
(no mustard added)

11 % gravimetric soil moisture

Sullivan, McQueen and Horneck, OSU
Take-home messages

• Soil testing was more informative than petiole testing in western OR organic potato production

• Targets for Western OR organic potato, based on limited research:
  – Soil nitrate-N = 30 ppm at tuber set
  – Petiole nitrate-N: 5000 ppm during tuber bulking
  – Lower soil test or petiole values may not indicate deficiency when plant-available N is supplied primarily by soil OM mineralization
Take-home messages

• Nitrogen from cover crop inputs can be estimated using the OSU Organic Fertilizer and Cover Crop Calculator
  – free download at http://smallfarms.oregonstate.edu/calculator

• History matters
  – organic inputs increase “baseline” soil N mineralization rate