Nutrient Management on Organic Vegetable Farms
Sources of Fertility

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Today’s Presentation

- Soil and Media Testing
- Most Common Fertilizers, Amendments, and Practices
- Determining Nutrients
- Nitrogen Credits
- Chilean Nitrate Caveat
- Conversions
- Liming Materials
- Base Saturation
- Lots of Resources
Soil and Media Testing

- Field soils
  - Field soil tests
  - UVM or Cornell
- Hoop or greenhouse soils
  - Saturated media tests
  - U-Maine or U-Mass
University of Vermont Soil Test

$14

http://pss.uvm.edu/ag_testing/forms.html
How to Take a Soil Sample

The reliability of a soil test is only as good as the sample you submit. The small amount of soil in the sample bag you send to the Agricultural Testing Lab must represent the entire area to be fertilized. Avoid unusual areas such as those where fertilizer or lime has spilled. Take samples before lime, fertilizer, or manure are added. Use only clean equipment for collecting soil samples.

Where to sample

The area to be sampled should be as uniform as possible in terms of soil type and cropping and fertilizing history. For practical purposes it should be an area you expect to fertilize as a unit. This means separate samples for annual mixed vegetables and a strawberry patch, for golf green and fairway, and for different major crops in a commercial nursery or vegetable operation. If you have a problem on part of a lawn, garden, or commercial production field, you may wish to determine if soil fertility is the cause by taking one sample to represent the “good” and the other to represent the “poor” area.

Take a good sample

Collect a number of cores or slices by walking in a zig-zag pattern over the area. Mix cores thoroughly in a clean pail for a composite lab sample. The greater the number of collected cores mixed together, the better the sample will represent the average condition of the sampled area. Consider 10 cores as the minimum for home gardens and lawns up to 10,000 square feet in size. Larger areas should be represented by at least 15 to 20 samples. Choose one of the following tools:

**Soil Probe or Auger** – A soil probe or auger, available from mail order catalogs and garden or farm supply outlets, is the best tool for sampling. An auger will be needed if the soil is very stony or gravelly. Simply push the probe (or push and turn the auger) into the soil to the desired depth, lift up to remove the core, and place it in the clean pail. Sampling depth should be 4 to 6 inches deep for lawns, turf, or other perennial sod, or tillage depth (usually 6-10 inches) for annually tilled crops.

**Garden Trowel or Shovel** – If a soil probe or auger is not available, collect your sample by pushing the blade of a garden trowel, shovel, or spade into the soil to the desired depth. Cut out a triangular wedge of soil and set it aside (to be replaced after sampling). Now slide your blade into the soil again taking a thin (half inch) slice from one side of the hole. With a knife, trim the slice to about a 1-inch strip of soil down the center of the spade – top to bottom. Save this “core” as part of your composite lab sample.

Mix the sample and fill the sample bag

Make sure that all the cores are thoroughly mixed together. Your soil test mailer contains a plastic bag intended for one lab sample. Fill plastic bag about 1/2 full (approximately 1 cup) with the mixed sample and place into mailer. If submitting multiple samples, include one check for total being tested.
UVM Soil Test Report - Commercial

- Soil Test Results
  - Limestone
  - Nitrogen
  - Phosphorus
  - Potassium
- Management Info
- Who to call
Soil Test 2nd Page

- Soil Test Results
- Micronutrients
- Organic Matter
- % Ca, %K, %Mg
- Heavy Metals-if tested.

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**UVM AGRICULTURAL TESTING LAB ANALYSIS RESULTS**

L 80363 05/13/08
LAB # Date Completed

**PACKAGE 1 MICRONUTRIENTS** *(ppm in soil)*

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Your results</th>
<th>Avg. levels in Vermont soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>12.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Iron</td>
<td>5.1</td>
<td>7.0</td>
</tr>
<tr>
<td>Boron</td>
<td>0.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Manganese</td>
<td>3.1</td>
<td>14.0</td>
</tr>
<tr>
<td>Copper</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Sulfur</td>
<td>14.0</td>
<td></td>
</tr>
</tbody>
</table>

* Micronutrients are not usually deficient in Vermont soils. The average levels are provided for comparison only and are not necessarily optimum levels for plant growth. Additions of micronutrient fertilizers should be done with caution because of the narrow range between deficiency and toxicity. Organic residues such as manure, are usually good sources of micronutrients.

% Organic Matter 4.6

% Ca %K %Mg
88.2 3.7 8.1
Soil and Media Testing: Cornell’s Soil Health Test Physical, Biological and Chemical Example: Low Biological but Chemical High $65

(Give Vern’s email and they will send him results for interpretation.)
 Soil and Media Testing: Cornell’s Soil Health Test  
Physical, Biological and Chemical  
Example: Low Chemical but High Biological  
$65

(Give Vern’s email and they will send him results for interpretation.)

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### Cornell Soil Health Test Report (Comprehensive)

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Value</th>
<th>Rating</th>
<th>Constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate Stability (%)</td>
<td>89</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Available Water Capacity (m/m)</td>
<td>0.21</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>Surface Hardness (psi)</td>
<td>258</td>
<td>16</td>
<td>rooting, water transmission</td>
</tr>
<tr>
<td>Subsurface Hardness (psi)</td>
<td>333</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Organic Matter (%)</td>
<td>4.1</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Active Carbon (ppm)</td>
<td>775</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>Permanganate Oxidizable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potentially Mineralizable Nitrogen (mgN/gdsoil/week)</td>
<td>11.4</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>Root Health Rating (1-5)</td>
<td>5.2</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>5.9</td>
<td>56</td>
<td>&lt;3.5: Plant P Availability, &gt;21.5: Env. Loss Potential</td>
</tr>
<tr>
<td>Extractable Phosphorus (ppm)</td>
<td>0.5</td>
<td>17</td>
<td>Plant K Availability</td>
</tr>
<tr>
<td>Extractable Potassium (ppm)</td>
<td>23</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Minor Elements</td>
<td></td>
<td>56</td>
<td></td>
</tr>
</tbody>
</table>

**Overall Quality Score (out of 100):** Medium  
55.5

**Sample ID:** G410  
**Date Sampled:** 4/29/2009  
**Location (GPS):** Longitude: ~ 0  
Latitude: ~ 0  
SAND (%): 56.7  
SILT (%): 38.2  
CLAY (%): 5.1

*See Cornell Nutrient Analysis Laboratory report for recommendations*
U-MASS or U-Maine Saturated Media Testing

- Example of low nutrient levels

$22

(Give Vern’s email and they will send him results for interpretation.)
U-MASS or U-Maine Saturated Media Testing

- Example of high nutrient levels
- $22

(Give Vern's email and they will send him results for interpretation.)
Most Common Fertilizers, Amendments and Practices

- Most certified organic growers will use compost at some point in their operation.
- If they have too much P—go to cover crops and bagged fertilizers.
- Compost (1-3 – 0.5-1 – 1-2)
  - Giroux poultry manure compost
  - Home-made compost
  - Vermont-made compost
    - Vermont Compost Company
    - Intervale Compost Products
    - Champlain Valley Compost
    - Moo Doo Compost- Vermont Natural Ag Products

Growers will spring apply as a broadcast or in beds; some sidedress later in the season.
Most Common Fertilizers, Amendments and Practices
Bagged Fertilizers Most Common

NCO Pro-Gro (5-3-4)  
NCO Pro-Booster (10-0-0)  
NCO Cheep-Cheep (4-3-3)  
Sul-Po-Mag (0-0-22 11% Mg, 23% S)  
Bone Char (0-16(32)-0)  
Sulfate of Potash (0-0-51 18% S)  
Gypsum (0-0-0 23% Ca 19% S)  
Solubor (17% B)  
NCO Custom Blend (5-1-9)  
Chilean Nitrate (16-0-0)  
Greensand (0-1-7)  
Kreher’s Poultry Fertilizer  
NCO Pro-Holly (4-6-4)  
Neptune’s Harvest (2-4-1)  
Fish Emulsion  
(Fish and Kelp 3-2-2)

Amendments are applied in spring in beds or used as a sidedress later when plants need more nutrients.

(Fertilizer materials must be approved by OMRI or VOF’s Product Review.)
Most Common Fertilizers, Amendments and Practices

- Cover Crops for N
  - Legumes
    - Clover
    - Vetch
    - Alfalfa
  - Legume grass mixtures
    - Winter rye and vetch
    - Oats and field peas
    - Many mixtures available

Growers plow down cover crops 2-3 weeks before planting or more.
Determining Nutrient Needs

- Fertilizer and compost use should be based on soil test reports and NEVMG.
  - Is P needed at all? If not, use materials that do not contain it.
  - We are getting this message through to growers.
  - Soil testing requirements are not written into NOP standards.

- Blended fertilizers can be used when growers need all nutrients—N-P-K.

- Single nutrient fertilizers should be used when some nutrients aren’t needed.

- Determine application rates of compost and fertilizer based on calculations or spread sheets.

- Use nitrogen credits.

- Use cover crops to build OM where no P is needed.

- Compare fertilizer costs.
Nitrogen Credits: Soil OM

- About 20 lbs N/acre for each percent OM

- Thus: 4% OM = 80 lbs of N per acre

(Units cancel out leaving units of lbs available N per acre.)

\[
\frac{2,000,000 \text{ lbs soil}}{\text{acre}} \times \frac{1 \text{ lbs OM}}{100 \text{ lbs soil}} \times \frac{1 \text{ lbs total N}}{20 \text{ lbs OM}} \times \frac{2 \text{ lbs available N}}{100 \text{ lbs total N}} = \frac{20 \text{ lbs avail N per acre}}{\text{for each 1% Soil OM}}
\]
## Nitrogen Credits: Previous Crop

<table>
<thead>
<tr>
<th>Previous Crop Nitrogen Credit</th>
<th>lbs N per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass Sod</td>
<td>20</td>
</tr>
<tr>
<td>“Fair” clover (20-60% stand)</td>
<td>40</td>
</tr>
<tr>
<td>“Good” clover (60-100% stand)</td>
<td>60</td>
</tr>
<tr>
<td>“Fair” alfalfa (20-60% stand)</td>
<td>60</td>
</tr>
<tr>
<td>“Good” alfalfa (60-100% stand)</td>
<td>100</td>
</tr>
<tr>
<td>Sweet corn stalks</td>
<td>30</td>
</tr>
<tr>
<td>“Good” hairy vetch cover crop</td>
<td>100</td>
</tr>
<tr>
<td>Corn stover after grain harvest</td>
<td>40</td>
</tr>
</tbody>
</table>

New England Vegetable Management Guide
Nitrogen Credits: Compost and Manures

- **Manure**—50% year 1, 5-10% in year 2:
  - **Dairy Cow**
    - Solid: 3 lbs/tons
    - Liquid: 12 lbs/ton
  - **Poultry**
    - Fresh (20-40% DM): 8 lbs/ton
    - Sticky-crumbly (41-60% DM): 11 lbs/ton
    - Crumbly-dry (61-85% DM): 13 lbs/ton
    - Liquid: 13 lbs/ton
- **Compost**
  - 1% N in total with 5-15% becoming available in year 1
  - Use a compost analysis or 2 lbs of N credit per ton

New England Vegetable Management Guide
Nitrogen Credits

- Example Need 160 lbs Total N for Crop
  4% OM = 80 lbs N
  Good Clover = 40 lbs N
  No compost = 0 lbs N
  Total N credits: 120 lbs N
  160 lbs/a total N need – 120 lbs/a credit = 40 lbs N still needed for the crop
Determining Fertilizers to Meet Nutrients Needs

- Start with N or P to ensure proper application rates
- Example: No P needed, 40 lbs N (with credits), and 80 lbs $K_2O$
- 40 lbs N needed; use Pro-Booster (PB):
  - 10-0-0 or 400 lbs/acre or 9 lbs/1000 sq feet ($250'' \times 4''$)
  - Multiple each side by 40 lbs to get $X$ by itself. (Remember: $40/40 = 1$)
    \[
    \frac{X \text{ lbs PB}}{40 \text{ lbs N}} = \frac{100 \text{ lbs PB}}{10 \text{ lbs N}} \quad X = 400 \text{ lbs PB to supply 40 lbs N}
    \]
- 80 lbs $K_2O$ needed:
  - Use Sul-Po-Mag (SPM), because Mg is low and pH is 6.8
  - 0-0-22 or 364 lbs/acre or 8 lbs/1000 sq feet
    \[
    \frac{X \text{ lbs SPM}}{80 \text{ lbs } K_2O} = \frac{100 \text{ lbs SPM}}{22 \text{ lbs } K_2O} \quad X = 364 \text{ lbs SSM to supply 80 lbs } K_2O
    \]
Determining Fertilizers to Meet Nutrients Needs

- Example: 40 lbs N (with credits), 80 lbs \( P_2O_5 \) needed, and 100 lbs \( K_2O \)
- 40 lbs N needed; use Pro-Gro (PG) 5-3-4:
  \[
  \frac{X \text{ lbs PG}}{100 \text{ lbs PG}} = \frac{X}{800 \text{ lbs PG}} \quad X = 800 \text{ lbs PG} \text{ to supply 40 lbs N}
  \]
  \[
  \frac{40 \text{ lbs N}}{5 \text{ lbs N}} = \frac{X}{800 \text{ lbs PG}} \quad X = 800 \text{ lbs PG}
  \]
  - N: 800 lbs/acre or 18 lbs/1000 sq feet (250" x 4") to supply N
  - Hitchhikers
    - P: 800 lbs Pro-Gro = 24 lbs \( P_2O_5 \); still need 56 lbs \( P_2O_5 \)
    - K: 800 lbs Pro-Gro = 32 lbs \( K_2O \); still need 68 lbs \( K_2O \)
- Choose other fertilizers that do not contain any N
  - P use Bonechar (BC), 0-16-0, 350 lbs/a or 8.0 lbs/1000 sq ft
    \[
    \frac{X \text{ lbs BC}}{100 \text{ lbs BC}} = \frac{X}{350 \text{ lbs BC}} \quad X = 350 \text{ lbs BC} \text{ to supply 56 lbs } P_2O_5
    \]
    \[
    \frac{56 \text{ lbs } P_2O_5}{16 \text{ lbs } P_2O_5} = \frac{X}{350 \text{ lbs BC}} \quad X = 350 \text{ lbs BC}
    \]
  - K use natural sulfate of potash (NSP), 0-0-51,133 lbs/a or 3 lbs/1000 sq ft
    \[
    \frac{X \text{ lbs NSP}}{100 \text{ lbs NSP}} = \frac{X}{133 \text{ lbs NSP}} \quad X = 133 \text{ lbs NSP} \text{ to supply 68 lbs } K_2O
    \]
    \[
    \frac{133 \text{ lbs } K_2O}{51 \text{ lbs } K_2O} = \frac{X}{133 \text{ lbs NSP}} \quad X = 133 \text{ lbs NSP}
    \]
Chilean Nitrate Caveat

- Chilean Nitrate, a naturally mined NaNO₃ fertilizer that is highly soluble, can only supply up to 20% of the total crops need in certified organic production.

- Chilean Nitrate 16-0-0
  - If 100 lbs of N is needed for a crop, then 20 lbs max may come from Chilean Nitrate
  - If 50 lbs of N is needed for a crop, then 10 lbs max may come from Chilean Nitrate.
Chilean Nitrate Caveat 2

- NCO Pro-Booster: 10-0-0, and 10% of Total N is Chilean Nitrate
  - VOF certified farmers can meet 20% of the total crop need with Chilean Nitrate—even in a blended fertilizer. (Pro-booster is essentially a 1-0-0 fertilizer in terms of Chilean Nitrate (10 x 0.1 =1).)
  - 100 lbs of N are needed for the crop, farmers can apply a max of 20 lbs as Chilean Nitrate.
  - But applying 2000 lbs per acre of Pro-Booster (PB) would still be at the 20% max allowed amount of Chilean Nitrate (CN):
    \[
    \frac{X \text{ lbs N}}{2000 \text{ lbs PB}} = \frac{10 \text{ lbs total N}}{100 \text{ lbs PB}} \Rightarrow X = \text{200 lbs N of which 10% is CN or 20 lbs from CN}
    \]
  - In this case where the farmer needs 100 lbs of N, applying 1000 lbs PB/acre would meet total N needs of the crop (note: we did not include N credits in this example).

- Or: 23 lbs per 1000 sq feet.
Conversions: Acres to 1000 sq ft

- Note: 1 acre = 43,560 sq feet
- Convert: 100 lbs fertilizer/acre to lbs/1000 sq feet

\[
\frac{100 \text{ lbs fertilizer}}{43,560 \text{ sq ft}} = \frac{X \text{ lbs fertilizer}}{1000 \text{ sq ft}}
\]

\[
\frac{1000 \times 100}{43,560} = X = 2.29 \text{ lbs fertilizer}
\]

Or divide 100 lbs fertilizer by 44.
Liming Materials

- Ag Lime – Calcitic Limestone
  - Mostly CaCO₃

- High Mag Lime – Dolomitic Limestone
  - A mix of CaCO₃ and MgCO₃

- Woodashes
  - Mostly K₂CO₃ and MgCO₃; has some B
  - Calcium Carbonate Equivalent (CCE) or equivalent liming power is unknown unless it is tested.

- Lime-Ash Mixes
  - Shelburne limestone still sells it, but it will be discontinued.
Percent Base Saturation

• Percent Base Saturation: A calculation of sum of the non-acid cations: \( \text{Ca}^{2+}, \text{Mg}^{2+}, \) and \( \text{K}^+ \) (Na\(^+\) in the mid-west and west) divide by the total CEC (in units of charge per weight of soil), multiplied by 100.
  – Indicates fertility.

• Percent Cation Saturation: A cation amount divide by the total CEC (in units of charge per weight of soil), multiplied by 100.
  
Units of charge: meq charge/100 g soil = cmol (+) per Kg (SI units), indicating the amount of CEC it is capable
NOFA Northeast Organic Farming Association of Vermont (NOFA-VT) and Other Certified Organic Resources

- Request these written documents from the VOF Office:
  - Vermont Organic Farmers 2010 certification Guidelines and Applicant Information
  - Brand Name Product List for Organic Crop Production

- Online Guidelines for Certification of Vegetable Crops

- Commercial Organic Vegetable and Fruit Pages:
  - [http://nofavt.org/programs/technical-assistance-education-vegetables](http://nofavt.org/programs/technical-assistance-education-vegetables)

- OMRI – Organic Materials Research Institute
  - [http://www.omri.org/](http://www.omri.org/)
Resources: Books

E-Resources

- Appropriate Technology Transfer for Rural Areas (ATTRA):
  - [http://attra.org/](http://attra.org/)

- New England Vegetable Management Guide
  - [http://www.nevegetable.org/](http://www.nevegetable.org/)

- Northeast Sustainable Agriculture Research and Education (NE-SARE):
  - [http://sare.org/](http://sare.org/)

- University of Vermont Extension - Vermont Vegetable and Berry Page:
  - [http://www.uvm.edu/vtvegandberry/](http://www.uvm.edu/vtvegandberry/)

- Nutrient Management on Organic Vegetable Farms by Dr. Vern Grubinger
E-Testing Resources

- Cornell University Soil Health Team
  http://www.hort.cornell.edu/soilhealth/extension/test.htm

- University of Maine: Analytical Laboratory and Maine Soil Testing Service
  http://anlab.umesci.maine.edu/

- University of Massachusetts Soil and Plant Tissue Testing Laboratory
  http://www.umass.edu/plsoils/soiltest/

- University of Vermont Agricultural and Environmental Testing Lab
  http://www.uvm.edu/pss/ag_testing/