Mineral Nutrition for Vegetable Crops

Liz Maynard, Dept. of Hort and LA, Purdue

January 5, 2017 Illiana Vegetable Growers Symposium
Task force continues to tackle Gulf of Mexico dead zone

Improving water quality takes collaboration, especially when it comes to the Gulf of Mexico. For years, excess nutrients carried down the Mississippi River from multiple states have drained into the Gulf, creating a large area of low oxygen that cannot support aquatic life, referred to as a "dead zone." These excess nutrients can come from a variety of different sources, such as wastewater treatment facilities or runoff from agricultural land, but they can also occur naturally, as a result of weathering of rocks/soil in the watershed or mixing of water currents in the ocean.

To tackle this issue in the Gulf, a task force was created in 1997 to understand the causes and effects of the nutrient pollution; coordinate activities to reduce the size, severity, and duration; and improve the effects of low oxygen, or hypoxia. Today, the Hypoxia Task Force, made up of state and federal agencies (including Indiana) and tribes, provides executive level direction and support for coordinating the actions of participating organizations working on nutrient management within the Mississippi River/Gulf of Mexico Watershed.

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**Fertilizer Cost**

15-50% preharvest variable costs

3 – 10%

**Gross Returns**

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*Fig. 2. Black rot at EcoHio and LIFE Farms. a. Soil amendment effects.*
Healthy Soil

Physical
  – Structure
  – Pore Space
  – Pore Sizes

Biological
  – Arthropods
  – Earthworms
  – Microbes

Chemical
  – pH
  – Mineral nutrients
  – Other elements and compounds
## Essential Elements for Plants

<table>
<thead>
<tr>
<th>Macronutrients</th>
<th>Micronutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen N</td>
<td>Copper Cu</td>
</tr>
<tr>
<td>Phosphorus P</td>
<td>Iron Fe</td>
</tr>
<tr>
<td>Potassium K</td>
<td>Manganese Mn</td>
</tr>
<tr>
<td>Calcium Ca</td>
<td>Molybdenum Mo</td>
</tr>
<tr>
<td>Magnesium Mg</td>
<td>Nickel Ni</td>
</tr>
<tr>
<td>Sulfur S</td>
<td>Zinc Zn</td>
</tr>
<tr>
<td></td>
<td>Boron B</td>
</tr>
<tr>
<td></td>
<td>Chlorine Cl</td>
</tr>
</tbody>
</table>
soil minerals

soil organic matter

soil solution

Inputs:
Fertilizers • Organic Matter
Nitrogen Fixation

Losses: Leaching • Plant Removal
Erosion • Denitrification

NH$_4^+$ → NO$_3^-$
H$_2$PO$_4^{2-}$
SO$_4^{2-}$

K$^+$
Ca$^{2+}$
Mg$^{2+}$
Fe

H$^+$

E. Maynard
Purdue Univ.
### Soil Test Report

**Date Reported:** 10/29/2008

<table>
<thead>
<tr>
<th>Organic Matter %</th>
<th>Phosphorus Bray P1 ppm-P</th>
<th>Bray P2 ppm-P</th>
<th>Potassium K ppm</th>
<th>Magnesium Mg ppm</th>
<th>Calcium Ca ppm</th>
<th>Sodium Na ppm</th>
<th>pH Soil</th>
<th>pH Buffer</th>
<th>Cation Exchange Capacity meq/100g</th>
<th>% K</th>
<th>% Mg</th>
<th>% Ca</th>
<th>% H</th>
<th>% I</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8</td>
<td>54 VH</td>
<td></td>
<td>167 H</td>
<td>200 VH</td>
<td>750 M</td>
<td></td>
<td>6.8</td>
<td>6.0</td>
<td>7.1</td>
<td>27.7</td>
<td>62.2</td>
<td>3.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.7</td>
<td>55 VH</td>
<td></td>
<td>156 H</td>
<td>190 VH</td>
<td>700 M</td>
<td></td>
<td>6.8</td>
<td>5.7</td>
<td>7.1</td>
<td>28.0</td>
<td>61.9</td>
<td>3.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>122 VH</td>
<td></td>
<td>172 H</td>
<td>235 VH</td>
<td>950 M</td>
<td></td>
<td>6.9</td>
<td>7.3</td>
<td>6.1</td>
<td>27.0</td>
<td>65.4</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sulfur ppm</th>
<th>Zinc Zn ppm</th>
<th>Manganese Mn ppm</th>
<th>Iron Fe ppm</th>
<th>Copper Cu ppm</th>
<th>Boron B ppm</th>
<th>Soluble Salts mmhos/cm</th>
<th>Nitrate NO3-N ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 M</td>
<td>4.0 M</td>
<td>57 VH</td>
<td>32 H</td>
<td>1.3 H</td>
<td>0.5 L</td>
<td>5 L</td>
<td>5 L</td>
</tr>
<tr>
<td>12 M</td>
<td>4.8 M</td>
<td>63 VH</td>
<td>34 H</td>
<td>1.4 H</td>
<td>0.5 L</td>
<td>5 L</td>
<td>5 L</td>
</tr>
<tr>
<td>12 M</td>
<td>8.0 H</td>
<td>59 VH</td>
<td>46 H</td>
<td>1.9 H</td>
<td>0.7 M</td>
<td>8 L</td>
<td>8 L</td>
</tr>
</tbody>
</table>
pH 6.0 - 6.8
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Nitrogen Recommendations for Vegetable Crops

Adapted from Warncke et al. 2004
# N Credits: Useful for Estimating N Needed from Fertilizer

<table>
<thead>
<tr>
<th>Previous Crop</th>
<th>Nitrogen Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa, established</td>
<td>40 + % stand</td>
</tr>
<tr>
<td>Clover, established</td>
<td>40 + 0.5 % stand</td>
</tr>
<tr>
<td>Wheat + Legume</td>
<td>30 + 0.5 % stand</td>
</tr>
<tr>
<td>Soybeans</td>
<td>30</td>
</tr>
</tbody>
</table>

Warncke et al. 2004
N Credits: Useful for Estimating N Needed from Fertilizer

Cover Crops

• Need to know dry weight of cover crop/A and percent N

Managing Cover Crops Profitably: BUILDING SOIL FERTILITY AND TILTH WITH COVER CROPS

www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition

Soil Organic Matter
Presidedress Nitrate Test (PSNT)

Useful for estimating nitrogen supply during the growing season
Sample soil shortly before rapid crop growth and sidedressing or topdressing
Dry sample quickly or freeze and send to soil analysis lab
Guidelines from the Northeast:
Sweet corn no sidedressing needed if NO3-N > 20-25 ppm in top 12 inches
Pumpkin, winter squash, cabbage, peppers: no sidedressing needed if NO3-N > 25-30 ppm in top 12 inches

Phosphorus (P)

Build-up: Amount based on soil test plus the maintenance amount

Maintenance: Amount removed by harvested portion of crop

<table>
<thead>
<tr>
<th>Soil Test P* (ppm)</th>
<th>Phosphorus Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 35</td>
<td>Build-up</td>
</tr>
<tr>
<td>35 - 80</td>
<td>Maintenance</td>
</tr>
<tr>
<td>&gt; 80</td>
<td>None needed</td>
</tr>
</tbody>
</table>

*Bray-Kurtz P1 extraction.

Warncke et al. 2004
P2O5 Removed in Harvested Vegetables (lb/ton)

Adapted from Warncke et al. 2004
Potassium (K)

Build-up: Amount based on soil test plus the maintenance amount

Maintenance: Amount removed by harvested portion of crop

<table>
<thead>
<tr>
<th>Soil K (ppm)</th>
<th>Potassium Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cation Exchange Capacity (meq/100g)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>&lt;85</td>
<td>&lt;115</td>
</tr>
<tr>
<td>85-135</td>
<td>115-165</td>
</tr>
<tr>
<td>&gt;135</td>
<td>&gt;165</td>
</tr>
</tbody>
</table>

Warncke et al. 2004
K2O Removed in Harvested Vegetables (lb/ton)

Adapted from Warncke et al. 2004

Lb. / 100 lb.

0.70
Pumpkins

Nitrogen:
- Preplant: 50
- Sidedress: 30-40
Total: 80-90 lb./A

Sidedressing N not needed if soil organic matter is greater than 3% and following a legume

MW Veg Prod Guide 2017 (ID-56) p. 104

Fertilizing

Lime: To maintain a soil pH of 6.0-6.8.

Preplant: N: 50 pounds per acre; P₂O₅: 0-150 pounds per acre; K₂O: 0-200 pounds per acre. Adjust according to soil type, previous management, and soil test results for your state. For summer squash transplants, a starter solution at a rate of 1 cup (8 ounces) per plant is recommended. If the transplant flat receives a heavy fertilizer feeding just prior to setting, the starter solution can be eliminated.

Sidedress: N: For soils with more than 3 percent organic matter and following soybeans, alfalfa, or a grass-legume hay crop, no N is needed. For soils with less than 3 percent organic matter with the same rotation or a rotation of corn, rye, oats, wheat, or a vegetable crop, apply 30-40 pounds N per acre when the vines begin to run. For sandy soils, the preplant N application can be replaced by an early sidedressing of 40 pounds N per acre when the plants show the first set of true leaves. Apply the second sidedressing of 45 pounds N per acre at onset of rapid vining.

For crops grown from transplants on plastic mulch, N losses from leaching are greatly reduced. For this culture system, apply 50 pounds N per acre broadcast preplant over the row just before laying the plastic. If sidedress N is recommended (see above), apply up to 30 pounds N per acre on either side of the plastic at vining when the plant roots have reached the edge of the plastic. If you are using trickle irrigation, apply the 50 pounds N per acre preplant, and apply 0.5-1 pound N per acre daily, or 3-6 pounds N weekly through the trickle system if additional N is needed.
Pumpkins

Phosphorus

– 0 to 150 lb /A $\text{P}_2\text{O}_5$
  depending on soil test

For this example:
36 lb./A $\text{P}_2\text{O}_5$

<table>
<thead>
<tr>
<th>Soil Test P (ppm)</th>
<th>Expected Yield (tons/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Recommended Lb. $\text{P}_2\text{O}_5$/A</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>118</td>
</tr>
<tr>
<td>45 - 80</td>
<td>18</td>
</tr>
<tr>
<td>90</td>
<td>0</td>
</tr>
</tbody>
</table>

Warncke et al. 2004\textsuperscript{30}
Pumpkins

Potassium
- 0 to 200 lb/A K₂O depending on soil test

For this example:
170 lb./A K₂O

<table>
<thead>
<tr>
<th>Soil K (ppm)</th>
<th>Expected Yield (tons/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15</td>
</tr>
<tr>
<td>CEC-&gt;</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>170</td>
</tr>
<tr>
<td>Recommended Lb. K₂O/A</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>156</td>
</tr>
<tr>
<td>115</td>
<td>102</td>
</tr>
<tr>
<td>135</td>
<td>0</td>
</tr>
</tbody>
</table>

Warncke et al. 2004
Pumpkins. Option 1.

Preplant:
- 36 lb./A N from 80 lb. urea (45-0-0)
- 14 lb./A N and
- 36 lb. P2O5 from 78 lb. DAP banded 2x2
- 170 lb./A K2O from 283 lb. KCl (0-0-60)

Sidedress:
- 30 lb./A N from 10 gallons 28% UAN

Urea: 45-0-0 (N-P2O5-K2O)
36 lb./A divided by 0.45 = 80 lb./A
DAP: 18-46-0
14 lb./A divided by 0.18 = 78 lb./A
36 lb./A divided by 0.46 = 78 lb./A
KCl: 0-0-60
170 lb./A divided by 0.60 = 283 lb./A
UAN: 28-0-0, 10.65 lb./gal
30 lb./A divided by 0.28 = 107 lb./A
UAN
107 lb./10.65 lb./gal = 10 gal

Formulas:
1. Lbs. nutrient per A divided by % nutrient in the fertilizer (written as a decimal, e.g. 10% = 0.10) = Lbs. fertilizer per A
2. Lbs. fertilizer per A times % nutrient in the fertilizer (written as a decimal) = Lbs. nutrient per A
Tomatoes

Nitrogen:
- Preplant: 30
- Transplant starter:
- Sidedress: 60-80
Total: 100-120 lb./A

Reduce by credits from legumes and soil organic matter greater than 3%
Tomatoes

Phosphorus

- 0 to 240 lb /A P$_2$O$_5$ depending on soil test

For this example:
24 lb./A P$_2$O$_5$

<table>
<thead>
<tr>
<th>Soil Test P (ppm)</th>
<th>20</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lb. P$_2$O$_5$/A</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>116</td>
<td>124</td>
</tr>
<tr>
<td>45 - 80</td>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td>90</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Warncke et al. 2004
**Tomatoes**

**Potassium**

-0 to 300 lb /A K₂O depending on soil test

For this example:

210 lb./A K₂O

<table>
<thead>
<tr>
<th>Soil K (ppm)</th>
<th>Expected Yield (tons/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>CEC-&gt;</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Lb. K₂O/A</td>
</tr>
<tr>
<td>40</td>
<td>194</td>
</tr>
<tr>
<td>115</td>
<td>140</td>
</tr>
<tr>
<td>135</td>
<td>0</td>
</tr>
</tbody>
</table>

Warncke et al. 2004

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Acres or Linear Bed Feet?

**Acres**

175 ft. X 90 ft. = 15,750 ft²

15,750 ft² / 43,560 ft²/A = 0.36 A

**Linear Bed Feet (LBF)**

Beds on 5-ft centers

175 ft. X 18 beds = 3,150 LBF
### Fertilizer Rates per Linear Bed Foot

<table>
<thead>
<tr>
<th>Bed Spacing (ft.)</th>
<th>LBF/A</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
<th>150</th>
<th>180</th>
<th>210</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>14,520</td>
<td>0.0021</td>
<td>0.0041</td>
<td>0.0062</td>
<td>0.0083</td>
<td>0.0103</td>
<td>0.0124</td>
<td>0.0145</td>
</tr>
<tr>
<td>4</td>
<td>10,890</td>
<td>0.0028</td>
<td>0.0055</td>
<td>0.0083</td>
<td>0.0110</td>
<td>0.0138</td>
<td>0.0165</td>
<td>0.0193</td>
</tr>
<tr>
<td>5</td>
<td>8,712</td>
<td>0.0034</td>
<td>0.0069</td>
<td>0.0103</td>
<td>0.0138</td>
<td>0.0172</td>
<td>0.0207</td>
<td>0.0241</td>
</tr>
<tr>
<td>6</td>
<td>7,260</td>
<td>0.0041</td>
<td>0.0083</td>
<td>0.0124</td>
<td>0.0165</td>
<td>0.0207</td>
<td>0.0248</td>
<td>0.0289</td>
</tr>
<tr>
<td>8</td>
<td>5,445</td>
<td>0.0055</td>
<td>0.0110</td>
<td>0.0165</td>
<td>0.0220</td>
<td>0.0275</td>
<td>0.0331</td>
<td>0.0386</td>
</tr>
</tbody>
</table>

See pp. 16-17 of 2017 ID-56
Tomatoes – Option 2. 1000 LBF

Nitrogen:

– Preplant: 3.4 lb N from 7.6 lb. urea. Broadcast or work into bed during formation.
– Transplant starter: 0.27 lb. N from 30 fl.oz. 10-34-0
– Fertigate: 8.0 lb. N
  • 5.0 lb. N from Calcium nitrate, 32.4 lb.
    – 3.2 lb. CN per week for 10 weeks
  • 3.0 lb. N from Potassium nitrate, 21.2 lb.
    – 2.1 lb. KN per week for 10 weeks

Total: 11.7 lb./1000 LBF
Cost: $2.27 + $16.77 + $15.58 = $34.62
(does not include starter)

Calculations for starter fertilizer
Recommended rate is 48 fl.oz. 10-34-0 in 50 gal. solution, use 8 oz. per plant.

1. How much 10-34-0 is needed?
Assume 500 plants X 8 fl.oz. solution per plant = 31 gal. of solution needed for 1000 LBF
For 31 gal. of solution, use 31/48 = 30 fl.oz. 10-34-0.

2. How much N and P2O5 is in the solution?
1 gallon 10-34-0 weighs 11.65 lb.
30 fl.oz. of 10-34-0 weighs (30/128)X11.65 = 2.7 lb.
10-34-0 is 10% N by weight and 34% P2O5

  2.7 lb X 0.10 = 0.27 lb. N
  2.7 lb. X 0.34 = 0.93 lb. P2O5
Tomatoes – Option 2., cont. 1000 LBF

**Phosphorus:**
- Starter: 0.93 lb. P$_2$O$_5$ from 30 fl.oz. 10-34-0

Total: 0.93 lb./1000 LBF
Cost: $0.61

**Potassium:**
- Preplant: 9.75 lb K$_2$O from 16.3 lb. potassium chloride (0-0-60). Broadcast or work into bed during formation.
- Fertigate: 9.75 lb K$_2$O from 21.2 lb. potassium nitrate
  - 2.1 lb. KN per week for 10 weeks

Total: 19.5 lb./1000 LBF
Cost: $4.84 + $15.58 (already included in N cost)

_N-P-K Total cost:_
$40.07
Tomatoes – Option 3. 1000 LBF

Nitrogen:

– Preplant:
  • 4.4 lb. N from hairy vetch/rye cover crop, killed early May
  • 3.4 lb. N from 48.6 lb. 13-0-0 organic fertilizer (assume 7% available)
    0.8 lb. N from 4 bushels (140 lb) compost 3-2-2 (assume 0.6% available)
– Sidedress: 2.9 lb. N if needed
  • from 41 lb. 13-0-0

Total: 11.5 lb./1000 LBF
Cost for 13-0-0: $58

If soil is high in organic matter and there is a history of adding organic soil amendments, 13-0-0 may not be needed.

Prices for 13-0-0 from price paid in 2013 for bagged product.
Tomatoes – Option 3., cont. 1000 LBF

**Phosphorus:**
- Preplant: 2.8 lb. from 4 bushels (140 lb.) compost (3-2-2)

Total: 2.8 lb./1000 LBF
Cost: ??

**Potassium:**
- Preplant:
  - 2.8 lb K₂O from 4 bushels (140 lb.) compost (3-2-2)
  - 16.7 lb K₂O from 33 lb. potassium sulfate (0-0-52)

Total: 19.5 lb./1000 LBF
Cost for potassium sulfate: $15 - $40

Cost of bagged N and K₂O: $73 - $98

Plus: cover crop seed, compost

Prices for K S from wholesale supplier web site and price quote in 2014.

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Efficient Fertilizer Use

Close to time of crop use
In root zone of crop
Foliar Fertilization
# Example Foliar Fertilization Rates from Product Labels

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate*</th>
<th>Sprays*</th>
<th>Nutrients Applied</th>
<th>% of Tomato Crop Uptake†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>P$_2$O$_5$</td>
</tr>
<tr>
<td>N-P$_2$O$_5$-K$_2$O</td>
<td>lb/A</td>
<td>no.</td>
<td>lb/A</td>
<td></td>
</tr>
<tr>
<td>18-18-18</td>
<td>5-10</td>
<td>3-5</td>
<td>2.7-9</td>
<td>2.7-9</td>
</tr>
<tr>
<td>20-5-5</td>
<td>3-10</td>
<td>5-10</td>
<td>3-20</td>
<td>0.75-5</td>
</tr>
<tr>
<td>4-41-27</td>
<td>5-10</td>
<td>3-5</td>
<td>0.6-2</td>
<td>6-20</td>
</tr>
</tbody>
</table>

*Rate and number of sprays suggested by product label. This is not a Purdue recommendation.

†Tomato uptake estimated at N: 182 lb/A; P$_2$O$_5$ 48 lb/A, K$_2$O 337 lb/A, for yield 30 tons/A. Lorenz and Maynard 1980.
### Foliar Fertilization When Root Uptake is Prevented – Primary and Secondary Nutrients

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Lb/A</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>4 - 5</td>
<td>Urea, UAN, A N, A S, Ca N</td>
</tr>
<tr>
<td>K</td>
<td>1 - 4</td>
<td>K sulfate</td>
</tr>
<tr>
<td>Ca</td>
<td>1 - 2</td>
<td>Ca nitrate, Ca chloride</td>
</tr>
<tr>
<td>Mg</td>
<td>1 - 2</td>
<td>Mg sulfate</td>
</tr>
</tbody>
</table>
Foliar Fertilization

Micronutrients

– Responsive crops
– Identified deficiency
– Soil application not practical or effective
# Foliar Fertilization - Micronutrients

<table>
<thead>
<tr>
<th>Element</th>
<th>Lb/A</th>
<th>Source</th>
<th>Highly Responsive Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>0.1 - 0.3</td>
<td>Sodium borate, boric acid</td>
<td>Beet, Broccoli, Carrot, Cauliflower, Celery, Parsnip, Rutabaga, Tomato, Turnip</td>
</tr>
<tr>
<td>Mn</td>
<td>1-2</td>
<td>Mn sulfate</td>
<td>Bean, Cuke, Garlic, Greens, Lettuce, Onion, Pea, Potato, Pumpkin, Radish, Spinach, Squash, Sweet corn</td>
</tr>
<tr>
<td>Zn</td>
<td>1/2</td>
<td>Zn sulfate</td>
<td>Bean, Onion, Spinach, Sweet corn</td>
</tr>
</tbody>
</table>

Chelated elements may also be used; follow label instructions.

Monitoring and Adjusting a Plan

In Season
- Soil nitrate test
- Plant tissue sampling
- On-farm plant or soil testing

After or Between Season
- Soil test
- End of season soil nitrate?
Recordkeeping

Soil test results
Lime: type and tons/A
Fertilizers:
  – Type, analysis, lbs./A
  – Application method
Other soil amendments
  – Type, nutrient content, lbs./A
Cover crops:
  – Species, seeding rates, plant and termination dates, termination method
Resources

Midwest Vegetable Production Guide for 2017 (ID-56) mwveguide.org/

Purdue Education Store edustore.purdue.edu Soil Sampling for P, K, and Lime AY-281-W

Nutrient Recommendations for Vegetable Crops in Michigan (E2934)
msue.anr.msu.edu/resources/nutrient_recommendations_for_vegetable_crops_in_michigan_e2934

Managing Cover Crops Profitably: BUILDING SOIL FERTILITY AND TILTH WITH COVER CROPS
www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition


Indiana Nutrient Management/Soil Health https://inagnutrients-public.sharepoint.com
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