Healthy plants in your school garden: Fertilizers

Anne Sawyer
PhD Candidate, Department of Soil, Water, and Climate
Master Gardener in Rice County
University of Minnesota
sawye177@umn.edu
What do plants need?

Food:
$$6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_2 + 6\text{O}_2$$

Also need:
Growth medium
Water
Oxygen
Nutrients
Today’s talk:

• What are nutrients and how do plants obtain them?
• How do I know which fertilizers to use?
Like us, plants need nutrients!

**17 essential minerals for plant growth**

- **Primary nutrients:**
  - Nitrogen, phosphorus, potassium

- **Secondary nutrients:**
  - Sulfur, calcium, magnesium

- **Micronutrients:**
  - Fe, B, Mn, Cu, Zn, Cl, Mo, Ni

Carbon, hydrogen, oxygen
How do plants get nutrients?

It depends!

http://www.sunkarresources.com/en/pages/nutrients_and_their__role
How do plants get nutrients?

It depends!

With the water,

https://www.scienceproject.com/projects/intro/Senior/SBt8t.asp
How do plants get nutrients?

It depends!

With the water, directly into the root (passive or active ion transport),
How do plants get nutrients?

It depends!

With the water, directly into the root (passive or active transport), or with a little help from their friends (beneficial microbes)!
How do plants get nutrients?

What do these things have in common?

Plants take up inorganic ions and don’t care where they come from!
Ions? Which ions (and molecules)?

**Primary nutrients:**
- Nitrogen
- Phosphorus
- Potassium

**Secondary nutrients:**
- Sulfur
- Calcium
- Magnesium

**Micronutrients:**
- Iron, copper, zinc, nickel, chlorine, molybdenum, manganese, boron

**Charged particles:**
- $\text{Fe}^{2+}$
- $\text{Cu}^{2+}$
- $\text{Zn}^{2+}$
- $\text{Ni}^{2+}$
- $\text{Cl}^-$
- $\text{MoO}_4^{2-}$
- $\text{Mn}^{2+}$
- $\text{H}_3\text{BO}_3$

**Neutral molecules:**
- $\text{CO}_2$
- $\text{H}_2\text{O}$
- $\text{O}_2$
- $\text{H}^+$

**Ions:**
- $\text{NH}_4^+$
- $\text{NO}_3^-$
- $\text{H}_2\text{PO}_4^-$
- $\text{HPO}_4^{2-}$
- $\text{K}^+$
Ions? Which ions (and molecules)?

- **Primary nutrients:**
  - Nitrogen
  - Phosphorus
  - Potassium

- **Secondary nutrients:**
  - Sulfur
  - Calcium
  - Magnesium

- **Micronutrients:**
  - Iron, copper, zinc, nickel, chlorine, molybdenum, manganese, boron

- **Ions:**
  - $\text{NH}_4^+$
  - $\text{NO}_3^-$
  - $\text{H}_2\text{PO}_4^-$
  - $\text{SO}_4^{2-}$
  - $\text{Mg}^{2+}$
  - $\text{Ca}^{2+}$
  - $\text{H}_3\text{BO}_3$
  - $\text{K}^+$
  - $\text{Cl}^-$
  - $\text{MoO}_4^{2-}$
  - $\text{Mn}^{2+}$

- **Molecules:**
  - $\text{CO}_2$
  - $\text{H}_2\text{O}$
  - $\text{O}_2$
  - $\text{H}^+$
Ions? Which ions (and molecules)?

- **Primary nutrients:**
  - Nitrogen
  - Phosphorus
  - Potassium

- **Secondary nutrients:**
  - Sulfur
  - Calcium
  - Magnesium

- **Micronutrients:**
  - Iron, copper, zinc, nickel, chlorine, molybdenum, manganese, boron

- Key ions:
  - $\text{Fe}^{2+}$
  - $\text{Cu}^{2+}$
  - $\text{Zn}^{2+}$
  - $\text{Ni}^{2+}$
  - $\text{Cl}^{-}$
  - $\text{MoO}_4^{2-}$
  - $\text{Mn}^{2+}$
  - $\text{H}_3\text{BO}_3$

- Molecular species:
  - $\text{CO}_2$
  - $\text{H}_2\text{PO}_4^-$
  - $\text{NH}_4^+$
  - $\text{NO}_3^-$
  - $\text{HPO}_4^{2-}$
  - $\text{K}^+$
  - $\text{H}^+$
  - $\text{H}_2\text{O}$
  - $\text{O}_2$
Ions? Which ions (and molecules)?

**Primary nutrients:**
- Nitrogen
- Phosphorus
- Potassium

**Secondary nutrients:**
- Sulfur
- Calcium
- Magnesium

**Micronutrients:**
- Iron, copper, zinc, nickel, chlorine, molybdenum, manganese, boron

**Other ions and molecules:**
- $\text{NH}_4^+$
- $\text{NO}_3^-$
- $\text{HPO}_4^{2-}$
- $\text{SO}_4^{2-}$
- $\text{K}^+$
- $\text{CO}_2$
- $\text{H}_2\text{O}$
- $\text{H}^+$
- $\text{O}_2$
- $\text{Cl}^-$
- $\text{MoO}_4^{2-}$
- $\text{Mn}^{2+}$
- $\text{H}_3\text{BO}_3$
Ions? Which ions (and molecules)?

**Primary nutrients:**
- Nitrogen
- Phosphorus
- Potassium

**Secondary nutrients:**
- Sulfur
- Calcium
- Magnesium

**Micronutrients:**
- Iron, copper, zinc, nickel, chlorine, molybdenum, manganese, boron

Most MN soils have adequate levels of micronutrients.

Carbon
Hydrogen
Oxygen

**Chemical formulas:**
- NH$_4^+$
- NO$_3^-$
- SO$_4^{2-}$
- Mg$^{2+}$
- Ca$^{2+}$
- K$^+$
- H$_3$BO$_3$
- Cl$^-$
- Fe$^{2+}$
- Cu$^{2+}$
- Zn$^{2+}$
- Ni$^{2+}$
- Mn$^{2+}$
- HPO$_4^{2-}$
- CO$_2$
- H$_2$PO$_4^-$
- H$^+$
- O$_2$
Where are the nutrients?
What is soil? Where are the nutrients?

Profile of a loam soil

- **Minerals:** Sand, silt, clay (~45%)
- **Water:** ~20-30%
- **Air:** ~20-30%
- **Organic matter:** ~5%
What are soil minerals?

http://www.ext.colostate.edu/mg/gardennotes/214.html
What is soil organic matter?

“Living things, dead things, and very dead things”
Living things

Decomposers responsible for nutrient turnover

University of Tokyo

http://cropandsoil.oregonstate.edu/content/soil-microbes
Living things: MICROBES!

~20,000 *species* of bacteria in ONE gram of soil

Microbes account for 80-90% of total soil metabolic activity
Dead things

Pool of *active* nutrient cycling from readily decomposed organic matter
Very dead things (humus)

Humate molecule

Complex molecules resistant to further decay

Slow but continuous source of nutrients

http://www.soils.umn.edu/academics/classes/soil561/content/OrganicMatter/graphics.htm
Organic matter affects...

- Drainage
- Water holding capacity
- Aggregate stability
- Aeration
- Microbial diversity
- Nutrients
How much does organic matter matter?
It depends…

Goals?

Budget?

Time?

It depends…
What’s *in* fertilizers?

Fertilizers have a **guaranteed analysis**:

By law, must contain % of nutrient listed on label

N-P-K, or N-P-K-(other)

Technically:

\[ N - P_2O_5 - K_2O \]
Fertilizer examples

Alaska FISH FERTILIZER
- All purpose deodorized fish emulsion
- Use on all indoor and outdoor plants
- Won’t burn

Guaranteed Analysis:
- Total Nitrogen (N) .................. 5.0%
- 0.50% Ammoniacal Nitrogen
- 3.75% Other Water Soluble Nitrogen
- 0.75% Water Insoluble Nitrogen
- Available Phosphate (P₂O₅) .......... 1.0%
- Soluble Potash (K₂O) ............... 1.0%

Primary nutrients from Seagoing Fish Emulsion,
*0.75% slowly available nitrogen from seagoing fish emulsion.
Fertilizer examples

N-P-K-S
0-0-0-90
Fertilizer examples

N-P-K = 24-8-16

Also has *guaranteed analysis* for micronutrients
Nutrient analysis of compost??

Unknown, unless you test it!
What else about compost??

Will have variety of nutrients released over time
What else about compost??

Will have microorganisms
What else about compost??

Will have other soil health benefits
Reduce waste stream from school

What else about compost??
What else about compost??

BUT... may not contain much available nitrogen and may have excessive P and K
What else about compost??

AND may contain weed seeds. Know your source!
OK... so how do I know which nutrient sources to use?

FEAR NOT!
Have you tested your soil lately?

Who can have their soil tested?
- Homeowners
- Farmers
- Golf Courses
- Florists
- Nursery Workers
- Athletic Fields
- Composters
- Cemeteries
- Agricultural Lime Producers
- Commercial Vegetable/Fruit Growers
- Industrial Lawn/Landscape Specialists

Why should you have your soil tested?
- Takes the guesswork out of fertilizer recommendations!
- Ensures fertile soil without excess fertilizer application or pollution of the environment!

Getting your soil tested is a good first step in diagnosing a problem, but it might not be your soil!

Here are some resources that can help your diagnosis:

Yard & Garden Desk
(612) 301-7590

Farm Information Line
1-800-232-9077 - fil@umn.edu

Plant Disease Clinic
(612) 625-1275 - pdc@umn.edu

Local County Master Gardener
www.extension.umn.edu/garden/master-gardener/contact/county/

Soil Testing and Research Analytical Laboratory
Crops Research Building Rm 135
1902 Dudley Avenue
St. Paul, MN 55108-6089

Phone: (612) 625-3101
Office Hours: Mon-Fri 8 AM - 4:30 PM
Website: soltest.cfans.umn.edu
STL email: soltest@umn.edu
RAL email: ral@umn.edu

Please make checks payable to the University of Minnesota
We also accept the following credit cards:

All fees and services are subject to change

Copyright © 2014 University of Minnesota
Soil Testing and Research Analytical Laboratory

Department of Soil, Water and Climate
College of Food, Agricultural and Natural Resource Sciences
**SOIL TEST REPORT**

Lawn and Garden

JANE DOE  
1900 SANDY LANE  
MINNEAPOLIS MN 55401

<table>
<thead>
<tr>
<th>Sample Field Number</th>
<th>Estimated Soil Texture</th>
<th>Organic Matter</th>
<th>Soluble Salts</th>
<th>pH</th>
<th>Buffer Index</th>
<th>Nitrates NO3-N ppm</th>
<th>Olsen Phosphorus ppm P</th>
<th>Bray I Phosphorus ppm P</th>
<th>Potassium ppm K</th>
<th>Sulfur SO4-S ppm</th>
<th>Zinc ppm</th>
<th>Iron ppm</th>
<th>Manganese ppm</th>
<th>Copper ppm</th>
<th>Boron ppm</th>
<th>Calcium ppm</th>
<th>Magnesium ppm</th>
<th>Lead ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1B</td>
<td>Medium</td>
<td>3.5</td>
<td>0.5</td>
<td>5.6</td>
<td>6.5</td>
<td>15</td>
<td>89</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**INTERPRETATION OF SOIL TEST RESULTS**

**Phosphorus (P)**

- Low: 5 ppm
- Medium: 10 ppm
- High: 15 ppm
- Very High: 20 ppm

**Potassium (K)**

- Low: 25 ppm
- Medium: 75 ppm
- High: 125 ppm
- Very High: 175 ppm

**pH**

- Acid: 3.0
- Optimum: 4.0 - 5.0
- Alkaline: 6.0 - 9.0

**Soluble Salts**

- Satisfactory: 0 ppm
- Possible Problem: 1.0 - 2.0 ppm
- Excessive Salts: 3.0 - 4.0 ppm

**RECOMMENDATIONS FOR: Vegetable garden**

LIME RECOMMENDATION: 20 LBS/100 SQ.FT.
TOTAL AMOUNT OF EACH NUTRIENT TO APPLY PER YEAR:

- **Nitrogen**: 0.15 LBS/100 SQ.FT.
- **Phosphate**: 0.2 LBS/100 SQ.FT.
- **Potash**: 0.3 LBS/100 SQ.FT.

THE APPROXIMATE RATIO OR PROPORTION OF THESE NUTRIENTS IS: 15-20-30

Use a fertilizer with the percentage of nutrients closest to the above ratio. Apply according to the instructions on the fertilizer bag or container, or determine the amount required from the instructions given on the back side of this report. Since meeting the exact amount required for each nutrient will not be possible in most cases, it is more important to apply the amount of nitrogen required and compromise some for phosphate and potash.

If a fertilizer contains phosphate and/or potash, it can be mixed in the spring or fall into the top 4-6 inches of topsoil. If a fertilizer containing only nitrogen is used, it should be applied in the spring, tilling or raking it into the surface. Nitrogen is easily leached through soil.

For sweetcorn, tomatoes, cabbage, and vine crops such as squash and cucumbers, an additional application of 1/6 lb. nitrogen per 100 sq. ft. may be desirable at midseason. This can be accomplished by applying 1/2 lb. (about one cup) of 34-0-0 fertilizer. Thoroughly water fertilizer into the soil.

County: HENNEPIN. For additional information, contact the YARD & GARDEN LINE: Phone: 612-624-4771  Website: www.extension.umn.edu/yardandgarden
```
<table>
<thead>
<tr>
<th>Sample/Field Number: 18</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOIL TEST RESULTS</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Estimated Soil Texture</td>
</tr>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

**INTERPRETATION OF SOIL TEST RESULTS**

<table>
<thead>
<tr>
<th>Phosphorus (P)</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>V. High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V. High</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potassium (K)</th>
<th>25</th>
<th>75</th>
<th>125</th>
<th>175</th>
<th>225</th>
<th>V. High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V. High</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>pH</th>
<th>3.0</th>
<th>4.0</th>
<th>5.0</th>
<th>6.0</th>
<th>7.0</th>
<th>8.0</th>
<th>9.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optimum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alkaline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Soluble Salts</th>
<th>0</th>
<th>1.0</th>
<th>2.0</th>
<th>3.0</th>
<th>4.0</th>
<th>5.0</th>
<th>6.0</th>
<th>7.0</th>
<th>8.0</th>
<th>9.0</th>
<th>10.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfactory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Possible Problem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excessive Salts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**RECOMMENDATIONS FOR:** Vegetable garden

LIME RECOMMENDATION: 20 LBS/100 SQ.FT.  
TOTAL AMOUNT OF EACH NUTRIENT TO APPLY PER YEAR:

- NITROGEN  
  0.15 LBS/100 SQ.FT.  
- PHOSPHATE  
  0.2 LBS/100 SQ.FT.  
- POTASH  
  0.3 LBS/100 SQ.FT.

THE APPROXIMATE RATIO OR PROPORTION OF THESE NUTRIENTS IS: 15-20-30

Use a fertilizer with the percentage of nutrients closest to the above ratio. Apply according to the instructions on the fertilizer bag or container, or determine the amount required from the instructions given on the back side of this report. Since meeting the exact amount required for each nutrient will not be possible in most cases, it is more important to apply the amount of nitrogen required and compromise some for phosphate and potash.

If a fertilizer contains phosphate and/or potash, it can be mixed in the spring or fall into the top 4-6 inches of topsoil. If a fertilizer containing only nitrogen is used, it should be applied in the spring, tilling or raking it into the surface. Nitrogen is easily leached through soil.

For sweetcorn, tomatoes, cabbage, and vine crops such as squash and cucumbers, an additional application of 1/6 lb. nitrogen per 100 sq. ft. may be desirable at midseason. This can be accomplished by applying 1/2 lb. (about one cup) of 34-0-0 fertilizer. Thoroughly water fertilizer into the soil.

County: HENNEPIN. For additional information, contact the YARD & GARDEN LINE: Phone: 612-624-4771  Website: [www.extension.umn.edu/yardandgarden](http://www.extension.umn.edu/yardandgarden)
University of Minnesota
Soil Testing Laboratory

JANE DOE
1900 SANDY LANE
MINNEAPOLIS MN 55401

SOIL TEST REPORT
Lawn and Garden

<table>
<thead>
<tr>
<th>Sample/Field Number: 19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Soil Texture</td>
</tr>
<tr>
<td>Medium</td>
</tr>
</tbody>
</table>

**INTERPRETATION OF SOIL TEST RESULTS**

<table>
<thead>
<tr>
<th>Phosphorus (P)</th>
<th>P</th>
<th>P</th>
<th>P</th>
<th>P</th>
<th>P</th>
<th>P</th>
<th>P</th>
<th>P</th>
<th>P</th>
<th>P</th>
<th>P</th>
<th>P</th>
<th>P</th>
<th>P</th>
<th>P</th>
<th>P</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>V. High</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td>25</td>
<td>50</td>
<td>75</td>
<td>100</td>
<td>125</td>
<td>150</td>
<td>175</td>
<td>200</td>
<td>225</td>
<td>250</td>
<td>300</td>
<td>350</td>
<td>400</td>
<td>450</td>
<td>500</td>
<td>550</td>
<td>600</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potassium (K)</th>
<th>K</th>
<th>K</th>
<th>K</th>
<th>K</th>
<th>K</th>
<th>K</th>
<th>K</th>
<th>K</th>
<th>K</th>
<th>K</th>
<th>K</th>
<th>K</th>
<th>K</th>
<th>K</th>
<th>K</th>
<th>K</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>V. High</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>75</td>
<td>125</td>
<td>175</td>
<td>225</td>
<td>250</td>
<td>300</td>
<td>350</td>
<td>400</td>
<td>450</td>
<td>500</td>
<td>550</td>
<td>600</td>
<td>650</td>
<td>700</td>
<td>750</td>
<td>800</td>
<td>850</td>
<td>900</td>
<td>950</td>
<td>1000</td>
</tr>
</tbody>
</table>

**LIME RECOMMENDATION:** 20 LBS/100 SQ.FT.
**TOTAL AMOUNT OF EACH NUTRIENT TO APPLY PER YEAR:**

<table>
<thead>
<tr>
<th>NITROGEN</th>
<th>PHOSPHATE</th>
<th>POTASH</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.15 LBS/100 SQ.FT.</td>
<td>0.2 LBS/100 SQ.FT.</td>
<td>0.3 LBS/100 SQ.FT.</td>
</tr>
</tbody>
</table>

THE APPROXIMATE RATIO OR PROPORTION OF THESE NUTRIENTS IS: 15-20-30

Use a fertilizer with the percentage of nutrients closest to the above ratio. Apply according to the instructions on the fertilizer bag or container, or determine the amount required from the instructions given on the back side of this report. Since meeting the exact amount required for each nutrient will not be possible in most cases, it is more important to apply the amount of nitrogen required and compromise some for phosphate and potash.

If a fertilizer contains phosphate and/or potash, it can be mixed in the spring or fall into the top 4-6 inches of topsoil. If a fertilizer containing only nitrogen is used, it should be applied in the spring, tilling or raking it into the surface. Nitrogen is easily leached through soil.

For sweetcorn, tomatoes, cabbage, and vine crops such as squash and cucumbers, an additional application of 1/6 lb. nitrogen per 100 sq. ft. may be desirable at midseason. This can be accomplished by applying 1/2 lb. (about one cup) of 34-0-0 fertilizer. Thoroughly water fertilizer into the soil.

County: HENNEPIN. For additional information, contact the YARD & GARDEN LINE: Phone: 612-624-4771 Website: www.extension.umn.edu/yardandgarden
## SOIL TEST REPORT

**Lawn and Garden**

**Sample/Field Number:** 1B

<table>
<thead>
<tr>
<th>Estimated Soil Texture</th>
<th>Organic Matter %</th>
<th>Soluble Salts mmhos/cm</th>
<th>pH</th>
<th>Buffer Index</th>
<th>Nitrates ppm</th>
<th>Olsen Phosphorus ppm P</th>
<th>Bray 1 Phosphorus ppm P</th>
<th>Potassium ppm K</th>
<th>Sodium ppm</th>
<th>Zinc ppm</th>
<th>Iron ppm</th>
<th>Manganese ppm</th>
<th>Copper ppm</th>
<th>Boron ppm</th>
<th>Calcium ppm</th>
<th>Magnesium ppm</th>
<th>Lead ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>3.5</td>
<td>0.5</td>
<td>5.6</td>
<td>6.5</td>
<td>15</td>
<td>89</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Interpretation of Soil Test Results**

- **Phosphorus (P):** PPPPPP PPPPPP PPPPPP PPPPPP
  - Low: 5
  - Medium: 10
  - High: 15
  - V. High: 20, 25

- **Potassium (K):** KK KK KK KK KK KK KK
  - Low: 25
  - Medium: 75
  - High: 125, 175, 225
  - V. High: 275

- **pH:**
  - Acid: 3.0
  - Optimum: 4.0
  - Alkaline: 5.0

- **Soluble Salts:** ****
  - Satisfactory: 0
  - Possible Problem: 1.0
  - Excessive Salts: 2.0

**Recommendations for:** Vegetable garden

**Lime Recommendation:** 20 LBS/100 SQ.FT.

**Total Amount of Each Nutrient to Apply Per Year:**

- **Nitrogen:** 0.15 LBS/100 SQ.FT.
- **Phosphate:** 0.2 LBS/100 SQ.FT.
- **Potash:** 0.3 LBS/100 SQ.FT.

The approximate ratio or proportion of these nutrients is: 15-20-30

Use a fertilizer with the percentage of nutrients closest to the above ratio. Apply according to the instructions on the fertilizer bag or container, or determine the amount required from the instructions given on the back side of this report. Since meeting the exact amount required for each nutrient will not be possible in most cases, it is more important to apply the amount of nitrogen required and compromise some for phosphate and potash.

If a fertilizer contains phosphate and/or potash, it can be mixed in the spring or fall into the top 4-6 inches of topsoil. If a fertilizer containing only nitrogen is used, it should be applied in the spring, tilling or raking it into the surface. Nitrogen is easily leached through soil.

For sweetcorn, tomatoes, cabbage, and vine crops such as squash and cucumbers, an additional application of 1/6 lb. nitrogen per 100 sq. ft. may be desirable at midseason. This can be accomplished by applying 1/2 lb. (about one cup) of 34-0-0 fertilizer. Thoroughly water fertilizer into the soil.

**County:** HENNEPIN. For additional information, contact the YARD & GARDEN LINE: Phone: 612-624-4771 Website: www.extension.umn.edu/yardandgarden
**SOIL TEST REPORT**

**Lawn and Garden**

**Sample/Field Number:** 1B

**SOIL TEST RESULTS**

<table>
<thead>
<tr>
<th>Estimated Soil Texture</th>
<th>Organic Matter %</th>
<th>Soluble Salts mmoles/cm³</th>
<th>pH</th>
<th>Buffer Index</th>
<th>Nitrates NO₃-N ppm</th>
<th>Olsen Phosphorus ppm P</th>
<th>Bray 1 phosphorus ppm P</th>
<th>Potassium ppm K</th>
<th>Sulfur SO₄-S ppm</th>
<th>Zinc ppm</th>
<th>Iron ppm</th>
<th>Manganese ppm</th>
<th>Copper ppm</th>
<th>Boron ppm</th>
<th>Calcium ppm</th>
<th>Magnesium ppm</th>
<th>Lead ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>3.5</td>
<td>0.5</td>
<td>5.6</td>
<td>6.5</td>
<td>15</td>
<td>89</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**INTERPRETATION OF SOIL TEST RESULTS**

- **Phosphorus (P):** PPPPPP
  - Low: 5
  - Medium: 10
  - High: 15
  - Very High: 20, 25

- **Potassium (K):** KKKKK
  - Low: 25
  - Medium: 75
  - High: 125, 175, 225

- **pH:** 3.0 Acid, 4.0 Optimum, 5.0 Alkaline
- **Soluble Salts:** 0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0

**RECOMMENDATIONS FOR: Vegetable garden**

**LIME RECOMMENDATION:** 20 LBS/100 SQ.FT.

**TOTAL AMOUNT OF EACH NUTRIENT TO APPLY PER YEAR:**
- **Nitrogen:** 0.15 LBS/100 SQ.FT.
- **Phosphate:** 0.2 LBS/100 SQ.FT.
- **Potash:** 0.3 LBS/100 SQ.FT.

**THE APPROXIMATE RATIO OR PROPORTION OF THESE NUTRIENTS IS:** 15-20-30

Use a fertilizer with the percentage of nutrients closest to the above ratio. Apply according to the instructions on the fertilizer bag or container, or determine the amount required from the instructions given on the back side of this report. Since meeting the exact amount required for each nutrient will not be possible in most cases, it is more important to apply the amount of nitrogen required and compromise some for phosphate and potash.

If a fertilizer contains phosphate and/or potash, it can be mixed in the spring or fall into the top 4-6 inches of topsoil. If a fertilizer containing only nitrogen is used, it should be applied in the spring, tilling or raking it into the surface. Nitrogen is easily leached through soil.

For sweetcorn, tomatoes, cabbage, and vine crops such as squash and cucumbers, an additional application of 1/6 lb. nitrogen per 100 sq. ft. may be desirable at midseason. This can be accomplished by applying 1/2 lb. (about one cup) of 34-0-0 fertilizer. Thoroughly water fertilizer into the soil.

**County:** HENNEPIN. For additional information, contact the YARD & GARDEN LINE: Phone: 612-624-4771 Website: www.extension.umn.edu/yardandgarden
Organic and inorganic fertilizers

- **Organic**: carbon-based (derived from plant/animal materials)
  *Examples*: Compost, manure, blood/bone meal

- **Inorganic**: chemical-based
  *Examples*: Rock phosphate, ammonium nitrate, elemental sulfur

- **Synthetic organic**: carbon-based, but derived from inorganic materials
  *Example*: Urea
Organic fertilizers

1) Contain organic matter, likely have micronutrients

2) Have slowly-available nutrients (microbially-mediated release)

3) Tend to have lower guaranteed analysis
   a) Less likely to ‘burn’ plants
   b) Fewer nutrients = more fertilizer ($$$$

4) May or may not be approved for organic production
Inorganic fertilizers (and urea)

1) Do not contain organic matter, chemically-based

2) Plant available = fast release (*unless otherwise specified)

3) Tend to have higher guaranteed analysis
   a) More likely to ‘burn’ plants
   b) More nutrients = less fertilizer ($)

4) May or may not be approved for organic production
But, what to do??
Containers:

- Teaching goals?
- Length of project?
- Type of potting soil?
- Nutrient leaching – need to add fertilizer regularly
- Budget?
- Time?
Garden beds:

• Teaching goals?
• Length of project?
• Type of soil?
• Soil test?
• Management practices?
• Budget?
• Time?
Why choose organic/inorganic fertilizers?

- **Building soil over time?**
  - Yes
    - Organic: Slow release, improve soil health, microorganisms, variety of nutrients
  - No
    - Inorganic: Fast-release, cheap

- Have you done a soil test??
  - Yes
    - Inorganic: Fast-release, cheap, can get only nutrients you need
  - No
    - Inorganic: Fast-release, cheap
Why choose organic/inorganic fertilizers?

Limited budget?

Do you need a soil test??

Yes

Inorganic: Cheap

No

Organic: Soil health, fewer chemicals, etc.
Why choose organic/inorganic fertilizers?

Need nutrients ASAP?

Have you done a soil test??

Inorganic: Quick release, higher guaranteed analysis, can get only what you need

No

Organic: Slow-release, low guaranteed analysis, variety of nutrients
Why choose organic/inorganic fertilizers?

Leaching nutrients (especially nitrogen)?

Yes

Inorganic: Quick release, can add only N

Organic: Slow release, harder to find only N
Why choose organic/inorganic fertilizers?

Are you growing organically?

Have you done a soil test??

Yes
Read the label.

No
Read the label.
Remember:

- Plants will grow – we can help them grow better with **smart** fertilizing

"Photosynthesis" by Ato9kg - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/
THANK YOU!
Additional image credits:
- Grass and soil profile: nrcs.gov
- Leaf litter: https://bioweb.uwlax.edu/bio203/f2013/crain_alex/nutrition.htm
- School garden and peppers in pails: http://design.ncsu.edu/natural-learning/content/growing-edibles-containers
- Tomato in container: http://www.extension.ucr.edu/admin/newsletter/201312/1.html
- Kids with raised bed garden: http://extension.uga.edu/k12/school-gardens/curriculum/index.cfm

The product images used in this presentation do not imply any endorsement whatsoever.