Fertilizer Management for Turf and Ornamentals

January 31, 2017, Assoc. MT Turf, Ornamental & Pest Professionals by Clain Jones, 406 994 6076; clainj@montana.edu

Photo by John Mirro
If you give a moose a clicker...it will:

A. Pay attention  25%
B. Improve its golf score  25%
C. Calculate fertilizer rates  25%
D. Fertilize the turf for you  25%
Today's objectives

• Explain soil properties that influence nutrient availability
• Discuss management to improve soil fertility
• Evaluate nutrient deficiencies/toxicities by visual assessment and soil testing
• Calculate fertilizer rates based on soil tests
• Review fertilizer sources and timing
An Ideal Soil – yes, “soil”, not “dirt” 😊

• 50% Pore Space
  ▪ 25% Air
  ▪ 25% Water

• 50% Solid Material
  ▪ 5% Organic Matter
  ▪ 45% Mineral
45% mineral = sand, silt, and clay

- Clay is hard when dry, sticky when wet, forms ribbon when rolled between fingers – doesn’t drain well
- Silt feels smooth, floury – very fertile
- Sand feels gritty between your fingers when moist – doesn’t hold water or nutrients well
### Texture effects on soil properties

<table>
<thead>
<tr>
<th></th>
<th>Drainage</th>
<th>Water holding capacity</th>
<th>Aeration</th>
<th>CEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>excellent</td>
<td>poor</td>
<td>excellent</td>
<td>low</td>
</tr>
<tr>
<td>Silt</td>
<td>good</td>
<td>good</td>
<td>good</td>
<td>med</td>
</tr>
<tr>
<td>Clay</td>
<td>poor</td>
<td>excellent</td>
<td>poor</td>
<td>high</td>
</tr>
</tbody>
</table>

**Ideal is loam = approx. equal parts of each**
Cation exchange capacity = parking spaces for nutrients on soil

- Indicates ability of soil to hold positively charged nutrients.
- Many essential plant nutrients carry positive charges. Example: Potassium (K⁺)
- A fertile soil has the capacity to attract and hold these nutrients.
- Soils with large surface areas, such as clay and organic matter, have more CEC and surface area and therefore are generally more fertile.
Which nutrients to watch?

33% A. Generally alkaline (pH > 7.0)
33% B. Generally acidic (pH < 7.0)
33% C. “Gumbo” = too hard to sample

pH affects soil nutrient availability
Most Montana soils are:
Why are MT soils high pH?

- Most MT soils are highly calcareous = alkaline
- Even if surface soil isn’t alkaline, the subsoil usually is
- Liming to increase pH doesn’t make sense in our soils

Mollisol – common in Montana and or semi-arid regions
What is the best option to lower pH in highly calcareous soils?

A. Add elemental sulfur (S) 25%
B. Add gypsum (CaSO₄) 25%
C. Add pine needles 25%
D. No reasonable option to lower significantly 25%
Adding elemental sulfur

Soil pH

Sulfur Added (lb/1000 sq. ft.)

- 0
- 23
- 230

April 5 months later

Consequences? Costs?

AgVise Laboratories

10,000 lb/acre
What might happen if you add 230 lbs S/1000 sq. ft.?

A. You spend $366/1000 sq ft
B. Your soil pH will drop by at least 1.5 units
C. Soil S levels will remain well below toxic
D. Soil salt levels will improve

Same study site – added 115 lbs gypsum /1000 sq. ft. with no change in soil pH
Salinity

- High salts (EC > 4.0)
  - reduce water availability
  - plant energy expenditure to exclude salts and take up water
- Sources
  - excess fertilizer
  - road salt
  - shale
Salinity

Management:
- check irrigation water for salts
- water to flush salt below root zone – 8-12” to leach salts from top foot of soil, but will also leach nutrients
- fertilize plants only when necessary
- limit fertilization when moisture stressed (e.g., summer)
- plant salt tolerant species by roadway and protect foliage from road spray with burlap shield in winter
Questions?

*On to nutrient deficiencies*
14 mineral nutrients have been found essential for growth of most plants:

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

The macronutrients are simply needed in larger amounts by the plant than the micronutrients.

Nutrient deficiencies of the **bolded** nutrients have been observed in Montana.
Nutrient cycling and major losses from system

Available nutrient pool in soil

Organic material

“Harvest” removal from site (all)

Plant Uptake

Conventional fertilizer e.g. urea

Runoff/erosion (N, P, K, S)

Leaching (N, S)

Mineralization

Immobilization
How to evaluate soil nutrient status

• Visual assessment of tissue: may identify what has been lacking to this point
Visual tissue assessment

MOBILE NUTRIENTS lower leaves first

Older/lower leaves affected

Effects mostly generalized; plants dark or light green

Effects mostly localized; chlorosis with or w/out spotting

Plants dark green, often becoming purple or red

Interveinal chlorosis; leaves sometimes red or with dead spots

PHOSPHORUS (P)

Plants light green with leaves light green or yellow; no necrotic spotting

No interveinal chlorosis; chlorotic areas with a burning or spotting along leaf margins

NITROGEN (N)

Plants light green; necrotic spotting on leaves; pale leaves sometimes scorched, cupped or rolled

No interveinal chlorosis; distinct chlorotic and necrotic lesions (spotting) with abrupt boundary between dead and alive tissue

MOLYBDENUM (Mo)

CHLORIDE (Cl)

MAGNESIUM(Mg)

In Nutrient Management Module 9
http://landresources.montana.edu/nm
IMMOBILE NUTRIENTS

Newer or younger leaves

Growing point (terminal bud) dies

Growing point typically stays alive

Leaves of terminal bud become light green at bases; leaves become twisted and brittle and die back at growing point; chlorosis of young leaves

Chlorosis w/out interveinal chlorosis

Leaves light green; typically no chlorotic spotting or striping

Leaves light green; tips appear withered and will eventually die

Young leaves of terminal bud hooked at first, finally turning brown and dying

Chlorosis of young leaves; tips appear withered and will eventually die

Dark green zone next to blunted necrotic leaf tip, thickened curling leaves

Chlorosis of young leaves; tips appear withered and will eventually die

Middle leaves with interveinal chlorosis; stunted growth

(Initially in middle leaves, young and/or old leaves become chlorotic in later stages of deficiency)

U of Arizona
What is/was deficient here?

33%   A. Ability to spell
33%   B. Time to read the bag label
33%   C. Shouldn’t have handed the moose the spreader

ID of ‘problem’ is not always clear cut
Questions?

On to soil tests
Advantages of soil testing

- ID current nutrient deficiency
- Help calculate fertilizer rates
- Save on fertilizer cost
- Decrease environmental risks
Soil testing

- Remove grass/mulch mat from top, sample 6 inches deep
- Combine 10 subsamples per 1000 sq. ft. or per acre turf
- Separate samples for, e.g., gardens, turf, shrub areas
- Use probe, auger or tulip bulb planter
- Best done in early spring, but not when soil is wet, therefore in our climate perhaps best done in late fall
Example soil test

### Analytical Laboratory Findings

<table>
<thead>
<tr>
<th>Sample Identification Laboratory Number</th>
<th>Linda 26716192</th>
</tr>
</thead>
</table>

#### Analyte

<table>
<thead>
<tr>
<th>Nitrogen (N)</th>
<th>Organic Matter</th>
<th>Phosphate (P₂O₅)</th>
<th>Potassium (K₂O)</th>
<th>Magnesium (Mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Units</strong></td>
<td>% ppm</td>
<td>ppm</td>
<td>ppm</td>
<td>ppm</td>
</tr>
<tr>
<td><strong>Results</strong></td>
<td>4.6</td>
<td>4</td>
<td>54</td>
<td>186</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>1</td>
<td>1</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td><strong>Medium</strong></td>
<td>1.5</td>
<td>2</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td><strong>Optimum</strong></td>
<td>2.5</td>
<td>3</td>
<td>45</td>
<td>60</td>
</tr>
<tr>
<td><strong>Very High</strong></td>
<td>3.5</td>
<td>4</td>
<td>55</td>
<td>70</td>
</tr>
</tbody>
</table>

#### Micro-Nutrients

<table>
<thead>
<tr>
<th>Sulfur (S)</th>
<th>Zinc (Zn)</th>
<th>Manganese (Mn)</th>
<th>Iron (Fe)</th>
<th>Copper (Cu)</th>
<th>Boron (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ppm</td>
<td>ppm</td>
<td>ppm</td>
<td>ppm</td>
<td>ppm</td>
<td>ppm</td>
</tr>
</tbody>
</table>

#### Calcium (Ca), Sodium (Na), Soluble Salts

<table>
<thead>
<tr>
<th>Calcium (Ca)</th>
<th>Sodium (Na)</th>
<th>Soluble Salts</th>
</tr>
</thead>
<tbody>
<tr>
<td>ppm</td>
<td>ppm</td>
<td>ppm/molar</td>
</tr>
<tr>
<td>2607</td>
<td>88</td>
<td>0.3</td>
</tr>
</tbody>
</table>

#### Excess Lime Rate, pH, Buffer Index, C.E.C.

<table>
<thead>
<tr>
<th>Excess Lime Rate</th>
<th>pH</th>
<th>Buffer Index</th>
<th>C.E.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ppm</td>
<td></td>
<td>mg/100g</td>
<td></td>
</tr>
<tr>
<td>88</td>
<td>8.1</td>
<td>18.6</td>
<td></td>
</tr>
</tbody>
</table>

### Midwest Suggestions for Garden

<table>
<thead>
<tr>
<th>Pounds Per</th>
<th>100 sq. ft.</th>
<th>1000 sq. ft.</th>
<th>Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (N)</td>
<td>0.29</td>
<td>2.87</td>
<td>125</td>
</tr>
<tr>
<td>Phosphate (P₂O₅)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Potash (K₂O)</td>
<td>0.11</td>
<td>1.15</td>
<td>50</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

### Suggested Amendment Guidelines

<table>
<thead>
<tr>
<th>Lime</th>
<th>Elemental Sulfur</th>
<th>Gypsum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What if lab doesn’t provide a recommendation (or is from another state)? Use Table 3 from MontGuide (MT200705AG) for N

<table>
<thead>
<tr>
<th>Soil Test</th>
<th>Location</th>
<th>Organic Matter (%)</th>
<th>lbs/1000 sq.ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrate - N</td>
<td>Location</td>
<td>&lt; 1.5</td>
<td>1.5 – 3.0</td>
</tr>
<tr>
<td>lbs /acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td>Lawn</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Tree/shrub</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Garden</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>20-40</td>
<td>Lawn</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Tree/shrub</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Garden</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>40-80</td>
<td>Lawn</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Tree/shrub</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Garden</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>&gt;80</td>
<td>All</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Use Tables 4 & 5 from MontGuide (MT200705AG)

<table>
<thead>
<tr>
<th>Olsen P (ppm)</th>
<th>Garden</th>
<th>Lawn</th>
<th>Trees/shrubs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lb $P_2O_5$/1000 sq.ft.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 4</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4 - 8</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>8 - 12</td>
<td>3</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>12 - 16</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>&gt; 16</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>K (ppm)</th>
<th>lb $K_2O$/1000 sq. ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 75</td>
<td>3</td>
</tr>
<tr>
<td>75 – 150</td>
<td>2</td>
</tr>
<tr>
<td>150 – 250</td>
<td>1</td>
</tr>
<tr>
<td>&gt; 250</td>
<td>0</td>
</tr>
</tbody>
</table>
Lawns vs. trees/shrubs

- Lawns and golf courses
  - higher N = lush green grass
  - Don’t ‘bloom’ = less P & K
  - 70% sand, 15% silt, 15% clay = less compaction
  - Organic matter 33% by volume (2” in top 6”) incorporated

- Trees & shrubs
  - avoid high N, lush growth is not winter hardy
  - P & K good for blossoms
  - Aim for loam = equal parts sand:silt:clay
Sample calculation

N required for lawn with 3.4% organic matter and 12 lb N/acre (< 20 lb N/acre):  4 lb N/1000 sq ft (Table 3)

APPLICATION RATE:
• Using a 20-6-12 fertilizer, 20% N (0.20 lb N/lb fertilizer), 6% P$_2$O$_5$ and 12% K$_2$O

• To calculate the amount of 20-6-12 fertilizer to apply:
  (Required Amount of N) ÷ (Amount N/lb Fertilizer) = Amount of Fertilizer to Apply /1000 sq ft
  (4 lb N/1000 sq ft) ÷ (0.20 lb N/lb fertilizer) = 20 lb of 20-6-12 /1000 sq ft
Using this data from a soil report and Table 3 from Montguide, how much N required for a lawn?

\[ N \text{ ppm} \times 2 = \text{N lb/acre} \]

Options:
- A. 3 lb/1000 sq. ft. 33%
- B. 4 lb/1000 sq. ft. 33%
- C. 5 lb/1000 sq. ft. 33%
How much 20-6-12 fertilizer is needed?

(Required lb N = 3) ÷ (lb N/lb Fertilizer) = Amount of Fertilizer to Apply /1000 sq ft

25% A. 30
25% B. 15
25% C. 5
25% D. Mental math before lunch?!

Hint: 20-6-12 means 0.20 lb N/lb fertilizer

(3 lb N/1000 sq ft) ÷ (0.20 lb N/lb fertilizer) = 15 lb of 20-6-12/1000 sq ft
Phosphorus (P) and potassium (K)

<table>
<thead>
<tr>
<th>OM %</th>
<th>Nitrate –N ppm</th>
<th>P ppm</th>
<th>K ppm</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test</td>
<td>1.8</td>
<td>18</td>
<td>14</td>
<td>300</td>
</tr>
</tbody>
</table>

15 lb of 20-6-12/1000 sq ft

How much P does this apply?
15 lb of 20-6-12/1000 sq ft x 0.06 =  < 1 lb P₂O₅/1000 sq ft

Appropriate? See Table 4  
Suggests 0 lb P₂O₅

How much K does this apply?
15 lb of 20-6-12/1000 sq ft x 0.12 = 1.8 lb K₂O/1000 sq ft

Appropriate? See Table 5  
Suggests 1 lb K₂O
Selecting fertilizer grade

15 lb of 20-6-12/1000 sq ft

= < 1 lb P₂O₅/1000 sq ft vs. suggested 0 lb P₂O₅ = a little too much P

= 1.8 lb K₂O/1000 sq ft vs. suggested 1 lb K₂O = a little too much K

What can you do? Will this fertilizer work for shrubs?

Based on Tables 3, 4, and 5

<table>
<thead>
<tr>
<th></th>
<th>OM %</th>
<th>Nitrate –N ppm</th>
<th>P ppm</th>
<th>K ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test</td>
<td>1.8</td>
<td>18</td>
<td>14</td>
<td>300</td>
</tr>
<tr>
<td>Tree/shrub need</td>
<td>1 lb N</td>
<td>1.5 lb P₂O₅</td>
<td>0 lb K₂O</td>
<td></td>
</tr>
</tbody>
</table>

Chances are one grade will not fit needs of both lawns and shrubs
Questions?

On to fertilizer sources and timing
Conventional/chemical fertilizers

• No carbon
• Easy to store
• Higher nutrient concentration
• Custom formulated
• Easy to use – but calibrate your equipment
• Liquid and solid
• Coated specialty products reduce leaching, volatilization, runoff losses.
Organic Fertilizers

- Bulkier
- Nutrient content low
- Nutrient content difficult to quantify
- Supply organic matter and other soil quality benefits

<table>
<thead>
<tr>
<th>Type</th>
<th>General % of dry weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Manure compost</td>
<td>0.3 - 0.5</td>
</tr>
<tr>
<td>Garden waste</td>
<td>1 – 1.5</td>
</tr>
</tbody>
</table>
Slow Release Fertilizers

- Release quickest in warm moist environments.
- Incorporate and apply early in growing season or use blend of quickly available source and slow release.
Application considerations

Conventional

- Water soluble sources can be lost to leaching or runoff, do not apply on snow, before heavy rains or snowmelt
- In active healthy soil (e.g. not frozen) can be taken up within a few days

Organic material

- Takes time to decompose and become available
- N may be tied up in the short term
- Manure creates rapid build up of P and K if fertilizing to meet N needs, can burn with salts, may contain residual herbicides
Timing

Shrubs/trees

- Newly planted: best to provide fertile soil than fertilizer first 1-2 years to minimize damage to roots and excessive vegetative growth
- Established: early spring

Lawn

- New: early spring or prior to spring seeding
- Established:
  - split total into monthly applications each max 0.5 lb/1000 sq. ft
  - home lawns, 3 times, about Memorial day, Labor day, and after last mowing but 4 weeks before soil freezes
  - If skip one, then skip the first. Last is most critical for the following year green-up.
- Too much in fall encourages gray snow mold
Summary

• Understanding soil properties guides proper fertilization

• Soil testing is an important tool to calculate fertilizer rates, maximize plant health, protect environment

• The right source, rate and timing leads to optimal fertilizer use and plant health.

• The foundation of healthy plants is healthy soils
For additional information on nutrient cycling and fertilization

http://landresources.montana.edu/soilfertility

Click on “Home Gardening” for Montguide pdf

Upcoming KSU webinar: “Solving Turf puzzles”, March 8, 9 am. To join go to: http://msuextensionconnect.org/gpdn2/
Questions?