Trends in Turf Nutrition:  
*Balancing Environmental Protection and Turf Performance*

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**Florida’s Water Situation**

*Water Resource Caution Areas: places where water is either scarce or contaminated as defined by Florida’s Water Management Districts*

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**Increased Scrutiny**

- Environmental activist groups have momentum.
  - General public poorly understands the issues.
- Increasing level of scrutiny over what you do – even from those whom you consider allies (i.e., your members).
  - Some, knowingly and unknowingly, are working against the efforts of the green industry.
  - Work to educate your members about the importance of plant nutrition.

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**“Do not fertilize when rain is imminent.”**

*This statement has led to numerous fertilizer “black out” ordinances – typically May through October.*
Increased Scrutiny
City of Rockledge Florida

Martis Jacobs of Live Oak Agri said: “We need to stop painting the lagoon with lawn fertilizers. It is more important to have a healthy lagoon than to have unnaturally green turf grass. Many people I know have healthy turf grass and use no fertilizers; painting the lagoon with lawn fertilizers is a completely unnecessary and unnecessary waste.”

BMPs are a Starting Point

The goal of fertilizer BMPs is to match nutrient supply with turf requirements and to minimize nutrient losses.

- Selection of BMPs varies by location, and those chosen for a given golf course are dependent on local soil and climatic conditions, crop, management conditions, and other site specific factors.

Nutrient Use in Florida

Florida Department of Agriculture and Consumer Services
Nutrient Use in Florida

- Source data is for golf AND athletic turf.
  - No way of estimating how much was applied to athletic fields.

Nutrient Use in Florida

- Landscape industry reduced N use by 36% and P use by 29% since 2008.
- Golf industry has increased N use by 45% and P use by 69% since 2008.
  - Likely attributed to bringing the golf course back up to par following the economic downturn.

**Bottom line – these numbers are favorable for the golf industry, but . . . increased scrutiny will continue!**

Nutrient Use Efficiency

- Generally defined as yield per unit input of fertilizer.
  - In turf, we don’t measure “yield” directly.

4R Nutrient Stewardship

- **Right Source** – Matches fertilizer type to plant needs.
- **Right Rate** – Matches amount of fertilizer to plant needs.
- **Right Time** – Makes nutrients available when plants need them.
- **Right Place** – Keeps nutrients where plants can use them.

4R Nutrient Stewardship

- **Right Source**
- **Right Rate**
- **Right Time**
- **Right Place**
  - Source, time, and place are more frequently overlooked and may hold more opportunity for improving performance.
SLAN / BSCR / MLSN

• SLAN = Sufficiency Levels of Available Nutrients
• BSCR = Base Saturation Cation Ratio
• MLSN = Minimum Level for Sustainable Nutrition

What is MLSN?

• Minimum Level for Sustainable Nutrition (MLSN) is a new, more sustainable approach to managing soil nutrient levels.
  – Decreases fertilizer inputs and costs
  – Maintain quality and playability levels
• Developed by PACE Turf (Dr. Larry Stowell and Dr. Wendy Gelernter) and the Asian Turfgrass Center (Dr. Micah Woods).
  – All soil analyses were conducted at Brookside Laboratories.
The Goal of MLSN?

- “To provide a scientific and data-based approach to interpreting soil tests for turfgrass sites, making sure that there is a high probability of good turfgrass performance, while minimizing unnecessary application of fertilizer.”

What is MLSN?

- From a database of >17,000 soil samples, 1,500 were selected that were classified as having:
  - Not poor performing turfgrass
    - **LOGIC:** If turf is good – nutrients likely aren’t a limiting factor.
  - pH of 5.5 – 7.5
    - **LOGIC:** Accurate for a range of elements using the Mehlich 3 soil test extractant.
  - Cation Exchange Capacity < 6 cmol/kg
    - **LOGIC:** If there is enough of an element to produce good turfgrass in a low CEC soil, then the same amount will be sufficient in a nutrient-rich soil that has a higher CEC.

- Because all of these soils were producing good turf, one could conclude that all the soils had sufficient nutrients, so anything at or above those nutrient levels would be fine.

- Log-logistic model used to identify the concentration (in ppm) of each nutrient that 10% of the soil samples fell below – but were still performing well.
  - The 10th percentile value is the MLSN soil guideline.

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**MLSN potassium data**

**MLSN phosphorus data**
Minimum Levels for Sustainable Nutrition Guidelines

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Analytical Test</th>
<th>Conventional Guideline - SLAN (ppm)</th>
<th>MLSN (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium</td>
<td>Mehlich 3</td>
<td>&gt;110</td>
<td>35</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Mehlich 3</td>
<td>&gt;50</td>
<td>18</td>
</tr>
<tr>
<td>Calcium</td>
<td>Mehlich 3</td>
<td>&gt;750</td>
<td>360</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Mehlich 3</td>
<td>&gt;140</td>
<td>54</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Mehlich 3</td>
<td>15 – 40</td>
<td>13</td>
</tr>
</tbody>
</table>

Before we give her a whirl...

- We apply fertilizer to a two-dimensional soil surface (length X width = area).

Problem 2.1

Using the geometric method of determining area, determine the area of the green (A), fairway (B + C + D) and the tee (E) for the 435-yard par-4 hole. All dimensions are noted in the figure below.

It’s early – but let’s do some math!

- Acre Farrow Slice (6" depth over an acre) has 21,780 ft³ of soil (43,560 ft² X 0.5 ft).
  - AFS of soil weighs ~ 2,000,000 lbs.
  - Each cubic foot of soil weights ~ 92 lbs.
- TEE: 1,000 ft² X 0.5 ft (6") = 500 ft³ soil
  - 500 ft³ soil X 92 lbs ft³ = 46,000 lbs soil
  - 1 lb nutrient X 46,000 lbs soil = 46,000 X lbs soil
  - 1,000,000 lbs soil
  - X = ~ 22 ppm

Let’s give her a whirl...

- Assumptions:
  - The grass cannot use more of an element than it harvests.
  - The growth and nutrient uptake are driven by the amount of nitrogen applied.
  - The concentration of macronutrient and secondary nutrients in the leaves are estimated to be proportional to the applied nitrogen.

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“Nutrient utilization by turfgrass has the characteristics of ‘demand driven uptake’

- Paired soil and clipping samples from 419 putting greens located throughout Wisconsin.

Nutrient uptake is strongly dependent on growth rate.
- As grass growth increases, nutrient uptake increases.
- Typically accounts for > 90% of the variation in nutrient uptake.

Three rates of late season N applied to bermudagrass linearly increased clipping production and leaf N, P, and K content.

Once the external nutrient supply attains the level where demand is satisfied, tissue nutrient concentrations plateau – little or no change with further increases in nutrient supply.
- Application of additional P and K did not alter clipping P and K content.

Applied four rates of N with and without Primo to a bermudagrass putting green.
- Primo reduced clippings by 67% over the 4 N rates.
  - Did not alter the N required to maintain acceptable turf.
- Nutrient removal by the clippings when Primo was applied was decreased by 70%.
  - Clipping production accounted for 83 – 99% of the variation in clipping removals of N, P, K, Ca, Mg, S, Cu, Fe, Mn, and Zn.

Pretty convincing evidence that N supply is a primary factor governing turfgrass nutrient demand.
- The application of a PGR changes demand in accord with the degree of suppression of turfgrass growth at any given level of N application.
Let’s give her a whirl...  

- Assumptions:  
  - The grass cannot use more of an element than it harvests.  
  - The growth and nutrient uptake are driven by the amount of nitrogen applied.  
  - The concentration of macronutrient and secondary nutrients in the leaves are estimated to be proportional to the applied nitrogen.
Expected Leaf Nutrient Content

- In the dry matter of turfgrass leaves, after the leaf water has evaporated, we can expect these approximate concentrations:

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Expected % in leaf dry matter</th>
<th>Amount in proportion to nitrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Potassium</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.5</td>
<td>0.125</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.5</td>
<td>0.125</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.2</td>
<td>0.05</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.2</td>
<td>0.05</td>
</tr>
</tbody>
</table>

*These values are a good starting point for most turfgrass species. If site specific data are available, these values can be substituted to better site specific management.

Growth Potential Model

Expected nutrient removal when applying 5.01 lbs N / 1,000 ft² / year

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Amount Removed</th>
<th>lb / 1,000 ft²</th>
<th>Soil Test ppm in top 4”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>1</td>
<td>5.01</td>
<td>83</td>
</tr>
<tr>
<td>Potassium</td>
<td>0.5</td>
<td>2.51</td>
<td>83</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.125</td>
<td>0.63</td>
<td>21</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.125</td>
<td>0.63</td>
<td>21</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.05</td>
<td>0.25</td>
<td>8</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.05</td>
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</tr>
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- Remember: One pound of an element (N, P, K, etc.) spread over 1,000 ft² on the surface (two dimensional) is equivalent to 33 ppm in the root zone.
- Potassium = 2.51 lb X 33 ppm = 83 ppm

MLSN Example

- We know that at the MLSN level, there is enough of that element in the soil to produce good turf – so we want to stay at or above the MLSN level.
  - We can estimate the amount harvested from the soil each year.
  - The amount “A” gives us the total amount of an element in the soil.

\[ A = MLSN + \text{Harvest} \]
Nutrient | Amount in proportion to nitrogen | Removed | MLSN
---|---|---|---
Potassium | 0.5 | 2.51 | 83 | 1.06 | 35

The amount “A” gives us the total amount of an element needed in the soil to keep the soil above the MLSN guideline.

\[ A = MLSN + Harvest \]

\[ A = 1.06 + 2.51 = 3.57 \text{ lbs / 1,000 ft}^2 \]

### MLSN Example

To find how much of an element needs to be added as fertilizer (F), subtract the actual amount on a soil test.

\[ F = A - \text{Soil}_{test} \]

– We have tested a putting green and found it to contain 55 ppm (1.67 lbs / 1,000 ft²) potassium.

\[ F = 3.57 - 1.67 = 1.9 \text{ lbs / 1,000 ft}^2 \]

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Potassium | 0.5 | 2.51 | 83 | 3.33 | > 110

The amount “A” gives us the total amount of an element needed in the soil to keep the soil above the SLAN guideline.

\[ A = SLAN + Harvest \]

\[ A = 3.33 + 2.51 = 5.84 \text{ lbs / 1,000 ft}^2 \]

### SLAN Example

To find how much of an element needs to be added as fertilizer (F), subtract the actual amount on a soil test.

\[ F = A - \text{Soil}_{test} \]

– We have tested a putting green and found it to contain 55 ppm (1.67 lbs / 1,000 ft²) potassium.

\[ F = 5.84 - 1.67 = 4.17 \text{ lbs / 1,000 ft}^2 \]