Advances in Turf Nutrition: *Moving Beyond the Norm*

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BMPs are a Starting Point

- The goal of fertilizer Best Management Practices (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 site are dependent on local soil and climatic conditions, turf variety, management conditions, and other site specific factors.

SLAN / BSCR / MLSN

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


RESEARCH
Clarifying soil testing:
III. SLAN sufficiency ranges and recommendations


Basic Cation Ratios for Sand-based Greens


Just what the grass requires:
Using minimum levels for sustainable nutrition
Good turf performance can be achieved at lower nutrient levels.

Minimum Levels for Sustainable Nutrition guidelines

GCM – Jan. 2014

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.

What is MLSN?

- 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.

MLSN potassium data

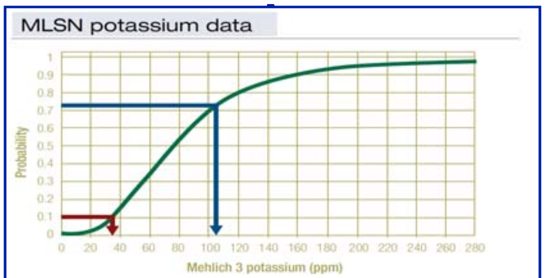


Figure 1. The cumulative distribution function for the potassium data was used to identify the MLSN guideline. At the 0.1 probability level, 10% of the samples report potassium values lower than 35 ppm (red line). This is the potassium MLSN guideline. The blue line indicates the conventional guideline of 110 ppm for potassium. Seventy-two percent (probability = 0.72 = sustainability index) of the samples report values lower than the conventional potassium guideline.

Minimum Levels for Sustainable Nutrition Guidelines

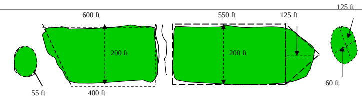
Nutrient	Analytical Test	Conventional Guideline - SLAN (ppm)	MLSN (ppm)
Potassium	Mehlich 3	>110	35
Phosphorus	Mehlich 3	>50	18
Calcium	Mehlich 3	>750	360
Magnesium	Mehlich 3	>140	54
Sulfur	Mehlich 3	15 – 40	13

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.



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Before we give her a whirl. . .

- But soil tests are three dimensional (length X width X depth).
  - One pound of an element (N, P, K, etc.) spread over 1,000 ft^2 on the surface (two dimensional) is equivalent to:
    - 22 ppm in the root zone (three dimensional) measuring 1,000 ft^2 to a 6” depth.
    - 33 ppm in the root zone (three dimensional) measuring 1,000 ft^2 to a 4” depth.

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It’s after lunch – but let’s do some math!

- Acre Furrow Slice (6” depth over an acre) has 21,780 ft^3 of soil (43,560 ft^2 X 0.5 ft).
  - AFS of soil weighs ~ 2,000,000 lbs.
    - Each cubic foot of soil weighs ~ 92 lbs.
- TEE: 1,000 ft^2 X 0.5 ft (6”) = 500 ft^3 soil
  - $500\ ft^3\ soil \times \frac{92\ lbs}{ft^3} = 46{,}000\ lbs\ soil$
  - $\frac{1\ lb\ nutrient}{46{,}000\ lbs\ soil} = \frac{x\ lbs\ nutrient}{1{,}000{,}000\ lbs\ soil}$; X = ~ 22 ppm

15

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 macronutrients and secondary nutrients in the leaves are estimated to be proportional to the applied nitrogen.

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Research Article

Evidence, Regulation, and Consequences of Nitrogen-Driven Nutrient Demand by Turfgrass

- “Nutrient utilization by turfgrass has the characteristics of ‘demand driven uptake’
- Paired soil and clipping samples from 419 putting greens located throughout Wisconsin.

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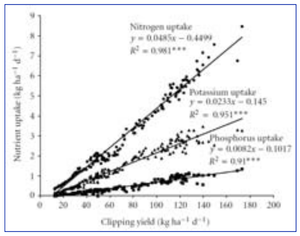
Evidence, Regulation, and Consequences of Nitrogen-Driven Nutrient Demand by Turfgrass

Wayne R. Kussow, Douglas J. Soldat, William C. Kreuser, and Steven M. Houlihan

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



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Evidence, Regulation, and Consequences of Nitrogen-Driven Nutrient Demand by Turfgrass

Wayne R. Kussow, Douglas J. Soldat, William C. Kreuser, and Steven M. Houlihan

- 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 P and K did not alter clipping P and K content.

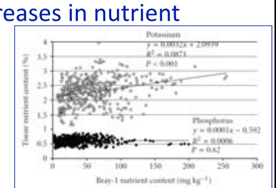

Figure 3: Relationship between Bray1-extractable soil P or K levels and tissue P or K content of cool season turfgrass species collected from 419 golf greens in Wisconsin (Experiment 1).

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Bottom line

- Pretty convincing evidence that N supply is a primary factor governing turfgrass nutrient demand.

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  - The growth and nutrient uptake are driven by the amount of nitrogen applied.
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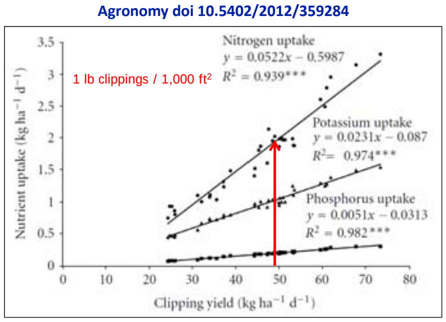
Kussow, Soldat, Kreuser, and Houlihan

Agronomy doi 10.5402/2012/359284



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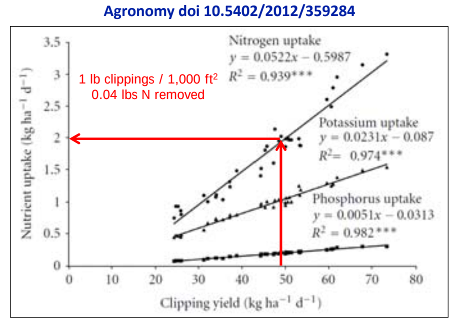

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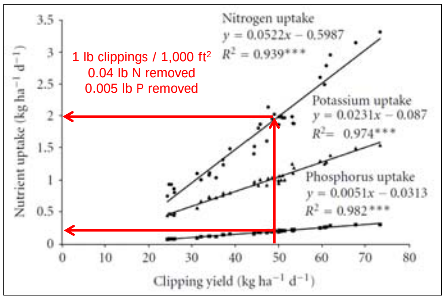

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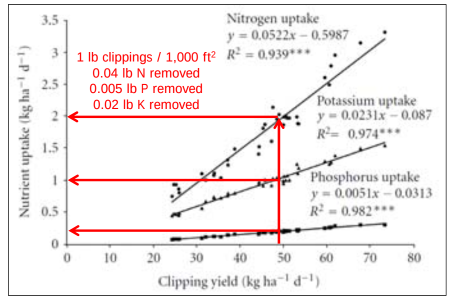

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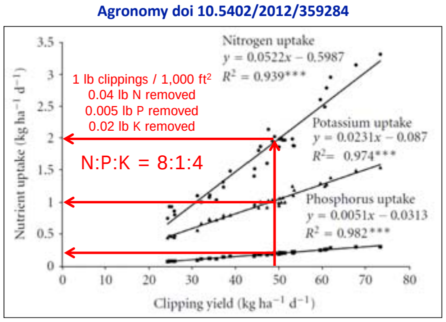

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Expected Leaf Nutrient Content

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

Nutrient	Expected % in leaf dry matter*	Amount in proportion to nitrogen
Nitrogen	4	1
Potassium	2	0.5
Phosphorus	0.5	0.125
Calcium	0.5	0.125
Magnesium	0.2	0.05
Sulfur	0.2	0.05

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

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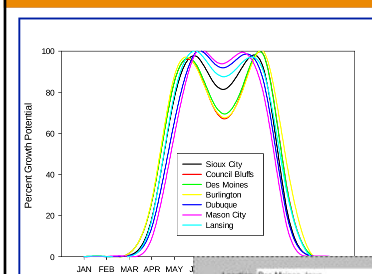

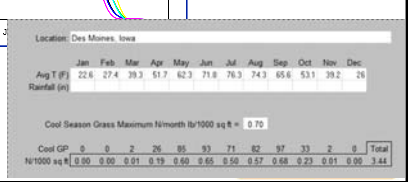

Growth Potential Model

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Expected nutrient removal when applying 3.44 lbs N / 1,000 ft² / year

Nutrient	Amount in proportion to nitrogen	lb / 1,000 ft²	Soil Test ppm in top 4"
Nitrogen	1	3.44	
Potassium	0.5	1.72	57
Phosphorus	0.125	0.43	14
Calcium	0.125	0.43	14
Magnesium	0.05	0.17	6
Sulfur	0.05	0.17	6

- 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 = 1.72 lbs X 33 ppm = 56.76 ppm

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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.

$$A = MLSN + Harvest$$

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Expected nutrient removal when applying 3.44 lbs N / 1,000 ft^2 / year

Nutrient	Amount in proportion to nitrogen	Removed (Harvest)		MLSN	
		lb / 1,000 ft^2	PPM in top 4"	lb / 1,000 ft^2	PPM in top 4"
Nitrogen	1	3.44			
Potassium	0.5	1.72	57	1.06	35
Phosphorus	0.125	0.43	14	0.55	18
Calcium	0.125	0.43	14	10.9	360
Magnesium	0.05	0.17	6	1.6	54
Sulfur	0.05	0.17	6	0.39	13

- Remember: One pound of an element (N, P, K, etc.) spread over 1,000 ft^2 on the surface (two dimensional) is equivalent to 33 ppm in the root zone.
- Potassium = 35 ppm / 33 ppm = 1.06 lb / 1,000 ft^2

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Nutrient	Amount in proportion to nitrogen	Removed (Harvest)		MLSN	
		lb / 1,000 ft^2	PPM in top 4"	lb / 1,000 ft^2	PPM in top 4"
Potassium	0.5	1.72	57	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.

$$A = MLSN + Harvest$$

$$A = 1.06 + 1.72 = 2.78 \text{ lbs / 1,000 ft}^2$$

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MLSN Example

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

$$F = A - Soil_{test}$$

  - We have tested a sports field and found it to contain 55 ppm (1.67 lbs / 1,000 ft^2) potassium.

$$F = 2.78 - 1.67 = 1.11 \text{ lbs / 1,000 ft}^2$$

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MLSN Example Summary

- Annual nitrogen rate: 3.44 lbs / 1,000 ft^2
- Annual potassium removal (harvested): 1.72 lbs / 1,000 ft^2
- Minimum level needed in the soil: 1.06 lbs / 1,000 ft^2
- Total K Needed: 2.78 lbs / 1,000 ft^2

- Soil Test Report – K: 1.67 lbs / 1,000 ft^2
- K Fertilizer Needed: 1.11 lbs / 1,000 ft^2

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SLAN Example

Nutrient	Amount in proportion to nitrogen	Removed (Harvest)		SLAN	
		lb / 1,000 ft^2	PPM in top 4"	lb / 1,000 ft^2	PPM in top 4"
Potassium	0.5	1.72	57	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.

$$A = SLAN + Harvest$$

$$A = 3.33 + 1.72 = 5.05 \text{ lbs / 1,000 ft}^2$$

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SLAN Example

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

$$F = A - Soil_{test}$$

  - We have tested a sports field and found it to contain 55 ppm (1.67 lbs / 1,000 ft^2) potassium.

$$F = 5.05 - 1.67 = 3.38 \text{ lbs} / 1{,}000 \text{ ft}^2$$

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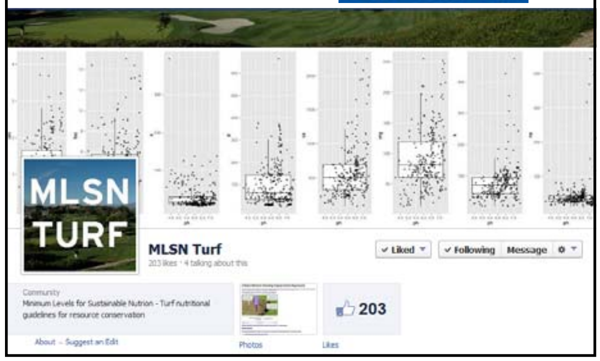

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