How I make nutrient recommendations for turfgrass

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General concepts

1. Keep nutrients from getting too low. They *can* get too low.
2. Grass grows well in a lot of soils.
3. Growth rate is important.
4. Think of it as ensuring nutrient supply matches the growth rate.

How I do it

One can express the quantity of an element required as fertilizer as Q.

$$a + b - c = Q$$

where,

a is the quantity of the element used by the grass
b is the quantity of the element kept in the soil
c is the quantity of the element present in the soil
Q is the quantity of the element required as fertilizer

Reference

September, 2014

Minimum Levels for Sustainable Nutrition Soil Guidelines

The Minimum Level for Sustainable Nutrition (MLSN) Guideline is a new, more sustainable approach to managing soil nutrient levels that can help you to decrease fertilizer inputs and costs, while still maintaining desired turf quality and playability levels. The MLSN guidelines were developed in a joint project between PACE Turf and the Asian Turfgrass Center. All soil analyses were conducted at Brookside Laboratories, New Bremen, OH.

	MLSN Soil Guideline
pH	>5.5
Potassium (K ppm)	37
Phosphorus (P ppm)	21
Calcium (Ca ppm)	331
Magnesium (Mg ppm)	47
Sulfur as sulfate (S ppm)	7

Nitrogen requirements are best determined based on **turf growth potential**, which incorporates site-specific weather and turf type to calculate nitrogen demand (Gelernter and Stowell, 2005. Golf Course Management, p. 108-113, March, 2005).

How the guidelines were developed

From a database of over 17,000 soil samples, we selected 3,721 that were classified as having:

- not poor performing turfgrass
- pH 5.5 - 8.5: to avoid aluminum toxicity at pH less than 5.5, and to avoid alkalinity hazard at pH greater than 8.5
- total exchange capacity <6 cmol/kg

A log-logistic model provided a significant fit of the data, and was used to identify the concentration (in ppm) of each nutrient that 10% of the soil samples fell below, but were still performing well. This 10th percentile value is the MLSN soil guideline shown above.

For more information, see the Facebook MLSN page at: www.facebook.com/mlsnturf

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MLSN Cheat Sheet

Definition

MLSN is an industry standard for minimum levels for sustainable nutrition. This is a method for soil test interpretation and fertilizer recommendations.

MLSN really quick start

If you have Mehlich 3 soil test data, you can directly compare your test results (in ppm) to the MLSN guideline levels. If your soil is above the guideline, then you don't need to add that element today. You can be confident that high quality turfgrass can be produced in soils with that quantity of the element. If your soil is below the guideline, you can have high quality turfgrass too. But you should be aware that there are few soils producing high quality turfgrass with nutrient levels that low. You'll probably want to add enough of the element to raise it above the MLSN guideline.

That's only the situation for today. Is your grass alive? We hope so! If it is, then it is using nutrients. The nutrient content in the soil is going to be lower tomorrow than it was today – unless your grass is dead or dormant – because the grass uses nutrients. To really use the MLSN guidelines, you need to look not at today, but into the future. This cheat sheet is meant to provide all the explanations and calculations you'll require.

MLSN quick start

These are the steps to use to get started using MLSN – in the standard way – immediately. If you don't know how to get these quantities, don't worry. The other sections of this cheat sheet show how to find these quantities, and how to make more modifications to fit your site.

1. **Soil test** Take soil samples to a depth of 10 cm. Then use the Mehlich 3 extractant to find the soil test K, P, Ca, Mg, and S. Look at the results in parts per million (ppm). Express the results as mass per area. Call this quantity **a**.
2. **Estimate grass use** Find grass use of these elements over a time duration (Δ). Express those use estimates as mass per area. Call this quantity **u**.
3. **Check the MLSN guideline** Express the value for each element as mass per area. Call this quantity **b**. The MLSN minimum levels for each element are given in the table.

Element	ppm

Estimating grass use

The value **u** is the expected grass use for time Δ. Here are three ways to get that value.

Estimate from growth One can collect the clippings, express them as a mass, and calculate the quantity of nutrients in that mass of clippings. Clipping volume is a rapid way to estimate the mass. For nearly 11 oz clippings/m², expect a dry mass of 60 g. Then, calculate nutrient content by considering the elements in healthy turf. Typical use these numbers.

Element	% in dry leaves			
	Agrostis & Poa	Cynodon	Paspalum	Festuca
N	4	3	3	5
K	2	2	3	1.5
P	0.5	0.5	0.5	0.5
Ca	0.5	0.5	0.5	0.5
Mg	0.2	0.2	0.2	0.2
S	0.2	0.2	0.2	0.2

If you know that your turf contains different concentrations of nutrients than shown in this table, please make the adjustments to fit your site.

Estimate based on N supply The grass cannot grow more than the N supply. Dividing the N supply by the percentage N in the leaves gives the maximum clipping yield. One can then work out the maximum use of all the elements. For example, Cynodon supplied with 16 g N/m² has a max mum clipping yield of $\frac{16}{0.03} = 500$ g. To convert for N nutrient utilization, I make an estimate based on soil organic matter being 5% N and 2.5% of that N mineralized in one year (Havlin et al., 1999, p. 103).

Predict based on GP If one doesn't know clippings or N supply, the remote-sensing-based growth potential (GP) provides a straightforward way to get an estimate of N use and consequently, of maximum possible growth. One sets a maximum N use for any duration (Δ) of the year. Calculate GP for time intervals of length Δ, and multiplying maximum N by GP gives the expected N use (Woods, 2013).

The MLSN guidelines

The MLSN guidelines are given in units of ppm. This is mg of element per kg of soil. In the calculation of a fertilizer requirement, I express the MLSN guideline amount as **b**. This amount is added to the amount the grass uses. This ensures that 100% of grass use, plus the MLSN minimum amount in the soil, are present in any fertilizer.

The soil test amount

The soil test amount **a** is the amount from a Mehlich 3 soil test. Note that conversion of soil test results from concentration units (ppm) to mass of nutrients per area, depends on the rooting depth and on the soil's bulk density. You can alter the calculations for your location, or use the standard conversions.

Soil tests other than Mehlich 3

We recommend Mehlich 3 soil testing (Mehlich, 1984) when using MLSN. If you use a different soil testing method, but want to use the MLSN guidelines, you will have to convert the test results to their expected values in Mehlich 3 – or convert the MLSN guidelines to expected values in the other extraction. This conversion process introduces an unknown amount of error into the calculation.

P We've calculated an MLSN for the Bray-2 (20 ppm) and Olsen (6 ppm) extractions. We don't have information on other extraction methods for P.

K, Ca, Mg When using the Ammonium Acetate, or the Morgan extraction, the approximate MLSN guidelines convert to 30 ppm for K, 265 ppm for Ca, and 35 ppm for Mg. Alternatively, multiply the Ammonium Acetate or Morgan test results by 1.2 and then use the unmodified MLSN guidelines.

S No known conversion.

How and why MLSN works

It works by ensuring the grass is supplied with all the nutrients it can use while keeping a safe amount of each nutrient untouched in the soil as a reserve. The MLSN calculation identifies the amount of nutrients the grass uses at a particular site. It then ensures the grass is either supplied with 100% of those nutrients from fertilizer, from soil, or from a combination of soil and fertilizer (Woods et al., 2014).

This approach recognizes that grass uses nutrients. Rather than trying to maintain all the nutrients the grass could ever use, and all in soil, in a hypothetical optimum soil that doesn't exist, the MLSN approach makes a careful estimate of client use and makes sure the grass is supplied with that much plus a little bit more, to preserve, untouched, in the soil. This approach puts the turfgrass manager in control.

> "The fundamental principle of successful green keeping is the recognition of the fact that the finest golfing grasses flourish on good soil and that more harm is done by over- rather than under-rich living" (MacConnie, 1958).

Why MLSN is needed

Some [illegible] soil test interpretations is based on calculating [illegible]

MLSN is a value for b

$$\overbrace{a+b}^{\text{amount needed}} - \overbrace{c}^{\text{amount present}} = \overbrace{Q}^{\text{fertilizer requirement}}$$

a is a site-specific use estimate, b is the MLSN guideline, and c is the soil test result.

General concepts

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Finding the *plant use* amount

Option 1: Easy and conservative (safe) method

The easiest way recognizes that the grass growth is limited by N. For any N rate (N), the maximum clipping yield (G) can be calculated from this equation, where N_{leaf} is the leaf N content:[1]

$$G = \frac{N}{N_{leaf}}$$

[1] Express the leaf N not as a percentage, but as g/g. For example, 4% N would be expressed as 40 g N/1000 g clippings, or 0.04.

Option 2: more precise, less conservative

Measure clipping volume, get mass of clipping volume (*clipvol*) from conversion equations. Bentgrass and bermudagrass clippings can be estimated as:

$$G = 0.06(clipvol)$$

N:P:K at 8:1:4

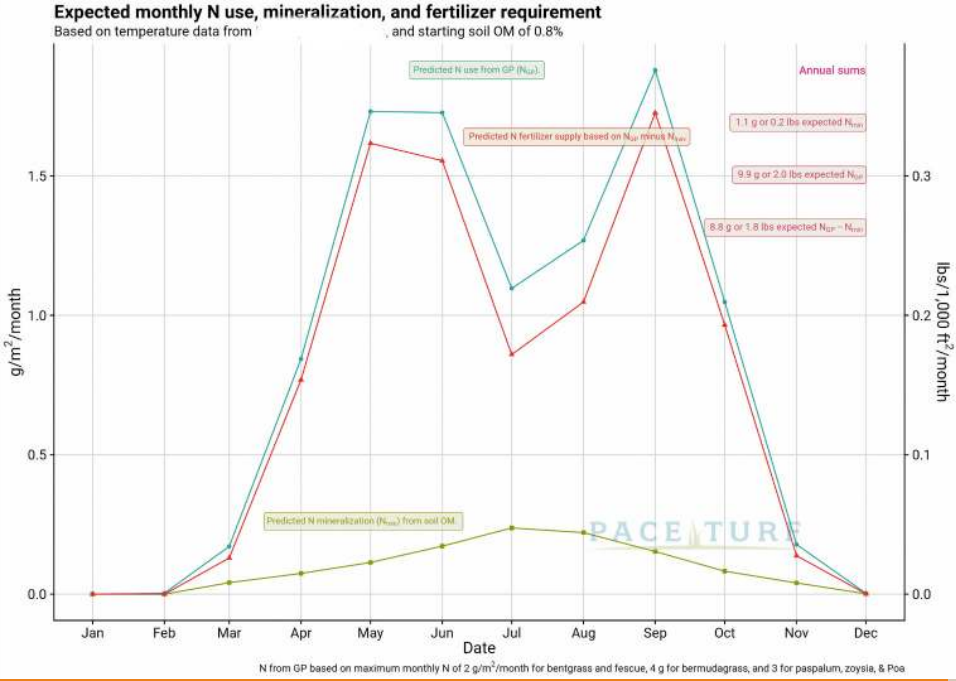
I’ve often used an N:P:K estimate of 8:1:4 to calculate expected nutrient use.

Normal nutrient content of bermudagrass leaves

element	25th percentile	Median (%)	75th percentile
N	3.4	3.7	4.6
P	0.34	0.39	0.47
K	1.1	1.3	1.7
Ca	0.28	0.34	0.38
Mg	0.15	0.18	0.19
S	0.35	0.39	0.45

Option 3: prediction based on grass type and weather

One can also predict the esimated N use using the PACE Turf growth potential (GP).


Expected monthly N use, mineralization, and fertilizer requirement
Based on temperature data from , and starting soil OM of 0.8%
Predicted N use from GP (N_{GP}):
Annual sums
Predicted N fertilizer supply based on N_{GP} minus N_{min}
1.1 g or 0.2 lbs expected N_{min}
9.9 g or 2.0 lbs expected N_{GP}
8.8 g or 1.8 lbs expected $N_{GP} - N_{min}$
Predicted N mineralization (N_{min}) from soil OM
g/m^2/month
lbs/1,000 ft^2/month
0.0
0.5
1.0
1.5
0.0
0.1
0.2
0.3
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
N from GP based on maximum monthly N of 2 g/m^2/month for bentgrass and fescue, 4 g for bermudagrass, and 3 for paspalum, zoysia, & Poa

A quick case study

Test results from this green (0–10 cm depth)

pH	5.7
OM	1%
M3 P	12 ppm
Bray 2 P	2 ppm
Ca	296 ppm
Mg	31 ppm
K	16 ppm

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