How to prevent nutrient deficiencies AND use less fertilizer

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There are four main points of discussion in this presentation.[1] First, I explain how nutrient deficiencies can be prevented by ensuring the grass is supplied with the full amount of each element that it can use. Second, I explain how soil test data can be useful. Then I explain how to use the MLSN guidelines specifically, and finally I show what might be a surprising result.

That is, if you soil test, and use the MLSN guidelines to determine how much fertilizer to apply, you will ensure the grass is supplied with all that it can use, thus preventing deficiencies. And the surprising result? It just so happens that this approach results in lower fertilizer recommendations too.

It happens by accident. By deliberately trying to prevent deficiencies, through a careful approach that estimates how much of each element the grass will use, and then ensuring it is supplied to the grass is adequate amounts, the result is less fertilizer use. The reason it works this way is because conventional nutrient guidelines recommend more of the macronutrients (P and K) and secondary nutrients (Ca and Mg) than the grass can use. Why is that? The simple answer is because the soil nutrient guidelines are based on normal nutrient levels in soils, but high quality turfgrass in the modern era is often grown in sand.[2]

[1] This presentation was delivered as part of the Campus del Césped seminar series (http://www.campusdelcesped.com/).

[2] The purpose of soil testing is to determine how much fertilizer to apply. With the misapplication of soil testing, one can be distracted from that purpose, and instead think of soil testing as a way to find how nutrient levels in the soil are below, within, or above certain guideline ranges. If the guideline ranges are set arbitratrily (or even deliberately high), as the conventional guidelines are for turfgrass, then fertilizer gets recommended trying to adjust nutrient levels in the soil to recommended levels that are not connected to how much the grass actually needs. For more about this, you can see this blog post. It contains an explanation in words, and as a cartoon: Why is the grass so good but the soil test results so bad?

Presentation slides and supplementary articles

The slides, and articles about many of the topics discussed during the presentation, are available in Spanish and in English.

En español

- The slides are available for viewing or download: https://speakerdeck.com/micahwoods
- Predecir los requerimientos nutricionales y el crecimiento del césped: http://www.files.asianturfgrass.com/201304_woods_gp_aedg.pdf
- Niveles mínimos de uso para una nutrición sostenible: introducción y guía: http://www.files.asianturfgrass.com/201401_woods_mlsn_aedg.pdf

In English

- The slides are at https://speakerdeck.com/micahwoods

- Read about using GP to estimate N use: http://files.asianturfgrass.com/201306_growth_potential.pdf
- Read about use of the MLSN guidelines: http://files.asianturfgrass.com/201401_woods_et_al_gcm_mlsn.pdf

Those articles provide a lot of the details. In this handout, I'm jotting down a few things that seem interesting and pertinent.

Ensure the grass is supplied with all that it can use

THERE ARE a few ways to get a quick estimate of how much of each nutrient the grass will use. You want to be sure the grass can get that quantity of each nutrient, so there won't be any deficiencies.

Here are a few ways I go about estimating the nutrient use.

1. If I know how much N is applied, that can be an upper bound on how much the grass is expected to grow. For example, if I apply N at $20\,g\,m^{-2}$, and if I am growing creeping bentgrass, then I estimate the maximum clipping harvest will be $500\,g\,m^{-2}$. That is the amount of dried clippings it would take to contain 20 g of N if the average leaf N content were 4 %. From that clipping harvest, I can then work out how much of each element will be used.
2. If I don't know yet how much N to apply, I'll get a starting point by estimating it from the temperature-based growth potential (GP). Or, if the grass is growing in a nutrient-rich soil and doesn't receive any N fertilizer, I will also use GP to estimate how much the grass is growing.[3]
3. I could also directly measure the amount of clippings. If measuring the volume of freshly cut clippings on putting greens, I expect every 1.3 L of clippings collected from $100\,m^2$ will equate to a dry weight harvest of $1\,g\,m^{-2}$. So in a year, if I measured a clipping volume of 400 L per $100\,m^2$, I would expect the dry matter harvest to be about $310\,g\,m^{-2}$. From that, I can work out how much of each nutrient is expected to be used.

Here's a little secret. You don't have to get this calculation exactly right. Because ... you can check it from soil test data and then correct it.

[3] If I have soil test data for organic matter, I may also make an estimate of how much N will be released from the organic matter in a year. To do that, I use these numbers. Soil organic matter is about 5 % N. Expect from 1 % to 4 % of that to be mineralized in a year. I usually pick 2 % for a conservative estimate. If you work through this using those values, you'll find that 2 % organic matter in a 10 cm rootzone with a bulk density of $1.5\,Mg\,m^{-3}$ gives an expected annual N release of $3\,g\,m^{-2}$.

Soil test data

WITH SOIL TEST DATA, you can check to see if nutrient levels are going up or are going down. This is very simple. If the nutrient levels are going up, then more is being added to the soil than is being removed. And if nutrient levels are going down, then it is the opposite situation.

This serves as a check, or a correction, on whatever calculations you've made to estimate the actual nutrient use of the grass.

I would like to emphasize this.

The purpose of soil tests is to determine how much fertilizer to apply.

That's where the MLSN guidelines come in.

Using the MLSN guidelines

NOW COMES the easy part. Making the estimate of nutrient use is a bit of work, but it becomes easy with a bit of practice. Getting soil test data is a bit of work too. Once you have the nutrient use estimate, and the soil test data, then the MLSN guideline gets plugged into an equation and you can calculate the fertilizer requirement with ease.

The concept is this. There is some amount of nutrient that we *need* for the grass to perform well.[4] There is also some amount of nutrient that we *have*. If the amount we need is more than the amount we have, then fertilizer is required. If the amount we have is more than the amount we need, then no fertilizer is required.

As an equation, this can be expressed as:

$$a + b - c = F$$

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

If you look at what the a, b, and c values stand for, you see that it works out exactly as described above – the amount we *need* minus the amount we *have* equals the fertilizer requirement.

$$\overbrace{a+b}^{\text{amount we need}} - \overbrace{c}^{\text{amount we have}} = \overbrace{F}^{\text{fertilizer requirement}}$$

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

The big picture – no deficiency with less fertilizer use

I USED THE DISTRIBUTION of potassium in the samples submitted during the first two years of the Global Soil Survey[5] to simulate soil K on 1000 putting greens in Barcelona. That is, I used the distribution of soil K in soils producing good turf around the world to predict what the soil K would be on 1000 greens if they have that same distribution.

[4] The MLSN amount acts as a buffer amount of the element in the soil that we don't want the soil to drop below. We could just ignore the soil and supply 100 % of what the grass could use. By using the MLSN guidelines, we can allow the grass to use nutrients from the soil while ensuring a safe amount is kept as reserve in the soil.

[5] Read more about the Global Soil Survey in the year 2 report: https://www.paceturf.org/PTRI/Documents/2015_gss_report.pdf

Then I calculated the fertilizer requirement for K for each of those greens. I used three methods. One was the MLSN approach. Another was supplying 100 % of predicted grass use. Another was applying enough to keep the soil above a conventional guideline of $117\,\mathrm{mg\,kg^{-1}}$.

As seen in the presentation slides, the MLSN approach results in the lowest quantity of fertilizer recommended, even though it accounts for 100 % of the amount the grass can use. That's how to prevent nutrient deficiencies, and as an accident, if you do it right, you can use a lot less fertilizer too.