From Soil Report To Solution

Source: www.TurfMagazine.com

Previously, Bill Urbanowicz, chief agronomist at Spectrum Analytic, Inc., demystified the numbers in a soil test report. In this article, he breaks down those numbers into real-world fertilizer selection and application. (Spectrum Analytic, is not able to recommend specific fertilizers brands, since they vary by area.)

Prior to making fertilizer and lime applications, the amount of area to be fertilized must be calculated so the correct amount of nutrients is applied to the soil. Google Maps can be used to get a somewhat accurate area. Or Spectrum's website library has a paper containing a variety of lawn sizes and shapes a landscaper may encounter when calculating area.

What's In A Grade?

As most know, fertilizer is identified by the percent of each nutrient contained in the product. While each fertilizer might contain any combination of up to 13 nutrients, the majority have a three number identification referring to the major nutrients: Nitrogen (N), phosphate (P_2O_5), and potash (K_2O) in that order. P_2O_5 is the fertilizer form of Phosphorus (P), and K_2O is the fertilizer form of Potassium (K). These three numbers are called the fertilizer analysis or "Grade." Fertilizer products that contain some amount of all three major nutrients are often called "complete" fertilizers.

Soil test nutrient recommendations are made in the same units (N, P_2O_5 and K_2O). But once you have those recommendations, you need to determine how much fertilizer will supply those nutrient amounts. This requires some basic arithmetic, presented in Formula #1.

For example, if the recommendation is for 3 lb. of N/1000 ft2 and your fertilizer grade is 20-5-10, first divide the 3 lb. N by 20 (the percent of N in this fertilizer grade). Next, multiply that result by 100. The result is the amount of 20-5-10 to apply per 1000 ft2 to get 3 lb. N per 1000 ft^2.

Formula #1

Amount of Fertilizer to apply/1000 ft^2 = (lbs. of Nutrient recommended/ % of Nutrient looking to calculate) × 100

Example:

3 lbs. N/1000 ft^2 recommended, fertilizer grade is 20-5-10
Amount of Fertilizer to apply/1000 ft^2

= (lbs. of Nutrient recommended / % of Nutrient looking to calculate) × 100
= (3 / 20) × 100
= .15 × 100
= 15 lbs.

When the 15 lb. /1000 ft2 of 20-5-10 is applied, you will, of course, also be applying some P_2O_5 and K_2O. But how much? Again, a basic formula is applied, shown below. Multiply the amount of fertilizer applied (15 lb.) times the percent of P_2O_5 or K_2O in the fertilizer (5 and 10), then divide that result by 100.

Formula #2

(Lbs. of fertilizer applied × nutrient %) / 100 = lbs. of plant food/1000 ft^2

Example:

15 lbs. of fertilizer with 5% P_2O_5

= (Lbs. of fertilizer applied × nutrient %) / 100 = lbs. of plant food/1000 ft^2
= (15 × 5) / 100
= 75 / 100
= 0.75 lbs. P_2O_5/1000 ft^2

Next calculate 15 lbs. of fertilizer with 10% k^20

= (Lbs. of fertilizer applied × nutrient %) / 100 = lbs. of plant food/1000 ft^2
= (15 × 10) / 100
= 150 / 100
= 1.5 lbs. K_2O/1000 ft^2

Therefore, 15 lb. of 20-5-10 per 1000 ft^2 supplies 3 lb. N, 0.75 lb. P_2O_5, and 1.5 lb. K_2O

These amounts of P_2O_5 and K_2O may be lower or higher than recommendations on the soil test report. But if either or both are close to the recommended amount, in most cases this is alright. In nearly all situations, N will be the most critical nutrient to be accurate. If, however, your application results in a significant shortage of P_2O_5 or K_2O, additional applications of a different fertilizer grade can be made at some other time. If there is a large excess of these nutrients, consider a different fertilizer grade that more closely matches the recommendation.

Measuring Fertilizer

While it’s much easier for most landscapers to apply fertilizer by volume rather than weight, it can be a problem when only small amounts are needed. The following list includes typical weight-to-volume conversions for a variety of fertilizers. (See chart below.)

FERTILIZER MEASUREMENT DATA

Fertilizer Product	Lbs./ ft3	Lbs./gal (dry vol)	Lbs./ cup	Cups/ lb.	Tbs./ lb.	Tsp./ lb.
26-3-3*	62	8.29	1.52	1.9	31	93
16-8-8*	68	9.09	0.57	1.8	28	84
12-12-12*	70	9.36	0.58	1.7	27	82
18-24-12*	62	8.29	0.52	19	31	93
5-10-5*	78	10.43	0.65	1.5	25	74
5-10-10*	78	10.43	0.65	1.5	25	74
6-24-24*	70	9.36	0.58	1.7	27	82
Urea (46-0-0)	47	6.28	0.39	2.5	41	122
Calcium Nitrate (15.5-0-0)	70	9.36	0.58	1.7	27	82
Potassium Nitrate (13-0-44)	66	8.82	0.55	1.8	29	87
Ammonium Sulfate (21-0-0-24S)	66	8.82	0.55	1.8	29	87
Triple Superphosphate (0-46-0)	66	8.82	0.55	1.8	29	87
Diammonium phosphate (18-46-0)	63	8.42	0.53	1.9	30	91
Monoammonium phosphate (11-52-0)	61	8.15	0.51	2.0	31	94
Sulfate of Potassium (0-0-50-18S)	93	12.43	0.78	1.3	21	62
Muriate of Potash (0-0-61)	67	8.96	0.56	1.8	29	86
K-Mag (0-0-22-22S-11Mg)	75	10.03	0.63	1.6	26	77
Ground Limestone	87	11.63	0.73	1.4	22	66
Elemental Sulfur (90%S)	70	9.36	0.58	1.7	27	82
Aluminum Sulfate (14.3%S)	67	8.96	0.56	1.8	29	86

* "Typical" complete dry fertilizer. Complete fertilizers with similar nutrient ratios will have similar weights/volume. Many fertilizer grades with a low total nutrient analysis may contain a significant amount of lime. This could be an important factor in your fertilization choices, depending on your soil pH and needs of your plants.

Fertilizer Product	Lbs./gal (liquid vol.)	Lbs./cup	Cups/lb.	Tbs./lb.	Tsp/lb.
Most manufactured liquid fertilizers	11.0	0.69	1.4	22	67

Determining How Much Fertilizer

When applying fertilizer to meet a soil test nutrient recommendation, it's often most difficult to apply the correct amount of K2O. This is because most fertilizer grades tend to be high in either N and/or P2O5, but few are high in K2O. If this is the case in your area, talk to suppliers and ask them to stock something with higher K2O.

To determine how much fertilizer you need, it's really a sequence of simple steps. It may seem complicated at first, but take it one step at a time and you shouldn't have a problem.

Let’s say you have a recommendation of 4 lb. N, 2 lb. P_2O_5, and 3 lb. K_2O per 1,000 ft^2. For simplicity, we’ll assume that your area to fertilize is 1,000 ft^2. Sometimes you won’t be able to apply the exact amount of nutrients recommended in a single application. As mentioned, the main goal is to apply the correct amount of N and try to get close to the recommended amounts of P_2O_5 and K_2O. Let’s assume you can buy the fertilizer grades: 12-12-12; 6-24-24; 26-3-3; and 5-10-15.

The recommendation is for 3 lb. of K_2O/1000 ft^2. We will get this from our 5-10-15 because it has the highest percentage of K_2O in it. Based on the previously described method, we calculate the amount of fertilizer needed as follows:

Formula #1

Amount of Fertilizer to apply/1000 ft^2 = (lbs. of Nutrient recommended / % of Nutrient to calculate) × 100

Example:

3 lbs. K_2O/1000 ft^2 recommended on the soil test results, grade fertilizer available is 5-10-15.
Amount of Fertilizer to apply/1000 ft^2 = (lbs. of Nutrient recommended / % of Nutrient to calculate) × 100

= (3 / 15) × 100
= .2 × 100
= 20 lbs. of 5-10-15/1000 ft^2 to get the recommended 3 lbs. K_2O/1000 ft^2

This amount of 5-10-15 also supplies some N and P_2O_5. Again, based on previous instructions, we find out how much N and P_2O_5 as follows:

Formula #2

Amount of additional nutrients supplied/1000 ft^2 = (amount of fertilizer applied/1000 ft^2 × % of nutrient to calculate) / 100

Example:

If 20 lbs. of 5-10-15/1000 ft² was applied, how much N and P2O5 were also supplied with this application?
Amount of nitrogen supplied/1000 ft² = (amount of fertilizer applied/1000 ft² × % of nutrient to calculate) / 100

= (20 × 5) / 100
= 100 / 100
= 1 lb. N/1000 ft² also applied

Amount of P2O5 supplied/1000 ft² = (amount of fertilizer applied/1000 ft² × % of nutrient to calculate) / 100

= (20 × 10) / 100
= 200 / 100= 2 lbs. P2O5/1000 ft² also applied

Therefore, we find that by applying 20 lb. of 5-10-15 /1000 ft². we can get 1 lb. N, 2 lb. P2O5, and 3 lb. K2O/ 1000 ft². This leaves us 3 lb. short of the recommended N. To get this, we must apply some 26-3-3. This will force us to over-apply P2O5 and K2O a little bit, but this is not a problem. To determine how much 26-3-3 to apply to get the needed 3 lb. / 1000 ft2 of N, we use the same formulas.

Formula #1

Amount of Fertilizer to apply/1000 ft² = (lbs. of Nutrient recommended / % of Nutrient to calculate) × 100

Example:

3 lbs./1000 ft² of additional N recommended, grade fertilizer available is 26-3-3

Amount of Fertilizer to apply/1000 ft² = (lbs. of Nutrient recommended / % of Nutrient to calculate) × 100

= (3 / 26) × 10
= .115 × 100
= 11.5 lbs./1000 ft² of 26-3-3 required

Putting this together we find the following:

		Nutrients Applied (lbs./1000 ft²)		
		N	P_2O_5	K_2O
	20 lbs./1000 ft² of 5-10-15	1	2	3
	11.5 lbs./1000 ft² of 26-3-3	3	0.4	0.4
TOTAL	31.5 lbs./1000 ft. ² of fertilizer	4	2.4	3.4

You can see that with the recommendation in our example, using 12-12-12 or 6-24-24 would not have been as appropriate because they have the same amount of P2O5 and K2O. Using either of them over an extended time would supply either too much P2O5 or too little K2O. Small over-applications of P2O5 for one or two seasons is not
normally a problem, but over a longer period, it could cause soil imbalances that might reduce the uptake of other nutrients. Excess P2O5 is also an environmental concern in some areas.

Your recommendation may suggest you split-apply the fertilizer, or specific nutrients at different times. If so, you can apply all or part of either fertilizer in this example to satisfy the recommendation.

General Application Tips

Soil pH

- There is a correct soil pH range for all plants. When soil pH is below or above this range, nutrient uptake is reduced and plant performance is hurt. Therefore apply only the recommended amounts of lime (to increase pH) or sulfur (to lower pH).
- Split lime applications into no more than 90 lb. /1000 ft2 spring and fall. On lighter soils, don’t apply more than 40 lb./1000 ft2 spring and fall.
- Split sulfur applications into no more than 10 lb. /1000 ft2.

Nitrogen

- Don’t over apply nitrogen. Excess N makes plants more succulent and susceptible to disease. Also nitrate N run off can be an environmental concern.
- Too little N reduces plant vigor and growth, plus reduces the uptake of other nutrients.
- Grasses tend to need more N than other plants. However, where possible, it’s usually best to split the total N recommendation into multiple,

smaller applications spaced throughout the growing season.
- Do not apply N to most woody perennial plants after about mid-September. Excess N in the fall can increase the plants susceptibility to winter damage.

Phosphorous

- If your soil test is poor or medium, you will find high phosphorous rates recommended to increase levels to the good/optimal range. This should be split-applied or mixed with the soil. Higher rates of application will primarily increase the soil test and is not likely to improve plant growth in the same year it's applied.
- If your soil phosphorous is already high or very high, it could be interfering with the uptake of some micronutrients like zinc (Zn), copper (Cu), or others, and applying more will only make the problem worse.

Potassium, Magnesium, and Calcium

- These three elements tend to compete with each other for uptake by the plant. An excess of one can suppress the uptake of the others.
- Calcium (Ca) and magnesium (Mg) are contained in lime, so most soils with a pH between 6.0 and 7.0 will have adequate amounts for plant growth. However, acid-loving plants such as rhododendrons, azaleas, some conifers, blueberries, and others may need Ca or Mg from fertilizer sources, since lime may not be an option.
- While most fertilizers are "salts", potassium (K) is one of the saltier fertilizers. Therefore, application rates that are significantly higher than recommended have the potential for causing salt damage to the plants.

Micronutrients

Micronutrients include the elements boron (B), copper (Cu), manganese (Mn), zinc (Zn), iron (Fe), and molybdenum (Mo). Plants need very small amounts of these micronutrients, and an excess of most of them can be very toxic to plants. Since the need is so small, and the risks are high, landscapers are advised to apply these nutrients as part of a pre-mixed fertilizer.

In challenging turf conditions, a soil test is a valuable start to the process, akin to a doctor running diagnostic tests. But it's the treatment that will bring back health. Knowing how to bridge the gap between soil test recommendations and actual product selection and application is the key to improving turf quality and appearance.

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