How to Interpret Your Soil Test Potassium Levels

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NR-151 has shoved the practice of soil testing into the spotlight. Many superintendents have been analyzing their soil consistently for several years. However, there is a substantial group of superintendents out there that will be looking at soil test reports from their courses for the first time. There is also a sizeable group of superintendents that has taken soil tests before, but do not place much emphasis on the practice. The primary focus for soil testing for NR-151 has been on phosphorus levels, with little attention paid to the soil potassium levels. This is because there are no known negative consequences of elevated potassium levels in ground or surface water. Properly interpreting a soil potassium test is not as straightforward as it might seem, and therefore the purpose of this article is to discuss the promises and pitfalls of using soil tests to schedule potassium applications.

Potassium is held in the soil rather tightly by negatively charged, "exchange sites." These sites are predominantly associated with clay and organic matter particles. The collective amount of negatively charged exchanges sites is called the cation exchange capacity or CEC. A cation is shorthand for a positively charged molecule. Important soil cations include hydrogen (H^+), potassium (K^+), calcium (Ca^{+2}), magnesium (Mg^{+2}), and sodium (Na^+). The cation exchange capacity of a soil is an indication of the quantity of nutrients that the soil can retain. However, measurement of CEC is tricky business and if the soil contains any appreciable amount of calcium carbonate, CEC is often over-estimated by even the most reputable laboratories. Therefore, the most practical way to estimate CEC is by classifying the soil into one of two groups: (1) fine textured soils (loams, silt loams, clay, etc) which can be assumed to have adequate CEC and (2) high-sand content soils which have a low CEC.

For high-sand content root zones (those we can assume have a low CEC), there are two important things to remember. First, large applications (>0.5 lbs K_2O/M) cannot be retained by the soil. The graph in Figure 1 demonstrates this for a USGA green in Utah. The different lines represent the various amounts of potassium applied each year. The line with the open circle is 100 kg K ha^{-1}, which is equivalent to 2.5 lbs/M of K_2O. Therefore the various annual potassium rates in this study were 0, 2.5, 5, 7.5, and 10 lbs/M. Potassium was applied in six equal doses during the growing season. That means the 2.5 lb/M rate was applied in six applications of 0.41 lbs/M.

When you look at this graph, you notice that the increases in soil test K are not following the increase in fertilizer application. If they were, we would expect to see twice as much soil K in the 400 kg ha^{-1} line (10 lbs/M) than the 200 kg ha^{-1} line (5 lbs/M). Instead, we see that the increase in soil K is substantially less. In fact, I would say that there is little benefit to applying more than 5 lbs K_2O/M during the year. It could also be concluded that individual potassium applications should not exceed 0.8 lbs/M during the year. Sand has a low CEC, and a significant fraction of the applied potassium is being lost to leaching. For fine textured soils, we would expect to see much greater potassium retention.

What about all that peat moss that was added to your USGA green to increase the moisture and nutrient retention? Well, believe it or not, the nutrient retention part is overrated. Peat moss additions

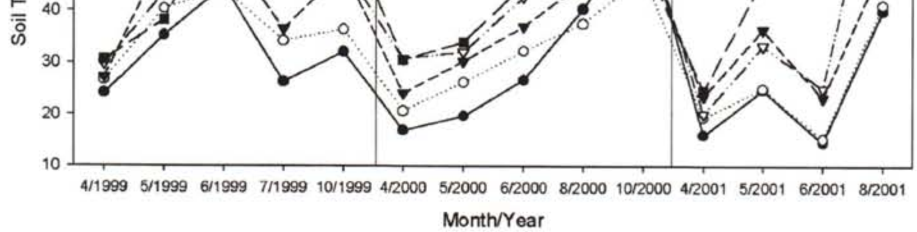

Figure 1. Seasonal changes in Olsen-extractable K during 1999-2001 from a sand putting green in Utah fertilized with various rates of potassium (from Johnson et al., 2005).

do to little, if anything, to improve the nutrient holding capacity of sand-based root zones. Here is some evidence. From 2002 to 2004, Dr. Kussow and I collected the leachate from an experimental putting green at the O.J. Noer Center. We analyzed that leachate for potassium and found that throughout the entire study period 26% of the applied potassium leached from the pure sand root zone, while 25% of the potassium fertilizer leached from the peat-amended root zone. Not exactly a confidence inspiring difference.

Back to Figure 1. The second thing to notice about this graph is that after each winter, all soil test levels drop dramatically. This result can be attributed to snowmelt and spring precipitation that leaches most of the applied potassium out of the root zone. The take-home message here is if you are using soil tests to schedule potassium applications, spring - not fall – is the ideal time to pull the cores.

For native mineral soils in Wisconsin, soils that we can safely assume have adequate CEC, soil cores can be pulled virtually anytime and the soil test levels should remain stable for a period of at least three years. Furthermore, we can have more confidence that larger applications of potassium will be retained efficiently.

How much potassium does turfgrass need?

If Frank Rossi is reading this, he is rolling his eyes right now. Frank and his co-workers recently demonstrated that potassium requirements are probably lower than what has been previously thought for creeping bentgrass on sand greens (Woods et al., 2005). They applied a wide range of potassium to plots on a sand-based putting green for three years. To one set of treatments, they applied no potassium for three years, which resulted in soil potassium levels that would be considered very low by any soil-testing lab. Throughout the study, no differences in ball roll among the various application rates were detected. They also found less gray snow mold damage, and faster recovery from plots receiving little or no potassium for three years. In addition, they reported significantly greater root mass between 4 and 8 inches from the plots receiving little to no potassium. They speculate that the extra root mass might be due to the bentgrass sending out deeper roots in search of potassium.

Research done by Dr. Kussow and Steve Houlihan has also found that healthy turfgrass can be grown on soils that might have been described as "low" in potassium just a few years ago. Take a look at Figure 2. This shows the amount of potassium in turfgrass leaves compared to the amount of Bray-1 extractable potassium in the soil. Each blue dot represents a single site where clippings were taken and analyzed for potassium content and a soil sample was pulled and also analyzed for available potassium. These data points include many different types of soils. If you look at the data points above the 50 ppm soil test level, you'll notice that the tissue content ranges from 1.5 - 3%, almost identical to the range that you notice for all the higher values of soil potassium. However, 50 ppm is considered by many labs to be between very low and low.

In conclusion:

1. Large applications of potassium to sand greens are not retained, and whatever amount was applied last fall will likely have been washed out of the root zone by spring.
2. For mineral soils, large potassium applications (1 lb/M) can be efficiently retained, and soil sampling time is not critical.
3. For sand-based root zones, soil samples should be taken in the spring when levels are likely to be at their lowest
4. Recommendations for potassium fertilizer are conservative, current and ongoing research has indicated that good turfgrass growth can be maintained at "low" soil potassium levels.

References

Johnson, P.G., R.T. Koenig, and K.L. Kopp. 2003. Nitrogen, phosphorus, and potassium responses and requirements in calcareous sand greens. Agon. J. 95:697-702.

Woods, M.S., Q.M. Ketterings, F.S. Rossi, and A.M. Petrovic. 2006. Potassium availability indices and turfgrass performance in a calcareous sand putting green. Crop Sci. 46:381-389.

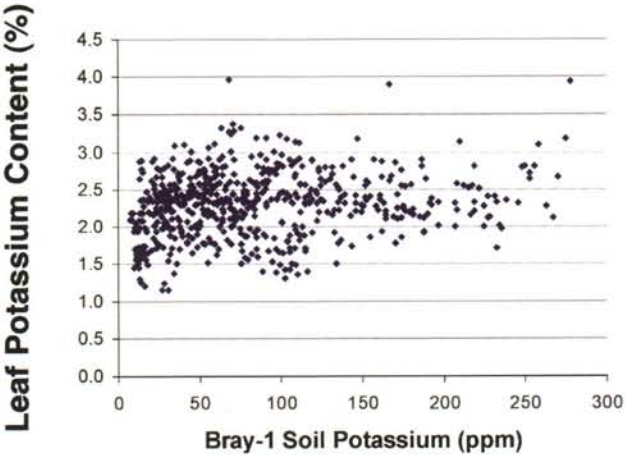

Figure 2. Relationship between soil test potassium and potassium in turfgrass clippings. Each of the approximately 600 data points represents a single site. Data collected and analyzed by Steve Houlihan and Wayne Kussow throughout Wisconsin.

Coming Events

April 21 • WGCSA Meeting
Geneva National Golf Club, Lake Geneva, Host- Kevin Knudtson

May 28 • WPGA/WGCSA Super Pro
Northern Bay Resort, Arkdale, Hosts- Ryan Ranguette and Scott Anthes

June 9 • WGCSA Meeting
Evergreen Golf Club, Elkhorn, Hosts- Bill Rogers and Mike Schmeiden

July 7 • WGCSA Meeting (Tournament Meeting)
Watertown Country Club, Host - Mike Upthegrove

July 22 - WTA Field Day
OJ Noer Research Facility, Verona, WI, Contact - Tom Schwab