Research Update: Determining Soil Potassium Requirements of Sand-Based Putting Greens

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Doug Soldat, Ph.D.

University of Wisconsin-Madison

Introduction

Potassium is an essential primary macronutrient required in relatively large quantities by turfgrass plants. Potassium does not have any structural role in the plant, but plays important roles in regulating osmotic pressure and facilitating enzymatic reactions. Potassium fertilization is thought to reduce many environmental stresses including heat, cold, and drought stress. It has also been associated with both increased and decreased disease pressure. Despite all these claims and associations, very few research studies have carefully examined how the soil and tissue levels of potassium influence turfgrass quality, growth, and disease pressure. The handful of studies that have addressed these topics often do not report soil test levels or tissue potassium content. In addition, many potassium studies are conducted over short time-scales (< 2 years) and do not quantify the long-term effects of various potassium fertilization strategies.

Because of the lack of quality data, turfgrass managers have hedged their bets and often apply large doses of potassium to turfgrass (>6 lbs per thousand square feet) – particularly to putting greens. However, with more accurate information, we feel that turfgrass managers will be able to confidently reduce their potassium applications, thus saving time and money, while not reducing and possibly enhancing the quality of the turfgrass they manage. The objective of this research is to evaluate putting green quality, growth, and disease incidence over a wide range of soil test and tissue potassium levels.

Methods and Materials

This project was initiated in 2011 at the O.J. Noer Turfgrass Research Facility in Madison, WI on a USGA putting green with 'A4' creeping bentgrass. The experiment is a randomized complete block design with four replications. The treatments include five different levels of biweekly liquid potassium sulfate at rates ranging from zero to 0.6 lbs/M every two weeks (~ 0 – 8 lbs K2O/M annually depending on the exact start and stop dates of the applications). Paired soil and plant tissue samples are collected monthly along with measurements of clipping yield. The soil samples are taken to a depth of 7 cm, and the plant tissue is collected by a walking greens mower, dried at 60°C, cleaned of debris (sand) and then dry weight is recorded. The dried turfgrass tissue is then analyzed for mineral nutrient content (N, P, K, S, Ca, Mg, Fe, Mn, Zn, Cu, and B) using a C/N/S analyzer and sulfuric acid digestion followed by inductively coupled plasma atomic emission spectroscopy. The soil samples are air dried, then analyzed for available nutrients using the Mehlich-3 method. Turfgrass color is evaluated biweekly using a reflectance meter that measures wavelengths corresponding to chlorophyll reflectance (CM-1000, spectrum technologies). Visual turfgrass quality is also evaluated biweekly using the standard National Turfgrass Evaluation Program rating scale of 1-9, where 1 represents completely brown or dead turf, 6 represents the minimally acceptable turf quality, and 9 represents the greatest possible quality. A golf cart traffic simulator is used six times per week to create wear stress on the plots, as potassium has been associated with wear tolerance in the past. The traffic simulator is a pull-behind unit consisting of two axels each holding six golf cart wheels. Above the wheels, approximately 500 kg of weight is added using water tanks. Although golf cart traffic does not duplicate foot traffic, it creates a great deal of wear stress on the turfgrass. Finally, because we are interested in how potassium may affect common diseases, we apply fungicides only rarely – usually in cases where we are concerned about losing the entire stand. In fact, only one fungicide has been applied during the past four years – a dollar spot control application was made last summer after a prolonged outbreak. Disease incidence is quantified by counting infection centers and by the grid intersection method, where an 81 point grid is placed on the plot and the presence/absence of the disease is recorded directly under each intersection.

Preliminary Results from 2015 Season

This season, we began to see visual signs of potassium deficiency for the first time since the study began in 2011. As shown in Table 1, the season average for color and quality were lowest in the control treatment (no K), significantly lower than treatments receiving K in most cases. Color and quality ratings for individual dates (Tables 2 and 3) show that the lower color and quality were most apparent in the first part of the growing season. Clipping data is still being processed, but no significant differences were detected among treatments on the two dates that are complete (Table 4).

Soil samples are taken monthly, but only the July data have been analyzed at this point (Table 5). The July samples show clear differences in soil K values, and the differences closely follow the fertility treatments. With the exception of significantly lower soil Mg in the gypsum treatment, no other differences in soil nutrients were observed.

Similarly, turfgrass tissue samples are collected and analyzed for nutrients monthly. However, at this point only the July tissue data are ready for the report. The July data (Table 6) show strong differences in K, Ca, and Mg among the treatments. This is expected as increasing leaf potassium must result in a decrease in other cations. The K ranges from 1.05% in the no K treatment to almost 1.6% in the high K treatment, demonstrating that our treatment applications have been successful in creating conditions suitable for testing the impact of K on turfgrass responses.

Potassium treatments affected pink snow mold severity, but not dollar spot (Table 7). The three treatments receiving potassium fertilizer had greater amounts of snow mold damage. This effect has been consistent for the last several years of the study. In the coming months data on clipping yield, Mehlich-3 soil test results, and tissue nutrient content will be analyzed and a complete reporting of the data will be made at the next interim report in February 2016.

Table 1. Average turfgrass color, quality and daily clipping mass for the 2015 season. Color is measured using the Spectrum CM-1000 on a scale from 1-999 (greenest) and quality is rated using the NTEP scale of 1-9 (best). Results followed by different letters within each column are statistically different according to Fisher's Least Significant Difference (alpha=0.05).

Treatment	Color	Quality	Clippings*
	1-999	1-9	g/plot
0.2 lb Ca/M (gypsum)	178 AB	4.1 BC	1.8 A
Control (no application)	172 B	4.0 C	1.7 A
0.1 lb K2O/M (K2SO4)	182 A	4.4 AB	1.6 A
0.2 lb K2O/M (K2SO4)	182 A	4.3 ABC	1.6 A
0.6 lb K2O/M (K2SO4)	181 A	4.5 A	1.8 A

* Data set incomplete for clippings (see Table x)

Table 2. Turfgrass color during the 2015 season as measured using the Spectrum CM-1000 on a scale from 1-999 (greenest). Results followed by different letters within each column are statistically different according to Fisher's Least Significant Difference (alpha=0.05).

Treatment	8 May	5 June	1 July	4 Aug.	1 Sept.
	1-999				
0.2 lb Ca/M (gypsum)	137 AB	145 AB	187 AB	214 A	208 A
Control (no application)	134 B	139 B	178 B	211 A	199 A
0.1 lb K2O/M (K2SO4)	137 AB	148 A	197 A	217 A	210 A
0.2 lb K2O/M (K2SO4)	137 AB	149 A	191 A	221 A	210 A
0.6 lb K2O/M (K2SO4)	141 A	147 AB	190 AB	216 A	210 A

Table 3. Visual turfgrass quality during the 2015 season. Visual quality is evaluated using the NTEP scale of 1-9 where 1 represents completely brown or dead turf and 9 represents the highest possible quality. Results followed by different letters within each column are statistically different according to Fisher's Least Significant Difference (alpha=0.05).

Treatment	8 May	5 June	1 July	4 Aug.	1 Sept.
	----------------------------1-9, (9=best quality)----------------------------				
0.2 lb Ca/M (gypsum)	4.5 A	2.5 AB	6.0 BC	5.3 AB	2.3 A
Control (no application)	4.5 A	2.3 B	5.5 C	4.8 B	3.0 A
0.1 lb K2O/M (K2SO4)	3.8 B	3.0 A	6.8 A	5.8 A	2.8 A
0.2 lb K2O/M (K2SO4)	3.8 B	2.8 AB	6.5 AB	5.5 AB	2.3 A
0.6 lb K2O/M (K2SO4)	4.0 AB	3.0 A	6.8 A	5.8 A	2.8 A

Table 4. Clipping yield measured during the 2015 season. Results followed by different letters within each column are statistically different according to Fisher's Least Significant Difference (alpha=0.05).

Treatment	8 May	5 June	1 July	4 Aug.	1 Sept.
	-----------------------------g dry wt./plot-----------------------------				
0.2 lb Ca/M (gypsum)	No data*	1.8 A	1.8 A	No data	No data
Control (no application)	No data	1.8 A	1.5 A	No data	No data
0.1 lb K2O/M (K2SO4)	No data	1.7 A	1.5 A	No data	No data
0.2 lb K2O/M (K2SO4)	No data	1.7 A	1.5 A	No data	No data
0.6 lb K2O/M (K2SO4)	No data	1.9 A	1.6 A	No data	No data

* clippings collected, but have yet to be cleaned of sand and debris by time of the report.

Table 5. Mehlich-3 soil test values from 1 July 2015. Results followed by different letters within each column are statistically different according to Fisher's Least Significant Difference (alpha=0.05).

Treatment	P	K	Ca	Mg	Na
	--------------------------mg/kg--------------------------				
0.2 lb Ca/M (gypsum)	24 A	14 C	587 A	131 B	2.4 A
Control (no application)	20 A	13 C	573 A	148 A	2.1 A
0.1 lb K2O/M (K2SO4)	21 A	15 BC	552 A	150 A	1.9 A
0.2 lb K2O/M (K2SO4)	24 A	20 AB	587 A	156 A	2.2 A
0.6 lb K2O/M (K2SO4)	21 A	24 A	610 A	153 A	2.5 A

Table 6. Turfgrass tissue nutrient content from 1 July 2015. Results followed by different letters within each column are statistically different according to Fisher's Least Significant Difference (alpha=0.05).

Treatment	P	K	Ca	Mg	Na
	----------------% dry wt.----------------				mg/kg
0.2 lb Ca/M (gypsum)	0.60 A	1.08 D	0.87 A	0.32 B	127 A
Control (no application)	0.58 A	1.05 D	0.75 B	0.35 A	127 A
0.1 lb K2O/M (K2SO4)	0.55 C	1.25 C	0.67 C	0.29 C	94 B
0.2 lb K2O/M (K2SO4)	0.57 BC	1.42 B	0.62 D	0.29 C	96 B
0.6 lb K2O/M (K2SO4)	0.57 BC	1.56 A	0.56 E	0.28 D	102 B

Table 7. Pink snow mold (PSM) and dollar spot disease severity was quantified by counting infection centers and/or visually estimating the percentage of plot area occupied by infection in March and May 2015. Results followed by different letters within each column are statistically different according to Fisher's Least Significant Difference (alpha=0.05).

	17 March 2015		8 May 2015		11 Sept. 2015
Treatment	PSM Infection Centers	PSM Damage	PSM Infection Centers	PSM Damage	Dollar Spot Infection Centers
	#/plot	% area	#/plot	% area	#/plot
0.2 lb Ca/M (gypsum)	3.8 B	1.5 BC	3.8 B	3.3 A	209 A
Control (no application)	2.3 B	1.0 C	3.3 B	1.8 A	253 A
0.1 lb K2O/M (K2SO4)	14.3 A	5.5 AB	18.8 AB	6.0 A	281 A
0.2 lb K2O/M (K2SO4)	16.3 A	8.8 A	25.0 A	7.5 A	209 A
0.6 lb K2O/M (K2SO4)	14.8 A	7.5 A	16.3 AB	6.0 A	215 A