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

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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 K_2O/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 was 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. Wear traffic was not applied in 2016. 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. 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 2016 Season

The season average for color and quality showed no difference among treatments (Table 1). Color ratings for individual dates (Table 2) show that there was no statistical significant difference among the treatments during the entirety of the growing season. However, quality ratings for individual dates (Table 3) show that there was a significant difference among treatments in the beginning and end of the growing season. In the beginning of the growing season, treatment receiving potassium application generally scored lower than the control (no K) and the treatment receiving gypsum. At the end of the growing season, treatments receiving higher potassium application rates scored higher than treatments receiving a lower rate or no potassium at all.

Soil samples are taken monthly, but only the July data have been analyzed at this point (Table 4). The July samples show clear differences in soil K values, and the differences closely follow the fertility treatments. Potassium, calcium, and magnesium show differences among treatments, however their levels do not relate linearly to fertility treatment.

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 5) show significant differences in P as well as K in certain treatments. Contrary to last year, there is not a significant difference in Ca, and Mg among the treatments. The K ranges from 16 mg/kg in the no K treatment to 29 mg/kg in the high K treatment, demonstrating that our treatment applications have been successful in creating conditions suitable for testing the impact of potassium on turfgrass responses.

Potassium treatments affected pink snow mold severity, as well as brown patch infection observed towards the end of the growing season (Table 6). 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 report in February 2016.

Table 1. Average turfgrass color and quality for the 2016 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 the least square mean Student's T-test (alpha=0.05).

Treatment	Color	Quality
	1-999	1-9
0.2 lb Ca/M (gypsum)	285.1 A	5.25 A
Control (no application)	281.5 A	5.63 A
0.1 lb K2O/M (K2SO4)	285.4 A	5.28 A
0.2 lb K2O/M (K2SO4)	285.0 A	5.66 A
0.6 lb K2O/M (K2SO4)	282.7 A	5.56 A

* Data set incomplete for clippings (see Table x)

Table 2. Turfgrass color during the 2016 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 the least square mean Student's T-test (alpha=0.05).

Treatment	3 May	3 June	6 July	2 Aug.	17 Aug.	25 Aug.	31 Aug.	8 Sep.
	-----1-999-----							
0.2 lb Ca/M (gypsum)	138 A	175 A	258 A	376 A	350 A	312 A	325 A	347 A
Control (no application)	140 A	173 A	252 A	370 A	342 A	311 A	328 A	336 A
0.1 lb K2O/M (K2SO4)	134 A	182 A	257 A	386 A	347 A	313 A	325 A	340 A
0.2 lb K2O/M (K2SO4)	136 A	179 A	256 A	377 A	343 A	310 A	338 A	342 A
0.6 lb K2O/M (K2SO4)	139 A	177 A	261 A	377 A	343 A	293 A	327 A	346 A

Table 3. Visual turfgrass quality during the 2016 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 the least square mean Student's T-test (alpha=0.05).

Treatment	3 May	3 June	6 July	2 Aug.	17 Aug.	25 Aug.	31 Aug.	8 Sep.
	-----1-9-----							
0.2 lb Ca/M (gypsum)	4.8 A	4 A	5.5 A	5.5 A	5.5 A	6 A	5.5 B	5.3 C
Control (no application)	4.8 A	4 A	5.3 A	6 A	6.3 A	6.8 A	6.3 AB	5.8 C
0.1 lb K2O/M (K2SO4)	3.8 B	3.3 B	5.5 A	5.5 A	5.8 A	6.8 A	6 AB	6 BC
0.2 lb K2O/M (K2SO4)	3.5 B	3.3 B	5.5 A	5.8 A	6.5 A	6.8 A	7 A	6.8 AB
0.6 lb K2O/M (K2SO4)	3.5 B	3 B	6 A	6 A	6 A	6.5 A	6.5 AB	7 A

Table 4. Mehlich-3 soil test values from 6 July 2016. Results followed by different letters within each column are statistically different according to the least square mean Student's T-test (alpha=0.05).

Treatment	P	K	Ca	Mg	Fe
	---------------------------		mg/Kg		---------------------------
0.2 lb Ca/M (gypsum)	23 A	13 C	854 AB	166 AB	48 A
Control (no application)	15 B	15 C	958 A	204 A	56 A
0.1 lb K2O/M (K2SO4)	18 AB	27 B	865 AB	183 AB	49 A
0.2 lb K2O/M (K2SO4)	17 B	32 B	767 B	162 B	50 A
0.6 lb K2O/M (K2SO4)	15 B	43 A	859 AB	186 AB	51 A

Table 5. Turfgrass tissue nutrient content from 6 July 2016. Results followed by different letters within each column are statistically different according to the least square means Student's T-test (alpha=0.05).

Treatment	P	K	Ca	Mg	Fe
	---------------------------		mg/Kg		-------------------------
0.2 lb Ca/M (gypsum)	33 A	20 AB	977 A	154 A	54 A
Control (no application)	21 B	16 A	867 A	165 A	51 A
0.1 lb K2O/M (K2SO4)	22 B	25 AB	897 A	172 A	53 A
0.2 lb K2O/M (K2SO4)	21 B	28 A	892 A	172 A	56 A
0.6 lb K2O/M (K2SO4)	20 B	29 A	893 A	173 A	56 A

Table 6. Pink snow mold (PSM) and brown spot severity was quantified by visually estimating the percentage of the plat area occupied by infection as well as estimating the severity using an 81-point grid at various times throughout the growing season. Results followed by different letters within each column are statistically different according to the least square means Student's T-test (alpha=0.05).

	11 April 2016		29 July 2016		11 Sept. 2016	
Treatment	PSM Infection Visually	PSM Infection Grid	Brown Spot Infection Visual	Brown Spot Infection Grid	Brown Spot Infection Visual	Brown Spot Infection Grid
	% area	% intercepts	% area	% intercepts	% area	% intercepts
0.2 lb Ca/M (gypsum)	3.5 B	5.6 B	7 A	3.3 A	51.2 A	36.1 A
Control (no application)	4.8 B	2.2 B	3.3 A	1.8 A	32.5 AB	37 A
0.1 lb K2O/M (K2SO4)	22.5 A	27.2 A	12.5 A	6.0 A	20.5 B	18.2 AB
0.2 lb K2O/M (K2SO4)	22.5 A	18.8 A	12.8 A	7.5 A	11.8 B	8 B
0.6 lb K2O/M (K2SO4)	20 A	25.3 A	6.8 A	6.0 A	14 B	14.5 B