Annual Bluegrass Response to Potassium and Calcium Fertilization and Soil pH

James A. Murphy, Charles Schmid, and Bruce B. Clarke
Rutgers University

Start Date: 2013
Project Duration: 2 years
Total Funding: $36,000

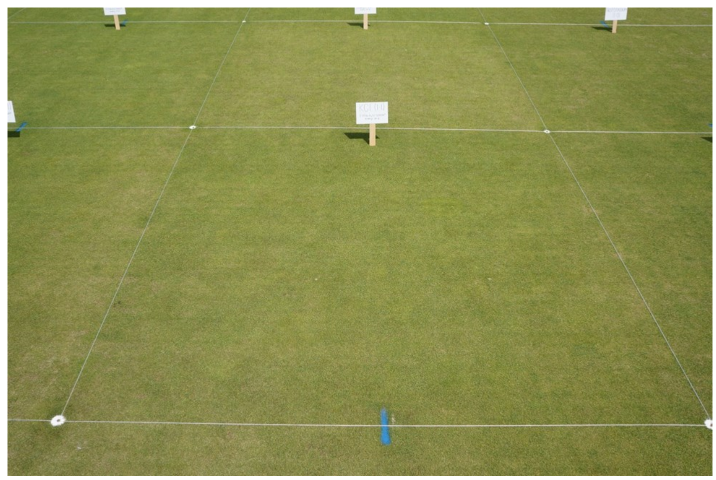
Turfgrass and Environmental Research Online
Volume 14, Number 2 | March—April 2015

Objectives:

The goal of this project is to develop sufficiency ranges for potassium, calcium, and soil pH for annual bluegrass turf. Our specific objectives are to:
1. establish sufficiency ranges for potassium based on soil test level, tissue concentration, and turf performance of annual bluegrass;
2. determine whether potassium source influences annual bluegrass growth and quality;
3. quantify the responses of annual bluegrass over a range of soil pH and determine a critical level; and
4. confirm that the response to soil pH adjustments is not due to calcium nutrition.

Annual bluegrass (ABG) is one of the most common species grown on putting green surfaces throughout temperate climatic regions. Despite its prevalence in golf course turf, there is limited information about the nutritional requirements of annual bluegrass. Improvements have been made in our understanding of nitrogen requirements for annual bluegrass turf. However, our recent work indicates that sufficiency levels for other nutrients including potassium and calcium, and soil pH could be determined from annual bluegrass performance in field trials.

Potassium (objectives 1 & 2). A field study was initiated in 2012 in North Brunswick, NJ, on a modified sandy loam rootzone with a 6.0 cm sand topdressing layer. Treatments were arranged as a 2 x 4 factorial with four replications. Potassium chloride (KCl) and potassium sulfate (K_2SO_4) were applied at rates of 0, 66, 131, and 262 kg K ha^{-1} yr^{-1} to establish differences in soil and tissue K levels. Potassium nitrate (KNO_3) and potassium carbonate (K_2CO_3) were also included at the 262 kg K ha^{-1} yr^{-1} rate, as well as a no nitrogen check (with KCl applied at a rate of 262 kg K ha^{-1} yr^{-1}). Mehlich-3 soil test K (STK) level, tissue K content, clipping yield, anthracnose disease severity, and visual turfgrass quality and color were quantified periodically for three growing seasons. Similar to previous years, K fertilization significantly reduced anthracnose severity compared to no K fertilization. Nonlinear regression models were used to calculate STK and tissue K content critical points for 2012 and 2013 data. Anthracnose disease severity was responsive to both STK and tissue K content and provided clear critical values using the Cate-Nelson model. Soil test K and tissue K content critical points for anthracnose disease on ABG ranged from 43 to 49 mg kg^{-1} and 1.95 to 1.96 %, respectively (Figures 1 and 2). Quadratic plateau analysis of STK and tissue K content indicates that maximum tissue K content for ABG ranged from 27.3 to 29.2 g kg^{-1} at STK levels ranging from 78.2 to 103.2 mg kg^{-1}. Soil test K levels above 100 mg kg^{-1} did not provide increased anthracnose suppression compared to levels within the sufficiency range; therefore, there may be no benefit to increasing STK above this level. Additional soil and tissue samples were collected in 2014 and are being analyzed. Data from 2014 will be included in the final model and used to further refine sufficiency ranges for ABG.



Anthracnose severity on potassium research plots (N:K of 1:1; KCl source) in North Brunswick, NJ; photo taken 31 July 2013.

Soil pH and Calcium (objectives 3 & 4). A study to determine the effect of soil pH and calcium nutrition on ABG turf quality and anthracnose severity was initiated in December 2011 on ABG turf that had an initial pH value of 5.3 in the 60-mm deep mat layer and 6.0 in the underlying soil. Limestone (CaCO3) was applied as a granular product at five rates (118, 569, 1184, 1739, and 2247 kg CaCO3 ha-1) based on target pH levels of 5.8, 6.3, 6.8, 7.3, and 7.8, respectively, in the mat-thatch layer. Elemental sulfur was sprayed as a wettable powder at two rates (24 and 49 kg S ha^{-1}) to decrease pH. By August 2013, soil pH in the study ranged from 5.2 (49 kg S ha^{-1}) to 6.4 (lime 2247 kg CaCO3 ha^{-1}). A second application of limestone (122, 889, 1631, 2148, and 2617 kg CaCO3 ha^{-1}) and sulfur (12 and 24 kg S ha^{-1}) was made on 1 April 2014 to broaden the soil pH range. In 2014, visual data (turf quality, turf color, chlorophyll index, and NDVI) was highly responsive to limestone applications. By early July, plots that received greater rates of limestone (889, 1631, 2148, and 2617 kg CaCO3 ha-1) had better quality and color ratings than sulfur plots and the control (Table 1 and 2). This trend continued through the rest of the growing season, with the highest limestone rate (2617 kg CaCO3 ha-1) having the best quality and color ratings by Sept 2014. The effect of limestone and sulfur on anthracnose severity was similar to previous years, with higher limestone rates decreasing disease and sulfur treatments increasing disease (data not shown). Soil and tissue data from 2014 is currently being analyzed. Once completed, this data will be correlated to visual and disease data to determine optimum pH range for ABG turf.

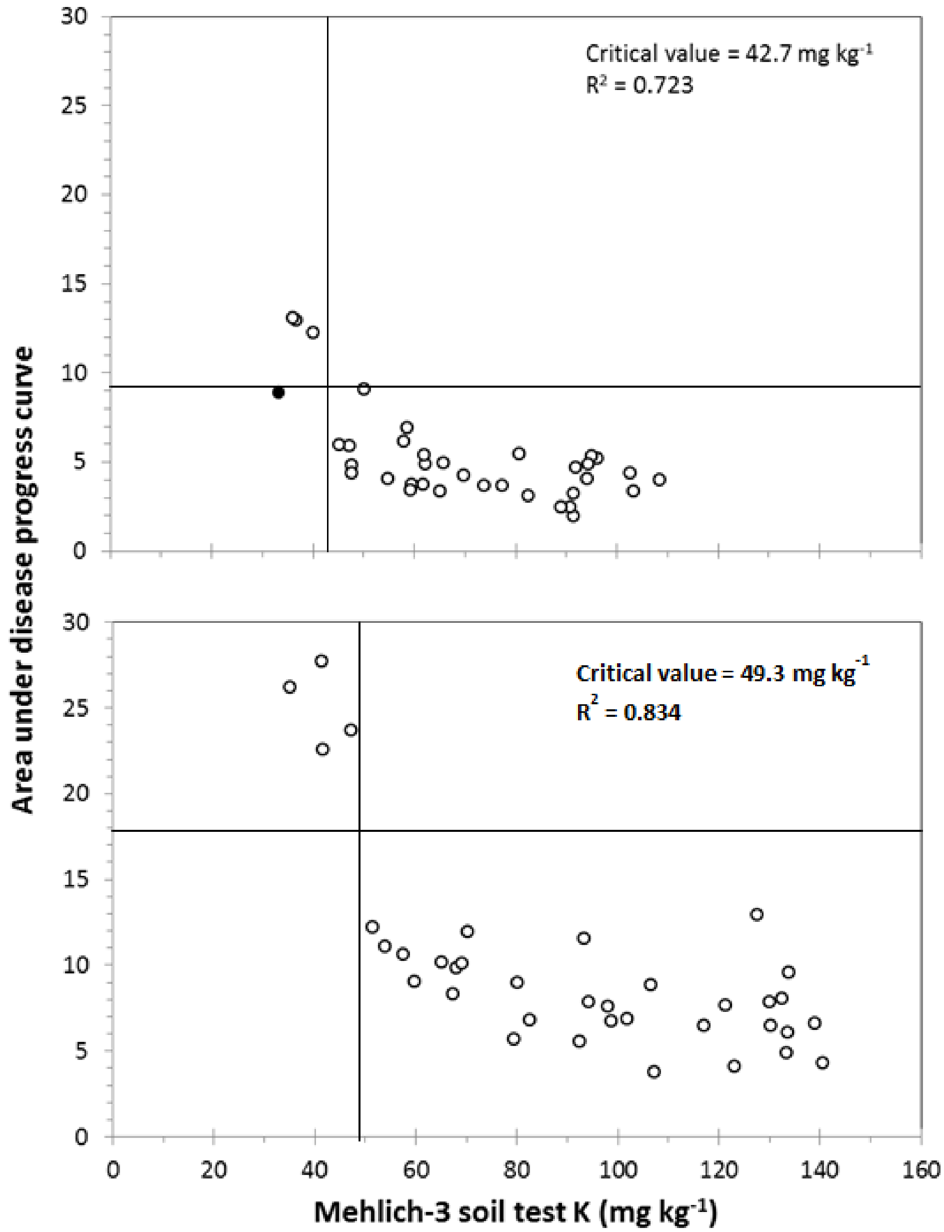


Figure 1. Response of anthracnose severity (area under disease progress curve) to Mehlich-3 soil K levels using the Cate-Nelson model in 2012 (top) and 2013 (bottom). The upper left quadrant of each graph represents soil K levels that would be highly responsive to K fertilization; the lower right quadrant represents soil K levels that are not likely to be responsive. Each data point is an average of three sampling dates (20 June, 6 Aug., and 17 Sept. 2012 and 20 June, 2 Aug., and 18 Sept. 2013) collected within each year.

Summary Points:

- Soil test K (Mehlich-3) and tissue K content below 50 mg kg-1 and 2%, respectively, represent deficient values for annual bluegrass turf. Our results indicate that anthracnose severity would be more severe if K fertilizer were withheld at these levels.
- A maximum tissue K content of 2.9% was achieved at a soil test K level of 100 mg kg^{-1}, suggesting that soil with greater K levels would not benefit from a fertilizer application.
- Soil pH values greater than 6.0 improved turfgrass quality and color in 2014. Further analysis of soil and tissue data from 2014 should identify an optimum pH range for ABG growth.

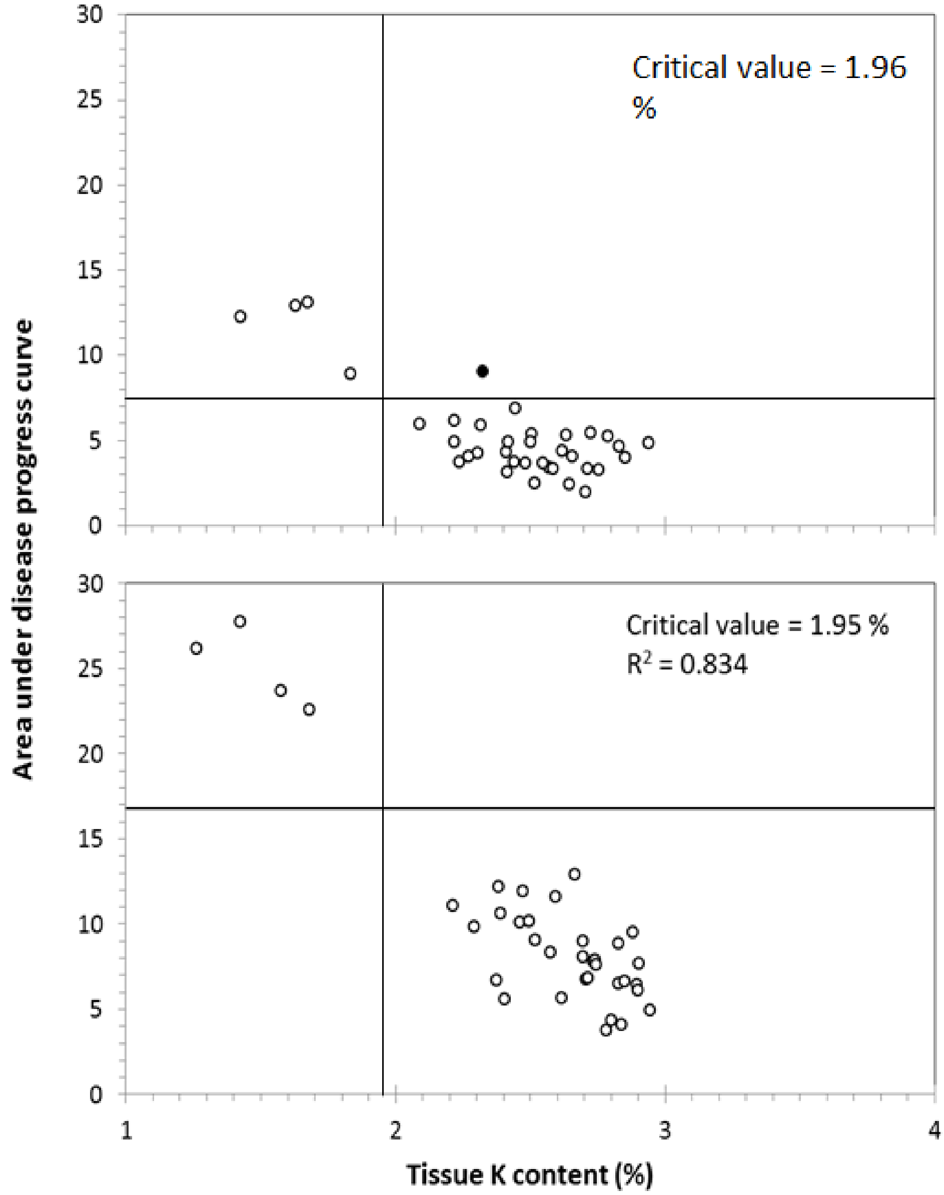


Figure 2. Response of anthracnose severity (area under disease progress curve) to tissue K content using the Cate-Nelson model in 2012 (top) and 2013 (bottom). The upper left quadrant of of each graph represents tissue K contents that would be highly responsive to K fertilization; the lower right quadrant represents tissue K contents that are not likely to be responsive. Each data point is an average of all tissue samples (3 July, 6 Aug., 21 Sept. 2012 and 20 June, 2 Aug. 2013) collected within each year.

Table 1. Limestone and sulfur effect on turfgrass quality of annual bluegrass turf in North Brunswick, NJ during 2014.

Treatment [a]	2014										
	8-Apr	28-Apr	16-May	29-May	12-Jun	3-Jul	18-Jul	1-Aug	14-Aug	27-Aug	19-Sep
	Turf quality (1-9 scale, 9 = best, 5 = acceptable)										
Untreated Check	5.8	5.8	5.5	6.3	6.5	6.0	6.5	5.3	4.8	5.5	5.8
Lime 122 kg ha^{-1}	5.8	5.0	6.0	6.5	6.8	6.8	7.5	7.0	7.0	7.0	7.0
Lime 889 kg ha^{-1}	6.3	5.8	6.8	7.3	7.8	7.3	8.3	7.8	7.5	7.8	8.0
Lime 1631 kg ha^{-1}	6.5	6.5	6.8	7.3	7.8	8.0	8.3	7.8	7.8	7.8	7.8
Lime 2148 kg ha^{-1}	6.5	7.0	6.8	7.0	7.3	8.0	8.5	7.8	7.8	8.0	8.0
Lime 2617 kg ha^{-1}	7.0	7.0	6.3	7.3	7.3	7.8	8.3	8.5	8.0	8.5	8.3
Sulfur 12 kg ha^{-1}	5.5	5.8	5.5	6.3	6.5	5.3	5.5	4.0	4.0	4.3	5.5
Sulfur 24 kg ha^{-1}	5.0	5.0	4.8	5.8	6.3	4.5	5.5	3.5	3.0	3.5	4.0
LSD ($P \leq 0.05$)	1.0	1.0	0.9	1.0	0.8	0.9	0.8	1.0	1.1	1.2	0.9
C.V. %	11.2	11.0	10.1	9.8	7.3	9.4	7.7	11.2	12.0	13.2	9.6

[a] Limestone and sulfur applications were made on 1 April and 3 April 2014, respectively

Table 2. Limestone and sulfur effect on turfgrass color of annual bluegrass turf in North Brunswick, NJ during 2014.

Treatment [a]	2014										
	8-Apr	28-Apr	16-May	29-May	12-Jun	3-Jul	18-Jul	1-Aug	14-Aug	27-Aug	19-Sep
	Turf Color (1-9 scale, 9 = dark green color, 5 = acceptable green color)										
Untreated Check	5.5	5.8	5.8	7.0	6.8	5.8	6.5	5.3	5.5	5.8	6.3
Lime 122 kg ha^{-1}	5.8	5.5	6.3	7.0	6.8	7.0	7.8	7.5	8.0	7.3	7.0
Lime 889 kg ha^{-1}	6.8	6.5	7.3	7.8	7.5	8.5	8.8	7.5	7.8	8.0	8.3
Lime 1631 kg ha^{-1}	6.8	6.8	7.5	8.0	7.5	8.0	8.5	8.3	8.0	8.0	7.8
Lime 2148 kg ha^{-1}	7.0	7.0	7.0	7.5	7.8	8.5	8.3	7.8	7.8	7.8	8.0
Lime 2617 kg ha^{-1}	7.5	7.8	7.0	7.8	7.5	8.0	8.8	8.5	8.3	8.5	8.5
Sulfur 12 kg ha^{-1}	5.0	6.0	5.8	6.8	7.0	5.3	5.8	4.8	5.0	5.0	6.0
Sulfur 24 kg ha^{-1}	4.5	5.5	4.8	5.8	6.5	4.5	5.3	4.5	4.0	4.0	4.5
LSD ($P \leq 0.05$)	1.1	0.9	0.8	1.0	0.9	1.1	0.9	1.2	1.0	1.4	1.1
C.V. %	13.1	9.5	8.6	9.3	8.3	10.5	8.1	12.2	10.3	14.0	11.04

[a] Limestone and sulfur applications were made on 1 April and 3 April 2014, respectively