

INDIRECT MEASUREMENT OF CREEPING BENTGRASS N, CHLOROPHYLL, AND COLOR FOR PRECISION GOLF GREEN MANAGEMENT

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ABSTRACT

Indirect measurement of turfgrass tissue through optical sensing may provide golf course managers with non-destructive and relatively simple real-time measurements of golf green N requirements. The objective of this study was to determine the effect of N rate on ‘Crenshaw’ creeping bentgrass (*Agrostis stolonifera* L.) tissue N, chlorophyll concentration, and color using the *GreenSeeker*TM (NTech Industries, Ukiah, CA) handheld sensor. Plots (0.9 X 1.5 m) were established at the Oklahoma State University Turfgrass Research Center in Stillwater, OK in a randomized complete block design with 4 replications and plots were evaluated over two growing seasons. Treatments consisted of plots fertilized with 0, 6.1, 12.2, 24.4, 36.6, and 48.8 kg N ha⁻¹ yr⁻¹. Normalized difference vegetative index (NDVI) and green normalized difference vegetative index (GNDVI), tissue collection (N and chlorophyll), and color ratings (1-9 scale) were recorded every 15 d. Normalized difference vegetative index, GNDVI, tissue N, chlorophyll content, and visual color ratings significantly increased with increasing N application rates. Linear regression of N rate with tissue N ($n = 576$) and chlorophyll content ($n = 264$) from all data combined were significant ($P < 0.01$), positive relationships. The strength of these relationships were $r^2 = 0.07$ for tissue N and $r^2 = 0.03$ for chlorophyll content. Linear regression of NDVI and GNDVI with tissue N from all data combined were highly significant ($P < 0.0001$), positive relationships. The strength of these relationships were $r^2 = 0.46$ for NDVI ($n = 576$) and $r^2 = 0.26$ for GNDVI ($n = 288$). NDVI was a better indicator of creeping bentgrass tissue N and visual color than GNDVI. NDVI may prove to be a useful tool for the potential of creating a variable rate N fertilizer applicator for precision N management on golf greens.

Keywords: creeping bentgrass, N, chlorophyll, color, NDVI, GNDVI

INTRODUCTION

Creeping bentgrass (*Agrostis stolonifera* L.) golf course greens are intensively managed to provide acceptable playing conditions. Nitrogen is an essential plant element that is required for growth and is the major nutrient that affects turfgrass growth rate and color response and can be directly measured in tissue or soil, but the process is destructive, expensive, and labor intensive (Biermacher et al., 2008). Indirect measurement of tissue N through optical sensing may provide turfgrass managers with inexpensive, real time measurements of turfgrass tissue N status. The objective of this study was to determine the effect of N rate on 'Crenshaw' creeping bentgrass tissue N, chlorophyll concentration, and color using the *GreenSeeker*TM (NTech Industries, Ukiah, CA) handheld sensor.

MATERIALS AND METHODS

Plots (0.9 X 1.5 m) were established at the Oklahoma State University Turfgrass Research Center in Stillwater, OK in a randomized complete block design with 4 replications and plots were evaluated during 2003 and 2004. Treatments consisted of plots fertilized with 0, 6.1, 12.2, 24.4, 36.6, and 48.8 kg N ha⁻¹ yr⁻¹. NDVI, GNDVI, tissue collection (N and chlorophyll), and color ratings (1-9 scale) were recorded every 15 d. Linear regression analysis and least significant difference mean separation test were performed using Statistical Analysis Software version 9 (SAS Inst., Cary, NC) at the 0.01 and 0.05 significance levels respectively.

RESULTS AND DISCUSSION

Average NDVI readings ranged from 0.701 to 0.795, average GNDVI readings ranged from 0.710 to 0.765, average tissue N ranged from 3.25 to 3.96%, average chlorophyll content ranged from 7.48 to 8.07 mg g⁻¹, and average color ratings ranged from 4.5 to 7.5 depending on N rate. Normalized difference vegetative index, GNDVI, tissue N, chlorophyll content, and visual color ratings significantly increased with increasing N application rates. Linear regression of N rate with tissue N ($n = 576$) and chlorophyll content ($n = 264$) from all data combined were significant ($P < 0.01$), positive relationships. The strength of these relationships were $r^2 = 0.07$ for tissue N and $r^2 = 0.03$ for chlorophyll content. Linear regression of NDVI and GNDVI with tissue N from all data combined were highly significant ($P < 0.0001$), positive relationships. The strength of these relationships were $r^2 = 0.46$ for NDVI ($n = 576$) and $r^2 = 0.26$ for GNDVI ($n = 288$). NDVI was a better indicator of creeping bentgrass tissue N and visual color than GNDVI. NDVI may prove to be a useful tool for the potential of creating a variable rate N fertilizer applicator for precision N management on golf greens.

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