DEVELOPMENT OF A PRECISION SENSING SPRAYER FOR THE APPLICATION OF NITROGEN FERTILIZER TO TURFGRASS

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ABSTRACT

Normalized difference vegetation index (NDVI) may be very useful for turfgrass managers to measure turf quality and obtain an indirect measurement of turf N status. The objective of this research was to develop a Nitrogen Fertilization Optimization Algorithm (NFOA) for use in a turfgrass variable rate N applicator on bermudagrass [*Cynodon dactylon* (L.) Pers] fairways and creeping bentgrass (*Agrostis stolonifera* L.) greens in Oklahoma. Plots (0.9 X 1.5 m) were established in Stillwater, OK on a sand based 'Crenshaw' creeping bentgrass green and a Norge silt loam (fine-silty, mixed, active, thermic Udic Paleustolls) common bermudagrass fairway in a randomized complete block design with 10 replications. Treatments consisted of plots fertilized with 0, 12.2, 24.4, 36.6, 48.8, and 61 kg N ha^{-1}. Handheld *GreenSeeker*^{TM} sensors (NTech Industries Inc, Ukiah, CA) were used to obtain NDVI readings twice per month over two growing seasons. Multiple regression analysis ($NDVI_{14} = a + b_1R_{14} + b_2NDVI_0$) was performed where: $NDVI_{14}$ = NDVI of turf 14 d following fertilization (Target NDVI), a = intercept, b_1 = regression coefficient for N application rate, R_{14} = N application rate in kg N ha^{-1}, b_2 = regression coefficient for NDVI prior to fertilization, and $NDVI_0$ = NDVI prior to fertilization (Current NDVI). Coefficients of determination for predicting N application rate for creeping bentgrass and common bermudagrass averaged $r^2 = 0.78$ and $r^2 = 0.76$, respectively and were highly significant ($P < 0.0001$), positive relationships.

Keywords: NDVI, creeping bentgrass, bermudagrass, N, fertilizer, turf

INTRODUCTION

A typical Oklahoma golf course consists of bermudagrass (*Cynodon* spp.) tees, fairways, and roughs and creeping bentgrass (*Agrostis stolonifera* L.) greens. Normalized difference vegetation index (NDVI) readings from optical sensors may be very useful for turfgrass managers to measure turf quality and obtain an indirect measurement of turf N status (Bell and Xiong, 2008). Turfgrass managers are not concerned with increasing yield, but are concerned with improving or maintaining adequate turfgrass quality for their particular playing conditions. The objective of this research was to develop a Nitrogen Fertilization Optimization Algorithm (NFOA) for use in a turfgrass variable rate N applicator on bermudagrass [*Cynodon dactylon* (L.) Pers] fairways and creeping bentgrass greens in Oklahoma.

MATERIALS AND METHODS

Plots (0.9 X 1.5 m) were established in Stillwater, OK on a sand based 'Crenshaw' creeping bentgrass green and a Norge silt loam (fine-silty, mixed, active, thermic Udic Paleustolls) common bermudagrass fairway in a randomized complete block design with 10 replications. All plots were irrigated to prevent stress and monthly N fertilizer treatments were 0, 12.2, 24.4, 36.6, 48.8, and 61 kg N ha^{-1}. Handheld *GreenSeeker*^{TM} sensors (NTech Industries Inc, Ukiah, CA) were used to obtain NDVI readings twice per month during the growing season in 2004 and was repeated during the spring of 2005. Multiple regression analysis ($NDVI_{14} = a + b_1R_{14} + b_2NDVI_0$) was performed where: $NDVI_{14}$ = NDVI of turf 14 d following fertilization (Target NDVI), a = intercept, b_1 = regression coefficient for N application rate, R_{14} = N application rate in kg N ha^{-1}, b_2 = regression coefficient for NDVI prior to fertilization, and $NDVI_0$ = NDVI prior to fertilization (Current NDVI).

RESULTS AND DISCUSSION

Coefficients of determination for predicting N application rate for creeping bentgrass and common bermudagrass averaged r^2 = 0.78 and r^2 = 0.76, respectively and were highly significant (P <0.0001), positive relationships. The results indicate that under well-irrigated conditions, monthly NDVI readings from the *GreenSeeker*^{TM} sensors may be very useful for estimating N application rate required to maintain creeping bentgrass greens and bermudagrass fairways. Target NDVI readings could be obtained monthly by maintaining a non-N limiting plot of turf, however further research is needed to determine if the turfgrass variable rate N application will provide similar turf visual and functional quality when compared to a single-rate broadcast N application.

REFERENCES

Bell, G.E. and X. Xiong. 2008. The history, role, and potential of optical sensing for practical turf management. p. 641-660. *In* M. Pessarakli (ed.) Handbook of Turfgrass Management and Physiology. CRC Press, Boca Raton, FL.