Creeping Bentgrass response to a stabilized amine form of nitrogen fertilizer

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Abstract
PiNT+potassium (PiNT+K) is a newly developed amine form of N fertilizer that is stabilized by reaction with the potassium cation. The influence of PiNT+K and an analog fertilizer (KNO_3 and NH_4NO_3) on the quality of creeping bentgrass were compared at different N rates (0, 25, 37.5 and 50 kg N/ha). At the same N rate, the normalized difference vegetation index (NDVI) of the PiNT+K treatments was 2-3% higher than the analog treatments, while the dark green color index (DGCI) was 4-7% higher. Fertilizer burn (osmotic desiccation) was observed on plots treated with the analog fertilizer, but treatments with PiNT+K appeared safe from osmotic desiccation even at high N rates. The application N rate of 37.5 kg N/ha of PiNT+K outperformed the analog fertilizer at 50 kg N/ha when the quality of creeping bentgrass, turfgrass management, and N use efficiency were considered. The PiNT+K treatment yielded better quality as measured by NDVI and DGCI, yielded similar above-ground biomass, and had less unused N (N application – N uptake) in comparison to the analog fertilizer.

Key Words
Nitrogen, amine, turfgrass, fertilizer.

Introduction

Nitrogen fertility is an important component of putting green management. Under optimal growing conditions and nutrient sufficiency, no other plant nutrient has as significant an influence on turfgrass canopy color and vigor (Waddington *et al.* 1978), root-to-shoot ratios (Schlossberg and Karnok 2001), or disease susceptibility (Davis and Dernoeden 2002). The N fertilizers can be divided into categories of fast- and slow-release sources (Guillard and Kopp 2004; Schlossberg and Schmidt 2007). Use of quick-release fertilizers is appropriate for correcting N deficiency, but may also yield greater biomass and have greater leaching. Less frequent applications can safely be made to turfgrass using slow-release N fertilizers. Slow release fertilizers steadily supply available nutrients and minimize risks of leaching and osmotic tissue desiccation (Carrow *et al.* 2001). The effect of these two sources of N on turfgrass quality and NO_3 leaching has been investigated in previous studies (e.g., Engelsjord and Singh 1997; Guillard and Kopp 2004; Saha *et al.* 2007). PiNT+potassium (PiNT+K) (Plant Impact Inc., Preston, UK) is a uniquely controlled uptake nitrogen /potassium fertilizer formulated to support plant quality, yield, root promotion and stress tolerance. The liquid PiNT+K fertilizer contains 13.7% stabilized NH_2, 1.3% NO_3, 7% K_2O, and 0.17% patented Speedo chemistry (Plant Impact Inc., Preston, UK). This unique manufacturing chemistry keeps the N in the amine form to support a better growth habit - more reproductive development growth of specialty horticultural crops (e.g., flowers and fruit) without over-stimulating vegetative growth. However, there is no published scientific information on the effect of PiNT+K on turf growth. The objective of this study was to compare shoot growth, nutrient concentration, and color of a creeping bentgrass (*Penn A-1/A-4*) putting green in response to typical nitrogen fertilizer application rates using PiNT+K versus a soluble analog fertilizer (prepared using KNO_3 and NH_4NO_3).

Materials and methods

A fertility trial was conducted on a Penn A1/A4 creeping bentgrass (*Agrostis stolonifera L.*) putting green, established in 2005 to a sand/sphagnum peat moss root zone maintained within the Penn State University Joseph Valentine Turfgrass Research Center, University Park, PA, USA. Plots (0.9 x 2.1 m) were mowed 6-7 times weekly at a height of 3.1 mm (⅛”). Clippings were collected for N content analysis and were not returned to the putting greens. Potable irrigation was applied to prevent plant wilt, but fertilizer treatments were not watered in. Replicates of six fertilizer treatments (and an untreated control) were randomly assigned to each of four blocks. An analog fertilizer (13–0–7) was formulated using KNO_3 and NH_4NO_3 for comparison to PiNT+K. On 20 July 2009, PiNT+K and analog fertilizers were applied to deliver 25, 37.5, or 50 kg N/ha in an 815 L/ha spray volume using a CO_2–pressurized, single nozzle wand (Tee-Jet TP11008E, Spraying Systems Co., Wheaton, IL). Concomitant K_2O deliveries from either fertilizer were 11.7 or 23.3 kg

K/ha, respectively. Observed N deficiencies in plots of both fertilizers receiving the 25 kg N/ha rate required reapplication of 25 kg N on 10 August, for a total application of 50 kg N/ha.

Two to five days per week, duplicate simultaneous measures of 660– and 850–nm light reflectance from the canopy of each bentgrass putting green plot were recorded using an ambient light-excluding FieldScout TCM–500 turfgrass chlorophyll meter (Spectrum Technologies Inc., Plainfield, IL). Reflectance data were used to calculate normalized differential vegetative indices (NDVI). Duplicate measures of percent green, red, and blue canopy reflectance collected by a color meter (FieldScout TCM-500-RGB) were converted to hue, saturation, and brightness levels to determine dark green color index (DGCI; Karcher and Richardson 2003). The week following fertilizer applications, above-ground biomass was collected every 6-7 d. Plant tissue was dried at 70ºC, ground to pass 1-mm sieve, and analyzed for total Kjeldahl nitrogen (TKN). Treatment effects on NDVI, DGCI, above-ground biomass, TKN, and N uptake were determined by ANOVA.

Results and discussion

NDVI and DGCI

The NDVI and DGCI, derived from multispectral data, have been widely used as an assessment of the overall health and quality of turfgrass (e.g., Fitz-Rodriguez and Choi 2002; Karcher and Richardson 2003; Xiong *et al.* 2007). Higher NDVI and DGCI were observed with PiNT+K compared to the analog N fertilizer (Figure 1). Generally at a given N rate, NDVI with PiNT+K was 2-3% greater than with the analog, while the DGCI was 4-7% greater. At 25 kg N/ha, NDVI was greater with PiNT+K (p<0.1) than with the analog on 13 of 24 measurement dates (data not shown), while at 37.5 and 50 kg N/ha, NDVI was greater with PiNT+K on 18 and 11 dates, respectively. Similarly, at 25 kg N/ha, DGCI was greater with PiNT+K on 10 of 22 dates, while at 37.5 and 50 kg N/ha, DGCI was greater with PiNT+K on 10 and 8 measurement dates, respectively. Differences in NDVI and DGCI between PiNT+K at 25 or 37.5 kg N/ha and analog at 50 kg N/ha were not significant (p<0.05) on most measurement dates.

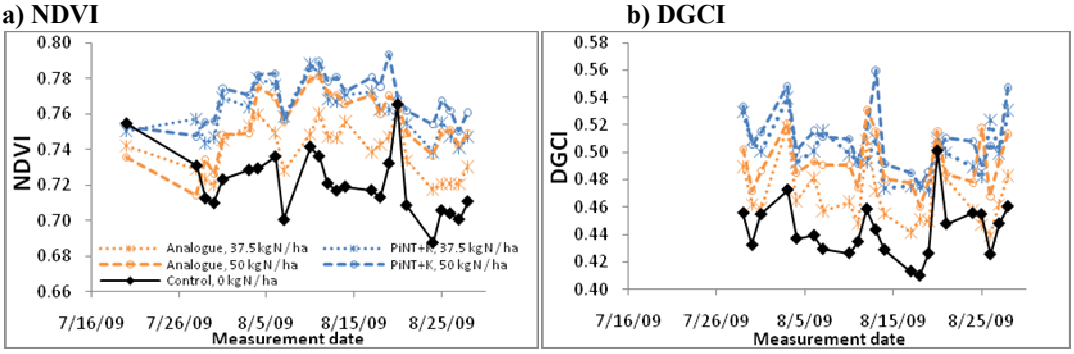


Figure 1. Temporal variations of a) NDVI and b) DGCI with different treatments.

Fertilizer burn (osmotic desiccation) is a concern for turfgrass management. In Figure 2, treatments with PiNT+K appeared rather safe from osmotic desiccation even at high N rates. However, treatments with the analog fertilizer, especially at high N rates, showed osmotic desiccation. The deviations of NDVI and DGCI of the PiNT+K treatments from the control were positive and significantly (p<0.05) greater than those of the analog.

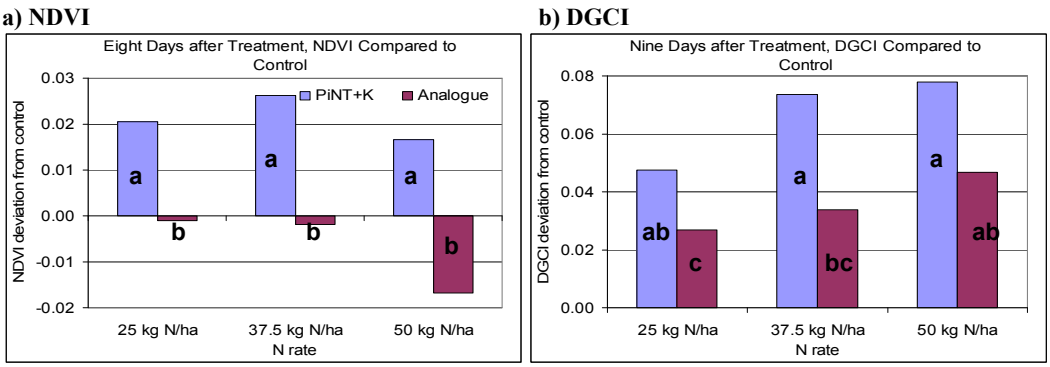
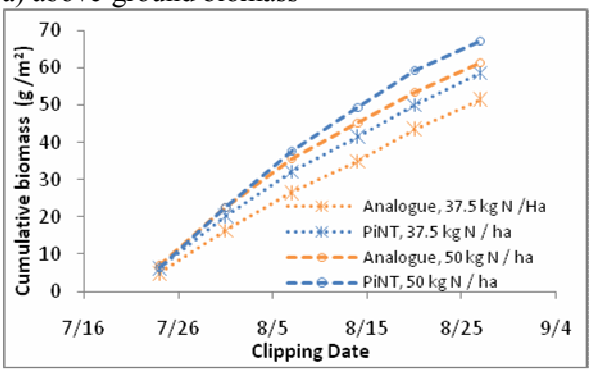


Figure 2. The deviations of a) NDVI and b) DGCI of fertilized treatments from control. In each graphic, bars with the same letter are not significantly different at p<0.05.

Above-ground biomass produced with PiNT+K at 37.5 kg N/ha was similar to that produced with the analog at 50 kg N/ha (Figure 3a; Table 1). By the end of the trial (8/27/2009), there was no significant difference in cumulative N uptake between PiNT+K at 37.5 kg N/ha and the analog at 50 kg N/ha (Figure 3b and Table 1). However, there was significantly less unused N (N applied - N uptake) with PiNT+K at 37.5 kg N/ha compared to the analog at 50 kg N/ha (Table 2).

Above-ground biomass and N uptake

a) above-ground biomass



b) N uptake

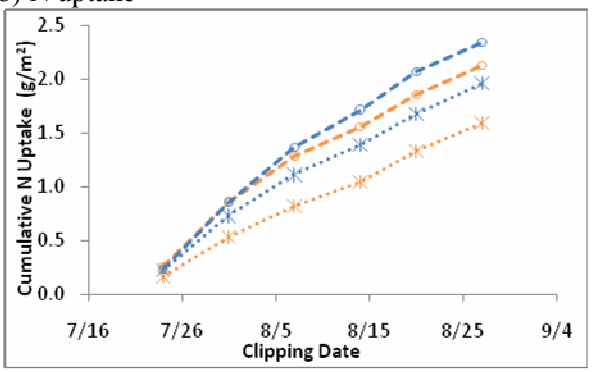


Figure 3. Cumulative curves of a) above-ground biomass and b) N uptake of creeping bentgrass with treatments (Trt) of PiNT+K and the analog at 37.5, and 50 kg N/ha.

Table 1. Comparing the cumulative above-ground biomass and N uptake on 8/7/2009 and 8/27/2009 of PiNT+K and analog treatments. For cumulative above-ground biomass or N uptake on each date, numbers with the same letter are not significant at $p<0.05$.

N rate (kg/ha)	Cumulative above-ground biomass (g/m^2)				Cumulative N uptake on (kg/ha)			
	8/7/2009		8/27/2009		8/7/2009		8/27/2009	
	PiNT+K	Analog	PiNT+K	Analog	PiNT+K	Analog	PiNT+K	Analog
37.5	32.2a	26.5b	58.5a	51.5b	11.1b	8.2b	19.6a	15.9b
50	37.6a	35.7a	67.1a	61.4a	13.7a	12.9a	23.4a	21.3a

Table 2. Comparison of N uptakes and N applied in creeping bentgrass treated with PiNT+K and analog at 37.5 and 50 kg N/ha. The unused N remaining is the difference between N applied and N uptake. At each day, numbers with the same letter are not significant at $p<0.05$.

Treatment	N applied (kg N/ha)	Unused N on 8/7/2009 (kg N/ha)	Unused N on 8/27/2009 (kg N/ha)
Analog, 37.5 kg N/ha	37.5	29.3ab	21.6ab
PiNT+K, 37.5 kg N/ha	37.5	26.4b	17.9b
Analog, 50 kg N/ha	50	37.2a	28.7a
PiNT+K, 50 kg N/ha	50	36.3a	26.6a

Conclusions

The responses of creeping bentgrass growth to PiNT+K and an analog N (KNO_3 and NH_4NO_3) were compared in this study. Greater quality of creeping bentgrass (greater NDVI and DGCI) was observed with PiNT+K at all rates. PiNT+K treatments did not exhibit osmotic desiccation. The 37.5 kg N/ha rate of PiNT+K was comparable to the analog at 50 kg N/ha in terms of vegetative growth and N uptake; unused N was significantly less, indicating greater N use efficiency of PiNT+K over the period of this trial. Using PiNT+K at the lower rate resulted in similar NDVI and DGCI measurements as the analog with greater N rates while producing similar or slightly less above-ground biomass, both of which are desirable characteristics for maintaining healthy and fast putting greens.

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