Supplemental Nickel Applications and Foliar Urea Fertility on Two Warm–Season Turfgrass Species under Salinity Stress

Haibo Liu and Nick Menchyk
Clemson University

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Objectives:

1. *Assess urease activity in leaf tissue of two turfgrass species after foliar applications of urea N,*
2. *Determine the effect of supplemental Ni applications on urease activity and amino acid content,*
3. *Determine if moderate salinity reduces urease activity and N metabolism in warm–season turfgrass leaf tissue and*
4. *Establish if Ni supplementation increases foliar urea N uptake and assimilation*

Elevated Ni concentrations are present naturally in serpentine soils, as well as in soils polluted by industrial processes. Nickel toxicity has been documented in a variety of plants to disrupt photosynthesis, and induce micronutrient deficiencies and oxidative stress. However no research has been performed investigating Ni toxicity in turfgrasses. An experiment repeated twice was conducted at the Clemson University greenhouse facility to examine Ni toxicity in two warm–season turfgrasses (Diamond zoysiagrass [*Zoysia matrella* (L.) Merr.] and TifEagle bermudagrass [*Cynodon dactylon* (L) Pers. X *C. transvaalensis* Burtt– Davy]), receiving four Ni concentrations (Control, 400, 800, and 1600 μM). A stimulation of urease activity and amino acid pool was documented with each increase in Ni supplied. However, visual toxicity symptoms and reductions in growth were

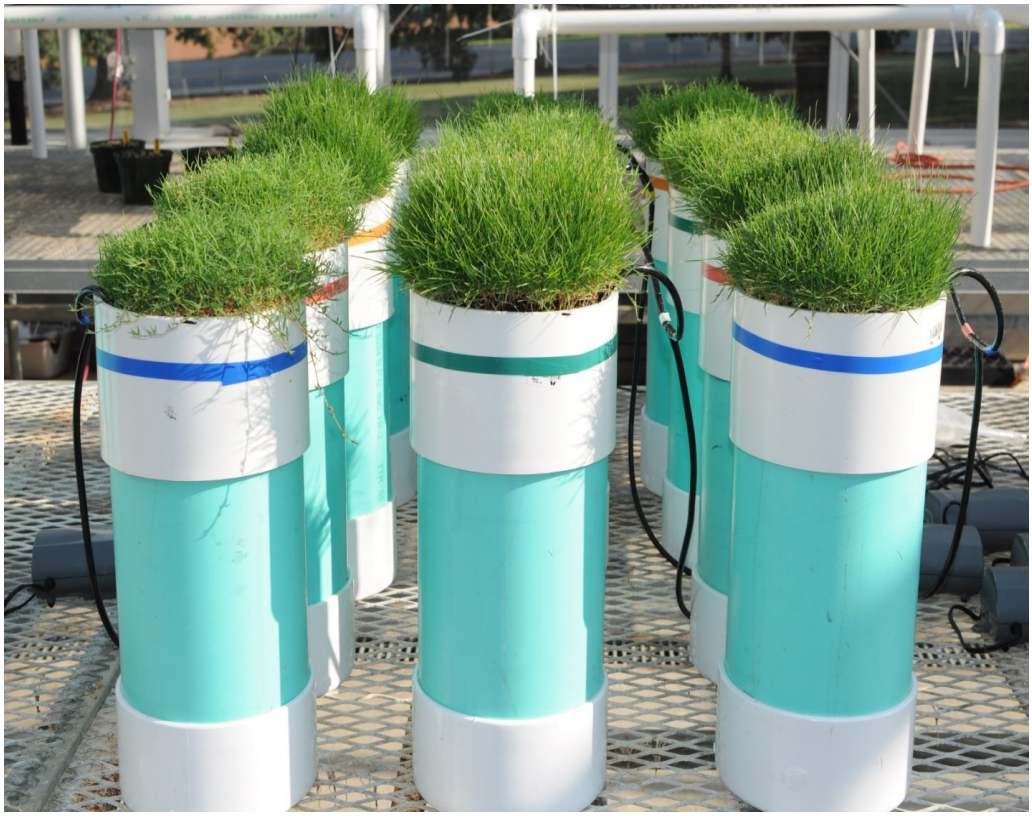

Figure 1. The greenhouse set up for the study with a hydroponic culture system of treatments of salinity and Ni at different levels. During the foliar application of N with the grass culture being removed to another container without to minimize the potential of contamination into the container´s solution.

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Table 1. Urease activity and amino acid content in leaf tissue of ´Diamond´ zoysiagrass and ´TifEagle´ bermudagrass as influenced by Ni concentration and turfgrass in Clemson University Greenhouse Research Complex during 2012.

Main effects	Urease	Amino Acid
	μmol NH_4^+ min^{-1} g^{-1}	mg g^{-1}
Ni μM (Ni)		
Control	66.30	25.90
400	93.70	23.90
800	102.00	30.60
1600	113.49	41.10
$LSD_{0.05}$	11.10	5.21
Turfgrass (TG)		
Diamond	81.30	29.70
TifEagle	106.49	31.00
ANOVA		
Source of variation		
Ni	***	***
TG	***	NS
Ni*TG	**	NS

* Significant at the 0.05 probability level.
** Significant at the 0.01 probability level.
*** Significant at the 0.001 probability level.

evident in turfgrasses receiving 400 μM Ni and reductions in turf quality and growth were more severe under 800 and 1600 μM Ni regimes, which resulted in Ni concentrations in leaf tissue of 226.54 and 419.57, respectively. Diamond and TifEagle exhibited a 34.1% and 46.4% reduction in clipping yield respectively at the highest Ni concentration supplied compared to the untreated control. Ni concentrations in leaf tissue greater than 28 mg kg^{-1} caused reductions in growth and symptoms of Ni toxicity. This study identified that negative impacts on Diamond and TifEagle growth and aesthetic value occurred when leaf tissue Ni concentration were >28 mg kg^{-1} but less than 100 mg kg^{-1}. Future research needs to look at Ni supplementations between 0 and 400 μM to determine turfgrass specific critical toxicity thresholds.

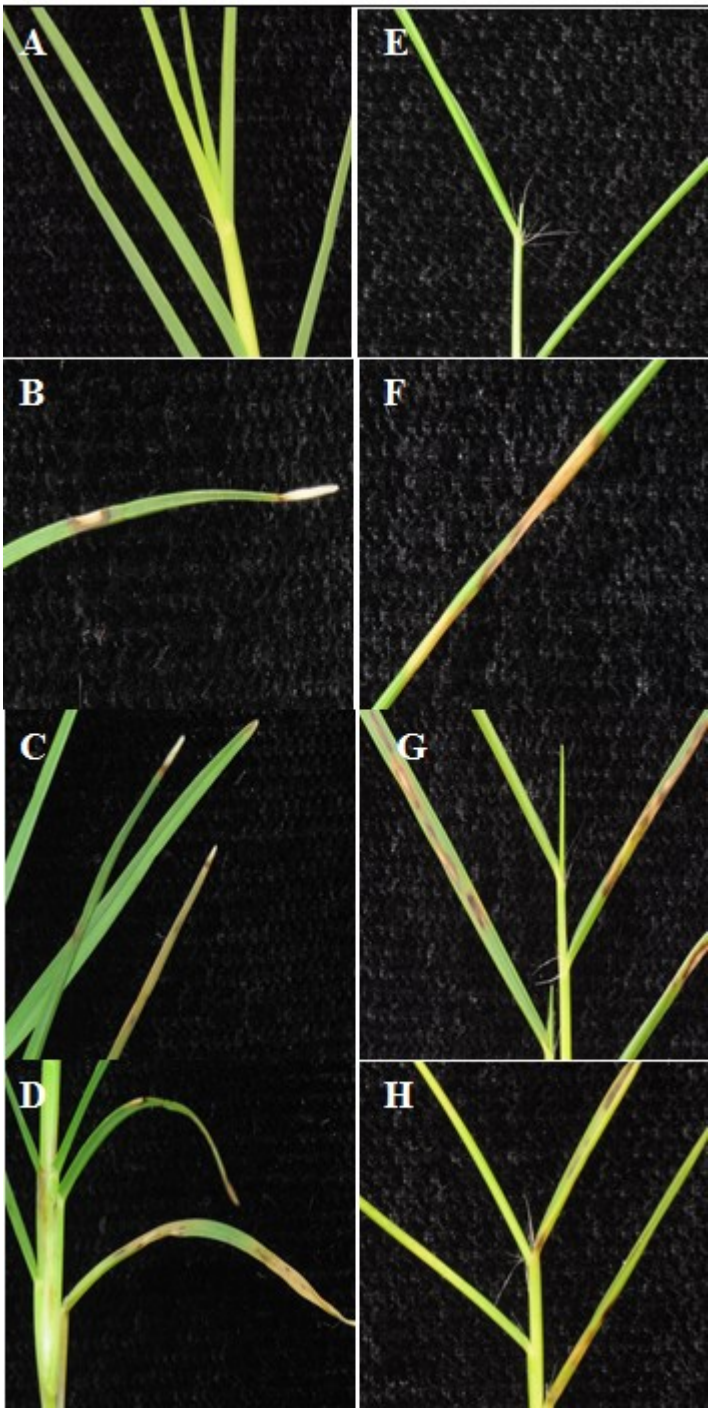

Figure 1. A–D, Ni toxicity symptoms on leaf tissue of TifEagle (Control, 400, 800, 1600 μM Ni). E–H, Ni toxicity symptoms on leaf tissue of Diamond (Control, 400, 800, 1600 μM Ni) at the conclusion of the study in the Clemson University greenhouse research complex during 2012.

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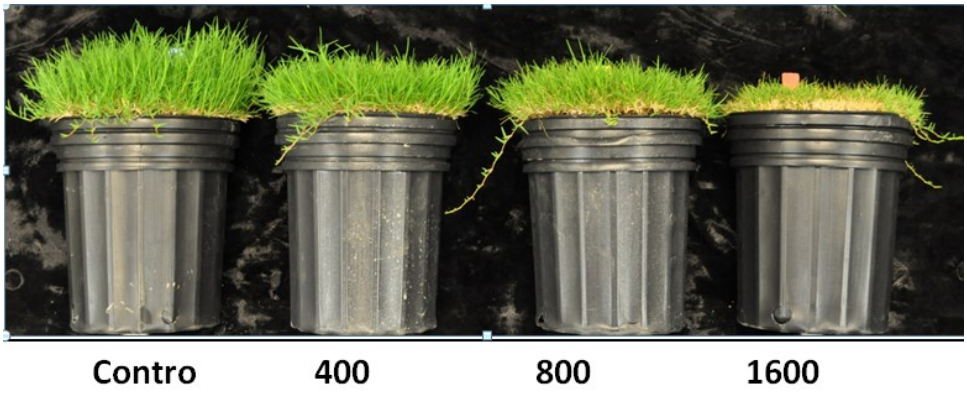

Figure 2. TifEagle bermudagrass growth reduction under five Ni levels (Control, 400, 800, 1600 μM Ni).

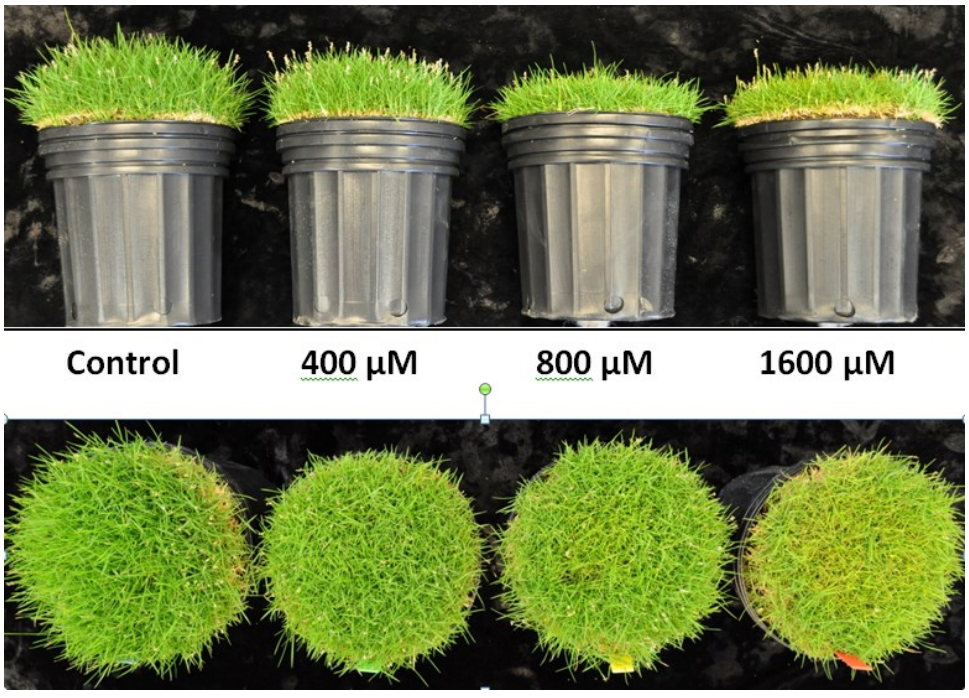

Figure 3. Diamond zoysiagrass growth reduction under five Ni levels (Control, 400, 800, 1600 μM Ni).

Summary Points

- This is the first study examining Ni toxicity of warm–season turfgrasses.
- Stimulation of N metabolism was recorded by increases in urease activity and amino acid content, however, increased Ni concentration in leaf tissue led to symptoms of toxicity, alterations in nutrient status, and reductions in growth.
- The different growth responses of Diamond and TifEagle, suggest that while the critical Ni toxicity concentration is above 28 mg kg−1, it is most likely different for each of the two turfgrasses.
- Future research examining Ni nutrition and toxicity needs to be conducted to determine specific Ni requirement and critical toxicity thresholds for different turfgrass species, and when fertilized with different N sources. Additionally, research needs to be conducted to examine if Ni supplementation aids in foliar recovery of applied urea N and if foliar applications of Ni is beneficial for turfgrass quality.
- Lastly, research should focus on Ni requirement of turfgrasses along with long term ecological and physiological implications of Ni supplementation in turfgrass environments.

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