

Zoysiagrass Growth as Influenced by Nitrogen Source in a Greenhouse Trial

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Photo by Aaron Patton

Nitrogen source influences the growth of zoysiagrass in controlled environment conditions.

Summary. Zoysiagrass (*Zoysia* spp.) has a modest response to nitrogen (N) fertilization, especially during establishment, and there is no indication about its preference for mineral form. A greenhouse study was conducted to determine the effect of urea and nitrate as nitrogen sources on zoysiagrass. Plants were planted in sand and treatments were applied with a nutrient solution at five urea:nitrate ratios (100:0,

75:25, 50:50, 25:75, 0:100). Results of growth analysis indicate that zoysiagrasses prefer a solution with a 50:50, 75:25, or 100:0 ratio with $\geq 50\%$ urea. Root and stem mass were higher in treatments with urea. This study demonstrates that zoysiagrass' preference for N form affects growth when grown in a sand rootzone, which could lead to reduced N inputs and/or improved establishment in these soils.

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Despite zoysiagrass (*Zoysia* spp.) having modest responses to nitrogen (N) fertilization, especially during establishment (Richardson and Boyd, 2001), no information about the preference for mineral form is available. Nitrogen source has been documented to influence growth in creeping bentgrass (*Agrostis stolonifera*) and annual bluegrass (*Poa annua*) (Glinski et al., 1990; Schlossberg and Schmidt, 2007). Fertilizing with the majority of N as nitrate improved growth and rooting of creeping bentgrass (Glinski et al., 1990), whereas an annual bluegrass/bentgrass mixture preferred applications with the majority of N as ammonium (Schlossberg and Schmidt, 2007). To date, no one has examined the effect of urea:nitrate ratio on zoysiagrass leaf growth, color, and rooting, but an anecdotal report found that urea and ammonium sulfate resulted in superior shoot growth compared to ammonium nitrate (Hwang et al., 1991), suggesting that zoysiagrass may favor ammonium and urea N sources. Fertilizing zoysiagrass with the appropriate urea:nitrate N source could have a dramatic effect on rooting, growth, and color that could lead to reduced N inputs. A greenhouse study was conducted with the objective to determine how nitrogen source affects the growth and rooting of zoysiagrass cultivars.

Materials and Methods

Based on previous research (Patton et al., 2007), one slow-growing and one fast-growing cultivar of both *Zoysia japonica* and *Z. matrella* were selected and assessed for this experiment. *Zoysia japonica* cultivars El Toro (fast-growing) and Meyer (slow-growing) and *Z. matrella* cultivars Zorro (fast-growing) and Diamond (slow-growing) were clonally propagated as phytomers (1- to 2-cm segment of stolon or rhizome) containing root tissue, crown, and shoot material. Cultivars were planted in USGA specification sand-filled 3.8-cm diameter cone-tainers. The growth medium was rinsed twice with deionized water before planting to flush any nitrogen prior to planting.

The experiment was conducted twice in the greenhouse. Experimental replication 1 was plant-

ed 24 October 2008 and experimental replication 2 was planted 23 February 2009. Plants were watered daily for 1 wk after planting to prevent wilt during establishment. One week after planting, uniform plants were selected and randomly assigned one of five N treatments. Each plant was supplied 3 times weekly with a half-strength modified Hoagland nutrient solution (pH 6.50 ± 0.05) containing the appropriate ratios of urea:nitrate (100:0, 75:25, 50:50, 25:75, 0:100) and equivalent concentrations of other minerals. Cone-tainers were arranged in a randomized complete block design with 4 cultivars, 5 nitrogen treatment ratios, and 10 replications per trial. Treatments were applied for 10 wk until harvesting.

Whole plants were harvested 10 wk after treatment initiation and separated into root fraction, leaf fraction, and stem fraction (inclusive of stems, crowns, rhizomes, and stolons). Root and stem tissues were washed with water to remove the majority of sand, and then all tissues were dried separately (at least 72 h at 60 °C) and weighed. Prior to drying, root tissues were analyzed with WinRhizo (Regent Instruments Inc., Quebec, Canada) for root morphological characteristics.

Results and Discussion

Cultivar had a significant impact on several measurements including leaf, stem, and root weight, root density, root length, root surface area, root diameter, root volume, root tips, and the proportion of long, short, fine, and coarse roots (data not shown). For all these effects, the relative cultivar rankings of the treatments were typically as follows: El Toro > Meyer > Zorro > Diamond, which are similar to previous reports on the leaf and stem growth of these cultivars (Patton et al., 2007).

Nitrogen source impacted stem, root, and whole plant mass with increased growth resulting from applications containing ≥50% urea (Table 1). There was a cultivar by N source interaction for stem weight measurements, where 100% urea or 75:25 (urea:nitrate) produced the highest amount of stems for all cultivars except El Toro (data not shown). This could be due to El Toro's reported preference for alkaline soils, as plants with a pref-

erence for alkaline soils are known to prefer nitrate N (Marschner, 1995).

Nitrogen source also impacted root diameter and the ratio of fine:coarse roots (Table 1). Applications containing $\geq 50\%$ urea had the highest root diameter. Similarly, fine:coarse root diameter ratio was high from applications containing $< 50\%$ urea. Nitrogen source did not affect leaf mass, root length, root surface area, root volume, root tips, short roots, long roots, fine roots, or coarse roots.

It is not clear why solutions with greater percentages of urea improved plant growth compared to 75 or 100% nitrate solutions. Uptake rate is known to differ among N form in some plant species (Marschner, 1995), but uptake was not measured in our study. Nitrogen source preference is known to vary by plant species (Marschner, 1995). This is the first report of a preference for urea nitrogen among zoysiagrass cultivars. Preliminary field research comparing ammonium nitrate, calcium nitrate, and urea indicates that increased zoysiagrass growth in sand in the greenhouse from applications of urea may not occur in native field soils.

Results of growth analysis indicate that zoysiagrasses prefer a solution with a urea:nitrate ratio with $\geq 50\%$ urea. Whole plant, root and stem mass were higher in treatments with urea. No specific difference among treatments was noticed for root volume, number of root tips, or root density. This study demonstrates that zoysiagrass' preference for N form affects growth when grown in a

sand rootzone, which could lead to reduced N inputs and/or improved establishment in these soils. Zoysiagrass growth (stem, root, whole plant, root diameter) was increased with a higher proportion of urea N instead of nitrate N when grown in sand, but preliminary field research indicates that this relationship may not occur in native field soils.

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Table 1. Effect of ratios of urea:nitrate (100:0, 75:25, 50:50, 25:75, 0:100) in a modified Hoagland's solution on whole plant mass, stem mass, and root characteristics across four zoysiagrass cultivars.

Nitrogen ratio	Whole plant mass	Stem mass	Root mass	Root diameter	Fine:coarse
					root diameter ratio
	-----g-----				
	-----mm-----				
100% nitrate	0.77 c ^z	0.436 c	0.083 b	0.249 c	0.804 a
25:75 (urea:nitrate)	0.85 bc	0.494 bc	0.090 b	0.253 bc	0.629 ab
50:50 (urea:nitrate)	1.02 ab	0.584 ab	0.100 ab	0.259 abc	0.616 b
75:25 (urea:nitrate)	1.08 a	0.615 a	0.115 a	0.267 ab	0.493 bc
100% urea	1.07 a	0.607 a	0.114 a	0.273 a	0.432 c

^z Values in a column followed by the same letter are not significantly different (LSD, $\alpha = 0.05$).