Leaf Cuticle Characteristics and Foliar Nutrient Uptake by a Cool-season and Warm-season Turfgrass

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Objectives:

1. Determine the seasonal dynamics of the turfgrass cuticle in a cool-season and warm-season turfgrass species managed under putting green conditions.
2. Compare the seasonal uptake of foliar nitrogen by a cool-season and warm-season turfgrass species managed under putting green conditions.

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Project Duration: two years
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Foliar fertilization refers to the process of nutrient uptake through the foliage or other aerial plant parts. Foliar fertilization has been observed to be an increasingly common practice in today's golf course management. Recent surveys of Arkansas golf course superintendents indicate that nearly all golf course superintendents use foliar fertilization on some area of their golf course, and this method of nutrient application often comprises a major portion of annual nitrogen (N) inputs to putting greens.

Although previous research has documented uptake of N by turfgrass leaves in controlled-environment studies, there have been no studies which demonstrate its potential effectiveness in a field environment. It is known from previous agricultural research that environmental factors and seasonal dynamics of leaf cuticle characteristics can influence the foliar absorption of N solutions. Therefore, the aim of this project is to increase scientific understanding of the turfgrass leaf cuticle, while assessing foliar uptake of N during a two-year putting green research trial.

Experimental areas of 'Penn A1' creeping bentgrass and 'Tifeagle' ultradwarf bermudagrass were developed on an established sand-based putting green in Fayetteville, Arkansas. The greens were maintained according to typical management practices for the region. Foliar uptake of N was studied each month from May to September to determine if foliar uptake was consistent across the growing season.

An isotopic tracer technique that allows for positive identification and direct measurement of fertilizer N in the plant tissue was used in the study. Solutions of ^{15}N-labeled urea (~2 atom %) were sprayed at two different rates to represent a low and high rate (0.10 or 0.25 lb. N / 1000 ft^2) common to foliar fertilization rates of golf course superintendents. For a 24-hour period after treatment, plots received no irrigation or rainfall in order to track only foliar absorption of N. Plant tissues were sampled at 1, 4, 8, and 24 hours after application. In addition, an enclosed chamber with an internal acid trap was installed within the plots after treatment to estimate the volatilization of N as ammonia from the plots. Plant cores were sampled and analyzed for total wax load associated with the cuticle and for components of the cuticle wax.

Golf course superintendents often use foliar fertilization as a primary means of feeding putting greens.

Results from our two-year field trial indicate that both species are receptive to foliar uptake of urea-N and ammonia volatilization losses were minimal (averaged < 2% of applied N). Ranges of 24-57% and 32-67% of the fertilizer N applied were recovered in leaves/shoots at 1 hour after treatment across months in 2007 and 2008, respectively. Peak foliar absorption was normally observed around 4 hours after treatment and the vast majority of the N, which would enter the leaf tissue after 24 hours, had already been absorbed at an earlier time interval.

Foliar uptake, when measured as a percentage of N applied, was significantly reduced at higher application rates. While this effect was statistically significant and observed on both species, it was not likely agronomically significant as the difference was only 5% (low vs. high rate) when averaged over all treatment dates and sampling times.

Absorption of urea-N by bentgrass and ultradwarf bermudagrass leaves was affected by month of application and year. Depending on month and/or year of application, values for foliar uptake of urea-N at 24 hours ranged anywhere from 36-70% of that which was applied on both species. Overall, foliar absorption efficiency, after spraying urea-N to putting green turf, was variable and there were no consistent seasonal trends associated with these differences.

Chemical extraction of bentgrass leaf cuticle wax in the laboratory showed a highly significant relationship between total wax load and percentage of N recovered in leaf/shoot tissue; however, the variability associated with our foliar uptake values could not be fully explained by cuticle wax amounts alone. Clearly, the foliar absorption process is complex and continued research is needed to better understand the overriding influences and factors in order to maximize the efficiency of foliar applications on golf course putting green turf.

Summary Points

- Both creeping bentgrass and ultradwarf bermudagrass greens are receptive to foliar uptake of urea nitrogen.
- Most of the nitrogen applied to putting green turfgrass foliage is absorbed in the first 4 hours after application.
- Foliar uptake in creeping bentgrass was reduced during warmer months, suggesting a change in the composition of the leaf cuticle.
- Loss of foliar-applied nitrogen to ammonia volatilization appears to be minimal.