Optimization of Foliar Nitrogen Nutrition to Improve Turf Performance Under Energy Stress

Shelby Henning, Bruce Branham, and William Sharp
University of Illinois

Objectives:

1. To determine the efficiency of N uptake from foliar feeding, particularly when done in combination with other turf-care products.
2. To determine the positive or negative benefits of foliar nitrogen applications on the energy status of highly managed turfgrass.
3. To determine fertilizer use efficiency through foliar feeding versus conventional fertilization in the field.
4. To determine the effect of foliar nitrogen applications on root and shoot growth, development, and performance.
5. To determine whether foliarly applied nitrogen is effectively utilized by plants that are mowed regularly.

Start Date: 2007
Project Duration: three years
Total Funding: $88,810

Plants primarily assimilate nitrogen through root uptake of nitrate from the soil solution. Plants must convert nitrate to ammonia before it can be incorporated into nucleic acids, proteins, and other nitrogen containing compounds. It is estimated that plants can use almost 25% of their photosynthetically derived energy in this conversion process. One possible way to reduce this energy-intensive process is to provide nitrogen in the form of ammonia, typically as urea or ammonium sulfate, directly to the plant so that the nitrate to ammonia transformation process does not have to occur.

In the soil, applications of ammoniacal nitrogen fertilizers are counterproductive as ammonium is quickly assimilated by microorganisms, a process which removes the nitrogen from the soil solution, or converted to nitrate. In addition, since ammonium is a positively charged molecule, it binds to negatively charged soil particles. This phenomenon may be counteracted by applying ammonium fertilizers directly to the leaves of the plant, where it may be absorbed and assimilated without interference from soil and microorganisms.

Both urea and ammonium sulfate applications were made to 1 ft^2 plots using a single-boom backpack-type sprayer. Treated plots were covered with a plywood sheet with 1 ft^2 hole cut out of the middle to limit the amount of land treated with ^{15}N.

Our research seeks to understand the practice of foliar fertilization and determine the positive or negative impacts of this process. By applying fertilizers enriched with ^{15}N, a naturally occurring stable isotope of nitrogen that has a natural abundance of only 0.36%, nitrogen uptake can be directly measured and tracked throughout the plant. We can determine the amount of uptake by determining the ratio of ^{14}N to ^{15}N in the plant (or soil). Any increase in abundance of ^{15}N above the normal level of 0.36 % is due to uptake of the fertilizer.

In field studies conducted during the summer of 2007, both urea and ammonium sulfate were applied to creeping bentgrass maintained at fairway height. The application rate of each fertilizer was 0.2 lbs. N/1000 ft^2, using a spray volume of 1 gallon/1000 ft^2. Applications were made to 1 ft^2 plots using a single-boom backpack-type sprayer. Treated plots were covered with a plywood sheet with 1 ft^2 hole cut out of the middle to limit the amount of land treated with ^{15}N.

Early trials indicated that ammonium sulfate was taken up as effectively as urea but caused unacceptable turf injury during hot (>70^{o} F) weather. Data suggest that most nitrogen applied to the foliage in ammonium form is absorbed by the plant within 4-6 hours. In addition, it appears that uptake efficiency is greatly reduced during periods of very hot (>90F) weather. Also, there is daily flux of nitrogen in the leaves of turf, indicating that there may be rapid transport of the nutrient throughout the plant during the day.

Early trials indicated that ammonium sulfate was taken up as effectively as urea but caused unacceptable turf injury during hot (>70F) weather.

We have repeated the uptake efficiency study during the cooler weather of fall to determine the role of temperature in uptake efficiency. We have also tested the effects of adjuvants, tank-mixing with pesticides, and spray volume on uptake efficiency. These trials have been completed ,but the process of analyzing the leaf tissue for ^{15}N is a laboratory procedure that will be completed by December, 2007.

In addition, we are developing a technique to measure the amount of nitrogen left on the leaf surface after foliar application. This will assist in determining how long fertilizer stays on the leaf surface post-application. We are also planning a study to compare the uptake efficiency of ammonium fertilizers as applied to the soil or the foliage, and in combination.

Summary Points

- Differences in foliar uptake of nitrogen from urea or ammonium sulfate are slight.
- Ammonium sulfate is unacceptable for use as a foliar fertilizer during periods of hot weather.
- The majority of foliar uptake of ammoniacal nitrogen occurs within 4-6 hours, with maximum absorption taking place by 24 hours.