# CLCA Environmental Research Funding Program
# Progress Report (1/1 to 12/1/2010)

**Project Title:** **Grasscycling as a Tool for Reducing Green Waste and Fertilizer Use on Tall Fescue Lawns in California**


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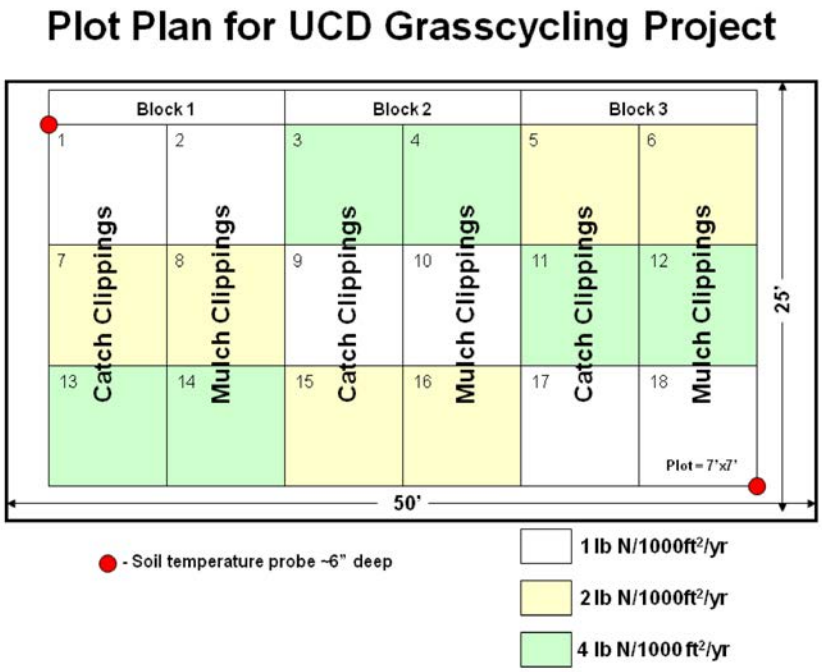
## Executive Summary


A tall fescue research plot has been established on the UC Davis campus to study grasscycling. Two factors are being studied: 1) type of mowing technique (mulched clippings versus caught and removed clippings) and 2) rate of nitrogen fertilization (1, 2, and 4 lb. N/1000 $ft^2$/year). Based on clipping yield data collected in 2010 we estimate 0.7, 1 and 1.8 lb. N/1000 $ft^2$/year were removed from plots receiving 1, 2, and 4 lb. N/1000 $ft^2$/year, respectively. Grasscycling would reduce or avoid this loss of nitrogen and require less nitrogen be applied to lawns. There was no significant difference in clipping yields throughout the year between the two mowing treatments. As expected, higher nitrogen fertilization rates led to higher clipping yields. From May, 2009 to November, 2010, NDVI (Normalized Difference Vegetation Index) as a measure of turfgrass color dropped below the acceptable level (0.6) during the winter and late-summer months for the 1 and 2 lb. N/1000 $ft^{2/}$/year rates. The 4 lb. N/1000 $ft^2$/year rate never dropped below the 0.6 threshold. Soil Electrical Conductivity (EC) increased with increasing fertilizer rates. No other soil characteristic measured (e.g. organic matter, total N, total C, $NO_3^-$ or $NH_4^+$ ) was affected by either the fertilizer or mowing treatments. As long as the tall fescue was growing rapidly very little if any nitrogen moved passed the rootzone. Total nitrogen in leaf tissue increased as fertilizer rate increased during the summer months of 2010. Mowing technique did not affect total nitrogen in leaf tissue. A successful protocol for collecting and measuring $N_2O$ has yet to be completed.

## Research Project Set-up

A tall fescue (*Festuca arundinaceae* cv. El Camino purchased from Sierra Sod, Davis, CA) research plot was established on the UC Davis campus in November, 2008. The plot has an automated irrigation system that applies water at 80% $ET_0$. Weekly $ET_0$ values were obtained from the UC Davis CIMIS (California Irrigation Management and Information System) and used to determine "valve on" times for the irrigations (3 per week).

Mowing and fertilization treatments using a randomized complete-block design were imposed in March, 2009 and have been maintained to date. The mowing treatments were imposed using a Black and Decker Model 1200 battery operated electric mower. The mower could be set-up to catch clippings (Catch treatment) or mulch the clippings (Mulch treatment). The fertilizer treatments were varying amounts of a 16-8-8 fertilizer (Simplot Mini-Turf) providing 1, 2 or 4 lbs. N/1000 $ft^2$/year. The yearly nitrogen amounts were divided over 4 applications performed on March 15, May 15, August 15 and October, 15. There were three blocks on the plot. In each block each combination of mowing treatment and fertilizer treatment were included in 7' by 7' plots.



## Results and Discussion

*Clipping Yield*

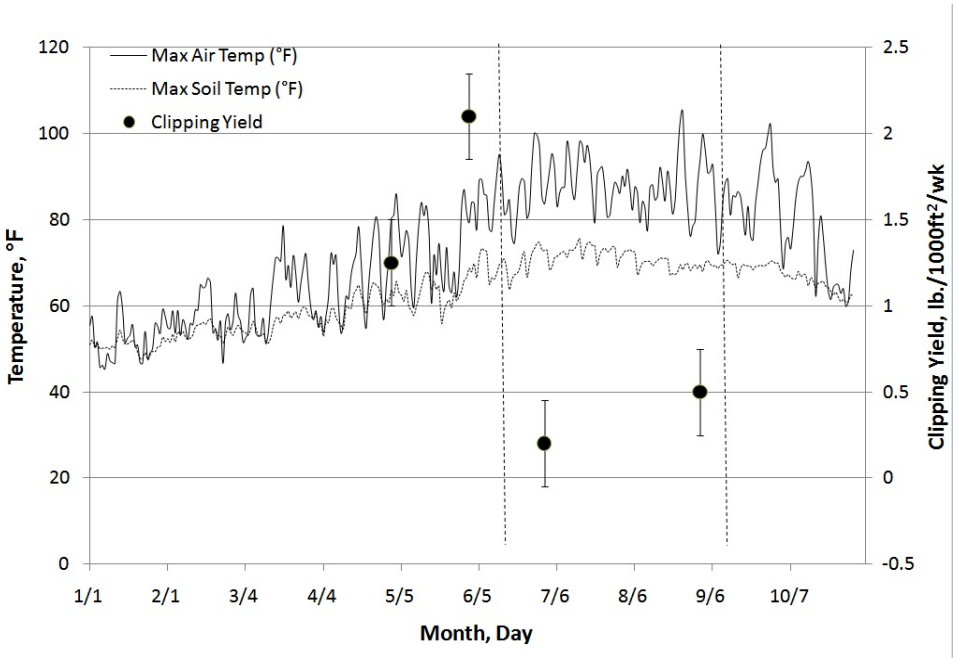
Clipping yield determinations were made roughly each month during the growing season. After mowing the borders of each 7'x7' plot, a single pass of the mower (~9.5 $ft^2$) was made through the center of the plot with the resulting clippings thrown by the mower into pre-weighed, numbered cotton bags. The fresh and dry mass of the clippings after 1 week's growth could then be determined for each plot.

| Fertilizer Rate (lb. N/1000 $ft^2$/year | Clipping Yield (lb./1000$ft^2$/week) | Yearly Yield* (lb./1000$ft^2$/year) | Nitrogen Removed* (lb./1000$ft^2$/year) |
|---|---|---|---|
| 1 | 0.6 | 24 | 0.7 |
| 2 | 0.8 | 32 | 1 |
| 4 | 1.5 | 60 | 1.8 |
| | | * Assume 40 weeks of mowing | *Assume nitrogen content in leaves is 3% |

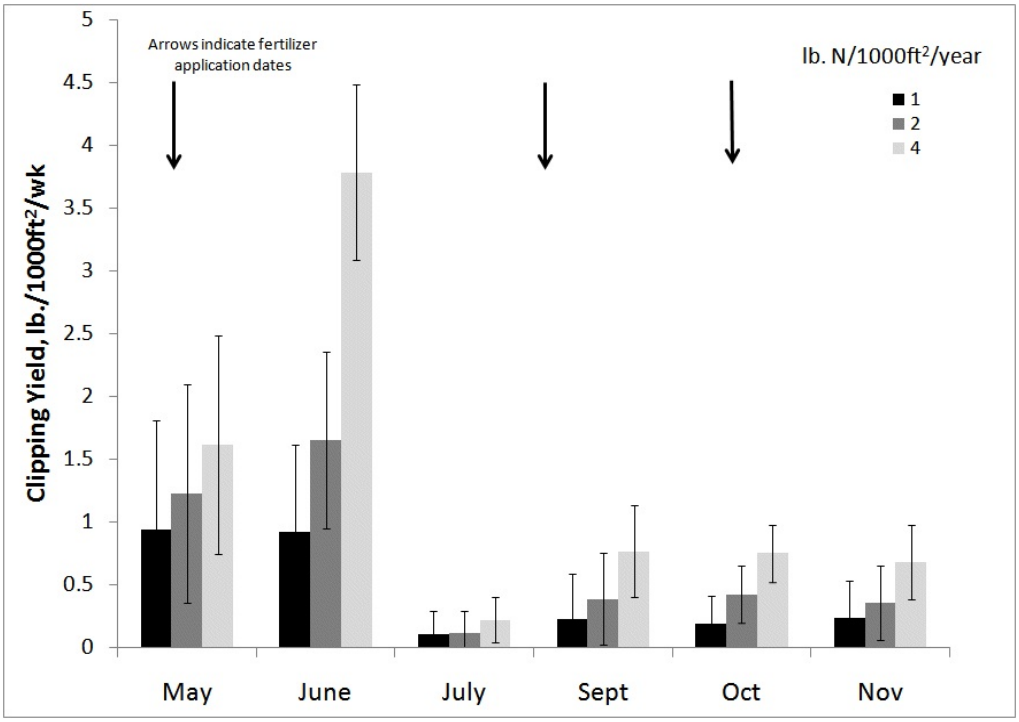
The recommended annual rate for nitrogen on tall fescue in California is between 2 and 4 lb./year. If one assumes that a lawn will need to be mowed 40 out of 52 weeks in the year, approximately 32-60 lb. of clippings can be saved from local landfills. If the average nitrogen content of the clippings is 3%, then 1 to 1.8 lb./1000$ft^2$ of nitrogen are removed each year.

Tall fescue is a cool-season grass and, although it has good tolerance to high air and soil temperatures, its growth rate is lower in the late-summer months compared to spring and fall.

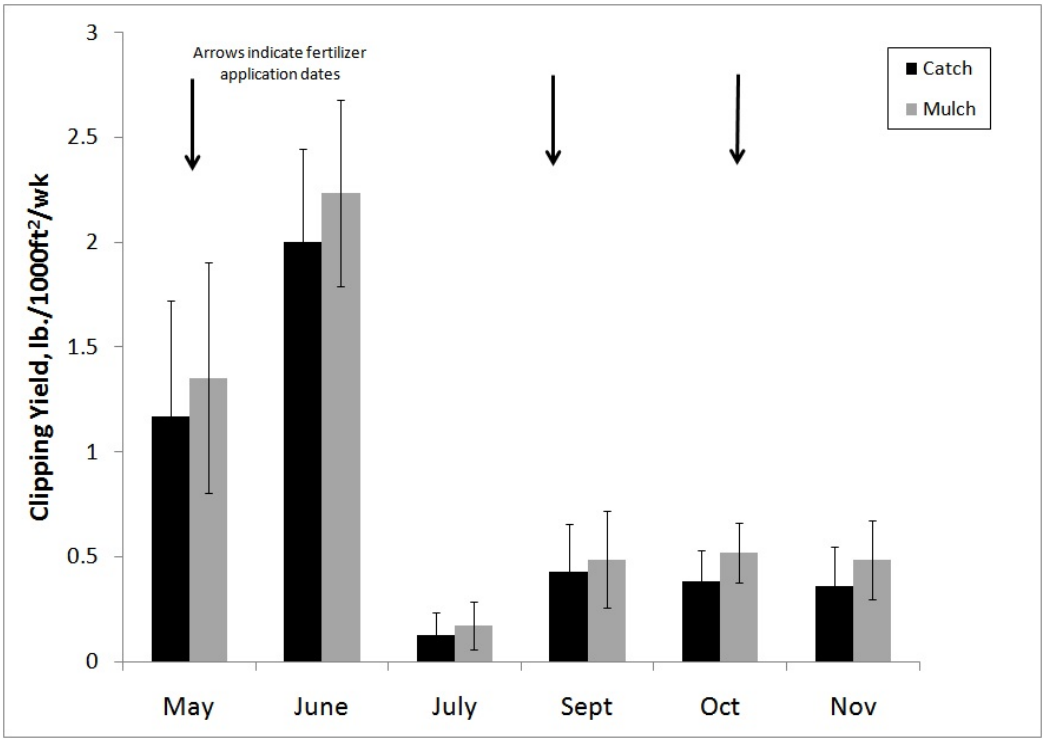
From early June to early September, 2010, maximum air and soil temperatures were quite high for this research plot in Davis. This resulted in a drastic and dramatic decrease in clipping yields determined July 6 and September 6.




Higher nitrogen application led to higher yields. On June 6, three weeks after a fertilizer application, the 1, 2 and 4 lb. nitrogen rates led to clipping yields of about 1, 1.5 and 4 lb./1000ft$^2$/week, respectively. Since then, clipping yields have been low and there have been no significant differences among any of the three fertilizer treatments.

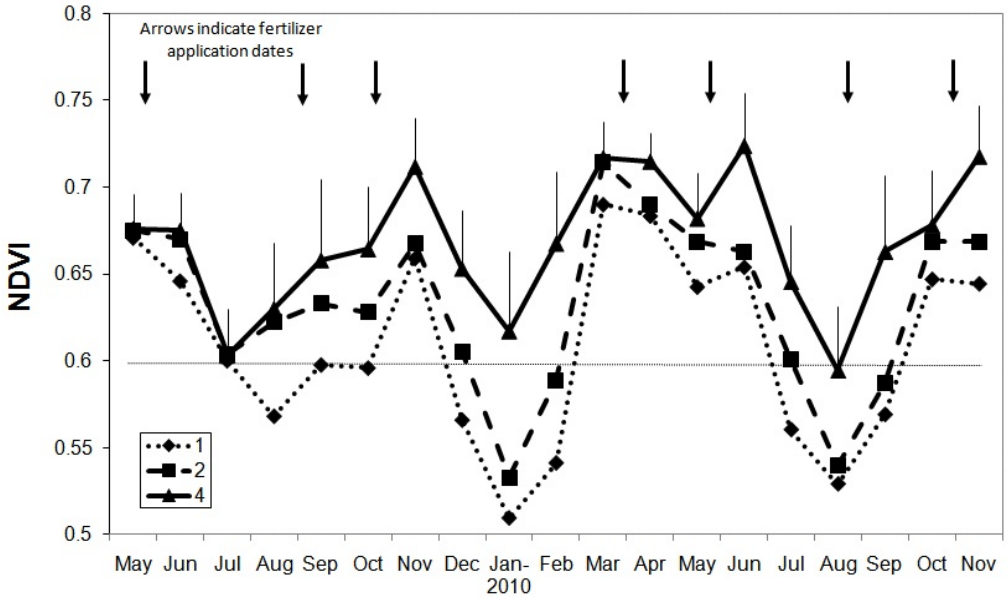


Clipping yield was not significantly different between the two mowing techniques; however, in every case the mean for the mulch treatment was higher than the catch treatment. This difference may increase as the project continues into 2011.



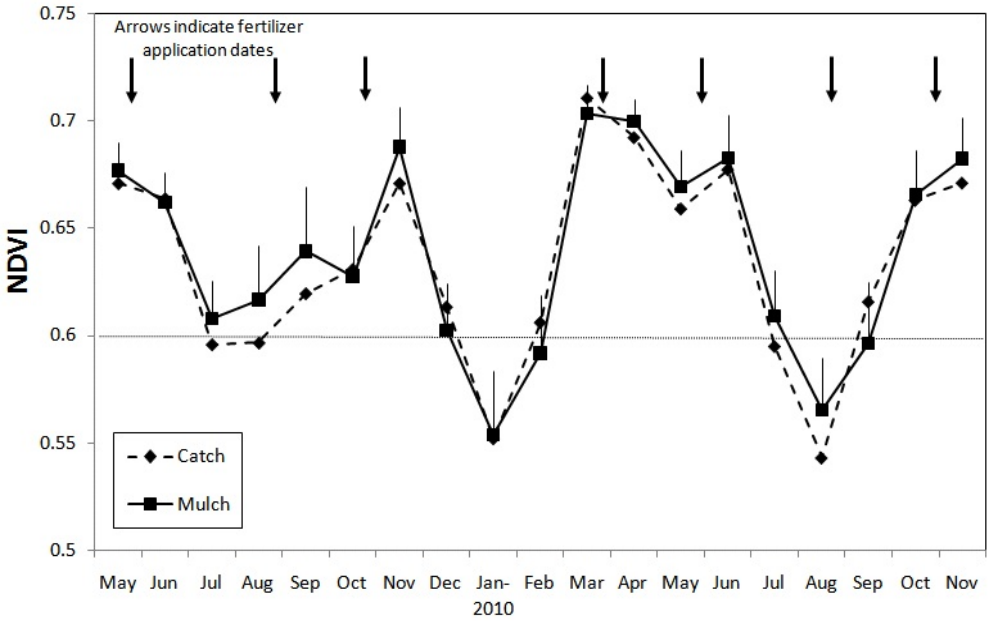

*Color - NDVI (Normalized Difference Vegetation Index)*

Measurement of NDVI was used to assess color in the plots instead of a color rating scale. Rating scales are subjective, whereas the NDVI is an objective, quantitative measure of the amount of chlorophyll in the turfgrass leaves. An NDVI of 0.6 (horizontal dotted line) was established as the threshold for acceptable color.



Fertilizer rates affected the NDVI over the entire period of the project. From May, 2009 to November, 2010, the 1-lb. N rate was at or below the acceptable color threshold from July to October, 2009, December, 2009 to February, 2010 and from July to September, 2010. Over the same time period, the 2-lb. N rate fell below the acceptable color threshold from December, 2009 to February, 2010 and from July to September, 2010. In contrast, the 4-lb. N rate never fell below the acceptable color threshold. The lower NDVI values in July-September, 2010 reflect the increased air and soil temperatures during that time.

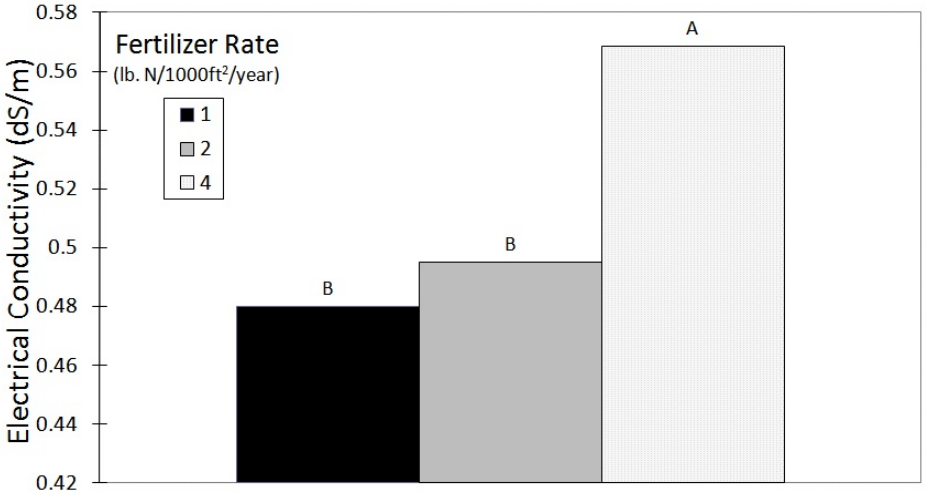
There was no significant difference in NDVI between the two mowing treatments from May, 2009 to November, 2010. NDVI for both treatments fell below the acceptable color threshold from December, 2009 to February, 2010 and from July to September, 2010.




*Soil*

Fertilizer rate had an effect on soil EC (Electrical Conductivity). The 4-lb. N rate had a significantly higher EC than either of the lower rates.

No other soil properties (e.g. organic matter, total N, total C, $NO_3^-$ or $NH_4^+$ ) were affected by either the rate of fertilizer or the mowing treatment.

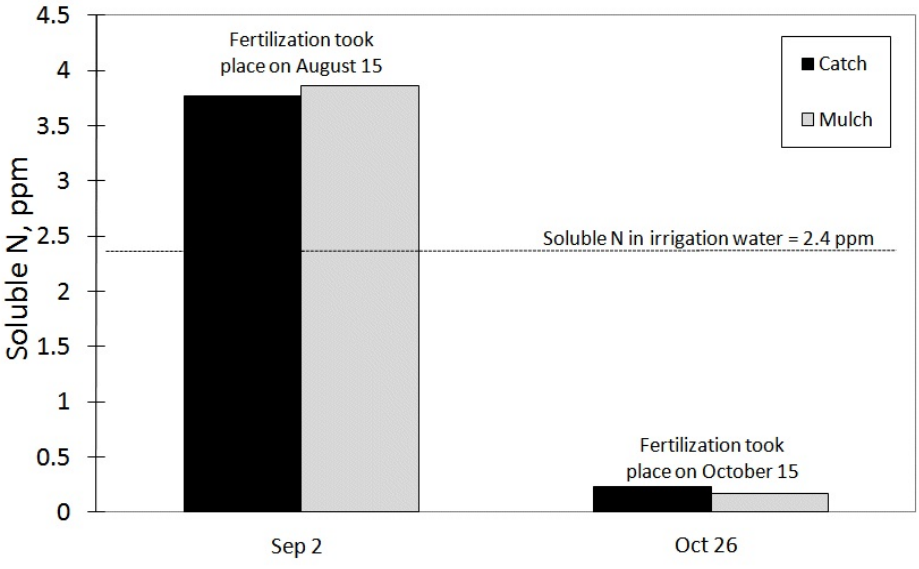


*Water*

Tall fescue turf is very efficient at taking up nitrogen following fertilizer applications. In order to determine how much, if any, nitrogen is moving past the tall fescue root system, lysimeters (6-inch, 1900 Series, soil water samplers, Soil Moisture Equipment, Goleta, CA) were installed in the plot in August, 2010. The day before an irrigation the sealed lysimeters were placed under a vacuum of -0.65 Bars.

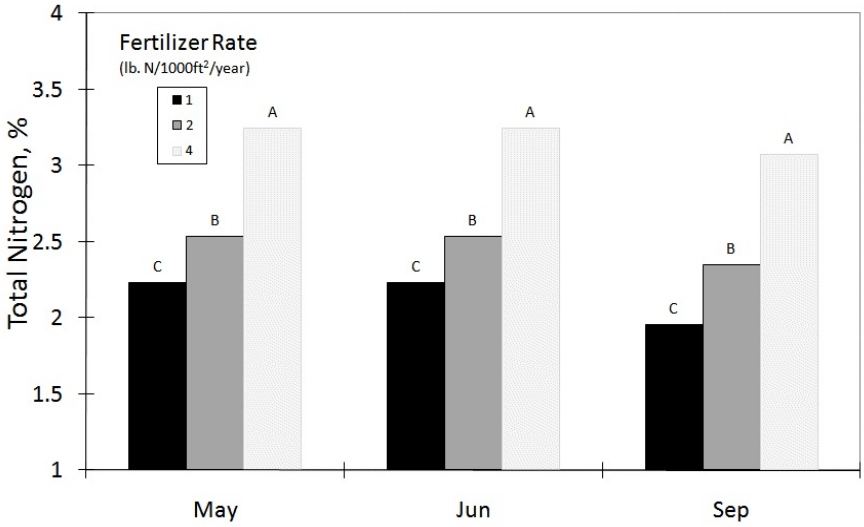
After 48 hours the lysimeters were opened, any collected solution inside removed and analyzed in a Timberline TL-2800 Single Channel Ammonia Analyzer / Nitrate Analyzer (Boulder, CO).

To illustrate the effect of the high air and soil temperatures in July to September, 2010 on the physiology of the turfgrass, total soluble N was determined 2 weeks after a fertilization in August and 2 weeks after a fertilization in October, 2010. Total soluble N went up 2 weeks after a fertilizer application, but not to high values even when the grass was not growing rapidly (September 2). Two weeks after a fertilizer application in October there was very little soluble N in the water sampled at 6". In fact, the amount of soluble N was below the concentration found in the irrigation water.

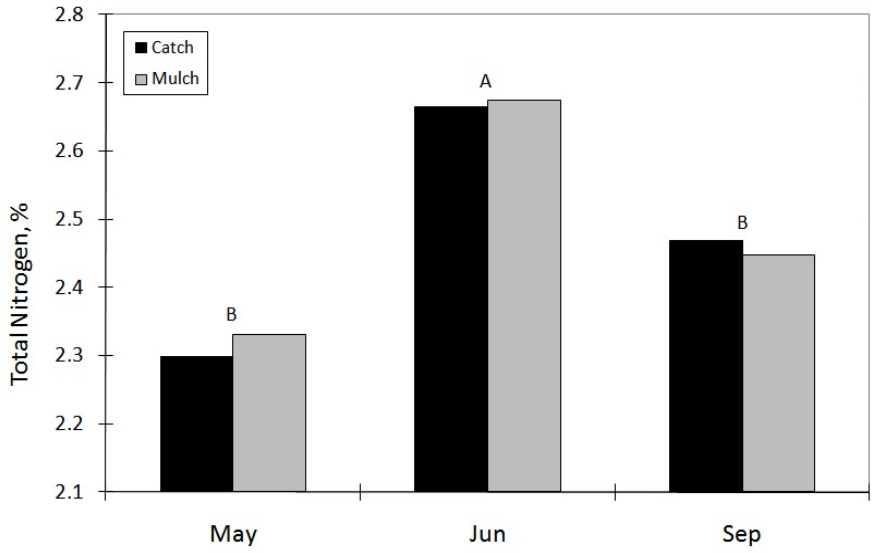


*Leaves*

Total nitrogen in leaf tissue increased as fertilizer rate increased during the summer months of 2010. For each of the three fertilizer rate treatments, total N remained constant from May to September, 2010.




Mowing technique did not affect total nitrogen in leaf tissue. Total nitrogen in leaf tissue was higher when the grass was growing rapidly (June) than when it was growing slower (May and September).



*$N_2O$*

Chambers have been installed in the research plots so that $N_2O$ gas can be measured. The methods for collecting the $N_2O$ gas and analyzing it via gas chromatography are still in development. Briefly, the chambers were made from 8-inch PVC pipe. The bottom half (3") was placed and kept permanently in the plot. When measurements were needed, the top half of the chamber was attached to the bottom half, sealed with a strip of tire innertube. At time 0 the gaseous atmosphere inside the chamber was sampled with a hypodermic needle and syringe and transferred to an evacuated Exetainer tube. After 30, 60 and/or 90 minutes each chamber was sampled again. The filled Exetainers were taken back to the lab for gas sample analysis. The data was used to calculate the flux of $N_2O$ emanating from the turf.

## Future Research

Good progress has been made during 2010. For the upcoming growing season in 2011 we would like to focus on:

- Growth analyses (clipping yield) as it relates to mowing technique and fertilizer rate.
- Developing a complete nitrogen budget for the turfgrass system understanding the relative quantities of nitrogen in the plant, soil, water and air.
- The effects of grasscycling on soil microbe activity and carbon sequestration.