FDEP Contract WM869: Warm Season Turfgrass Nitrogen Rate and Irrigation BMP Verification.

Preliminary Draft Final Report Comments
5/30/2012

Contract Requirement:

In addition to quarterly and individual final project reports, a comprehensive final report on all findings and containing electronic copies of all data collected under DEP Contract WM869, and all publications generated to date, shall be provided to the DEP not later than March 31, 2012. Technology transfer presentations shall be made at various other industry and scientific venues. At least 15 journal articles shall be submitted to peer-reviewed scientific journals, as described below:

- Project 1, N-Leaching, establishment, 3 papers.
- Project 2, N-Leaching, established, 4 papers.
- Project 3, N-Sources, established 3 papers.
- Project 4, Dormant Fertilization, 2 papers.
- Project 4, P test kits - Submission to Notes or Proceedings (not peer-reviewed).
- Project 5, P Requirements, 1 paper.
- Project 5, P Leaching/Growth, 1 Paper.
- Project 6, N leaching, Slow release N Source comparison, 1 paper.

Change order 1 modified this to

Description of Change: Eliminate Final Report due date of 3/31/12,. Add Draft Final Report, including all required data, due date of 4/31/12, Department will review and make comments within 120 days. Final Report due date at contract expiration, 10/31/12. Funding availability for all categories is extended to 10/31/12, with the restriction on expenditures after 3/31/12 removed.

General:

Submission of all data required for the draft report has not been fully accomplished as of 5/30/12. The following points address missing requirements.

- Need all data and cross references to treatment and plot.

- Need copies of current SAS output P and R^2 levels for all leaching trials.

- Need all regressions, with R^2 and causative reasons for outlier removal from N leaching trials. Outliers are defined as > 2 SD by the researchers, however, such a deviation caused by heavy rains, or very high concentrations due to a low volume first flush effect may well be legitimate N loads that must not be removed.

- Need a thorough discussion of QA issues, how resolved, and citations to published data, and copies of unpublished data and SAS analysis in the appendix. This should include a head to head comparison of UF-IFAS freezing vs. the DEP QA SOP methods.

In addition, the following applies to the Department's preliminary review of what has been submitted. Note that P may refer to phosphorus or probability, depending on context.

Some authors have not provided data tables, charts or discussion on broad areas of the research. Some of this data was provided in piecemeal form in quarterly and annual reports or project reports, but have been omitted from the final deliverable that is the only document that will be broadly distributed to policy makers, ordinary citizens and public officials. Since annual reports have not been submitted since 2009, the final report is the only source for this information for data collected 2010-2012.

The report is not written as a seamless document addressing statewide effects on Nitrogen leaching, the objective of this study, with informative graphs and all statistical analysis described by actual probability results. Rather, it appears as a compilation of individual reports, focused largely on the aesthetic qualities of the turf. The purpose of this extensive project (over 8 years and $4,000,000) was to study leaching of nitrates and phosphorus from turf under various management routines for the express purpose of verifying, or modifying, statewide best management practices to protect water quality.

The report needs to tie the parts of the study together. Phosphorus issues should be grouped in a logical manner. Dr. Sartain's work is well described, but one must go to page 4 of the executive summary to get the narrative explaining the project. Dr. Cisar's P work on field leaching vs. soil test results and his P test-kit evaluation should logically follow this work, with a narrative section tying them together and discussing how this work might illuminate efforts to protect water quality. Caveats and statistical explanations must be included to avoid mistaken assumptions by those unfamiliar with the data.

Well over 80% of the report appears to be devoted to non-environmental efforts such as turf color, quality ratings, growth rate, and density, with extensive data provided in over two hundred tables, leaving environmental leaching issues as an afterthought. One would expect the data presented to be weighted in precisely the opposite direction, with the primary focus of the document on the leaching and notations that quality of the turf was acceptable at most BMP recommended rates and comments provided where management actions might prove inadequate to maintain the turf or excessive nutrients were counterproductive.

Due to a misunderstanding of the scope of work, early studies did not continue measuring leachate through the winter when no fertilizer was added. This lost the leaching data from soil reservoirs of N built up during fertilizer trails and subsequent N release as turf entered dormancy, as well as the winter background N loads, therefore invalidating the reference to "annual" loading. In later trials this was corrected and these effects should be discussed.

In lieu of reporting the actual P value, the authors generally report NS (not statistically significant at the $P<.05$ level), which obscures the use of the actual probability results in weighing environmental risk vs. benefit options. A (1-P) value of 0.9, or even 0.7, might identify promising areas of investigation and further research, which would be missed if lumped with values of less than 0.5. Similarly, trend analysis is inhibited by an almost complete lack of regression plots, correlation, graphs, etc. and R^2 values are rarely provided, especially where P was $>.05$ when means testing.

One statistical reviewer commented," please understand that it will take many figures and corresponding data in order to properly evaluate leaching rates as compared to application rates. Recall that the various factors included application rate, location, irrigation rates, grass types, seasons/time, and nitrogen sources (fertilizers). For each of the factors the authors of WM 869 used different levels for their ANOVA tests. For the Department to appropriately evaluate leaching rates, we will need the corresponding raw data for each of their levels in their ANOVA projects."

The authors frequently refer to the failure to prove difference at the $P<.05$ level as proof that means are identical. In a highly charged, politically sensitive study for public consumption, the nuances between "because of a large amount of variability in the samples over time, there is less than 95% confidence that 2 means are different", and "there is no difference" can lead to extensive confrontation, especially when researchers step into the policy areas by then suggesting that fertilization rates be increased from current BMPs. Such statements are beyond the scope of the researcher's duties under this contract, and should be removed from the document (Pg 153, pg 172).

Likewise, reference to the drinking water MCL as the "safe" standard for leaching is improper at best. The researcher has no knowledge of whether a product will be used where only human health is an issue or in a springshed where numeric nutrient criteria are 1/30th of that level (pg 171).

Similarly, on page 4, Dr. Sartain would be better advised to state that the research supports the current P_2O_5 application limits in the Urban Turf Rule for St. Augustine grass, and then indicate further review may be needed for other grasses or when no soil test is performed, rather than it is "environmentally safe."

DEP would like the following questions answered within the report:

For all questions: How much influence? With what variability? How much confidence in the data? How well do regression equations fit the data? Provide actual statistical results, not only significance at $P<.05$.
Provide scatter plots with regressions, bar and line graphs, and tables to assist in understanding. How does information from other studies in this project overlap and contribute to broader understanding?

Please remember that the audience of this report includes the public, the press, and elected officials, many of which have little or no formal scientific or statistical training.

Discuss the effects of CEC and soil type on leaching of N-forms nitrate, ammonium, and urea so that this audience can understand the differences.

Establishment of turf by seed and sod:

What are the fundamental influences on nitrogen and phosphorus leaching when establishing a new turf from seed or sod?

Should fertilizer be applied before seeding or sodding, or wait until after roots have developed to take up the nutrients, or both?

What irrigation regimes are most efficient at minimizing leaching and water use for new seed, sod?

How does turf species affect leaching during establishment?

Established turf:
What are the fundamental influences on nitrogen and phosphorus leaching?

How does leaching vary with climate and seasonality? How much influence? With what variability?

How can zero fertilization soluble urea controls in N-source and dormancy studies be used to develop estimates of natural background leaching levels? These are needed as control baseline levels for those projects that need to subtract baseline leaching to evaluate leaching only from fertilizer where no zero-N control plots were included.

What seasons are most susceptible to leaching from applied fertilizer? How great are differences? With what variability? How much confidence in the data?

How does dormancy affect leaching?

What are effects of rainfall and irrigation? Does the common 1″ once a week watering restriction in some WMDs increase leaching over twice a week limited to ½″ per application? By how much?

How do short-term and seasonal rainfall patterns affect leaching?

What are effects of Turf Species on leaching.

What effect does total annual rate of soluble N have on leaching?
How does it vary with rate per application?

What is the effect of seasonality on leaching as a function of application rate? Is correlation different in summer when growth peaks compared to fall-winter-spring?

Do high rates of nutrient uptake in summer mask important differences with application rate at lower growth rates? Does this vary with species?

How does N leaching vary with soluble vs. various types of slow-release at the BMP rate and at lower and higher rates.

Is 0.5 lb-N/1000ft^2 per application the safest rate for preventing leaching?

Is 0.7 safer or riskier than 0.5 for prevention of soluble-N leaching. By how much? How certain are we about each?

How do these studies compare to previous work by Cisar and Snyder on leaching in bermudagrass between 1980 and 2005 including work done under contract for FDACS under the Nitrate Bill (FDACS contract 3953A)? What about work on St. Augustine by Texas A&M and the city of Austin? What about work done on warm-season grasses by the USGA Green Section, USDA-ARS or other research institutions? Compare and contrast these studies to the studies in this project.

What are the release rate characteristics of various classes of controlled release fertilizers? Provide graphs of each study and studies combined across locations and times.

Can new polymer/resin coated extended release products be applied at higher levels than conventional slow release products without increasing leaching of N?.

How much N, P is provided in returned clippings. How long to release plant-available N?

What are the minimum N, P requirements for healthy grass turfs of various types. How does this vary with region?

Are home test kits sold in hardware stores accurate enough to use to soil P testing to determine P application? How do they compare to IFAS extension service soil tests.

Is healthy turf consistent with current BMP rates?

Is leaching reduced by fertilizing at moderate levels compare to little or no fertilizer? How does this vary by species?

How does mowing height affect leaching?

Dr. Cisar.

Test Kit study is not included.

Data tables for the established turf study were not provided, at least 12 cycles were done. Please provide P values and R^2 for all plots. Data from years 2 and 3 of N-Source and timing studies is also missing.

Following the 2007 QA audit FTL was to have frozen duplicates of the nitrate and orthophosphate samples analyzed by the ARL to compare with previous sample analyses, and provide scientific evidence the project was not jeopardized by failure to follow standard QA protocol. Dr. Trenholm provided limited data in the report from later studies at Citra, however your data is not included. Neither are citations to published studies. From a September 2007 email from our QA section:

Based on our preliminary findings (the researchers have not had an opportunity to respond), the salient problems are associated with the manner in which samples are collected or handled prior to analysis:

The samples from all researchers were frozen, which does not comply with the DEP SOPs for preservation of either nitrate or o-phosphorus.

The QAPP states that freezing samples will only be done in an emergency, but freezing is routine, rather than occasional. Neither the researchers nor the laboratory have studies to demonstrate the long-term effects of freezing on the samples and the EAS cannot make any recommendations concerning whether or not freezing is a viable option without such a study.

Most of the freezers used for storage are "frost-free". This means that especially for freezer units above refrigerators, the freezer compartment temperature is not stable because 'frost-free" refrigerators go through a cycle in which the coils are heated to the 0 degrees C to melt and remove any frost build-up. Therefore, samples are not maintained at a temperature of minus 10 degrees C.

None of the field offices monitor the temperature of the freezers in which the samples are stored, and the laboratory only has intermittent records of temperature monitoring. Therefore, no one can demonstrate that the freezer temperature was stable.

All samples were analyzed beyond the 48-hour holding requirement, some as late as 6 months after collection.
Because of the length of time between collection and analysis, the fact that field records do not accurately record the time of collection is not critical. However, if future work is to be completed within the 48-hour requirement, both laboratory and field records have information concerning the exact analysis and collection times.
Without a long-term holding time study (related to 1a above), EAS cannot make recommendations as to whether the time affects the concentrations of the target analyte.

Data comparability because of different field techniques o-phosphorus requires that samples be filtered thought a 0.45 um filter immediately after sample collection. Only one group filters samples. Therefore, it is not clear whether the results from the three sites can be compared.

One group filters samples for nitrate, while the other two do not. Again, because of this difference, it is not clear whether the results from the three sites can be compared.

We are observing significant o-phosphorus in blank samples from all locations. Depending on how the data are to be interpreted, the presence of high concentration in the blank samples may affect data usability.

In comparing the laboratory data from Ft. Lauderdale with the field records, it appears that many samples may have been mislabeled or switched. We have data for field blanks with hits of o-P as high as 1809 ppb, hits in samples identified as rain water as high as 8100 ppb, and nitrate spikes with no recovery. There are also notes in the field records that seem to indicate that sets of samples may not be properly identified. This could have a big impact on the attempt to compare data from this site with others.

The report must address all of the QA issues raised in the audit and how they were resolved, including presentation of data correlation curves for corrective action studies.

Dr. Sartain:
The text in the executive summary also belongs in the Phosphorus section. Additional detail is needed.

For table 78 and 79, what is the "control treatment" and how does it differ from the zero-P application rate.

Please provide P values along with the letters in a table for figures 27-30.
Please provide regression curves and R^2 for each application rate and grass type in figures 27-30.

Dr. Trenholm:

There is no reference to the nutrients in the returned clippings study on Zoysiagrass. This is a study of nutrients fate and transport in turfgrass. If nutrient data was not obtained, funding used for that study may need to be returned.

The QA sample preservation page is inadequate as a QA section of the report. It should contain a complete discussion of the issue and its resolution, including both the Citra follow-up study in table 126 in greater detail and all of the FTL data from duplicate samples, along with other citations on the issue. A discussion of other QA issues and a guide to QA data in the appendix and procedures followed after the audit should be presented, as mentioned in Dr. Cisar's section.

The statement regarding 2 lb PCU vs. 1 lb PCU is incorrect. It is significantly different in table 104.

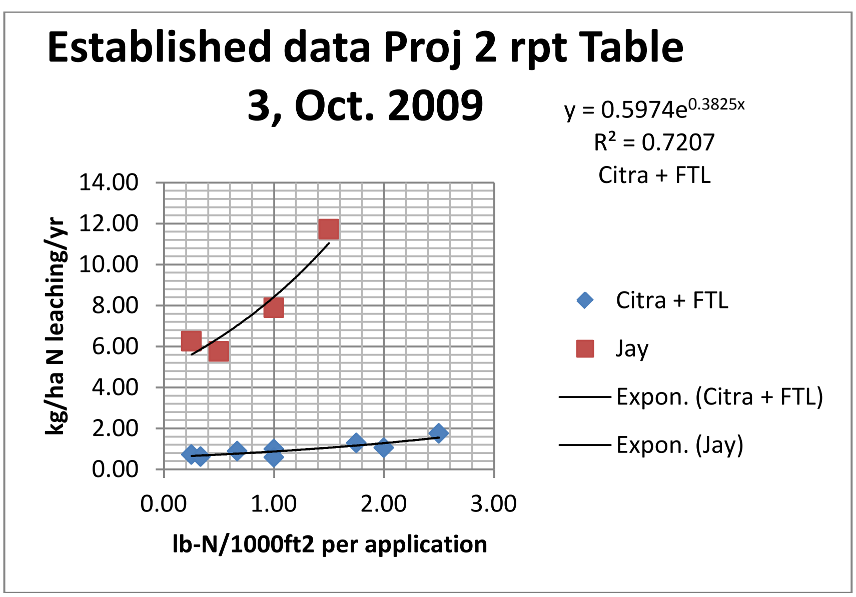
Dr. Unruh:

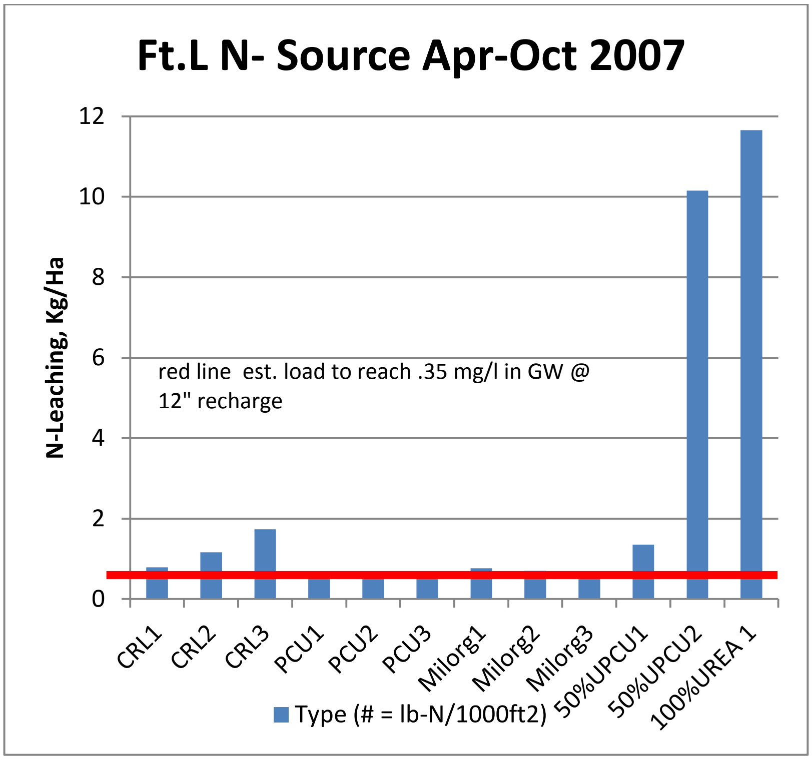
It appears that the influence of externally supplied N in the new sod warrants eliminating periods T1 and T2, possibly T3, from the study. Similar situations exist in tables 214 and 215.

Additional Comments:

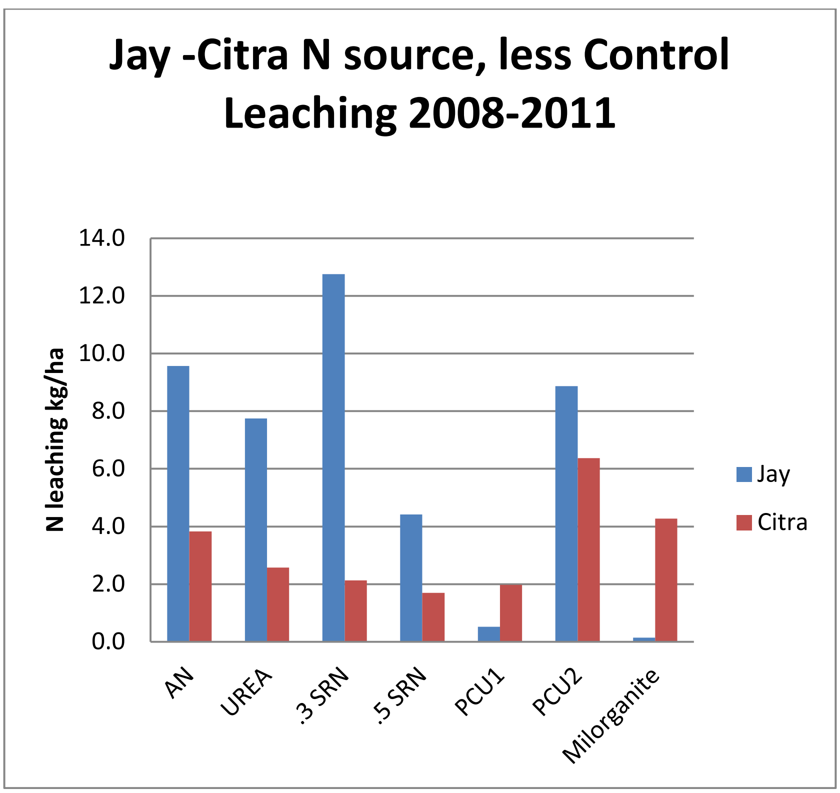
Many of these aspects of this work have been referred to in annual progress or individual progress reports. This is the official final report of a four million dollar project, and the data should be presented in this report in as much or greater detail than in the project reports. This is the only work that will be officially retained beyond mere contract management requirements, and the only report widely disseminated. In addition, this is the only report for post 2009 years and the only report where all of the work at all of the sites may be examined in one place. It is not reasonable to expect the wider populace to seek out individual quarterly or annual reports to find this data.

Several simplistic graphs are presented below in an effort to communicate the type of visual presentations expected.

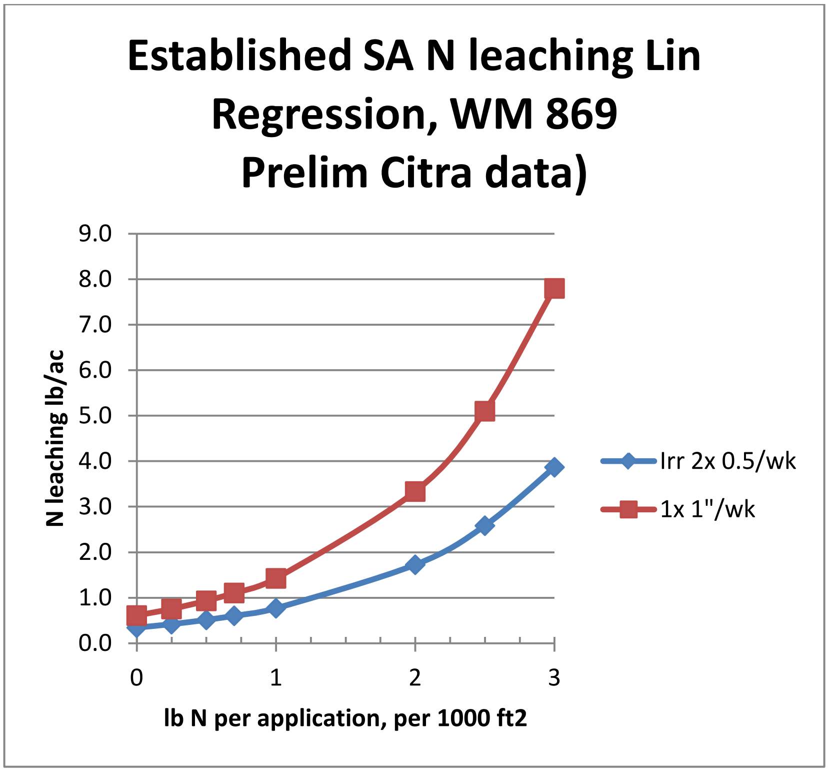


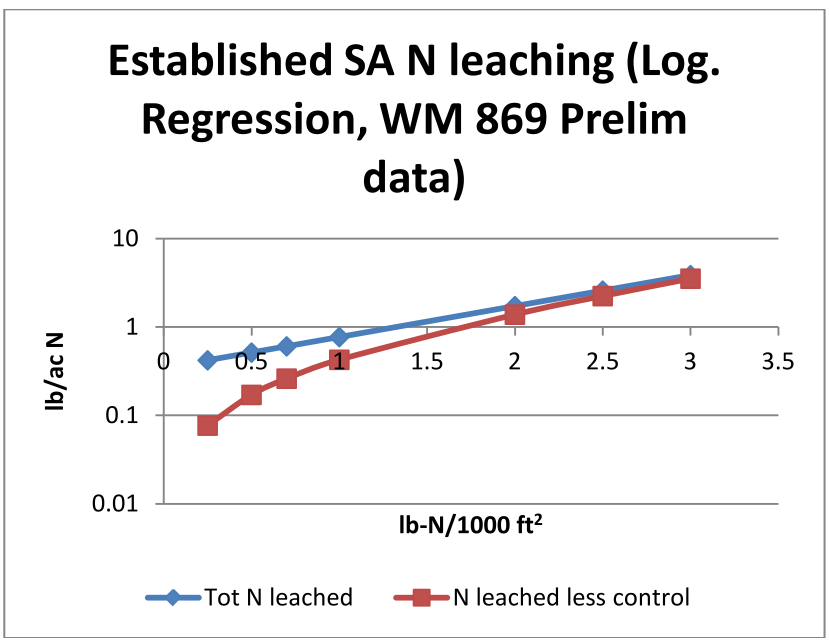


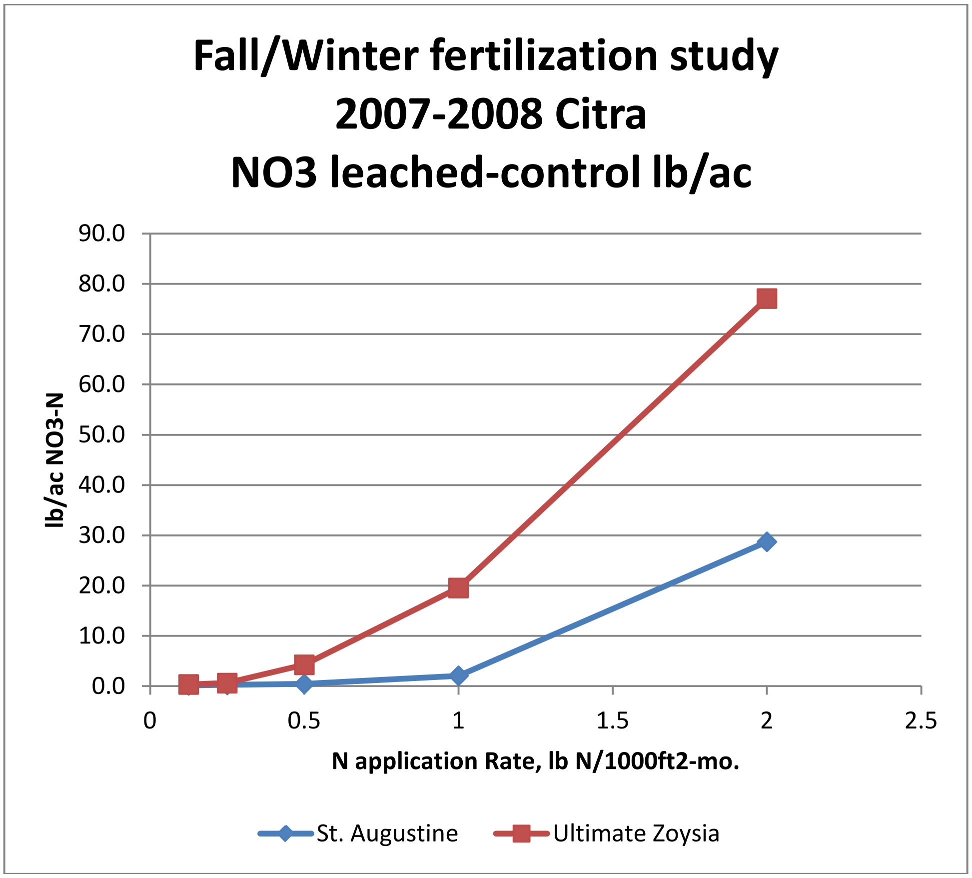
Ft.L N- Source Apr-Oct 2007
N-Leaching, Kg/Ha
12
10
8
6
4
2
0
red line est. load to reach .35 mg/l in GW @ 12" recharge
CRL1
CRL2
CRL3
PCU1
PCU2
PCU3
Milorg1
Milorg2
Milorg3
50%UPCU1
50%UPCU2
100%UREA 1
Type (# = lb-N/1000ft2)

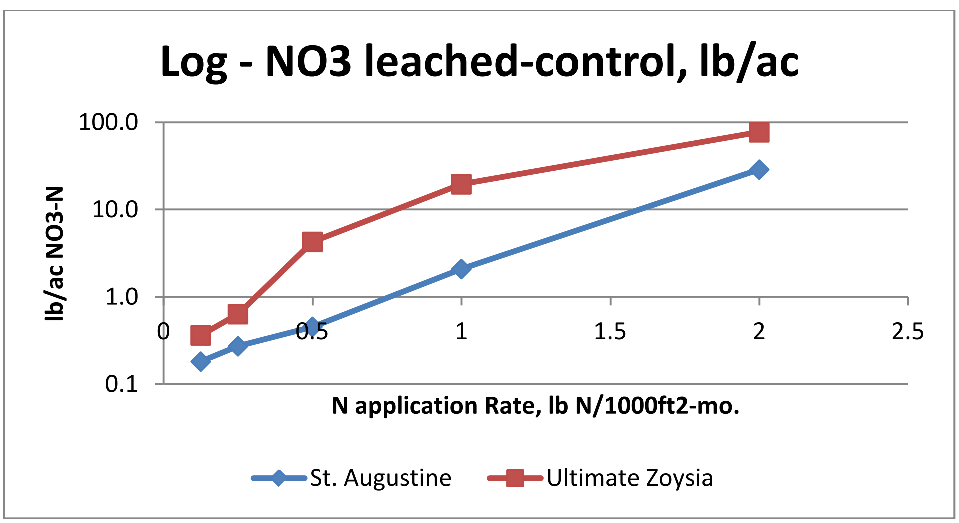


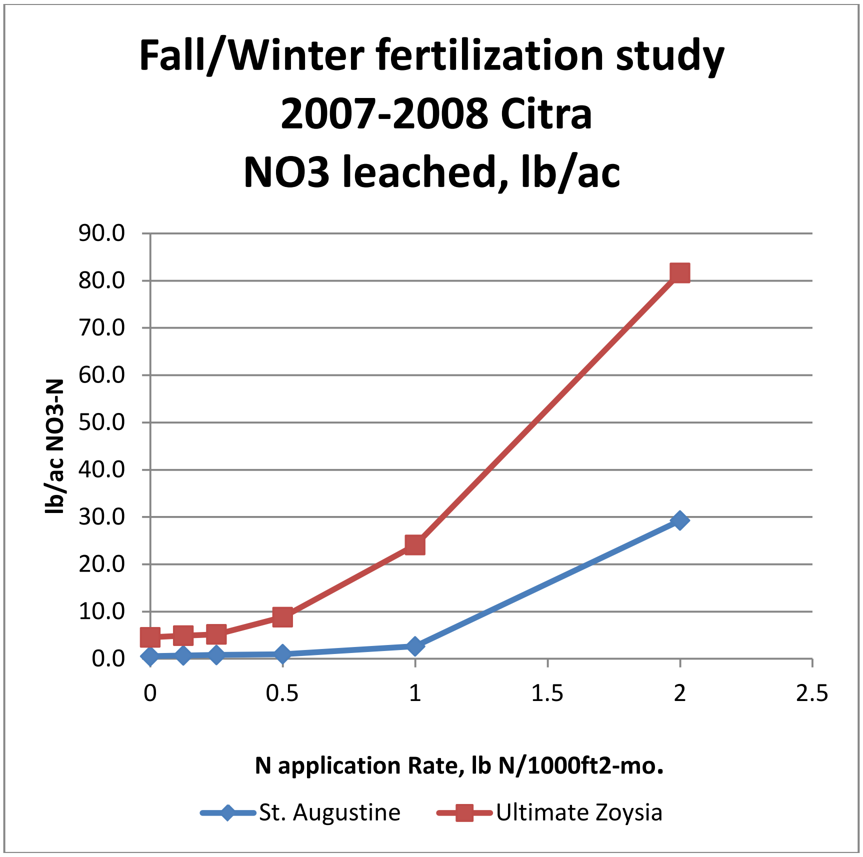
Jay -Citra N source, less Control Leaching 2008-2011
N leaching kg/ha
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
AN
UREA
.3 SRN
.5 SRN
PCU1
PCU2
Milorganite
Jay
Citra

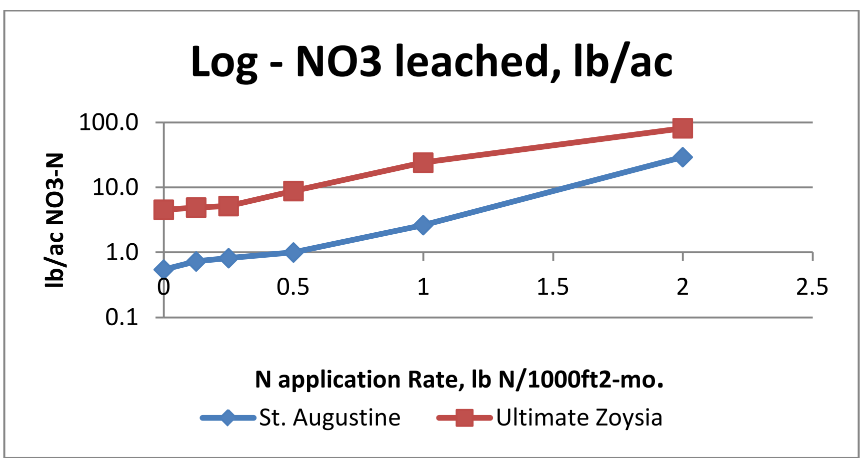

Established SA N leaching Lin Regression, WM 869 Prelim Citra data)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
N leaching lb/ac
0
1
2
3
lb N per application, per 1000 ft2
Irr 2x 0.5/wk
1x 1"/wk


Established SA N leaching (Log. Regression, WM 869 Prelim data)
10
1
0.1
0.01
lb/ac N
0
0.5
1
1.5
2
2.5
3
3.5
lb-N/1000 ft²
Tot N leached
N leached less control


Fall/Winter fertilization study
2007-2008 Citra
NO3 leached-control lb/ac
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
lb/ac NO3-N
0
0.5
1
1.5
2
2.5
N application Rate, lb N/1000ft2-mo.
St. Augustine
Ultimate Zoysia


Log - NO3 leached-control, lb/ac
100.0
10.0
1.0
0.1
lb/ac NO3-N
0
0.5
1
1.5
2
2.5
N application Rate, lb N/1000ft2-mo.
St. Augustine
Ultimate Zoysia


Fall/Winter fertilization study
2007-2008 Citra
NO3 leached, lb/ac
lb/ac NO3-N
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
0.5
1
1.5
2
2.5
N application Rate, lb N/1000ft2-mo.
St. Augustine
Ultimate Zoysia


Log - NO3 leached, lb/ac
lb/ac NO3-N
100.0
10.0
1.0
0.1
0
0.5
1
1.5
2
2.5
N application Rate, lb N/1000ft2-mo.
St. Augustine
Ultimate Zoysia

The following figures are strictly hypothetical. In the figures, both the data units and dates are unspecified. Start with Figure 1a. Not unexpectedly, leaching is greatest for the greatest application rate. However, over time the leaching rates decrease and eventually approach background conditions. To assist in visually understanding the relationships, “smoothed” curves are used in Figure 1b.

If FDEP had the necessary data to produce the figures below, then we could evaluate the slopes of the various curves in order to determine how long after fertilizer application that leaching to ground water becomes insignificant relative to background. In the examples below, the slopes of background level off (slopes become close to zero) beginning about date 6 or 7. Application rates 0.5 and 1.0 begin to level off at about date 10 or 11. If replicates of experiments were performed and if the data becomes available, then statistical tests could be used to compare the mean or median values of background to the various application rates for different dates (or days) after fertilizer application.

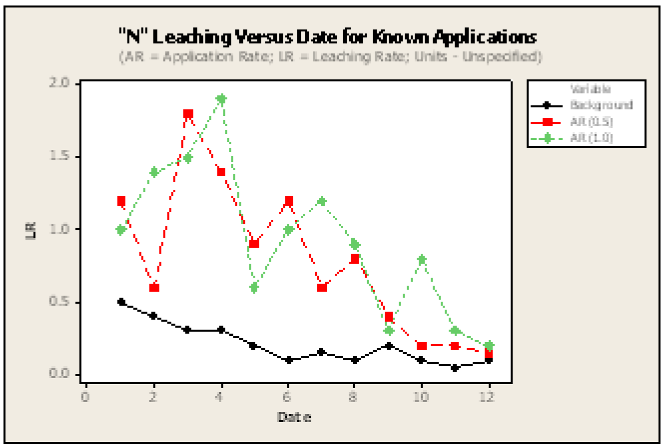


Figure 1a. “N” Leaching vs. Date for Known Applications (Raw Data)

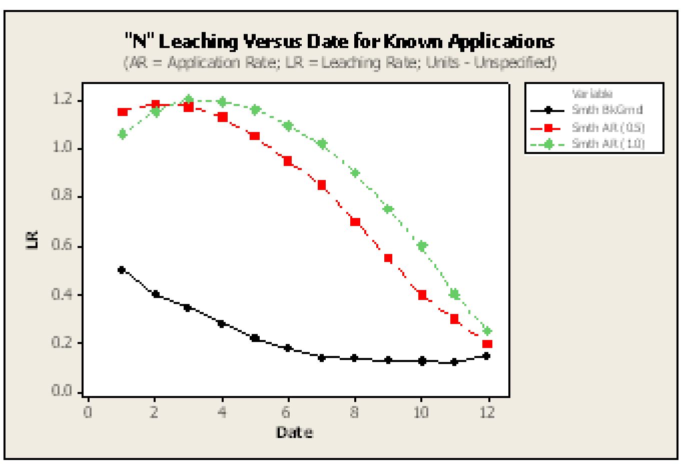


Figure 1a. “N” leaching vs. Date for Known Applications (Data Smoothed)