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Late Application Nitrogen Management in Corn Systems to Optimize Yields and Reduce Nutrient Losses in Southern Illinois

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Background and Objectives

Nitrogen management in agronomic systems in the Midwest remains one of the greatest opportunities for optimizing crop yield and minimizing environmental impacts to water quality. Mounting pressure on the agricultural sector to reduce nitrogen losses requires more efficient management strategies in timing, placement, sources, and rate. Late season nitrogen application, with appropriate nitrogen stabilizers may offer an efficient nutrient management alternative. This study examines nitrogen rates, delayed timing of N application, and enhanced efficiency fertilizers to optimize yield and minimize N losses. This project will help southern Illinois farmers improve nitrogen management in no-till corn/soybean systems. The objectives for this project are to: 1) Evaluate N sources for late application N management; 2) Evaluate late application N to slow release fertilizer; 3) Evaluate plant tissue nitrogen and yield due to late N application; 4) Determine soil ammonium and nitrate levels based on N application; and 5) Disseminate this information to CCAs, producers, and the scientific community.

Summary of work for 2014

Site Locations

Research plots were established in the spring of 2014 at three southern Illinois locations: the Agronomy Research Center in Carbondale, the Belleville Research Center in Belleville, and the UI Dixon Springs Research Center in Dixon Springs, IL. Dr. Emerson Nafziger has also implemented this protocol with some modifications at other central and northern Illinois research locations to expand the study (Brownstown, Orre Center, DeKalb, and Monmouth).

Only the three southernmost locations will be included in this report as that was the original scope and funding for this project.

Experimental Design

The experimental layout is a randomized complete block design with four replications of each treatment. Treatments were adjusted from the proposal after additional consideration and consultation. Treatment applications consisted of:

1. Untreated Check (No nitrogen)
2. 50 lb N as broadcast UAN at planting
3. 100 lb N as broadcast UAN at planting
4. 150 lb N as broadcast UAN at planting
5. 200 lb N as broadcast UAN at planting
6. 150 lb N as ESN broadcast at planting
7. 50 lb N broadcast UAN at planting + 100 lb N sidedress injected UAN at V3-4
8. 50 lb N broadcast UAN at planting + 100 lb N as Urea as OTB* at V9-V10
9. 50 lb N broadcast UAN at planting + 100 lb N as Urea with AgrotainUltra® OTB at V9-V10
10. 50 lb N broadcast UAN at planting + 100 lb N as UAN dribbled between rows at V9-V10
11. 50 lb N broadcast UAN at planting + 100 lb N as UAN + AgrotainUltra® (dribbled between rows) at V9-V10
12. 150 lb N as broadcast UAN + Agrotainultra at planting

*OTB = Over the top broadcast

Challenges

The spring of 2014 presented a challenging planting season due to exceedingly wet conditions. Soils remained saturated for much longer than normal and planting was delayed to some extent. Conditions throughout the growing season were fairly good, but some of the stand at the Carbondale location was fairly uneven in some places possibly due to saturated site conditions. Plant, application, sampling, and harvest dates are included in Table 1. Plant injury data was not collected because there were no visible signs of injury after late application N.

Table 1. Important dates for Late N Management trial.			
	Carbondale	Belleville	Dixon Springs
Planting	5/23/2014	5/20/2014	5/6/2014
Soil Sampling - prior to planting	5/23/2014	5/19/2014	5/1/2014
Initial N application	5/24/2014	5/21/2014	5/1/2014
Sidedress N application - V3 Injected	6/15/2014	6/6/2014	5/31/2014
Soil Sampling - prior to late N application	7/7/2014	6/27/2014	6/15/2014
Late N application	7/8/2014	6/27/2014	6/24/2014
SPAD meter	7/7/2014	7/10/2014	NA
Plant injury	NA	NA	NA
Harvest	10/27/2014	10/20/2014	9/22/2014
Soil Sampling - post harvest	10/30/2014	10/28/2014	10/31/2014

Outreach:

After the first year of the project, results were presented at the Illinois Fertilizer and Chemical Association annual meeting and will be presenting in 2015 outreach presentations.

Preliminary Results

The purpose of this study is to examine late application Nitrogen treatments in three locations in Southern Illinois and the response to timing, placement, source and rate. We conducted an N-rate trial at each location and chose a likely optimum N rate to examine various splits, sources and enhanced efficiency fertilizers. The goal of this study is to determine yield responses to N treatments while reducing the likelihood of N loss. During the first year of the study, we found variable responses to some N treatments in each of the three locations.

Agronomy Research Center – Carbondale, IL

In the N-rate response curve, we found a linear response to the N-rates applied (0, 50, 100, 150, and 200 lbs/acre; Figure 1), and therefore the optimum N rate (at $0.45/ton N and $3.75/bu corn) was at the highest rate (Optimum N = 200 lbs N/acre; Yield = 139 bu/acre). This is not a great surprise considering another N-rate trial in Carbondale showed that yield plateaued beyond the 200 lb N rate this year.

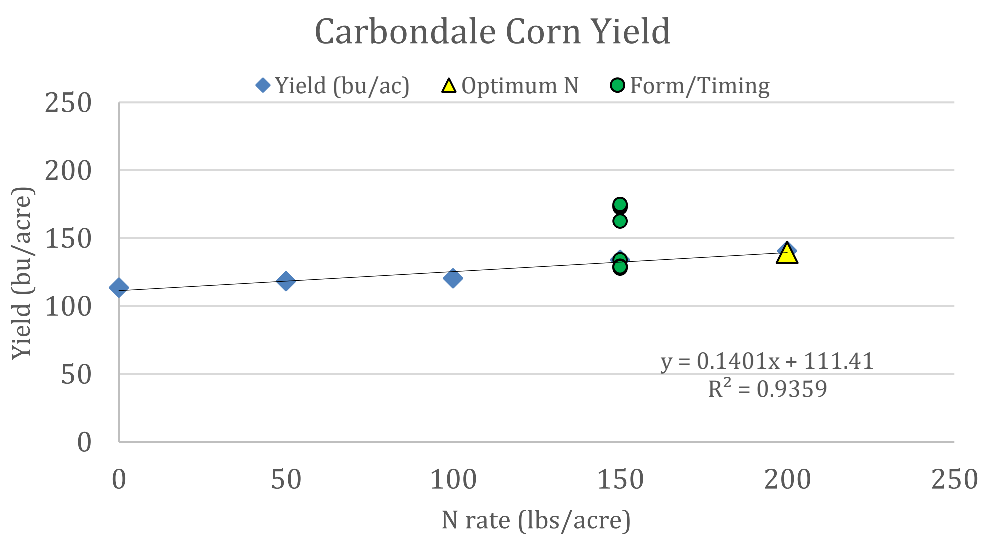

Figure 1. N-rate response for Carbondale, IL plots shows a linear regression.

For the different sources and split applications (Form/Timing), we found significant differences between treatments. At Carbondale, there was a 47 bu/acre advantage to using a split treatment of 50 lbs N (UAN at planting) followed by 100 lbs N of Urea at V10, or ESN at planting, over Broadcast UAN at planting (with or without Agrotain) or split treatments with 100 lbs N as UAN dribbled at V10 (with or without Agrotain). Injecting UAN at sidedress (V6) fell in between (Figure 2). Agrotain appeared not to have an advantage at the Agronomy Research Center in Carbondale, which may be due to rainfall patterns showing sufficient precipitation following applications (Figure 3).

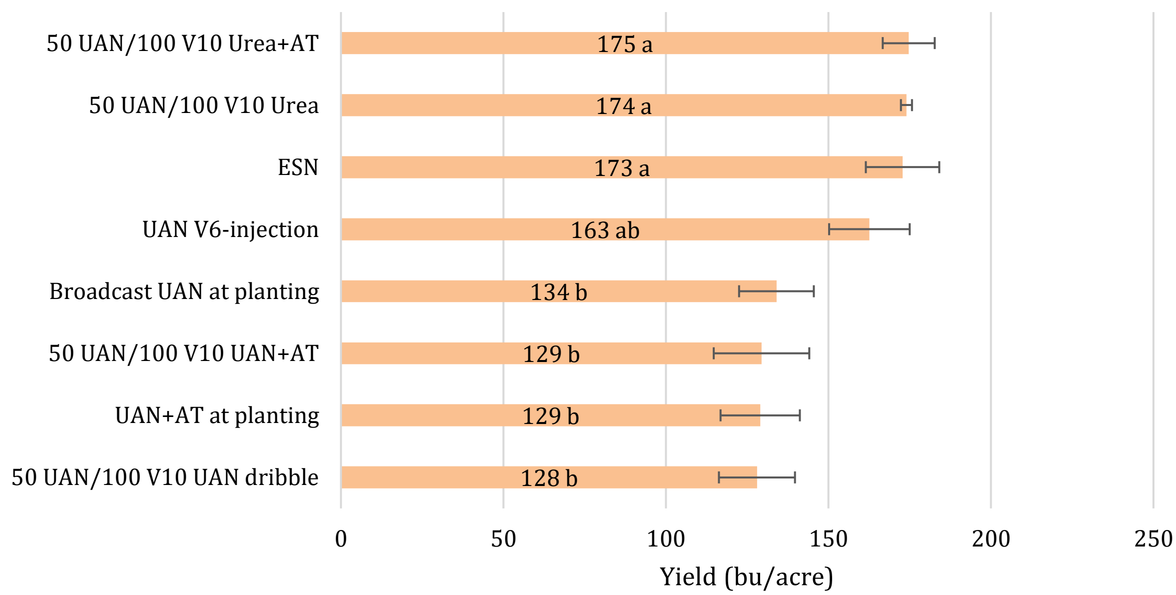

Figure 2. Agronomy Research Center corn yields. Error bars indicate standard error of the mean (n=4).

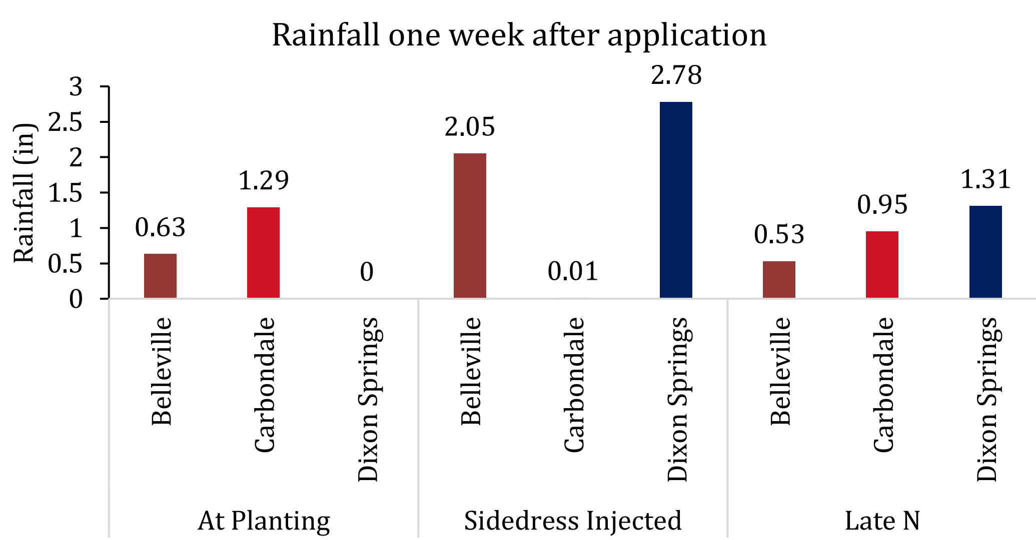

Figure 3. Cumulative rainfall for one week after application of nitrogen.

Belleville Research Center – Belleville, IL

The N-rate response curve at Belleville (Figure 4), shows that our rate for the Form/Timing treatments was very close to the optimum N treatment (Optimum N = 156 lbs N/acre; Yield = 228 bu/acre).

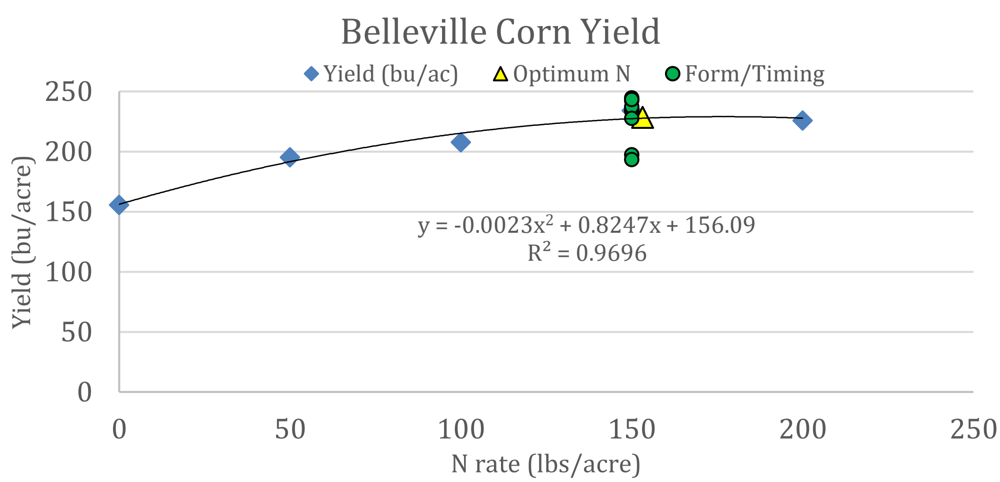

Figure 4. Belleville Research Center N-rate response curve shows are Form/Timing treatments were very close to the Optimum N value.

Interestingly, at the Belleville Research Center, like at the Agronomy Research Center, there appeared to be a penalty for the split treatment of 50 lbs UAN at planting with 100 lbs N as UAN dribble at V10. This treatment seems to underperform compared to urea at V10 (Figure 5). There was a 30-50 bu improvement in all other treatments over the split UAN dribble application at V10 (with or without Agrotain).

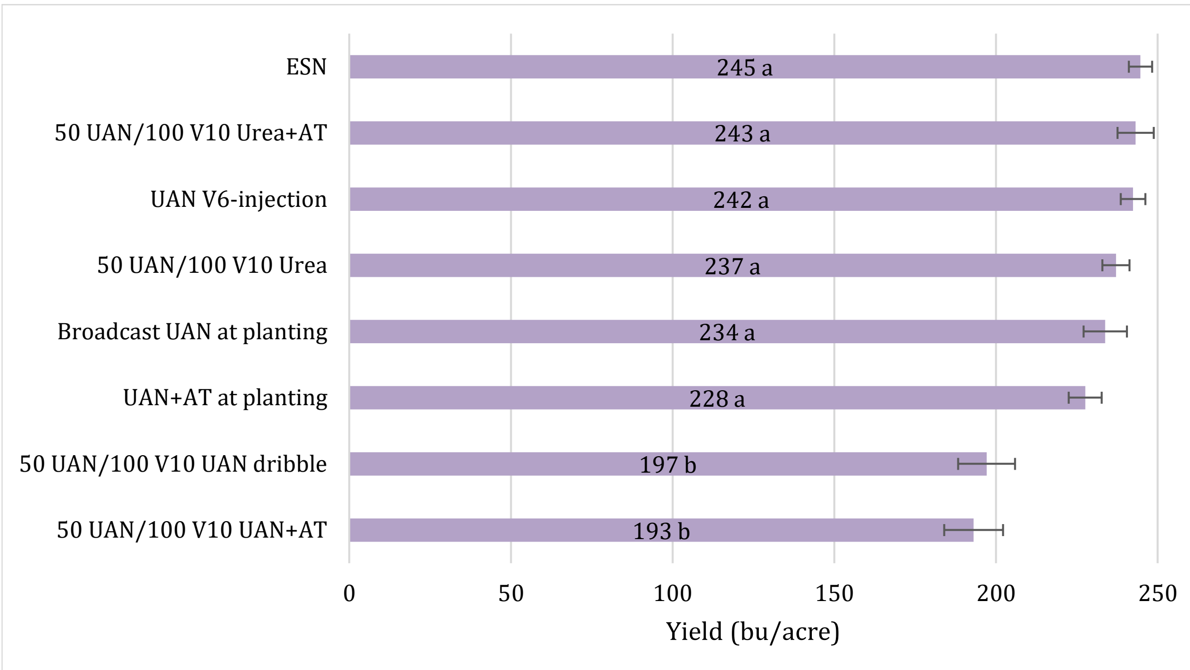

Figure 5. Belleville Research Center corn yields. Error bars indicate standard error of the mean (n=4).

Dixon Springs Agricultural Research Center, Dixon Springs, IL

At Dixon Springs Agricultural Research Center, we found our optimum N-rate (Optimum = 156 lbs N/acre; Yield = 163 bu/acre; Figure 6). In the N Form/Timing treatments, we found a completely different response to N treatments compared to other sites. All treatments proved to be statistically similar at the 0.05 level (Figure 7). The variable responses to nitrogen applications are not entirely unexpected. Response to nitrogen can vary depending on environmental variables.

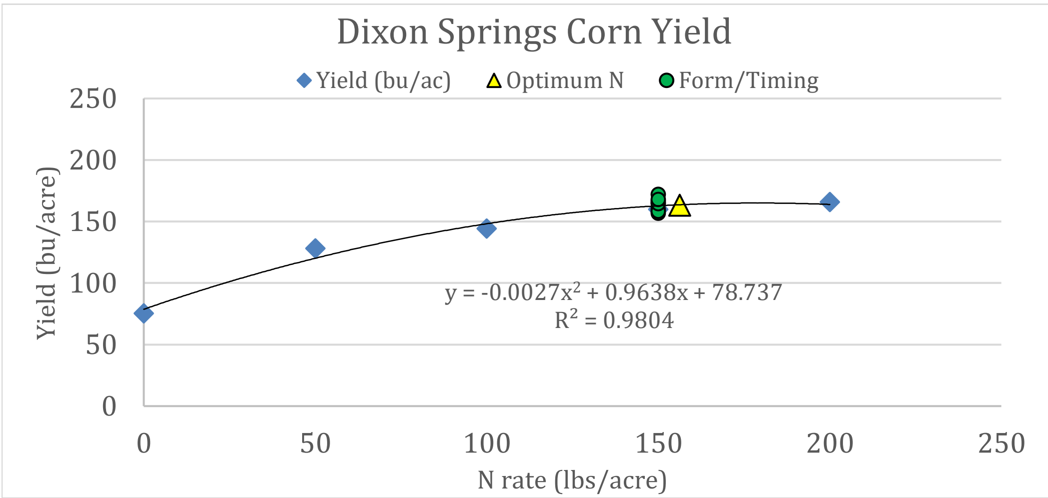

Figure 6. Dixon Springs N-rate response curve shows our optimum N-rate was slightly above the N Form/Timing treatments.

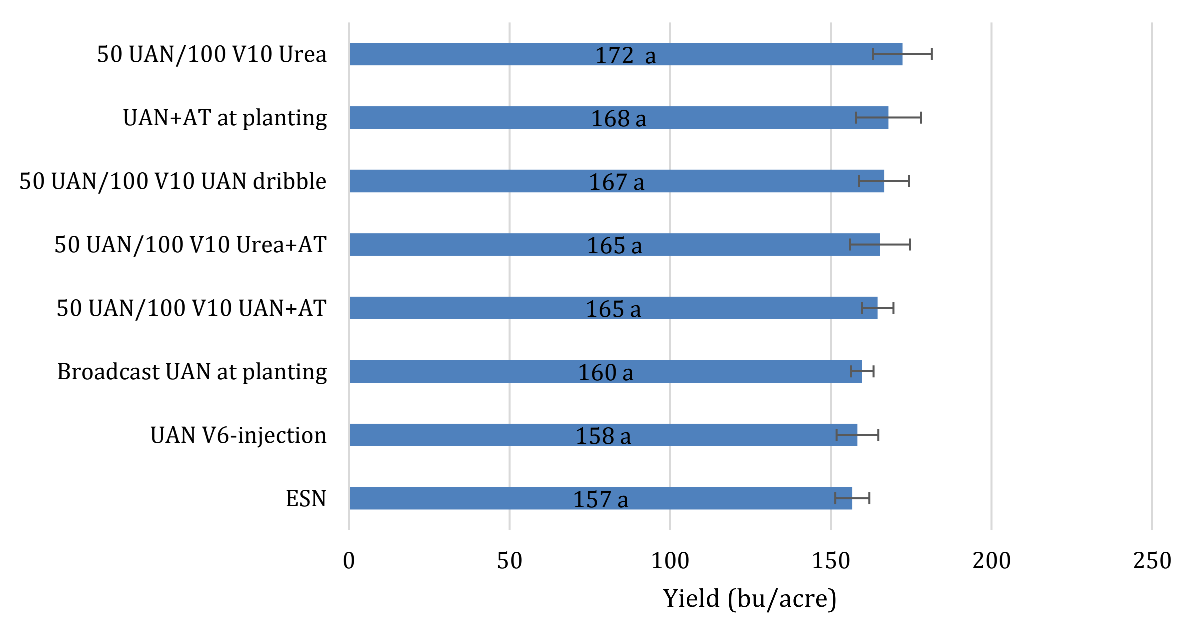

Figure 7. Dixon Springs Agricultural Center corn yields. Error bars indicate standard error of the mean (n=4).

Soils

We evaluated soil ammonium and nitrate at 1) prior to fertilization, 2) prior to V10 nitrogen application, and 3) following harvest. Pre-fertilization levels showed that there were no prior differences between treatments before starting the experiment and that the BRC had overall greater levels of ammonium and nitrate than did the ARC and BRC. This in part can help explain the greater productivity of the Belleville site.

The sampling at V9 showed that at Dixon Springs, the plots with the highest soil ammonium and nitrate were the plots that had received "at planting" treatments. This would be the expected result as they had been fertilized while the others had not had their full treatment. However, the odd result was that at the ARC we did not see this pattern. Plots that had received the full 150 lb N/ac rate at planting had the same soil ammonium and nitrate as those that did not. This may be due to the greater residue cover that may have resulted in greater immobilization of N.

Post-harvest soil sampling showed that most soils were statistically similar. One concern with later application nitrogen is that in a dry year, there may be more residual nitrogen left over that could contribute to leaching or runoff. One treatment (50 lbs N as UAN broadcast at planting followed by 100 lbs N as Urea + AT at V10) at Dixon Springs was of concern that has 2.5x higher soil nitrate than the next highest plot in the 6-12 inch depth. This plot had 19 ppm soil nitrate while most others had 3-7.5 ppm. This number is high enough to cause some concern. We will continue to monitor these post-harvest levels in the following years of this experiment to determine under which conditions and under what treatments there is a greater likelihood of leaving behind more residual N than would be deemed appropriate.

Summary

Given the appropriate rainfall conditions, late nitrogen management at the V10 stage is a viable alternative to preplant or at planting nitrogen applications in southern Illinois according to this study. However, at two of three sites, UAN dribble application at the V10 stage was not as effective as other treatments with or without a urease inhibitor. Using urease inhibitors in this study in general did not result in additional yield response, most likely due to sufficient rainfall following fertilizer application. One surprise, however, was the lack of response to a urease inhibitor at Dixon Springs in the "at planting" treatment considering there was no rainfall for a week after application. Next year, we plan to document soil moisture levels as well to help explain response to urease inhibitors.

Continued support of this project will improve our recommendations to growers and our understanding of nitrogen management systems. Understanding later nitrogen treatments effects on yield and residual soil nitrates will be important in the years to come as we will be required to manage our nitrogen applications more effectively and efficiently.

Budget

Personnel ($22,204 remaining of $30,777)
In 2014, the graduate student I intended to hire took a position at another university. This left the graduate student salary line unfilled and the work was completed by the PI (Rachel Cook) and undergraduate labor for the first year (which was paid for in part with other funds). At this time I would like to request to carry over this salary into 2015 to help cover undergraduate labor, a month of researcher time to help with site installation, and possibly additional graduate student support. A graduate student has now been identified (Brent Sunderlage) to take on this project as his Masters' thesis. He has started as of January 2015. If we do not expend these fund on the project by the end of the grant, we can return them to the NREC fund.

Equipment ($18,000 remaining of $20,000)
The sidedress injector acquired for the project was found used at 10% of the expected cost. We would like to roll the remaining equipment fund forward to 2015 to leverage other funds towards a new small plot combine which is desperately needed for this type of trial. I am discussing the option of cost-sharing with the Vice Chancellor of Research's office.

Travel ($314 remaining of $2,000)

Most of the travel money from 2014 has been spent on travel to meetings.

Commodities ($7.61 remaining of $500)

Commodities expenses were well underestimated in the grant and were expended early in the year. It would be helpful to move some funds ($1,000) from either salary or equipment into commodities.

Contractual ($5,134 overspent of $10,891)

Contractual services was underestimated in part due to additional sampling and analysis conducted and for shipping. In the original budget, we anticipated only sampling two times per location, but we realized we needed three sampling events. We also did 12 treatments instead of the proposed eight, and samples cost $6/sample rather than $3/sample. We request to move $5,000 from salary to contractual. The UI contract ($6,903) also came in very late in the year and pushed the expenditures well over the estimated budget.