TRACKING SOIL NITROGEN LOSS AND AVAILABILITY

Report for Year 1 (2015), Project 802 NREC 2015-02615, February 2016

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This project was initiated to use soil N data gathered under the N-Watch program and to generate new data on soil N trends following application of different forms and times of N application in small-plot trials at research centers and on farmer fields.

2015 Trials and Results

In the summer of 2015 we were provided some of the 2015 N-Watch soil N data gathered under that program from producer fields, mostly in central Illinois. These were identified only by GPS coordinates. The data were used to initiate setting up retrieval of soil and weather information by site, but the data have not yet been used to develop or calibrate a model.

The planned N-tracking studies at six Crop Sciences Research & Education Centers were carried out as planned. At the four northern RECs, 200 lb N per acre was applied 4 ways: NH_3 in the fall with N-Serve; NH_3 in the early spring as NH3 without inhibitor; 100 lb NH_3 in the fall with N-Serve + 50 lb N as UAN at planting + 50 lb N as UAN at sidedress (V5-V6); and 50 lb N as UAN at planting + 150 lb N as UAN at V5-V6 sidedress. These same treatments were applied as part of on-farm N rate trials at 3 sites in McLean, Sangamon, and Christian counties. In the two RECs in southern Illinois, only no-N and 150 lb N/acre of planting-time and two split-N treatments were sampled, beginning at planting.

Soil samples were taken from two reps of each N treatment beginning in fall after application, at the time of early spring NH_3, then at planting and every 10 days after planting, through pollination time. Samples were sent to a commercial soil lab for analysis of NO_3 and NH_4. Soil N amounts were calculated as lb N/acre in the top 2 ft, by adding the ppm nitrate and ppm ammonium from both depths and multiplying by 4. Yields were taken by plot combines on the RECs and by hand-harvest at the on-farm sites.

As shown in the following table, May and June rainfall totals were above normal at all of the RECs in 2015, especially in June. We think this may have caused above-normal movement of nitrate out of the top 2 feet of soil.

2015 rainfall	DeKalb	Monmouth	Urbana	Perry	Brownstown	Dixon Springs
May	5.60	4.76	6.06	5.21	5.91	5.28
June	6.75	8.12	9.01	10.55	10.75	5.34

Soil N amounts recovered through the spring are shown by REC in Figures 1 to 6, and those in the on-farm tracking trials in Figures 7 to 9 below. As this is the first year of the study we don't have a basis for comparison, but note only that amounts recovered tended to follow what we expected from the N form applied: for example, soil N increased after the sidedress application in the 50 planting + 150 sidedress treatment. One surprise was the consistently high soil N maintained following fall NH_3 application; except at Perry, it had the highest average N level in May samples than did spring-applied NH_3.

Splitting spring N, with 50 lb at planting and 150 applied as sidedressed (injected) UAN, produced the highest yield at all four on-REC sites, though its yield was higher than the those from the other three ways to apply 200 lb N at only two sites – Urbana and Perry, and was not higher than the fall-spring-sidedress split at Perry (Table 1.) That treatment had higher soil N after sidedress at Urbana and Perry, which may have been related to its higher yield, though it was not higher than soil N in the fall NH_3 treatment at Urbana. For reasons that are not clear levels of soil N at Perry were lower than at other sites, and were considerably higher with UAN used as an N source than when NH_3 was used. Yields reflected this difference to some extent, but not on a proportional basis; soil N levels in the treatments receiving UAN (at sidedress) were more double those following NH3 application by late June, but yields were only 10-15 bushels higher.

The on-farm sites weren't sampled as often as the on-REC sites, but they showed similar trends in soil N through the spring (Figures 7-9). The 200-lb fall NH_3 application showed consistently high soil N in the spring, as high as or higher than that found following the spring-applied NH_3 at each site. As we found in the on-REC trials, soil N levels were quite low by late June, and though there were differences in soil N between the different N sources used, these differences were not very large in absolute terms. At the Sangamon and Christian County sites N form and timing had not effect on yield, but at the McLean County site, the fall-spring-sidedress split produced somewhat higher yield than the other three treatments (Table 2). This was also the site with the largest range in soil N by late June, and soil N level in early July at this site was correlated to yield level.

At the southern Illinois REC sites, of the three 150-lb N treatments ranged from 119 to 150 at Brownstown and from 159 to 189 at Dixon Springs. Following 50 lb at planting, sidedressing 100 lb at V5 (injected UAN) and at V9-10 (UAN dribbled between rows) produced inconsistent yield responses, with V5 application yielding more at Dixon Springs and less at Brownstown.

The major part of the modeling work in Year 1 was based on soil N levels measured in the on-REC trials. We chose these sites due to more frequent sampling, the replicated samples within treatments, and the fact that official weather records are kept at each REC. We reviewed 23 existing models to identify the best publicly-available model which is capable of simulating daily crop growth and soil N transformations across locations using a small amount of input data. We selected the DSSAT-CERES model because of its performance in other settings and its potential to turn into a real-time decision support tool using field data collected in this project. The remainder of our efforts were dedicated to calibrating the DSSAT-CERES model against the field data collected in this project. We are working on improving the model to better reflect Illinois soil processes. We are also working on computer programming to automate procedures for integrating this model with real-time weather data, as well as designing a user-friendly model interface that will be further developed throughout this project.

We believe the first year of this project was very productive, and plan no major changes for Year 2. We may decrease the sampling interval in the on-REC projects by a few days, and are testing a "chain-saw"-type sampling device (a portable trencher) to try to improve speed and accuracy of soil sampling. Fall-applied N was applied on time in 2015 at the RECs and at two (of the planned three) on-farm sites, and we hope to add sampling at a few additional on-farm sites for 2016. We are moving the Brownstown trial to an on-farm site near Effingham, and the Dixon Springs one (both of these RECs have been unexpectedly closed) to a site near Marion.

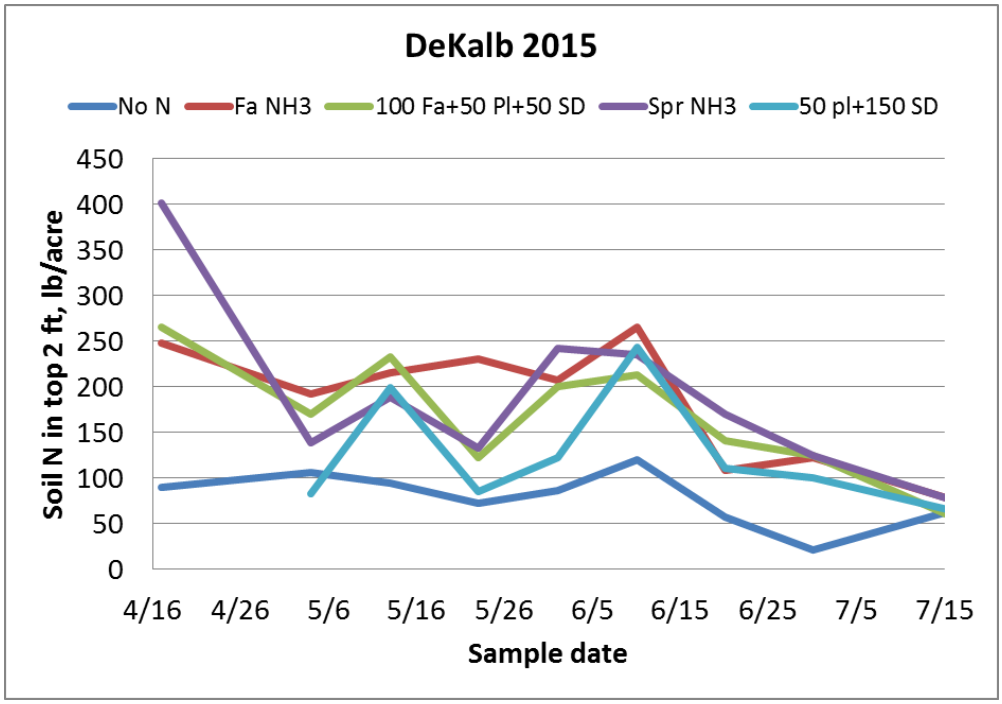

Figure 1. Soil N following application of N at different times and forms, DeKalb, 2015.

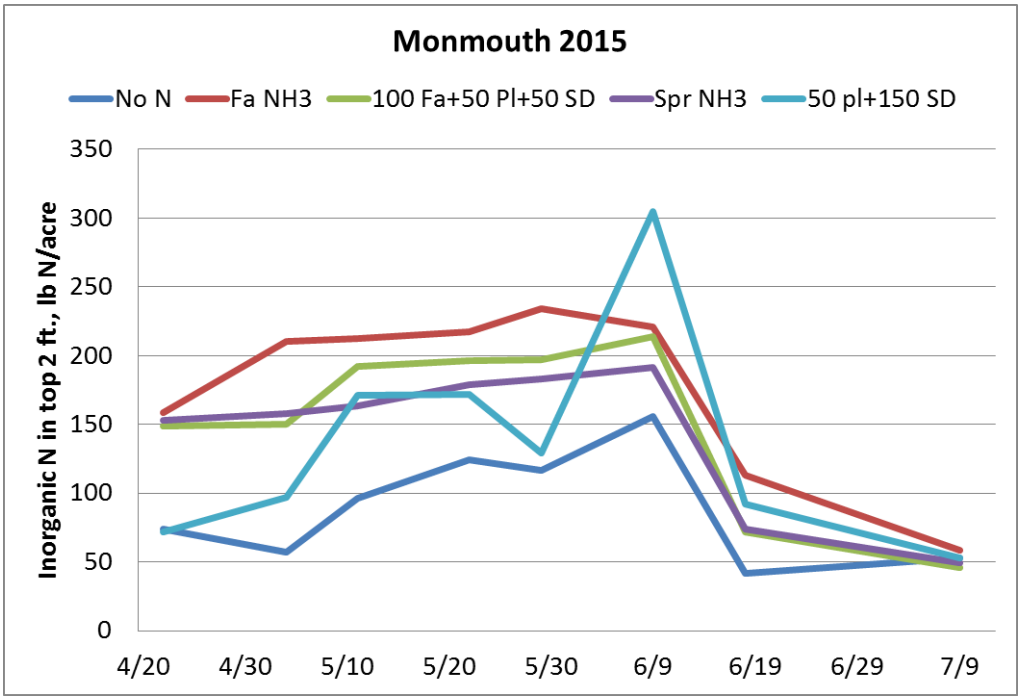

Figure 2. Soil N following application of N at different times and forms, Monmouth, 2015.

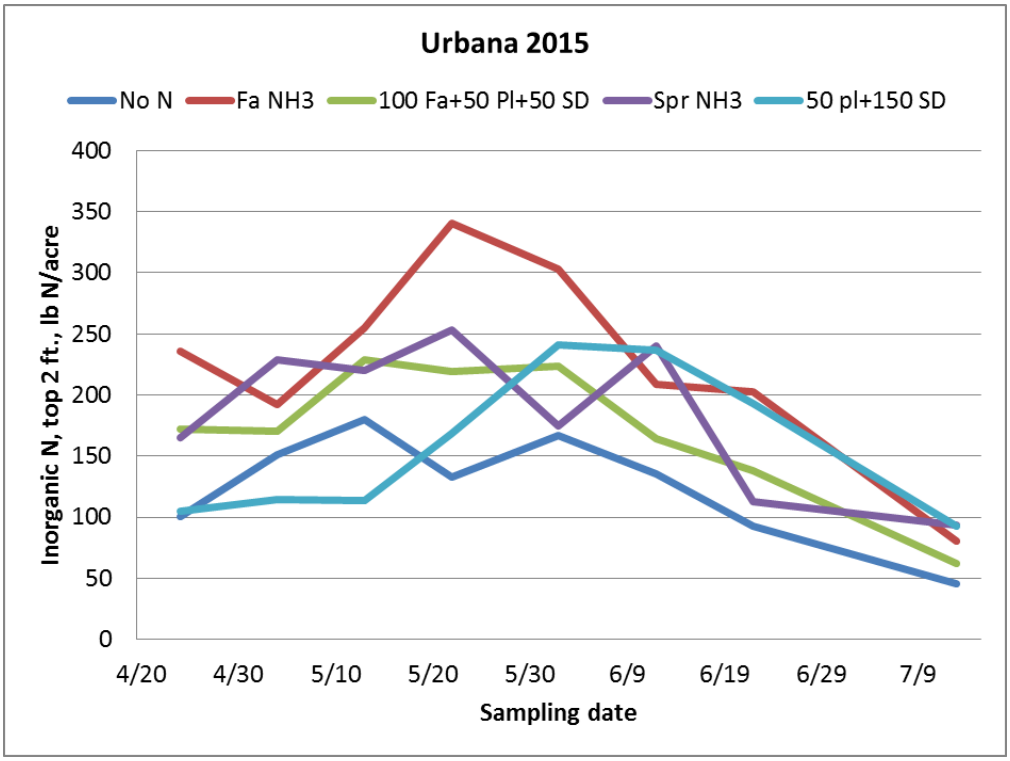

Figure 3. Soil N following application of N at different times and forms, Urbana, 2015.

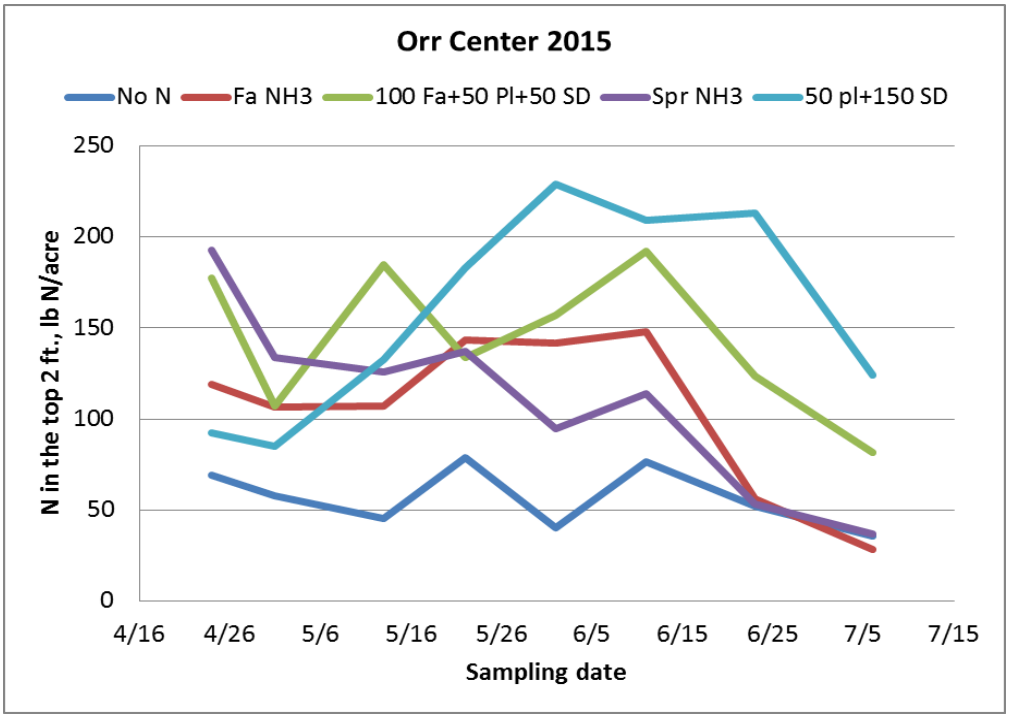

Figure 4. Soil N following application of N at different times and forms, Perry, 2015.

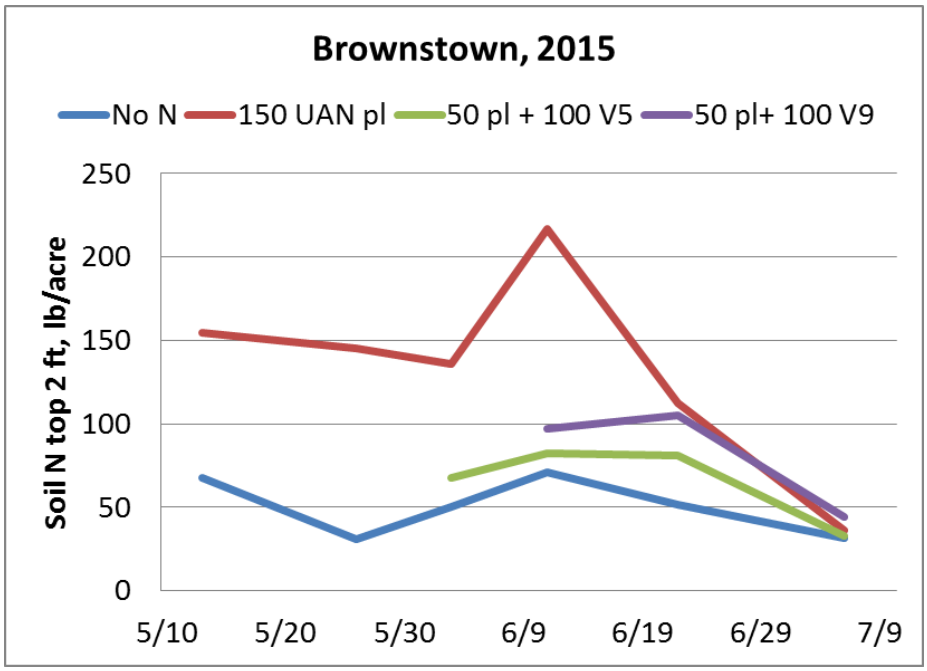

Figure 5. Soil N following application of N at different times and forms, Brownstown, 2015.

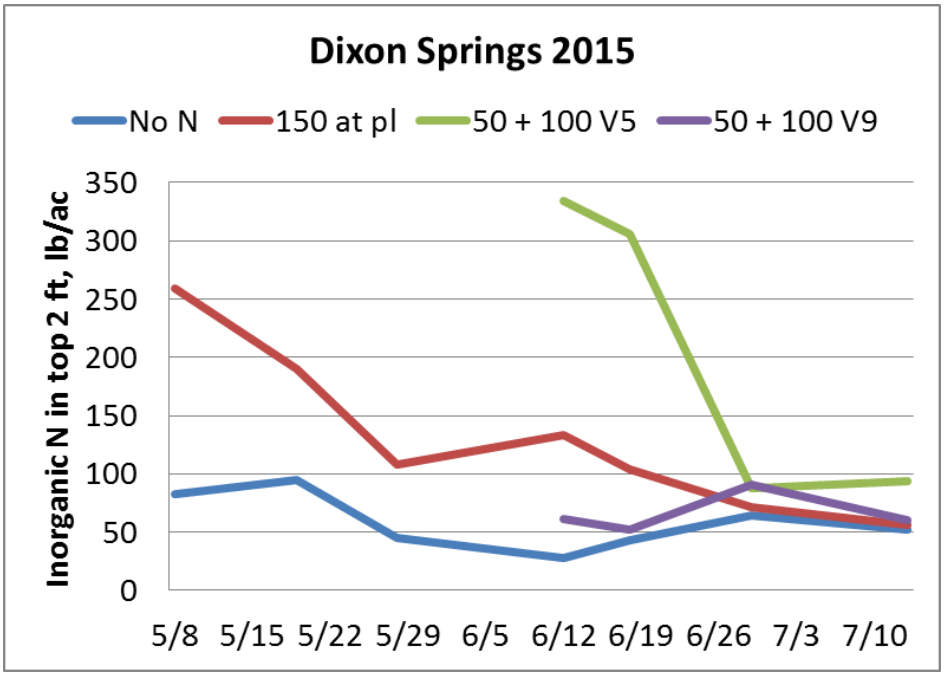

Figure 6. Soil N following application of N at different times and forms, Dixon Springs, 2015.

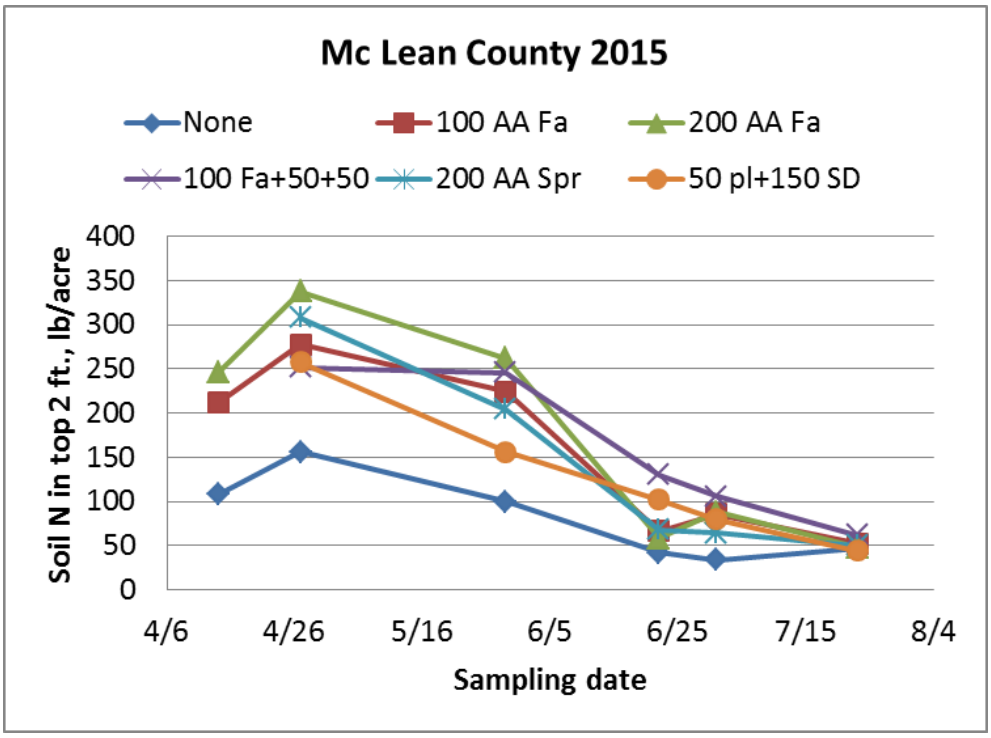

Figure 7. Soil N tracked in the on-farm location in McLean County, 2015.

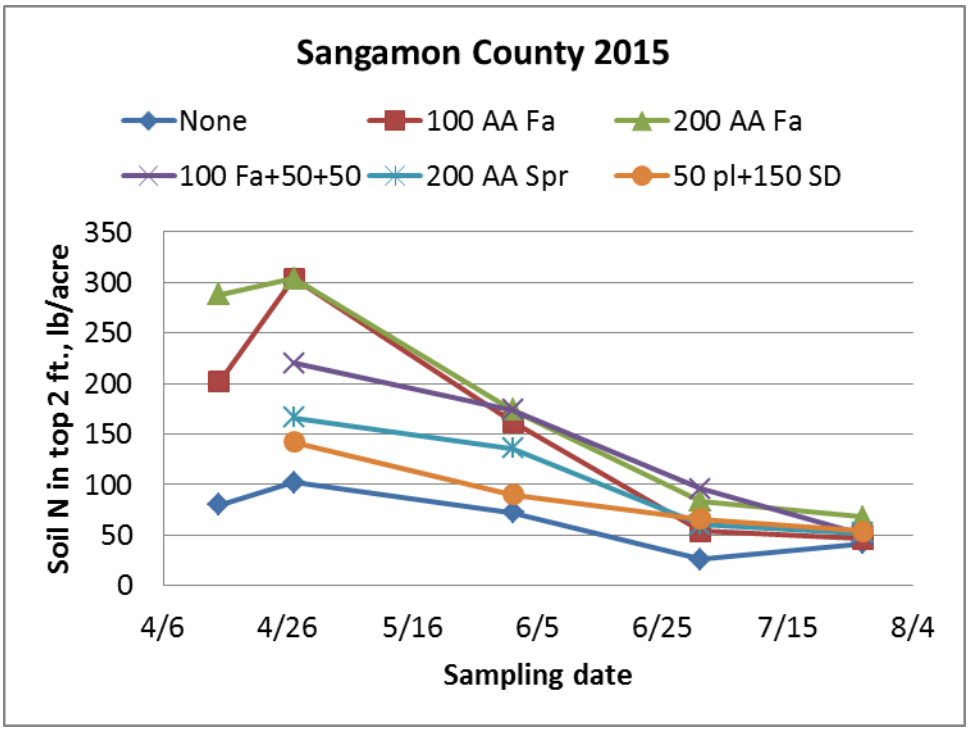

Figure 8. Soil N tracked in the on-farm location in Sangamon County, 2015.

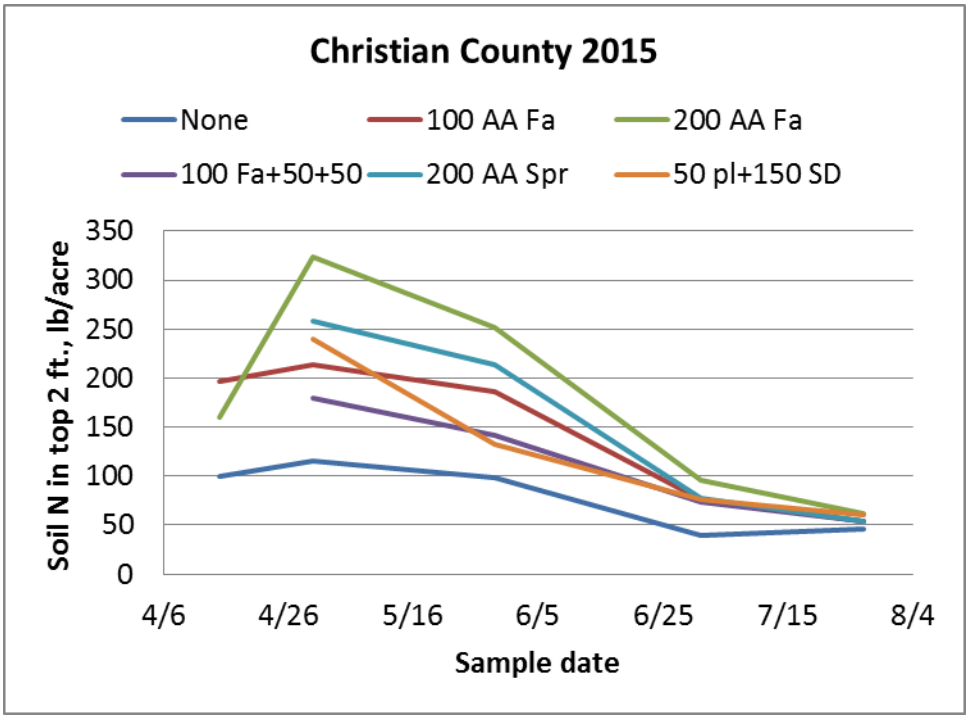

Figure 9. Soil N tracked in the on-farm location in Christian County, 2015.

Table 1. Corn yields with different N forms and timings in the N-tracking sites on RECS in 2015. Numbers followed by the same letters within a location aren't significantly different.

Treatment	DeKalb		Monmouth		Urbana		Perry	
	----------bu./acre----------							
None	---		---		165	c	133	c
Fall NH_3	193	a	217	a	238	b	199	b
Fa-spr-SD split	188	a	217	a	234	b	209	ab
Spring NH_3	192	a	223	a	235	b	197	b
Spring split	198	a	233	a	249	a	213	a

Table 2. Corn yields with different N forms and timings in the on-farm N-tracking sites in 2015. Numbers followed by the same letters within a location aren't significantly different.

Treatment	McLean		Sangamon		Christian	
	----------bu/acre----------					
None	122	c	145	b	195	b
Fall NH_3	258	ab	270	a	277	a
Fa-spr-SD split	280	a	269	a	247	a
Spring NH_3	235	b	264	a	249	a
Spring split	259	ab	277	a	265	a