Villamil – Nafziger • NREC 2017-03556
Research Report VII- 03/03/17
Agronomic and Environmental Assessment of Cover Crop in Illinois

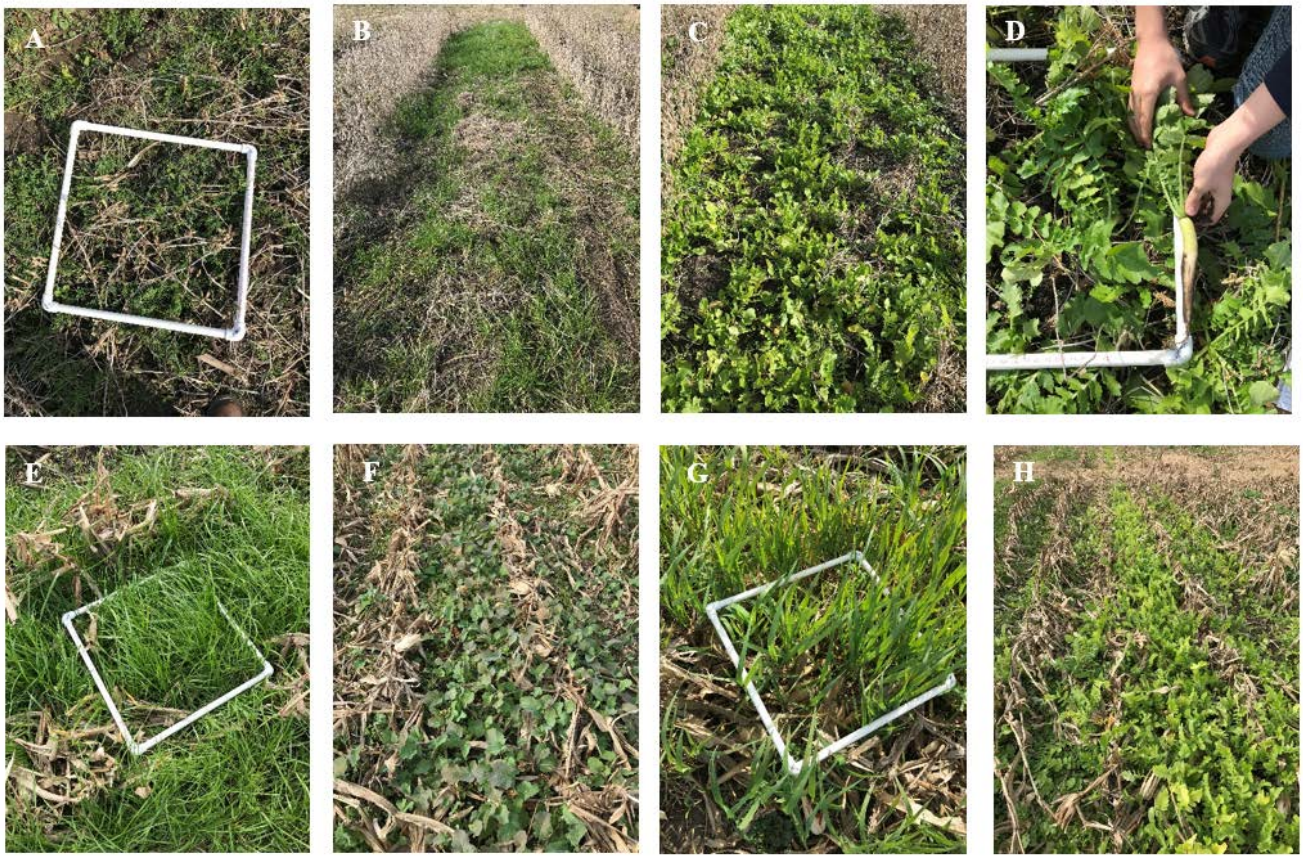
Project description:
In partnership with Illinois farmers, our long-term goal is to develop environmentally-sound crop management strategies that improve nutrient use efficiency in current cropping systems and make those farms more sustainable and profitable. By utilizing on-farm and Research & Education Center (REC) trials throughout the state, we plan to evaluate relevant and location specific information that will allow a realistic assessment of the cover crop's ability to scavenge N at the landscape level.

Objectives: 1) To develop a comprehensive set of trials to look at effects of cover crops in both on-farm and REC sites, 2) To measure the effect of cover crops in scavenging N and sequestering nutrients in their biomass, 3) To evaluate the effect of cover crops on commercial crop stands and yields, and on economic returns, and 4) To evaluate the effect of tillage on crop and soil responses to cover crops.

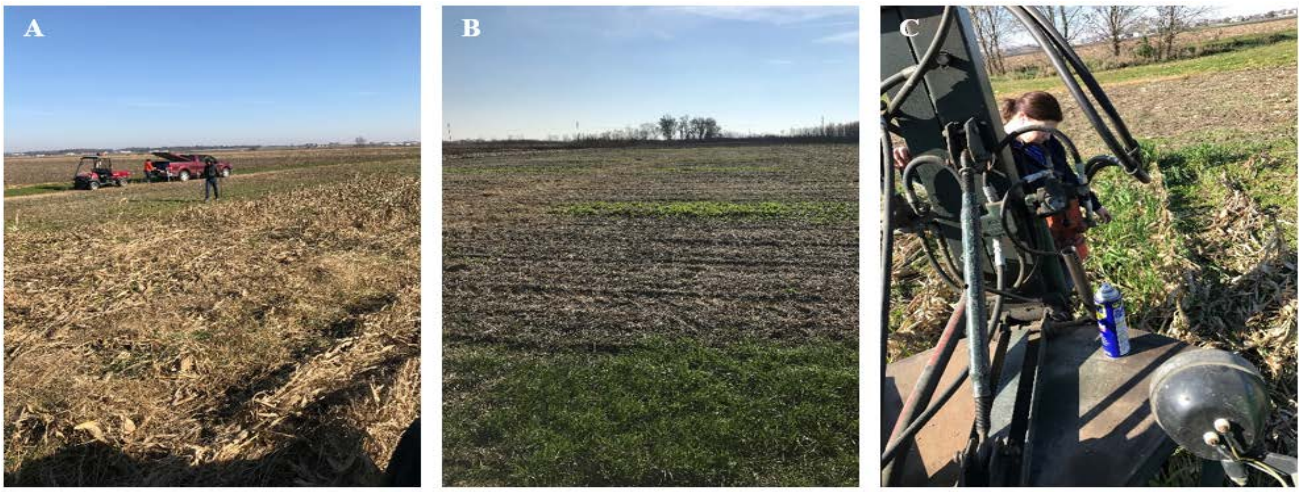
Outcomes for the period 07/01/16 to 02/28/17:

- **General description:** Air temperatures in Illinois were very favorable to fall cover crop growth, which allowed a sizeable growth of the annual ryegrass, radish, hairy vetch, cereal rye, and spring oats. The Urbana location had considerable biomass from most, if not all, of the species seeded. Timely fall rain around seeding allowed the cover crops to thrive and in conjunction with a very late frost, allowed the fall species to grow well.
- **Cover crop counts** occurred on November 11th, 2016 at the Urbana research Center.
- **Cover crop growth and emergence** of all the seeded species was seen at the Urbana location. Counts indicate that cereal rye, annual ryegrass, radish, spring oats, and hairy vetch growth was respectable to outstanding.
- **Soil sampling** was completed at both of the research centers (Monmouth and Urbana) sites during the November of 2016. Brownstown, DeKalb, Dixon Springs, and Carbondale were not sampled this year. Three subsamples per plot were taken to a depth of 90cm, and divided into 0-30, 30-60, and 60-90 cm depth increments in the lab. The soil samples from Urbana and Monmouth are being analyzed at the Villamil Lab in Urbana for available N.
- **Corn and soybean harvest** occurred at normal times for both crops at the Monmouth and Urbana sites in mid to late October.

Pictures A-C were taken from corn stubble plots in Urbana.



Pictures A-D were taken from the soybean stubble plots in Urbana on Nov. 11th 2017. Cover crop growth is in order from left to right: hairy vetch, annual ryegrass, radish and radish. Pictures E-H were also taken from the corn stubble plots in Urbana. Cover crop growth is in order from left to right: annual ryegrass, canola, cereal rye, and radish.



Pictures A-C were taken from the cover crops on November 16th, 2017 during soil sampling for available nitrogen.

Preliminary results:

Our results so far indicate that there exists a substantial amount of nitrate in the field during the fall and spring seasons yet the variability among season-year combinations is now more evident. Figure 1 shows the levels of soil NO_3 in the top 1ft of soil across 6 Illinois locations in the fall and spring of each year since the initiation of the study (Panel A, ***), showing the combined effects of season-year and tillage options (B, ns), of the cash crop and the cover crop rotation (C, ns), of the tillage option and cover crop rotations (D, ns), and of the season-year and cover crop rotations (E, ***). Based on these results we can see that the statistically significant effects of the interaction between season-year and cover crop rotation are mainly due to a slight reduction on the soil NO_3 levels caused by the rotation including annual ryegrass (CarSar) during the years where this cover crop was successfully established. Figure 2 shows the overall effect of cash crop and cover crop rotations on the levels of soil NO_3 within successive depths (1-3ft from top to bottom). These 2 factors are the only ones that have a statistically significant effect on the levels of soil NO3 within the top 3 ft when we consider the season-year and locations variability as random effects. As expected and similar to our previous analysis, we measured more soil NO_3 right after corn crops and we also measure a slight decrease with the rotations including annual ryegrass (CarSar). There are on average about 25 lbs/acre of nitrates in the top 3 feet of soils yet the overall profiles of soil nitrate are strikingly similar for bare fallows and cover crop rotations (Figure 2).

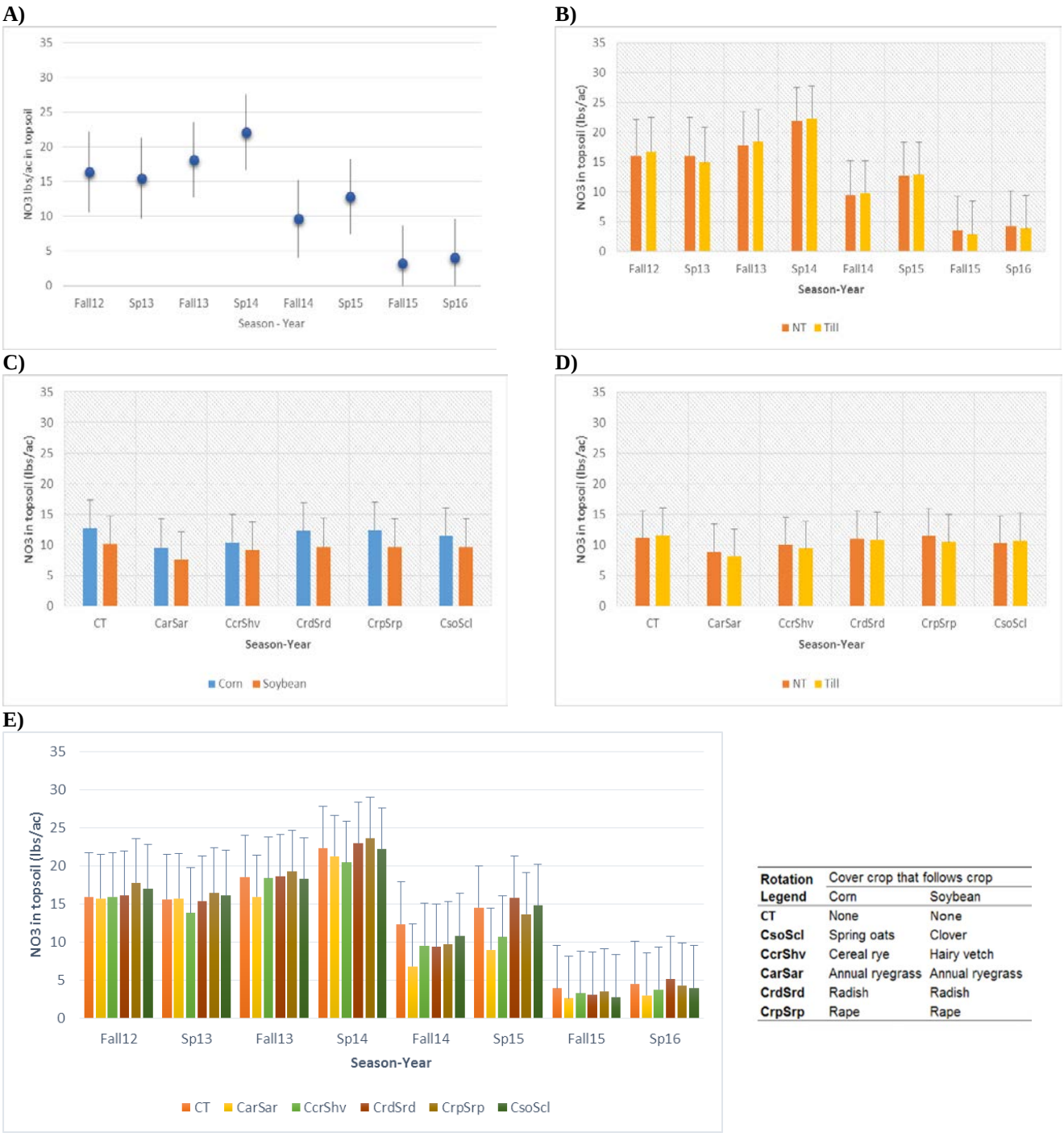
Regarding cash crop yields, if we look at them across locations, tillage options, and cover crop rotations, corn yields ranged between 117 – 164 bu/acre whereas soybean yields ranged between 44 – 57 bu/ac during the initial 4 years of the study (Figure 3 A). The variability associated with the year of production at each of the 6 geographical locations (Year x Loc) showed the most important effect on yields for each corn (Figure 3 B) and soybean crops (Figure 3 C). However additional 3 way interaction effects of these factors with tillage (Year x Loc x Till) and cover crop rotations (Year x Loc x CCrot) were only significant for the corn crop. Tilled corn plots yielded slightly more than their no-till counterparts across years for most locations except Dekalb (DK, Figure 3 D). The addition of cover crops of annual ryegrass into the rotation decreased corn yields slightly at the Urbana and Dixon Spring sites (DK and UR, Figure 3 E). Cover crops of rape (CrpSrp), and spring oats and clover (CsoScl) as part of the corn soybean rotations at Brownstown (BT) site showed potential to increase corn yields above the levels of the fallow controls. When we look at the overall effects of tillage and cover crop rotations across years and locations, there is a clear trend for higher yields of corn in tilled plots and lower corn yields when the cover crop rotation includes annual ryegrass (CarSar, Figure 3 F).

Outreach: Mr. Ivan Dozier received his MS degree in the Department of Crop Sciences in May 2016 working under this project and Dr. Villamil's advising. A peer review manuscript is currently in print on Agronomy Journal: Dozier, I.A., G.D. Behnke, A.S. Davis, E.D. Nafziger, and M.B. Villamil. 2017. Tillage and cover cropping effects on soil properties and crop production in Illinois. Agronomy Journal.

Gevan Benhke presented on "Soil Available Nitrogen Uptake Under Cover Crops in Illinois" during the poster session (number 328-422) at the Agronomy Society of America Annual Meetings held in Phoenix, AZ, November 8, 2016.

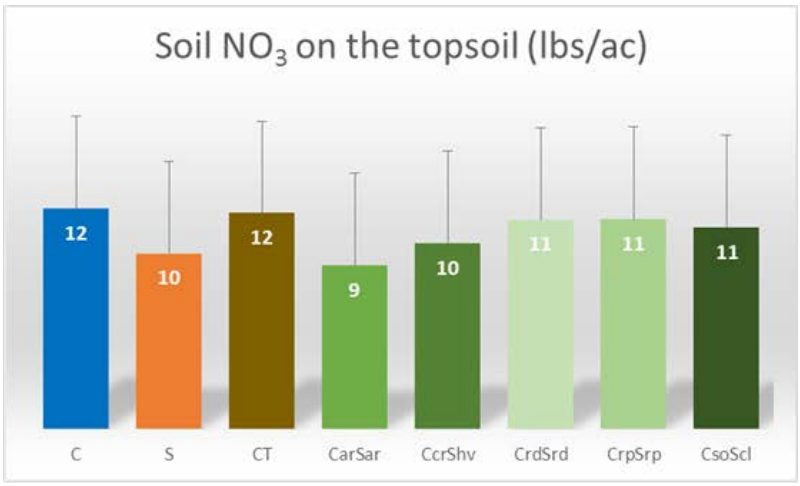
Dr. Villamil had the opportunity of sharing results from this project during the Soil Fertility Webinar, organized by University of Illinois Extension on Feb 28 2017.

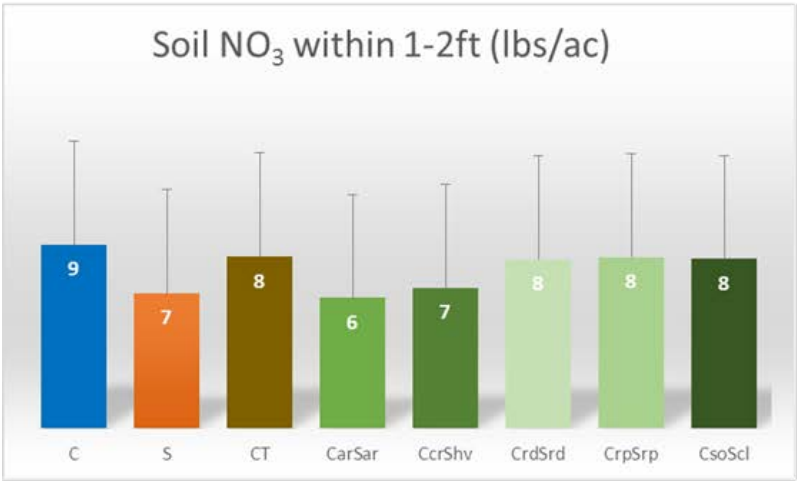
Budget updates: No changes are required at this time.



Rotation Legend	Cover crop that follows crop	
	Corn	Soybean
CT	None	None
CsoScl	Spring oats	Clover
CcrShv	Cereal rye	Hairy vetch
CarSar	Annual ryegrass	Annual ryegrass
CrdSrd	Radish	Radish
CrpSrp	Rape	Rape

Figure 1. Levels of soil NO_3 in the top 1ft of soil across 6 Illinois locations in the fall and spring of each year since the initiation of the study (A, ***), showing the combined effects of season-year and tillage options (B, ns), of the cash crop and the cover crop rotation (C, ns), of the tillage option and cover crop rotations (D, ns), and of the season-year and cover crop rotations (E, ***).





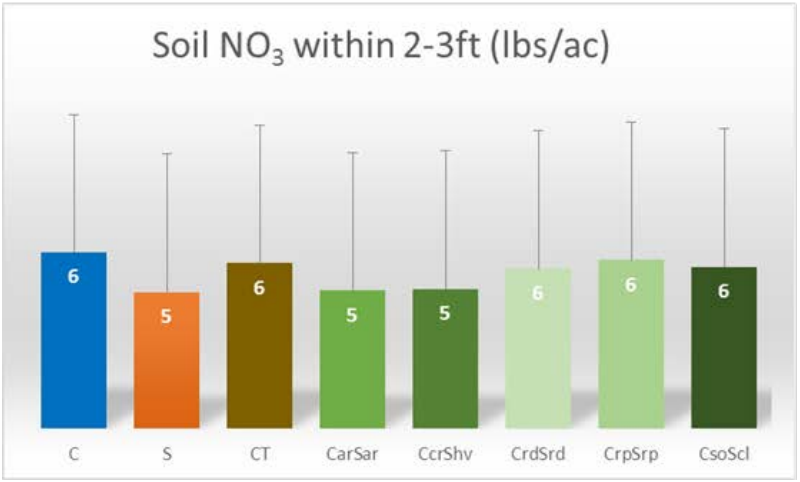
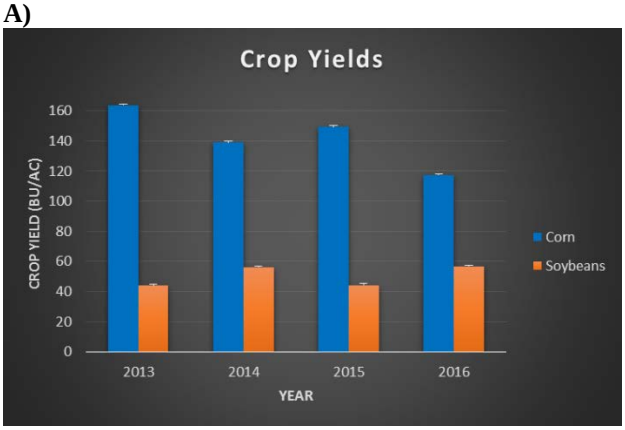


Figure 2. Overall effect of cash crop and cover crop rotations on the levels of soil NO3 within successive depths (1-3ft from top to bottom panels). These 2 factors are the only ones that have a statistically significant effect on the levels of soil NO3 within the top 3 ft when we consider the season-year and locations variability as random effects.

A)



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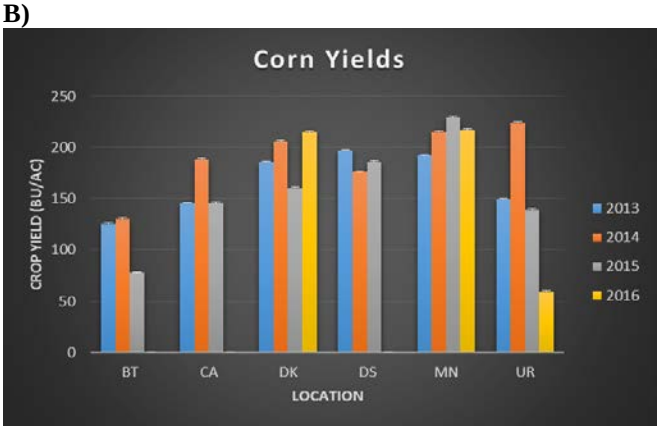
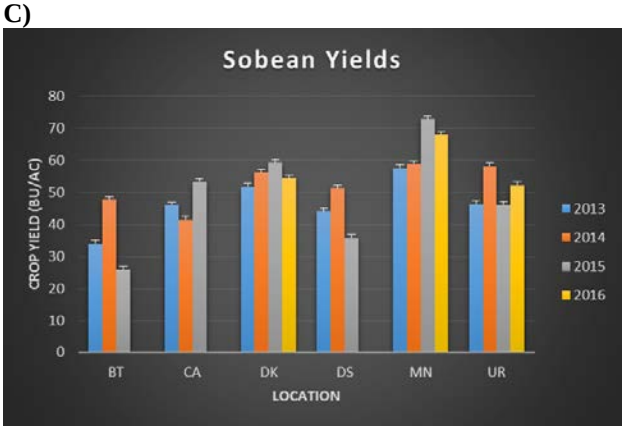
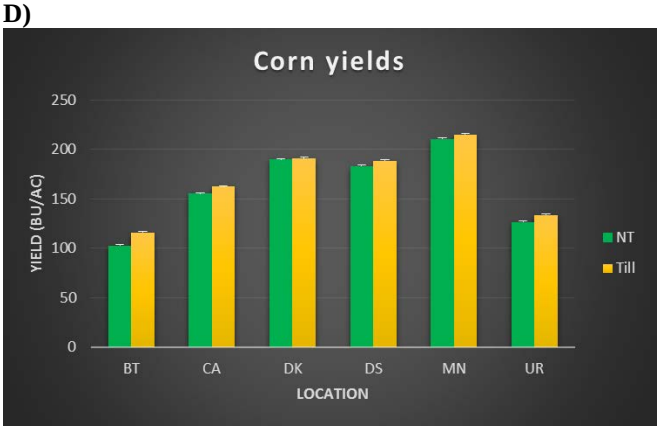


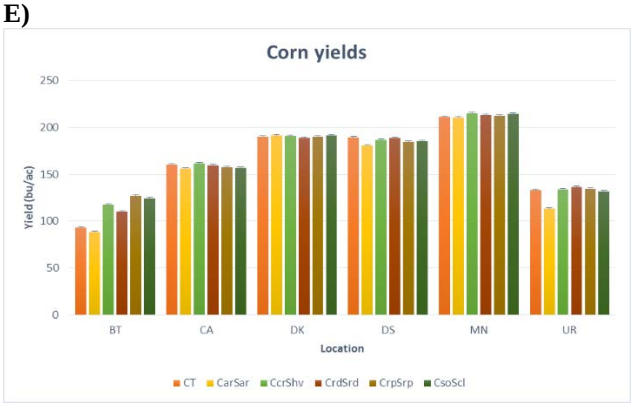
C)



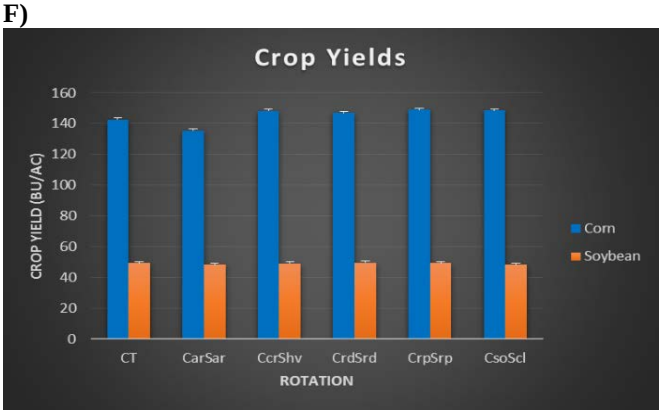
D)



E)



F)



Rotation	Cover crop that follows crop	
Legend	Corn	Soybean
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CarSar	Annual ryegrass	Annual ryegrass
CrdSrd	Radish	Radish
CrpSrp	Rape	Rape

Figure 3. Cash crop yield levels across 6 Illinois locations since the initiation of the study (A), showing the combined effects of location and year on corn (B,***), and soybeans (C, ***). Tillage affected the responses of the corn crop (D, ***) whereas rotations with cover crops affected corn yield differently(E, **) at Brownstown (+ response with CrpSrp or CsoScl), at Urbana (- response to CarSar) compared with the other locations (neutral responses). Overall, CarSar rotations slightly decreased corn yields (F, ***) when we consider the year and locations variability as random effects.