Long Term Tillage and Cover Crop Rotational Effects on Soybean Performance

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Introduction

- No-till offers multiple benefits including improved soil water holding capacity, infiltration, and carbon (C) sequestration.
- Cover crops such as *hairy vetch (Vicia villosa Roth)* and winter rye (*Secale cereal*) (WR) could change soil nitrogen (N) availability early after termination and therefore, affect crop yield and nitrous oxide (N_2O) emissions.
- We hypothesized that WR could increase N_2O emissions by increasing soil volumetric water content (VWC) during the soybean growing seasons. We also hypothesized that soybean yield could be decreased by a combination of no-till and WR due to delay in soybean growth and pushing soybean for N fixation.

Objectives

Our objectives were to evaluate the effects of tillage vs. no-till and WR vs. no-cover crop combinations on (i) soil VWC, temperature, and N dynamics, (ii) soil N_2O emissions during the soybean years, and (iii) soybean growth, nodulation, and grain yield.

Study Site, Design, and Management

- A field experiment was initiated in 2013 in Agronomy Research Center (ARC) in Carbondale, IL and has been continued until present.
- The experimental design was a randomized factorial design with three replications.
- Treatments were two tillage systems (no-till vs. conventional tillage) and two cover crops (no-cover crop control vs. WR prior to soybean; hairy vetch prior to corn).
- WR was planted in late Oct. and was terminated in early May.
- Soybean planted late-May to early-June.

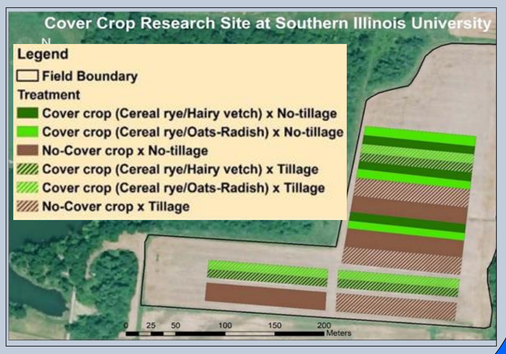

Fig. 1: Field trial established in 2013 and has been continued until 2020 at Agronomy Research Farms at SIUC.

Measurements

- Leaf area index (LAI) and normalized difference vegetative index (NDVI), were measured during the soybean growing seasons (Fig. 2A).
- A closed vented chamber method was used for greenhouse gas sampling (17 rounds in total) (Fig. 2B). Sampling intervals were at times 0, 15, 30, and 45 minutes. Gas Chromatography (GC) was used to analyze nitrous oxide emissions (Fig. 2C). Nitrous oxide flux was calculated based on linear regressions between time and emitted N_2O.
- We monitored soil VWC and temperature at each N_2O measuring date. Soil NO_3-N was also monitored at cover crop termination date, during the growing season and at harvesting time.

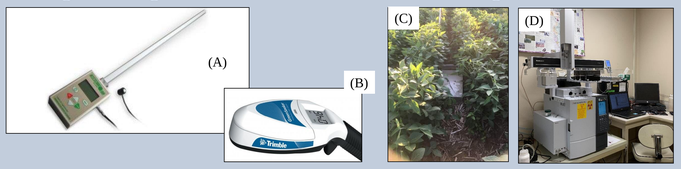

Fig. 2: Leaf area meter and Trimble GreenSeeker (A-b), closed vented chamber for N_2O sampling (C), and a GC for N_2O analysis (C).

Results

Soybean Morphology

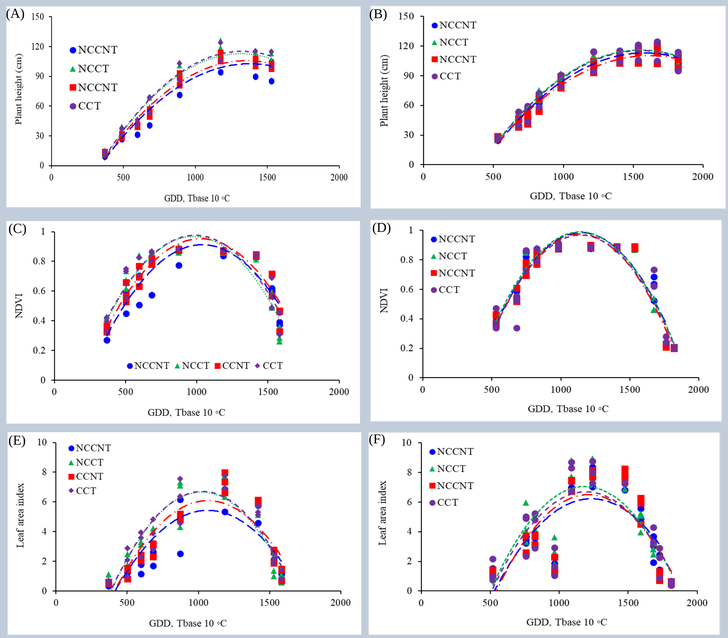

Fig. 3: Plant height (A-B), NDVI (C-D), and leaf area index (E-F) of soybean for cover crop-tillage combinations in 2020 and 2022

Acknowledgement/Contact Information

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Results

Soybean Biomass and Grain Yield

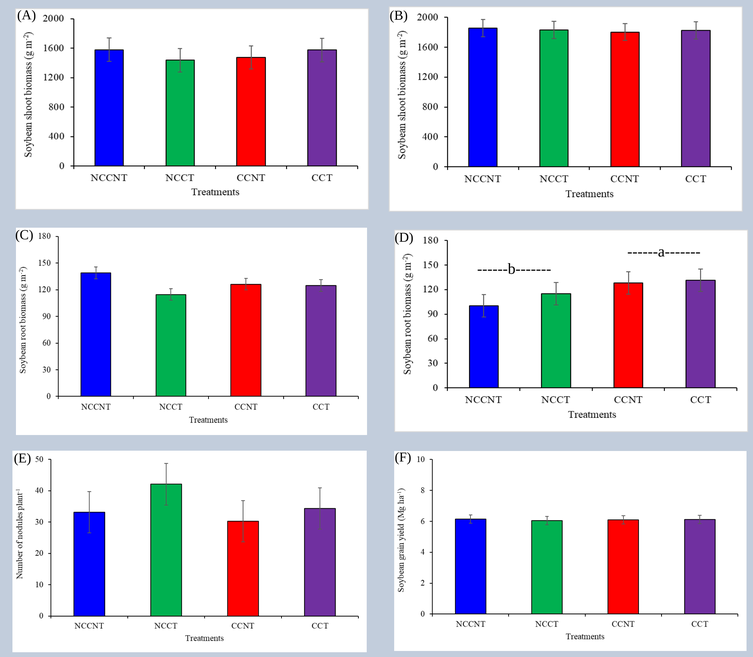

Fig. 4: Soybean shoot biomass (A-B), root biomass (C-D), number of nodules (E), and grain yield (F) in response to tillage and cover crop combinations.

Nitrous Oxide Emissions (Soybean 2020)

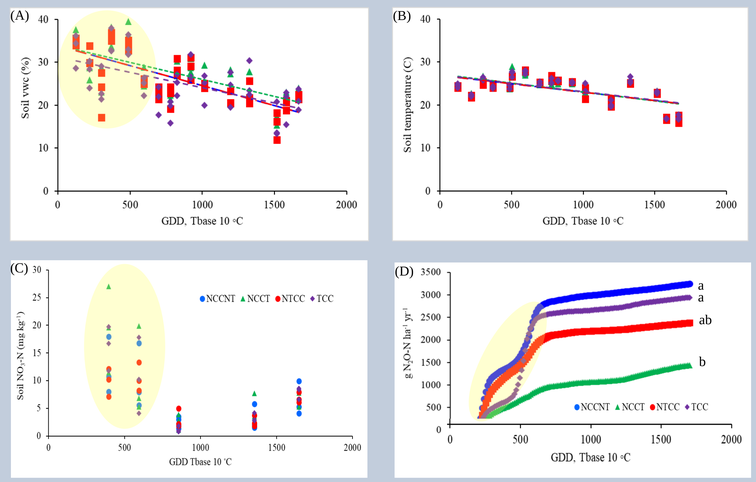

Fig. 4: Soil VWC (A), temperature (B), and NO_3-N trends (C), and cumulative N_2O-N trend over the soybean growing season in 2020.

Preliminary Conclusions

- Winter rye did not influence soybean morphology.
- Plant height was the only morphology parameter that was influenced by tillage by cover crop combination but this had no effect on soybean grain yield.
- Soybean shoot biomass was similar among all treatments in all years but root biomass was higher in cover crop treatments.
- Soybean yield was unaffected by treatments indicating a combination of no-till with winter rye can be practiced.
- No-cover crop and tillage reduced N_2O-N losses during the soybean growing season in 2020.