PROGRESS REPORT

PROJECT TITLE: Impact of Cover Crop Strategies on Productivity of Corn
PROJECT NUMBER: 4123-16SP
REPORTING PERIOD: Oct 1 – December 31, 2016
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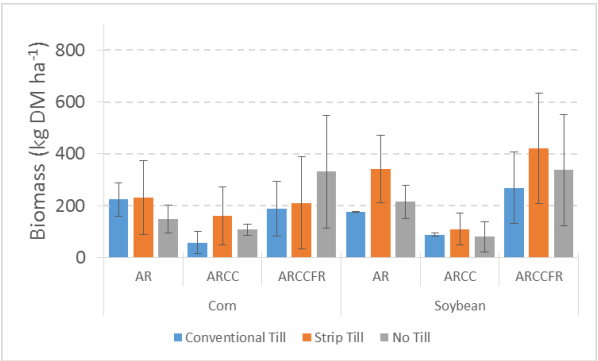
1.) PROJECT ACTIVITIES COMPLETED DURING THE REPORTING PERIOD. (*Describe project progress specific to goals, objectives, and deliverables identified in the project workplan*)

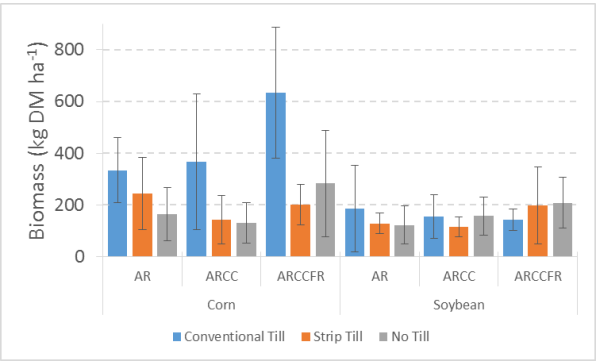
The objectives of the project are to a) assess the viability of cover crop strategies on corn-soybean rotation under different tillage practices and b) determine the effect of cover crop strategies on growth and yield of corn and soybean produced across multiple environments. Experiments for objective (a) are conducted within the Long-Term Tillage Trial platform (LTTT) located in Lamberton and Waseca. Experiments for objective (b) are conducted within the Long-Term Agricultural Research Network (LTARN) located in Grand Rapids, Lamberton, and Waseca. The trials were successfully completed. Cash crops were harvested as scheduled. Soil solution samples have been prepared for [N-NO_3] analysis. Soil moisture readings are being analyzed as well. Preliminary results for both objectives follow.

<u>Cover crops and tillage practices (objective a)</u>

Cover were seeded mid-September of 2016 on standing corn and soybean grown under different tillage practices. Preliminary results showed a slight effect of location on the establishment of covers (Fig. 1).



(A) Lamberton



(B) Waseca

Figure 1 - Average end-season (mid-Nov 2015) aboveground biomass of cover mixes seeded on standing corn and soybean grown under different tillage practices. Mixes included annual rye (AR), AR + crimson clover (CC), and AR + CC + forage radish (FR). Vertical lines indicate the standard deviation.

Cover crops in multiple locations (objective b)

Location effect on establishment and ground coverage in the fall

Differences on establishment and on the potential of living canopy cover from cover crops were observed among locations. In the north (Grand Rapids, MN), covers tended to establish better under soybean than under corn, while the opposite seem to happen in the south (Waseca, MN) (Fig. 2). In general, the farther north, the less aboveground biomass (Fig. 2A) and the less living coverage (Fig. 2B) by the end of the season (mid-November). Also, biomass and living canopy cover showed less variation among cash crops and mixes in the southwest (Lamberton, MN; Fig. 2C,D) than in the south (Fig. 2E,F). Finally and contrary to what we observed in the south, cover crops in the colder north seem to establish better under soybean than under corn.

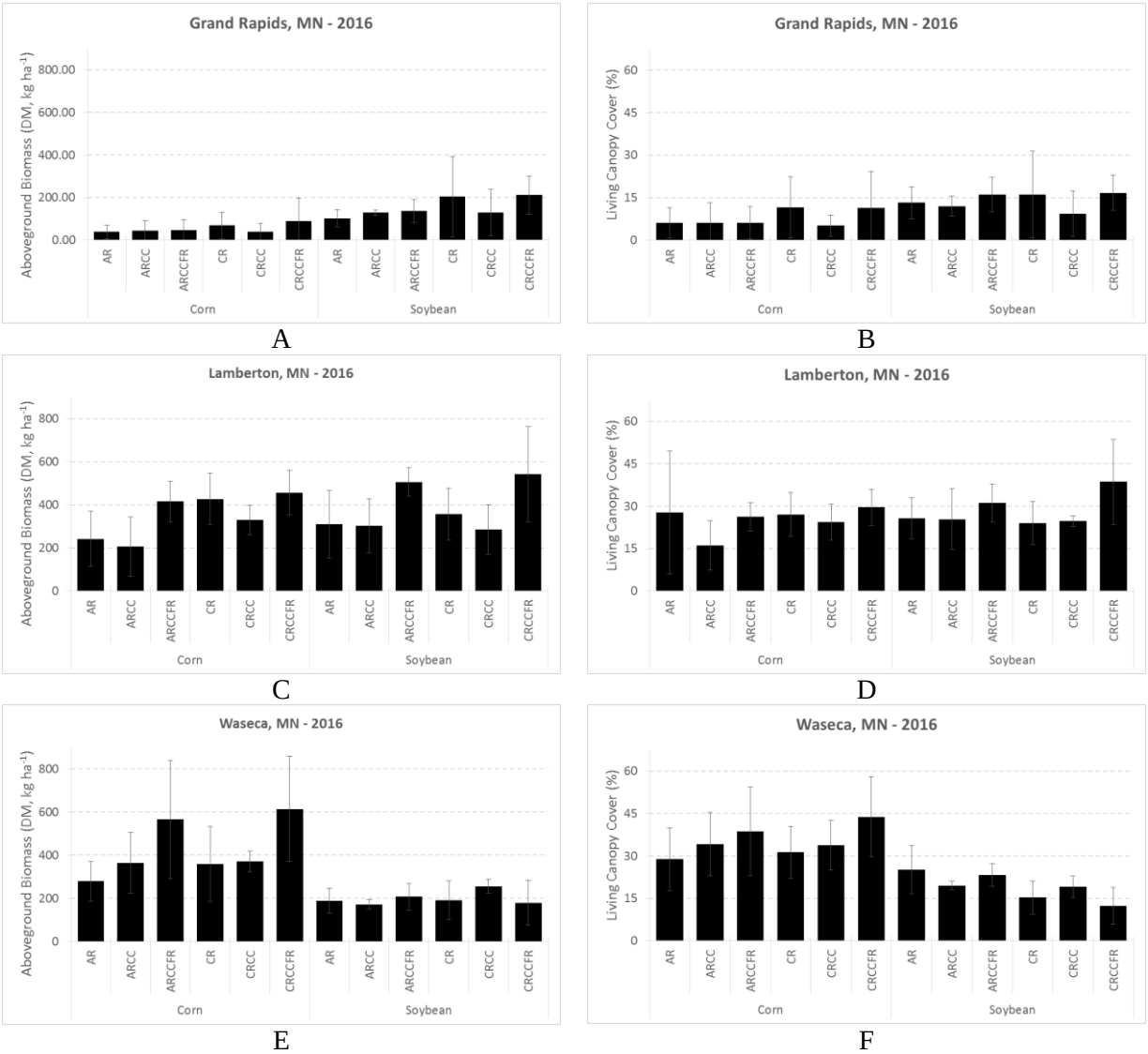
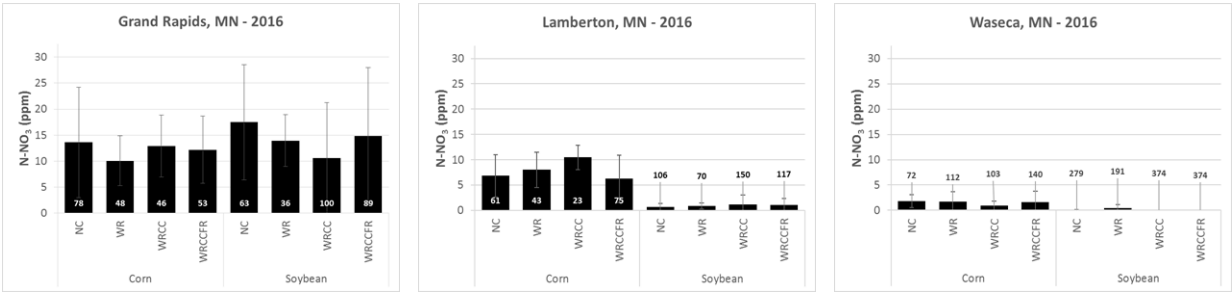


Figure 2 - Average end-season (mid-November) aboveground biomass and living canopy cover of different cover crop strategies seeded on standing corn and soybean at different locations in Minnesota. Covers were seeded mid-September 2016. Cover crop mixes included AR and Winter Rye (WR); each grass was mixed with crimson clover (CC) and CC + Forage Radish (FR). Vertical lines indicate the standard deviation.

Nitrate levels in leachate in the fall

Due to weather conditions, cover crops seeding was delayed by 2-3 weeks. As a result, the effectiveness of covers at reducing nutrients losses may have been affected. Our preliminary results showed that by the end of the season, nitrate levels in leachate at 1.0 m depth were much higher in the sandy soils of Grand Rapids than in the heavier soils of Lamberton and Waseca (Fig. 3). Within location, nitrate levels in leachate were highly variable, the highest variation occurred in Waseca and the lowest in Grand Rapids. Nitrate levels in the leachate were similar under corn and soybean in Grand Rapids but higher in corn than in soybean in Lamberton and Waseca (Fig. 1).



A B C

Figure 3 – Average nitrate levels in leachate from ceramic cup lysimeters placed at 1.0 m soil depth. Averages were calculated from four samples obtained at around 2-weeks interval from Sep 1 to Oct 15. Cover crops were seeded Sep 14-20 and emerged Sep 25-30. Vertical lines indicate the standard deviation and numbers in and outside the bars indicate the coefficient of variation.

Early seeding cover crops

Our preliminary results showed that end-season (mid-November) living canopy cover from early seeded cover crops was higher than that from late seeded cover crops (Fig. 4 at V4 corn vs Fig. 2D at R5-R6 corn). We also found that for conditions in Lamberton, MN annual rye alone or blended with one or two more covers performed better than winter rye alone or blended with one or two more covers (Fig. 4). This finding, if confirmed in the second year, has important practical consequences. Annual rye winter kills, making it an attractive choice as cover crop for those trying to avoid the issues related to termination in the spring.

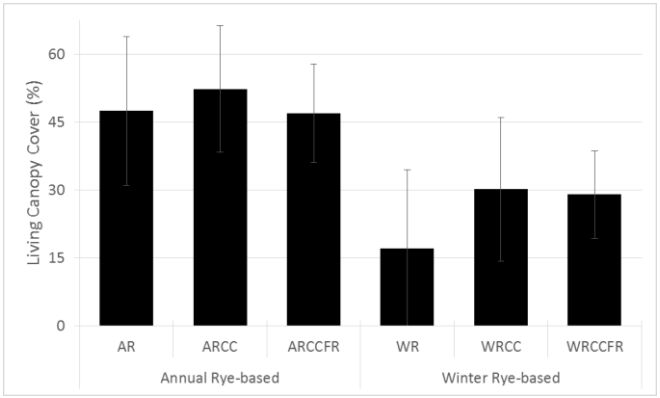


Figure 4 - Average living canopy cover of early (at V4 corn) seeded covers. Cover crops were seeded end-June 2016 on standing corn. Cover crop mixes were based on two grasses; Annual Rye (AR) and Winter Rye (WR). Each grass was mixed with crimson clover (CC) and CC + Forage Radish (FR). Southwest Research and Outreach Center, Lamberton, MN, 2016. Vertical lines indicate the standard deviation.

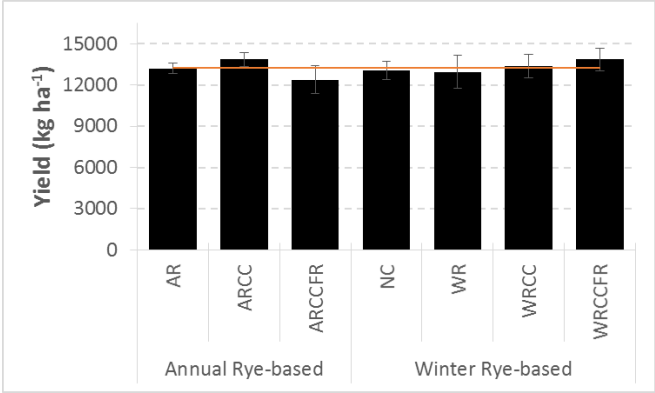


Figure 5 – Average yield of corn grown with early (at V4 corn) seeded cover crops. Cover crop mixes were based on two grasses; Annual Rye (AR) and Winter Rye (WR). Each grass was mixed with crimson clover (CC) and CC + Forage Radish (FR). Southwest Research and Outreach Center, Lamberton, MN, 2016. Orange horizontal line indicates the average corn yield among treatments. Vertical lines indicate the standard deviation.

Corn average yield was 13235 kg ha^{-1} (±776 kg), equivalent to 210 bu/A (±12 bu). Based on results from one year-location only, the use of cover crops seem not to negatively affect the yield of corn (Fig. 5).

Information in process

Results on pest and beneficial insects, growth stage of crops, maximum leaf area index, maximum canopy height, grain yield of crops from the LTTT and the LTARN, soil analysis, N content in plants, soil moisture, and daily weather data have yet to be completed and analyzed.

2.) IDENTIFY ANY SIGNIFICANT FINDINGS AND RESULTS OF THE PROJECT TO DATE.

Our preliminary results suggest that cover crop establishment is affected by location, time of seeding (early vs late season), and management practices. We also observed that late-season seeded annual rye seem to establish better than late-season seeded winter rye. This is a preliminary indication that annual rye might be the choice for those looking for a cover crop that winterkills. Contrary to what was observed in the south, cover crops in the north seem to establish better when seeded on standing soybean.

3.) CHALLENGES ENCOUNTERED. (*Describe any challenges that you encountered related to project progress specific to goals, objectives, and deliverables identified in the project workplan.*)

The major challenge was the wetter than normal year (e.g.: Fig. 6). Conditions varied from one location to another; the beginning of the growing season (April – June) was wetter than normal in Lamberton and slightly drier than normal in Waseca and Grand Rapids (data not shown). The period from July through October was wetter than normal in all three locations, delaying cover crops seeding by about two weeks. However, and except for the complementary study in Waseca, most activities were successfully conducted and the objectives were not compromised.

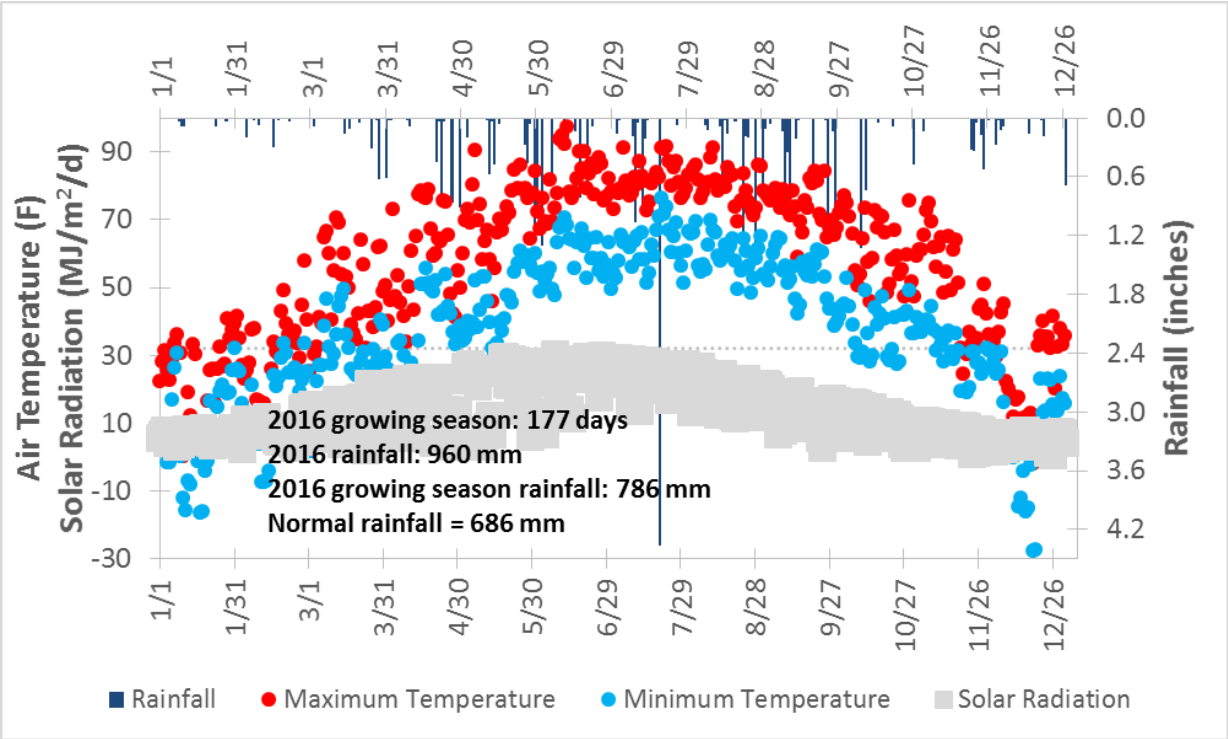


Figure 6 – Weather conditions at SWROC – Lamberton, MN in 2016. Data obtained from the automated weather station at the center.

In Grand Rapids, the installation of the ceramic cup lysimeters and access tubes for the moisture probe needed extra care due to the nature of the sandy soils in the region so re-installation was necessary. This issue, however, did not compromise our data gathering protocol.

4.) FINANCIAL INFORMATION (*Describe any budget challenges and provide specific reasons for deviations from the projected project spending.*)

No budgetary challenges to report.

5.) EDUCATION AND OUTREACH ACTIVITES. *(Describe any conferences, workshops, field days, etc attended, number of contacts at each event, and/or publications developed to disseminate project results.)*

1. November 3, 2016. I spoke to an audience of 33 people (Cover Crop Field Day, USDA-NRCS-SWCS) at the SRWOC-Lamberton. The subject was about field trial findings on cover crop research. I talked about challenges and opportunities with the use of cover crops and presented some preliminary results from this and other projects.
2. January 26, 2017. I presented the project at the 2017 MN Ag Expo in Mankato, MN.
3. January 30, 2017. I spoke to an audience of 13 people (Winter Crops and Soils Days) in Fairmont, MN. Preliminary results on the establishment of cover crops at different environments and under different tillage practices, as well as the potential of cover crops to reduce nitrate levels in leachate, were presented.