Progress report 1 – August 31, 2022 MSRPC Project: 10-15-48-22018

Farmer-driven Research into Planting Green along the Red

Institution/Organization: Regents of the University of Minnesota

Principal investigator: Angie Peltier, apeltier@umn.edu, 218-281-8692 (o) 414-704-1931 (c)

Co-PIs: Jodi DeJong Hughes, UMN Extension; Anna Cates, UMN Extension & Minnesota Office for Soil Health; Lindsay Pease, UMN Extension & Northwest Research & Outreach Center.

Cooperators: Dorian Gatchell, Minnesota Agricultural Services; Melissa Carlson and Chris Matter, On-Farm Research Network, Minnesota Wheat Research & Promotion Council.

Sponsors: Minnesota Soybean Research & Promotion Council, UMN Extension, UMN College of Food Agriculture & Natural Resource Sciences, Minnesota Wheat Research & Promotion Council, Agassiz Seed & Supply, Bayer Crop Science.

Leveraged funding: $264,639 This project leveraged approximately $13,800 in funding ($1000 in plot fees and farmer payments, $10,800 in in-kind labor, $2000 in seed costs donated by Agassiz Seed & Supply, $1000 in Roundup PowerMax3 donated by Bayer Crop Sciences) that was used to establish an eight-location field trial in Fall 2021. This supports the project because data collection and analysis can begin right away without the need for a set-up year. Our annual match for this project is estimated at approximately $11,250 per year. DeJong-Hughes', Cates', Pease's and Peltier's time, equal to about $8,800 per year, should also be considered an in-kind match for this project.

The MSRPC funding was critical to allowing us to close out the 2022 growing season focusing on growing soybean in the cover crops plots established in fall 2021. **To fund this project going forward, with MSRPC's initial funding we were successful in obtaining a $249,839 grant from the USDA North-Central Region – Sustainable Agriculture Research & Education (NCR-SARE) program to carry this project forward for an additional 3 years.**

Project Summary: Minnesota (MN) farmers face difficult choices when deciding to prioritize either long-term soil health goals or the immediate benefits of tillage for residue management and seedbed preparation. This decision is particularly challenging for farmers in northwest (NW) and west-central (WC) MN due to the already narrow planting window. Despite the reported soil health benefits, a short growing season makes delays to spring field work risky. Research on cover cropping suggests that early season cover crops can stabilize yields by mitigating excess and limited soil moisture, improving field trafficability, and reducing wind erosion. However, there has been limited research on how implementation of soil health practices will affect crop nutrition, residue decomposition, and weed and disease pressure. Reliable advice on these agronomic outcomes is critically needed by MN farmers interested in adopting reduced-tillage and cover cropping systems. To meet this need, we partnered with six farmers and two University of Minnesota Research & Outreach Centers (Crookston and Morris) to design 8 replicated, production-scale research and demonstration sites that were sown in *Fall 2021*. We will use these sites to investigate the effect of different reduced-tillage and cover cropping scenarios on soybean production across MN. This project focuses on collecting data on the broad agronomic implications of reduced tillage and cover cropping and will help to develop research-based information and enact technology transfer to soybean farmers with an interest in adopting soil health practices within WC and NW MN.

Project Objectives: This project will address multiple agronomic impacts of planting green (i.e., planting soybeans into a living rye cover crop). This project will meet this goal by achieving the following objectives:

1. **Determine optimal combinations of seeding rate and termination timing for planting green in a wheat-soybean, corn silage-soybean, or corn grain-soybean rotation**
   Cereal rye is a hardy, overwintering cover crop capable of surviving the harsh winters of the Northern Great Plains. The tradeoff for its winter-survivability is that it requires additional attention in the spring to avoid interference with the subsequent cash crop. Because we will be planting green, we cannot use tillage to terminate the rye cover. Instead, we will rely on glyphosate for rye termination. Finding both the optimal seeding rate and the optimal termination timing will be critical to control the rye cover and avoid associated soybean establishment issues in the spring.

Two UMN research and outreach center locations (northwest and west-central) and six farmer fields were seeded to winter rye in fall 2021 (**Figures 1-3, Table 1**). The 2021-2022 project ended up with five on-farm research sites as we lost the location labeled "Dragseth", as the farmer (Paul Dragseth) unexpectedly passed away over the winter.

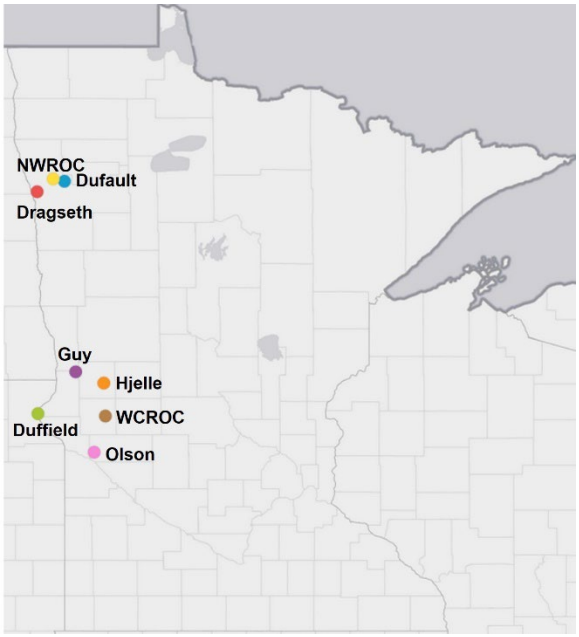

Figure 1. Locations of "Farmer-driven Research into Planting Green along the Red" project's on-farm and UMN Research & Outreach Center research plots seeded to cover crops in 2021 and seeded to soybean in 2022.

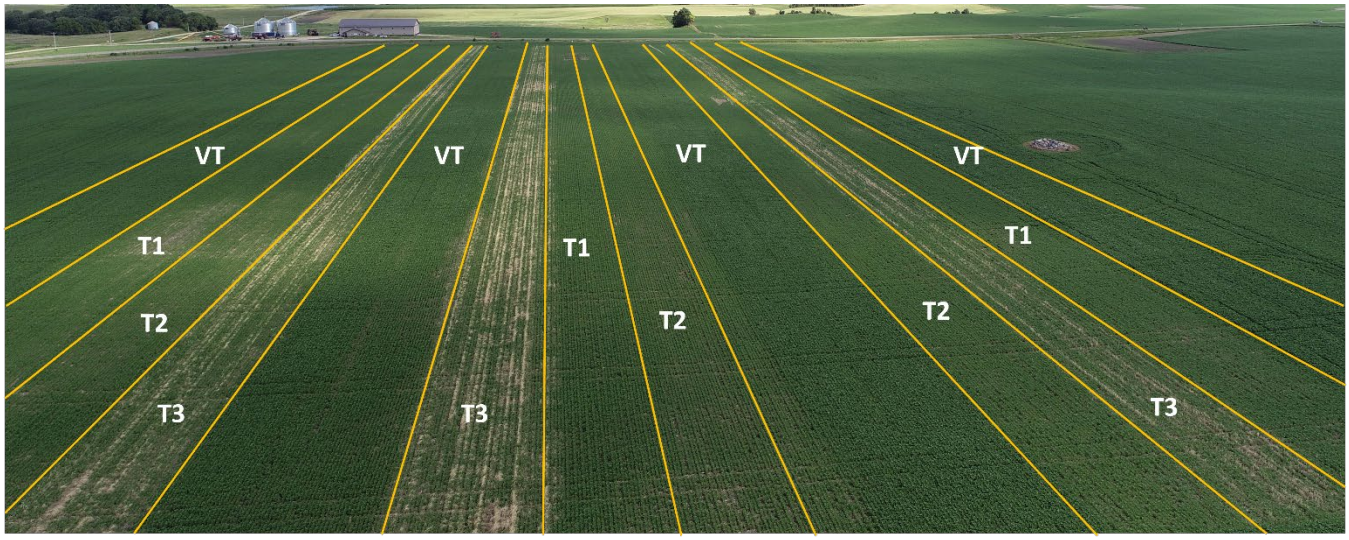

Figure 2. Aerial photo of the Barrett, MN on-farm research plots captured by drone (Courtesy of Dorian Gatchell). The labels between each yellow line indicate the abbreviations associated with each rye termination timing: T1 = terminated 1-2 weeks before soybean planting, T2 = terminated at soybean planting, T3 = terminated 1-2 weeks after soybean planting, VT = vertical tillage, these are no-rye control plots.

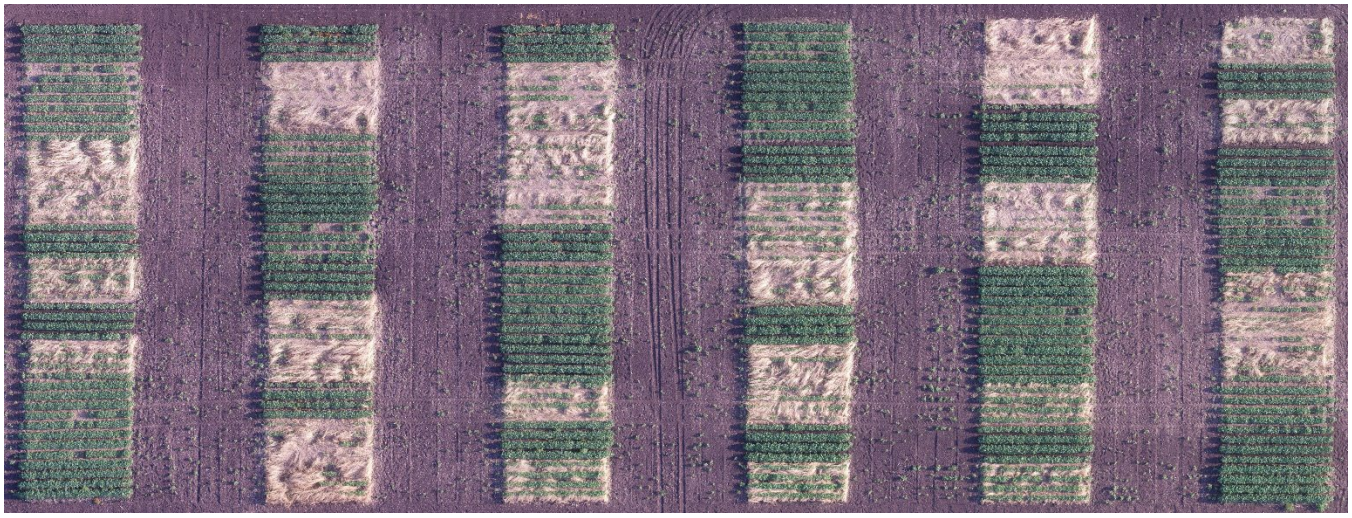

Figure 3. Aerial photo of the Morris, MN West-Central Research and Outreach Center small plots captured by drone (Courtesy of Dorian Gatchell).

Table 1. Dates that the 2021 cash crop was harvested, the 2021 winter rye cover crop was seeded, the 2022 soybean crop was seeded, and the soybean variety and per acre seeding rate at on-farm trial locations (farmer last name) and UMN Research & Outreach Centers

	Appleton, MN (Olson)	Browns Valley, MN (Duffield)	Tintah, MN (Guy)	Barrett, MN (Hjelle)	Gentilly, MN (Dufault)	Morris, MN WCROC	Crookston, MN NWROC
Crop harvested	Oct 14	Oct 25	Sept 8	Oct 6-7	Jul 28	Sept 5	Aug 4
Rye seeded	Oct 30-31	Oct 31	Sept 8	Oct 31	Sep 7	Sept 8	Sep 1
Soybean seeded	May 10	May 23	June 8	May 27	June 7	June 8	May 27
Soybean variety		Peterson	Legend 05E256N	LGS0822			Peterson 19en008
Soybean seeding rate	140,000	165,000	140,000	165,000	175,000		170,000

2. **Quantify the effect of cereal rye on agronomic production impacts such as: a) soybean nutrition, b) soil microbial activity, and c) incidence of soybean disease and weed pressure**
    a) Cereal rye is often promoted for its ability to scavenge nutrients from the prior year's cash crop. Following the 2021 drought, there is a high potential that the rye has scavenged excess nutrients from the soil profile. Just prior to cover crop termination, we will sample above-ground cereal rye biomass to assess nutrient content. To determine the timing of nutrient release by the rye cover crop, we will collect soil samples from the top 8 inches of each ROC plot twice during the growing season (4 weeks and 12 weeks following cover crop termination: 2 depths, x 3 reps x 4 treatments). Target nutrients that we will monitor will include nitrogen, phosphorus, potassium, and sulfur. We will also monitor chloride levels in the soil.

To determine how cover crop seeding affects soybean growth, development and yield, multiple types of data were collected from research plots, including cover crop biomass, soybean stand count and plant height. Cover crop biomass was collected on or around the different rye termination timings from three areas of each plot (**Table 2**). In order to estimate the nutrients moving from rye into the soil system, we'll analyze N, P, K, S, Ca, Mg, Na, B, Cu, Fe, Mn, Zn and C on a subset of biomass samples. All samples have been dried, weighed and ground in anticipation of analysis.

Table 2. Biomass collection occurred 1-2 weeks before soybean planting, at soybean planting and 1-2 weeks after soybean planting at each location immediately preceding rye termination. Note that the Appleton location was planted before the 1-2 week before-planting biomass samples were collected, necessitating a fourth rye termination timing

	Appleton, MN (Olson)	Browns Valley, MN (Duffield)	Tintah, MN (Guy)	Barrett, MN (Hjelle)	Gentilly, MN (Dufault)	Morris, MN WCROC	Crookston, MN NWROC
Before planting	N/A*	May 10	May 17	May 17	May 24 sampled, May 27 sprayed	May 23	May 16 sampled, May 17 sprayed
At planting	May 10	May 23	June 9	May 28	June 7	June 9	May 27
After planting	May 23	June 2	June 17	June 9	June 16	June 17	June 6 sampled, June 7 sprayed
Late termination	Jun 17	N/A	N/A	N/A	N/A	N/A	N/A

*N/A = Not applicable or not available.

b) Soil microbial activity is a key factor in residue decomposition, nitrogen availability, and carbon sequestration potential. These effects will be monitored by measuring potentially mineralizable carbon and organic nitrogen pools in each plot 4 and 12 weeks following cover crop termination. Soil moisture and temperature in each plot will be monitored on a weekly basis. Soil aggregation, a common soil health metric, will be monitored in each plot at the beginning and end of the experiment.

Baseline soil samples were collected from each plot in fall 2021 and again 4 and 12 weeks after soybean planting (**Table 3**). Soil nitrogen (N) and phosphorus (P) content will be analyzed in all samples, and soil organic matter pools (potentially mineralizable carbon and protein extraction) will be analyzed on the 4 week post-planting samples. Analyses are in progress.

Table 3. When soil samples for nutrient and soil health metric analyses were collected in relation to soybean planting

	Appleton, MN (Olson)	Browns Valley, MN (Duffield)	Tintah, MN (Guy)	Barrett, MN (Hjelle)	Gentilly, MN (Dufault)	Morris, MN WCROC	Crookston, MN NWROC
Previous fall	Oct 27	Oct 30	Sept 26	Oct 8	Sep 1	Dec 1	Aug 31
4 weeks after	Jun 7	Jul 7	Jul 7	Jun 27	N/A*	Jul 7	Jun 24
12 weeks after	Aug 2	Aug 12	Aug 12	Aug 12	Aug 31	Aug 31	Aug 19

*N/A = Not applicable or not available.

c) Excess nitrates in the soil profile can potentially worsen iron deficiency chlorosis (IDC), a common soybean disease in NW and WC MN. We will monitor incidence and severity of IDC in

the different plots, to cross reference with plant-available nitrogen measurements if it is observed. The effects of cover crop treatment on weed species composition and biomass will also be assessed. Specifically, weed species and total above-ground weed biomass from three areas of each plot will be determined 28 days after cover crop termination.

Soybean stand count, iron deficiency chlorosis ratings and weed species composition and biomass were assessed 4 weeks after the last herbicide application from three areas of each plot (**Table 4**). We used the 1-5 scale used by North Dakota State University to rate IDC severity.

Table 4. When data regarding soybean stand, IDC severity and weed assessments took place

	Appleton, MN (Olson)	Browns Valley, MN (Duffield)	Tintah, MN (Guy)	Barrett, MN (Hjelle)	Gentilly, MN (Dufault)	Morris, MN WCROC	Crookston, MN NWROC
Stand counts/IDC	Jun 21	Jun 21	Jul 5	Jul 5	Jul 5	Jul 5	Jun 28
Weed assessments	Jul 18	Jul 11	Jul 29	Jul 25	Jul 29	Aug 8	Jul 7-8

3. **Develop educational and outreach material on the nutrient scavenging potential of cereal rye in Minnesota**

   This work will provide valuable insight into what agronomic impacts farmers can expect to see when integrating cover crops into their rotations. We anticipate that ~200 farmers will learn the benefits and challenges of cold-climate cover cropping from farmers and researchers alike through on-farm field days and the initiation of peer-to-peer support networks with the aim of increasing cover crop acres. Findings will also be shared with >2900 people through UMN Extension's platforms (e.g., websites, social media, newsletters, podcasts).

Two field day programs at research locations have already taken place in 2022 and one is coming up soon:

- July 19. Crookston, MN. University of Minnesota, Northwest Research & Outreach Center, Minnesota Wheat Research & Promotion Council, Research Committee meeting. Presenter: Angie Peltier, Melissa Carlson. ~ 25 attendees.
- July 20. Crookston, MN. University of Minnesota, Northwest Research & Outreach Center, Crops & Soils Day tour stop. Presenter: Angie Peltier. ~ 90 attendees.
- September 14. Barrett, MN. Field day event at the Glen Hjelle Farm research plot. Presenters: Jodi DeJong-Hughes, Dorian Gatchell and Melissa Carlson.