Williams Ranch Case Study: Comparison of Cover Cropping and Chemical Fallow in Low Precipitation Dryland Cropping Systems of the Inland Pacific Northwest

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Introduction

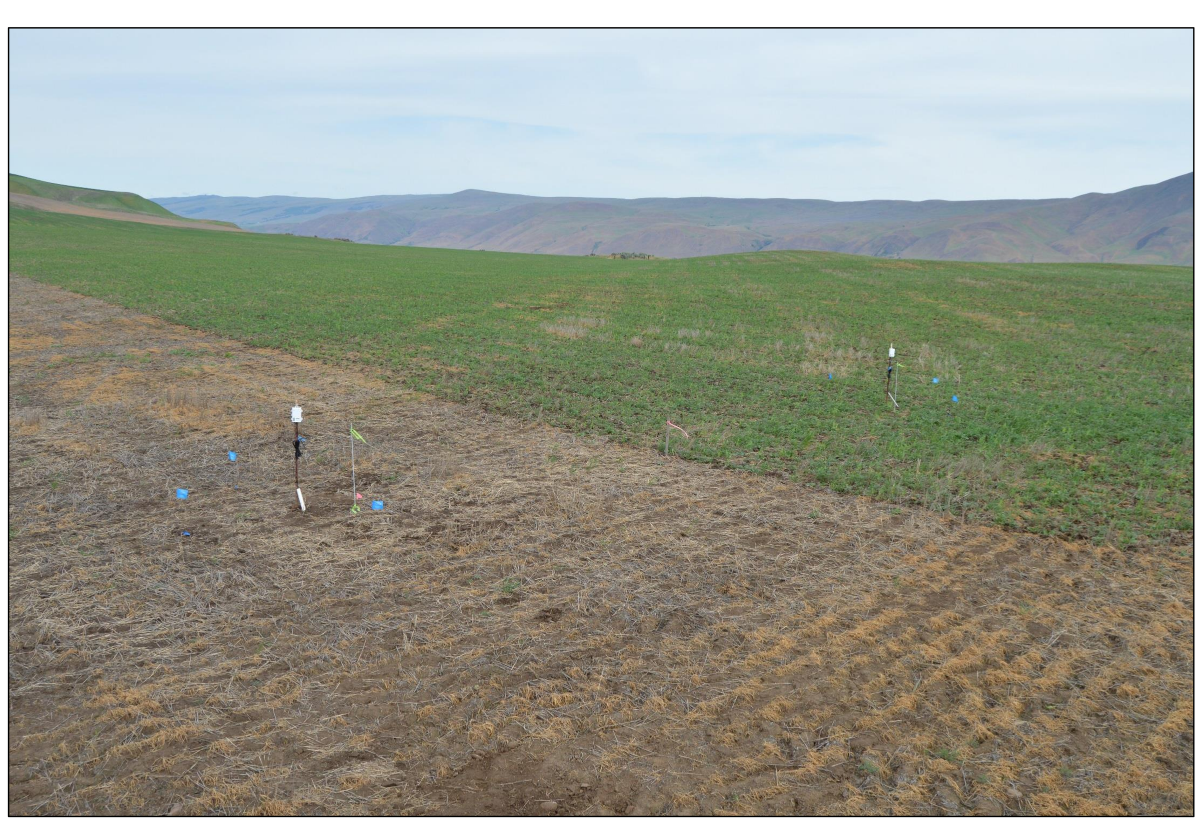
Chemical fallow is a widely adopted agronomic technique in the low precipitation dryland cropping systems of the Western U.S., including the Inland Pacific Northwest, as a risk management tool. Besides being effective in minimizing erosion, chemical fallow offers little for improving soil health and performance. As an alternative, cover cropping has been considered for its benefits of increasing soil organic matter, providing nitrogen, improving soil tilth and infiltration, etc., but is largely avoided due to risks of soil water use and depletion. This two-year study was conducted to determine the effects of cover cropping on soil water, crop yield, and soil health in these cropping systems.

Materials and Methods

The study was conducted by executing two trials on the same field site on Williams Ranch in Northeast Wasco County, Oregon. The field site has been in a direct seeded, conventional chemical fallow winter wheat rotation for at least 10 years. The Chemical Fallow Trial was treated conventionally with a series of herbicide applications (primarily glyphosate) throughout a 14 month period to arrest volunteer crop and weed growth on 88 acres of the study field. Concurrently, the Cover Crop Trial included growing a spring cover crop on 56 acres of the study field. Following the trials, winter wheat and spring wheat was grown across each trial (144 acres) under identical conditions (seed cultivar, fertility, tillage, seeding date, etc.). Several criteria were measured to compare the performance between each trial including soil water, fertility, and yield.

For this study, **CC** means "cover crop," **CF** means "chemical fallow," **WW** means "winter wheat", and **SW** means "spring wheat."

The CC was planted with a direct seed drill on March 22, 2016. The species mix was planted at a rate of 38 pounds per acre and included: common vetch (*Vicia sativa*), spring forage pea (*Pisum sativum*), spring oats (*Avena sativa*), triticale (*Triticosecale*), purple top turnip (*Brassica rapa*), forage collard (*Brassica oleracea*), safflower (*Carthamus tinctorius*), sunflower (*Helianthus*), and phacelia (*Phacelia tanacetifolia*). Prior fertility included several applications of municipal bio-solid waste. The CC was grazed by cattle from May 25 to June 15 with average gains of 1.76 pounds per head per day. The CC was terminated with herbicide on July 1, 2017.

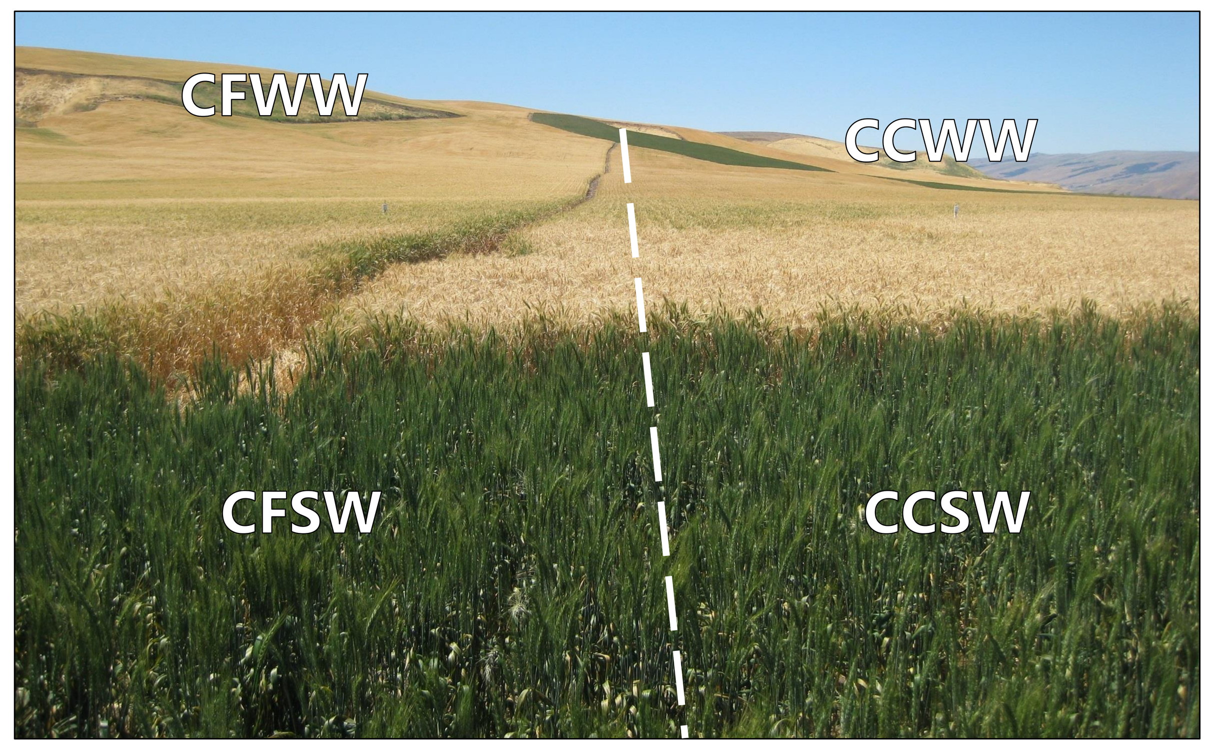


The locations of each soil water sensor station in both trials on May 5, 2016

Decagon EC-05 Soil Moisture Sensors were installed at soil depths of 6 inches, 12 inches, and 24 inches in each trial. The CC and CF sensor stations were located 30 yards apart and in the same soil type. Volumetric soil water content at these depths were recorded hourly.

WW was planted with a direct seed drill on October 1, 2016 across both trials. It was fertilized with 4 pounds of nitrogen, 10 pounds of sulfur, and 10 pounds of phosphorus per acre. It was harvested in July 2017. SW was planted with a direct seed drill on April 15, 2017 across both trials. It was harvested in August 2017.

Cover crop in bloom on May 20, 2017. Phacelia and other flowering plants in the cover crop provided forage for an abundance of bees, many of which are native and suffer from habitat loss



Winter wheat and spring wheat crops following each trial on June 30, 2017

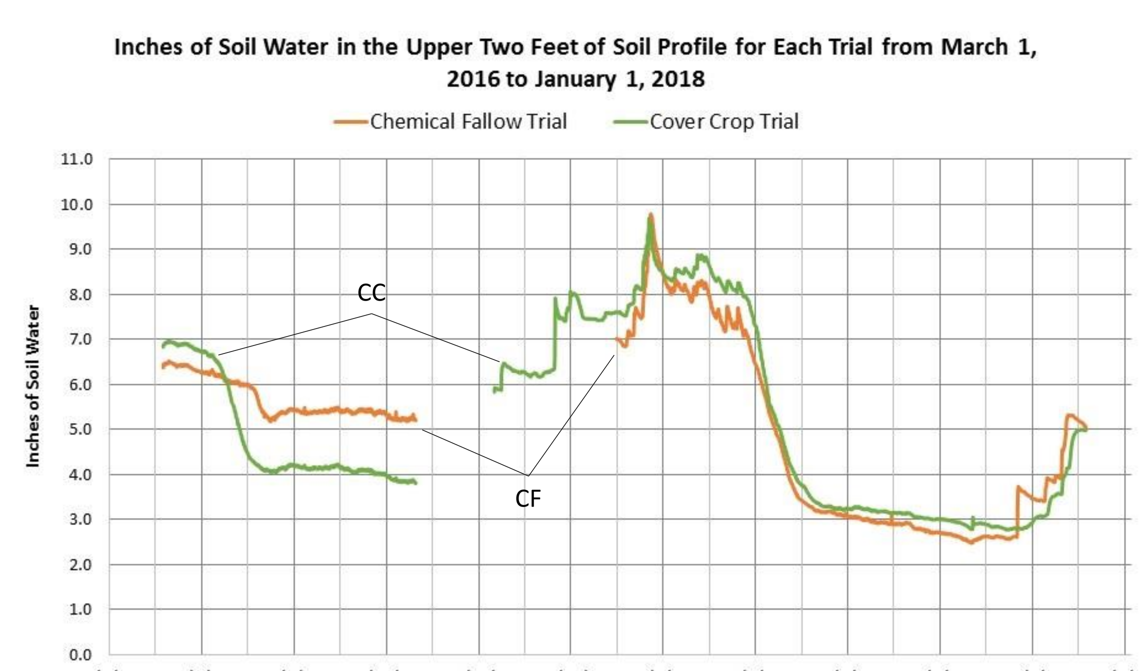
Results

During the study several anecdotal observations were made of the wheat crop following the trials:

- Germination timing and rate appeared to be equivalent
- Plant density appeared to be equivalent
- Canopy density appeared lower in CCWW than CFWW
- Leaf color appeared darker in CCWW than CFWW, especially during days of heat stress
- CCWW matured approximately one week later than CFWW

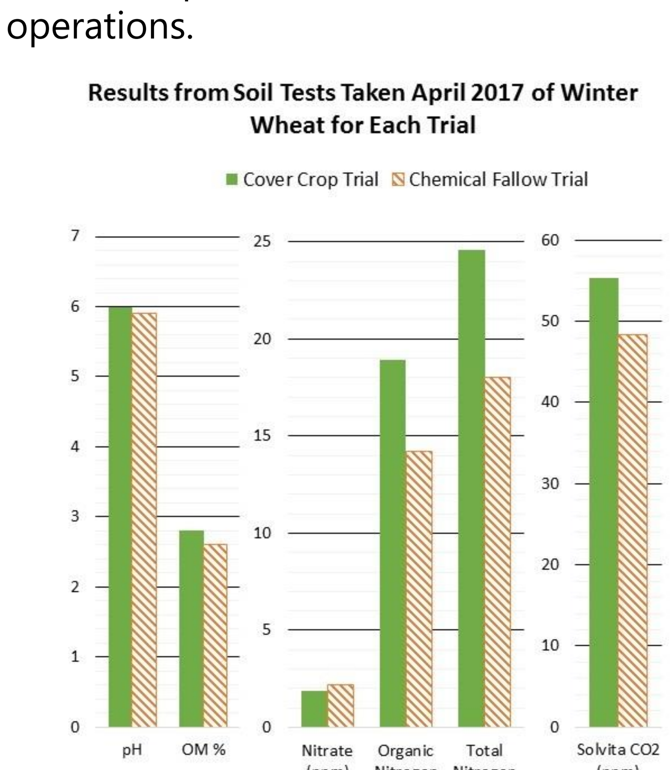
Volumetric Soil Water Content

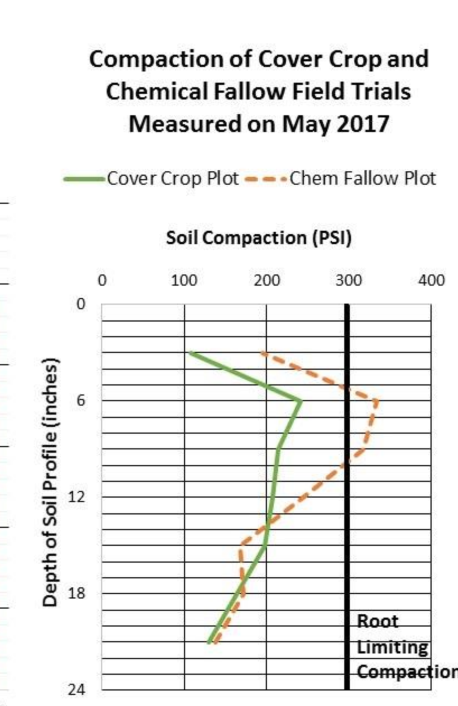
Soil water sensors demonstrated no substantial differences in total water volume between the trials with the exception of May 15 to September 21, 2016. Data records were lost between September 21 and January 29, however data observed in October following WW planting showed little difference between the trials. Analysis of activity at each depth in response to precipitation suggested the CC trial infiltrated water faster than CF.



Soil Tests

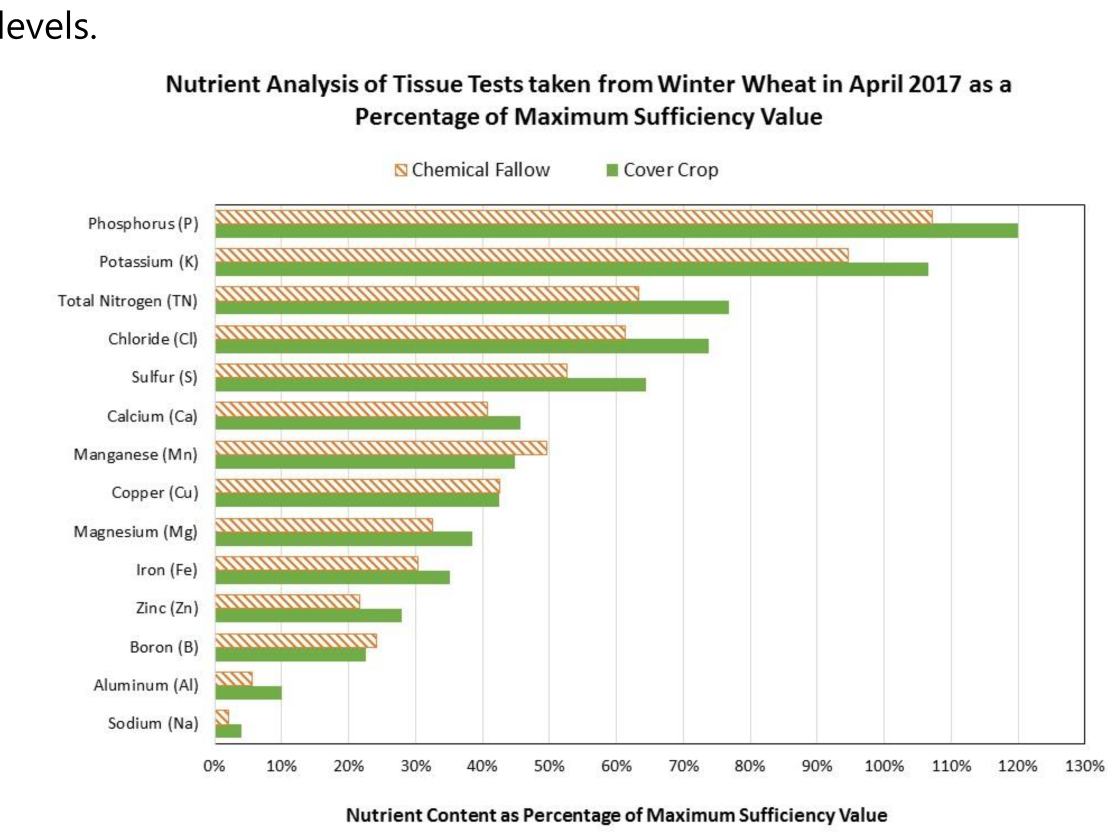
Soil tests taken in April 2017 demonstrated the CC trial exhibited higher organic matter, Solvita CO_2 (biological activity), and organic nitrogen. Compaction tests demonstrated the CC trial exhibited lower compaction which was evident from subsequent tillage operations.





Tissue Tests

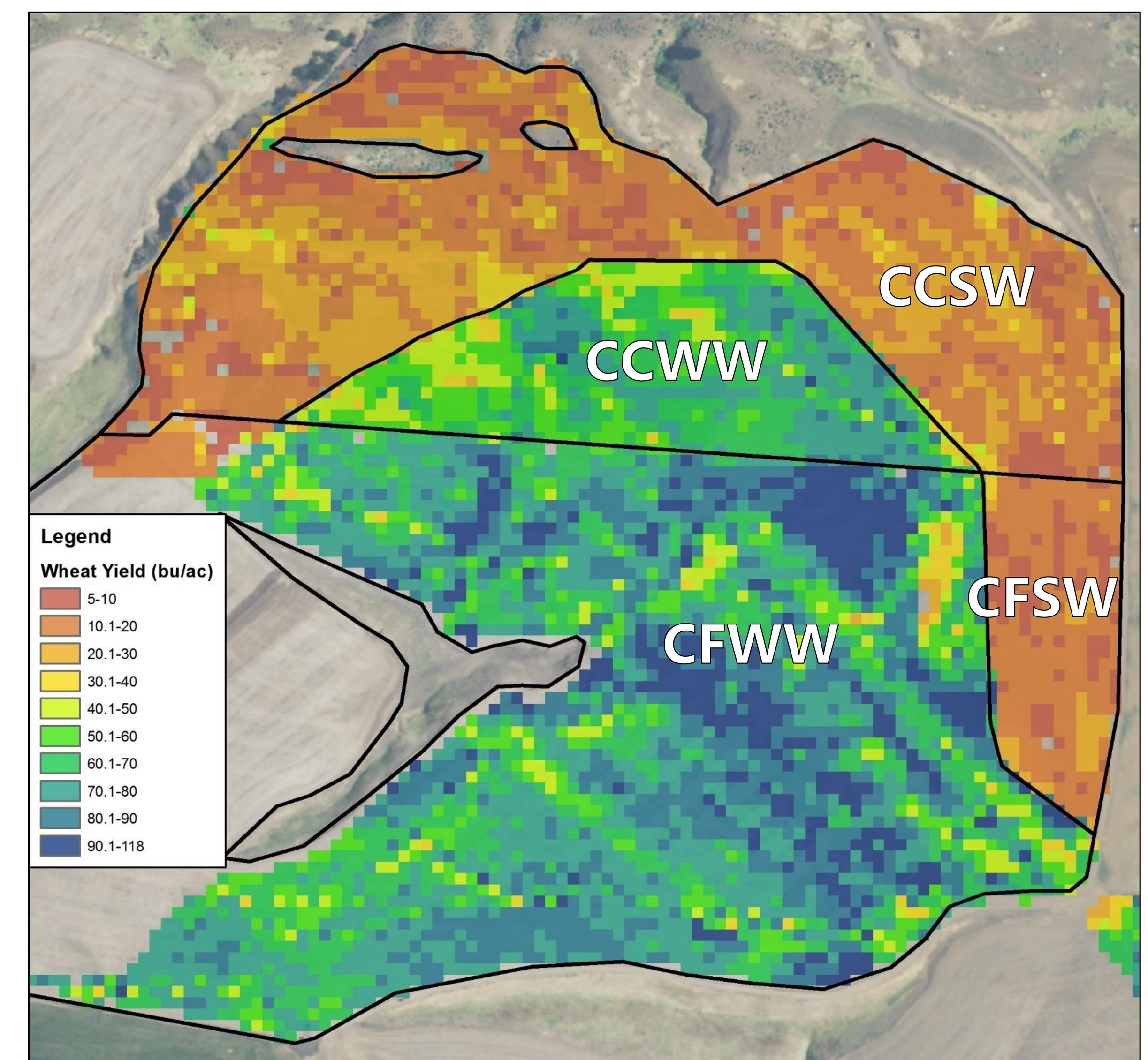
Tissue tests taken in April 2017 demonstrated the CCWW exhibited higher amounts of all nutrients tested except manganese, copper, and boron. None of the tested nutrients were detected at toxic levels.



Results (continued)

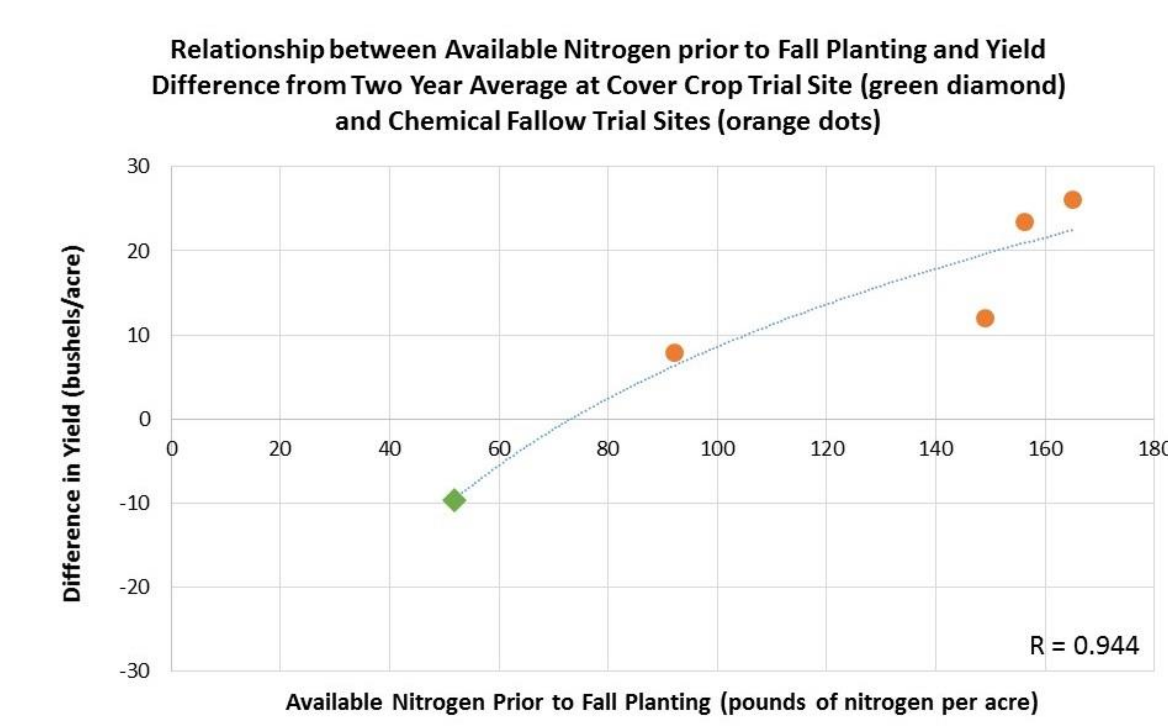
Yield

Wheat yields were compared to the two-year yield average for normalization. Yield of CCWW was significantly lower than CFWW while CCSW was slightly higher than CFSW. Available nitrogen that was tested prior to planting WW in several random locations was compared to the WW yield at those locations and suggests a strong correlation between available nitrogen at planting and yield.



Yield Results (bushels/acre)

	Chemical Fallow Winter Wheat	Cover Crop Winter Wheat	Chemical Fallow Spring Wheat	Cover Crop Spring Wheat
2017 Yield	73.1	66.3	12.1	17.2
Difference from 2-Year Yield Average	+10.24	-1.12	+0.01	+0.25



Discussion

After only one cover crop we have observed measurable improvement in soil health even though this has not translated into improved yield. We think the CC immobilized soil nitrogen in the form of organic matter and that insufficient time had passed to allow for nitrogen mineralization to meet crop demand. As a result, reduced available nitrogen restrained fall tillering which caused the reduction of CCWW yield.

We believe this hypothesis explains why:

- CCSW outperformed CFSW because SW does not fall tiller
- CCWW canopy cover density was markedly lower than CFWW
- CCWW matured nearly a week later than CFWW
- The difference in yield between CCWW and CFWW was much greater in high yielding areas. This may be a result of uniform bio-solid applications causing an accumulation of fertility in low yielding areas which compensated for low nitrogen availability
- Testimonials from farmers and researchers who have grown cover crops assert that it takes 5-10 years to experience improvement in crop yields

We are not discouraged by this result. We believe that building soil health will take time and that cover crops are an investment that should be treated as such. For our cropping system, we believe it is important to include grasses and legumes in cover crop mixes, to increase organic matter, cover the soil with residue, and balance carbon-to-nitrogen ratios, and that comprehensive soil testing is valuable and worth the cost.

We are going to continue this study and expand our trials to include other variables, including: deeper soil water sensors, varying termination dates, and varying amounts of fertilization.

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