Managing Iron Deficiency Chlorosis (IDC) Through a Cropping System Approach

Project 12-2021

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Background and Objectives

There have been numerous studies in other states on different management strategies to address IDC and the factors that are causing symptomology and intensity of symptoms. One particular study indicated that using an oat companion crop increased soybean yields 5 - 18 bushels/acre. The theory behind this approach is to use the companion crop to reduce soil nitrate levels. It has also been noted that tractor wheel tracks in Mississippi and Minnesota fields have greener plants in the fields due to soil compaction. Soil compaction is considered a poor management system for farmers and reduces yields. However, tractor wheel compaction reduces soil nitrate levels in that area and increases subsequent nitrogen loss by denitrification. Usually in fields with low soil nitrate levels, plants are not as green. In the case of iron chlorosis, though, the opposite occurs because higher soil nitrate levels make iron chlorosis symptoms worse. Some researchers have indicated that higher seeding rates (200,000 – 250,000 plants/acre) with wide row spacing in chlorosis-prone areas have increased yields. The theory is that more plants per row foot will use more nitrate and reduce IDC issues. Variety selection has been the most common method for reducing losses from IDC, but with all the information studied in the IDC subject area, no single researcher has implemented a multiple cropping system approach. This project puts all cropping systems mentioned together in one field with the goal to find relief from IDC and reduce yield loss. Specific objectives are to 1) evaluate different cropping systems to determine their effect on IDC and soybean yields; 2) evaluate soil moisture sensor data in correlation with iron chlorosis symptoms; and 3) share project results with producers and stakeholder groups.

Report of Progress/Activity by Objective

Objective 1: Determine if seven selected cropping systems will improve soybean yields for the three selected varieties that have low tolerance to IDC and increase yield capabilities for the three selected varieties with strong tolerance to IDC.

Oats were planted on November 6, 2020 and were terminated on April 7, 2021 with 32 oz. of RoundUp PowerMax. Soybeans were planted in the project plots with 38-in. row spacing on May 21, 2021. In the split-plot design, the seven cropping systems (Table 1) served as the main-plots, and two rows of the six selected soybean varieties (Table 2) served as the sub-plots. There are six two-row sub-plots per cropping system for a total of 42 treatments that were labeled at planting and replicated four times (168 total sub-plots). Composite and bulk density soil samples were also taken for each cropping system across all replications (28 total samples) at planting. The composite soil samples were sent to the MSU soils laboratory for pH and nutrient analysis and confirmed a high pH at the project site. Beginning on June 11, 2021, IDC visual ratings and chlorophyll readings using a SPAD 502DL Plus chlorophyll meter were recorded weekly (with weather permitting) for all 168 sub-plots. Beginning on July 8, 2021, leaf area index (LAI) readings were taken weekly using a LiCor 2200C Plant Canopy Analyzer along with plant height in a low-tolerance (AG53X9) and high-tolerance (AG52X9) sub-plot in each cropping system. The plots were flown approximately weekly throughout the growing season to collect aerial imagery with normalized difference vegetation index (NDVI) calculated. All plots were harvested on October 19, 2021. On October 26, 2021, another set of bulk density and composite soil samples were taken for planting and post-harvest comparison, followed by the broadcast planting of oats for the 2022 growing season. The decision was made to shift plots down two plots and have the main plots in reverse order from prior years. This will allow for a better understanding of the effects of planting after corn with the alleviation of possible residual effects from previous years. Visual ratings and yield data have been statistically analyzed for the 2021 growing season and combined with data from the first two years of the project as seen in Figures 1 and 2, respectively. In the future, yield data and visual ratings will be compared using annual differences rather than three-year average differences and evaluated by variety in addition to comparison by cropping system. Chlorophyll measurements, LAI data, and aerial imagery are currently being analyzed.

Objective 2: Evaluate the relationship of soil moisture to iron chlorosis symptoms using soil moisture sensor data.

On June 24, 2021, two sets of Watermark granular matrix sensors were installed in each cropping system across all replications. Each set consisted of one sensor installed at a 12-in depth and another sensor installed at a 24-in depth. One set of sensors was installed in a tolerant sub-plot variety (AG52X9), and the second set was installed in a susceptible sub-plot (AG53X9) variety. These two varieties were chosen because of the amount of data available on their productivity in soils similar to those found in the study area in Verona, MS. The two sets of sensors in each cropping system were connected to a Watermark 900M datalogger and were set to record soil water tension each hour. Data collection began at installation, and the dataloggers were checked and data was downloaded during the weekly field measurements. With the soybeans reaching maturity, the sensors and loggers were removed on October 12, 2021 just before harvest. The data collected throughout the growing season was extracted via direct USB download or using a portable data shuttle. During download, dataloggers were checked for malfunctions or missing data and were sent back to the manufacturing company for inspection if needed. The soil moisture data has been compared to average rainfall throughout the growing season, and the preliminary results can be seen in Figure 3. The soil moisture data is also being compared to yield and average ratings by cropping system for 2021.

Objective 3: Share project results with local producers and stakeholder groups.

Project results were presented at the ASABE Annual International Conference in a poster presentation titled "Iron Deficiency Chlorosis (IDC) in Soybeans: Effect of Cropping System and Variety" by Dr. Tagert on July 13, 2021. Two 'Turnrow Talks' were held on June 29 and June 30 in Noxubee County and Monroe County, respectively, where Drs. Tagert and McCoy shared project results with area producers. Project methods and preliminary results were shared with area stakeholders by graduate student Katelin Waldrep and Dr. Justin McCoy at the NMREC Field Day on August 17th in Verona, MS. An article on the project was also submitted and included in the 2020 NMREC Annual Report (http://extension.msstate.edu/publications/north-mississippi-research-and-extension-center-annual-report) which was published in early 2021. A poster was presented at the ASA, CSSA, SSSA International Annual Meeting in Salt Lake City, UT by Mr. Mark Harrison on November 9, 2021. Project methods and results were shared by Katelin Waldrep at the Fall Graduate Research Symposium on October 23rd through a virtual presentation (tied for 3rd place oral competition). Katelin Waldrep also presented the project as part of the Three-Minute-Thesis (3MT) competition on November 17th and again on November 18th as one of eight finalists in the competition. Graduate student Katelin Waldrep presented a poster at the ASA Southern Branch Annual Meeting on February 12th, 2022 in New Orleans, LA (2nd place poster session). A poster with project methods and results was also on display at the NMREC Producer Advisory Council meeting on February 17th, 2022 and at the Mid-South Farm and Gin Show the following week in Memphis, TN on February 25th and 26th. An abstract for an oral presentation has been submitted and accepted for the Mississippi Water Resources Conference in April, and this talk will focus on the soil moisture data. Finally, an abstract has been submitted for the ASABE AIM Annual Meeting taking place in Houston, TX on July 17-20.

Impacts and Benefits to Mississippi Soybean Producers

Our results to date have shown that cropping systems have a large impact on yield in IDC-prone areas. Preliminary results have shown that rotating with corn at a seeding rate of 160,000 seeds/acre has produced significantly higher yields for all three years of the project – for both tolerant and susceptible varieties. These findings alone will help Mississippi producers increase yields and alleviate symptoms from iron deficiency chlorosis. Current data analysis will allow producers to understand the effect of soil moisture on IDC intensity in Mississippi growing conditions.

End Products – Completed and Forthcoming

- Poster presentations – Posters were presented at five combined scientific meetings (3) and producer events (2).
- Oral presentations – Oral presentations were made and project results were shared at three field days and two graduate student competitions; abstracts have been submitted for oral presentations at two conferences taking place summer of 2022.
- Graduate student Katelin Waldrep has placed in three separate conference and student competitions.
- A summary of the project was included in the North Mississippi Research and Extension Center 2020 Annual Report for 2020.
- An Extension publication and peer-reviewed journal paper will be produced at the completion of the project.

Graphics/Tables

Table 1. Cropping systems used in project[+].

Cropping Systems for Mitigating IDC in Soybeans	
CROPPING SYSTEM 1	Corn stubble @ 160,000 seeds/acre
CROPPING SYSTEM 2	Corn stubble + oat cover @ 160,000 seeds/acre
CROPPING SYSTEM 3	Soybean stubble + oat cover @ 160,000 seeds/acre
CROPPING SYSTEM 4	Soybean stubble + oat cover + roller/packer @ 160,000 seeds/acre
CROPPING SYSTEM 5	Soybean stubble + roller/packer @ 160,000 seeds/acre
CROPPING SYSTEM 6	Soybean stubble + roller/packer @ 120,000 seeds/acre
CROPPING SYSTEM 7	Soybean stubble @ 160,000 seeds/acre

[+]Due to a change in personnel, corn was not planted in 2019 for the 2020 cropping system plots.

Table 2. Varieties used in project.

Soybean Varieties in Each Cropping System	
HIGHER Tolerance Varieties	*LOWER* Tolerance Varieties
1. Asgrow 52X9 2. Delta Grow 4670 (2019); 48X05 (2020, 2021) 3. Terral 4927X (2019, 2020); Pioneer 53A67X (2021)	4. Asgrow 53X9 5. Delta Grow 46X25 (2019, 2020); 46X65 (2021) 6. Terral 4679X (2019, 2020); Pioneer 48A60X (2021)

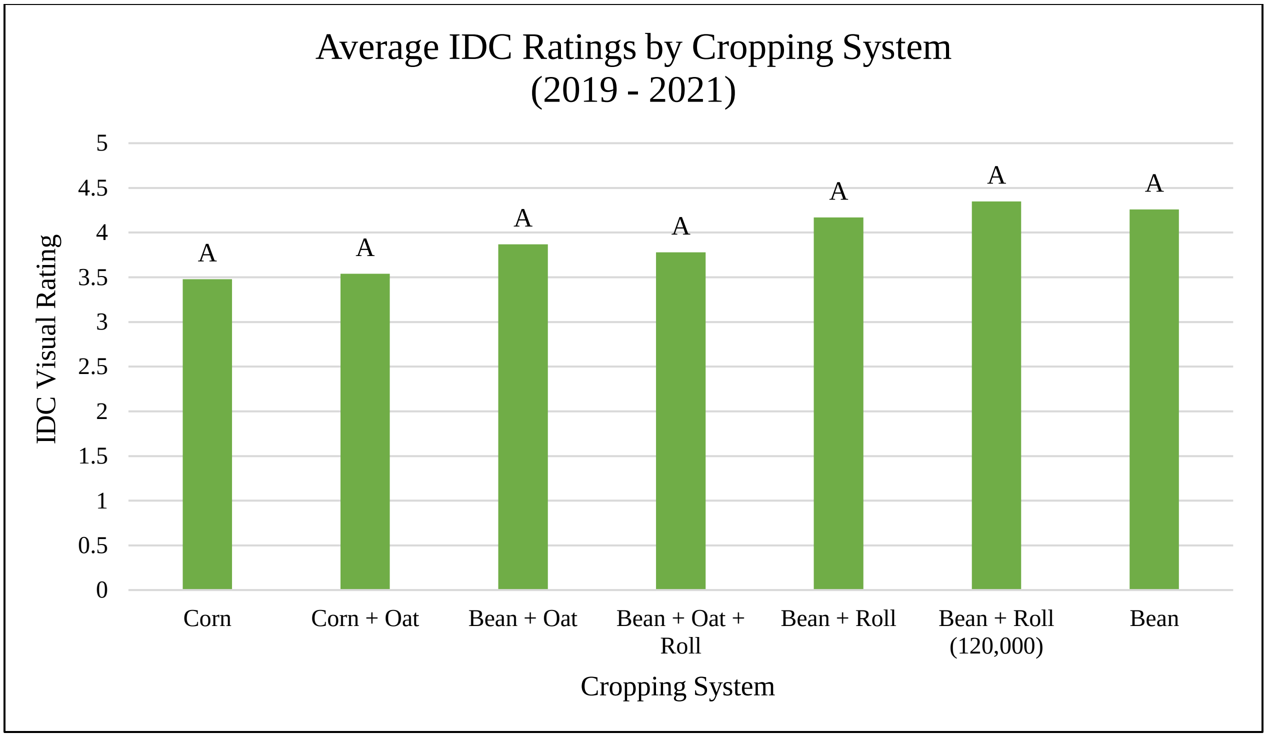

Figure 1. Average visual IDC ratings for each cropping system. Letters represent statistical significance (t-groupings).

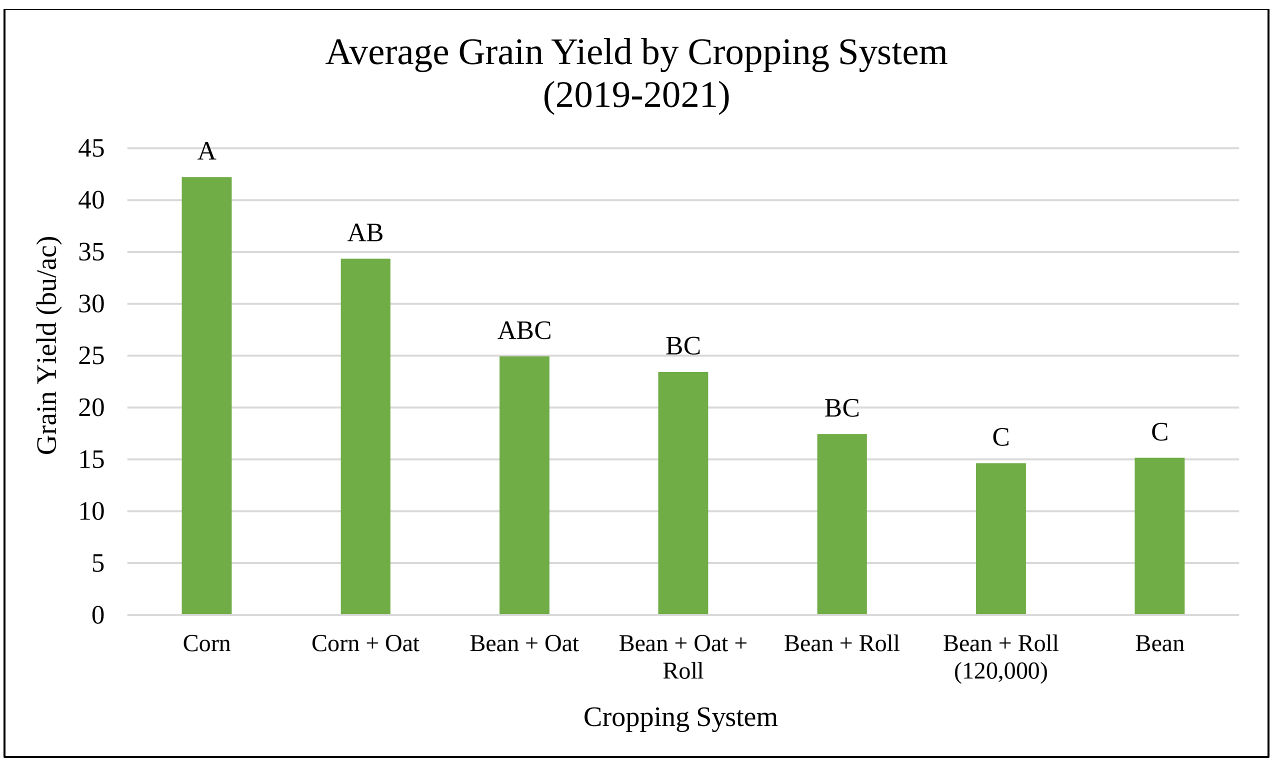

Figure 2. Average grain yield in bu/ac for each cropping system. Letters represent statistical significance (t-groupings).

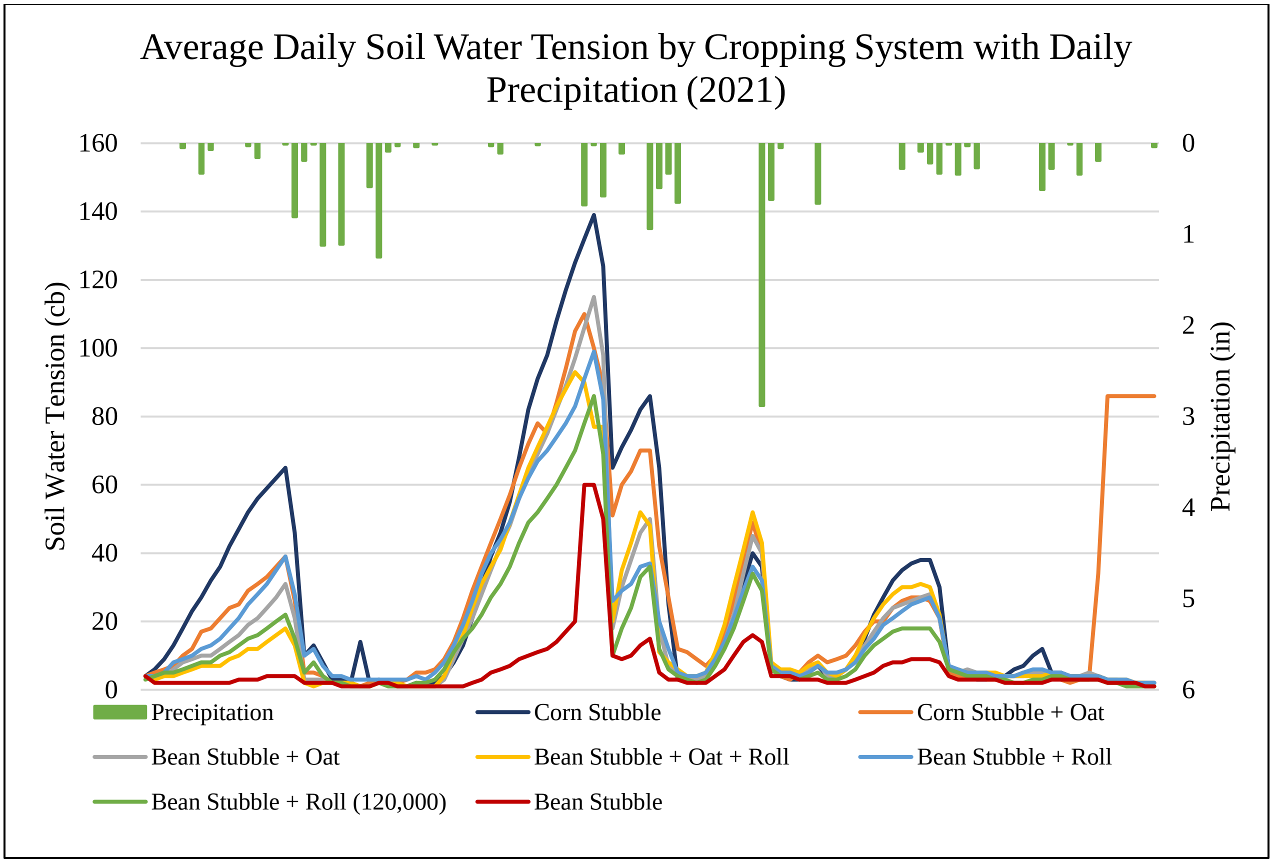

Figure 3. Average daily soil water tension (centibars) for each cropping system and average daily precipitation (in) for 2021. These are preliminary results.