Managing Iron Deficiency Chlorosis (IDC) Through a Cropping System Approach, Project 12-2020 Annual Report

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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 seeding rates (200,000 – 250,000 plants/acre) with wide row spacing in chlorosis-prone areas have increased yields. The theory is more plants per row foot will help utilize nitrate and reduce IDC issues. Variety selection has been the most common method for reducing losses from IDC, but with all of 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 will 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 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 Nov. 21, 2019 and terminated on April 16, 2020. Soybeans were planted in the project plots on May 12, 2020. The seven cropping systems are the main plots, and the six soybean varieties were planted in 38-in. rows in two-row sub plots. Each cropping system has two rows for each of the six varieties, and treatments are replicated four times. All plots were labeled the same date as planting. There are six sub plots per cropping system plot for a total of 42 treatments per rep and a total of 168 two-row plots. Also on May 12, 2020, soil samples were taken from each cropping system in each rep, for a total of 28 samples, and analyzed for nutrients and pH at the MSU soils lab. Beginning on June 3, 2020, ratings were recorded weekly for each of the 168 plots to track the IDC symptoms displayed by the plants. Beginning on June 12, leaf area index (LAI) readings were taken weekly using a LiCor 2200C Plant Canopy Analyzer, and plant height and chlorophyll readings were also recorded. The growth stage of the crop was noted when weekly field measurements were taken. Oats were planted again on November 6, 2020 and terminated on April 7, 2021 with 32 oz. of RoundUp PowerMax. In addition, soil samples were taken to measure bulk density to quantify the impact that rolling the plots has on the overall compaction of the soil. These samples yielded contradictory results to what would be expected, but this could be because samples were taken at the end of the growing season. The plots that were not rolled had higher bulk density measurements that the plots that were rolled. Additional samples will be taken in the 2021 growing season at planting.

At the end of the 2020 growing season, the average yields of the cropping systems were analyzed and compared to the yield results from 2019 (Fig. 1). In 2019, yield for the cropping system with soybeans planted into corn stubble at a seeding rate of 160,000 was significantly better than all other cropping systems. This cropping system also had the highest yield in 2020, even though the 2020 crop was planted into soybean stubble. The cropping system main plots were in the same physical location in 2020 as in 2019, so there may have been some residual effect of the corn residue. Visual ratings for IDC were also averaged by cropping system for the 2020 growing season and compared to 2019 results (Fig. 2). In 2019, planting into soybean stubble at the 160,000 seeding rate had a significantly lower IDC rating than the other cropping systems. In 2020, the lowest IDC ratings were in the three cropping systems with oats. Varieties generally followed the same yield trends for both years, and Terral 4927X was the variety with the best yield in both years (Fig. 3). In 2019, Terral 4927X had the lowest IDC ratings, and 2020, Terral 4927X and Delta Grow 48X05 varieties had the lowest average IDC ratings (Fig. 4). Finally, the trial was flown once during the growing season to collect an aerial image of the study site. Will Monroe was hired to work on the project starting May 15, 2020 but decided to pursue a non-thesis master's degree in May 2021. Therefore, as of May 2021, he is no longer working on the project, and we are trying to recruit a new graduate student.

Objective 2: Evaluate the correlation of soil moisture sensor data with iron chlorosis symptoms across cropping systems and varieties.

On June 12, 2020, two sets of Watermark soil moisture sensors were installed in each cropping system throughout each rep. Each set consists of one sensor at a 12-inch depth and one at a 24-inch depth. One set of sensors was installed in a high tolerant variety sub-plot (AG 52x9), and one set of sensors was installed in a low tolerant variety sub-plot (AG 53x9). These two varieties were selected because of the amount of data available on their production in soils similar to those found in the study field in Verona. The two sets of soil moisture sensors in each cropping system plot were set to record hourly soil moisture data across the 28 total cropping systems through all four replicates. Data collection for soil moisture began on June 12 at 12:00 pm using Watermark 900M monitors. Data is pulled off these monitors weekly (when field measurements are collected) using a portable data shuttle and compared to the daily rainfall on the site. Daily precipitation is logged and reported by the "Verona VTso" weather station installed at the North Mississippi Research and Extension Center. Data from this weather station is reported regularly to the Mississippi State University Delta Weather Extension site (http://deltaweather.extension.msstate.edu), where it can be downloaded. The Year Two soil moisture and precipitation data can be found below in Figure 5.

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

The North Mississippi Research and Extension Center - Verona held a small field day on Aug. 18, 2020 where farmers and agronomists from the area were invited to see the research being conducted on site. Dr. Tagert gave a presentation on the project titled 'Effects of Cropping System on Iron Deficiency Chlorosis' on Nov. 11 at the 2020 Annual Meeting of the MS Chapter of the American Society of Agronomy, held in Grenada, MS. Drs. Tagert and McCoy presented results from the project during the Feb. 11, 2021 Mississippi Soybean Promotion Board Virtual Research Roundup. This presentation was titled 'Effects of Cropping System on Iron Deficiency Chlorosis.' An abstract on the project was submitted for the ASABE Annual International Conference which was accepted for a poster presentation, and an article was submitted for inclusion in the North Mississippi Research and Extension Center annual report. 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.

Impacts and Benefits to Mississippi Soybean Producers

This project will benefit all soybean growers affected by IDC. Preliminary results show a clear benefit in yield when rotating soybeans with corn in areas affected by IDC. Even in 2020, there appeared to be a positive carryover effect from corn that was planted in 2018, two years prior to the 2020 growing season.

End Products

- Aug. 18, 2020 – field day at the North Mississippi Research and Extension Center - Verona
- Nov. 11, 2020 – Dr. Tagert gave a presentation on the project titled 'Effects of Cropping System on Iron Deficiency Chlorosis' at the 2020 Annual Meeting of the MS Chapter of the American Society of Agronomy, held in Grenada, MS.
- Feb. 11, 2021 – Drs. Tagert and McCoy presented results from the project during a Mississippi Soybean Promotion Board Virtual Research Roundup. This presentation was titled 'Effects of Cropping System on Iron Deficiency Chlorosis.'
- Abstract submitted for the ASABE Annual International Conference which was accepted for a poster presentation on July 13, 2021
- An article was submitted for inclusion in the North Mississippi Research and Extension Center annual report.
- June 29 and June 30, 2021 – Two 'Turnrow Talks' were held in Noxubee County and Monroe County, respectively, where Drs. Tagert and McCoy shared project results with area producers.
- An Extension publication and peer-reviewed journal paper will be produced at completion of the project.

Graphics/Figures

Table 1. Cropping system description.

Cropping Systems for Mitigating IDC in Soybeans	
CS 1[1]	corn (2019)/soybean (2020) stubble @ 160,000 seeding rate
CS 2[1]	Corn (2019)/soybean (2020) stubble plus small grain cover @ 160,000 seeding rate
CS 3	soybean stubble plus small grain cover @ 160,000 seeding rate
CS 4	soybean stubble, small grain cover, plus a roller/packer @ 160,000 seeding rate
CS 5	soybean stubble and a roller/packer 2020 @ 160,000 seeding rate
CS 6	soybean stubble and a roller/packer @ 120,000 seeding rate
CS 7	soybean stubble @ 160,000 seeding rate

[1] In Year One of this project (2019), these cropping systems followed corn that was planted in 2018. However, no extra plots were added in Year One for corn stubble in these systems during Year Two (2020). As a result, the intended corn stubble plots in Year Two were planted into soybean stubble. This is addressed in Year Two, and in Year Three, these cropping systems will be corn stubble rather than soybean stubble.

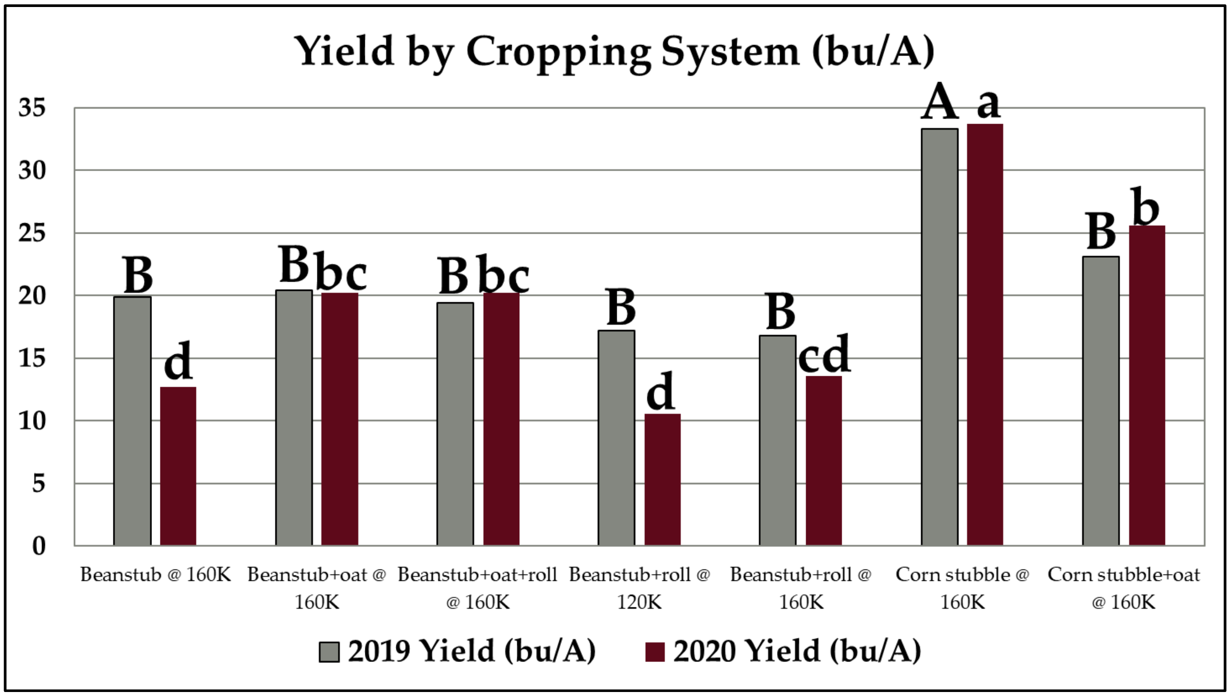

Figure 1. Yield by cropping system for 2019 and 2020.

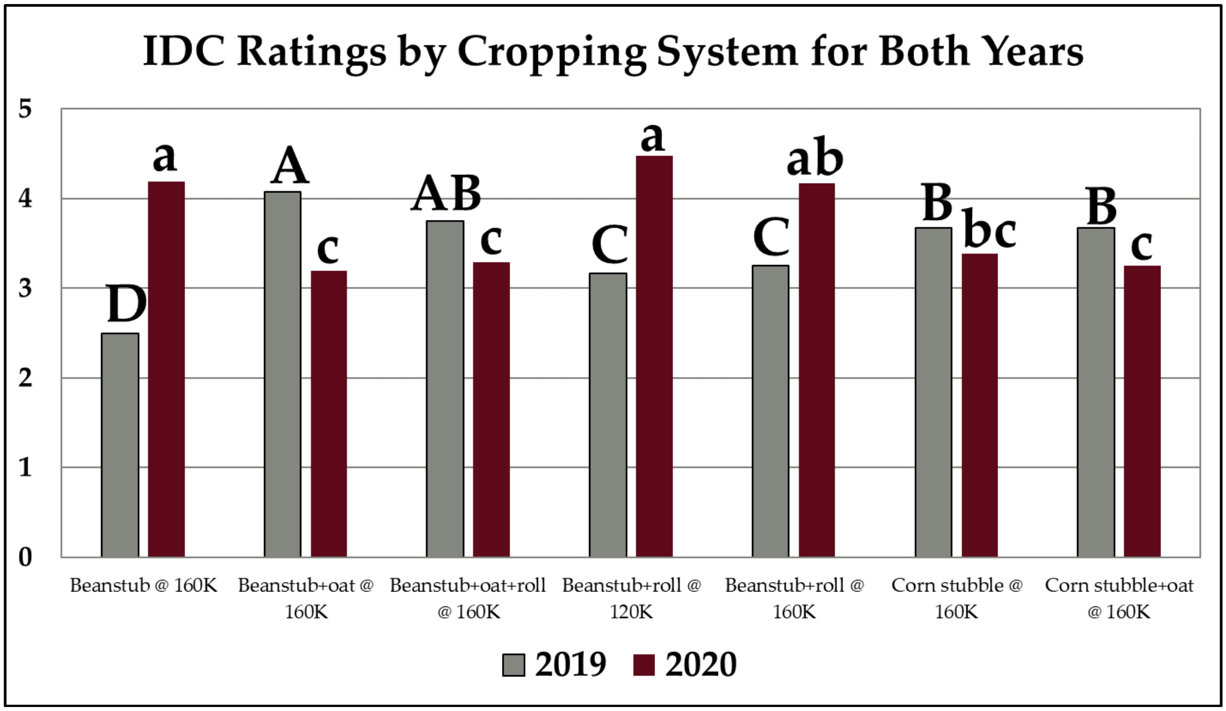

Figure 2. Visual rating by cropping system for 2019 and 2020.

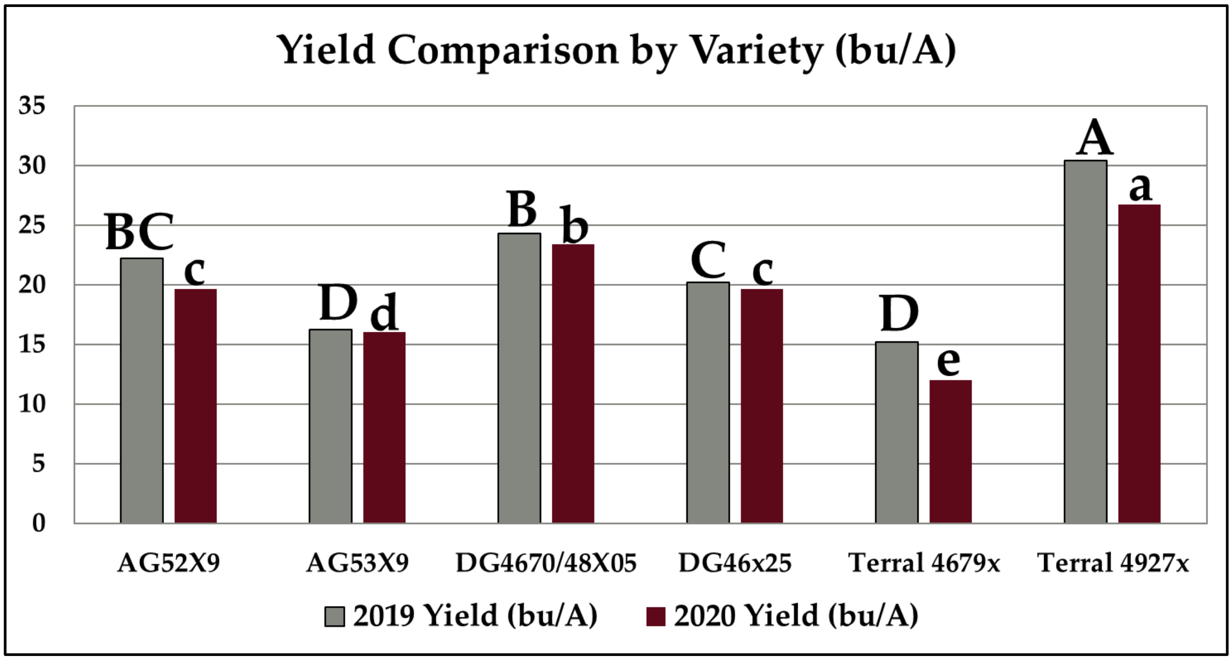

Figure 3. Yield by variety for 2019 and 2020.

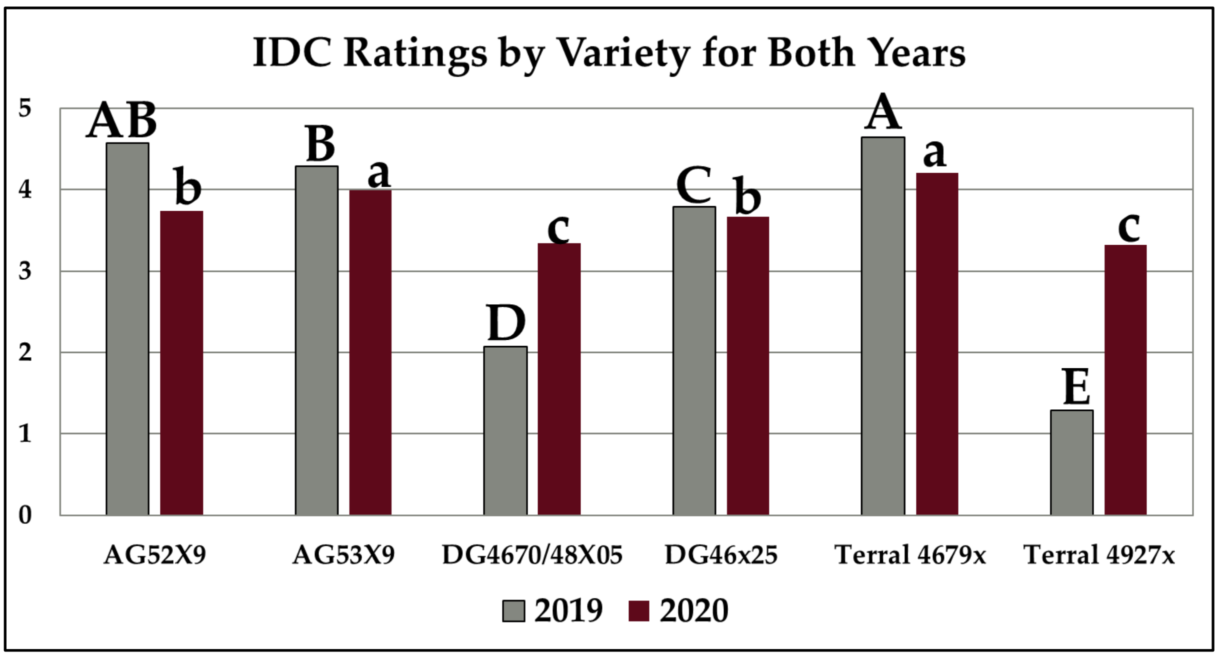

Figure 4. Visual rating by variety for 2019 and 2020.

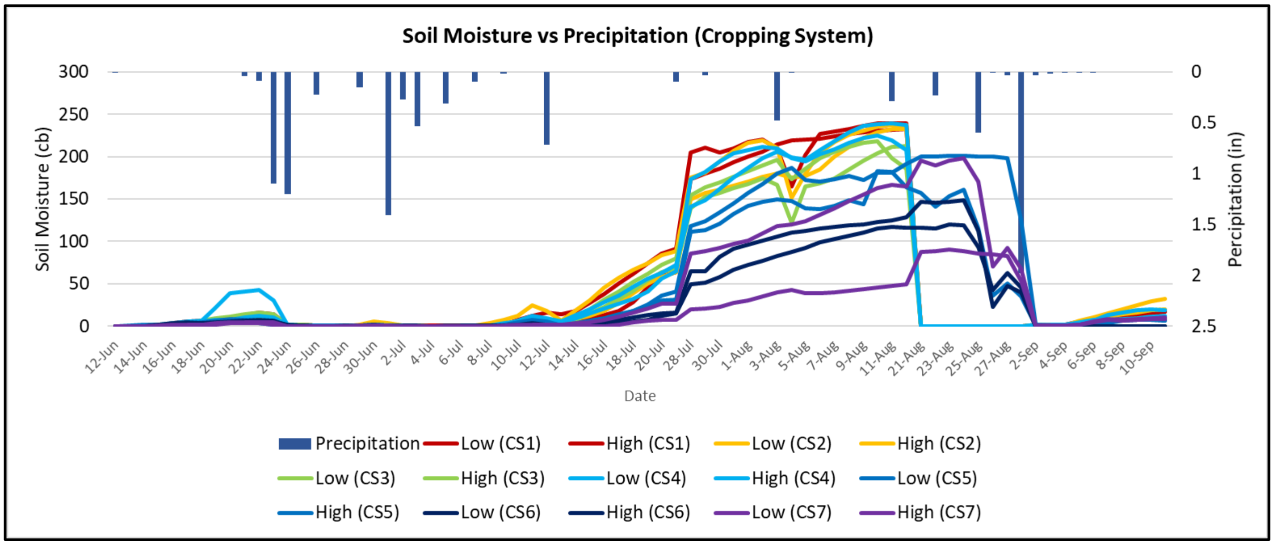

Figure 5. The lines are colored by cropping system (Table 1) and represent the soil moisture data collected from the Watermark sensors. When one of the sensors went above 10 cb, the data from the 12- and 24-inch sensors were averaged.