Final Grant Reports 2019 and 2020 Field Corn Seasons

1. Final Report for 2019 Field Corn Season: BMP Mini-Grant

Project Title: The Environmental and Economic Efficiency of Fertilizer Application Methods in Row Crops

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Background and Objectives:

In this project we conducted an on-farm trial in Columbia County with a field corn producer to compare fertilizer application methods broadcasting and sidedressing. The use of control release fertilizer (CRF) was also investigated. The trial compared the cost of each method, the amount of fertilizer applied, and crop yield between the different nutrient management regimes. The intended audience for the study was row crop farmers in the Suwannee and Santa Fe river watersheds.

Columbia County lies in both the Santa Fe and Suwanee river basins. Many tourists come to Columbia County each year to visit the rivers and associated springs. These water bodies provide recreational opportunities such as swimming, canoeing, boating, fishing, diving, and wildlife observation. Tourism supports the local economy by generating income for local businesses and creating jobs. There is concern about increasing nutrient concentrations reducing the environmental, recreational, and aesthetic value of these water bodies. Increased nutrient loading, especially in the form of nitrate, can increase the abundance of filamentous algae. This reduces water clarity and contributes to negative water quality issues such as eutrophication.

Fertilizer has been estimated by the Florida Department of Environmental Protection to contribute to 48% of the nitrate load into the Santa Fe River. Best management practices have been created and implemented to reduce nutrient loading from agricultural producers in the region. One-way agricultural producers could further reduce their nutrient loading is through the placement and timing of fertilizer. Fertilizer is commonly broadcasted meaning that it is spread uniformly throughout the surface of the field. This is a fast and easy fertilizer application method but can result in high nutrient losses. Sidedressing refers to the application of fertilizer in a line between rows of young plants. Sidedressing fertilizer application takes more time to apply compared to broadcasting, but could reduce nutrient losses. This method achieves high nutrient use efficiency by applying fertilizer close to the plants at optimal timing. Sidedressing not only results in less nutrient loss but has also been found to increase yield compared to other earlier timed application methods. Control release fertilizer is another method of increasing nutrient use efficiency. Polymer coated fertilizers are thought to increase nutrient use efficiency because nutrients are released at a slower rate that the crop is better to take up.

A video, fact sheet, and educational meeting were conducted to present the results of the trial and educate local row crop producers.

Materials and Methods:

In order to conduct the field trial an agricultural producer, Ronald Norris farm, was identified. At planting, 15 gallons of 28-0-0-5 liquid fertilizer was applied across the entire field. Corn was then fertilized using different application methods and fertilizer types. Six replications of 12 rows of conventional broadcasted fertilizer were applied alongside six 4 row replications of sidedressed CRF.

The CRF was sidedressed at 700 lbs an acre in a one-time application after planting. The CRF was a Harrell's 22-0-14 costume blended based on soil test results. Resulting in 154 lbs N and 98 lbs K_2O being applied per acre. The fertilizer was blended to last 80 days (Fig. 2). The conventional broadcasted corn received three broadcasted fertilizer applications after planting. Including 200 lbs per acre of 15 - 0 – 25 - 5, 270 lbs per acre of 20 - 0 - 18 - 4, and 230 lbs per acre of 30 - 0 - 0 - 6. In total, the broadcasted conventional corn received 153 lbs of N and 98.6 lbs of K_2O. Overall, the sidedressed CRF corn and the broadcasted conventional corn received roughly the same amount of N and K_2O. Including the starter the side dressed CRF corn received 198.81 lbs of N and 98 lbs of K_20. The broadcasted conventional corn received 198.81 lbs of N and 98lbs of K_2O.

Corn yield was measured through hand harvesting ears along 20ft transects. In the transects the number of ears and plants were recorded. Ears were shucked and the moisture content and weight of the shelled corn was recorded to estimate bushels per acre.

Results and Discussion

The sidedressed CRF corn averaged 191.9 bu/acre while the broadcasted conventional corn averaged 169.64 bu/acre (Table 1). The standard deviation among the six replications for the sidedressed CRF corn was 17.3 bu/acre. The standard deviation in the broadcasted conventional corn was 30.08 bu/acre.

The months of April and May in 2019 were hotter and dryer than the average in Columbia County, Florida. Nutrients are released from CRF dependent on temperature. Therefore, weather regimes can influence the rate nutrients are released. A normal summer rainfall regime began in June 2019 after the prolonged hot and dry period. In May 2019 about 40-50 days after planting the sidedressed CRF corn showed clear visual difference being taller and greener compared to adjacent rows of broadcasted conventional corn (Fig. 1). According to Waters Agricultural Laboratory Inc., leaf tissues samples taken from sidedressed CRF corn during the month of May 2019 showed Mg testing in the low range. Tissues samples collected at the same time from the broadcasted conventional corn tested by Water Agricultural Laboratory Inc. showed low range for N and Mg.

The higher price of CRF and the difficulty of using a sidedressing rig to fertilize large acreages remain issues preventing the adoption of the method. The cost of the 15 gallons of 28-0-0-5 and 700 lbs of 22-0-14 Harrel's CRF per acre in the sidedressed CRF application was $363.84. The cost of the 15 gallons 28-0-0-5, 200 lbs 15-0-25-5, 270 lbs 20-0-18-4, and 230 lbs 30-0-0-6 per acre in the broadcasted conventional fertilizer application was $136.87. The farmer saved time and fuel associated with applying fertilizer using the sidedressed CRF method through making fewer fertilizer applications. However, the benefit of saving time and fuel is difficult to quantify.

A soil moisture sensor was also provided to the farmer to help manage irrigation. The regional and county extension agents helped to educate the producer on how to read the soil moisture sensor. The farmer cites that the soil moisture sensor helped him manage his water resources more efficiently and save money as a result.

Information about the trial was shared in factsheets, Suwannee Valley Corn Field Day Meeting (75 attendees), The Columbia County Best Management Practices Field Day Meeting (13 attendees), Columbia County Best Management Practices and Forage Field day (6 attendees), and a You Tube video (126 views). A trial was started at Columbia High School's FFA farm to compare sidedressing and broadcasting conventional fertilizer in sweet corn. The trial was not completed due to dry hot weather during the months of April and May of 2019 and lack of irrigation system. The trial served as a learning opportunity for two Columbia High School FFA seniors. Since the sweet corn trial, the students have successfully grown Sunn hemp and planted a winter cover crop at the Columbia High School FFA farm.

Conclusion

There was an average yield increase in the sidedressed CRF corn of 22.26 bu/acre compared to the broadcasted conventional corn. The cost of CRF ($363.84 per acre) was considerably higher than the cost of conventional fertilizer ($136.87 per acre). Further research is needed to investigate the benefits of using CRF to save farmers time and fuel. The hot and dry weather regime in April and May 2019 could have affected the results of the trial. Replicating the trial next season may help to account for the abnormally hot and dry weather conditions. Further research is needed to quantify the environmental benefits of sidedressing CRF to reduce nutrient runoff and leaching.

Treatment	Weight Shelled Corn lbs	Moisture %	Plants	Ears	Bu/acre
Broadcasted Conventional 1	6.81	14.40	25	16	123.19
Broadcasted Conventional 2	9.65	14.30	23	20	174.77
Broadcasted Conventional 3	8.72	13.90	19	19	158.66
Broadcasted Conventional 4	8.14	13.50	21	19	148.80
Broadcasted Conventional 5	11.59	14.70	25	25	208.92
Broadcasted Conventional 6	11.29	14.70	27	28	203.52
Side Dressed CRF 1	8.97	14.90	26	26	161.32
Side Dressed CRF 2	10.4	14.80	27	27	187.25
Side Dressed CRF 3	11.25	14.90	24	23	202.32
Side Dressed CRF 4	11.4	15.40	26	26	203.81
Side Dressed CRF 5	11.97	15.30	25	25	214.25
Side Dressed CRF 6	9.97	13.40	24	24	182.46
Average Broadcasted Conventional	9.37	14.25	23.33	21.17	169.64
Average Side Dressed CRF	10.66	14.78	25.33	25.17	191.90

Table 1: Data from corn harvest.

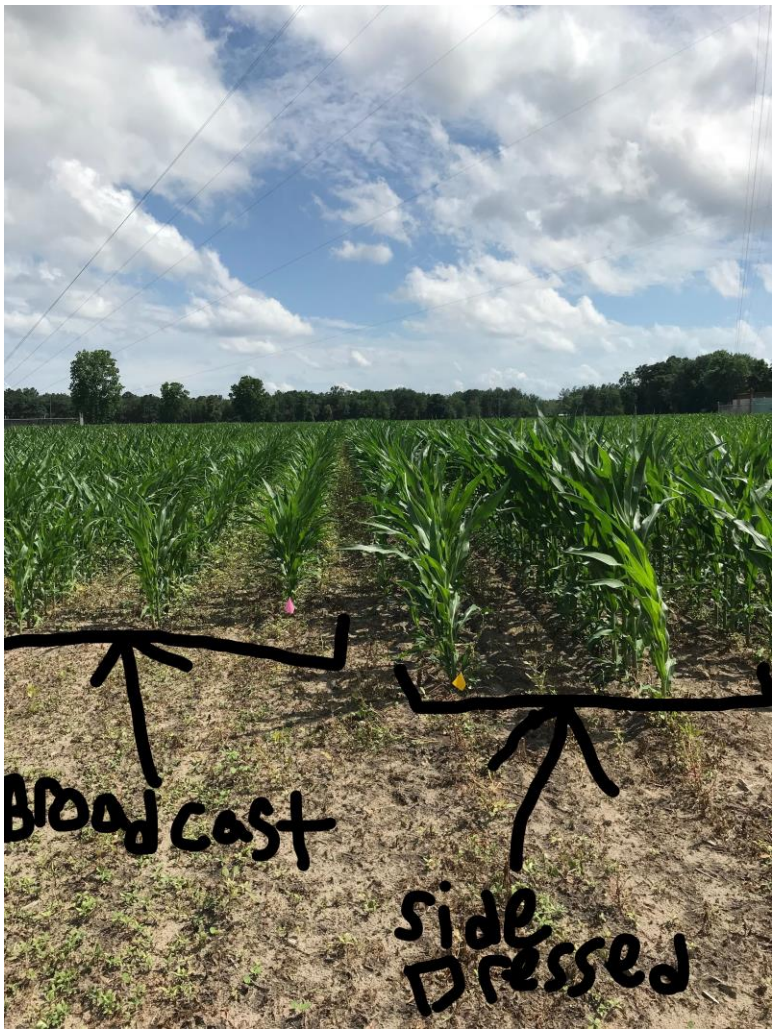


Figure 1: Image taken in May of 2019. Corn at the V10 stage.

Application Date: 4/15/2019 **Longevity (Months):**

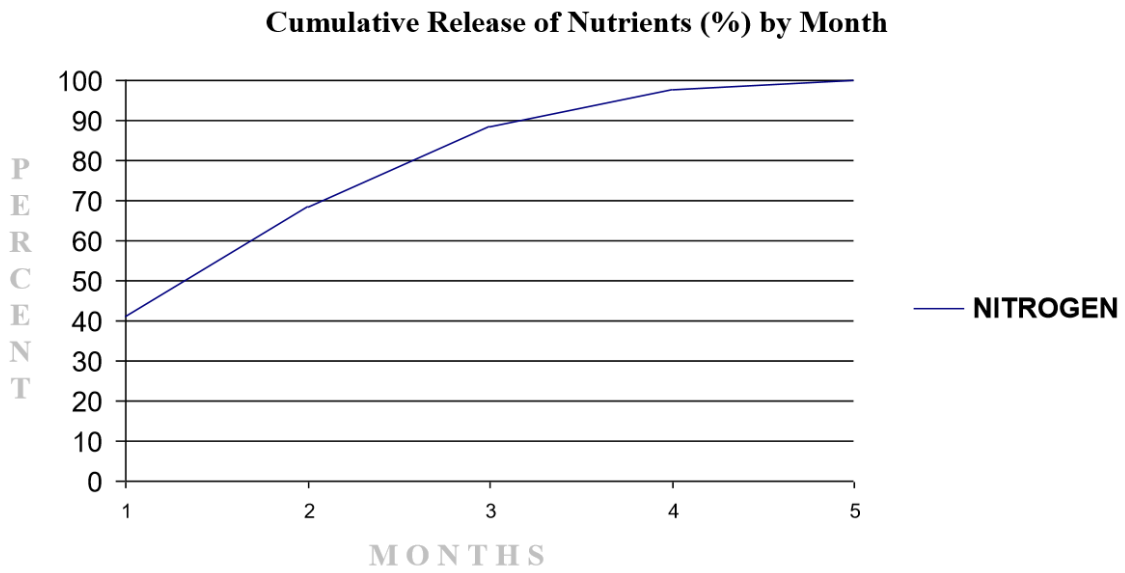


Figure 2. Nitrogen CRF release curve.

2. Final Report for 2020 Field Corn Season: Stetson Sustainable Farming Fund

AGREEMENT NUMBER:	**Report Type (Circle One):** Interim Report Final Report x	**Report Date: 1/14/2021**
Department Sustainable Farming Fund Stetson University 421 North Woodland Blvd. Unit 8262 Deland, FL 32723	**Recipient**	

What major activities and accomplishments have been completed during this reporting period?

Since the last progress report data was summarized in graphs and tables (see section below). Also, an educational video was created to inform growers about agricultural cost share opportunities. Grower Ronald Norris provided insight on the use of soil moisture sensors. He credits soil moisture sensors for allowing him to more sustainably manage fertilizer, irrigation water, and money as a result. See link below to access the video. We worked with Suwannee River Water Management District to create this educational video. We hope the video will encourage more producers enrolled in the BMP program to adopt agricultural cost share available through local water management districts and Florida Department of Agriculture and Consumer Services and result in more efficient use of fertilizer and irrigation water use.

Agricultural Cost Share Opportunities (please note that the video is currently unlisted on YouTube but will be shared with the public the week of the 1/18/2021).
https://www.youtube.com/watch?v=FmxUDvFTQyM&t=53s

Are there any unforeseen delays in completing the project within the project period?

N/A

Significant findings and events (in this section, *please include discussion of data you have gathered on achieving your nitrogen reduction goals, detailed data, if available, may also be appended at the end of the report*):

2021 CRF Corn Trial Updates – Ronald Norris Farm – Jay Capasso UF/IFAS Columbia County Extension.

Methods
At Ronald Norris farm soil nitrate was sampled from 4 different depths 0-6, 6-12, 12-24, and 24-36 inches from 4 replications of two different nutrient management treatments side-dressed control release fertilizer (CRF) and broadcasted (BC) conventional fertilizer. The UF/IFAS recommended fertilizer rate for irrigated corn of 210 lbs. N was applied in both fertilizer treatment methods. Soils were sampled for soil nitrate at 9 different samplings throughout the 2020 season between May 12th and August 4th. Soil nitrate samples were sent

to Water's Agricultural laboratory where they were analyzed for soil nitrate. Tissue samples were collected from each replication during 6 samplings between May 19th and July 21st. Corn tissue was sampled and analyzed for N, P, K, Mg, Ca, S, B, Zn, Mn, Fe, and Cu. Corn was hand harvested along 17.5 ft of row from two different locations per replicate on August 20th to determine yield. Yield formula - **((100-%)/100) *weight*21.13.**

Results and Discussion

Soil nitrate concentrations generally decreased with depth. Apart from the-36-inch depth, the side-dressed CRF average soil nitrate concentrations were lower than average nitrate concentrations in the BC conventional fertilizer treatment. Tissue sample nutrient concentrations were similar between fertilizer treatments. Concentrations of nutrients in corn tissue were slightly higher in N, P, K, Mg, Ca, S, B, Zn, Mn, and Cu in the side-dressed CRF treatment compared to the BC conventional treatment. Yield was also slightly higher in the side-dressed CRF treatment which averaged 211.37 bu/acre compared to 202.63 bu/acre in the BC conventional fertilizer treatment.

There is also a more gradual decline in soil nitrate in the side-dressed CRF treatment compared to the BC conventional treatment (Figure 1, Figure 2). The CRF is coated in a polymer that slowly releases nitrogen over the entire crop season while conventional fertilizer can be lost very quickly under the right conditions such as heavy rainfall events. Soil nitrate concentrations decreased quickly after the June 25th sampling in the BC conventional fertilizer treatment (figure 2). Due to COVID precautions we were unable to travel during the beginning of the season when the starter fertilizer and CRF was applied in the side-dressed CRF treatment. By sampling soil nitrate at various depths in late March or early April shortly after the application of CRF should provide more insight on how much fertilizer is released at the beginning of the season in the side-dressed CRF treatment. Funding was secured for future research in 2021 to consider sampling for the entire crop season to compare fertilizer treatments.

Outliers were identified in the dataset using the interquartile range method of identifying outliers. These outliers contributed to the higher nitrate concentrations in 24–36-inch depth in the side-dressed CRF treatment compared to the BC conventional fertilizer treatment. If outliers are removed the 24–36-inch depth average nitrate concentration in the side-dressed CRF treatment changes to 4.44 ppm and the BC conventional fertilizer nitrate concentration changes to 4.95ppm. It is unclear how quickly agricultural practices at the soil surface affect the nitrate concentration at the 24–36-inch soil depth. Soil texture was also observed to change around the 20–24-inch depth in this field to a finer textured clay. Also, the water table is also generally present around this depth which could affect nitrate concentrations as well.

Table 1: Ronald Norris Soil Nitrate Data

Depth	CRF	BC
0--6	11.35	22.60
6--12	6.77	10.73
12--24	4.33	6.78
24--36	6.57	4.95

Table 2: Ronald Norris tissue sample average nutrient concentration throughout season.

Treatment	N (%)	P (%)	K (%)	Mg (%)	Ca (%)	S (%)	B (ppm)	Zn (ppm)	Mn (ppm)	Fe (ppm)	Cu (ppm)
CRF	3.4432	0.3508	2.2968	0.284	0.4596	0.2224	6.12	35.24	67.24	115.84	10.08
BC	3.3716	0.3308	2.2384	0.2612	0.4492	0.2152	6.04	31.28	62.6	119.76	9.52

Table 3: Ronald Norris Yield Data.

Sample	Yield (Bu/acre)
CRF Rep 1	189.23
CRF Rep 2	234.28
CRF Rep 3	205.07
CRF Rep 4	216.91
BC Rep 1	212.71
BC Rep 2	183.90
BC Rep 3	197.42
BC Rep 4	216.50
CRF average yield	211.37
BC average yield	202.63

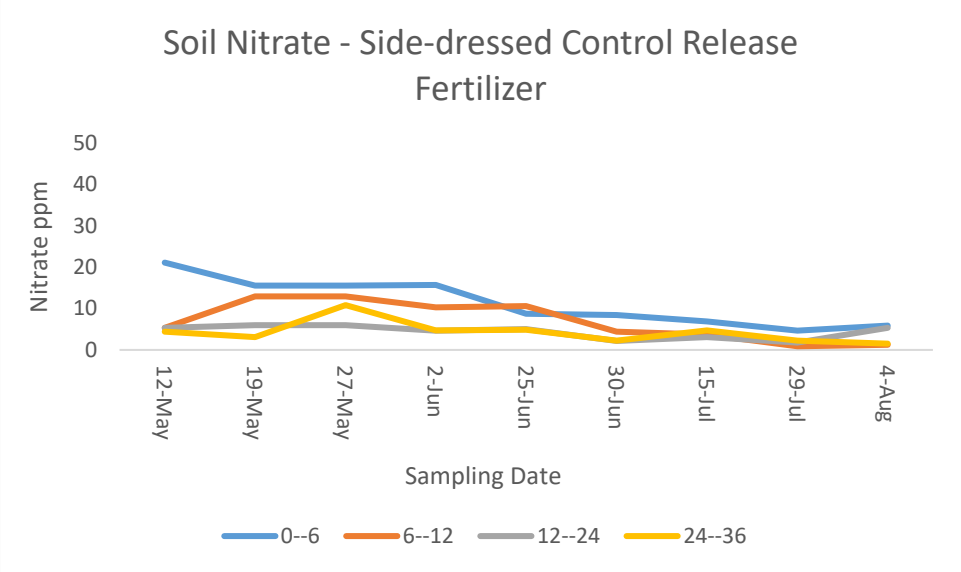


Figure 1: Soil nitrate concentrations over the cropping season sampled soils where replications of the side-dressed CRF treatment was applied. Each line represents soil nitrate concentration at a different depth.

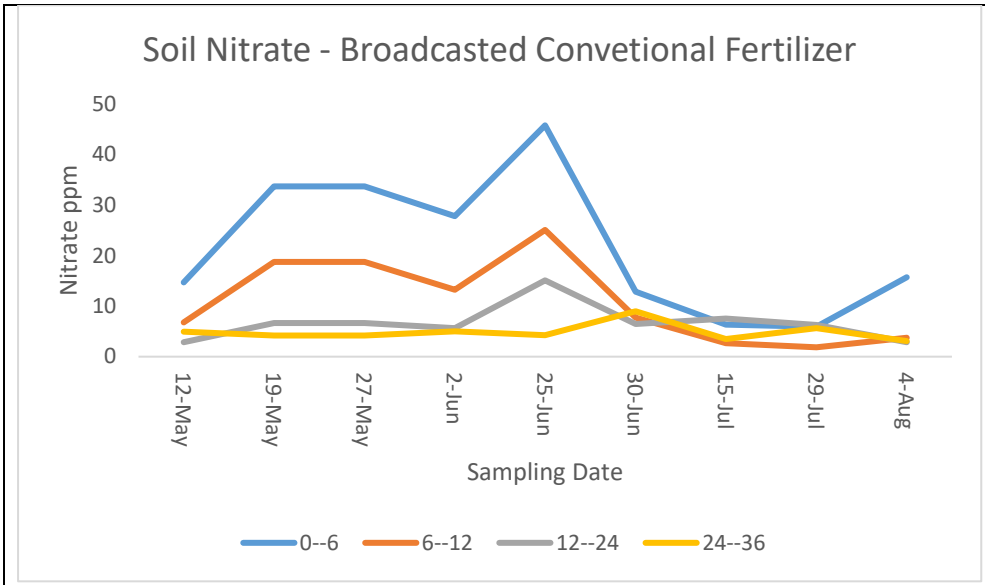


Figure 2: Soil nitrate concentrations over the cropping season sampled from soils where applications of BC conventional fertilizer was applied. Each line represents soil nitrate concentration at a different depth.

2021 CRF Corn Trial Updates – Donnell Gwinn Farm – Sylvia Willis UF/IFAS Suwannee County Extension.

At the Gwinn Brother's Farm, the agent compared two treatments - conventional fertilizer and Controlled Release Fertilizer (CRF). The two treatment areas were compared by taking samples in 5-acres of each treatment field. Varying depth soil samples, tissue samples, and yield samples were taken.

Soil Sampling and Results

Soil sampling was conducted throughout the corn growing period in May, June, and July. Two sampling areas were selected randomly in the conventional field and the CRF field. Soil was pulled from 4 depths: 0-6in, 6-12in, 12-24in, and 24-26in. The samples were sent to the Waters Lab and nitrate analysis was performed. Each soil depth was placed in a separate bag and analyzed for nitrate concentrations to track how fertilizer moved throughout the soil. The grower applied 68 lbs. of N on May 25th via the pivot to the CRF field due to low nutrient concentrations, so that is why we see a spike in nitrate concentrations during this period on the CRF field.

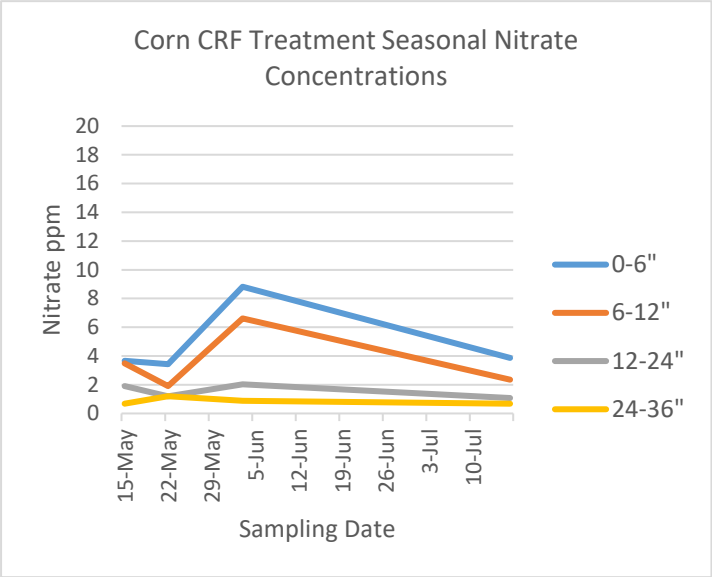


Figure 1: Average soil nitrate concentrations of the CRF field throughout the season. Each line represents soil nitrate concentration at a different depth.

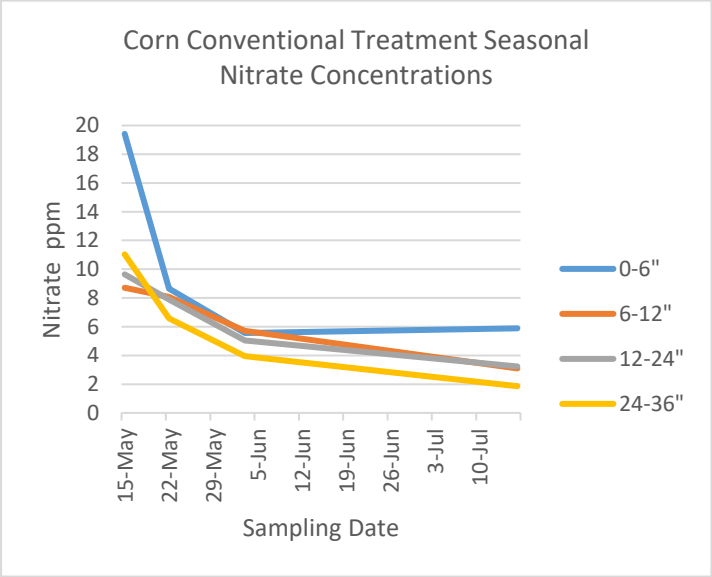


Figure 2: Average soil nitrate concentrations of the CONV field throughout the season. Each line represents soil nitrate concentration at a different depth.

Table 1. Donnell Gwinn average soil nitrate date from each depth throughout the season.

Depth (in)	CRF	CONV
0-6"	4.94	9.88
6-12"	3.59	6.40
12-24"	1.55	6.45
24-36"	0.86	5.85

Tissue Samples and Results

Tissue sampling was also conducted throughout the corn growing period in April, May, and June. The agent collected 10 leaves randomly throughout the conventional field and CRF field 4 times. The samples were sent to the Waters Lab and a basic analysis was performed - N%, P%, K%, Mg%, Ca%, S%, B ppm, Zn ppm, Mn ppm, Fe ppm, and Cu ppm.

Table 2. Donnell Gwinn average tissue sample nutrient concentrations throughout the season.

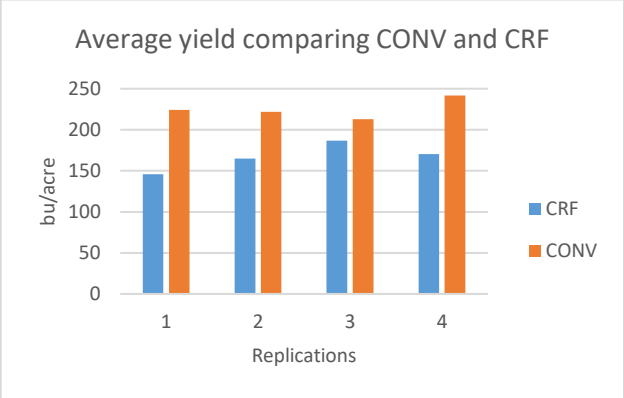
Treatment	N (%)	P (%)	K (%)	Mg (%)	Ca (%)	S (%)	B (ppm)	Zn (ppm)	Mn (ppm)	Fe (ppm)	Cu (ppm)
CRF	2.17	0.28	2.11	0.17	0.62	0.16	9.24	33.94	50.88	73.41	8.53
CONV	2.90	0.32	2.38	0.18	0.53	0.20	14.47	40.93	60.40	144.07	10.87

Yield and Results

Yield was taken July 30th from each 5-acre treatment area. Four yield samples from each pivot quadrant of each field were taken randomly from 17.5-foot rows. Corn was shelled, weighed, and moisture was taken to calculate bu/acre. Yield formula - **((100-%)/100) *weight*21.13.**

Table 3. Donnell Gwinn average yield data.

Sample	Yield (bu/acre)
CRF Rep 1	145.65
CRF Rep 2	165.04
CRF Rep 3	186.89
CRF Rep 4	170.49
CONV Rep 1	224.28
CONV Rep 2	221.98
CONV Rep 3	213.03
CONV Rep 4	241.63



Discussion

Though the conventional field showed higher yield compared to the CRF field, there is still opportunities to show how beneficial CRF can be in corn production. By using CRF, growers can limit the amount of nitrogen applications applied throughout the growing season. In addition, the application of CRF is applied directly near the root zone of the plant, so it can be easily taken up and is not wasted. If 75% of the nitrogen required for the season is applied upfront with CRF, then if a leaching event occurs or tissue samples show low nitrate concentrations, the grower can come back and apply the rest of the 25% nitrogen through the pivot.

CRF slowly releases nutrients to the plants to uptake as they grow throughout the season. This keeps the nutrients in the root zone for appropriate uptake as the corn grows. From the tables provided, the conventional field had high nitrate concentrations at the 0-6in depth for

the first soil sampling. Also, the nutrient concentrations of the conventional 24-36in depth were high, meaning nutrients had already reached this depth. The conventional field showed nutrients below the root zone during the beginning of the season and plants cannot benefit from this because their roots have not reached where the fertilizer is for uptake. This could be wasted fertilizer. CRF slowly releases fertilizer throughout the growing season. We can see that from May 15 to May 22 the fertilizer nitrate concentration decreases because the plant is taking up nutrients and the fertilizer is moving through the root zone. Though additional N was applied to the CRF field, we can see from the graph, that the plants up took nutrients during the growing season decreasing concentrations.

CRF has shown promising results in previous corn operations, so with this research showing conventional with higher yields, could be due to the release curve of the CRF since temperatures were lower in the beginning of the growing season.

Budget
All current invoices have been paid except for one to Gwinn Brother's Farm for $380.00 for soil moisture probes. We owe Gwinn Brother's Farm for paying the 10% of a soil probe to BMP Logic. This is currently being worked on and paperwork had to be filed with the University of Florida to complete payment.

Activities planned for next reporting period:

N/A

Are you on target to achieve the project goals? If not, please explain.

Yes.

Provide any pertinent information including, when appropriate, explanation of cost overruns or high unit costs.

N/A

Is there any further information that will help us understand the progress you have made on the project?

N/A