2020 Project Reports

Current Outlook for Corn – April 2020

North Carolina State University Corn Specialist Dr. Ron Heiniger:

There are times when we face challenges that reveal our character and our grit. The widespread CoVid-19 virus is such a challenge.

While much is unknown about how this virus will affect our health, our circumstances, our finances, and our lives, one thing is certain: this will pass and when it does the world will need the fundamentals of life – the food, fiber and fuel we produce on the farm.

The grocery shelves will have to be restocked. Economies will have to be rebuilt. How quickly and successful this happens will depend on the farmers of the United States of America. You are essential to the future of the world!

So first of all – Stay Healthy! Keep personal contacts to a minimum. Second of all, keep your eye on the important things! No time for fancy this season. Use the best hybrid, meet the nutrient needs as efficiently and inexpensively as possible, keep fuel in the tanks. I recommend buying fuel while it is cheap and easily available.

Increase the amount of N you place prior to or at planting, essentially front loading this year's fertility. This promotes early root growth, increases nutrient use efficiency, and reduces the risk of problems with fertilizer supply bottlenecks. Rely on the best information available. The research results discussed below are a part of that information. Make use of your Extension agronomists and specialists to guide your decisions.

Remember, decisions made on emotion are usually the worst decisions you make. Pay no mind to commodity prices right now. They are based on emotion. With the situation across the world there will be a struggle to get crops planted resulting in shortages which will eventually drive markets higher. We need to be ready to step up to meet whatever the future demands.

So, lets show who we are - bravely going forward into a new world, ready to take on any challenge!

Novel Agricultural Water Management Systems for Increasing the Production and Consistency of Corn Yields in North Carolina

NCARS/NCCES Code: 18-01

Project Leaders: Mahamed Youssef, Chad Poole

Annual Report for the period 2/1/2019-1/31/2020

Experimental Research

The experimental component of this project is carried out at two field sites near Bath, NC. The BATH 2 field site is 55.8 acres. The soil on the site is Altavista fine sandy loam. Two treatments were implemented on this site 1) SMART drainage-sub irrigation, and 2) uncontrolled conventional drainage.

The 2019 growing season was extremely dry with monthly precipitation at 50% of the 30-year norm during May, June and July. Based on analysis of the long-term weather records for this area, the 2019 growing season was the second driest growing season in the last 30 years. In addition to the dry conditions, the maximum daily air temperature exceeded 90-degrees F on 58 days during the May 1-July 15 time period. The harsh weather at the site resulted in substantial crop damage and yield loss. Due to the severe and extended drought, the water storage in the pond could not provide enough water to compensate for the water deficit during the growing season. A total of two inches of water were sub-irrigated from the storage pond over 30 days of the growing season. If irrigation water was not limiting, the researchers believe the corn yield of the irrigated treatment would have been much greater than the measured yield of 28.3 bu/a. In the 2020 growing season, corn will be grown at the BATH 1 field site which has an irrigation well.

Impact Statement: The results of the research indicate that sub-irrigation has a great potential for increasing corn yield, protecting corn against dry spells and in the growing season and thus reducing the year-to-year variability of corn yield. The results of DRAINMOD model simulations showed that sub irrigation implemented on carefully designed drainage systems could increase corn yield by 11% for Portsmouth soil and 20% for Rains soil on average over the 30-year simulation period.

The performance of sub-irrigation also varies depending on soil type. Model simulations showed that the critical period for sub-irrigation includes the months of June and July.

Corn Problem Diagnosis Support for Cooperative Extension Agents

NCARS/NCCES Code: 11-09

Project leaders: Carl Crozier, Lindsey Thiesen, Ron Heiniger, Kristin Hicks

Annual Report for the period 2/1/2019-1/31/2020

Report: The researchers' approach to strengthening crop problem diagnosis efforts is to gain support from each of several commodity groups to fund analysis of samples

submitted by Cooperative Extension agents. Diagnostic samples of corn plants have been analyzed at the NCDA&CS Agronomic Division Laboratory from 25 counties. When pooled with funds provided by other commodity groups (cotton, small grains, soybean, tobacco) samples from a total of 43 counties were analyzed.

Problem diagnosis records from the NCSU PDIC for 30 samples submitted in 2017-2019 from 27 counties identified the following problems: abiotic stresses such as chemical drift or injury, drought, nutritional/pH/excess fertilizer salts, Anthracnose, Bacterial stalk rot, Billbug, Cephalosporium, charcoal rot, common rust, other rust, common thrips, corn gray leaf spot, southern & northern corn leaf blight & other, diplodia, Fusarium seedling blight, leaf spot, ear or stem rot, Gibberella stalk rot, helminthosporium leaf spot/blight, holcus spot, pollination problems, pseudomonas syringae, Pythium root rot, root knot nematode, other nematodes, curvularia blight, yellow poplar weevil, damping off, and some undiagnosed problems.

This project thus represents a personnel training resource for a substantial portion of the agricultural Extension agents of the state.

Impact statement: This program should result in more qualified agricultural agents, and in farmers that better understand their production constraints. This project will also allow the researchers to monitor problem diagnosis and more formally document the potential crop losses or economic benefits if managed per recommendations.

Developing GLS-Resistant Female Lines NCARS/NCCES Code: 17-04

Project Leader: MD Krakowsky

Annual Report for the period 2/1/2019-1/31/2020

Report: 2019 was a good year for evaluating the material for Gray Leaf Spot (GLS) at Salisbury and Waynesville. Some plots for the hybrids were lost, but the data were still usable from Laurel Springs. As compared to 2018, the scores are generally similar to slightly higher (ie less disease). Familiar hybrids are highly resistant, including NC line combinations and such stalwarts as DeKalb 689.

Impact Statement: Work with GLS has had a great influence on the male side of hybrid corn breeding, with NC258 and NC300 probably having the greatest impact, both as male parents or parents of male lines. The number of NC releases, planned releases, and experimental lines with near immunity to GLS is impressive.

The researchers probably have the most extensive GLS-resistance in their breeding program of any program in the US, but most of it is still on the male side of potential hybrids. They are working hard to provide resistance on the female side; so far, the NC320 derivatives look the most promising.

Are Nutrient Deficiencies Limiting High Yield? Tissue and Soil Analyses of NC Corn Yield Contest Winners

NCARS/NCCES Code: 17-10

Project Leaders: JG White, RW Heiniger, GG Wilkerson

Final Report for period 2/1/2019-1/31/2020

Report: Sample numbers in 2018 were substantially lower than in 2017, probably because poor weather adversely affected yield with a concomitant decrease in Yield Contest entries. Average yields for study fields were 237 vs 221 bu/a in 2017 and 2018 respectively.

All soil samples had nutrient statuses for P, K, Mn, Zn, Cu, and S that were above the low index level whereby a crop response would be expected. Less than 10% of soil samples were within the index range of 25-50 (medium) for all nutrients except for Mn and S, where 12 and 25% of samples, respectively, were within this range.

Tissue nutrient levels were highly variable, especially with Mn, and were not correlated with yield except for S in 2017 and Mg in 2018. In both years, levels of tissue nutrients were below critical values in a high percentage of samples and there was little difference in these percentages between years. About 45% of samples were below the critical value for N and about 50% were below the Ca critical value at some point in the season.

In comparing the results from the critical value approach with those from the DRIS analysis, there were cases (P, K, Ca, Mg, Zn, Fe) where the two approaches gave very similar results with respect to nutrient deficit sufficiency, and excess; and other where they did not.

Goals and Objectives: The researchers sought to a) determine whether tissue macro- and micronutrient deficiencies are apparent at the high yields achieved by Corn Yield Contest entries and b) explore the extent to which any deficiencies may be yield limiting. They were adding value to the Yield Contest by studying corn tissue and soil nutrient levels, grower management, and their association with yield.

2019-2020 Activities

Analysis of study participants' management gleaned from Corn Yield Contest Entries.

The researchers tallied grower management practices and analyzed them statistically to determine yearly averages and the relationships between management factors and yield.

Impact Statement: The researchers' study of tissue and soil nutrient levels in high-yield Contest entries will provide valuable information either in support of current soil test calibrations and corn tissue sufficiency ranges or in deciding whether recalibration

and adjustment are needed and for which nutrients so that research can be prioritized appropriately. They emphasize that this is a 'study', rather than experiments or trials.

Please note: many of these results remain preliminary and will be finalized in a Ph.D. dissertation and journal manuscript(s) which will be shared with the Association when complete.

Unique Inbred Line Development for Central and Eastern NC NCARS/NCCES Code: 18-03

Project Leader: MM Goodman

Annual Report for period 2/1/2019-1/31/2020

Report: The researchers have developed four inbred lines; NC524, NC526, NC528 and NC530 that are awaiting release. NC524 and NC526 were derived from backcrossing NC320 (derived from SC76 stocks from South Carolina) twice to Pioneer 3737 (an early-maturing non-Stiff Stalk hybrid widely represented in the EX-PVP lines), followed by ear-to-row selfing.

Impact Statement: The researchers had major impact by combining yield and general disease resistance, mostly from tropical sources. In national and international corn breeding meetings, NC State is often compared to CIMMYT when a new disease appears (tar spot and maize lethal necrosis are the most recent headlines-resistance to both are found among NC lines, with little or no resistance found among other temperate sources). They are the number one source of Gray Leaf Spot (GLS) resistance and often the only U.S. source of resistance to diseases from abroad. Much of this traces to use of tropical sources for breeding, but some also traces to the breeding program from South Carolina (now closed), mostly from SC76 derivatives (the NC320's). Almost all of the materials in the NCSU Breeding program are unique.

NC320 and its derivatives have the potential to replace B73 derivatives as female parents in the South. This would contribute immensely to heat and drought resistance in the Southeastern U.S.

Developing Techniques for Measuring Emergence and Early Growth on Corn Hybrids in North Carolina NCARS/NCCES Code: 18-04

Project Leaders: Ronnie W. Heiniger, Ryan W. Heiniger

Annual Report for period 2/1/2019-1/31/2020

Report: Four sites were utilized for this research in 2019. Two sites, one on farm in Camden County and the Tidewater Research Station in Washington County, were used to test the use of aerial sensors in measuring corn emergence and growth. The other two locations, Haslin Farm in Beaufort County and Gray Farms in Pasquotank County were sites where the North Carolina Official Variety Test (NCOVT) were conducted.

These two NCOVT trials were used to measure emergence on all of the corn hybrids tested in the NCOVT.

Results: Across all plots where hand counts were taken, the differences between the plants observed in the visible (RBG) orthomosaic image and spikes counted manually ranged from 1 to 10 within the 3-meter sampling area. As expected, the counts from the image tended to underestimate the manual counts. This is the result of difficulties in 'seeing' the very small spikes of emerging plants. However, when counts were taken from an image using the red edge spectrum the small spikes were more visible against the soil background resulting in differences between image and manual counts of only 0 to 3 spikes.

Conclusions: Two years of data from this study shows that aerial images can be used to effectively quantitively measure plant emergence. Differences in fractional emergence starting on the first day of emergence are closely related to subsequent differences in plant height and canopy cover and differences in grain yield.

In summary, early emergence and growth is a critical component of maximum grain yield. Furthermore, this study is showing that there are genetic differences among hybrids for early emergence and growth that the hybrids that have better emergence are generally the same hybrids that exhibit greater grain yield.

Impact Statement: Research in the first year of this project has shown that aerial sensors are effective in quantitatively measuring emergence and early growth in corn. Early emergence and growth is a critical component of maximum grain yield. Furthermore, this study is showing that there are genetic differences among hybrids for early emergence and growth and that the hybrids that have better emergence are generally the same hybrids that exhibit greater grain yield.

Rapid Cycling Selection for Resistance to Fusarium Ear Rot and Fumonisin Accumulation in Corn

NCCARS/NCCES Code: 18-05

Project Leaders: CW Stuber, C Iglesias, and J Holland

Annual Report for the period 2/1/2019-1/31/2020

Report: Objective 1. Optimize a protocol for rapid high throughput genotyping for corn.

In the first year of the project the researchers accomplished this objective. They now have a working protocol to extract high quality DNA from small plants in the field, develop sequencing libraries, and obtain useful genotypic data from short read next generation sequencing. They have been able to obtain genomic predictions from sequencing leaf tissue samples before planting the next cycle, allowing for application of genomic selection models in the breeding program.

Objective 2. Use high throughput genotyping to select corn populations for resistance to Fusarium ear rot and fumonisin contamination two generations per year.

The researchers developed a genomic selection model using three years of previous Fusarium ear rot and fumonisin contamination evaluations on more than 500 lines from a recurrent selection population. They attempted to apply this model to ~400 individual plant samples from the population in the Florida winter nursery this year, the genotyping methods failed to produce good quality sequence information. However, they were able to use the same leaf samples to obtain good DNA genotype information using a commercial provider, they have planted a selected set of the best crosses in the Florida winter nursery and are self-fertilizing these lines to make seed for field testing the original population, the latest genomic selection population, the last phenotypically-selected population, and the intermediate generations of phenotypic and genotypic selection.

Impact Statement: The most desirable control strategy for Fusarium ear rot and fumonisin contamination is the use of resistant corn genotypes, but most commercial hybrids lack adequate resistance. The research should lead to the development of inbred lines with improved resistance to Fusarium and will be useful for the development of more resistant corn hybrids by commercial seed companies.

Precision Placement of Fungicides in Corn NCARS/NCCES Code: 18-11

Project Leaders: Scott Tilley, Lindsey Thiessen, Rod Gurganus

Final Report for the period 2/1/2019-1/31/2020

Report: Objectives of this study were to determine if a lower volume of water can give greater or equal coverage using the new 360 UnderCover spray accessories compared to traditional over-the-top applications.

Measure canopy penetration and leaf coverage under the two methods of application.

Measure efficacy by monitoring the presence of disease on the earleaf +2, earleaf, earleaf -2 among each treatment.

Determine if precision concentration of fungicides will increase final yield.

Impact Statement: It is yet to be determined what percentage of leaf coverage is considered adequate for control of foliar diseases. Based on yield results from this study, it is reasonable to conclude no matter the method or tools used to apply the fungicide, both the traditional and 360 UnderCover methods were able to cover plant leaves adequately enough to protect plants from disease. The question on whether or not more emphasis should be placed on covering the top or bottom canopy to increase yield and protect from disease needs further investigation. Current understanding of the source and sync relationship the energy needed to fill the ear pulls from the upper

leaves. However, this study indicated a clear, significant difference in lower and upper canopy coverage with results showing no significant difference in final yield.

Therefore, the 360 UnderCover accessory should not be a priority for corn growers and is deemed unnecessary if the goal is to have adequate fungicide coverage.

Effects of Cover Crops and Tillage on Long-Term Tillage Plots

NCCARS/NCCES Code: 19-01

Project Leaders: D. Osmond, Heitman, and Woodley

Annual Report for the period 2/1/2019-1/31/2020

Objectives: 1. To assess nitrogen uptake of corn at historical nitrogen fertilizer rates and with no nitrogen fertilizer to determine whether long-term conservation tillage provides additional nitrogen to corn allowing producers to reduce their rates.

2. Compare crop yields from different tillage systems with and without a cover crop (and another tillage type without cover crop) and with and without nitrogen.

3. Continue to assess changes to soil properties after introducing a winter wheat cover crop to a long-term corn and soybean rotation under five different tillage systems (no-till, chisel plow, chisel-disk, chisel, and moldboard plow), with and without cover crops, and disk with cover crop. All treatments are with and without nitrogen fertilizer for the corn crop.

4. Devise nutrient recommendations for cover crop use in corn/soybean rotations specific to tillage systems used and cover crops.

Objectives 1 and 2

Cover crops were planted December 6, 2018 and terminated April 15, 2019. The cover crop was sampled for biomass and nitrogen content just before the cover crop was terminated.

Corn was planted on May 1, 2019, and harvested October 10, 2019 following 2018 soybeans. Prior to planting, plots were fertilized according to soil test results from NCDA&CS. Total aboveground dry matter of corn was harvested separately, as grain and stover, and analyzed for nitrogen so that aboveground dry matter nutrient content could be calculated. Corn yield was very low due to serious drought stress during the 2019 growing season.

Yields ranged from a high of 39 bu/a to a low of 15 bu/a. Plots without N, not surprisingly had statistically lower yields (29 bu/a with nitrogen and 19 bu/a without). When tillage treatments for fertilized plots were compared to chisel plow, cover crop was significantly greater than moldboard plow+disking, cover crop.

Cover crops (wheat) treatments were planted in a timelier manner (late October) in 2019 than 2020 due to better weather conditions.

Results: Objective 3

The researchers found that measured values were different for the same soil metrics (water capacity, surface hardness, aggregate stability, organic matter, ACE soil protein index, respiration, active carbon, pH and overall score) between 2015 and 2018 except surface hardness. Values were lower in 2015 than for the same treatment in 2020.

Impact Statement: This long-term trial (~35 years) has been critical in determining yield and soil property differences between tillage types. Recently, the researchers added cover crops to determine yield and soil property effects, but it will take years, if not decades, to assess these differences. Additionally, they want to determine the effects of nitrogen applications on carbon cycling. Maintaining these plots is essential to answer the multiple questions that are being researched in Piedmont soils.

Identification of Genes for Resistance to Nutritional Deficiency in Maize

NCARS/NCCES Code: 19-02

Project Leaders: Eric Davis and Peter Balint-Kurti

Final Report for the period 2/1/2019-1/31/2020

Report: Calcium (Ca) is an essential plant nutrient. It is required for signaling, cell wall fortification and plays an important role in maize growth and development. Calcium deficiency in maize causes leaf tip rot, and a so-called 'buggy-whipping' phenotype.

Impact Statement: While this project was initiated before CGANC funding was secured, the extra funding provided by CGANC enabled the researchers to develop the mini-hydroponic system and to complete the QTL mapping experiment. These results describe for the first time the genetics of Ca-deficiency symptoms in maize and in plants in general and therefore of considerable interest. They continue to work on identifying the genes and mechanisms involved in this response.

Evaluation of Novel Approaches for Early Detection of and Detailed Characterization of Maize Foliar Disease

NCARS/NCCES Code: 19-03

Project Leaders: P. Ojiambo, P. Balint-Kurti, M. Kudenov

Final Report for the period 2/1/2019-1/31/2020

Report: The researchers have traditionally assessed quantitative levels of field resistance to maize foliar pathogens using a visual scale.

In general, they scored the plants two or three times over the season, starting when the disease is already well established. This method provides robust quantitative data but does not provide data on several parameters that would be useful to construct a

model to determine the optimal timing for fungicide applications. For such a model it would be helpful to be able to measure parameters such as rate of disease progress and timing of first appearance.

Furthermore, it would be helpful to be able to extract qualitative as well as quantitative data from the field trials.

In 2019 Corn Growers Association of North Carolina funded the researchers to undertake a study to assess the utility of novel phenotyping approaches for the detailed characterization of foliar disease resistance in the field (Project 19-03).

Impact Statement: The hyperspectral imaging data the researchers have thus far analyzed suggests that they can identify regions of the spectrum that are effective in differentiating resistant and susceptible plants more accurately and earlier than is possible using visual genotyping.

While more work is needed, they are confident that this work can be extended to other foliar corn diseases and will help to develop methods for the early detection of foliar disease in the field. It will also help characterize disease progression and aid in the development of predictive models to guide decisions on the timing of fungicide application.

North Carolina Corn Basis Fundamentals

NCCARS/NCCES Code: 19-04

Project Leaders: Nicholas Piggott, Heidi Schweizer, Robert Thompson, Ashling Murphy

Annual Report for the period 2/1/2019-1/31/2020

Objective: A primary objective of this project was to develop a database and a tool for corn farmers in North Carolina to have access to historical prices and basis. The researchers achieved that goal. The NC State University corn, soybean, and wheat price and basis database tool unitizes local price and basis time-series data and over the period beginning in 2000 until the present.

Report: Historical data can help to put current price and basis levels into perspective. Sellers can use these data to see how current price and basis levels compare to those in previous years and to detect seasonal trends in price and basis levels. It was established that the five top buyers for 2018 were: Murphy-Brown dba Smithfield, Perdue Agribusiness Grain, Prestage Farms Inc., Goldsboro Milling Grain, and Sleepy Creek Turkeys. It was also estimated the majority of corn is purchased in October, followed by purchasing declines in subsequent months until an increase in March.

How NC is Linked to Other Markets

The researchers used a variety of data sources to establish baseline facts about grain and oilseed movements, specifically: a) grain movements within the state, b) domestic imports of grains into NC, and c) international imports of grain to NC. They found that trucks are responsible for 99% of local grain shipments by weight using data from the US Census Bureau's 2012 Commodity Flow Survey.

However, over 80% of corn, by weight, sources outside of NC is imported via rail. These rail shipments averaged 874 miles.

Transportation Prices

There are two sources of information available that may be used to analyze the cost of rail shipments of corn terminating in North Carolina, the Grain Transportation Report (GTR) published by USDA-AMS, which is publicly available, and the second source is the confidential dataset Surface Transportation Board Carload Waybill Sample.

The Waybill sample reports show that on average in 2017 (the last year available) were approximately $1.00 per bushel to ship corn from Ohio to NC, compared to the rates reported by the GTR in 2017 ranged from $1.53 to $1.60 per bushel.

The Waybill samples also show that most corn delivered to North Carolina by rail originates in Ohio, Indiana, and Michigan.

Using UAV Imagery to Detect Crop Damage after Severe Weather Event

NCARS/NCCES Code: 19

Project Leader: Jason Ward

Annual Report for the period 2/1/2019-1/31/2020

UAV imagery from 2018 was analyzed to create tools which automatically detect crop damage. Simulated crop damage was created at Cherry Research Station in Goldsboro, NC. Two different modes of damage were simulated by creating lodging just below the first ear and at ground level. Imagery was collected over five weeks which centered on the estimated relative maturity of the crop.

A different model was created with imagery from each individual week and one which combined all the weeks.

RetinaNet, which is the tool Facebook uses to detect people in uploaded photographs, worked well even in non-filtered data, is the tool the researchers determined worked best for their needs.

Unlike the 2018 study, which was a proof-of-concept, the 2019 study was replicated and was repeated at two locations; Goldsboro and Butner. The replicated data and additional locations will add much more robustness to the data, which will improve the

ability of the model to automate crop damage detection. Traditional vegetative indices and machine learning approaches are being tested to reduce analysis complexity. Real-world data was collected from near Englehard, NC after Hurricane Dorian. This imagery is being processed for analysis and will allow the method to be tested under actual conditions.

Expanding Corn Testing Capabilities (OVT Planter Purchase)

NCARS/NCCES Code: 19-06

Planter purchase was completed in May 2019 and the planter arrived in October. The researchers are currently in the process of mounting tanks to the new JD5090R tractor for application of fertilizer at planting. Once that is complete, they have scheduled a training with both Wintersteiger (planter) and Trimble (GPS system) in February/March of 2020 to finalize attachment and to train on the planter operation. This will be done in conjunction of the annual service that occurs with Dr. Ron Heiniger's planter to save costs.

From the Executive Director

At the Corn Growers Association of North Carolina, we strive to utilize your assessment funds wisely. The 2019 research reports paraphrased here, as well as the 19 research projects funded for the 2020 season is just a small example of what your Corn Growers Association is doing for you, every day. We also advocate for you in the halls of Congress, sponsor field days near you, support corn growers at the national and international level and more.

As you peruse this letter, feel free to reach out to us, your NC Department of Agriculture Regional Agronomist or County Extension team with ideas for future projects. We'd love to hear them and present those ideas in the Fall for researchers to consider. This is YOUR association, and we strive to serve your needs.

These are uncertain times, to be sure. But, one thing is certain; agriculture will go on. Is going on. This country and the world is relying on us, those on the tractors, in the feed & seed stores, at the bank, at the Extension offices and everyone in between, to provide for the needs of this nation.

Please visit our website; www.nccorngrowers.com frequently for updates and useful links found under the Useful Resources tab. If you do not receive our e-newsletter and would like to, please email me at rhonda_corngrowers@yahoo.com to be added to the list. Lots of good, timely information there. And visit us on Facebook at Corn Growers Association of North Carolina.

Thank you, be well, and farm on!

Rhonda Garrison