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In Good Years and in Bad, Research Makes a Difference

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In 2021 North Carolina experienced almost ideal weather for growing corn, resulting in a record corn crop. That certainly hasn't been the case in 2022, however.

Dry weather and drought conditions were common across the state this summer. Even so, the common refrain that you hear from most corn growers is that the crop is better than expected.

While we credit research and development of corn hybrids and advanced management practices with increasing corn yields, the true value comes in years like 2022. Despite the worst weather in a decade, North Carolina corn growers will harvest a respectable crop that will pay the bills.

This is the result of the investment you are making in research and market development through your corn checkoff dollars as directed by your fellow corn growers through the Corn Growers Association of North Carolina. The projects outlined in this report show how your research dollars are being directed to help reduce fertilizer costs, improve water management, control weeds and pests, and a whole lot more.

The investments you are making in this research along with the investments you are making in market growth and development through the US Grains Council and the National Corn Growers Association allow you to overcome adversity no matter where it might arise.

Reports

Improving Resistance to Gray Leaf Spot in Corn for North Carolina

NCARS/NCCES Code17-04
Report Period 2/1/2021-1/31/22
Final

Project Leaders: MD Krakowsky, MM Goodman, D Dowden

Report: 2021 was another difficult year to screen for GLS, due not only to the pandemic but also to very dry weather after planting at Waynesville and later in the season at Salisbury.

When contrasting with ratings for GLS for the same hybrids evaluated in 2020, the 2021 scores are generally higher (i.e. less disease). Hybrid scores below 8 (on a 9=immune, 1=dead scale) suggest susceptibility to GLS. Familiar hybrids are highly resistant, including NC experimentals and such stalwarts as DeKalb 689.

A group of releases from the GEM project were planted again in 2021 at Salisbury and Waynesville. As with the hybrids, scores were higher than 2020, indicating less disease. Several entries showed consistently high levels of resistance to GLS across years, including some releases from the Stiff Stalk heterotic group (GEMS-0215 and GEMS-0256) was included in the trial for the first time in 2021, and GEMS-0320 and GEMS-0321 were only just released in January 2021.

The researchers' efforts to this date have focused on evaluation of resistance in commercial hybrids and identification of resistance on the Stiff-Stalk Synthetic (SSS) side of the heterotic pattern. They had planted ex-PVP (formerly propriety) inbreds to identify those with resistance, but these efforts often fell short due to the poor agronomic performance of the inbreds. Some SSS ex-PVPs have shown resistance to GLS (i.e., PHMKO and LH236) which raised the question of whether the resistance observed in these formerly commercial lines is genetically similar (or even identical) to the resistance the researchers observe in the North Carolina inbreds.

Impact Statement

The researchers' 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 experimentals 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 NC 320 derivatives look the most promising, but they also have NC368, GEM lines and the ex-PVP's that show promise.

Status of Soil Fertility and Soil Health in Soils from North Carolina

NCARS/NCCES Code:20-04
Report Period 2/1/2021-1/31/22
Annual

Project Leaders: Luke Gatiboni, Deanna Osmond, Stephanie Kulesza, Amy Johnson

Report: The goal of this project is to assess the soil health and soil fertility of agricultural fields in North Carolina. By coordinating with local extension agents and using an ARCGIS Web mapping application that divided counties into grids, samples were collected from 200 fields across 83 counties from 0-4- and 4-8-inch depth, totaling 400 samples. The number of fields per county was determined by the proportion of

field crop acres in that county compared to the total field crop acres in the state (data averaged from the 2012 and 2017 USDA Ag Census). Any county with less than 7,000 acres of field crops was excluded from the study. A set of survey questions covering crop history, fertilizer amendments, tillage practices and soil type was been recorded for each field sampled.

The samples were collected and ready for analysis in 2021 and split into three subsamples. Subsamples 'a' were shipped to the NCDA&CS Soil Testing Lab for a full fertility assessment. Subsamples 'b' were submitted to EATS lab for total carbon and total nitrogen analysis. Subsamples 'c' were processed in the NCSU Soils Fertility Lab where textural analysis were performed and POX Carbon analysis, analysis for Soil Health were done. All soil analysis were completed by September 2021. As the samples were collected from two depths, it will be possible to look at the concentration of nutrients in the top layer of he soils under no-till system. Also, it will be possible to correlate the nutrient concentration and soil health with tillage system, soil type, and organic fertilizers usage (data collected during the survey).

Impact Statement

Information about average soil fertility and soil health status in NC soils, linked with information about soil type and tillage system will be a valuable tool for farmers, extension agents, and researchers. Once completed, the researchers expect to have a better understanding of the relationship between soil fertility and soil health and what soil health means to North Carolina farmers.

Managing Canopy Temperature in Corn

NCARS/NCCES Code:20-06
Report Period 2/1/2021-1/31/22
Annual

Project Leader: Ron W. Heiniger
Report: The objective of this research was to identify management practices that reduce canopy temperature in corn. This study was conducted at three sites in the Coastal Plain (Duplin, Sampson and Bertie Counties), two sites in the Tidewater Regions (Pamlico and Washington Counties) and one site in the Piedmont (Surry County) on different soil types.

The main plots had row spacing 20 and 30 inches apart. Subplots had 10-27-0 starter fertilizer and two in-furrow treatments of endomycorrhiza (SP1 and Heat Shield). The subplot treatments were seeded at 30,000 and 40,000 seeds per acre. Individual plots were 4 rows wide by 12.2 m long. Planting dates ranged from April 8th to April 28th.

At planting, starter fertilizer (10-27-0) was applied at the rate of 20 gal per acre and the two endomycorrhiza treatments were applied in-furrow at the recommended rates (SP1@1.5 gal/acre and Heat Shield @ 0.1 oz/acre along with 30% UAN broadcast applied at 50 lbs N per acre. At V7 140 lbs N per acre was applied to achieve a rate of 210 lbs N per acre. Standard pre- and post-emergence weed control practices were used resulting in 99% or greater weed control.

At V10 temperature sensors (HOBO pendant 64K, Onset Computer Corp., Boume, MA) were attached to the underside of the potential earl leaf on one plant within row two of each four-row plot.

Results:

Canopy Temperature

Statistical analysis found few significant interactions among row spacing, seeding rate, and starter treatments but there were significant main effects for row spacing, seeding rate, and/or starter treatments at all locations. At all three locations canopy temperatures were cooler in the 20-inch rows compared to the 30-inch row plots. The use of a starter fertilizer or in-furrow applications of endomycorrhiza were also significant at all locations. Previous research had indicated that row spacing was an important factor in reducing canopy temperature and that was also the case in this research.

Grain Yield

Statistical analysis of grain yield at each location found no significant three-way interactions and only a few significant interactions among row spacing and seeding rate or row spacing and starter endomycorrhiza treatments. However, row spacing as the main factor, resulted in significant grain yields at all locations except Surry County. Twenty-inch rows increased corn yield from as much as 25.5 bu/a in Washington County to as little as 4.3 bu/a in Surry County. Seeding rate also resulted in significant yield increases at all locations except Sampson County. Increasing seeding rate from 30,000 to 40,000 seed per acre increased corn yield by as much at 20.2 bu/a in Duplin County to as little as 7.4 bu/a in Bertie County. In Sampson County increasing seed rate by 10,000 seeds per acre decreased corn yield by 5.5 bu/a.

Summary:

1. Row spacing: row spacing is an important tool in decreasing canopy temperature and increasing grain yield at most locations in North Carolina. More spacing between plants results in wider root distribution in the upper 16 inches of the soil profile resulting in better water utilization. At most locations this helped decrease canopy temperature during grain fill in July and was a key factor in the yield increases found. In Surry County where row spacing did not result in a significant yield increase, the clay loam soil held more water and cooler nighttime temperatures did not put as much stress on the corn. Therefore, the advantages of planting in a 20-inch row were not as great.
2. Seeding Rate: seeding rate was the next most important factor in this study in 2021. Analysis of water extraction at the higher seeding rates indicate that the increasing water demand that occurs as seeding rate increases was offset by deeper root growth. Good environmental conditions at planting promoted early root growth in 2021. Therefore, at most locations increasing seeding rates from 30,000 to 40,000 seeds acre resulted in an increase in yield. In contrast, cold, wet planting conditions in 2020 limited early root growth and no yield differences were found among seeding rates in 2020. These past two years of data indicate that yield benefits from increasing seeding rate are dependent on environment early in the growing season.

Impact Statement

This research proves that temperature is an important factor in corn yield and that small reductions in early leaf temperature during periods when air temperatures are exceeding growth limits can result in increased corn yield. Decreasing row spacing increases water availability in the upper soil profile resulting in better transpiration, reduced ear leaf temperature, and increased grain yield. An endomycorrhiza treatment applied in-furrow at planting also decreased ear leaf temperatures at sites with sandy loam soils and resulted in corn yields that were similar to those measured using a starter fertilizer.

Identifying Corn Fields at Risk for Stink Bug Infestation

NCARS/NCCES Code:20-09
Report Period 2/1/2021-1/31/22
Final

Project Leaders: Dominic Reisig, Anders Huseth, Clyde Sorenson

Report: The objectives were:

1. Classify stink bug overwintering habitats adjacent to corn based on the categorization of host plants and forest structures.
2. Measure brown stink bug colonization into spring corn adjacent to non-crop overwintering habitats and annual crops
3. Estimate stink bug injury in focal corn fields.
4. Relate corn yields to stink bug density and landscape features adjacent to fields.

Objectives 1 & 2: During 2021, 17 fields were sampled in the central Coastal Plain and 14 fields in the Blacklands continuously from emergence until R3. Pressure was low in most fields across the central Coastal

Plain and almost non-existent in the Blacklands. In the Blacklands, no fields reached threshold and stink bugs were simply absent from most fields. Southern corn billbugs, in contrast, were abundant in Blacklands fields. In the central Coastal Plain, stink bugs were present in nearly every field.

Objectives 3 & 4: The researchers determined that they had overestimated with regards to these objectives. Fortunately, the researchers received at $325,000 grant from USDA NIFA to support this work in 2022 and 2023. Soybean fields were sampled during 2021 that were expected to be planted in 2022 using USDA funding.

Impact Statement

Forty percent of growers indicated they sprayed stink bugs in corn during 2019. Of those growers that sprayed corn in the previous season, 39% sprayed 1-10% of their acres (probably representing a field or two), while 34% sprayed >90% of their acres. Growers were asked to estimate their cost estimate due to stink bugs in corn, and assuming 40% of North Carolina's 990,000 corn acres were sprayed during 2019, this would total <$28 million in North Carolina alone. This research will help growers predict where stink bugs are likely to occur in corn and reduce their costs and losses.

Evaluating the Benefits and Drawbacks of Twin-Row Corn in North Carolina

NCARS/NCCES Code:20-11
Report Period 2/1/2021-1/31/22
Final

Project Leaders: Matthew S. Tilley, David Jordan, Ron Heiniger, Rachel Vann

Report: Funding in 2019 and 2021 supported a total of five individual corn studies evaluating the benefits and drawbacks of twin-row production in eastern NC. They are as follows:

1. "A survey of twin-row cropping systems in North Carolina."
    a. Crop Forage & Turfgrass Management. Published July, 2021. M. Tilley, D. Jordan, R. Heiniger, R. Vann, C. Crozier, and L. Gatiboni
2. "Evaluating twin vs. single-row corn spatial arrangement and its influence on final yield"
3. "Does planter speed influence spatial arrangement in twin-row corn?"
4. "Determining optimum twin-center spacing and starter fertilizer placement in corn."
5. "Optimum row configurations for decreasing canopy temperature in corn."

The information gathered from these studies will be used in an Extension format to reach current twin-row growers to share knowledge gained from these experiments but also explore other avenues to produce higher corn yields using this unique row configuration. Work has already begun in Extension for 2022 looking at fertility placement in twin-row.

Impact Statement

1. "A survey of twin-row cropping systems in North Carolina."

Based on the responses from the general survey, single row (SR) spatial arrangement on 36 inches or greater is the most preferred production system among NC grain crop farmers. Based on the responses to the general survey, if farmers follow through with a transition from wide to narrow rows, row center < 36, will be the standard practice for grain crop production in NC. The twin row (TR) spatial arrangement will continue to be an option for growers looking to transition grain crops from traditional wide-row to more narrow-row systems.

2. "Evaluating twin vs. single-row corn spatial arrangement and its influence on final yield"

The following study observed three spatial arrangements. The first being twin-row synchronized, the second twin-row non-synchronized, and the third a standard single-row arrangement.

Results found that plants that had emerged 36 to 48 hours after planting among the twin-row treatment had the ability to grow taller and establish larger stalks compared to single-row treatments emerged in the same hour. This indicates twin-row synchronized or non-synchronized, can reduce plant-to-plant competition. This is certainly true when growing corn on 36-inch or greater row spacing.

After two years at four site locations, yield results indicated no significant difference among the three planting patterns. Only a 2 bu/a increase was found among the twin-row synchronized compared to twin-row non-synchronized and single row.

3. "Does planter speed influence spatial arrangement in twin-row corn?"

Though a majority of twin-row producers do not synchronize their planters, some growers view synchronization being worth the effort. It is hypothesized that planter speed may disrupt the synchronization pattern mainly due to the fact that the twin planter units work independently from one another

4. "Determining optimum twin-center spacing and starter fertilizer placement in corn."

The twin-row survey administered in 2019 and 2020 revealed a small number of growers use the twin-row planting pattern in NC. However, among those who do plant twin-row, a diverse number of methods are used ranging from 30 to 38-inch row centers but also twin-row planting from 6 to 11 inches apart.

Results concluded no significant difference in plant characteristics between the three twin-center spacing indicating that any spacing above 6 inches has no influence in improving crop performance.

North Carolina Corn Basis Fundamentals

NCARS/NCCES Code:
Report Period 2/1/2021-1/31/22
Final

Project Leaders: Nicholas Piggott and Heidi Schweizer

Report: The outputs are an online tool, a comprehensive report made available online, Extension presentations on the research material and a PhD chapter.

In addition to the PI's, multiple staff and students contributed. Research highlights are below:

1. Creating and analyzing a database of historical corn prices and basis for different NC locations.
   Historical corn bids reported by USDA gathered and saved in an accessible and updateable format currently consists of 89,730 data points.
   Econometric tests show that NC corn prices vary by both region and season. The basis carry has direct implications for varying returns to storage based on the NC region.
2. Establishing information on the source and timing of flows of feedstuffs to and within NC.
   Six data sources used to look at truck, rail, and boat shipments of feedstuffs to and within NC

From 2002 to 2017 some NC counties have switched from being feed deficit to feed surplus.

NC's feed deficit is largely met with feedstuffs from MI, OH, and IN. Even in years with the highest international import volumes, ocean imports accounted for less than 5% of total energy feed and needs.

Impact Statement

The data compiled and gleaned into a useful time series for analysis through the course of this project will continue to be used and analyzed in research and Extension-related projects. This unique and substantial database provides a foundation to explore important research questions on historical prices and the basis in the future.

Evaluation of Corn Hybrids for Climate Resiliency and Nutrient Use

NCARS/NCCES Code:21-01
Report Period 2/1/2021-1/31/22
Annual

Project Leaders: Chad Poole, Ron Heiniger, and Luke Gatiboni

Report: Fifteen corn hybrids representing three relative maturity (RM) groups were evaluated to identify the components of yield and stress resilience favorable for efficient, profitable production in areas of Eastern North Carolina with a high seasonal water table, controlled or free drainage, or a combination. Three managed water regimes were tested at two sites. The first site, located at the Tidewater Research Station at Plymouth, NC, had three components (1) rainfed treatment, intensive tile drained with lines spaced 37.5 inches apart, open throughout the growing season and with no supplemental irrigation to simulate dryland cropping; (2) adequate, combining elements of tile drainage lines spaced 75' apart, subirrigation, and surface drip irrigation, and monitoring soil matric potential in the effective corn rooting zone, designed to maintain non-limiting transpiration rates during the critical growth stages with economical drainage and (3) wet, combining elements of controlled intensive tile drainage, subirrigation, surface drip irrigation, and monitoring soil metric potential to simulate saturated or near-saturated conditions in the effective corn rooting zone.

Key Findings from the 2021 Trials

-Yield Response. On the Plymouth site, rainfed, intensively tile drained and adequately tile drained plots with supplemental surface drip irrigation yielded 65.1% and 46.8% more grain, respectively, than wet stressed, non-tile drained plots, 180 and 160 vs 109 bu/a respectively.

-Maturity Group. On the Plymouth site, full (>116 Day RM) and medium (110-115 Day RM) season hybrids performed significantly better, on average, across stress environments than early (103-109 Day RM) season hybrids. Yield response was more variable with the >116 Day RM hybrids under wet stress compared to 110-115 Day RM and 103-109 hybrids.

-Test Weight and Shellout Percentage. Differences in test weight and shellout percentage were detected across water stress environments, generally favoring rainfed, intensively tile drained and adequately tile drained field conditions compared to stressed, undrained conditions.

-Yield Components. On the Plymouth site, poor internal drainage coupled with a high seasonal water table decreased kernel weight; kernels per row; and ear row number irrespective of maturity group. On average, kernel weight was impacted to a greater degree than kernels per row and ear row number, suggesting that differences in yield were primarily driven by environmental stress during the active grain filling period R2 through R5.

-Plant Tissue Nutrients. At the Plymouth site, in-season tissue testing revealed variably low or deficient concentrations of N, P, S, ZN, Cu and B at V6 just prior to side dressing in four >116 Day RM hybrids and one 103-109 Day RM hybrid. Leaf N, P, and S concentrations may have been affected by saturated field conditions that occurred around V4-V5, as levels of these nutrients generally were in the sufficient range at V12 and thereafter. Leaf Zn levels were low through R3; leaf B levels were low at all sampled dates except V12; and leaf Cu levels strongly elevated under wet stress at V12 and thereafter.

Impact Statement

This project has created two excellent research and extension sites to evaluate the performance of elite, commercially available corn hybrids in different simulated water stress environments. These sites will be available as venues for field days and serve as a platform for future investigations related to field crop response to water stress.

Paraquat-resistant Italian Ryegrass; What Does it Mean for Corn Producers?

NCARS/NCCES Code:21-05
Report Period 2/1/2021-1/31/22
Final

Project Leaders: Charles W. Cahoon, Jr. and Wesley J. Everman

Report:

Objectives:

1. Confirmation of paraquat-resistant Italian ryegrass
2. Tolerance of Various Corn Hybrids to Commonly Used POST Herbicides
3. Comparison of Non-encapsulated and Encapsulated Acetochlor of Residual Weed Control in Corn

Project Update:

1. Confirmation of paraquat-resistant Italian Ryegrass

Herbicide-resistant Italian ryegrass has long infested North Carolina. In particular, the southern Piedmont has widespread ALS-resistance (Osprey and PowerFlex) and spotty ACCase (Hoelon and Axial XL) as well as glyphosate resistance. For farmers battling Italian ryegrass biotypes resistant to glyphosate, ALS, and ACCase herbicides, paraquat is the last line of defense for emerged Italian ryegrass. While pyroxasulone (Zidua/Anthem Flex) provides residual control of the weed, it, and other related herbicides, do not control emerged ryegrass.

In October 2020, the researchers were alerted to a field of Italian ryegrass in Stanly County not controlled by paraquat. Because of this, the grower decided to try a fall burndown of paraquat to control the ryegrass while small with the hopes of planting a winter small grain. However, the ryegrass survived an initial one-quart per-acre paraquat (3lbs/gal product) application and the another two-quart-per-acre application a couple of weeks later.

While at the initial site in Stanly County, the NC State Weed Science team was alerted to a second location where Italian ryegrass survived paraquat. At this location 2X, 4X and 6X rate of paraquat was applied to approximately 3–4-inch ryegrass. Also, in Stanly County there was a clearer rate response at this location. The 2X rate caused only slight necrosis whereas the 6X rate caused approximately 70% necrosis. However, despite the extremely high rates and small ryegrass size, the weed was not completely controlled, as expected.

This objective has been completed. Despite initial reports of ineffective Italian ryegrass control by paraquat and confirmation by the NC State Weed Science Team, to be classified as resistant, resistance must be passed to the progeny.

To confirm resistance NC State Weed Science Team collected Italian ryegrass plants surviving paraquat at the two sites described above and an additional site in Union County where a similar issue was reported. These collected plants were grown to seed production in separate greenhouses. Seed were then collected and sprayed with several rates of paraquat (0,1/X, 1X, 2X, 4X, 8X, 16X, and 32X) to confirm resistance.

Two runs of this experiment have been completed results confirm all three suspected Italian ryegrass biotypes (H1, B1, and SB1) are resistant to paraquat.

2. Tolerance of Various Corn Hybrids to Commonly used POST Herbicides

During 2019, many complaints were received during mid-to-late-May of corn injury resulting from herbicides. Most cases involved a HPPD-containing product including Capreno, Resicore, Halex GT, and ShieldEX. In conclusion, corn injury from HPPD-inhibiting herbicides is highly dependent on environmental conditions but can also be influenced by corn hybrid choice. Under good growing conditions, differential response to HPPD

herbicides is unlikely. However, a stressful environment, like cool and/or wet conditions, may exacerbate a corn hybrid's response to HPPD herbicides. Despite differential bleaching and stunting of corn hybrids, yield loss is unlikely. This project directly addresses CGANC Research and Extension Priority-Herbicide tolerance in corn hybrids.

3. Comparison of Non-Encapsulated and Encapsulated Acetochlor for Residual Weed Control in Corn.

Harness herbicide has favorable chemical characteristics for activity in high organic soils including moderate water solubility and low Koc (affinity for binding to organic matter) which is why the herbicide was the long-standing standard for residual weed control for Blackland corn production. Harness contains an EC formulation of the active ingredient, acetochlor. However, EC acetochlor has been replaced in the marketplace by a micro-encapsulated version of acetochlor sold under the tradename Warrant. Growers in the Blacklands have complained that residual activity of Warrant pales in comparison to the EC formulation of Harness. No direct comparison of residual activity by Harness and Warrant on high organic soils has been conducted to determine if encapsulation of acetochlor reduces activity in Blackland soils.

Experiments were conducted at the Tidewater Research Station (TRS), and on a private farm near Swan Quarter (SQ). During 2020, corn was planted on April 25 and May 8 at SQ and TRS respectively. During 2021, corn was planted in two adjacent locations on April 29. Preemergence (PRE) herbicides were applied within two days of corn planting. Paraquat was applied across the entire trial area to ensure control of any weed emerged at planting.

In general, where greater weed pressure existed, Harness, Outlook and Warrant performed better than Dual II Magnum and Zidua. However, differences in weed control between Harness and Warrant were minimal. Corn growers in the Blacklands would be wise to use Harness, Outlook, or Warrant in combination with atrazine for residual control of small seeded broadleaves and most annual grasses. Outside of high organic soils, all of the group 15 herbicides including Dual II Magnum and Zidua, provide similar weed control.

Corn Problem Diagnosis Support for Cooperative Extension Agents

NCARS/NCCES Code:21-06
Report Period 2/1/2021-1/31/22
Annual

Project Leaders: Luke Gatiboni, Matthew Bertone, Ron Heiniger, and Kristin Hicks

Report: The researchers' approach to strengthening crop problem diagnosis efforts is to request funding from each of several commodity groups to fund the analysis of samples submitted by Cooperative Extension agents.

From January to November 2021, 552 diagnostic samples were analyzed at NCDA for different crops (barley, corn, cotton, oats, pepper, sorghum, soybeans, sweet potato, tobacco, tomato, and wheat) of those, 126 samples were for corn diagnostics. This program has been active since 2010 and in the beginning, just a couple of samples were analyzed each year. However, over the years the Extension agents are actively using this resource to help them identify problems in the field.

Impact Statement

This program should result in more qualified agricultural agents, and farmers that better understand their production constraints. Once the value of these diagnostic efforts is better understood, the researchers expect producers will be more willing to pay the standard diagnostic fees themselves.

Maintenance of Long-term Soil Test Calibration Trials in North Carolina

NCARS/NCCES Code:21-07
Report Period 2/1/2021-1/31/22
Annual

Project Leaders: Luke Gatiboni, Deanna Osmond

Report: The objective of this project is to maintain long-term functional trials used to refine the soil test calibration and recommendation of fertilizers for corn and soybean in North Carolina. NC State University is maintaining three long-term trials to check yearly if the recommendations of phosphorus and potassium fertilizers based on soil analysis are still adequate. The three long-term trials are located at the Tidewater Research Station (TRS), Peanut Belt Research Station (PBRS), and Piedmont Research Station (PRS) and the three locations are tested for rates of phosphorus and potassium fertilizers. These trials were initiated in 1966 (TRS), 1982 (PBRS), and 1985 (PRS) and they have been cultivated every year with row crops, most of the time using a soybean-corn rotation.

In the 2021 cropping season, corn was planted at all three locations. Prior to planting, the experimental fields at TRS and PRS were desiccated, and PBRS trial was disked for weed management.

For all locations, P and K fertilizers were broadcast within seven days of planting. The source of P was triple superphosphate (0-44-0), and the source of K was muriate of Potash (0-0-60) for both crop seasons. In 2021 all fields received 150 lb N/ac, split between 50 lb/ac at planting and 100 lb/ac as a layby application at the V5-V6 growth stage in corn. At PRS and PBRS, the N source at planting as ammonium sulfate (21-0-0-24S), which in a broadcast application to the plots. At TRS, the N source was Urea ammonium nitrate (UAN)(28-0-0). At all three locations, the layby N source was UAN (28-0-0).

In all three locations it was observed a response to phosphorus fertilization but not for potassium fertilization. The lack of response to potassium was attributed to the excellent rainfall during the season and medium to high potassium levels in the soil. The maximum yield obtained was 150 bu/a at PBRS, 127 bu/a at PRS, and 40 bu/a at TRS. The yields were very low at the Tidewater Research Station because that site suffered excessive flooding during the cropping season. After data analysis, the results showed that the phosphorus critical level was 55 P-1 for TRS and PBRS, and 10 P-1 for PRS. It means the current critical levels in the 'Orange book" are adequate for soils from Coastal Plain and Tidewater regions but it is overestimated for Piedmont soils.

Impact Statement

The results obtained in 2021 showed that climatic factors affect deeply the nutrient efficiency. The good moisture conditions during the season promoted a good supply of potassium for plants, even in soils with medium levels of this nutrient. The relationship between water supply and nutrient efficiency is something that should be studied in our state to refine the fertilizer recommendation for years too dry or too wet. Regarding phosphorous, the current critical levels in the "Orange book" are adequate for soils from Coastal Plain and Tidewater regions but they are overestimated for Piedmont soils.

Rip Depth and Fertilizer Placement for Corn

NCARS/NCCES Code:21-08
Report Period 2/1/2021-1/31/22
Annual

Project Leaders: Luke Gatiboni, Rod Gurganus, Ron Heiniger

Report: Because information about strip-tillage and under-row subsurface application of fertilizers for corn production is lacking in North Carolina, the researchers proposed to test fertilizer placement and strip-tillage impacts on corn production in two locations within the Coastal Plain (in Beaufort County on coarse textured soils and in Washington County on organic soils). The researchers wanted to study the effect of applying

nitrogen at planting as a surface-applied broadcast treatment vs. a subsurface direct-under-row treatment on corn yield.

Only one trial was implemented. It was planted on mineral organic soil near Wenona in Washington County on May 7th, with a plant population of 32,000. None of the treatments receiving nitrogen differed significantly from each other. All treatments receiving nitrogen yielded significantly higher than the check. While disappointed with these results, the trial will be implemented again in 2022.

Impact Statement

Information about strip-tillage and under-row subsurface application of fertilizers for corn production is lacking in North Carolina. Trials are being conducted to test fertilizer placement and strip-tillage impacts on corn production in the Coastal Plain region. In 2021 the effect of applying nitrogen at planting vs a subsurface direct-under-row treatment on corn yield was studied. During the first year, no differences between treatments were observed. These studies will be repeated in 2022 on different soil types to obtain a robust dataset to support the researchers' conclusion. Additionally, in 2022 different depths of ripping, with and without deep fertilizer application will be studied.

Incorporating Emergence Ratings into the North Carolina Official Variety Trial Corn Hybrid Selection Tool

NCARS/NCCES Code:21-09
Report Period 2/1/2021-1/31/22
Annual

Project Leaders: RW Heiniger, and Ryan Heiniger

Report: Several improvements in both equipment and methods were used to detect and measure early emergence in the official corn variety trial. A newer sensor was tested, calibration was performed on all images and a software program was used to perform plant counts automatically alongside ground truthing as opposed to last year where all plant counts came by hand counting from images.

Results

The improvements this year include a properly calibrated a multispectral sensor, automated plant counting through Agremo, permanent and measured ground control points, and ground truthing. The accuracy of this plant count averaged out at 6.77% error across all six locations using the Red Edge sensor with a 1.3 cm/pixel GSD. The automated plant counts for all six locations were used to calculate fractional emergence. Fractional emergence determined between VE and V3 has been shown to be highly correlated to uniformity and time of emergence.

This statistic is useful in determining differences among corn hybrids in early vigor and emergence. Fractional emergence for all of the hybrids entered into the North Carolina Official Variety Trial at these six locations. This will allow agronomists and farmers to select hybrids based on early, uniform emergence.

Summary

The most important advancement this season was the creating of an official process and a standardization of equipment.

Impact Statement

An improved technique for separating the soil background from emerging plants was successful in measuring fractional emergence on corn hybrids entered into the NCOVT at six locations across North Carolina. Measurements across locations identified several hybrids that consistently rated very good to excellent for emergence and a few hybrids that consistently had only average emergence ratings. Corn growers now have the ability to select hybrids that will emerge in difficult soil environments.

Increasing Corn Yield by Managing Root Growth

NCARS/NCCES Code:21-10
Report Period 2/1/2021-1/31/22
Annual

Project Leaders: Ron Heiniger

Report: The goals of this research were to examine root development in corn under different soil environments and management practices and identifying key management factors that increase root growth, nutrient and water uptake, and corn yield. Specific objectives were: 1) to measure corn rooting depth and water extraction over the growing season in different soils in North Carolina using different management practices such as row spacing, fertility practices, and hybrids, and 2) to use these measurements to identify key management factors that lead to increased root growth and better nutrient and water uptake. This study was conducted at one site in the Coastal Plain (Bertie County), two sites in the Tidewater Region (Pamlico and Washington Counties) and one site in the Piedmont (Surry County) on different soil types.

Results

Soil Moisture Extraction Row Spacing

Statistical analysis of volumetric soil water content found significant main effects for row spacing and starter or biological treatments at all locations. Analysis of soil moisture found that more water was available from the upper layers of the soil profile (4-16 inches) in the 20-inch row spacing because plants were spaced further apart in the row resulting in less water demand. In comparison, corn roots grew deeper in the 30-inch row spacing plots because there was less soil moisture available in the upper soil profile.

Soil Moisture Extraction Starter and Biological Treatments

Analysis of soil moisture under plots where starter fertilizer was applied compared to the use of biological treatments found that the biological treatments increased the amount of soil moisture extracted from the 8 to 16-inch depths of the soil profile compared to the use of starter fertilizer. These data suggest that these biological endomycorrhiza treatments increase the ability of the corn root system to extract water from these layers of the soil profile thereby increasing use efficiency.

Grain Yield

Statistical analysis of grain yield at each location found no significant three-way interactions and only a few significant interactions among row spacing and starter or endomycorrhiza treatments. However, row spacing as the main factor resulted in significant grain yields at all locations except Surry County. The application of 10-27-0 starter or endomycorrhiza treatments resulted in significantly different yields at Washington County and Pamlico County. In both Washington and Pamlico Counties 10-27-0 starter resulted in significantly greater yield (from 11.7 to 15.7 bu/a) compared to the use of SP 1 or Heat Shield. At the other locations there were no significant differences between the use of a starter fertilizer and the use of an endomycorrhiza treatment.

Impact Statement

This research found that water extraction from the upper soil profile is important in determining corn yield. Analysis of volumetric soil moisture shows that using 20-inch rows increases the amount of water in this region of the soil that is available to each plant compared to using 30-inch rows, and that biological endomycorrhizal treatments improved water extraction in the area 8 to 16 inches below the soil surface.

Developing a Weather and Climate Dashboard for NC Corn Growers

NCARS/NCCES Code:21-11
Report Period 2/1/2021-1/31/22
Interim

Project Leaders: Ron Heiniger, Rebecca Ward

Report:

Climate Dashboard Development

A Climate Dashboard has been developed to provide tailored weather forecasts and seasonal climate information for corn growers in North Carolina. Building the tool involved assimilating data from multiple gridded sources (PRISM, RTMA, and NWS-NDFD) to generate grids of weather observations and forecasts (temperature and precipitation) for each year from 1991-present. From these grids, growing degree days (GDDs) with a base temperature of 50 degrees Fahrenheit were computed at a daily timestep. These data are the basis for all output displayed by the dashboard.

Climate and Corn Yield Analysis

In addition to developing the climate dashboard, an analysis comparing historic climate data to historic annual corn yields was carried out to assess the predictability of longer-term climate patterns on annual yield with the aim of improving pre- or within-season guidance to the state's corn growers.

County-level grain corn yield (bu/a) data were obtained from the US Department of Agriculture National Agricultural Statistics Service (USDA-NASS) for the most recent 30-year period (1991-2020). The yield timeseries were detrended by subtracting a linear regression line through the data to remove the influence of factors other than interannual climate variability (e.g., advances in technology). To distinguish the detrended yield data from the raw data, detrended data are referred to as 'yield anomaly'.

A number of climate variables were assessed and the analysis with the greatest potential for corn yield guidance is included here.

Impact Statement

The Climate Dashboard for Corn Growers is now available to the public from the NC State Climate Office's website: https://products.climate.ncsu.edu/ag/corn. The 2022 growing season will the first season that the dashboard will be available, and the researchers anticipate it will provide growers with needed weather and climate information to support their pre-season planning and within season management decisions.

Understanding the Long-Term Implications of Tillage on Water Storage and Corn Yields

NCARS/NCCES Code:21-15
Report Period 2/1/2021-1/31/22
Final

Project Leaders: A. Woodley, J. Heitman, C. Mathers, C. Cahoon

Report:

Objectives: The goal of this study is two-fold; understand the effects of long-term tillage practices on soil water dynamics during the corn season, to determine if water storage and/or water infiltration is the primary reason for historical yield differences that have been otherwise unaccounted for. In addition, the goal is to prepare a long-term trial for overdue management updates and future studies on appropriate cover crop selections for corn-soybean rotations in the Piedmont region of North Carolina.

Objective 1: Compare root zone soil water storage dynamics across tillage treatments. Less intensive methods of tillage, or no-till, have produced higher yields at the site, but it is critical to understand why this phenomenon occurs.

Objective 2: Understand and quantify how the tillage treatments have impacted physical properties at the soil surface, leading to crusting, water run-off and erosion.

Objective 3: Eradicate weed pressure which threatens the longevity of the site. Yields have been declining over the past five years due to an ever-growing weed bank that has not responded to the usual herbicide applications of glyphosate.

Results

Objectives 1 & 2

Water storage in the top 35 cm of soil was calculated using measurement from in situ water content sensors for three tillage treatments, representing high (moldboard-disc), medium (chisel), and low (no-till) tillage intensity. Over the course of the growing season, total water storage was consistently greater in the no-till plots than moldboard-disc plots. Over the 123 days measured while the corn was growing, the no-till plots had significantly greater soil water storage 67% of the time.

However, there appears to be a middle ground with tillage and soil crusting. In 2021, the chisel plots were comparable to the no-till plots through the growing season. The chisel plots have an estimated 45% residue retained on the surface. The combination of partially undisturbed soil and residue prevents the surface sealing observed in the moldboard plots and subsequent loss of rainfall through surface run-off.

Previous studies examining soil health using the Cornell CASH Soil Health Test conducted at this site showed no significant difference in overall soil health scores between tillage treatments. This was surprising as there had been consistent and significant differences in corn yields between tillage treatments. Historically the lower the disturbance (ie.no-till) the greater the yield, with the average 42% lower yield in moldboard plots compared to no-till plots, with the chisel plots being only 12% lower.

The corn grain yields of all the plots showed typical trends of the last several years where the poorest performing plots tended to be the moldboard plots (87 bu/a) and highest were the lower disturbance no-till and chisel plots at 153 and 140 bu/a, respectively.

Objective 3:

The weed seed bank study confirmed what was observed in the 2020 soybean year. The no-till plots, due to lack of seed inversion and healthier soils more capable of supporting life had, over time, developed a greater seed bank than the other plots. When broken down between broadleaf weeds and grasses there was no significant difference in broadleaf weeds but in the no-till plots there was significantly more grasses. A 2.7-fold increase compared to the moldboard plow.

Impact Statement

The long-term Reidsville site continues to provide both relevant research and Extension outcomes useful for farmers in the Piedmont region of NC and beyond. The researchers are continually refining their understanding of yield controlling soil health properties, with the goal to provide regionally relevant soil health metrics that better suit the soils and climates of this region. This funding provided a key insight on how tillage practices have direct impacts on yield outcomes due to changes in available water. Low disturbance management that leaves the maximum amount of crop residue on the surface prevents surface soil degradation and crusting.

Management of Plant Parasitic Nematodes in North Carolina Corn Production

NCARS/NCCES Code:21-16
Report Period 2/1/2021-1/31/22
Annual

Project leader: Adrienne Gorny

Background and Objectives:

Plant-parasitic nematodes pose a significant limitation to corn production in North Carolina and the southeastern United States. Several genera of plant-parasitic nematode are yield limiting pathogens of corn, including Southern root-knot, stubby-root, stunt, sting, and lesion nematodes. No host resistance is known to these nematodes, which means corn hybrids commonly grown are susceptible to infection by these nematodes. Thus, management options are limited to crop rotation, cultural practices, and chemical control options.

In the Coastal Plain region of North Carolina, growers have noted in recent years an increase in nematode pressure and yield loss attributed to plant-parasitic nematodes. The purpose of this project is to evaluate chemical control tactics for plant-parasitic nematodes common in the Coastal Plain region of North Carolina, while also taking into account the common soil types, popular hybrids, and other production practices in the area. The findings will be used to enhance current nematode management recommendations, with the goal of supporting profitable corn production in North Carolina. Further, there is currently a lack of Extension resources available for nematodes in corn.

Results

Nematode chemical control options were tested in a field trial. A field site with naturally high populations of sting nematode was identified at the Central Crops Research Station near Clayton, NC. Nematicides tested included Counter 20G at 5.0 lb/ac, Velum Prime at 3.0 fl oz/a, Propulse at 8.0 fl oz/a, and Aveo EZ seed treatment. Non-treated plots were included as control.

Nematicide treatment had a significant effect at the alpha=0.1 level on total yield per plot.

Conclusions/Findings/End Products and/or Producer Impacts:

- These results illustrate the high impact that sting nematodes can have on corn production in North Carolina. All treatment and non-treated plots were heavily impacted by nematode feeding, as evident by suboptimal yields, poor plant growth, and damaged roots.
- The use of the granular nematicide product Counter 20G provided a statistically significant increase in yield over the non-treated control, at the alpha =0.1 level. Yet, even this treatment resulted in suboptimal yields from a production perspective.

Use of a nematicide may therefore be beneficial to protecting corn in fields with known history of sting nematode infestation.

Yield and Cost Comparison of Non-Bt and Bt Hybrids

NCARS/NCCES Code:21-17
Report Period 2/1/2021-1/31/22
Final

Project Leaders: Dominic Reisig, Zach Brown, Nick Piggott, Rod Rejesus

Report: Paired Bt and non-Bt hybrids were planted at 21 locations across North Carolina in 2021. The researchers approached the major trait providers for these pairs and were given P1197R (non-Bt), P1197YHR (Optimum Intersect), DKC65-93 (non-Bt), and DKC65-99 (Trecepta).

Yields, averaged across locations were as follows:

P1197R (non-Bt) = 175 bu/a
P1197YHR (Optimum Intersect) = 179 bu/a
DKC65-93 (non-Bt) = 183 bu/a
DKC65-99 (Trecepta) = 189 bu/a

Impact Statement

There are virtually no datasets demonstrating the economic consequences of non-refuge compliance to farmers in terms of yield potential, pest injury, and risk of resistance evolution. The main goal of our project is demonstrating that the economic value of non-Bt can make refuges a more viable practice with growers by strategically partnering directly with these growers and the agents that serve them. This project will directly benefit North Carolina corn and cotton growers, since increasing refuge will delay the time that Bt resistance evolves.

Environmental Factors Influencing Aflatoxin and Fumonisin Contamination in Corn

NCARS/NCCES Code:21-18
Report Period 2/1/2021-1/31/22
Annual

Project Leaders: Carlos Iglesias and James Holland

Report: The researchers prepared, boxed and labeled sample bags for more than 40 cooperating researchers and farmers. Four ears of each of four hybrids were received, grown in two separate replications within each of 20 environments from the multi-state Genomes to Fields project. Four ears were also received from each of two Bt and two non-Bt commercial hybrids grown in farmers' fields within North Carolina as part of the Corn Grower Association-funded project 21-17 "Yield and Cost Comparison on Non-Bt and Bt Hybrids". Each ear has been visually rated for symptoms of Fusarium and Aspergillus ear rot. The grain is being shelled and ground from those ears and fumonisin and aflatoxin tests were to be performed over the winter.

Impact Statement

The most desirable control strategy for Fusarium ear rot and fumonisin contamination and aflatoxin contamination is the use of resistant corn genotypes, but most commercial hybrids lack adequate resistance. This places NC corn producers at risk of mycotoxin contamination in their grain, which can lead to rejection of corn by buyers and animal health risks if grain is used as feed on-farm. In parallel with this work on improving genetic resistance to Fusarium ear rot and fumonisin contamination, the hope is to improve understanding of the weather and other environmental factors that contribute to mycotoxin contamination in corn grain.

Farmers may be able to use this information to better manage mycotoxin contamination risks by optimizing fertilizer and irrigation applications, and harvest timing.

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