NC SOYBEAN PRODUCERS ASSOCIATION

2020 RESEARCH REPORT

PROTECTING YIELD & PROFITS | VARIETY DEVELOPMENT & TESTING

PEST MANAGEMENT | NUTRIENT MANAGEMENT

President's Letter

As we set about compiling our annual research findings, the world, confronted by the challenges of the novel coronavirus, feels like a very different place. Across the country, schools are closed, business is being conducted by "zoom", unemployment is up and life for millions has been put on hold. In the face of disruption, certain sectors have been singled out as being essential to the underpinning of modern society. This includes industries like Healthcare, Defense, Emergency Services, Utilities, and the one most important to farmers - *Food and Agriculture*.

To be sure, agriculture has not been immune to the challenges presented by coronavirus. Consumption patterns have been severely disrupted, with billions of dollars of dairy and produce going to waste, as has the availability of agricultural labor. That said, times of crisis have a way of focusing the mind on what is important. With access to safe and affordable food falling squarely in that category there seems to be a renewed appreciation in the wake of coronavirus for modern agricultural supply chains which are unparalleled in their ability to deliver food to consumers efficiently and safely.

As farmers, we have always embraced science as a means of making our operations more productive - the research findings presented in the following pages speak to that commitment. But, there has been a troubling trend in recent years whereby consumers express skepticism of the scientific consensus when it comes to subjects like GMOs and crop protection in favor of the opinion of "influencers". If there is any silver lining for the agricultural community that comes from coronavirus, it may be that consumers once again place their trust in credentialed scientists who have long been our partners in making the US food supply the safest and most abundant in the world.

Going into the 2020 research season, the coronavirus imposes a few logistical hurdles, some resolved and others pending. Because of a shutdown of most University operations, there was initially a concern that field trials conducted through NCSU would go unplanted. Fortunately, through the work of the Association and our partners at NCFB and other commodity organizations, we are confident the majority of our research portfolio will proceed uninterrupted. And, as we go into the summer meeting season the Association and the University will be exploring new platforms to deliver research findings to you as we navigate this new "virtual world".

As we reflect on the unique role of science in overcoming agricultural *or* epidemiological challenges I would be remiss to not acknowledge the retirement of a valued asset in the N.C. soybean industry. Dr. Tommy Carter, who has been with USDA-ARS since 1981, most recently as head of the Nitrogen Fixation Unit will be retiring this summer. Dr. Carter's contribution to improved drought tolerance of soybeans in the Southeast has been invaluable. We wish him well in retirement and welcome his successor, Dr. Ben Fallen, to the role.

Wishing you and your family best of health this growing season.

Jeff Tyson
President

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Maximizing Soybean Yield through Maturity Group, Population, and Planting Date Selection

Rachel Vann, NCSU

Soybean growers across N.C. plant soybeans in a wide window (March – August) and across a wide range of maturity groups (II – VIII). Being strategic about planting date and maturity group selection can help growers maximize yields. While weather plays a large role in which maturity group by planting date combination will maximize yield, the more that is understood about the relationship among these parameters, the greater the likelihood of increasing yields. In an effort to help growers maximize yields the NCSPA is funding a trial to evaluate optimum maturity group and seeding rates across planting dates with the N.C. State Soybean Extension program.

In 2019, trials were established at five locations across the state with planting dates ranging from mid-March through late-July. A variety from maturity groups II – VIII were planted at each planting date. Within each maturity group and planting date combination, five seeding rates were compared ranging from 75,000 to 175,000 seeds/ac.

Below are observations from the first year of research combined across locations:

Graduate student Tristan Morris discusses results from this research at the 2019 NE Ag Expo in Currituck County, N.C.

EARLY PLANTING

(mid-March through late-April)

At the earliest planting dates (mid-March), soybeans took 19-26 days to emerge but eventually did so with respectable stand. **Preliminary yield results indicate that in early planting situations, soybean yield was optimized using later maturing varieties (≥MGV).** Declines in seed quality (damage and purple seed stain) were observed with MGII and III soybeans planted before May.

FULL SEASON

(late-April through late-May)

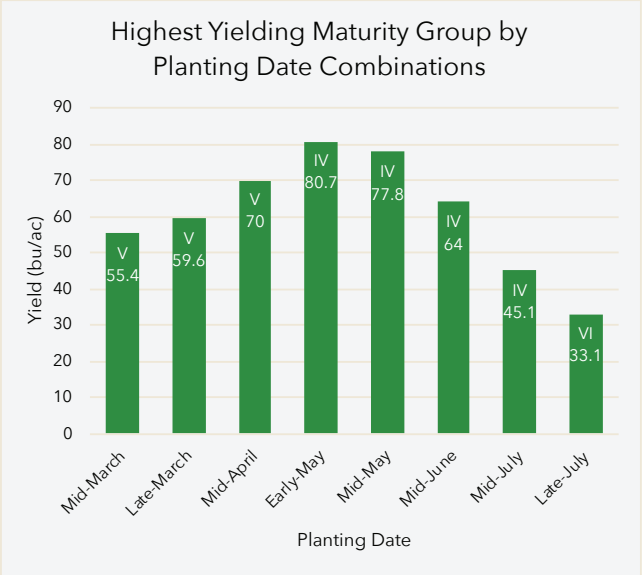
In full-season planting situations, soybean yield was optimized using a MGIV and V variety. A trend identified in some of the highest yielding scenarios was that these soybeans were often flowering by the middle of June, when they should be able to capitalize on maximum photosynthesis.

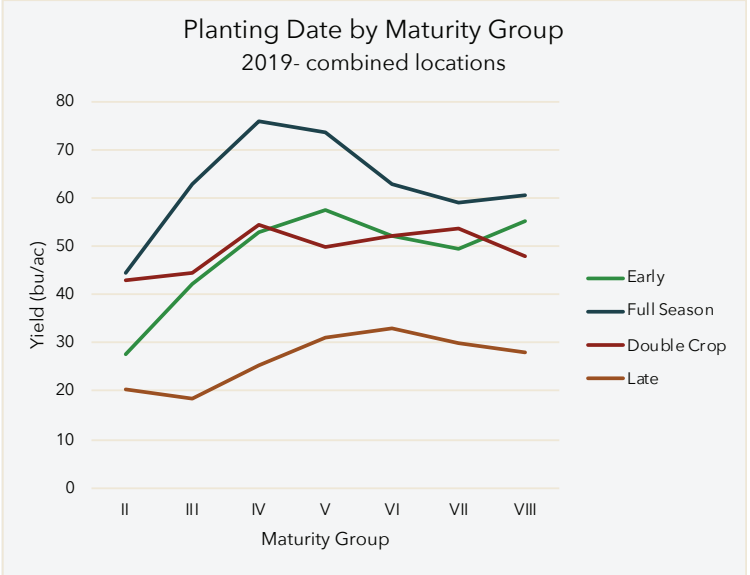
LATE PLANTING

(mid-June through late-July)

In double crop planting situations (June), soybean yield was optimized using a MGIV variety. In late planting situations (July), as long as the earliest maturing varieties were avoided (MGII and III) soybean yield was similar across maturity groups.

The widespread drought across N.C. from late August through early October had an inevitable impact on 2019 yield results. These results only capture one year of data and thus one year of weather patterns. Caution should be exercised when making any decisions based on this first year of data collection. This work will be repeated in 2020 to further validate these observations.





Managing Early Maturing Soybeans in N.C.

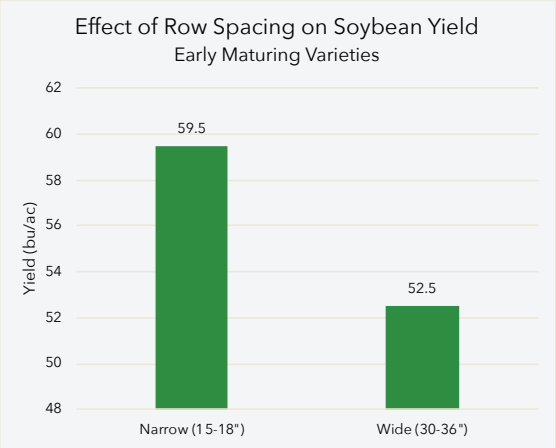
Rachel Vann and County Extension Agents, NCSU

Growers across N.C. are increasingly interested in producing earlier-maturing soybean varieties (groups III and IV). These soybean maturity groups typically have an indeterminate growth habit, which allows simultaneous vegetative and reproductive growth over several weeks. This is different than the determinate growth habit of most soybeans produced in N.C. Some growers are successfully producing early-maturing soybeans, but limited research has been conducted on the best management practices for these varieties. So, in collaboration with county Extension agents and the N.C. State Soybean Extension program, the NCSPA funded a project to investigate agronomic best practices for managing indeterminate varieties. The trials evaluated row spacing, seeding rate, and fertility for both a group III and IV variety.

Compiling data from 2018 and 2019 revealed some trends discussed below.

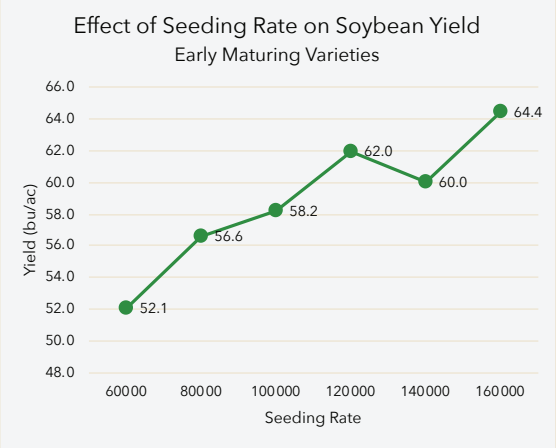
ROW SPACING

Similar to what is known from years of research with determinate varieties, narrow rows (15 or 18 in) out-yielded wide rows (30 or 36 in) by about 7 bu/ac. The yield advantage in narrow rows seems to be more pronounced in higher yielding environments.



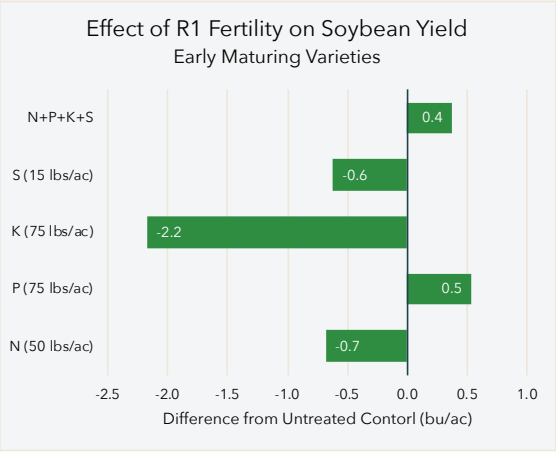
SEEDING RATE

Seeding rates from 60,000 to 160,000 seed/ac were evaluated. Yield declined as seeding rate decreased at the lower seeding rates and stabilized at rates of 120,000 seed/ac or greater. **This suggests earlier maturity groups may benefit from slightly higher populations than what is recommended with later maturity groups.** The yield potential of the environment likely plays an important role in the impact of seeding rate and it seems higher yielding environments benefit more from higher seeding rates.



R1 FERTILITY

As growers push for higher yields, adequate fertility becomes a question. Soybean nutrient requirement explodes at R1 (beginning flowering) for several nutrients, therefore soil-applied fertility applications at R1 were evaluated. **Across research locations and varieties, R1 fertility treatment did not affect soybean yield when compared to the untreated control.** This is consistent with what has been observed in other trials in N.C. and across the U.S. over the last few years.



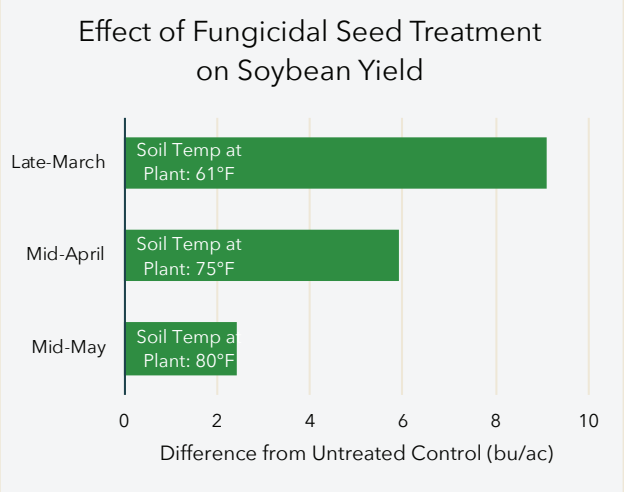
While there are advantages to planting earlier maturating soybeans, one challenge with these varieties in N.C. is the requirement of timely harvest to prevent seed quality declines. These varieties are coming into physiological maturity when it is hot, humid, and wet, which can intensify issues such as phomopsis and purple seed stain. It is important to keep in mind other events happening on the farm at the time early-maturing soybeans would need to be harvested before deciding to try these varieties.

Does Early Planting Justify a Fungicidal Seed Treatment?

Rachel Vann, Bill Foote, Lindsey Thiessen, NCSU

The Soybean Extension Program has conducted research over the past few years to evaluate the effect of various seed treatments on soybean yield. In these trials, it was found that there was no impact of fungicidal seed treatments on soybean yield, but these trials were generally planted from mid-May through early July with a maturity group V or VI soybean variety and only a few fungicidal seed treatments were evaluated. To more robustly evaluate fungicidal seed treatments across earlier planting dates, the NCSPA funded additional work with N.C. State Extension.

The five fungicidal seed treatments were compared to an untreated control within three maturity groups (III, IV, and V) across three planting dates (late-March, mid-April, mid-May) over the course of 2019 at three locations. Plant stand and yield were both measured.



Among the 2019 planted trials, the use of a fungicidal seed treatment protected stand at two of the three locations across planting dates and maturity groups. Yield was only measured in two locations, but at both locations the use of a fungicidal seed treatment protected yield (+5.9-6.9 bu/ac) across planting date and maturity groups. No statistical differences were observed among the five fungicidal seed treatment products tested, indicating any fungicide seed treatment would provide similar results. Combining across maturity groups, locations, and products, data from 2019 indicates that a **fungicidal seed treatment is beneficial for earlier planting dates.**

These results only include one year of data so this work will be continued in 2020 to further validate these conclusions.

Graduate student MaKayla Gross planting into a cereal rye/crimson clover blend.

Winter Crop Effect on Soybean Production in N.C.

Rachel Vann, NCSU

The wheat/double crop soybean system has been investigated thoroughly in the Southeast region for many years, however less emphasis has been placed on investigating other winter crop scenarios, such as emerging specialty winter grain crops. As cover crop adoption is increasing rapidly in N.C., growers want to understand their impact on soybean production. To help answer these questions the NCSPA funded a winter cover crop project with N.C. State Extension.

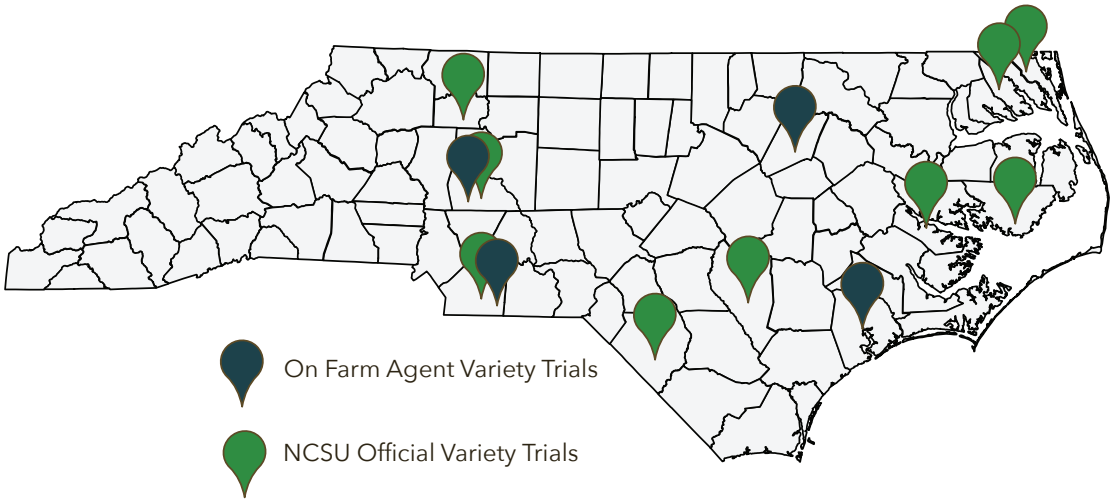
In 2019, the trial was installed at two research locations, Rocky Mount and Salisbury, to investigate the impact of various winter crop scenarios and soybean maturity groups on soybean yield. Three soybean maturity groups (III, V, VII) were evaluated across six winter crop scenarios including: May fallow planting, planting behind a cereal rye cover crop, planting behind a cereal rye/crimson clover cover crop, June fallow planting, planting behind a wheat grain crop, and planting behind a rapeseed grain crop. Preliminary results indicate that winter crop biomass production can have an impact on soybean stand and soil moisture conservation, however this does not necessarily translate into an impact on soybean yield. This work will be continued in 2020 so more definitive conclusions can be drawn.

On Farm Variety Strip Trials

Rachel Vann, Ryan Heiniger, Andrew Baucom, and Extension, NCSU

A wide range of maturity groups (II-VIII) are successfully grown across N.C. This, coupled with rapid turnover of soybean varieties due to ever changing trait packages, makes soybean variety selection in N.C. a challenge. To help N.C. soybean growers become more familiar with variety options and to provide consistent, local soybean variety testing information, the NCSPA funded work with N.C. State OVT and Extension in 2019 to build a network for an on-farm variety testing program.

In 2019, usable data was generated at four replicated soybean variety testing sites and this data was distributed to growers locally through the county agent. The on-farm variety strip trials will continue in 2020 and the hope is to expand the footprint to improve the impact of the program.



Investigating a Potential Link between Drought Tolerance, Yield, and Seed Composition

Anna Locke, USDA-ARS

Summer drought and heat are limitations to soybean yield in N.C. and there is an expectation that future summer heat waves and drought cycles could be even more extreme than they currently are. One of the first processes limited by drying soils is biological nitrogen fixation, which is critical for supplying nitrogen to the developing seed for protein production. Weather stress can have an adverse impact on seed composition, but the response varies among soybean genotypes.

While biological nitrogen fixation is important for protecting yield, it also plays a role in soybean seed composition. Understanding factors that impact seed composition is critical for the soybean industry. The top consumer of soybeans is animal agriculture, and meal accounts for the majority of value in the seed. As such, the price of soybeans is impacted significantly by the downstream value of soybean meal to livestock feeders. Soybean meal boasts an outstanding package of protein, amino acids, and energy, but competition from synthetic amino acids and other protein sources is a real threat. To ensure profitability, growers need to be able to depend on high-quality seed composition, regardless of the weather during the growing season.

To better understand the interaction of water availability, nitrogen fixation and how it relates to yield and seed composition, the NCSPA funded research with the USDA-ARS Soybean Physiology group. Varieties were evaluated at the Sandhills Research Station where the sandy soils allow for drought conditions to develop in the absence of irrigation. **Results from three field seasons indicate there is genetic variation in soybean seed composition stability following mild to moderate environmental stress.** Future efforts will focus on identifying which genotypes and genes can maintain seed protein concentration during drought stress to work towards the ultimate goal of developing soybean varieties with a denser nutrient package.

Plots beginning to show flood damage at the end of a seven day flooding cycle in the summer of 2019 at the Tidewater station.

Flood Tolerant Varieties for N.C.

Tommy Carter, USDA-ARS

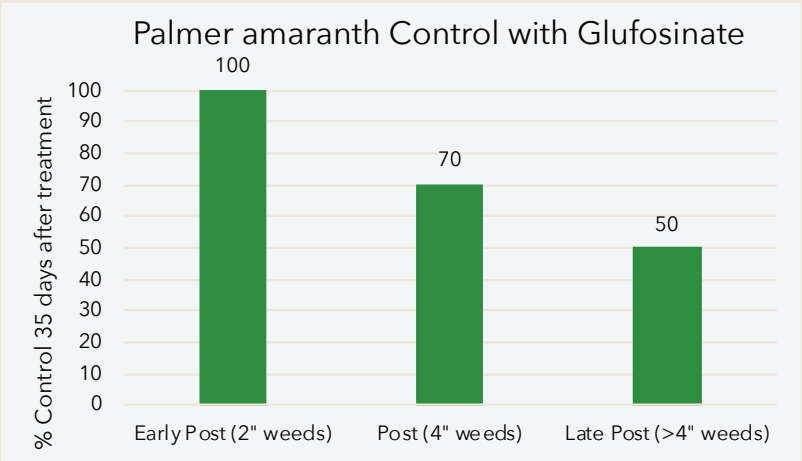
Soybean varieties in N.C. do not tolerate wet feet- or more precisely wet roots- very well. When farmers experience excessively wet springs and summers, especially in the eastern and northeastern part of the state, chronic wet roots cause slow grow-off as well as lead to poor leaf color, and spindly plants. Getting yields greater than 45 bu/ac under those conditions is a challenge, even when all other production aspects are perfect.

New discoveries in Arkansas and Missouri, where flooding and wet feet are even more common than in N.C., suggest that this problem can be overcome. Data demonstrates that some soybean varieties can handle extra water much better than others in the field. New Mid-South varieties appear to be even better than the existing stocks. The big question for N.C. farmers is, "will this new Mid-South technology really show a payoff in our N.C fields?" Given that the past three seasons have been very wet in N.C., the NCSPA is funding research with the USDA-ARS and N.C. State University to explore the potential of this new flood tolerance technology.

The outdoor laboratory for flood tolerance research in N.C. is the Tidewater Research Station. **Results thus far have revealed the surprising result that several breeding lines developed by the USDA Soybean Breeding program on the N.C. State campus have good levels of flood tolerance.** These newly identified materials are on par and perhaps better than flood tolerant material from the Delta. As a result of this work, the release of two flood tolerant cultivars is anticipated in the next 18 months.

Rapid Monitoring & Testing for Early Glufosinate Resistant Palmer

Wes Everman, NCSU



Palmer amaranth is the most troublesome weed in N.C. soybean production due to its ability to produce dense and competitive populations, and its resistance to important herbicides, including glyphosate and ALS-inhibitors. Currently, one of the few options for controlling glyphosate-resistant Palmer amaranth is glufosinate (Liberty).

In order to prevent the establishment of glufosinate resistant Palmer amaranth, it is critical to have a monitoring system for early detection so eradication can be implemented before the glufosinate resistant trait is dispersed. Hence, the NCSPA funded work with the N.C. State Weed Science program to help researchers better understand where glufosinate resistance is likely to occur and to develop a rapid detection system.

Results from grower surveys, field trials, and greenhouse evaluations indicate **glufosinate provides the greatest efficacy of control when applied to Palmer amaranth plants less than four inches in height** (early-post). If glufosinate is applied at a taller Palmer amaranth height, control is less effective and some escape plants will produce seeds, resulting in more weeds to control the following season.

Work will continue on this project in 2020 with the ultimate goal of providing growers more insight to the risks of not applying glufosinate in a timely manner as well as the risks of solely relying on this important herbicide. While the evolution of resistance to glufosinate is likely inevitable in Palmer amaranth populations, this research will provide N.C. growers with the necessary tools to extend the efficacy of the herbicide.

Building a Better Pheromone Trap

Anders Huseth, NCSU

Data-driven solutions to predict pest population outbreaks are an increasingly important component of contemporary Integrated Pest Management (IPM). A prime opportunity to implement an automated solution exists with corn earworm in N.C. Corn earworm has been the target of black light and pheromone trapping networks across the eastern U.S. for decades. Information generated by these networks has been communicated to growers through traditional extension meetings and digital platforms, but the lag between observation and data availability prohibits accurate deployment of scouting and remedial measures. To begin to address these lag issues, the NCSPA funded a project to develop an innovative sensor design targeting corn earworm.

A prototype at Central Crops Research Station. The trap recorded number of moths, time moth entered the trap, temperature, and humidity.

Researchers retrofitted insect pheromone traps to log moth catches and environmental conditions in real-time. Pheromone traps are made of two metal mesh units: a cone and a cylinder trap: the moths travel up the cone until they pass through the narrow tip, at which point they become caught in the cylindrical trap. The prototype uses an InfraRed (IR) sensor system at the cone tip to count moths as they enter the trap. Through multiple iterations of lab and semi-field testing, the first automated prototype was deployed it at the Central Crops Research Station in Clayton, N.C. The trap automatically counted moths and was 96% accurate. After improvements, 25 automated insect traps were built in the winter of 2019-2020. These traps will be deployed throughout eastern N.C. in 2020 to monitor corn earworm populations in space and time. **Access to real-time corn earworm data will improve the management of this pest with the goal of reducing pesticide use in multiple crops.**

Corn Earworm Thresholds for Determinate & Indeterminate Soybeans

Dominic Reisig, NCSU

As more growers shift to production systems with earlier maturing soybeans, the NCSPA has recognized the need for tailored management recommendations for these varieties. One of the areas where management practices may be different between determinate and indeterminate soybeans is insect control. Corn earworm is almost always the most economically damaging insect for soybeans in N.C. The thresholds developed for managing this pest were developed with determinate soybean varieties in our state, and previous work across the U.S. indicates that corn earworm management thresholds may vary between determinate and indeterminate varieties. To investigate this, the NCSPA funded research with the N.C. State Entomology Program.

Trials were planted at five locations in 2019 and researchers observed a range of corn earworm pressure across locations. While results from 2019 were inconclusive, this work will be continued through 2021 to determine if corn earworm thresholds should be different for indeterminate soybean varieties.

As a reminder: current recommendations for treating corn earworm include:

Prior to bloom: *Threshold is 30% defoliation prior to blooms.*

Once Blooming: *Only treat earworm in blooming soybeans if they are present at the podding threshold levels and if the plants are stressed.*

Podding: *Corn earworm management is critical once there are pods on the plant. The threshold calculator can be found in the NC Soybeans App or on the N.C State Soybean Extension Portal.*

**Current recommendations encourage growers to avoid chlorantranilprole products (Besiege and Prevathon) in soybeans to preserve it in cotton and to prevent increasing resistance to these products in looper populations. Instead growers should use Blackhawk, Intrepid Edge, or Steward to control corn earworms in Soybeans.*

Application of poultry litter treatments at the Vernon James Center in Plymouth, NC.

Effect of Poultry Litter on Soybean Yield & Quality

Stephanie Kulesza, NCSU

Over the past few decades, the poultry industry has grown dramatically in N.C., which has increased the supply of poultry litter for farmers to utilize as a fertilizer source. While poultry litter has traditionally been applied to corn and/or wheat within a rotation that includes soybean, some producers are applying litter specifically for soybean production.

Unfortunately, there is little information available regarding the optimal rate of poultry litter applied directly before soybean. Because of this knowledge gap, the NCSPA funded a study which aims to determine the optimum application rate for poultry litter prior to soybean to help farmers maximize yield while minimizing the potential for nutrient accumulation and/or nutrient loss to the environment.

In the 2019 growing season, various rates of inorganic nitrogen fertilizer and poultry litter were applied to soybean research plots on three research stations across the state, with poultry litter application occurring four weeks prior to planting and inorganic fertilizer application the day of planting. Initial data indicate that nodule formation decreased with increasing inorganic nitrogen application. Researchers also saw a slower release of nitrogen from the poultry litter than anticipated. While nitrogen application rate did affect biomass nitrogen concentrations, yield was not significantly affected by any of the inorganic fertilizer or poultry litter applications. This project will continue in the 2020 growing season to further investigate the impact of poultry litter application on soybean production.

Mycorrhizal Fungi to Improve Potassium Acquisition

Kevin Garcia, NCSU

Potassium is an essential macronutrient for plants, and its availability strongly affects biomass production, tolerance to stress, and yield. Since only a small fraction of the soil potassium content is plant available, plants must develop efficient strategies for the uptake of potassium from the soil. The most important strategy used by plants to acquire nutrients is the arbuscular mycorrhizal (AM) symbiosis, a mutualistic association between most plants and soil fungi. To help better understand this relationship and improve fertilizer use efficiency the NCSPA funded work to investigate the impact of AM fungi on K acquisition in soybeans.

In 2019 the commercial AM seed treatment, MycoApply EndoPrime was evaluated on three different soybean varieties in the lab, greenhouse, and field. This work will continue through 2021 and ultimately results will help N.C. growers select varieties that are able to interact efficiently with their surrounding microbes, resulting in a more efficient use of commercial fungal biofertilizers in the field.

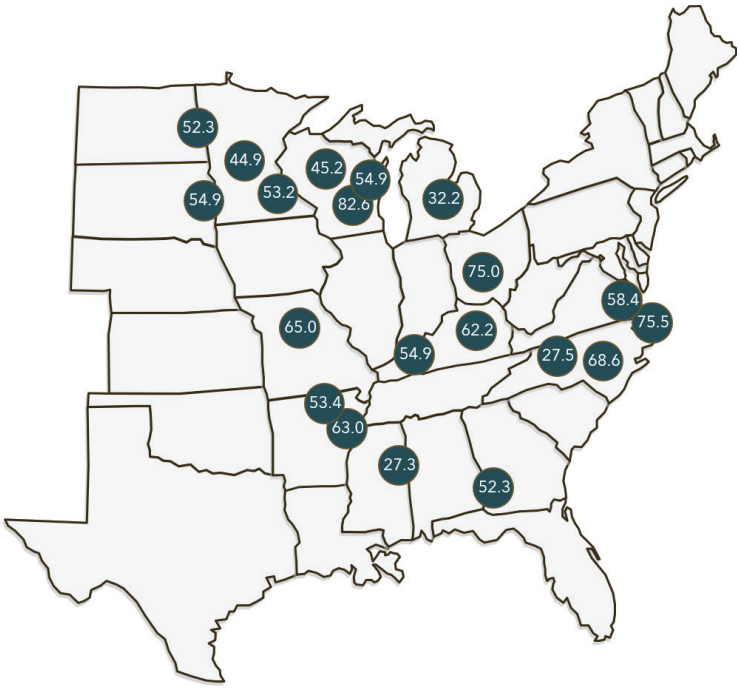
Soybean plants inoculated with AM fugni are grown in clear containers to evaluate root colonization.

Determining Yield Impact from Foliar Feeding

Rachel Vann, NCSU

Many soybean growers are interested in the use of foliar fertilizers, and multitudes of products are marketed to growers. Growers often use these products while applying fungicides and/or insecticides during early soybean reproductive development. However, with low profit margins, the effect of foliar fertilizers on soybean yield and economic return is important to understand. To understand the environmental and soil factors where yield response to foliar fertilizers is most likely to occur, the NCSPA funded the N.C. component of a national trial to evaluate commonly marketed foliar fertilizer products.

In 2019, 12 states evaluated various foliar fertilizer products applied at soybean growth stage R3 in 20 environments. There were three N.C. locations. In 2019, the data indicate there was **no impact on soybean yield from the application of any foliar fertilizer product at R3** in the N.C. environments. This was consistent with results from >95% of the 20 U.S. research locations. These initial results indicate that with the current narrow profit margins for soybeans, growers can invest in something more impactful to yield than a foliar fertilizer application at R3, but this work will be carried out again in 2020 to confirm these conclusions.



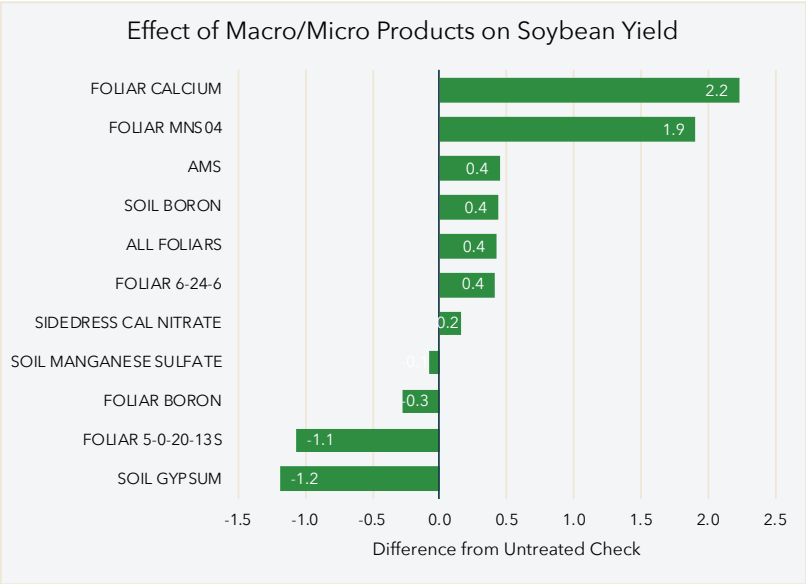
Location of the 2019 sites with their average yield (bu/ac).

Evaluation of Macro/Micro-Nutrient Fertilizer Products

Tidewater Agronomics, Fowler Crop Consulting, McLawhorn Crop Services, Protech Advisory Services, Impact Agronomics

As a complement to the Foliar Feeding trial described above, the NCSPA also sponsored research with a group of crop consultants across the state to study the agronomic and economic aspects of supplemental applications of macro/micro-nutrient fertilizer products as either preplant incorporated or foliar products.

Fertilizer products were selected based on common use and availability with attention to covering a broad spectrum of macro and micro-nutrients. Three dry fertilizer products: gypsum, boron, and manganese sulfate were evaluated as pre / at-plant fertilizers. Five liquid foliar fertilizers: boron, calcium, manganese sulfate, 5-0-20-13s, and 6-24-6, were evaluated when applied at the R1-2 growth stage. And ammonium sulfate and calcium nitrate were applied at R1-2 as broadcast and side-dress applications, respectively. An untreated check was included for comparison purposes.



When analyzing yield data from each location separately, or combined across all five locations, **no treatments were statistically better than the control** although a few were numerically better. In addition to yield, product cost is also important in deciding what products and practices to add into a management plan. When factoring in product and application cost (assuming $9/bu soybeans) Foliar $MnSO_4$ (+$14.54), and Foliar Calcium (+$12.58) are the only two products that had a positive return on investment.

These results were consistent with the above study and demonstrate that often most macro/micro-nutrient compounds don't net a positive return on investment. However, both these trials represent only one year of data so more work will be conducted to validate these results.

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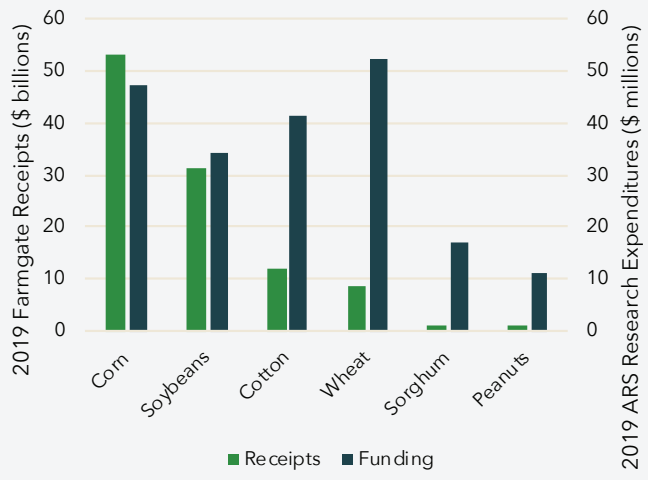
Changing of the guard at USDA's Nitrogen Research Unit

One of the hallmarks of N.C. agriculture has always been a strong, local research presence. Across the country and around the world individuals involved in agricultural will recognize RTP as one of the leading locations for agricultural research. While private corporations certainly raise our profile, those of us from N.C. know that the foundation of our research ecosystem lies in the presence of strong public institutions, namely N.C. State University and the USDA, and a robust farm economy that allows research to be scaled up in a commercial setting.

Comparison of National USDA-ARS Funding and Farm-gate Receipts By Commodity



This summer, a valued member of N.C. soybean's research team will be retiring. Dr. Tommy Carter has been the head of USDA-ARS' Soybean and Nitrogen Fixation Unit since 2011 and the facility's leading research geneticist since 1981. Dr. Carter grew up in Georgia as the son of an extension agent and graduated with a PhD in Plant Breeding from N.C. State in 1980. Since joining USDA, Dr. Carter's work has become synonymous with efforts to increase genetic diversity and improve drought tolerance of commercial soybean varieties in the U.S. Replacing Dr. Carter is Dr. Ben Fallen, who grew up on a tobacco farm in Halifax, Virginia and comes to USDA from Clemson where he led the University's soybean breading and genetics program.

The NCSPA looks forward to working with Dr. Fallen in his new role and wishes Dr. Carter all the best in retirement!

Thanks to the work of the ARS researchers at the Nitrogen fixation unit, the facility has always allowed N.C. to punch above its weight in terms of our state's share of the USDA total funding of soybean research. In 2019, for example, the Unit brought in 6.5% of ARS soybean funding compared to N.C.'s 1.5% of US soybean receipts. Going forward, the NCSPA will be working with the American Soybean Association to increase the amount of ARS soybean funding nationally which has lagged that of cotton and wheat in recent years despite soybeans being a far larger crop.