2023 RESEARCH REPORT

SOYBEAN QUALITY – PEST MANAGEMENT – ENHANCING YIELD & PROFIT

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Gary's Insights

The information presented in this report is the result of the farmers' soybean checkoff at work. Your checkoff funded the research plots & experiments, the data analysis, and the resulting publications. Producing information for farmers from practical agricultural research is a fundamental objective for our checkoff and our association. This approach generates a return of $12.34 in value for every checkoff dollar invested by U.S. soybean farmers, according to the most recent analysis.

Just like when managing a farm, the board of directors of the soybean association makes decisions about what research projects to support based on experience, wisdom, and current & future opportunities to make a difference. The association follows a strategic plan that prioritizes continually improving soybean yield and quality. The board of directors analyzes the research rationally, logically, and systematically, always looking for the best value for the farmers' checkoff dollars.

I would like to recognize the association's Research Committee Chair, Forrest Howell, and the staff Research Coordinator, Jeff Chandler, for their leadership and creativity in leading our research effort, including our support for research at NC State University, our on-farm research trials, and our partnerships with N.C. Cooperative Extension agents.

Gary Hendrix President, NCSPA

FORREST HOWELL

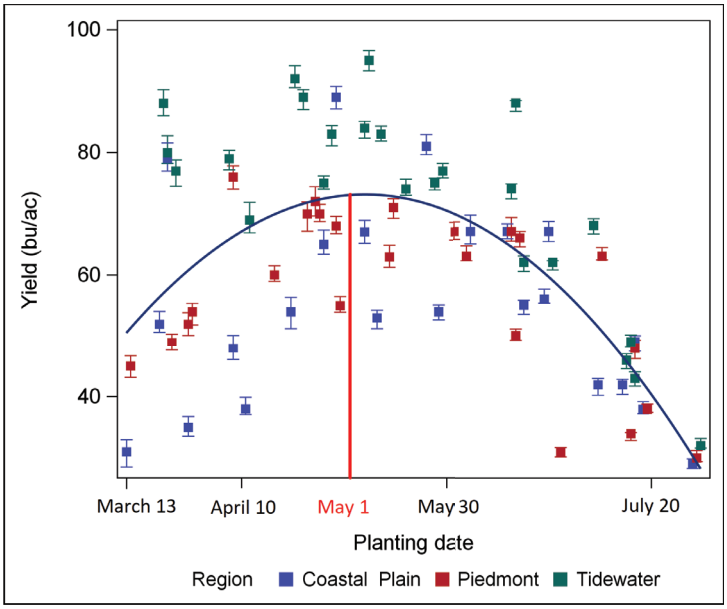
JEFF CHANDLER

Optimal Planting Date is Earlier than Previously Reported

THE OPTIMAL PLANTING PERIOD FOR SOYBEANS IN NORTH CAROLINA IS APRIL 20 THROUGH MAY 20, EARLIER THAN PREVIOUSLY REPORTED.

Recently collected information indicates that the optimal planting date for soybeans in North Carolina is earlier than previously reported. The new optimal planting period is April 20 through May 20, about 10 days earlier than the previous date of May 1, and a full 20 days earlier than the previous date of June 10. This finding is part of an ongoing NC State University project to develop a grower decision tool to assist producers in navigating decisions about planting date and variety selection based on their location in the state. NC State will make the new tool available to growers in 2024.

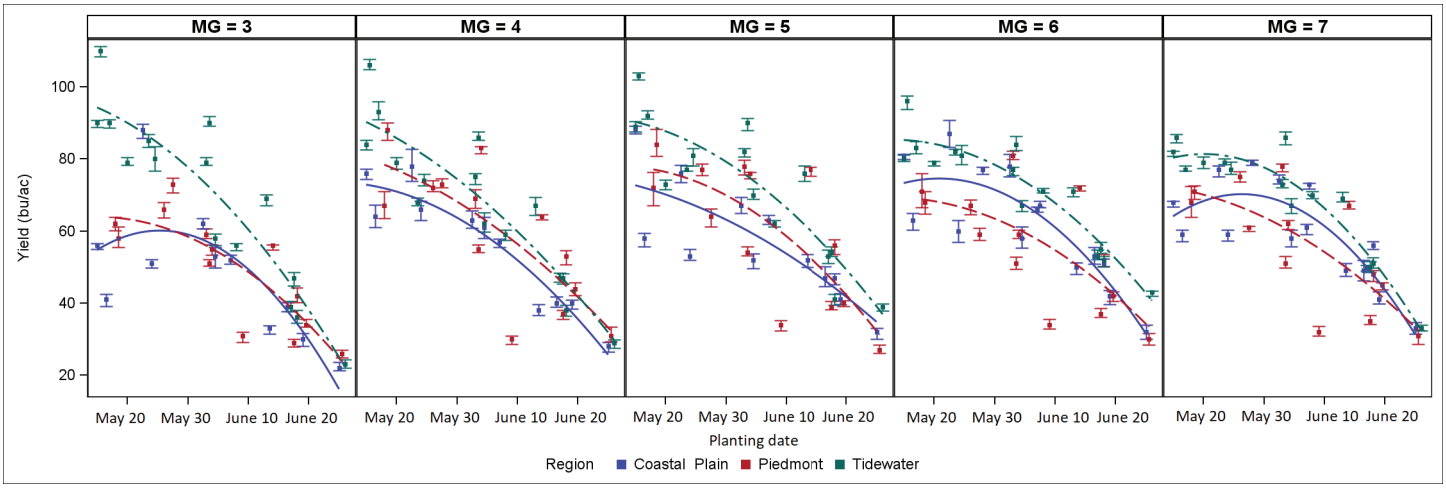
As soybean production practices shift in North Carolina, some core agronomic recommendations will need to change to accommodate the production practices shift. The goal of the decision tool project is to provide a data-driven tool that allows producers to manage these decisions and increase yield and protect seed quality. Starting in 2019 and continuing in 2023, researchers conducted small-plot research trials at 19 environments across North Carolina. The data collected from the trials, which includes information on planting date and soybean variety performance in different conditions, will power the grower decision tool.



Soybean yield response to planting date combined over maturity group and seeding rate at 15 North Carolina environments from 2019-2022. Each dot represents an individual environment by planting date combination.

As of 2023, the broad conclusions from the project are (1) the optimal planting period for soybeans in North Carolina is April 20-May 20 and the optimal planting window will vary slightly by region within the state, (2) the optimal maturity group for full-season planting in high yield environments will be maturity group 4 and 5 varieties, (3) maturity group 5 and 6 varieties will maximize yield in full-season, lower yielding environments. (4) When planting in mid-to-late June and into mid-July, growers will have the flexibility to use varieties ranging from maturity group 4 to 7. According to the data, the optimal seeding rate will vary depending on the planting date and maturity group of the selected variety. As a rule of thumb, the seeding rate generally needs to be increased as the planting date is delayed and when soybean maturity groups 5 or earlier are selected.

PROJECT LEADERS: Rachel Vann, D.J. Stokes, NC State University



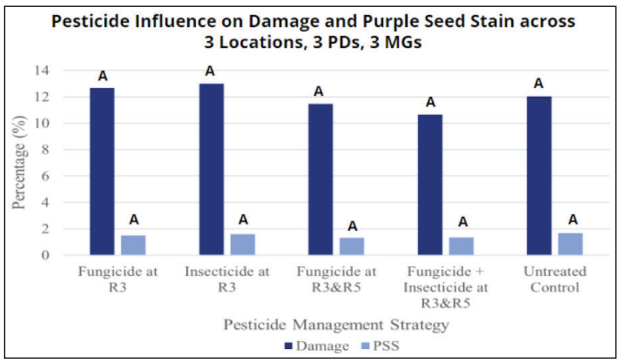
Managing Stinkbug Damage in Early Maturing Soybeans

FURTHER INVESTIGATION IS NEEDED INTO THE PROBLEM OF INSECT DAMAGE AND PURPLE SEED STAIN IN EARLY MATURING SOYBEANS.

Seed quality is a big concern with the earlier maturing soybean varieties. Limiting insect damage and purple seed stain has become one of the quality issues addressed by NC State University researchers. According to the findings of an experiment conducted at three different locations in the state, pesticide applications did not impact seed quality enough to be practical. This finding confirms that more research is needed to understand what causes soybean quality declines in early varieties, and what solutions can be developed to assist producers in mitigating the issue.

The NC State team conducted field research to investigate the impact of pesticide management on mitigating seed quality issues. At one of the sites, the research team discovered that when stinkbug pressure exceeded the threshold, using both a fungicide and insecticide at R3 and R5 reduced seed damage and purple seed stain. Although the late-season insecticide application reduced seed damage and purple seed stain, it was not an economically significant reduction. The current thinking is that environmental conditions remain the strongest factor behind seed quality declines in many environments. At this site, a fungicide application at R3 and R5 did not reduce seed damage, making the late-season insecticide necessary to reduce damage. However, the foliar fungicide did protect against foliar disease and increase soybean yield. The NC State team believes that further investigation is merited to determine if late-season insecticide applications targeted at stink bugs can meaningfully reduce seed damage.

PROJECT LEADERS: Rachel Vann, Dominic Reisig, Kelly O'Reilly, NC State University



When combined across all sites, maturity groups, and planting dates, there was no significant reduction in purple seed stain or damage.

Science for Success Initiative Delivers Best Practices to Growers

NC STATE UNIVERSITY LEADS THE SCIENCE FOR SUCCESS INITIATIVE THAT ENCOMPASSES EXTENSION RESEARCHERS FROM MORE THAN 20 U.S. STATES. FINDINGS ARE COLLECTED ON THE SOYBEAN RESEARCH AND INFORMATION NETWORK (WWW.SOYBEANRESEARCHINFO.COM).

Science for Success is a collaboration between soybean Extension specialists involving more than 20 states and covering 90% of all U.S. soybean acres. A team from NC State University leads the initiative through a multi-year grant of farmer checkoff dollars from the United Soybean Board (USB). The goal of Science for Success is to deliver Best Management Practices (BMPs) to soybean producers across the United States. The initiative supports annual research projects and protocols that are conducted on a variety of research topics. Each year, the initiative typically results in 30 or more research sites producing annual data sets for each research topic under investigation. A list of these topics and the resulting reports is available on the Soybean Research and Information Network website **(www.soybeanresearchinfo.com)**. Ultimately this project facilitates the development and delivery of data-driven soybean BMPs on a national scale to provide farmers with the tools and information they need to be profitable and efficient.

One of the topics examined by Science for Success is to evaluate situations where a biological seed treatment might improve soybean yield. Lately, producers have been bombarded with marketing claims about numerous biological seed treatments. In many cases, the retailers provide little or no third-party evidence regarding the ability of these biological seed treatments to improve soybean yield and profitability. An NC State University research team examined the role of biological seed treatment products that claim to aid in Biological Nitrogen Fixation (BNF). The researchers examined ten products & active ingredients for signs that the products improve yield. The two-year trial wraps up in 2023 and the results will be available after the research plots are harvested in Fall 2023.

PROJECT LEADER: Rachel Vann, NC State University

BNF trial in mid-August 2022 at an on-farm location in Beaufort County

Drone Imagery is a Decision-Support Tool for Growers

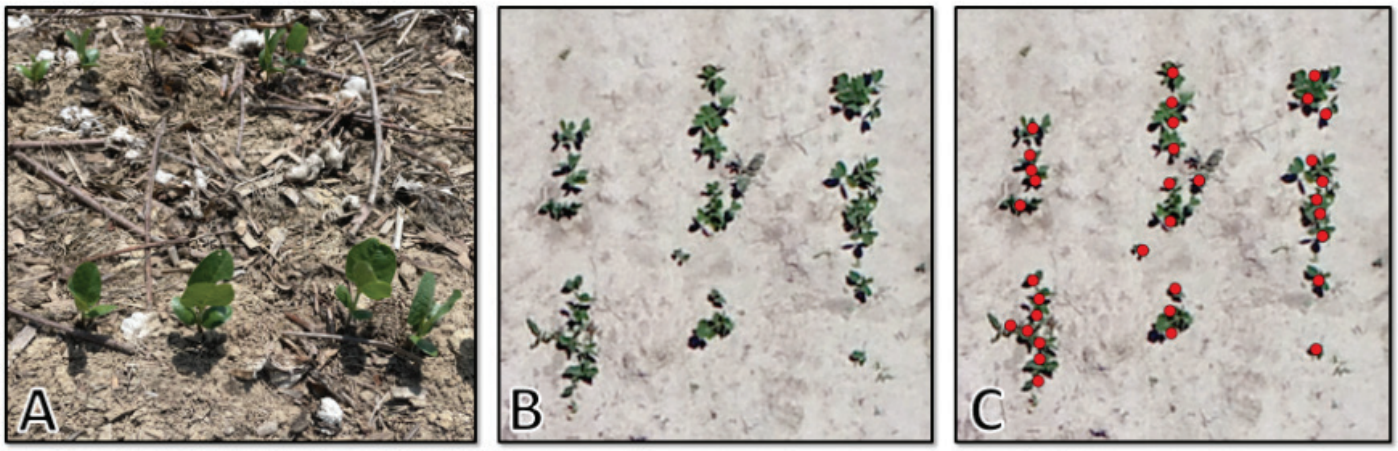
THE SOYBEAN CHECKOFF HAS FUNDED RESEARCH INTO THE MOST PROMISING AND PROFITABLE USES OF DRONE TECHNOLOGY. DRONES CAN AID IN MANAGING PLANT HEALTH AND PREDICTING STAND COUNTS AND GUIDING RE-PLANT DECISIONS MOST ACCURATELY WHEN AERIAL DATA IS COLLECTED BETWEEN 20-30 DAYS AFTER PLANTING.

To better understand the applications and the value of technologies for on-farm imagery, such as drones, the soy checkoff funded research aimed at identifying the most promising and profitable uses for these technologies. In 2022, NC State University researchers reported how drones can be used to determine the incidence of frogeye leaf spot in soybeans. In 2023, the same researchers focused their effort on testing the accuracy of drone-based stand counts for guiding re-plant decisions and predicting yield potential.

Two field trials were established including a plot-scale trial at the Upper Coastal Plain Research Station in Rocky Mount where some plants were manually removed to artificially create a poor stand, and a field-scale strip trial at Cherry Research Station outside Goldsboro where soybeans were planted in a field with a history of poor stands. In the plot-scale trial, emerging soybeans were manually removed in different patterns to mimic a poor stand that might result from mechanical planter issues or due to poor drainage or crusted soils. In the field-scale trial, soybeans were planted at three different seeding rates and in two different row spacings in 1000 ft strips. At both sites, drones collected images of plant emergence and growth weekly. The research team manually conducted its own plant counts on the ground for comparison. At the end of the season, the researchers harvested the trials, collected the yield data, and looked for relationships between plant counts and yields. The team used the opportunity to test two commercially available stand count prediction technologies, Solvi **(www.solvi.ag)** and Agremo **(www.agremo.com)**.

The data indicate that drone-based stand counts do have advantages over traditional methods used to estimate stand establishment. However, the team discovered that the results were influenced by the commercial stand count solution chosen, by the altitude and timing of the drone flight, and by the timing of data collection. Additionally, management factors including row spacing and weed management affected the accuracy of the plant count. The team concluded that drone-aided stand predictions should be done in a timely manner. Using a drone to aid in stand count predictions beyond 30 days after planting increases risk of significantly lower accuracy and ultimately, less economic benefit.

PROJECT LEADERS: Rob Austin, Rachel Vann, NC State University

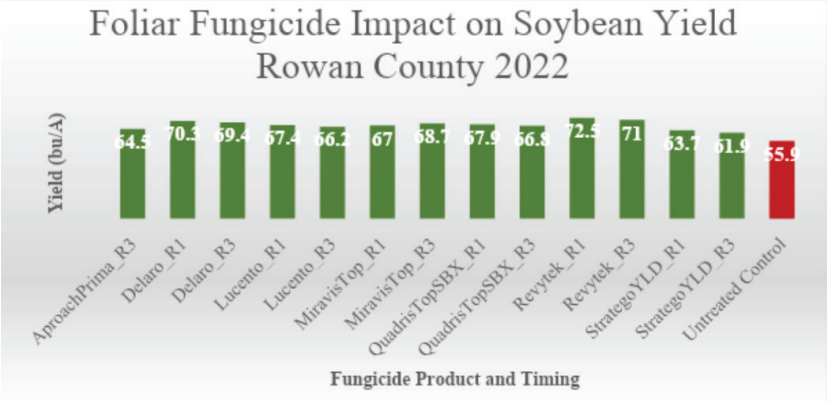


Stand count algorithms were most accurate when UAV imagery was collected within 20 to 30 days after planting. The timing and altitude of the flights were the most significant factors influencing the accuracy of the UAV-based stand counts.

When Foliar Fungicide Applications Predict a High Soybean Yield

MULTI-MODE OF ACTION FUNGICIDES APPLIED AT R1 TO R3 GROWTH STAGE CAN PROVIDE CONSIDERABLE YIELD PROTECTION.

Foliar fungicides have been identified as a common factor in the North Carolina soybean yield contest entries in the last 20 years. Does foliar fungicide application predict a high yield? This question is under investigation by a Soybean Extension Specialist, Rachel Vann, at NC State University. Results from three of Vann's field trials in 2022 show that multi-mode of action fungicides can provide considerable yield protection, but within reason. Farms that are susceptible to diseases such as soybean vein necrosis, frogeye leaf spot, fusarium, and Cercospora are good candidates for a positive yield response from foliar fungicides.



Foliar fungicide had a variable impact on soybean yield depending on disease pressure. The green bars indicate a significant difference from the untreated control.

Disease pressure can vary significantly from farm to farm and from research site to research site. At Vann's research sites, no specific timeline for the application of the products proved to provide superior yield protection. At the Camden County site, where there was minimal disease pressure, only 1 of 13 product applications produced a significant yield response. But at the Rowan County site, where disease pressure was heavy, each of the 13 product applications produced a significant yield response. Some products increased yield by as much as 15 bushels per acre compared to the untreated control.

PROJECT LEADER: Rachel Vann, NC State University

The Rowan County site experienced heavy disease pressure. The treated plots appear visibly different in the image.

The World's Worst Nematode?

THE GUAVA ROOT-KNOT NEMATODE IS KNOWN FOR ITS AGGRESSIVENESS AND ABILITY TO OVERCOME RESISTANCE. RESEARCH SUGGESTS THIS NEMATODE CAN BE MITIGATED IN SOYBEAN FIELDS FOLLOWING A NON-HOST COVER CROP LIKE GRASS AND CEREAL PLANTS, AND THROUGH THE APPLICATION OF IN-FURROW NEMATICIDES.

Severe root galling caused by southern root knot nematode (M. incognita) on a soybean plant. Andrea Gibbs, N.C. Cooperative Extension Agent, Hyde County, **www.content.ces.ncsu.edu/root-knot-nematode-of-soybean.com**

The guava root-knot nematode is relatively new to North Carolina soybean producers. The first reported incidence of guava root-knot nematode on soybeans in North Carolina occurred in 2013. According to NC State Extension, this nematode species is aggressive, with high rates of reproduction, and overcomes all known host resistance genes.

According to NC State University nematology specialist Adrienne Gorny, fumigants are the most effective control for the invasive guava root-knot nematode. However, despite fumigants reducing nematode populations at the beginning of the season, nematode populations can regenerate to damaging levels by the end of the growing season on a susceptible crop like soybeans. Plus, fumigation is cost-prohibitive for soybean producers. Given these limitations, genetic host resistance, in-furrow applied nematicides, and cultural control methods such as cover crops appear to be the most promising methods to mitigate losses caused by this new root-knot nematode species.

In greenhouses, Gorny tested different cover crops to see if they were hosts for guava root-knot nematode, and for their ability to suppress populations of the nematode in a following soybean crop. Gorny found that the broadleaf cover crops including crimson clover, yellow mustard, and hairy vetch were direct hosts to the pest and supported a high population of the nematode. Grass and cereal cover crops, on the other hand, were not hosts to the nematode and did not support a high population of the nematode. For soybeans planted in the greenhouses behind these cover crops, Gorny found significantly higher root galling in soybean plants following crimson clover, yellow mustard, and hairy vetch. The results of this research will be used to direct future field trials for the evaluation of cereal winter cover crops for suppression of guava root-knot nematode under field conditions.

Nematicides applied in-furrow are a promising, cost-effective means of reducing nematode populations in soybeans. Gorny is continuing work with in-furrow applications in research trials in 2023 and beyond.

PROJECT LEADER: Adrienne Gorny, NC State University

Automated Corn Earworm Traps Are More Efficient

NC STATE UNIVERSITY HAS DEVELOPED AN AUTOMATED CORN EARWORM TRAP THAT PROVIDES INCREASED MONITORING CAPABILITIES ACROSS NORTH CAROLINA.

Corn earworm is the top insect pest in North Carolina. Trapping corn earworm is labor-intensive and costly. The number of traps maintained in North Carolina does not adequately cover all soybean-producing regions in the state. In response a team at NC State University developed an automated corn earworm trap to increase monitoring capabilities. The latest version of the trap is being tested at 21 different field locations. North Carolina soybean farmers will soon have increased access to real-time trap information that will enable better decision-making about timely insecticide applications.

PROJECT LEADERS: Anders Huseth, Alper Bozkurt, and Natalie Nelson, NC State University

Automated corn earworm traps that can plug into mobile data networks are being tested in the field.

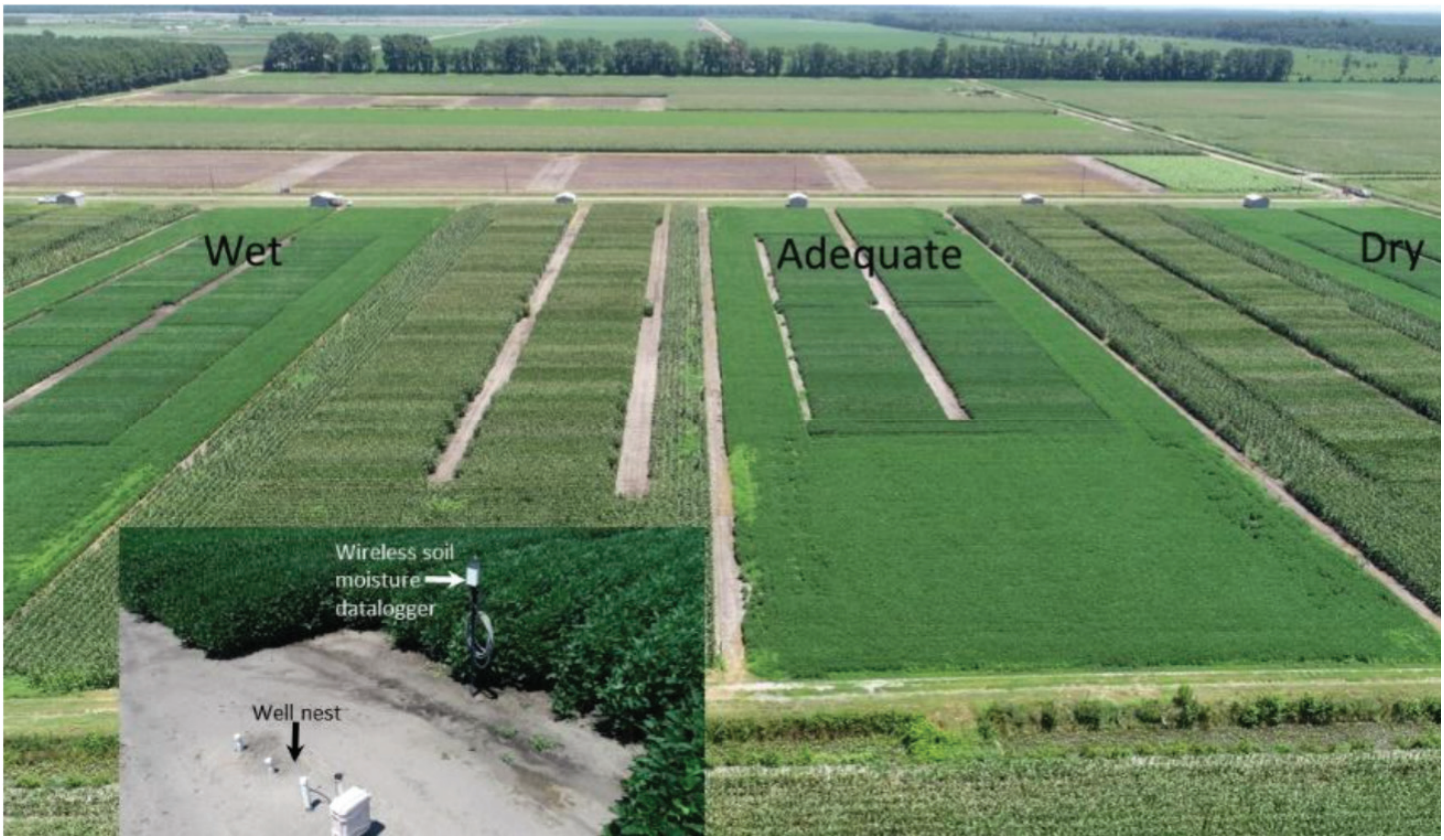
Too Much, Too Little Rain Impact on Yield and Nutrient Use Efficiency

EIGHTEEN COMMERCIAL SOYBEAN VARIETIES EXHIBITED REMARKABLY DIFFERENT YIELD PERFORMANCES UNDER DIFFERENT WATER MANAGEMENT SCENARIOS.

Some say that the weather is either too wet, too dry, too hot, or too cold. Growers cannot know what conditions will apply this growing season or the next. Growers can take steps to mitigate the risk. Investment and use of soil water management infrastructure to better control moisture in the crop root zone can be successful, but only with proper management, good decision-making, and an excellent understanding of the agronomic resiliency of the soybean varieties that are planted.

NC State scientists are working to accelerate our understanding of the impact of water stress in the soybean root zone and its relationship to yield potential, grain quality, and nutrient use efficiency across soybean maturity groups and genotypes in the lower coastal plain of North Carolina. The information is valuable to growers looking for top-performing varieties and to seed technology companies who invest millions of dollars annually in soybean genetic improvement, but who may lack the infrastructure to conduct robust testing for stress resiliency.

PROJECT LEADERS: Chad Poole, Rachel Vann, Luke Gatiboni, NC State University



Aerial view of the soybean soil-water treatment block at the Total Agricultural Water Management Site, Plymouth, N.C. Each soil-water regime has two blocks to accommodate the annual rotation of corn and soybean.

Blowing Hot and Cold

RESEARCHERS ARE LOOKING FOR GENETIC MARKERS OF BOTH COLD TOLERANCE IN SOYBEAN SEEDLINGS, WHICH IS IMPORTANT FOR GROWERS LOOKING TO PLANT EARLY, AND HEAT TOLERANCE IN SOYBEANS. SEED QUALITY (PROTEIN & OIL COMPOSITION) IS AFFECTED BY ELEVATED TEMPERATURES IN WAYS THAT COULD IMPACT SOYBEAN'S MARKET VALUE.

Open-top heated plots located at the Lake Wheeler Road Field Lab in Wake County.

Hotter-than-average temperatures can negatively affect soybean productivity, especially when elevated temperatures occur during flowering and seed fill. While yield is usually not reduced by elevated temperatures if sufficient water is available, the seed quality is affected in ways that could impact soybean's market value. USDA and NC State researchers at the Plant Sciences Building in Raleigh wanted to identify soybeans that handle elevated temperatures better than others. Ross Sozzani and Anna Locke evaluated multiple soybean genotypes under elevated temperature stress in the field, using experimental, open-topped heated plots. The objective was to identify new genetic markers to use in breeding for heat tolerance.

Two years of field experiments showed that seed oil concentrations consistently decreased when soybeans experienced higher-than-average temperatures during the seed fill period. But soybeans responded to high temperatures differently. This research indicates that the end-use value of soybean, which depends on seed composition, could be threatened by future climate conditions. Future research to continue identifying breeding markers and understand the underlying physiology could help improve soybean responses to heat stress.

By looking at data from cold-stressed soybean seedlings, Sozzani and Locke identified several key protein regulators that underlie seedling cold responses and may be important targets for improving seedling cold tolerance. In seedling cold stress responses, these protein regulators are only activated in cold conditions, and vary between genotypes. The project will continue to evaluate the potential to use these proteins as markers of early-season cold stress tolerance or as potential targets for soybean improvement via biotechnology.

PROJECT LEADERS: Ross Sozzani, NC State University, and Anna Locke, USDA-ARS

When Auxin Herbicides are Not an Option

WHILE PRE AND POST COMBINATIONS OF HERBICIDES REMAIN EFFECTIVE FOR CONTROLLING RESISTANT WEEDS SUCH AS PALMER AMARANTH, RESEARCH SUGGESTS INCORPORATING COVER CROPS CAN IMPROVE CONTROL OF KEY WEED SPECIES BY 20% WITHOUT HARMING YIELD.

Research by Wes Everman at NC State University suggests that growers have options for managing Palmer amaranth in the absence of auxin herbicides (2,4-D, dicamba) and that cover crops can play a critical role. Specifically, the use of cover crops helps in reducing the selection pressure on PRE and POST herbicides. This is especially important now that Protoporphyrinogen oxidase (PPO) inhibiting herbicide, glufosinate, and Group 15 (metolachlor, acetochlor) resistant populations of Palmer amaranth have been confirmed in North Carolina. Everman recommends that growers utilize cover crops in combination with herbicide applications wherever possible to maintain the effectiveness of herbicides currently labeled for use on Palmer amaranth.

Everman evaluated herbicides in 48 unique combinations applied PRE, early-POST, and late-POST to determine which ones provided the best control of Palmer amaranth. Everman found that growers may expect to see some difference initially among the PRE herbicides, but the POST application should erase any differences in control observed due to the PRE herbicide used. Palmer amaranth control was greatest where at least two applications were made, either PRE followed by a POST (either early or late) or two POST applications. Liberty and Flexstar provided similar control as a sequential application.

Use of a cover crop improved control by approximately 20% for key weed species. In these experiments, the use of cover crops did not statistically impact the soybean yield, which is a valuable insight. Cover crops add flexibility for managing resistant weeds when used with PRE and POST combinations of herbicides, without harming yields.

PROJECT LEADER: Wes Everman, NC State University

Breeding Results in First Soybean Germplasm Release with Flood Tolerance in NC

USDA SOYBEAN BREEDER BEN FALLEN HAS IDENTIFIED AND IS RELEASING A NEW N.C. SOYBEAN BREEDING LINE THAT SHOWS TOLERANCE TO FLOOD CONDITIONS AND IS HIGH YIELDING UNDER NORMAL CONDITIONS, THE FIRST GERMPLASM RELEASE WITH THIS TRAIT.

Flooding can be just as detrimental to soybean yield as drought. Either can diminish yield by 25% or greater. Standing water and water-logged soils deprive plants of the necessary light, oxygen, and carbon dioxide required for growth. Symptoms of flood stress include reduction of nitrogen fixation within the root nodules, chlorosis and necrosis of the leaves, defoliation, stunting, and plant death.

USDA soybean breeder Ben Fallen developed three flood-tolerant breeding lines that perform very well in comparison to commercially available varieties. Under flooded field conditions N05-7380, N10-792 and N11-352 yielded about 6.6bu/a, 13.5bu/a, and 8bu/a better than the check. The three new flood tolerant breeding lines are high yielding under normal field conditions and are ideal cultivars for growers to plant in flood prone fields. N11-352, the first to be released, is a maturity group VI soybean with high yield potential, an elevated oil content, and flood tolerance.

Fallen, a breeder, and colleague Anna Locke, a plant physiologist at the USDA Soybean & Nitrogen Fixation Unit on the NC State University campus, evaluated the new flood tolerant lines at locations in the N.C. coastal plain in 2022. Fallen perfected the parental stock in North Carolina and at the winter soybean nursery at the USDA Tropical Agriculture Research Station in Puerto Rico. The winter nursery is indispensable to soybean breeders because of its frost-free winter and accelerates soybean variety development by allowing two crops to be produced each year instead of just one crop.

Approximately 60 maturity group V and VI varieties were flooded for 7 days. Almost all varieties did poorly, but a few fared much better.

Development of a soybean variety typically requires seven or eight years of research. The first five years are needed to develop hybrids from the cross of two or more parental stocks. Three more years are required to yield test the progeny in North Carolina to find the most productive lines. The process can be shortened by two to three years by advancing early generations at the winter nursery in Puerto Rico.

In addition to the three flood-tolerant varieties, six additional soybean varieties adapted to North Carolina - USDA-N6004, USDA-N6005, USDA-N7004, USDA-N7005, USDA-N5001, and USDA-N7006 - were all released by the USDA breeders during the last three years.

PROJECT LEADERS: Ben Fallen and Anna Locke, USDA-ARS

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3600 HAWORTH DRIVE | SUITE 2
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NCSPA has been awarded a grant of $825,000 to initiate Farmers for Soil Health in North Carolina! Farmers for Soil Health is a farmer-led **cover crop** program that advances the use of **soil health** practices on farms while increasing **farmer profitability** through incentive payouts.