



## 2019 Research Report

PROTECTING YIELD & PROFITS | VARIETY DEVELOPMENT & TESTING  
PEST MANAGEMENT | NUTRIENT MANAGEMENT



# North Carolina Soybean Producers Association Board of Directors

- Jeff Tyson, Nashville – President
- David Heath, Dover – Vice President
- John Fleming, Scotland Neck – Treasurer
- Jacob Parker, Columbia – USB Director
- Derek Potter, Grantsboro – USB Director
- Jimmy Thomas, Timberlake – ASA Director
- Reggie Baker, Monroe
- Angela Berben, Pantego
- Andy Bland, Dover
- Ray Bullard, Stedman
- Jessica Burgess, Eure
- Bert Dixon, Maury
- Sydney Edwards Dunn, Edenton
- Curtis Furr, Albemarle
- Reid Gelderman, Pantego
- Phil Gore, Nakina
- Auston Harris, Kinston
- Gary Hendrix, Raeford
- Forrest Howell, Plymouth
- Aaron Kirk, Hillsborough
- Trey Liverman, Columbia
- Ben Long, Scotland Neck
- Duncan Malloy, Lumber Bridge
- Greg Manning, Nashville
- Kevin Matthews, East Bend
- Michael McPherson, Mebane
- Ben Moses, Jr., Conway
- Christopher Naylor, Clinton
- Cody Paul, Bayboro
- Craig Seaman, Manson
- Philip Sloop, Mt. Ulla
- Wade Stanaland, Bladenboro
- Jason Starnes, Salisbury
- Reggie Strickland, Mt. Olive
- Logan Watson, Monroe
- Simmy Williams, Shiloh

## From the President

Each year the North Carolina Soybean Producers Association invests the largest portion of the funds it receives from the checkoff into research efforts to ensure growers have the information they need to be successful. Our efforts include funding almost all the soybean research conducted through N.C. State and N.C. Cooperative Extension, funding research projects with outside consultants, conducting our own trials, communicating the successful practices identified through the research to farmers and promoting best agronomic practices. Our goal, the mission of the Association, is to maximize the profitability of North Carolina’s soybean farmers in an economically and environmentally friendly manner.



In the current soybean environment, it is more important than ever for growers to evaluate practices carefully to ensure they can save money and increase yields where possible. We publish this Research Report every year to provide the tools for you to do so.

The Association developed another new tool in February to provide growers instant, mobile access to the resources and tools created by the NCSPA, an NC Soybeans App. The app includes a mobile version of the N.C. Soybean Production Guide and Variety Selection Tool, local elevator prices and Chicago board of trade prices updated in real time, the latest updates from the NCSPA, and links to resources from the Association and N.C. State. It is a one-stop shop for soybean production information, all readily searchable from your tractor, and we hope you find it useful.

In addition to the normal course of our research work this year, there were also some new developments. Dr. Rachel Vann took over as soybean extension specialist from Dr. Dunphy in April 2018 and completed her first growing season. She wrapped up many of Dr. Dunphy’s projects, the results of which are included in this report, and has some exciting ideas for new projects in the coming years.

I wish you all the best for a successful and productive season!

Jeff Tyson  
President

# PROTECTING YIELD & PROFITS

## Foliar Yield Enhancements Rachel Vann, NCSU

A variety of products claim to improve soybean yields and profits. Having an unbiased and trusted source evaluate the efficacy of such products is essential to making decisions about what products, if any, should be added to a farm operation. Over the last six years, the NCSU has utilized checkoff funding to evaluate the efficacy of these products with N.C. State Extension.

While products tested varied from year-to-year, the trial has generally included foliar fungicides, foliar fertilizers and stress reducers. It was conducted across 19 different N.C. environments from 2013-2018. The number of environments in which a product was evaluated is included in the graph below, with only products tested multiple years reported. Confidence in the results increases the more times and environments a product has been tested.

### FUNGICIDES

When combining the 19 trial environments and various fungicide products evaluated, **fungicide use provided on average a 2 bu/A yield advantage compared to the nontreated control.** This varied by environment, with a large increase in yield seen in some environments and not in others. A number of factors can influence the effectiveness of a fungicide application, including the soybean variety and the resistance package it carries and environmental conditions (heat, moisture, disease pressure, soybean biomass), which can impact foliar disease pressure.

The multi-mode of action (MOA) fungicides evaluated (Priaxor, Quadris Top, Stratego Yld) provided a 2.5 bu/A yield advantage on average over the nontreated control, whereas the single-MOA fungicides only provided a 1.6 bu/A yield advantage on average over the nontreated control. The yield advantage provided by the multi-MOA fungicides may indicate the presence of fungicide-resistant diseases, which require additional inputs to manage. In addition to the yield increases from the use of a multi-MOA fungicide, it is also beneficial for fungicide-resistance management.

### FOLIAR FERTILIZERS

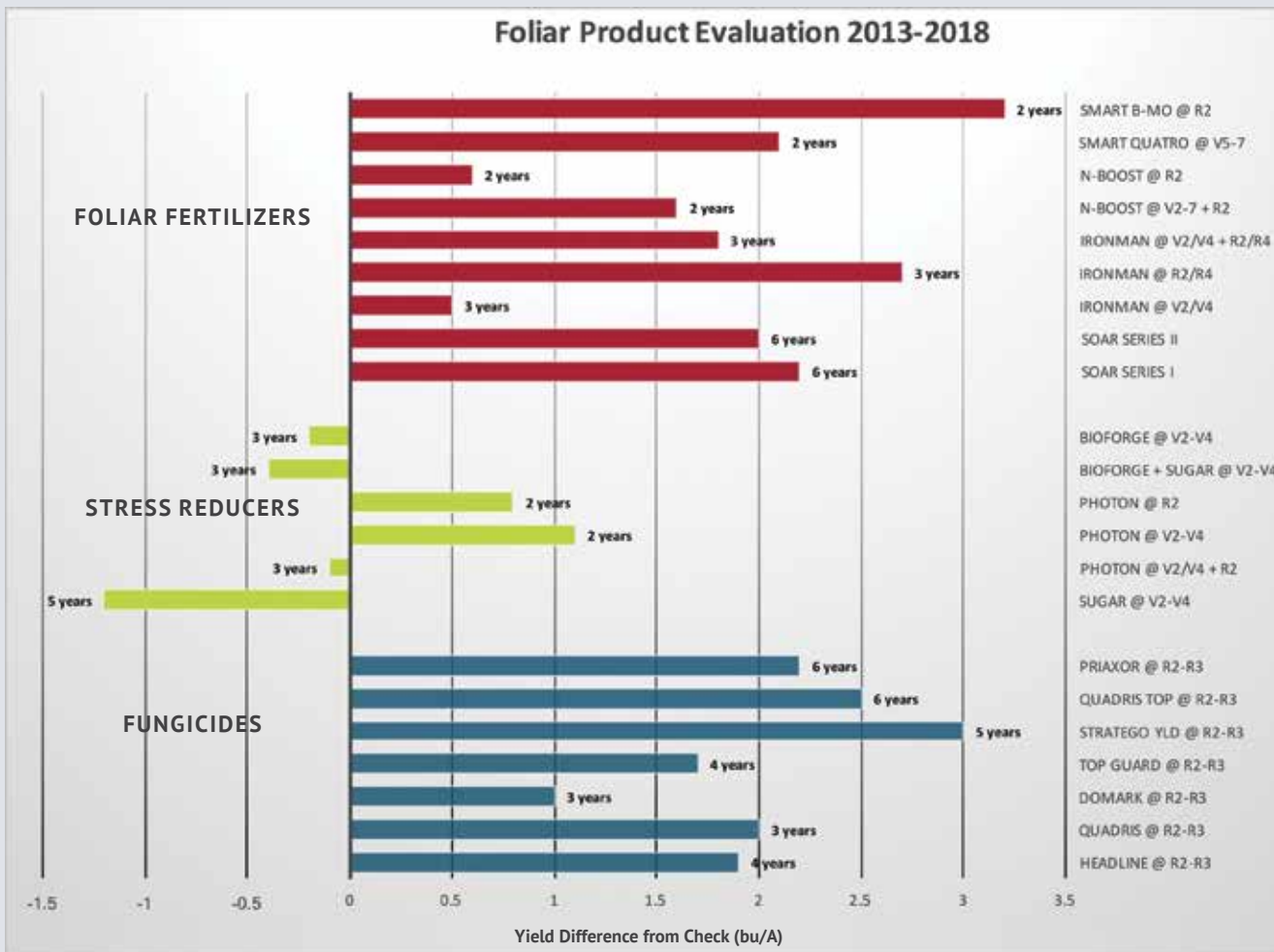
Significant yield increases were seen when Soar, Ironman or Smart B-Mo were applied, but there was no significant increase observed with N-Boost or Smart Quatro.

### STRESS REDUCERS

The stress reducers evaluated in this trial (Photon and Bioforge) did not significantly impact soybean yield in the environments tested. Also, sugar applied with or without Bioforge did not impact yield.

When considering adding inputs to a management program it is essential to look not only at the potential yield increase but to consider the potential return. The cost of the product and the cost of application should be considered when deciding which products to use. Of the foliar products evaluated in this trial, **foliar fungicide use at early reproductive development would provide the most**

**consistent positive impact on soybean profit compared with other foliar inputs evaluated.**



## Non-Foliar Yield Enhancements

Rachel Vann, NCSU

There are many non-foliar yield enhancement products available to N.C. soybean producers. Profit margins are currently narrow for soybeans and the potential yield advantages and associated costs of using these products should be considered. Over the last five years, the NCSU has used checkoff funding to evaluate the efficacy of these products with N.C. State Extension.

This test was conducted across 15 environments from 2014 – 2018. Products in this trial have varied from year-to-year, but have generally included seed treatments, in-furrow applications and broadcast applications. Products tested include insecticides, fungicides, nematicides, inoculants, biologicals and fertilizer. The number of environments in which a product was evaluated is included in the graph at right, with only products tested multiple years reported. Confidence in the results increases the more times and environments a product has been tested.

### FUNGICIDE SEED TREATMENTS

Across all environments, **the use of a fungicidal seed treatment did not significantly impact soybean yield.** However, most of these trials were planted in June or July and it is possible that fungicidal seed treatments would have more impact at earlier soybean planting dates when

conditions are generally cooler and wetter, which can intensify seedling diseases. Fungicidal seed treatments may be more important in years where there is low seed quality and limited seed quantities of some varieties, making it more important to prevent the possibility of replanting.

### INSECTICIDAL/BIOLOGICAL SEED TREATMENTS

The Poncho/Votivo seed treatment was evaluated over eight environments and had no impact on soybean yield. Insecticidal or nematicidal seed treatments were not comprehensively evaluated in this trial, but other tests by Dr. Dominic Reisig have **consistently shown no yield advantage to using an insecticidal seed treatment on soybeans in N.C.** In addition to a lack of yield response, the use of an insecticidal seed treatment in soybeans can intensify resistance development to these seed treatments used in other crops, like cotton, where they are needed.

In other studies, nematicide seed treatments show inconsistent results for reducing damage from nematodes. Given the inconsistency in yield response from nematicidal seed treatments, their use appears to be best placed in systems with moderate nematode populations and are probably not economical in nematode environments with high or low populations.

### INOCULANT SEED TREATMENTS

Soybeans can fix their own nitrogen through a symbiotic relationship with bacteria (*Bradyrhizobia japonicum*) that can convert atmospheric nitrogen (N<sup>2</sup>) into a plant usable form. For this reason, soybeans are often not fertilized with any additional N fertilizer and farmers generally depend on N-fixation and residual soil N to fulfill soybean N demand. There has been interest in the value of inoculating soybeans with appropriate bacteria to promote N-fixation. Two seed applied inoculants were evaluated in this trial, Optimize LCO XC and TagTeam LCO XC. Both provided a slight yield advantage from the nontreated control (+1.1 bu/A). Previous work by Dr. Jim Dunphy indicated that in-furrow inoculants are generally more effective than seed-applied inoculants. It is generally believed that inoculating soybeans is more valuable on a field that has not produced soybeans for four to five years, than one in which soybeans have consistently been in rotation.

### BIOLOGICAL SEED TREATMENTS

BioForge is a biological plant growth promoter that claims to promote early root growth by reducing stress. This product was evaluated as a seed application and did not significantly impact soybean yield. Other research has found that BioForge, applied both as a seed treatment and a foliar



treatment, was more effective at impacting soybean yield than when used as a seed treatment alone.

### IN-FURROW FUNGICIDES

The use of Quadris, Proline and Headline did not impact soybean yield across environments, however Priaxor did increase soybean yield (+1.6 bu/A). The trials were generally planted in June and July, and a larger impact on soybean yield may have been observed at earlier soybean planting dates when environmental conditions might be more conducive for disease development. In-furrow fungicides are best used in environments with high disease risk (cool, wet soils) since fungicide resistance develops rapidly in soilborne fungi populations. Caution should be taken not to use the same fungicide chemistry on a continued basis, as it could result in fungicide resistance, making future disease management more challenging.

### IN-FURROW MICROBIAL STIMULANTS

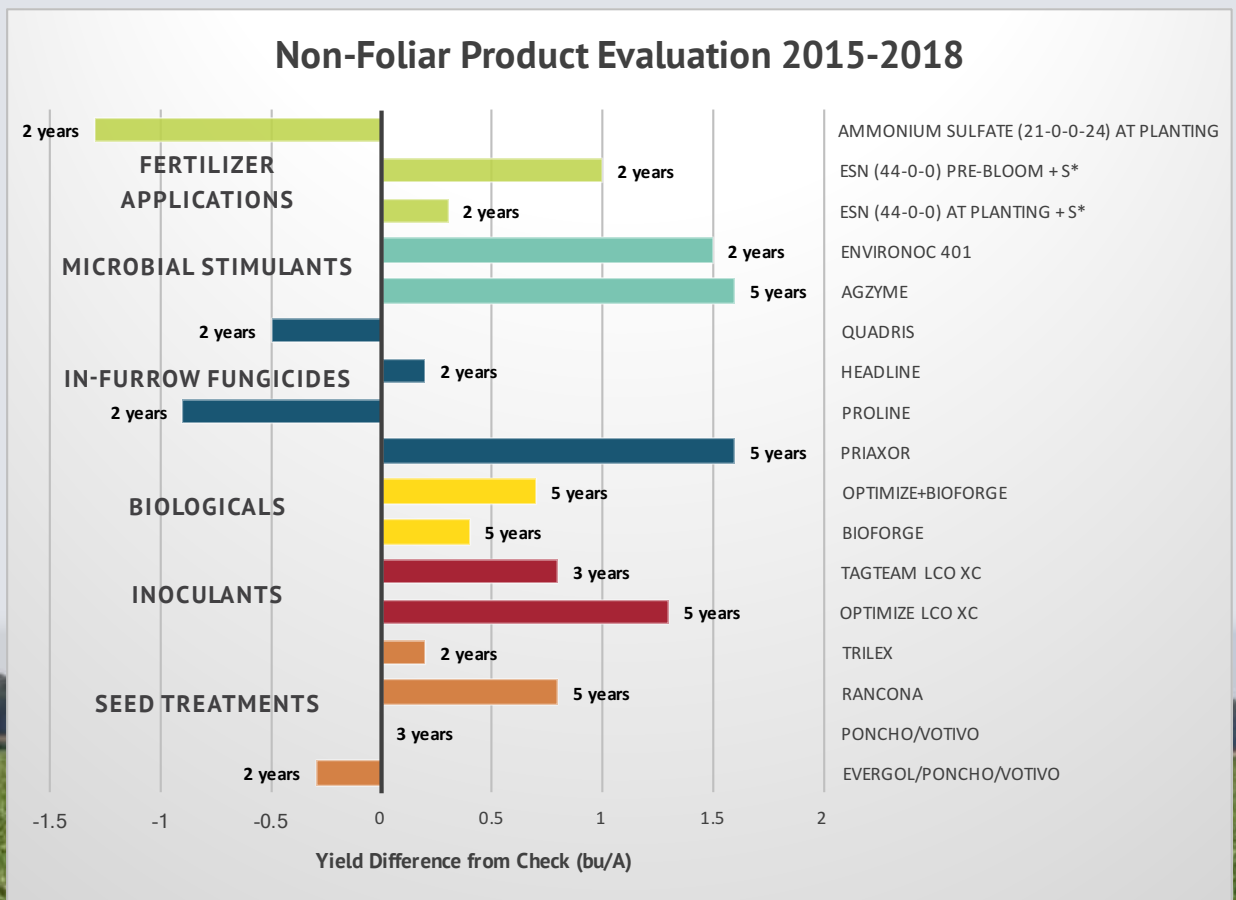
Agzyme and Environoc 401 are both microbial stimulant products that claim to enhance microbial activity. Both had approximately a 1.5 bu/A increase on soybean yield when evaluated in this trial.

### FERTILIZER APPLICATIONS

There is a question about the necessity of adding additional N fertilizer to soybeans as yields are pushed higher. The evaluation of both ESN and ammonium sulfate applications in soybeans was of interest to growers in North Carolina. In this trial, the use of ESN or ammonium sulfate at planting or pre-bloom did not impact yield. There have been many field experiments conducted in N.C. showing that inorganic N fertilizer applications to effectively

nodulated soybeans are rarely profitable. A recent nationwide study found there was a **minimal effect of N fertilizer application on soybean yield in most environments and the practice would rarely be profitable.**

Over the years the non-foliar yield enhancement products evaluated in this project have provided modest soybean yield increases, if any. The evaluation of these products across 15 environments is context-specific to late May through early July planting and these results may be different if earlier planting dates were evaluated. Many of these products are relatively inexpensive, however **growers should consider if the modest increases in soybean yield coupled with the risk of resistance development would justify investment.**



## Soybean Dry-Land Maximum Yield

Rachel Vann, NCSU

In order to push soybean yields in N.C., growers must be willing to change the way they manage the crop. For many years, soybeans have not been as intensively managed as other crops in N.C., but growers that commit to an intensive systems-approach management style for soybeans are often rewarded. To determine which practices and products will result in the greatest yield increases, the NCSU has funded research through the checkoff known as the “Cadillac” test.

The project sought to identify practices and products resulting in the greatest yield increases for N.C. soybean production. It includes a “Cadillac” maximum yield treatment using many different inputs. Other treatments in the test subtract one input at a time to determine the influence the product/practice has in a relatively high-yield, non-irrigated environment. This trial was conducted at four environments in 2018 to complement data gathered from 2015-2017. Averaged over 14 environments, the **production practices with the largest impact on soybean yield included maximal variety selection, narrow row spacing and foliar fungicide use.**

soybean yield by about 6 bu/A on average, but three fungicide applications in one season is probably not profitable. The data indicates that fungicide applications made at R2 and R4 were more effective at increasing soybean yield than at R5. Based on other data generated in the N.C. State Extension Program, the impact of the R2 and R4 fungicide applications on soybean yield has more to do with the timing of the application and the susceptibility of the plant to disease at that stage than the products themselves.

Variety selection impacted yield in some environments in these trials. A Cadillac variety was selected for inclusion in this trial based on its ability to perform well in a high-yield environment, and then compared to a variety with more consistent performance over time. **Soybean variety selection is a critical component to maximize soybean yield.** Growers should be intentional about selecting maturity groups, herbicide packages and disease resistance packages to achieve maximum soybean yields using high-quality yield data.

Increasing plant population by 20% has a negligible impact on yield of less than 1 bu/A, **indicating growers can save money by reducing seed populations to 120,000 seed/A or lower.**

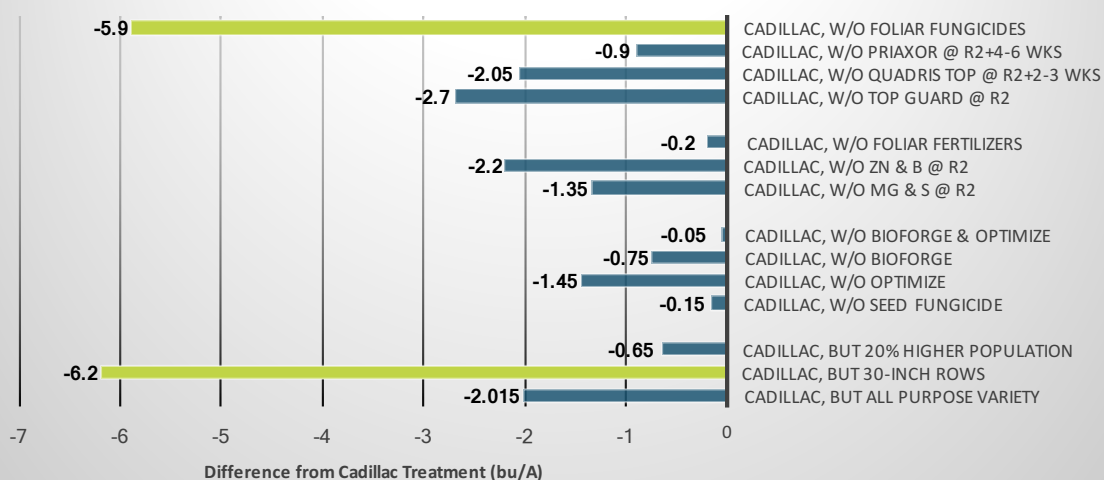
In general, **the use of a seed fungicide, seed inoculant or seed biological enhancement product did not impact soybean yield** despite claims these are important components of a high-yielding soybean system. However, a fungicidal seed treatment may be more important at earlier planting dates than were used in this trial.

**Foliar fertilizer products had a variable impact on soybean yield** in this test. The application of  $MgSO_4$  at R2 did not impact soybean yield in most environments.

The application of Zn and B at R2 had an impact on soybean yield in some environments with an average of about 2 bu/A increase. Foliar fertilizers are believed to have benefits in situations where micronutrient deficiencies occur, which might have been the case at some environments where yield responses were observed. Growers should make educated decisions on foliar fertilizer use based on product cost, cost of application and potential yield increases.

Incorporating even one of these proven practices may result in yield increases or cost savings. **If growers commit to putting the time and energy into managing soybeans like they invest in some other crops, results will be positive.**

Maximum Dryland Yield 2015-2018



The **largest impact on yield came from decreasing row spacing**, with 15-inch rows yielding about 6 bu/A more than 30-inch rows. There are circumstances where wider row spacing may be more appropriate than narrow row spacing (i.e., when wide rows are being ripped or when bedded production is implemented), however all environments tested consistently saw yield benefit from narrow row spacing. Additionally, narrow rows have the benefit of quicker canopy closure, an increasingly important tactic for weed control in soybeans given the increase in herbicide-resistant weed management challenges.

The **second highest impact to yield came from a foliar fungicide application.** Three fungicide applications at R2, R4, and R5 increased

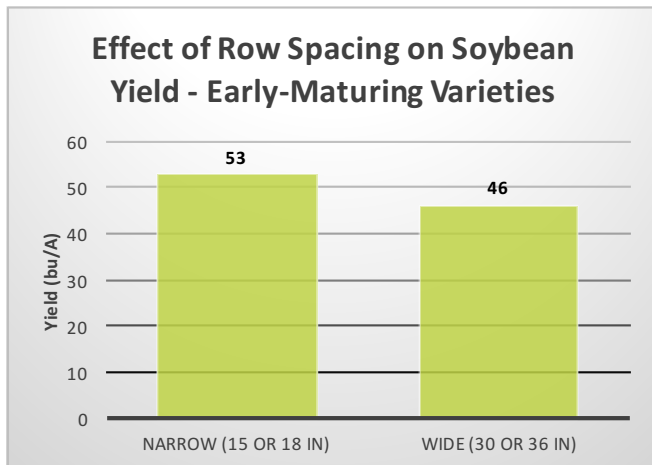
# Managing Early-Maturing Soybeans in North Carolina

Rachel Vann, Austin Brown, Rod Gurganus, Jarette Hurry, Mac Malloy, Anna-Beth Williams

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

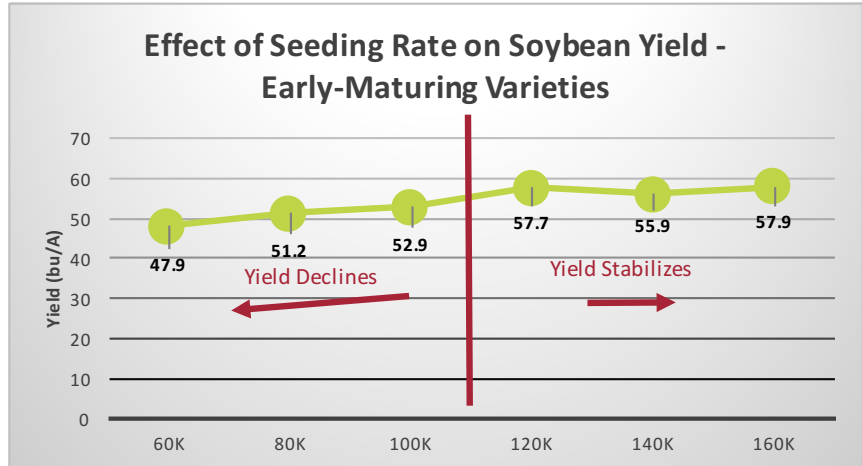
## ROW SPACING

Narrow rows (15 or 18 in.) were compared to wide rows (30 or 36 in.) In combined analysis across locations and varieties, the narrow row spacing provided a 7 bu/A yield advantage over the wider row spacing. These results are aligned with what Dr. Dunphy found with determinate varieties, that there **can be a yield advantage from narrow row spacing, especially in high-yield environments.**



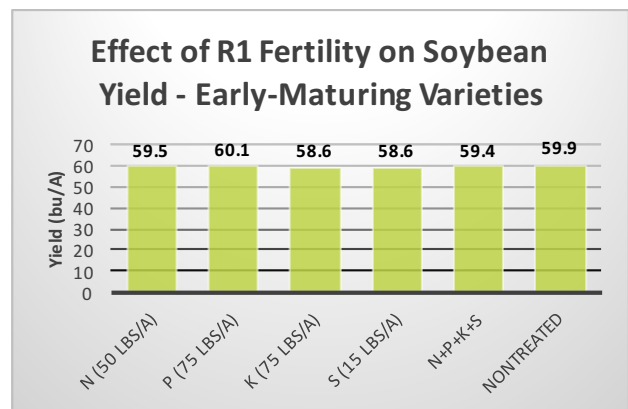
## SEEDING RATE

Six different seeding rates were evaluated from 60,000 to 160,000 seeds/A. Across locations, soybean yield declined at the lowest seeding rates (60,000 and 80,000) and stabilized at rates greater than 100,000 seeds/A. Yield declines at lower seeding rates were generally more pronounced in high-yielding environments. This is also similar to what is seen in determinate varieties.



## R1 FERTILITY

There has traditionally been less emphasis in N.C. on fertilizing soybeans than other crops, but soybeans have very high nutrient requirements to maximize yields given that 245 pounds N per acre, 43 pounds P and 170 pounds K are required to produce a 60 bu/A soybean crop. 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.** Soybean fertility is important to increased soybean yields across the state, however, this research indicates that soil-applied R1 fertility applications will not help accomplish that goal.



**A challenge with producing early-maturity soybeans 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 purple seed stain. In addition to the agronomic practices above, it is important to keep in mind other events happening at the time early-maturing soybeans would need to be harvested before deciding to try these varieties.

This work will be continued in 2019 to give a more comprehensive idea of how to manage these varieties.

## Optimizing Planting Date and Maturity Group

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

Soybean producers have been trying to push the yield limits on modern, high-yielding soybean varieties in recent years. One means to improve yields is to be strategic about planting timing and maturity group selection, which play a major role in achieving maximum yield potential. Weather is the driving factor in deciding when field activities take place in N.C., making it difficult for growers to stick to a strict planting and management calendar. However, the more that is understood about the relationship between maturity group, planting date and weather patterns, the more likely yields can be improved. The NCSPA has funded a multi-year study with a group of consultants to better understand the influence of planting date and maturity group selection.

**The response of soybeans to planting date was very different from location to location.** Data was averaged from 2017 and 2018 to give a more complete picture of what is typical of each location evaluated.

In Perquimans, mid-April and mid-May planted soybeans in the RM range of Late III to Late IV were on average 13 bu/A better compared with mid-June planted beans. The benefit of early planting in Perquimans was minimal when later-maturing varieties were planted. The highest-yielding scenario in Perquimans was an Early IV planted in mid-April and May.

In Beaufort, the highest yields were achieved when soybeans of Late III, Early IV and Late IV RM groups were planted in May. On average, these early varieties planted in mid-May out-yielded mid-April beans by almost 14 bu/A and mid-June planted beans by nearly 29 bu/A. Several late-planted plots were lost in 2018 due to bad weather, making it difficult to analyze the full impact.

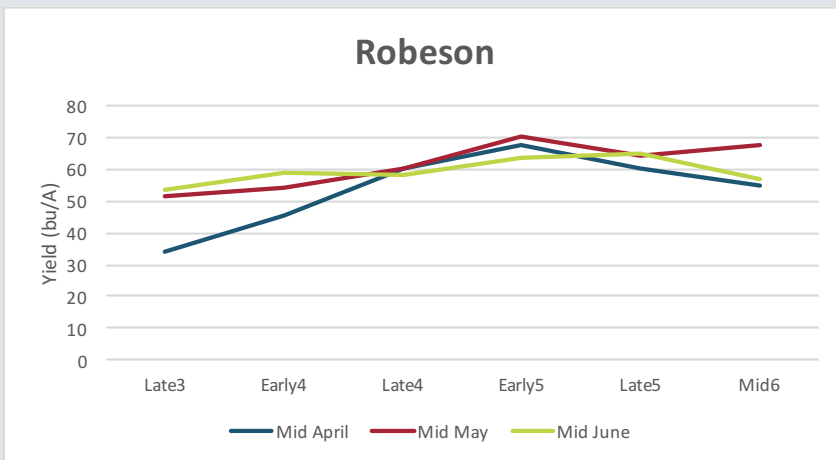
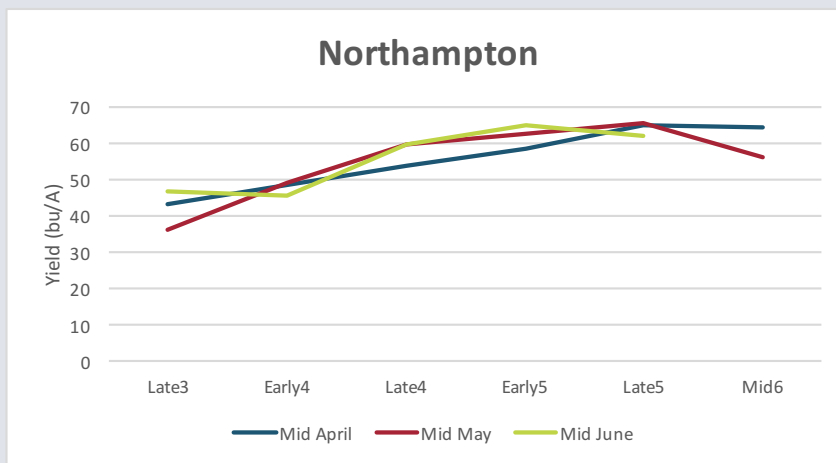
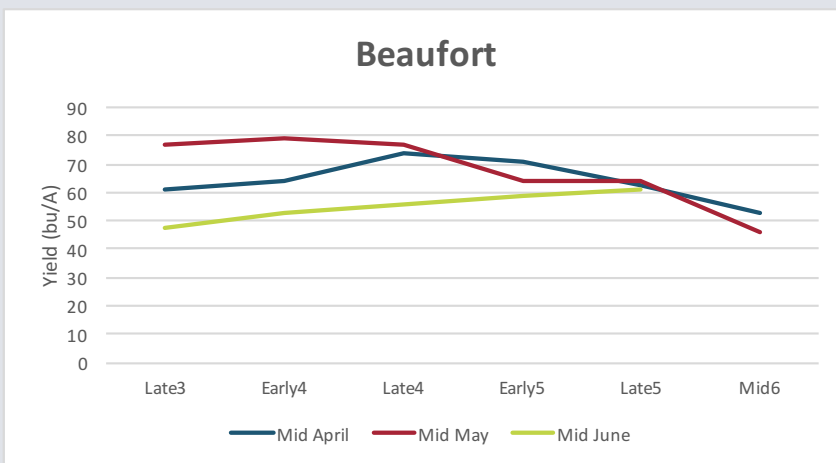
In Pitt, the opposite trend was observed compared with Perquimans and Beaufort. At this location, early-maturing varieties of Late III to Late IV performed better, as planting date was later and later-maturing varieties performed better when planted earlier in the season. Optimal yields were achieved when Group IV's were planted in June and when Group V's were planted in April or May.

In Robeson County, planting in mid-May and mid-June was better than planting in mid-April across all maturities. The best option for Robeson was mid-May planting and an Early V soybean. Similar to Pitt, early-maturing varieties seemed to do better when planted later.

In Northampton County, Late V's and Mid-Late VI's performed best overall compared to all other maturity groups. Group V and VI beans out-yielded group III and IV beans by nearly 15 bushels on average. The highest yields were achieved by

planting a mid-to-late Group VI soybean in mid-April.

Weather played a major role in the outcome of this study in 2018. Heavy rains in the early fall from Hurricane Florence hurt yields of early-planted and/or early-maturing soybeans, particularly in Robeson, Pitt and Northampton counties. Less than ideal growing conditions in April were not conducive to producing the high yields seen with early-maturing varieties in the Tidewater region in 2017.



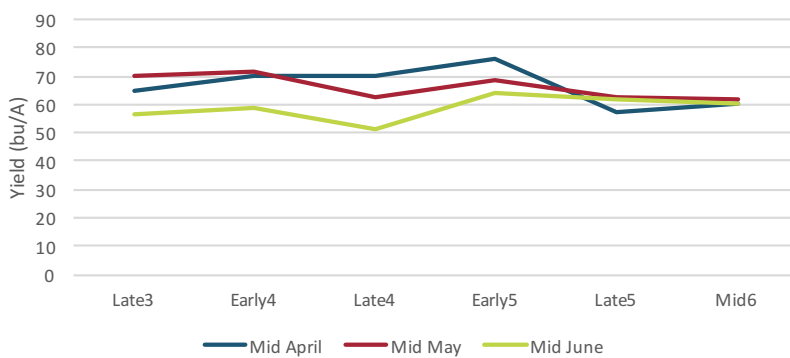


Abnormally high rainfall in June hurt stands of late-planted beans in Beaufort, causing some plots to be abandoned.

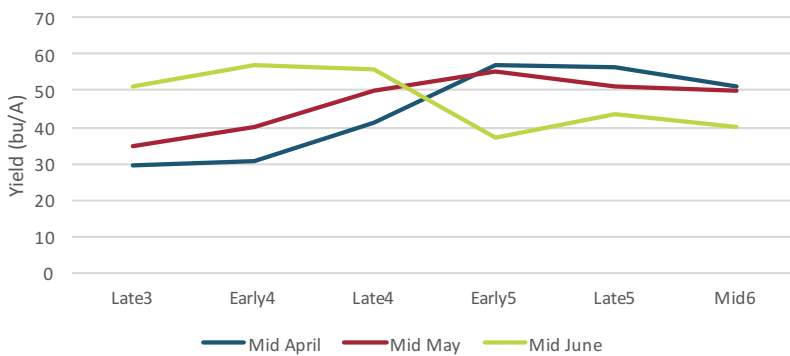
**This two-year study suggests that across all locations and environments, the ideal combination is a Late IV or Early V planted from mid-April to mid-May.** While most seasons have a “sweet spot” with the highest potential for outstanding yields, finding it can be difficult unless risk is spread. For instance, averaged across

all locations, the cost of making the wrong decision in variety and planting date could have been as much as 35 bu/A. There is no way to predict the weather, but **this research shows it is critical to manage risk by paying attention to weather forecasts at planting time and planting multiple varieties of varying maturities to avoid significant weather events.**

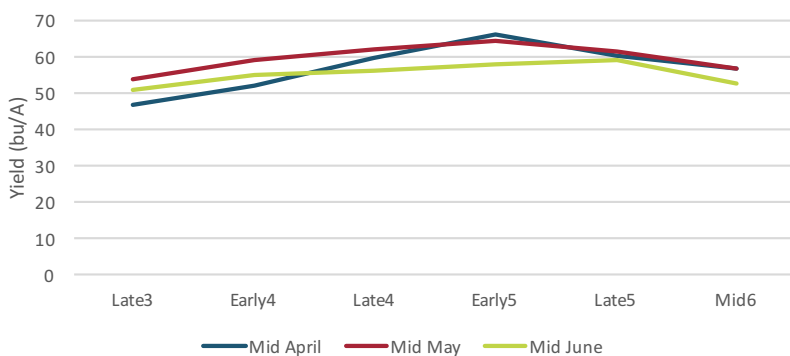
### Perquimans



### Pitt



### All Locations



# PROTECTING YIELD & PROFITS

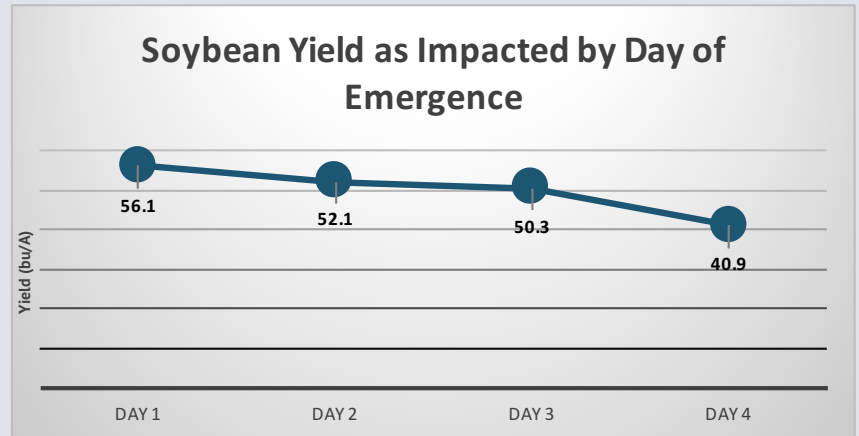
## Uniform Emergence

Rachel Vann, NCSU

Dr. Ron Heiniger has demonstrated that uniform emergence is important for corn yield, so it raises the question of whether uniformity of emergence is important to maximize soybean yields too. Soybeans typically emerge over a period of several days, but little is known about whether the seedlings that emerge later are as productive as those that emerge the first day. The NCSU funded a research project over two years through the soybean checkoff on soybean seedling emergence to find out.

Nine environments were tested. In each environment soybeans in a designated area were flagged when they started emerging with one color stake, to indicate the first day of emergence. Individual soybean plants were then harvested based on emergence date and threshed by hand or with a belt thresher. Seed yield per plant was quantified and those values were extrapolated to bu/A based on a quantified population.

In many environments, **soybean yield declined with delayed soybean emergence. On average, a 15 bu/A yield decline was observed from first day of emergence to the fourth day of emergence.** This would indicate that uniform emergence is important in soybeans, but soybeans are also able to compensate for different plant populations better than corn, so this may not impact final yields as significantly. Using the knowledge that uniform soybean emergence is important in many production situations, growers can make planting decisions to achieve more uniformly emerging soybean stands.



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

Anna Locke, NCSU

Drought is a primary limitation to soybean yield. Drought lowers yield, but also typically lowers seed protein. **One of the first processes limited by drying soils is biological nitrogen fixation, which is critical for supplying N to the developing seed for protein production.** To better understand how to combat dry conditions, the NCSPA sponsored a project using checkoff funds to investigate links between drought tolerance and yield.

The project evaluated various soybean genotypes at the Sandhills Research Station where the sandy soils allow for drought conditions to develop in the absence of irrigation. The goal was to better understand the interaction between drought responses, nitrogen metabolism and seed protein. While only preliminary results are available from year one, this experiment will be continued the next two years to determine if some varieties are able to maintain protein levels even in drought conditions.

## Variety Demonstrations

Rachel Vann, NCSU

As more states and companies provide soybean varieties for N.C., it becomes more difficult to stay current on what is available. In 2018, there were more than 230 soybean varieties tested in the N.C. State Official Variety Trials. Despite having good yield data from a range of N.C. environments, many farmers are slow to use a variety they have never seen under local conditions, tending instead to grow varieties they are familiar with. The NCSPA has funded unreplicated soybean variety demonstrations so farmers can see new varieties in the field under local conditions.

In 2018 seven different locations across the state showcased 15 different popular varieties. These locations hosted field days for farmers, Extension personnel and industry colleagues.

## Flood Tolerant Soybean Varieties for North Carolina

Tommy Carter, USDA

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, poor leaf color and spindly plants. Getting yields greater than 45 bu/A 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., give hope this problem can be overcome. Some soybean varieties have been shown to handle extra water much better than others. New mid-South varieties in development appear to be even better than existing stocks.

The big question for N.C. farmers is, will the Mid-South technology show a payoff in N.C. The NCSPA, along with the USDA-ARS and N.C. State, are funding a graduate student to explore the potential of new flood tolerance technology. This summer, a hybridization program was initiated to develop flood-tolerant soybeans adapted to N.C. and the Tidewater area. NC-Dunphy is a high yielding group VI that also appears to have some tolerance for flooding. Four of the better flood-tolerant candidates were crossed to NC-Dunphy and the progeny from these crosses will be evaluated in 2019 and beyond.

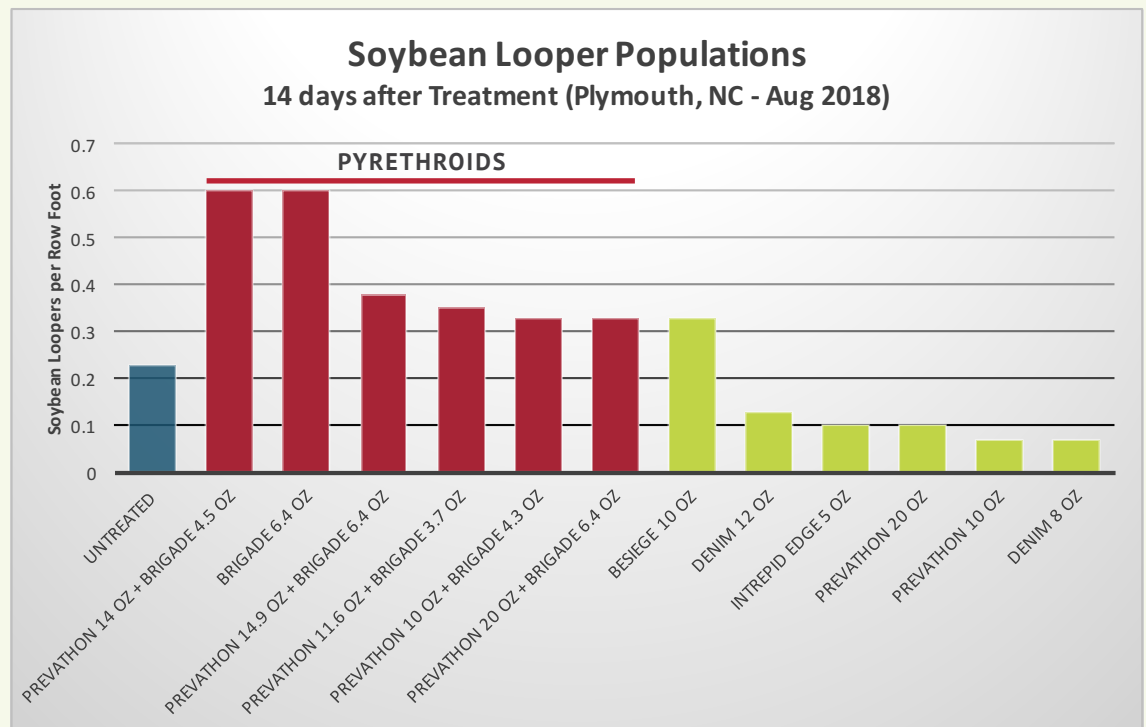


## Improving and Reducing Cost of Control for Caterpillar Pests in Soybean

Dominic Reisig, NCSU

As a group, caterpillar pests are by far the most damaging insect pests to N.C. soybean. For example, while many growers claim not to have problems with insect pests, most end up spraying for them. In 2014, caterpillar pest numbers were about average, and caused an estimated **\$43.7 million dollar loss and cost of control in N.C. soybeans**. Management of these pests is threatened due to increasing insecticide resistance. One way to reduce these losses is to identify where pests are present, minimize unnecessary sprays where they are not and identify where expensive caterpillar insecticides are needed and where they are not.

The NCSU checkoff funded a project to better understand the nature of resistance for corn earworm and soybean looper. Results indicate that soybean loopers are highly resistant to pyrethroids, like bifenthrin (Brigade), in N.C. As a result, pyrethroids can flare looper populations even when tank mixed with chlorantraniliprole (Prevathon), a caterpillar-specific insecticide. As this research continues, it will help growers select the most effective and inexpensive insecticide for both corn earworm and loopers in future seasons.



## Testing Strategy for Early Detection of Glufosinate-Resistant Palmer Amaranth in Soybean

Wes Everman and Ramon Leon, NCSU

Palmer amaranth is the most troublesome weed in soybean production in N.C. due to its ability to produce dense and competitive populations, and its resistance to important herbicides, including glyphosate and ALS-inhibitors. Currently, glyphosate-resistant Palmer amaranth is mainly controlled using glufosinate and Liberty Link varieties. Recently a glufosinate-resistant (GFR) Palmer amaranth population was identified in N.C. In order to prevent the establishment of GFR Palmer amaranth, it is critical to have a monitoring system for early detection, so eradication can be implemented before the GFR trait is dispersed. The current project is in the process of developing a rapid bioassay to identify GFR Palmer amaranth populations and a monitoring strategy for soybean-producing areas in N.C. The NCSU and the checkoff are funding a graduate student to continue this work in the coming years.

## Soybean Problem Diagnosis Support for Cooperative Extension Agents

Lindsey Thiessen, NCSU

Accurate diagnosis is important for economical management of soybean pests and diseases. To facilitate this, samples submitted by Cooperative Extension Agents are funded by the NCSU to provide accurate diagnosis and management strategies. This work helps reduce costs associated with improperly placed management practices.

Of the 67 samples submitted to the Plant Disease and Insect Clinic in 2018, environmental stress and Fusarium root rot were the primary issues. The symptoms of excess water are easily confused with viral, fungal and insect damages. Secondary diseases (e.g. Fusarium root rot) are common and can convolute diagnosis. Sudden Death Syndrome was also confirmed, which is likely the result of extreme weather conditions. Insect pests, like aphids and stem borers, were also identified.

# Minimizing Carryover Herbicide Damage to N.C. Soybean Production

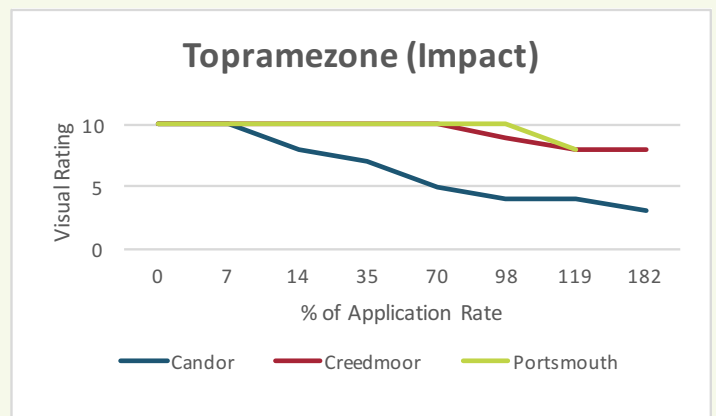
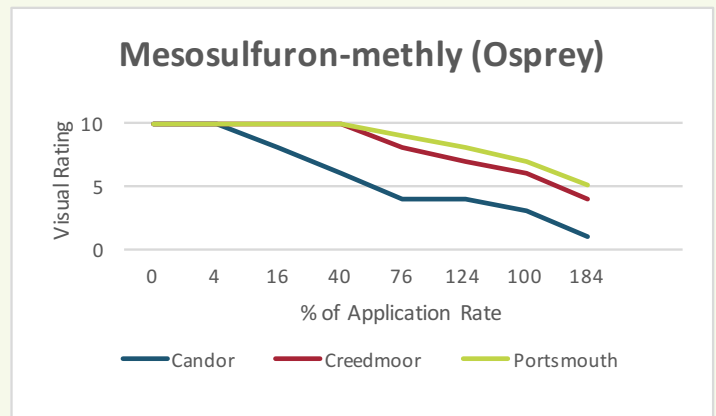
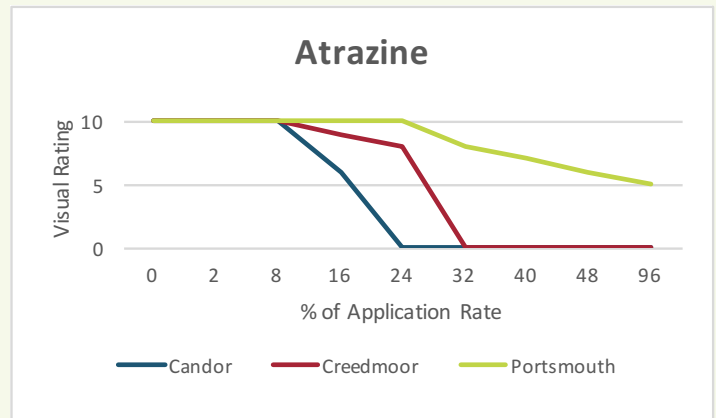
Travis Gannon, NCSU

Soybean is grown in rotation with corn or winter wheat crops, an essential management practice to maintain soil health and maximize crop yields. Though herbicides are critical for weed management, there is potential for damage to soybean from carryover herbicide concentrations in the soil in a rotation system. Global climate forecast models predict drier summers and intensified drought conditions, both factors that favor herbicide persistence and carryover. The NCSU funded a project through the checkoff with N.C. State to help producers begin to understand the issues soybean production could encounter in the near future and find ways to minimize them.

Varying soil types were collected from different regions of N.C. and herbicide persistence experiments conducted. As hypothesized, persistence was influenced by a combination of soil and herbicide physicochemical properties which resulted in different carryover concentration estimates for each soil type. Environmental conditions such as soil temperature were shown to influence herbicide degradation and consequently, carryover concentrations.

Atrazine, Mesosulfuron (Osprey) and Topramezone (Impact) were evaluated. **Residual atrazine was most likely to cause visual injury to soybeans.** Regardless of the herbicide tested, **the sandier the soil, the more likely a herbicide was to have residual activity.** Soybeans planted in Candor sands from Jackson Springs had the greatest visual injury from residual herbicides.

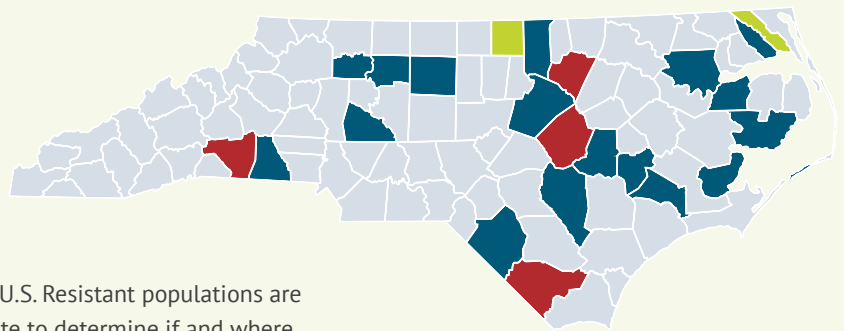
More work is being carried out to determine bioavailability across soils and the threshold for soybean damage in each soil to identify those of concern. N.C.-adapted soybean germplasm will also be screened for variation in carryover herbicide sensitivity.



## Fungicide Resistance of Frogeye Leaf Spot in N.C. Soybeans

Lindsey Thiessen, NCSU

Frogeye leaf spot (FLS), caused by *Cercospora sojina*, causes damage to soybean in hot, humid climates within the U.S.. Fungicides are a major tool for managing damage caused by *C. sojina*, particularly the QoI fungicides like azoxystrobin and pyraclostrobin. But QoI fungicides are high risk for fungicide resistance due to the single-site mode of action. Resistance to QoI fungicides was first detected in Tennessee soybean fields in 2010. Since then, isolates of *C. sojina* resistant to QoI fungicides have been found in several other states in the U.S. Resistant populations are suspected in N.C., so the NCSU funded a project with N.C. State to determine if and where these populations are located.



**Fungicide-resistant Frogeye Leaf Spot was found across several soybean production regions in N.C., so producers should select fungicides that utilize multiple modes of action and not use single FRAC 11 fungicides to avoid control failures.** The mechanism for fungicide resistance development is still poorly understood, however, the effects of resistance may be mitigated with integrated pest management strategies. Rotation of fungicide chemistries, use of mixed modes of action and other cultural disease management practices are all important to reduce losses to disease like Frogeye Leaf Spot.

- Fungicide Resistant Isolates
- Mixed Population (Both Resistant and Sensitive Isolates)
- Fungicide Sensitive Isolates

## Chemical Control of Nematodes in N.C. Soybeans

Lindsey Thiessen, NCSU

Soybean Cyst Nematode (*Heterodera glycines*) and Root Knot Nematode (*Meloidogyne* spp.) cause damages to soybean throughout N.C. Resistance is available for several races of SCN, but there is minimal resistance available to race 2, 4, and 5 which are dominant in N.C. Host resistance is also available for some RKN species, but is primarily for Southern Root Knot Nematode (*Meloidogyne incognita*). Crop rotation is the best control method for managing nematode populations, but some regions of N.C. lack economical options for crop rotation.

Several chemical and biological products have recently been introduced to the market, but their efficacy under different environmental conditions and to different products has not yet been established. The NCSU funded a project through the checkoff to begin to evaluate the efficacy of seed treatments and chemical/biological agents for nematode control.

Given the different environments in which soybean is produced in N.C., the level of control of seed treatments may differ between regions and nematode populations. To address this, seed treatments were assessed in Hyde, Johnston and Moore counties. **Seed treatments did not improve yields at any site, nor were nematode populations or damages reduced by the seed treatments.** This study is currently being repeated in 2019 at several other sites with several different nematode species to determine the best fit for seed treatments in N.C. soybean production.

## Validation of Soil Test Potassium Recommendations

David Hardy, NCDA

Potassium (K) deficiency is the most prominent nutrient deficiency in plant tissue samples analyzed by the N.C. Department of Agriculture (NCDA) and 40% of soil samples submitted by the NCDA are medium to very low for K. If recommendations are followed, K fertilizer costs can be a significant part of growers' annual operating expenses (about 20%). However, if under-applied and K is limiting, seed yields are decreased from 5-20%. There is a need to evaluate current soil test K recommendations and plant tissue testing sufficiency ranges so the checkoff funded this work to ensure N.C. growers are receiving the best information for economical production and competitive yields.

Sites of varying K levels were selected under conventional and no-till production systems to evaluate applications of muriate of potash (MOP) ranging from 0 to 200 pounds per acre. The study was carried out for three years and no yield response to K was found at any site despite some sites being sufficiently low enough to warrant potash recommendations. Also, no yield response occurred in plots where tissue samples of plants at early growth or R2 indicated K levels below sufficiency. This study **supports the idea that soil test recommendations are adequate for a range of yield conditions as related to soil types commonly found in N.C.**

## Cover Crops to Improve Soil Properties and Yields

Josh Heitman and Deanna Osmond, NCSU

Conservation tillage and cover cropping are commonly considered to be among the most important aspects of soil health management. Cover crops may be beneficial in increasing soil health by increasing organic matter and nutrient cycling by biological processes. However, regional variation in soil properties and local climates may affect the impacts of using cover crops and it is not clear how long it takes for improvements to be measurable. To start to evaluate the benefit of introducing cover crops into a system, the NCSU helped fund a study of long-term corn-soybean rotation under nine different tillage treatments. Soil properties and crop yields were compared.

Results from this study indicate **soil health is difficult to measure, especially in many of the sandy, low-organic-matter soils found in N.C.** While a winter wheat cover crop may provide potential benefits in terms of soil protection or nitrogen capture, such effects will not be apparent to growers using current soil health tests or yield as a way to gauge the performance of their management. Reduced tillage systems **provide an effective means of protecting soil and their adoption with or without crops is encouraged.**



# The Importance of Investment in Agricultural Research

Owen Wagner, NCSPA

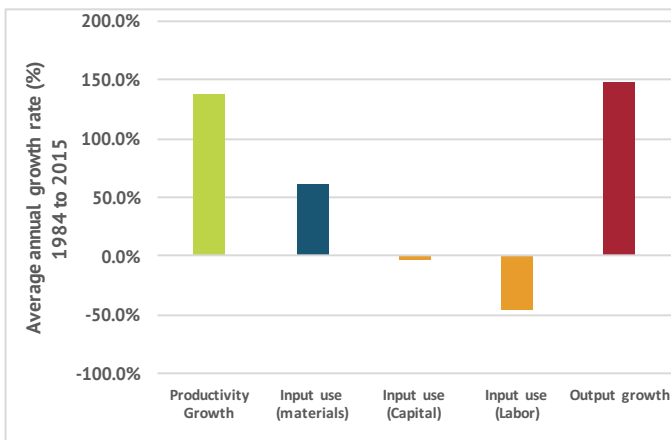
The North Carolina Soybean Producers Association spends a significant amount of its budget on research, roughly 50% on average, over the past 5 years. We hope that after reading through this year's Research Report and based on your on-farm experience you agree this is a wise investment.

With the crop portfolio of N.C. evolving in recent years, the NCSPA has prioritized research to help our members transition soybeans from a rotational crop to a profit crop. Key projects funded include studies of planting date x maturity group interaction, fertility, management of early-maturing varieties and various practices to maximize yields.

N.C. State University continues to be a great partner in carrying out the NCSPA's research interests. Since joining the University last year, extension specialist Dr. Rachel Vann, has generated energy and new research ideas. The NCSPA has made significant investments in N.C. State's soybean research, and through the stewardship of the board and Dr. Stowe, the University has contributed in kind. For example, for every dollar the Association has invested in Dr. Vann's and other research programs, including the \$1 million investment in the Plant Sciences Initiative, it is estimated the University contributes \$1.30 in salaries, overhead and equipment.

The return on investment in agriculture has historically been very strong and there is every reason to believe gains will continue. Since 1948 (chart below), U.S. agricultural

## Sources of growth: U.S. farm sector (average annual growth rates, percent), 1948-2015



211 SIX FORKS ROAD, SUITE 102  
RALEIGH, NORTH CAROLINA 27609

[www.ncsoy.org](http://www.ncsoy.org)

Non-Profit  
Organization  
U. S. POSTAGE  
PAID  
Raleigh, NC  
Permit No. 2106

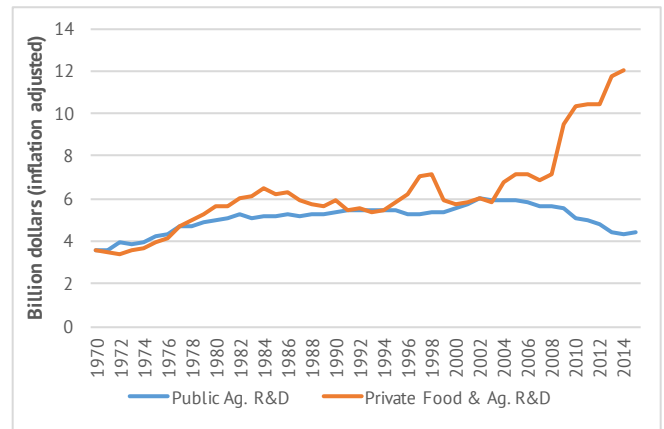
To assist us in maintaining an accurate address file and reduce postage costs, please notify the N.C. Soybean Producers Association (919-839-5700) of any address changes or corrections. Comments and suggestions are also welcome.

output (red bar) has averaged growth of nearly 1.5% per year. The use of materials like fertilizer and crop protectants (blue bar) has increased over time, but this has been almost entirely offset by decreases in the use of capital and labor (orange bars). The result is a productivity growth (green bar) averaging 1.38% annually that can be attributed to scientific advancements and improved farming practices.

Given the unique importance of an ample, low-cost food supply,

the government has historically played a leading role in financing agricultural research, but this has been changing over time (chart above right). In 1970, public expenditures on agricultural research were nearly equivalent to those of the private sector. By 2014, the private sector was spending three dollars for every dollar spent by the public sector.

## Agricultural research funding in the public and private sectors, 1970-2015



While U.S. farmers have benefited from privately funded research in a time of increased consolidation in the sector, they and all who rely on safe and affordable food, must continue to push for government funding or at least find ways to fill the void. Without the complementary support and funding from the USDA, our land grants and organizations like the NCSPA, there is a risk of agricultural science being dominated by a handful of private companies.

Thank you again for supporting the NCSPA and its research activities with your checkoff dollars.