2024-2025 PROPOSALS

and

ANNUAL PROGRESS REPORTS

to the

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

JULY 17, 2024

NORTH CAROLINA STATE UNIVERSITY

COLLEGE OF AGRICULTURE AND LIFE SCIENCES

North Carolina Cooperative Extension Service

North Carolina Agricultural Research Service

NC STATE UNIVERSITY

NEW PROPOSALS

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

FOR RESEARCH OR EDUCATION ENTITLED:

Small Grains Breeding and Genetics Research for North Carolina Growers

COVERING THE PERIOD FROM **10/01/2024** TO **09/30/2025**

REQUESTING SUPPORT IN THE AMOUNT OF **$100,000**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Nonoy Bandillo	**Crop and Soil Sciences**

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RALEIGH, NORTH CAROLINA
IRS No. 56-6000-756
Second Congressional District

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Note: This is a fundamental research or scholarly project and, as such, the University shall be free to publish or disseminate the results of this research or otherwise treat such results as in the public domain, and it will conduct the research in an open forum consistent with the University's mission of research, instruction and public service.

NCARS/NCCES Code: 25-01

OBJECTIVE(S):

Objective 1. Develop and release new cultivars and germplasm of small grains best suited for landscapes, ever-changing climate, and ever-evolving diseases and pathogens in North Carolina.

Objective 2. Identify and incorporate new genes/traits/germplasm for:

- resistance/tolerance against biotic stressors, including Hessian fly, scab, leaf and stripe rust, powdery mildew, root and crown rot;
- better adaptation to early heading, freeze damage, photoperiod sensitivity;
- improved nitrogen-use efficiency.

Objective 3. Create approaches and tools for mitigating major phenotyping bottlenecks and production issues in wheat development.

Objective 4. Improve breeding efficiency and better placement of new cultivars with genomics-assisted breeding.

PROJECT DESCRIPTION AND RELEVANCE:

Increasing productivity of wheat and other small grains in North Carolina will require stacking durable resistance genes against ever-evolving diseases and pathogens, as well as adapting the crops to highly variable, stressful environments. New cultivars with greater agronomic and disease trait packages, combined with efficient nitrogen-use and better adaptation to temperature fluctuation are most likely to be productive in a wide range of environments. This project will lead an effort to develop the next-generation modern cultivars through product profiling that prioritizes the “must-have” traits and “value-added” traits for targeting different market segments in North Carolina production environments. In the next five year, we are proposing to build off past success while looking to implement new breeding technologies that can accelerate breeding cycles, increase the number of lines screened, improve selection accuracy, and scaling up data collection processes at a reduced cost. We will also lead the effort to increase the next-generation big data for predictive and prescriptive cultivar selection and management to aid in better profiling of new environments, enhancing selection and deployment of new climate-resilient cultivars adapted to North Carolina. We will identify and incorporate new genes/traits/germplasm into North Carolina adapted cultivars, including for adaptation to early heading, freeze damage, photoperiod sensitivity, better nitrogen-use efficiency, combined with improved durable resistance to Hessian fly, scab, leaf and stripe rust, powdery mildew, root and crown rot.

RESEARCH PRIORITIES BEING ADDRESSED:

Increasing and protecting yield and quality from biotic stressors in wheat production
In North Carolina, the average life of a wheat variety in North Carolina is five years. The effectiveness and success of new cultivars depend mainly on key biotic and abiotic stressors affecting wheat and other small grains production. The key biotic stressors include Hessian fly, and ever-evolving disease and underlying pathogen for scab, leaf and stripe rust, powdery mildew, root and crown rot. Hessian fly has occurred at high levels in North Carolina over the past five years. Powdery mildew, leaf rust, stripe rust and Hessian fly have threatened production during the past five years. The occurrence of powdery mildew and leaf rust is every year. Above threshold levels of stripe rust were observed in eastern North Carolina in the past multiple years. The climactic shift in North Carolina production environments favoring pathogens to evolve perhaps cause stripe rust to cause some production damages. Thus, there is a continuous need to conduct research on these ever-evolving pathogens and diseases, and to provide wheat producers with new varieties with improved durable resistances.

Increasing and protecting yield and quality from abiotic stressors in wheat production.
In North Carolina, late spring freezes severely impacted wheat yields in the state in multiple years. Looking at some alternative genetic approaches to help wheat varieties avoid too early growth should be a priority. One approach is to breed for better adaptation by manipulating the key flowering genes, including changing the primary trigger for flowering in wheat varieties from vernalization (chilling unit accumulation) to photoperiod (daylength). With ever-changing climate and instability, we hypothesize moving away from temperature-based triggers to daylength-based triggers can provide a greater degree of yield stability. We hypothesize that development of predictive models for characterizing and predicting environments and genotype-by-environment interactions will be key and will help for better placement of new cultivars for North Carolina production environments.

Improving breeding efficiency and shortening the breeding cycle.
A key focus is to identify, prioritize, and validate the new breeding approaches and technologies within the logistical context in the NCSU small grains breeding program. We will develop 'the essential breeding tools' to support selection breeding decisions that can accelerate breeding cycles, increase the number of lines screened, improve selection accuracy, and scaling up data collection processes at a reduced cost.

Data integration and collaboration is key.
We can assess many critical issues in wheat development and production by collaborating, data integration and data mining from the NCSU and other public universities ((VA, NC, SC, GA, FL, LA and AR) breeding programs. This project will generate and use all possible ranges of biological and environmental data to make predictions. The key hypothesis is that extensive data, including genomic, environmental, and management information within the North Carolina production environments can improve our ability to identify new genes, and then use for deployment of new cultivars into well-characterized environments. Predictive algorithms will be developed to integrate this knowledge into a refined modeling framework for characterizing future environments and deployment of new varieties.

APPROACHES AND PROCEDURES:

Objective 1. Develop and release new cultivars and germplasm of small grains best suited for landscapes, ever-changing climate, and ever-evolving diseases and pathogen in North Carolina.

Activity 1.1 Development of breeding populations targeting different market classes. About 90 percent of our variety development efforts go to wheat, 5 percent to oats, and 5 percent to triticale. The established variety development pipeline will be implemented for generating approximately over 30,000 new lines. About 300 unique cross combinations will be created in the winter greenhouse crossing program during September 2024 to March 2025. To save a year in the breeding process seed of all F_1 oat hybrids and 300 wheat F_1 will be advanced in the greenhouse to the F_2 generation.

Activity 1.2 Early generation advancement and selection. Wheat and oat F_2 and F_3 generation populations will be advanced in Clayton in 25' by 4' plots. Approximately 100 heads will be selected from each population. Approximately 20,000 wheat and oat head rows (1' x 4') in the F_5 and F_6 generations will be evaluated in Clayton, Kinston, and Plymouth under intense disease pressure.

Activity 1.3 Advanced testing, disease and quality evaluation. Approximately 1,000 wheat and 100 oat lines will enter the advanced phase of testing (F_7, F_8, F_9 and doubled haploid generations). Evaluations will be conducted at six in-state locations and up to 30 multi-state locations, depending on the generation of the materials. Advanced lines will be evaluated in multiple nurseries and locations, including Laurel Springs, Salisbury, Lake Wheeler (Raleigh), Clayton, Kinston, and Plymouth, North Carolina, and Florence, South Carolina. Two special

inoculated and misted scab nurseries will be planted at Kinston and Lake Wheeler. Three specialized Hessian fly screening nurseries will be planted in late September / early October at Kinston. A specialized Root and Crown rot nursery will be planted at Hugo in Lenoir County. Multiple critical traits in these advanced lines will be evaluated as follows: milling and baking quality (Soft Wheat Quality Laboratory, Wooster, OH), DON toxin content, a by-product of scab infection (University of Minnesota), laboratory evaluations for Hessian fly resistance (USDA-ARS, West Lafayette, Indiana) and Ug99 stem rust resistance (USDA-ARS, Njoro, Kenya). The proposed NCSU Elite Breeding Pipeline is summarized in Figure 1. Briefly, a combination of new omic technologies and breeding methodologies will be used for increasing breeding efficiency and speeding up development of new cultivars.

Activity 1.4 Integration of genomic selection, rapid hybridization and high-throughput phenotyping.

Figure 1 illustrates how new technologies and breeding methodology will be used for increasing genetic gain in the program. Briefly, whole-genome prediction will be used to identify the best, optimal cross combination before making any actual hybridization. Genomic selection will be used at the preliminary yield trial where phenotypic selection is likely ineffective. Rapid generation advancement or also know as speed breeding will be used to shorten the inbreeding phase from 3 years to only 1 year. High-throughput phenotyping will be implemented at the preliminary and advanced yield trials.

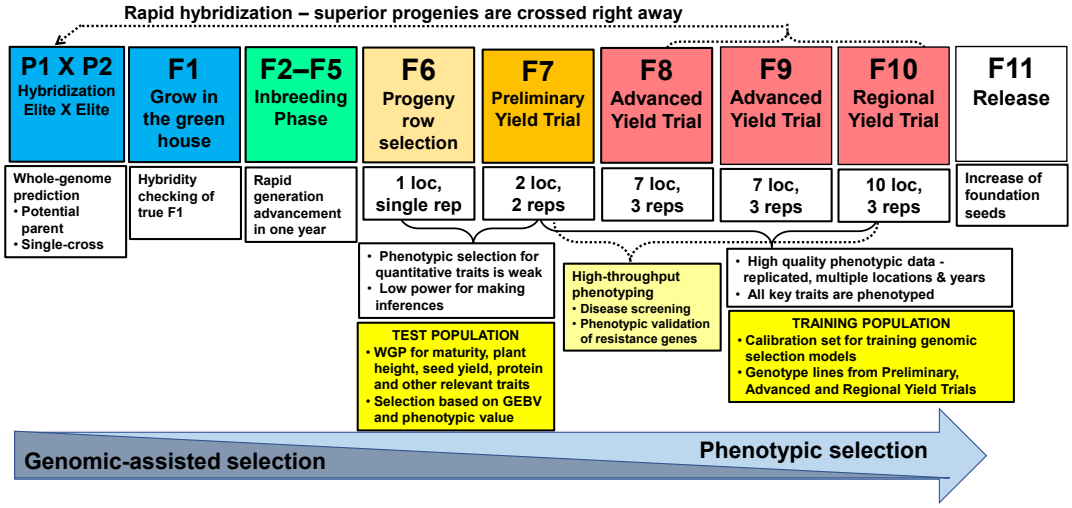

Figure 1. Schematic representation of the proposed integrated omics technologies and new breeding methodologies for accelerated cultivar enhancement for small grains.

Objective 2. Identify and incorporate new genes/traits/germplasm:

Development of new genetic resources and mapping populations is a prerequisite for identification of new resistance and genetic dissection of genomic regions underlying biotic and abiotic stresses. A Multi-parent Advanced Generation Inter-Cross (MAGIC) is an integrated multi-parent population approach that combines the advantages of linkage mapping and association mapping for high resolution, high-power mapping of complex traits. We will use the MAGIC approach to stack genes for durable resistance by recombining 16 founder parents. The selected founder parents are known to have high protein, superior quality traits, high-yield potential, and exhibit tolerance to a suite of biotic and abiotic stresses for wide-adaptation potential. This project will develop and advance up to 2,000 pre-breeding lines that exhibit tolerance to a suite of biotic and abiotic stresses in target environments in North Carolina.

The breeding materials will be distributed for evaluation through a network at Research Extension Centers and collaborating universities. Among the targeted desired traits are:

- Resistance/tolerance against biotic stressors, including Hessian fly, scab, leaf and stipe rust, powdery mildew, root and crown rot;
- Better adaptation to early heading, freeze damage, photoperiod sensitivity;
- Improved nitrogen-use efficiency.

The new assembled MAGIC population will be characterized with known DNA markers and then link to known traits through genome-wide association mapping. We hope to provide up to 400 lines to the two-testing network for agronomic evaluation in local environments. All data will be curated and displayed to enable continued use by the NCSU Small Grains Breeding Program.

Objective 3. Create approaches and tools for mitigating major phenotyping bottlenecks and production issues in wheat development and production.

Developing and deploying cheaper, more effective methods for collecting accurate, interpretable, and biologically meaningful data remains a perennial bottleneck in public breeding programs. Two platforms are proposed to be deployed and evaluated: 1) a greenhouse-based platform for disease evaluation, and 2) an unmanned aerial vehicle for phenology and agronomic evaluation under field conditions. In addition, we will evaluate the 'speed breeding' technique using the rapid generation advancement. This technology will permit pulse breeders to turnover generation and reduce the length of the breeding cycle under controlled greenhouse conditions. We will continue to make progress on development of well-designed breeding data management platform for bringing together all breeding-related data, including phenotype, genotype, pedigree, and environmental data (e.g., weather, soil) from multi-year, multi-location experiments. A robust and computationally powerful database management system must be created and integrated into breeding workflows to enable a comprehensive evaluation on the performance of new lines across various environments. With increasing data generated from different platforms, we will explore and/or develop algorithms and software to permit the digital collection of phenotype data in both field and greenhouse.

Objective 4. Improve breeding efficiency and better placement of new cultivars with genomics-assisted breeding.

To deploy genomics-assisted breeding into variety development efforts, our team will re-establish a dedicated molecular marker laboratory and make it fully operational. We aim to identify, validate, and prioritize molecular approaches that work effectively within the logistical context of applied breeding efforts. The development and implementation of diagnostic markers will be explored for tracking large-effect genes underlying resistance to major biotic stressors, including Hessian fly, scab, leaf and stripe rust, powdery mildew, root and crown rot. Genomic selection (GS) has become an attractive option as a decision tool as genotyping costs have significantly declined to the extent that the per-individual cost of sequencing is less expensive than the per-sample cost of multiple-environment testing. GS should be found to be beneficial mainly for 1) replacing and/or complementing PS with GS by generating genomic estimated breeding values (GEBV) for multiple traits at early stages of testing (e.g., OYT, PYT); 2) shortening the breeding cycle by skipping a field trial year; 3) selection of potential parents; and 4) further reducing the operational cost by culling out unfavorable breeding lines at earlier stages of testing. In this project, we propose to genotype selection candidates representing all possible families in the preliminary yield testing stage with no to limited phenotypic data, and then perform 1) selection of candidate parents for the next crossing cycle and 2) selection of advanced lines for next phase of field testing on the basis of GEBV.

FUNDS REQUESTED:

2024-25 ..... **$100,000**

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

FOR RESEARCH OR EDUCATION ENTITLED

Italian Ryegrass Management Strategies

COVERING THE PERIOD FROM **10/1/2024** TO **9/30/2025**

REQUESTING SUPPORT IN THE AMOUNT OF **$100,000**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Charlie Cahoon	**Crop and Soil Science**
Wesley Everman	**Crop and Soil Science**
Morgan Menaker	**NC Cooperative Extension Union County**
Andrew Baucom	**NC Cooperative Extension Union County**

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Note: This is a fundamental research or scholarly project and, as such, the University shall be free to publish or disseminate the results of this research or otherwise treat such results as in the public domain, and it will conduct the research in an open forum consistent with the University's mission of research, instruction and public service.

OBJECTIVE(S):

1: Using impregnated herbicide materials in corn, cotton, and soybean prior to harvest. Conducted on-farm and in small plots.
- Before leaf drop
- At harvest
- POST harvest

2: Seeding rate and timing of cover crops in corn, cotton, and soybean prior to harvest. Conducted on-farm and in small plots.
- Before leaf drop
- At harvest
- POST harvest

3: Seeding method of cover crops in corn, cotton, and soybean prior to harvest. Conducted on-farm with county agents.
- Spreader truck
- Plane
- Drone
- Drill

4: Summer cover establishment in corn, cotton, and soybean prior to harvest to suppress Italian ryegrass prior to wheat planting. Conducted on-farm and in small plots.
- Sorghum
- Sorghum-sudangrass
- Sunhemp

PROJECT DESCRIPTION AND RELEVANCE:

Resistant weed species continue to be one of the greatest challenges facing growers in North Carolina. Although new technologies are on the horizon, no silver bullets exist for current resistant weed problems such as Italian ryegrass. While alternative control methods continue to be investigated, it is clear that there is a lack of effective control methods for Italian ryegrass in North Carolina.

Over-the-top grass weed control in wheat has been an effective means to control most weed species in North Carolina. However, the continued spread of resistance is a real threat to postemergence Italian ryegrass control. In addition, with the increase in resistance to burndown herbicides (glyphosate and paraquat) in our southern piedmont region, real challenges face our growers in all commodities. A multi-faceted management approach with novel practices is needed to manage Italian ryegrass considering increased chemical resistance. We propose as series of research trials both small plot and on-farm that will investigate the use of herbicide impregnated fertilizers to deliver residual herbicides prior to Italian ryegrass emergence, various seeding times for cover crops, and novel establishment methods and cover crops. This broad suite of projects will allow us to dial in the most effective herbicide timings, most effective cover crop timings, and what novel practices are practical and effective, as well as how to best utilize them to give growers options for managing resistant Italian ryegrass.

To accomplish these objectives, a series of research and extension activities surrounding Italian ryegrass management are planned to address Research Objective 1 and Extension Objectives 1 and 3 in the Small Grain Growers list of priorities. The research we propose is a multi-faceted three-year proposal with funding for two graduate students (1 MS and 1 PhD) simultaneously. We plan to utilize both on-farm and small plot research sites to host training and field days where results can be shared. We feel confident the outcomes will provide a range of real-world practices which growers can adopt to reduce Italian ryegrass pressure both in wheat and rotational systems.

The proposed research is no small undertaking, as each objective will require several treatments evaluated at multiple application times to several crops. A detailed treatment program follows for each objective listed above.

The initial studies will consist of various herbicide impregnated material application in corn, cotton, and soybean crops prior to harvest. Additionally, we plan to conduct a series of trials to look at cover crop establishment methods and timings in corn, cotton, and soybean crops prior to harvest to identify the optimal time and method to seed cover crops prior to Italian ryegrass emergence. While this will focus on winter cover, we also have plans to investigate summer cover crops to suppress Italian ryegrass germination prior to planting wheat.

The research questions are:

1) What are the best impregnated herbicides, and application timings in corn, cotton, or soybean to reduce Italian ryegrass germination prior to wheat or cover crop planting?
2) What are the best application timings for fall cover crops in corn, cotton, or soybean to reduce Italian ryegrass establishment in the fall and reduce populations?
3) What are the best seeding methods for fall cover crops?
4) Can summer seeded cover crops be established in corn, cotton, or soybean to suppress Italian ryegrass germination prior to wheat or cover crop planting?

Within these questions, we plan to establish small plot research trials and complementary on-farm trials to look at effectiveness of each practice, but also feasibility on a large scale. As we collect data, we will assess the economics of various practices and impact on wheat and rotational crops as appropriate.

Research Methods:

1: Using impregnated herbicide materials in corn, cotton, and soybean prior to harvest.
Trials will be established in small plots and on-farm in corn, cotton, and soybean. Various impregnated herbicides will be spread on fertilizer in each crop prior to leaf drop, after leaf drop but prior to harvest, and after harvest to determine the impact of timing in each crop system on Italian ryegrass control. For example, does control improve if herbicides are applied prior to leaf drop, with more soil contact? Or does control improve if application occurs near harvest? At least 2 trials per crop (one small plot and one on-farm) will be established in Year 1 and in Year 2 for a total of 6 trials each year and 12 trials total.

2: Seeding rate and timing of cover crops in corn, cotton, and soybean prior to harvest.
Trials will be established in small plots and on-farm in corn, cotton, and soybean. Cereal rye will be spread in each crop prior to leaf drop, after leaf drop but prior to harvest, and after harvest to determine the impact of seeding timing in each crop system on Italian ryegrass suppression. For example, does suppression improve if cereal rye is applied prior to leaf drop, with more soil contact? Or does suppression improve if application occurs near harvest? At least 2 trials per crop (one small plot and one on-farm) will be established in Year 1 and in Year 2 for a total of 6 trials each year and 12 trials total.

3: Seeding method of cover crops in corn, cotton, and soybean prior to harvest.
Trials will be conducted on-farm with county agents to determine what methods are best utilized to seed cereal rye in corn, cotton, and soybean prior to crop harvest. Trials will investigate the use of spreader trucks and aerial platforms (plane or drone) compared to traditional drill seeding to determine if spreading seed is as effective at suppressing Italian ryegrass. In addition, economic factors such as fuel, seed, and application costs will be collected to determine feasibility of the various practices.

4: Summer cover establishment in corn, cotton, and soybean prior to harvest to suppress Italian ryegrass prior to wheat planting.

Trials will be established in small plots and on-farm in corn, cotton, and soybean. Summer cover crops (i.e., sorghum, sorghum-sudan, sunhemp) will be interseeded in each crop during the summer growing season to determine the impact of each cover crop on each crop and the level of Italian ryegrass suppression. For example, do summer cover crops interseeded with each crop impact growth and yield? Do the summer cover crops produce enough biomass to suppress Italian ryegrass germination, growth, or establishment prior to wheat planting? At least 2 trials per crop (one small plot and one on-farm) will be established in Year 1 and in Year 2 for a total of 6 trials each year and 12 trials total.

RELATIONSHIP TO SIMILAR PROJECTS, IN NC AND OTHER STATES:

No current projects are similar in nature to this proposal; however, the NC Soybean Producers Association has expressed interest in providing additional support toward this project as it has implications for their growers as well.

FUNDS REQUESTED:

2024-25 ..... **$100,000**

2025-26 ..... $100,000
2026-27 ..... $50,000

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

FOR RESEARCH OR EDUCATION ENTITLED

The Effects of Using Cereal Rye (*Secale cereale)* as a Cover Crop for Control of Italian Ryegrass (*Lolium multiflorum)* in Fallow Land in the Southern Piedmont of North Carolina

COVERING THE PERIOD FROM **10/01/2024** TO **09/30/2025**

REQUESTING SUPPORT IN THE AMOUNT OF **$4,000**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Charles W. Cahoon, Jr.	**Crop and Soil Sciences**
Wesley Everman	**Crop and Soil Sciences**
Morgan S. Menaker	**NC Cooperative Extension**
Andrew L. Baucom	**NC Cooperative Extension**
Rachel E. Owens	**NC Cooperative Extension**

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NCARS/NCCES Code: 25-03

OBJECTIVES:

1. Explore the effectiveness of using cereal rye as a management tool for controlling Italian ryegrass
2. Determine the ideal planting date, seeding rate, pre-emergent herbicide, and which combinations best control Italian Ryegrass.
3. Determine fertilization rates for the production of cereal rye for hay and straw production.

Significance of Research:

1. Explore the effectiveness of using cereal rye as a management tool for controlling Italian ryegrass

Herbicide-resistant Italian ryegrass has long infested North Carolina. In particular, the southern Piedmont has widespread ALS resistance (Osprey and PowerFlex) spotty ACCase-(Hoelon and Axial XL), and glyphosate resistance. And there is now confirmed paraquat-resistant ryegrass in the region. While pyroxasulfone (Zidua/Anthem Flex) provides residual control of the weed, it, and other related herbicides, do not control emerged ryegrass. It is only a matter of time before our few pre-emergent modes of action are lost to resistance. Preserving these tools for small grain production is essential to maintain the efficacy of the herbicidal mode of action.

Paraquat-resistant Italian ryegrass poses a serious threat to all crops in North Carolina. Although small grain production will most likely be hit the hardest, the inability to control Italian ryegrass burndown seriously threatens the timely planting of corn, cotton, and full-season soybeans. Waiting for Italian ryegrass to decline naturally will push planting of these crops into June and greatly reduce yield potential.

2. Determine the ideal planting date, seeding rate, pre-emergent herbicide, and which combinations best control Italian Ryegrass.

While there is current research on cereal rye as a forage crop, there is a need to determine the ideal planting dates and seeding rates for cereal rye in the specific application of controlling Italian ryegrass in fallow land in the southern Piedmont of North Carolina.

3. Determine fertilization rates for the production of cereal rye for hay and straw production.

Federal programs such as NRCS will not cover the total costs incurred when using a cover crop. Some producers may be interested in offsetting this cost by utilizing cereal rye as a forage crop. There is a need to determine the economic viability of forage production in this system by exploring different fertility rates to increase tonnage and overall forage quality.

Prior and Current Research:

1. Explore the effectiveness of using cereal rye as a management tool for controlling Italian ryegrass

Recent work from the NC State Weed Science programs has identified up to 98% reduced seed germination in field plots of drilled cereal rye at 100 lbs/A. Research conducted in Union County in 2023-2024 demonstrated a reduction in seed production, an improvement in a following corn crop's early season vigor, and comparable stands to fallow ground in cotton.

2. Determine the ideal planting date, seeding rate, pre-emergent herbicide, and which combinations best control Italian Ryegrass.

NC State Extension has publications with seeding rates and planting dates for cereal rye as a forage crop. There is no current recommendation for seeding rates for cereal rye when used to control Italian ryegrass, which may have success at a lower seeding rate, impacting a producer's bottom line. Additionally, cereal rye for the trial year 2024-2025 will be following a soybean crop scheduled for a fallow winter. However, planting dates will align with other cash crop harvest periods.

3. Determine fertilization rates for the production of cereal rye for hay and straw production.

The current recommendation for fertilization of cereal rye as a forage crop is 50 lbs of N per acre. However, since producers want to offset establishment costs, different rates must be explored to establish the economic viability of using cereal rye as an additional revenue source. Cereal rye is harvested before bermudagrass and fescue (March/April), when both forages are in low supply.

Plan of Work:

1. Explore the effectiveness of using cereal rye as a management tool for controlling Italian ryegrass

The proposed study will be conducted at one heavily infested field site in the southern Piedmont. The site will be comprised of three replicated trials. Data collection will include Italian ryegrass control, cover crop biomass, and pre-emergent + cereal rye compatibility.

Trial 1: *Seeding rate x planting date* (PD). Seeding rates are 0, 50, and 100 lbs/ac with the variety Wrens Abruzzi, a forage variety. This variety will be used for all trials. PD 1, will occur in early September. The seed will be broadcast into standing soybeans before leaf drop. Soybeans will then be desiccated. A burndown post planting will be determined at the planting time for each PD. 30 lbs N/ac will be applied to aid in stand establishment. PD 2, 3, and 4 will be drilled between the end of September and October. Data Collection: Cover crop biomass, cover crop establishment broadcast versus drilled and ryegrass reduction.

2. Determine the ideal planting date, seeding rate, pre-emergent herbicide, and which combinations best control Italian Ryegrass.

Trial 2: *Cereal Rye + Pre-emergent*. All treatments will include 100 lbs seed/ac, drilled, a pre-emergent, and 30 lbs N/ac applied at the spike stage. Data Collection: Cover crop biomass, herbicide compatibility, and ryegrass reduction.

3. Determine fertilization rates for the production of cereal rye for hay and straw production.

Trial 3: *Fertilization Rate x Seeding Rate*: Rye will be drilled at 50 and 100 lbs seed/ac, and treated with 0, 30, and 60 lbs N/ac in a single application. Data Collection: Forage sample, tonnage, and biomass.

FUNDS REQUESTED:

2024-25 ..... **$4,000**

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

FOR RESEARCH OR EDUCATION ENTITLED:

Utilizing Barley for Mitigation in Coastal Salty Soils

COVERING THE PERIOD FROM **10/01/2024** TO **09/30/2025**

REQUESTING SUPPORT IN THE AMOUNT OF **$27,500**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Angela R. Post	**Crop and Soil Sciences**

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NCARS/NCCES Code: 25-04

OBJECTIVE(S):

1. Evaluate whether barley has sufficient salt tolerance to perform well in coastal salty soils compared to traditional crops grown in the region for a grain crop and not just a cover.
2. Identify 2- and 6-row barley varieties particularly suited to high performance in coastal salty soils.
3. Educate producers in areas subject to salt-water intrusion on crop rotations which incorporate barley.
4. Graduate student training in the impacts of salt intrusion and strategies to mitigate a solution.

PROJECT DESCRIPTION AND RELEVANCE:

This research proposal addresses 2024-25 Research Priorities #6 and #7 as defined by the Small Grain Growers Association.

Rationale: Coastal agricultural land in Northeastern North Carolina is threatened with saltwater intrusion as a result of storm surge, land subsidence, increased drainage ditch salinity, coastal groundwater salinization, and sea level rise. While many strategies may mitigate these threats, one solution is for landowners to plant crops that are tolerant to increased levels of salt. Plants tolerant of salty soils are classified as halophytes, but not many of them are cash crops. Barley is one of these crops. In the past North Carolina barley trials have been mostly conducted at in Mills River, Salisbury, and at the Oxford Research Station, but not evaluated close to the North Carolina coast.

Approach: In 2023-24 we took preliminary data on 'Atlantic' barley planted on several salt intruded soils. Barley dry biomass accumulated on soils with negligible salt content was 2067 lb/A. In a high salt content soil the barley was still able to accumulate 1683 lb, or 81.4% of biomass accumulated on unaffected soils. Compare this to previous trials we have had with multiple varieties of rice and soybean, none of which could survive on the salted soils. In the saltiest soils tested, the barley was able to accumulate as much as 2% salt by weight in its tissues and, on average, plots in this field accumulated 0.75% by weight in their tissues. Most crop plants do not have the ability to sequester salts inside their tissues, but barley does.

Following up on these preliminary findings we would like to test multiple 2- and 6- row barley varieties available to growers for their salt tolerance. Replicated field trials will be evaluate up to ten barley varieties on soils contaminated with varying levels of saltwater intrusion. Trials will be established in three locations: one severe salt intrusion area, one moderate salt intrusion area, and one non-salted soil, if possible, in the same soil type. Plots will be maintained using recommendations for best management practices for winter barley production. Fertility will be maintained based on soil testing recommendations. Pest control will be applied on an as needed basis for insect, disease and weed pests utilizing only products labeled for use in barley. Per plot soil testing will be taken twice at each location and biomass will be taken once. Tissue sampling will be completed at Growth Stage 36. Data will include: fall tiller counts, height, lodging, yield, test weight, and grain moisture at harvest. Harvest samples will be submitted for full quality analysis. All data will be collected on a per plot basis except final quality, which will be a single composite sample of each variety by site.
One graduate student will be trained over the course of this project. They will gain experience in North Carolina Small Grains Cropping systems and learn how important winter grain rotations are to North Carolina producers. The student will gain valuable outreach and research presentation opportunities through their work and learn to effectively communicate, interact and work closely with producer partners as well as extension agent partners. Currently this student intends to continue pursuing a research-based career following graduation and these skills will be invaluable to their success. Student progress toward graduation, extension outputs resulting from the work and research publications will all be a measure of success for this project.

Expected Outcome: The project will have an impact on the advancement of barley as an important feed and specialty crop in North Carolina, but especially within an area of land where there are increasingly fewer options for landowners impacted by saltwater intrusion. Barley may offer an opportunity as an alternative crop for landowners to keep their affected acres in production.

Timeline: This is part of a PhD project and we are requesting 50% student and project support for this work. It will continue for two additional seasons (2025-26 and 2026-27).

RELATIONSHIP TO SIMILAR PROJECTS, IN NC AND OTHER STATES:

There are other projects along the east coast evaluating crop plants for their tolerance to saltwater intrusion. Saltwater-intruded acres are increasing and projected to continue increasing in the coming decade. Currently there are no published studies evaluating commercially available barley lines for tolerance to salted soils.

FUNDS REQUESTED:

2024-25 ..... **$27,500**

2025-26 ..... $27,500
2026-27 ..... $27,500

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

FOR RESEARCH OR EDUCATION ENTITLED:

Production Practice Development for Milling Quality Wheat

COVERING THE PERIOD FROM **10/01/2024** TO **09/30/2025**

REQUESTING SUPPORT IN THE AMOUNT OF **$55,000**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Angela R. Post	**Crop and Soil Sciences**

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IRS No. 56-6000-756
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Note: This is a fundamental research or scholarly project and, as such, the University shall be free to publish or disseminate the results of this research or otherwise treat such results as in the public domain, and it will conduct the research in an open forum consistent with the University's mission of research, instruction and public service.

NCARS/NCCES Code: 25-05

OBJECTIVE(S):

1. Evaluate plant growth regulators, late applications of micronutrient packages, bio-stimulants, and potassium products in separate field trials to identify their individual influence on wheat quality
2. Develop and release a set of production practices to assist producers growing milling quality wheat

PROJECT DESCRIPTION AND RELEVANCE:

Each year growers strive to meet milling quality in North Carolina and receive as much as $1.00 premium for this higher quality wheat. However, only a small proportion of NC wheat meets this quality and makes it to the mill, 15-20% in any given year. While there are a small number of producers in south central and northeastern North Carolina who are skilled at producing milling wheat, there are a large proportion of producers who struggle to find the management balance needed to meet quality standards. All North Carolina growers need a clear set of management practices to follow in order to more frequently meet the milling quality standards. Use of plant growth regulators, late applications of micronutrient packages, bio-stimulants, and potassium products have all been reported to elevate wheat quality at harvest in limited studies. Comprehensive research needs to be completed to assess the impact of each of these on wheat quality to increase the proportion of wheat in NC that can meet and be sold for milling grade.

Approach: Replicated field trails will be conducted in areas of the state where wheat growers have access to sell milling quality wheat. There will be separate trials for potassium and plant growth regulators. There are additional opportunities to evaluate bio-stimulants and micronutrient packages in addition to these trials.

Plant Growth Regulator: Recent trials in North Carolina evaluating the effect of Palisade used at full rate 14.4 oz/A across short vs tall and early vs late maturing varieties has demonstrated that earlier maturing varieties benefit more for reduction in height and later maturing varieties benefit more from increases in stem diameter and reduction in first internode length. Many studies have evaluated the height, stem diameter and yield influences from the use of Palisade, but none for North Carolina have evaluated the potential increase in grain quality characteristics. The trials planned for this proposal will include three palisade rates and a purposefully lodged check plot to compare decreases in quality due to lodging as well.

Potassium: Gu et al. (2021) demonstrated that foliar potassium applications could improve grain protein and dough quality when applied at boot or flowering stages. Hossain et al (2015) conducted research in spring wheat and demonstrated increasing grain yield and biomass accumulation as potassium rates increased up to 65 lb K/A. We initiated studies in 2024 to evaluate three granular and three foliar potassium rates at planting and at flowering. However, we are still evaluating the grain for quality and pre-sprouting. We would like to continue investigating potassium effects on grain quality for another season. There were some yield and test weight differences which may influence grower decisions about timing and source for potassium applications.

Bio-stimulant products and micronutrient packages have not been evaluated thoroughly in a research-based way for NC growers. Many companies push the use of these products and many growers are utilizing them. Growers may be realizing some yield benefit from these products, but it is unknown if they are realizing any milling quality benefits. Pasquotank county plots evaluating zinc, copper, and manganese products individually in 2021-2022 did not perform better than control plots. Evaluating in-season applications of biostimulants and micronutrient packages to improve test weight and protein content will assist growers in making decisions on which combination of products to utilize for maximizing grain quality.

Research trials will be on-farm and on research stations. Each trial will be randomized and replicated four times with appropriate controls included. Data collected for all trials will include: tissue samples throughout the growing season, height, % lodging, yield, test weight, % protein, Falling number, DON and % pre-sprouting. Each grain sample by plot will be graded to determine if it would meet milling quality. Economic analysis will be completed after year two to evaluate the return on investment for these products used in the system. All trials will receive 150 lb N/A and crop protection including herbicide, fungicide and insecticide as needed using best management practices and weekly scouting to identify problems.

Expected Outcome: Production practices that most frequently improve wheat to milling grade will be identified and compiled into the Wheat Quality chapter of the Small Grain Production Guide. This will also create a protocol to begin combining the most relevant practices to elevate wheat quality in North Carolina. Increasing the number of bushels sold for milling quality should increase receipts through the farm gate and receipts from assessment that can be used to re-invest in wheat research for NC.

This is a Master's student project. We are asking for support for two planting seasons.

RELATIONSHIP TO SIMILAR PROJECTS, IN NC AND OTHER STATES: Lots of work has been done on individual project aspects offered here, however, most work has been aimed at improvement in yield over other quality metrics. There are no local or regional data to demonstrate the added products or timings a grower should utilize to maximize their ability to produce milling quality wheat season after season.

FUNDS REQUESTED:
2024-25 ..... **$55,000**

2025-26 ..... $55,000

References:

Gu, Xiaoyan, Yang Liu, Na Li, Yihong Liu, Deqiang Zhao, Bin Wei, and Xiaoxia Wen (2021) Effects of the Foliar Application of Potassium Fertilizer on the Grain Protein and Dough Quality of Wheat *Agronomy* 11, no. 9: 1749.

Hossain, A., J. T. Da Silva, and M. Bodruzzaman (2015). Rate and Application methods of potassium in light soil for irrigated spring wheat. Songklanakarin J. Sci. Technol. 640 37 (6), 635-642.

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

FOR RESEARCH OR EDUCATION ENTITLED:

Small Grains Extension & Outreach Program

COVERING THE PERIOD FROM **10/01/2024** TO **09/30/2025**

REQUESTING SUPPORT IN THE AMOUNT OF **$20,000**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Angela R. Post	**Crop and Soil Sciences**

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Note: This is a fundamental research or scholarly project and, as such, the University shall be free to publish or disseminate the results of this research or otherwise treat such results as in the public domain, and it will conduct the research in an open forum consistent with the University's mission of research, instruction and public service.

NCARS/NCCES Code: 25-06

OBJECTIVE(S):

1. Continuing education training for agents through Small Grains Short Courses.
2. Incorporate complete datasets into consumable products for online and in-person dissemination.
3. Support on-farm visits by the small grains specialist to troubleshoot for farmers and extension agents.
4. Support and execute the 2024-25 Whistle Stop Tour program.

PROJECT DESCRIPTION AND RELEVANCE:

The Small Grains Extension program provides agent training, physical and virtual consumables for education of farmers and the public on small grains topics, and site visits to troubleshoot small grain problems that arise throughout the year on-farm. This proposal is a request to support each of these items as a comprehensive package.

Agent Training: To ensure we are cultivating the best possible resource in our ag agents, they are in need of comprehensive training in small grains production. Turnover in county agents has been high for many years and some counties even go without agents for extended periods of time when there is a vacancy. We provide short courses to make sure the agents we have in place and those just coming on board are well-trained and prepared for what the season sends their way. We will offer the Annual Small Grains Short Courses both basic and advanced. The basic course will be offered in Raleigh, NC with demonstration plots on-farm in Johnston County and at the Clayton Research Station. By offering these trainings at a separate time from farmer training events, we can educate and answer agent questions out of the view of farmers. This allows them to be more open and free to ask questions on the topics they need to learn more about. In-depth training at these events helps agents become a valid and reliable resource for growers.

New Consumables & Virtual Education Opportunities: By the end of 2025 season, all chapters in the small grain production guide will have paired video content. Throughout 2024-25 we will continue to increase the level of video content for the production guide so that producers and agents can consume the information in written and visual formats. New videos will be released from the program on important topics as they arise during the season.

Site Visits: Each year I make site visits to troubleshoot on-farm problems. Fuel costs and any overnight travel required to complete these site visits are covered under this proposal. I often make 30-40 farm visits each year under this proposed extension and outreach work. I also present efforts on our extension programming at the national level and these funds support travel to the CSSA/ASA/SSSA meeting each year to learn from other grains specialists around the country and present our programming from North Carolina.

Whistle Stop Tours: Each year we host 12 to 15 Whistle Stop tours on small grains. Most of these do not require monetary support except to pay for my travel to and from the sites. However, at a few of them we offer snacks or a light meal to encourage participation. We will continue to support these stops through the Extension and Outreach budget. They are a great resource for farmers and industry professionals to get their final questions answered during the grain-fill period and to highlight some of the agent trials around the state for their local growers.

Farmer Grain Quality Samples: Grain quality samples submitted by farmers through their extension agents remains a “free” service to NC growers. This is supported through funds received by my program from the wheat assessment. The Extension and Outreach budget pays for the consumable supplies and some hourly wages for team members to analyze these samples for NC farmers.

RELATIONSHIP TO SIMILAR PROJECTS, IN NC AND OTHER STATES:

Almost every other state with large acreages of small grains has comprehensive extension programming to offer to stakeholders in their state and greater region. We look to those successful programs to better our work here in NC and in the future, we hope to inspire those successful programs to adopt some of our strategies as well. We have moved in a team direction here involving several specialists in our field days each year and inviting them to participate in our short course and Whistle Stop training events. We have successfully integrated with the NC OVT and are continuing to impress programs around the country to work towards a model of collaboration rather than isolation.

FUNDS REQUESTED:

2024-25 ..... **$20,000**

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

FOR RESEARCH OR EDUCATION ENTITLED

North Carolina Wheat: On-Farm Trial (OFT) Network

COVERING THE PERIOD FROM **10/01/2024** TO **09/30/2025**

REQUESTING SUPPORT IN THE AMOUNT OF **$11,500**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Angela R. Post	**Crop and Soil Sciences**
Andrew L. Baucom	**NC Cooperative Extension Union County**

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NCARS/NCCES Code: 25-07

Objectives of Research:

1. Conduct agent-led, high-quality, on-farm research at the county level that addresses specific local production issues, while complementing small plot research being conducted by the NC State Extension Small Grain Extension team.

2. Create a network of extension agents who have the skill set and abilities to conduct large plot on-farm research, analyze the corresponding data, and present conclusions at local and regional meetings to agricultural professionals.

3. Build relationships for new and beginning agents alongside local producers to enhance the overall NC State Extension Field Crops Extension program.

Significance of Research:

1. To educate small grain producers on local research that enhances their overall production

Small grain production varies across North Carolina, with different regions of NC having varying production challenges. By utilizing local extension agents to generate high-quality on-farm data that address local needs, producers will be able to enhance their overall production practices in areas that are specific to their region of North Carolina. This research will enhance the overall Small Grains Extension program and complement small plot research that is currently conducted by NC OVT and the NCSU Small Grains Extension program.

2. Empower local extension agents to conduct and present on-farm research

Agent-led, on-farm research is becoming increasingly uncommon across North Carolina. Agents who previously conducted this work have retired or moved on to other career opportunities. Additionally, large-plot research is extremely valuable to producers for visualizing and understanding how a production practice will affect whole fields. The OFT Network seeks to cultivate the next generation of field crop agents who conduct on-farm research that is relevant to local producers and is then presented at local, regional, and statewide conferences.

3. Develop high-quality field crop agents across North Carolina

Most field crop agents across North Carolina have less than 5 years of experience, with many agents never having conducted any research trials. Additionally, countless early career agents have expressed challenges in developing relationships with local producers. This program seeks to address both of these issues. By providing agents with a package program, agents have the confidence to execute on-farm research. Through conducting on-farm research, agents will gain confidence and skills to enhance relationship-building across their county to connect with a larger audience of field crop producers.

Prior and Current Research:

1. <u>Prior Research:</u>

In 2018, NC OVT began the first Agent Variety Trial (AFT) network. This network sought to complement data generated by the Official Variety Trial (OVT) program. Additionally, the network captured local data outside of the NCSU small plots trials, addressed differences in small-scale vs. large-scale variety testing, and sought to enhance agent/producer relationships.

2. <u>Current Research:</u>

Beginning in 2020, The NCSU Soybean Extension Program created On-Farm Tests (OFT) to begin conducting high-quality, agent-led, on-farm testing. This program has continued since 2020 from its inception to now include the major soybean production areas across North Carolina.

Plan of Work:

1. Study Design

- A replicated strip trial with a minimum of 4 pairs of strips should be planted and harvested.
- Wheat should be planted by Thanksgiving
- Treatments include an untreated control/check and one product/treatment
- Strip width should match the grower's equipment.
- Strips will be measured at the time of harvest

2. Data Collection and Management

- Strips should be scouted for plant health throughout the growing season. Observations should be recorded
- Data collection will include: yield, test weight, 1 gallon grain sample from each plot at time of harvest for quality analysis
- Any suspected disease will be sent to the Plant disease and insect Clinic at NC State for identification
- Yield data can be collected using a properly calibrated grain cart or weigh wagon

3. Protocol Options for Agent Selection

County agents will have the opportunity to select between two (2) packaged protocols.

A. Foliar Fungicide

One (1) product will be applied at Feekes 10.5.1 growth stage of wheat, regardless of disease pressure. All other production practices will be determined by the local cooperator. The objective of this protocol is to investigate the residual activity of a fungicide application made during at-flower timing in relation to disease pressure, to determine the impact of a foliar fungicide on grain yield and quality, and to determine the economic viability of a foliar fungicide application.

B. Plant Growth Regulator

One (1) application of a PGR will be made between Feekes 4 and Feekes 5, leaf sheaths lengthening and strongly erected. Total nitrogen applied to the crop will be consistent at 150lbs/A. The remaining production practices will be determined by the local cooperator. The objective of this protocol is to determine varietal differences to a PGR application - including total plant height, lodging at harvest, overall length of grain heads, and grain yield.

4. Agent/County Selection

- Funding requested for this budget cycle will support the selection of five (5) sites
- A call for participants will go out on 01 September with commitments by mid-September to provide ample time to secure and distribute products.
- Agents who are not currently participating in NCSU-led small plot trials, will receive first priority.

FUNDS REQUESTED:

2024-25 ..... **$11,500**

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

FOR RESEARCH OR EDUCATION ENTITLED:

Uncovering the Rotational Benefits of Wheat to the Following Soybean Crop

COVERING THE PERIOD FROM **10/01/2024** TO **09/30/2025**

REQUESTING SUPPORT IN THE AMOUNT OF **$60,000**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Rachel Vann	**Crop and Soil Sciences**
Angela Post	**Crop and Soil Sciences**
Jenny Carleo	**NC Cooperative Extension**
Nick Piggott	**Ag and Resource Economics**
Derek Washburn	**Ag and Resource Economics**
Luke Gatiboni	**Crop and Soil Sciences**

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OBJECTIVE(S):

1. Understand the impact of wheat residue on moisture dynamics, soil nutrient availability, pest pressure and ultimately soybean yield and quality in diverse wheat producing areas of North Carolina.
2. Expand double-crop budgets to more robustly capture cost/benefit of a double-crop system.
3. Deploy a comprehensive outreach campaign to accompany research findings that includes timely result reporting, dissemination in face-to-face Extension channels including double-crop focused meetings, consistent use of NC State Extension Portals, and diverse digital outreach strategies (social media, field videos, etc.)

PROJECT DESCRIPTION AND RELEVANCE:

Project Relevance: A key pillar in the success of North Carolina agriculture is our diversity of crop production which provides local feed for our sizeable and grain-deficit animal industries. Winter wheat production is an important component of that diversity and double-cropping wheat and soybeans is an example of a sustained cropping system approach in our environment. However, the impact of wheat in this system on the subsequent soybean crop is not well understood with current crop management and genetics. This lack of knowledge makes decision making on double-cropping soybeans a challenge, as the wheat residues role in climate-resilience is not understood and could be crucial in overcoming erratic weather patterns and high input costs.

Research Sites and Treatment Description: Research will be deployed in diverse wheat producing regions of North Carolina at four sites annually (Coastal Plain, Northeast NC, Rowan, and Union Counties) for a total of eight environments of research. At each environment, 3 treatments will be deployed that include a full season soybean planting date, a double-crop soybean planting date following wheat, and a double-crop soybean planting date planted fallow as a comparison. The trial design will be a randomized complete block design with each treatment replicated 6 times in each environment for a total of 18 plots/environment. Plots will be at least 100 ft long and as wide as needed for wheat harvest and residue management. Each treatment will be managed using grower standard management practices for wheat management and harvest.

Data Collection

Soil moisture dynamics: One of the key areas of interest in wheat residue impact on soybean production is the role of wheat residue in conserving soil moisture for the soybean crop. To investigate this, we need to deploy soil moisture sensors that constantly monitor soil moisture throughout the soybean production season. The team is still investigating the most robust and cost-effective mechanisms to dynamically monitor soil moisture across these plots, but options include purchasing commercially available soil moisture sensors or working with technology developed through the NC Plant Sciences Initiative to monitor soil moisture dynamics.

Fertility dynamics: Soil samples will be collected twice a year, before wheat and soybean planting, to evaluate the effect of treatments on soil fertility. Samples will be submitted for routine soil analysis at the NC Department of Agriculture & Consumer Services (NCDA&CS) labs and soil organic carbon will be analyzed at the NC State University Biological and Agricultural Engineering laboratory. Nutrients in the wheat residue and their contribution to soil fertility will be evaluated by measuring the wheat residue dry matter at harvest. Straw samples be analyzed by the NCDA&CS plant testing lab. In the no-till field sites, decomposition mesh bags with wheat residue will be added on the soil surface at soybean planting and removed immediately before soybean harvesting. The remaining residue dry matter and nutrients will be measured to estimate the nutrient release during the soybean season.

Pest Management dynamics: One of the key differences in production between full season and double-crop soybean production is the influence of pest pressure (nematodes, disease, insect, and weed pressure). These differences have an economic impact but to robustly capture these differences, frequent scouting at a site with both full season and double-crop soybeans must occur so these differences can be captured in a way that would allow them to be incorporated into crop budgets. To understand the pest pressure differences between both full season and double-crop soybean production, but also between double-crop soybean planting dates with and without wheat, bi-weekly scouting will occur in all treatments across environments to evaluate pest pressure differences across treatments. Scouting will include visual assessments for disease and nematode pressure and sweeping for insects per Extension guidelines. If nematode pressure is evident, treatments will be soil sampled to understand rotation impact on nematode presence. Additionally, plots will be chemically managed to keep them weed-free and differences in weed management needed to execute this across treatments will be documented. This information will feed into the revamping of the double-crop soybean budgets.

Soybean Yield and Quality: Soybean yield will be captured using a small-plot combine. In each plot, a subsample of grain will be collected and analyzed for protein content, oil content, seed damage, and purple seed stain.

Double-Crop Budget Development: Double-crop budgets for soybeans following wheat will be developed based on the results of the field trial work, which will measure the key elements that can impact the economics of double-cropping and the profitability of the system. Double-cropping can impact crop revenues, which can be impacted by changes in yields and possibly prices because of changes in the quality of soybeans and wheat. Double-cropping also impacts variable costs of production because of changes in fertilizers, herbicides, pesticides, fuel, and labor associated with the double-cropping system.

Outreach Campaign: A comprehensive outreach campaign will be deployed to share findings from this research. Results will be widely extended to North Carolina soybean producers. This will include in-person presentations in the field and at winter grains meetings, written reports, scientific posters, factsheets, videos and other online resources such as websites and social media. Additionally, there is interest in hosting double-crop specific programming in regional meetings across the state, as modeled by efforts in Illinois, to disseminate the most up-to-date double-crop production information.

RELATIONSHIP TO SIMILAR PROJECTS, IN NC AND OTHER STATES:

There has been considerable effort dedicated in North Carolina in recent years to update soybean agronomic recommendations to align with new genetics and more aggressive crop management. These efforts have spanned many planting dates (March through July), many soybean maturity groups (2-8), and many North Carolina locations (n=20). Regardless of North Carolina location, yield losses of 0.45 to 0.87 bu/Acre/day have been observed as planting dates were delayed past the third week of May. However, due to logistical constraints, later planting dates investigated were generally planted into fallow situations rather than planted behind wheat. Despite these consistent results from our research trials over a 5-year period, it is not uncommon for producers in high yielding soybean areas to indicate that their double-crop soybean yielded as much or more than their full season soybeans. International research on soybeans following wheat has shown that wheat straw increased soil moisture and decreased soil temperature, and straw mulch significantly increased soybean yield (Akhtar et al., 2019). Additionally, research done in 2019 and 2020 across North Carolina showed there was no difference in soybean yield between full season soybeans planted fallow, full season soybeans planted behind cereal rye, double-crop soybeans planted behind wheat, and double-crop soybeans planted behind rapeseed. These results were surprising and underscore the complexity of growth dynamics in North Carolina for diverse soybean production scenarios. For

these reasons, we have a strong interest in understanding what impact wheat residue has on soil fertility, pest pressure, soybean yield, and grain quality in environments with varying residue levels, wheat production intensity, and soybean production intensity.

This project is a critical component of a holistic research effort to better optimize management in double-crop soybean production in North Carolina. In addition to recently conducted research on later planted soybeans across the state, Co-PIs Carleo and Vann are currently working on a two-year ($69,316) research and Extension project funded by NC Soybean Producers Association with the goal to systematically identify which management practices are most productive, from a yield standpoint and also economically, in double-crop soybean production.

FUNDS REQUESTED:

2024-25 ..... **$60,000**

2025-26 ..... $62,500

2026-27 ..... $21,825

References:

Akhtar, K., Wang, W., Khan, A., Ren, G., Afridi, M. Z., Feng, Y., Yang, G. (2019) Wheat straw mulching offset soil moisture deficient for improving physiological and growth performance of summer sown soybean. *Agricultural Water Management*, 211, 16-25.

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

FOR RESEARCH OR EDUCATION ENTITLED

Evaluating Modern Wheat Varieties for Yield Response to Nitrogen Fertilization and Nitrogen Use Efficiency (NUE)

COVERING THE PERIOD FROM **10/01/2024** TO **09/30/2025**

REQUESTING SUPPORT IN THE AMOUNT OF **$18,740**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Andrew L. Baucom	**NC Cooperative Extension Union County**
Morgan S. Menaker	**NC Cooperative Extension Union County**

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Note: This is a fundamental research or scholarly project and, as such, the University shall be free to publish or disseminate the results of this research or otherwise treat such results as in the public domain, and it will conduct the research in an open forum consistent with the University's mission of research, instruction and public service.

NCARS/NCCES Code: 25-09

Objectives of Research:

1. Determine optimum nitrogen fertilization rates for top-performing wheat varieties in the south-central Piedmont.
2. Analyze varieties for nitrogen use efficiency (NUE) and quality.
3. Determine what correlation exists for varietal response to total N applied, and percent lodging.

Significance of Research:

1. Determine optimum nitrogen fertilization rates for top-performing wheat varieties in the south-central Piedmont.

Properly managed applications of nitrogen are critical for a successful wheat crop. Mismanaged applications can increase crop lodging, foliar diseases, and environmental damage as well as decrease profitability. Growers are currently managing varieties they produce with similar nitrogen rates, based on tiller count, tissue sampling, and environmental conditions. We have termed this “adaptive management.” A knowledge gap exists in knowing how modern varieties will respond to nitrogen fertility.

2. Analyze varieties for nitrogen use efficiency (NUE).

Misapplying nitrogen is far too costly. While the four R’s of nutrient management are the right source, right rate, right time, and right place, this proposal begs the question of a fifth R; right variety. The Official Variety Testing team has put forth a great tool for bringing localized data to the palm of a farmer's hand. This proposal aims to keep adding information to that readily accessible database.

3. Determine what correlation exists for varietal response to total N applied, and percent lodging.

Crop lodging significantly slows harvest, and decreases quality, and yield. While lodging can be weather dependent, nitrogen rates and varietal differences influence a crop's standability. Determining what modern varieties can tolerate, in terms of nitrogen fertilization, without lodging, will aid in optimizing nitrogen applications.

Prior and Current Research:

1. Determine optimum nitrogen fertilization rates for top-performing wheat varieties in the south-central Piedmont.

<u>Prior Research</u>

An NC State University graduate student, Kaitlyn Moody, published a paper in 2019, *five years ago*, titled “Varietal Response to Increasing Nitrogen Rates Compared to Sensor Based Rate in Soft Red Winter Wheat Using GreenSeeker™ Technology.” This study, investigating 15 varieties, found that some varieties hold a strong correlation between yield and increasing nitrogen rates while others did not. Many of the varieties tested are now not commercially available.

Current Research

The Union County Cooperative Extension office and Small Grains OVT team have already performed one year of this trial over the 2023-2024 season. Varieties included were: Agrimaxx 505, USG 3118, Dyna-Gro 9120, USG 3472, Agrimaxx 492, SH 7222, USG 3451, SY Viper, Pioneer 26R59, and AP 1995. Data are still being analyzed.

2. Analyze varieties for nitrogen use efficiency (NUE).

Previous research has been done in North Carolina. However, with commercial lines having a "lifespan" on the market, new research is needed to determine which lines have a higher NUE than others.

3. Determine what correlation exists for varietal response to total N applied, and percent lodging.

A varietal response to lodging has been identified in scientific literature, proving that some varieties have better standability than others. Some varietal factors that influence lodging are plant height, stem internode thickness, and stem diameter.

Plan of Work:

1. Determine optimum nitrogen fertilization rates for top-performing wheat varieties in the south-central Piedmont.

Variety will be chosen based on the following criteria. 1.) Are at least 3% better than the trial mean on the Official Variety Selector Tool between 2022-2024 for the south-central Piedmont region of North Carolina (Union and Rowan sites). 2.) Have a history of being entered into wheat yield contests.

Varieties will be planted in a randomized complete block design. Treatments include 0, 60, 100, 150, and 200 lbs N/acre across ten varieties. Nitrogen will be applied at planting, early spring, and at Zadoks growth stage (GS) 30 or topdress.

2. Analyze varieties for nitrogen use efficiency (NUE).

Except for the at-plant nitrogen application, tissue samples will be collected pre- and post-topdress nitrogen applications. Soil samples will be collected at planting and harvest. This will be done to evaluate the relationship between applied nitrogen, soil nitrogen, plant nitrogen, and varietal efficiency.

3. Determine what correlation exists for varietal response to total N applied, and percent lodging.

Lodging ratings will be taken on the day of harvest based on a visual rating scale. Plant height will be measured at harvest.

FUNDS REQUESTED:

2024-25 $18,740

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION, INC.

FOR RESEARCH OR EDUCATION ENTITLED

The Effects of Utilizing an Intense Management Approach, with Proper Maturing Varieties and Planting Dates, to Maximize Wheat Yields through Scouting, and Making Appropriate and Timely Fertility, Herbicide, Insecticide, and Fungicide Applications

COVERING THE PERIOD FROM **10/01/2024** TO **09/30/2025**

REQUESTING SUPPORT FOR **$5,000**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Tim Britton	**NC Cooperative Extension Johnston County**

NORTH CAROLINA STATE UNIVERSITY
RALEIGH, NORTH CAROLINA
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Note: This is a fundamental research or scholarly project and, as such, the University shall be free to publish or disseminate the results of this research or otherwise treat such results as in the public domain, and it will conduct the research in an open forum consistent with the University's mission of research, instruction, and public service.

Objectives of Research:

1. To assist in developing regional management recommendations for the Coastal Plain of North Carolina by investigating planting dates, varieties, fertility, and pest control.
2. To compare an intense management program to the standard hands-off approach of most growers to determine the economic viability of inputs for growers.
3. To determine the effect of scouting for insect and disease pressure and nutrient deficiencies issues in wheat with weekly visits and tissue sampling as needed through emergence to harvest.
4. To determine what effect inputs have on wheat yield so that agents can make recommendations to growers.

Extension Objectives:

1. Applied on-farm research specific to regional needs to assist agents and growers and increase profits. Local priority strip trials and replicated field trials initiated in collaboration between growers, Extension agents, area-specialized Extension agents, NCDA agronomists, and NC State Extension specialists gives validity to Extension recommendations.

Significance of Research:

1. **To assist in developing regional management recommendations for the Coastal Plain of North Carolina by investigating planting dates, varieties, fertility, and pest control.**

    - Each year, agents are asked how late is too late to plant wheat and make a profit. We have data supporting planting windows for the coastal plain. We also know that you plant late maturing varieties early and early maturing varieties late. These trials are designed to determine the effect of planting date (3 different dates) and variety maturity (early, medium, and late) on yield, with the three planting dates having early, medium, and late maturing wheat varieties. The trial is designed to support current extension recommendations while gaining quantitative data on how much yield is lost every week planting is delayed.

2. **To compare an intense management program with a standard hands-off approach of most growers to determine the economic viability of inputs for growers.**

    - Growers tend to believe there is enough nitrogen left over from the previous crop to warrant not applying any preplant fertilizer and spray an insecticide at layby with a fungicide if needed. In making recommendations, what can we tell growers looking to make a profit on wheat to do to increase yields and profits? Price per bushel and weather are things we cannot control. We know that yield does not always correlate with profit. We have kept up with all inputs, and we know that in 2022 and 2023, an increase of 21.7 bushels/A was needed for the intense management treatments to make a profit. In 2021, wheat prices were higher ($8.47/bushel), and the increase in the number of bushels was considerably lower in this region of North Carolina.

3. **Scout for insect and disease pressure and nutrient deficiencies issues in wheat with weekly visits and tissue sampling as needed through emergence to harvest.**

    - Being from Johnston County, I know that crops like tobacco and vegetables are scouted weekly, and an intense management program is used for these crops. With that said, there is a need to determine the economic viability of weekly scouting and crop sampling to determine the needs of the wheat crop throughout the growing season and see if the management style can increase profits.

4. **To determine what effect inputs have on wheat yield to assist agents in recommendations to growers**

    - We have determined that intensive management increases wheat yields but may not always increase profits. The objective of trial 2 is to determine which input makes the most difference in yields on soil types found in the coastal plain when wheat is planted on time.

Prior and Current Research:

For the past three years, we have conducted this field trial. We have used different wheat varieties but have always had an early, medium, and late variety. We have planted on three planting dates: The beginning of our planting window (October 26-28), the end of our planting window (November 14-16), and a late planting date around December 1. Based on extension recommendations, we have increased the lbs./A of seed with each planting date.

We had an intense management plot and a standard practice plot for each maturity and each planting date. Treatments were randomized with four replicated plots for each treatment and planting date for a total of 72 plots (24 for each planting date).

We have learned that the intense manage plots have outperformed the standard practice plots by 15-30 bushels/A, and the first planting has out-yielded the second planting by 10-15 bushels/A and the third planting by 20-30 bushels/A. We know there is a correlation between January tiller counts and yields. In evaluating test weight and falling numbers, we have not been able to correlate a difference between management styles.

Plan of Work:

Three varieties of wheat, an early, a medium, and a late maturing variety, will be planted using a Model 606N Great Plains grain drill on three different dates. The planting dates will be late October, mid-November, and early December. Seeding rates will be adjusted accordingly based on the planting date. After planting, plots will be divided into standard management practices and intense management practices. Treatments were replicated four times per planting date for each variety in a randomized complete block design.

Intense Management treatments will receive 30 lbs./A of preplant nitrogen and 90 lbs./A of preplant potassium, with an additional 120 lbs./A of nitrogen and 30 lbs./A of potassium in spring. Anthem Flex will be applied at 80% spike stage for ryegrass and bluegrass control. Axial Bold will be applied in January, and Miravis Ace and Warrior will be applied in early spring.

Grower standard treatments will receive no preplant fertilizer with 120 lbs./A of nitrogen and potassium applied in the spring, with the Warrior applied at layby.

The number of tillers per sq ft will be counted in January, and harvest will occur when wheat has dried. For this trial, it is important to evaluate seed quality and vomitoxin levels as most of our wheat goes for livestock feed with some of our higher quality wheat going to Bartlett Milling for flour.

In addition to this study, a separate trial 2 will be initiated on the first planting date to determine which one of the intense management inputs has the most effect on increasing yield.

Treatments will be as follows

Treatment 1: 30 lbs./A of preplant nitrogen and 90 lbs./A of preplant potassium with an additional 120 lbs./A of nitrogen and 30 lbs./A of potassium in spring. Anthem Flex will be applied at 80% spike stage for ryegrass and bluegrass control. Axial Bold will be applied in January, and Miravis Ace and Warrior will be applied in early spring.

Treatment 2: No Preplant with 120lbs./A of Nitrogen and Potassium in spring. Anthem Flex will be applied at 80% spike stage for ryegrass and bluegrass control. Axial Bold will be applied in January, and Miravas Ace and Warrior will be applied in early spring.

Treatment 3: 30 lbs./A of preplant nitrogen and 90 lbs./A of preplant potassium with an additional 120 lbs./A of nitrogen and 30 lbs./A of potassium in spring. Axial Bold will be applied in January, and Miravis Ace and Warrior will be applied in early spring.

Treatment 4: 30 lbs./A of preplant nitrogen and 90 lbs./A of preplant potassium with an additional 120 lbs./A of nitrogen and 30 lbs./A of potassium in spring. Anthem Flex will be applied at 80% spike stage for ryegrass and bluegrass control. Miravis Ace and Warrior will be applied in early spring.

Treatment 5: 30 lbs./A of preplant nitrogen and 90 lbs./A of preplant potassium with an additional 120 lbs./A of nitrogen and 30 lbs./A of potassium in spring. Anthem Flex will be applied at 80% spike stage for ryegrass and bluegrass control. Axial Bold will be applied in January, and Warrior will be applied in early spring.

Treatment 6: 30 lbs./A of preplant nitrogen and 90 lbs./A of preplant potassium with an additional 120 lbs./A of nitrogen and 30 lbs./A of potassium in spring. Anthem Flex will be applied at 80% spike stage for ryegrass and bluegrass control. Axial Bold will be applied in January, and Miravis Ace will be applied in early spring.

Cooperator Support:

The research will take place in a donated grower field. Nutrien Ag Solutions, FMC, Syngenta, and several seed companies have supported this project and will again this year. I will partner with Angela Post and Ryan Heiniger to conduct harvest and data analysis. The objectives of this proposal rely on support from the Small Grains Extension/Official Variety Testing programs for harvest and grain quality analysis. We estimate this support will contribute $4,000 to the project's cost. Dr. Post also analyzes and summarizes the data for distribution to growers.

FUNDS REQUESTED:

2024-25 ..... **$5,000**

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

FOR RESEARCH OR EDUCATION ENTITLED:

When are Fungicide Applications Profitable in North Carolina Winter Wheat?

COVERING THE PERIOD FROM **10/01/2024** TO **09/30/2025**

REQUESTING SUPPORT IN THE AMOUNT OF **$30,000**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Jenny Carleo	**NC Cooperative Extension**
Christina Cowger	**USDA-ARS, Plant Sciences Research Unit Adjunct, Entomology and Plant Pathology**

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NCARS/NCCES Code: 25-11

OBJECTIVE(S):

1) Conduct field experiments to determine profitability of fungicide applications under a variety of conditions. **Expected outcome:** Realistic recommendations for fungicide profitability and timing that include head scab (Fusarium Head Blight/FHB) and are applicable to various regions across North Carolina.

2) Development of a dynamic online decision tree for growers answering the question **"Should I spray my wheat?"** This will be a simple and easy-to-use tool that will aid growers in determining the probability of making a profit from a fungicide application depending on their current situation. It will also provide optional education including photos, videos, scouting instructions and additional resources to growers aspiring to learn more about the information behind the reasons for the recommendations. **Expected outcome:** Simplifying spraying decisions for growers while increasing profitability and grower knowledge on disease management and prevention.

PROJECT DESCRIPTION AND RELEVANCE:

This study will identify the optimal fungicide approach that will achieve the widest and most reliable profit margin to the grower. North Carolina is an agriculturally and geologically diverse state with widely differing cultural practices and weather variations from year-to-year. We are requesting a continuation of the field research project that we have been conducting since 2020 to ensure validity of conclusions across regions in North Carolina that include head scab.

In addition to field research, we will compile and organize five years of data into a format useful for all growers of wheat in North Carolina. The Extension Information Technology Department (EIT) at NC State University is prepared to develop a simple tool that farmers can use when making fungicide application decisions during the season. This will also include several educational pieces that will aid the grower in learning more about wheat diseases and cultural methods of disease prevention, and understanding why these practices are successful when implemented.

Field Research:

Variables in the study will continue to involve fungicide mode-of-action and application timings. Data to be collected are disease severity, wheat yield, quality, grain market price received, and fungicide application costs. Research will be conducted in two locations: the Lake Wheeler Research Station in Raleigh and the NCDA&CS Piedmont Research Station in Rowan County. Wheat samples will be submitted to a wheat quality testing lab.

The replicated small plot research will examine the effects of the following treatment combinations in a split-split plot design including non-treated controls:

1) Susceptible vs. resistant variety to head scab
2) Propiconazole; propiconazole+pydiflumetofen and, no fungicide (check)
3) Application timings at top-dress, flowering and top-dress+flowering

The effects of these treatments and interactions between treatments will be compared against the economic input data on:

1) Yield
2) Quality (test weight, falling number, protein, DON/vomitoxin)
3) Input costs, including fungicide product and application costs
4) Market price earned at the time of harvest for both feed wheat and milling wheat

Grower Decision Support and Education:

This will be a simple and easy-to-use website that aids growers in determining the probability of making a profit from a fungicide application depending on their current situation. It will also provide optional educational links and resources to growers aspiring to learn more about the information behind the reasons for the recommendations. The tool will be optimized for use on mobile devices.

Goals:

1) Simplifying spraying decisions for growers
2) Grower education on wheat disease prevention and management
3) Increasing farm profitability through appropriate disease management

Five years of data will be analyzed with the assistance of Quentin Read, USDA-ARS Southeast Area Statistician. This complex dataset will then be loaded into the background of the new grower decision tool. The results will be structured in a simple format that will allow for growers to establish the probability that they would make a profit - based on the results of our field research, current weather conditions and the farmer's own projected wheat price and fungicide costs. Ms. Carleo will be responsible for working with EIT to produce a user-friendly interface for the tool.

RELATIONSHIP TO SIMILAR PROJECTS, IN NC AND OTHER STATES:

1) *Lux, L. et al. 2023. Effects of Metconazole + Prothioconazole, Pydiflumetofen + Propiconazole, and Variety Resistance on Fusarium Head Blight and Yield in Hard Red Spring Wheat. Plant Health Progress 24(2) 155-161.* The use of fungicides on a moderately resistant variety offered a higher return on investment when compared with their use on a susceptible variety under lower head scab pressure environments. This study suggests that a combination of genetic resistance and fungicides containing multiple modes of action may be more profitable than relying on one crop protection method alone under years with disease pressure. Research conducted in North Dakota.

2) *Cowger, C., Read, Q.D., Clark, L., and Dong, Y. 2023. Optimal Timing of Fungicide Application to Manage Fusarium Head Blight in Winter Barley. Plant Disease, 30 Jun 2023. https://doi.org/10.1094/PDIS-01-23-0021-RE.* This research conducted on small grains in North Carolina identifies the optimal fungicide application timing to prevent Fusarium head blight in barley. Due to the direct relationship between growth stage and the ability of FHB to infect small grain species, this study supports the importance of determining the optimal timing of fungicide applications to wheat to prevent yield loss.

3) *Roth, M.G., Mourtzinis, S., Gaska, J.M., et al. 2021. Wheat grain and straw yield, grain quality, and disease benefits associated with disease management intensity. Agronomy Journal. 113:308-320. https://doi.org/10.1002/agj2.20477.* This study was conducted in Wisconsin and revealed that in the upper Midwest a more intensive management system improved yield, test weight and net income and reduced disease prevalence. The intensive management systems tested included nitrogen management as well as foliar fertilizers and multiple mode of action fungicides. Due to the scope of that study, we cannot identify which treatment may lead to a benefit to North Carolina growers. These results do indicate, however, that in a year of high disease pressure we may see increased yield, test weight and net income for growers in North Carolina from the use of fungicides.

4) *Weisz, R., and Cowger, C. 2011. Multiple mid-Atlantic field experiments show no economic benefit to fungicide application if fungal disease pressure is low or absent in winter wheat. Phytopathology 101:323-333.* A total of 42 publicly sponsored tests of fungicides on soft red winter wheat in Virginia and North Carolina were analyzed for the period 1994 to 2010. To calculate profitability, data used included grain price and fungicide application costs including drive-down losses. With routine fungicide application based solely on wheat growth stage, total fungicide application costs had to be <$10 per acre in order to average a ≥50% probability of breaking even or making a profit (compared with not spraying). By contrast, if fungicides were applied when fungal disease was present, total application costs of up to $19 per acre for strobilurins and up to $29 per acre for propiconazole alone were associated with a ≥50% probability of breaking even or making a profit at a wheat price of $5 / bu. The results support basing the decision to apply fungicide on observation of disease, if an economic return for the input is desired.

FUNDS REQUESTED:

2024-25 ..... **$30,000**

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

FOR RESEARCH OR EDUCATION ENTITLED:

Exploring the Viability of Alternative Wheat/Soybean Production Systems: Relay-Cropping vs. Double-Cropping

COVERING THE PERIOD FROM **10/01/2024** TO **09/30/2025**

REQUESTING SUPPORT IN THE AMOUNT OF **$10,000**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Rod Gurganue	**NC Cooperative Extension Beaufort County**

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NCARS/NCCES Code: 25-12

OBJECTIVE(S):

1. Determine production practices to optimize wheat and soybean yield/profit in a relay-crop planting system

2. Determine practicality of relay-cropping systems for North Carolina, including equipment modifications needed for adoption.

PROJECT DESCRIPTION AND RELEVANCE:

This project will explore the viability and adaptability of growing wheat in a planting configuration which allows for soybeans to be interplanted into the growing wheat before harvest, known by some as “relay-cropping”. The project will lay the groundwork for identifying the agronomic production practices that maximize both yield and profitability of wheat in a relay-crop system in our growing conditions. In addition, the practicality of relay-cropping will be examined and accounted for due to the modification of equipment needed to implement and manage wheat grown in this system.

As wheat yield is likely to be reduced when grown in this manner, it is obvious that we must also consider the yield of the soybeans planted and grown in this system. To determine the economic sustainability and ultimate adoption of relay-cropping in North Carolina, we have to see gains in efficiency and/or increases in revenue ***per acre, per year***.

To put it another way, because a living crop is always growing on an acre from wheat planting through soybean harvest, we must evaluate relay-cropping as a system, not as two individual crops grown separately.

To do this, the project will be comprised of several small plot tests designed to determine best agronomic practices (BAPs) for growing wheat in a relay-crop system. The same plots will be used to evaluate BAPs for soybeans, when possible. The soybean phase of the project will hopefully be funded by the North Carolina Soybean Producers Association or some other source.

We have access to a plot planter and combine, so no funding for planting or harvest assistance from Small Grains Extension or Official Variety Testing is requested.

RELATIONSHIP TO SIMILAR PROJECTS, IN NC AND OTHER STATES:

During the 2023-2024 growing season, both large- and small-scale plots were implemented in Belhaven, North Carolina at Circle Grove Seeds with Beaufort County Farmer Darren Armstrong to investigate how to modify equipment for relay-cropping. We planted wheat in two configurations to accommodate two soybean row spacing patterns. These plots were not replicated, rather they were an attempt to learn more about equipment needs before we initiated more serious research efforts.

It was quickly determined that considerations about tractor, planter, sprayer, and combine wheel spacing are crucial to success. Also, planting date of soybeans into a relay-crop system needs to be early to avoid shading and competition for moisture from aready established wheat.

Darren has already invested in a small soybean planter and modified it to plant soybeans between standing wheat on 38-inch rows. He also invested in an auto steer system for a small tractor, as well as a small combine, all for larger scale research.

Beaufort County Extension has much of the equipment needed for the replicated small plot research planned for this project, including a tractor equipped with auto-steer capability needed to perform this research. Some of the funding requested in this proposal will be used to modify our existing equipment to be used in planting and managing these plots.

No other efforts to explore relay-crop systems with wheat and soybeans are known to exist currently in North Carolina. A small grain “turn-row” meeting at our research site in Belhaven in the spring with Dr. Post and Ryan Heiniger drew a lot of interest in our attempt at relay-cropping, with 30 people in attendance and many questions.

FUNDS REQUESTED:

2024-25 ..... **$10,000**

Most of the funding will be used to purchase narrow tires and rims for our John Deere 6110M Tractor. The existing tires are too wide to accommodate the narrow non-planted areas between wheat rows which provide lanes for applying pesticides and fertilizers on the existing wheat, as well as for the soybeans to be planted.

Also, our existing sprayer will need modification as well to apply crop inputs on the planted wheat, and not the empty strips.

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

FOR RESEARCH OR EDUCATION ENTITLED

Small Grain Field Days and Whistle Stop Tours, 2024-25

COVERING THE PERIOD FROM **10/01/2024** TO **09/30/2025**

REQUESTING SUPPORT IN THE AMOUNT OF **$4,000**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Morgan S. Menaker	**NC Cooperative Extension Union County**
Andrew L. Baucom	**NC Cooperative Extension Union County**
Angela R. Post	**Crop and Soil Sciences**

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NCARS/NCCES Code: 25-13

Objectives:

1. Execute one Small Grains Field Day in Union County.

2. Execute one Whistle Stop tour in Union County.

Project Description and Relevance:

This proposal covers three small grain field days in 2024. These events will focus on presenting timely information to growers. Event outlines may change due to the characteristics of the growing season.

1. Southern Piedmont Region Union County Site ($4,000)

a. Led by Morgan Menaker
b. Location to be determined
c. Early or mid-February tentative date
d. OVT and special demonstration plots
e. County agents will identify tests for the event
f. Specialists will coordinate to have tests co-located
g. Planting, plot maintenance, and harvest will be coordinated with Dr. Post.

The field day will be held early in the season and before top-dressing timing if possible. In order to address the unique challenges of each growing season, presentation topics will change from year to year and location to location in order to provide growers with the best information. In 2024 agent training was held after the field day activities.

Small Grains Whistle Stop Tour: ($0)

We will continue with the approach initiated in 2017-18 to reach more growers and stakeholders that may not have a large field day local to their area. There will be a Small Grains Whistle Stop Tour during wheat grain fill. We will target dates in April and May to include topics important during wheat heading. The Small Grains Extension team is asking agents in up to 15 counties to initiate a wheat variety demonstration or other production topic demonstration of interest in their county. Funding to travel to and host the events will be supported through the Small Grains Extension program. Ten of the events will be targeted for wheat and five will be open for other specialty small grains. The schedule of events for this field tour will be available in early January and we will target two locations per day for a total of eight days traveling the state to educate wheat and other small grain producers. Dr. Post will be in attendance at every event and other specialists will attend depending on the topic selected by the agent for their demonstration plots. For example, at variety demonstrations, we would invite Mr. Ryan Heiniger; for fungicide demonstrations we would invite Dr. Christina Cowger; and for weed control demonstrations we would invite Dr. Wes Everman, and so on.

IMPACT

Holding the small grain field days earlier in the year has greatly improved growers' ability to implement new and timelier management practices on-farm. In 2024-25 we will continue to train agents more in-depth at this time when they will be receiving lots of questions in small grains leading up to topdress.

We are still able to train producers on what to look for late season with regard to split nitrogen applications or foliar fungicide applications through the Small Grains Whistle Stop tour. At that time we can also look at the impact we have had in season with additional small grain management tests.

We have been successful at greatly reducing the per-person cost of these events over the last several seasons, utilizing Small Grains Assessment dollars wisely while educating as many producers and stakeholders as possible. We have also encouraged agents in each region to secure industry support to assist in funding these events.

As a program, we are open to new ideas about the field day and whistle-stop tour program and changes in the coming seasons to retain and improve producer engagement.

FUNDS REQUESTED:

2024-25……. $4,000

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

FOR RESEARCH OR EDUCATION ENTITLED:

Northeast Ag Expo Small Grain Field Day

COVERING THE PERIOD FROM **10/01/2024** TO **09/30/2025**

REQUESTING SUPPORT IN THE AMOUNT OF **$5,000**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Jared Harrell	**NC Cooperative Extension Perquimans County**

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NCARS/NCCES Code: 25-14

OBJECTIVE(S):

To provide relevant research information for growers of northeast NC by hosting and executing a Small Grains Field Day in Perquimans County.

PROJECT DESCRIPTION AND RELEVANCE:

Wheat is one of the major field crops for northeast North Carolina. The Northeast Ag Expo Small Grain Field Day is one way that the Extension Centers of Camden, Chowan, Currituck, Gates, Pasquotank, and Perquimans County provide much needed information to the growers and other members of the agricultural community.

FUNDS REQUESTED:

2024-25 ..... **$5,000**

USDA ARS PROPOSAL

Proposal to NC Small Grain Growers Association, 2024-25
Improving Small-Grain Disease Management in North Carolina -- C. Cowger, USDA-ARS

Christina Cowger, USDA-ARS Research Plant Pathologist, requests $30,000 for small-grain disease research and education to benefit the North Carolina small-grain industry in 2024-25. Funds will be used in the following areas:

(1) Support to the North Carolina Small Grain Industry

Funds will be used for small-grain disease education, diagnostics, action alerts, and decision support. Our program will continue to provide:

- **timely, research-based information and advice** to growers, county agents, agronomists, and crop consultants;
- **talks at field days and agent/consultant trainings** on small-grain disease diagnosis & management; and
- **diagnosis and recommendations** to clients of the NCSU Plant Disease & Insect Clinic (PDIC)

(2) Collaboration to test wheat OVT entries in FHB Nursery

NC commercial wheat OVT entries have not been tested in a replicated, misted nursery for Fusarium head blight (FHB) resistance since 2022. Our lab maintains the only FHB screening nursery in the state (at Inwood Road in Raleigh). We will plant 2024-25 commercial wheat OVT entries with replication, and will inoculate, mist-irrigate, and rate the experiment.

(3) Provide growers and crop advisors with data-based recommendations on efficacy and timing of pesticides for wheat and barley.

- Finish a multi-year field experiment with Drs. Reisig, Murphy and Huseth to compare insecticides at 3 timings with genetic resistance (*Bdv2/3*) to barley yellow dwarf virus (BYDV) in winter wheat.
- Continue collaboration with Jenny Carleo on fungicide profitability experiment using wheat field plots in Raleigh and Salisbury.

(4) Help Southeast US breeders by screening advanced wheat and barley experimental lines for resistance to FHB and Septoria nodorum blotch (SNB).

- Provide breeders with FHB ratings for advanced experimental wheat and barley lines. This work is done in the misted, inoculated nursery at Inwood Road in Raleigh.
- Provide SNB ratings on advanced experimental lines to wheat breeding programs throughout the eastern U.S. to raise the overall level of SNB resistance. This work is done on over 350 wheat lines in replicated field plots with straw inoculation and irrigation at Raleigh and Kinston.

BUDGET:

Fusarium head blight research and resistance screening	
Supplies & equipment for inoculum production, harvest bags, supplies for sample collection & processing for DON testing …….....	$ 10,000
Irrigation equipment for FHB screening (pipe, zone controllers, risers & sprinklers).....	10,000
Travel to field days, meetings with extension agents, and field research sites; transportation of straw inoculum……...	5,000
Pesticides, herbicides, fertilizer for field experiments……	5,000
TOTAL ……	**$ 30,000**

RENEWALS

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

FOR RESEARCH OR EDUCATION ENTITLED

Support of the NC OVT Wheat Variety Selection Tool

COVERING THE PERIOD FROM **10/01/2024** TO **9/30/2025**

REQUESTING SUPPORT IN THE AMOUNT OF **$4,000**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Ryan Heiniger	**Crop and Soil Sciences**
Angela R. Post	**Crop and Soil Sciences**

NORTH CAROLINA STATE UNIVERSITY
RALEIGH, NORTH CAROLINA
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Note: This is a fundamental research or scholarly project and, as such, the University shall be free to publish or disseminate the results of this research or otherwise treat such results as in the public domain, and it will conduct the research in an open forum consistent with the University's mission of research, instruction and public service.

OBJECTIVE(S):

The goal of this proposal is the annual support of the NC OVT Wheat Variety Selection Tool. This tool can be found at ncovt.medius.re.

PROJECT DESCRIPTION AND RELEVANCE:

Variety selection is one of the most important decisions a grower can make, accounting for up to 60% of their overall yield level at the end of the season. The role of the North Carolina Offical Variety Testing program (NC OVT) is to provide growers with an unbiased source of variety performance data across North Carolina. Prior to 2020, this data was delivered to growers using hard copy printed yield tables (Green Book) or electronic yield tables loaded to the NC OVT website. While these data delivery methods were effective, they were limited by their static nature and lack of data depth. A grower could identify the highest yielding variety at a location or across the state but was unable to access characteristic information or performance information by other criteria such as maturity or disease resistance without navigating to multiple tables.

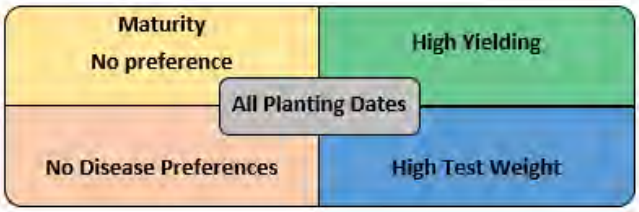
To solve this issue, the NC OVT partnered with Medius.Re to develop a database for wheat variety results from the NC OVT trials (Wheat Variety Selection Tool). The Medius group has had a long history of providing variety performance data to growers and personnel in the potato industry. Using this experience, and the base tool they use for potatoes, we were able to develop a comprehensive database for wheat varieties. This database spans multiple years and provides the growers with several options to search and filter their data to meet the specific demands of their operation from one data view (Figure 1). A search that would take multiple hours using the old tables, now takes minutes using the Medius database. Additionally, growers can access images and other supporting documentation for each variety that was previously unavailable.

Figure 1. Yield data view in the variety selection tool. Single year (left 9 columns) and multiple year (right 4 columns) included in same view.

An example of the output possible from the Wheat Variety Selection Tool is shown below in Figure 2. In this example, a grower from Pasquotank County requested high yielding wheat varieties with excellent test weight. While yield and test weight data are available on the old static tables, it would be very difficult to combine and sort this data together and compare the top performing lines, particularly over multiple years. However, because this data is available in the Wheat Variety Selection Tool, the OVT group organized this report and provided it back to the grower within an hour of the initial request. Moving forward, additional disease and characteristic data will be added to this tool for each variety, further enhancing the scope and scale of the available data.

NC STATE EXTENSION Variety Selection Tool Report

Area of Impact: Pasquotank County



	3 Years of Data					2 Years of Data		1 Year of Data			
	Hilliard	SH 7200	Shirley	9811	USG 3118	9002	AgriMAXX 492	9172	AgriMAXX 514	CPB045	LW2169
Years	2019, 2020, 2021	2019, 2020, 2021	2019, 2020, 2021	2019, 2020, 2021	2019, 2020, 2021	2020, 2021	2020, 2021	2021	2021	2021	2021
Variety Records	14	14	14	14	14	11	11	5	5	5	5
Variety / Company	Virginia Crop Improvement	Southern Harvest	Dyna-Gro	Dyna-Gro	UniSouth Genetics	Dyna-Gro	AgriMAXX	Dyna-Gro	AgriMAXX	CROPLAN	Local Seed
Variety / Availability	Available	Available	Available	Available	Available	Available	Available	Available	Available	Available	Available
Research											
Yield	83.3	84	80.6	88.1	88.1	75.8	80.0	75.7	75.7	77.8	76
Top Yield Group	31.00%	31.00%	23.00%	15.00%	15.00%	20.00%	31.00%	20.00%	20.00%	40.00%	40.00%
% of Hilliard	100.00%	100.80%	96.60%	105.60%	105.60%	92.60%	101.30%	101.20%	104.30%	107.90%	105.50%
% of P26R41	105.60%	111.90%	107.60%	106.00%	116.10%	113.60%	114.00%	116.20%	113.80%	117.00%	114.90%
Test Weight	57.1	58.5	56.2	58.1	58.6	58.1	57.9	57.5	58.6	57.5	57.8
% Protein	10.70%	11.20%	10.70%	10.70%	11.00%	10.00%	10.30%				
Falling Number	299	277	377	275	379	277	300				
Height	34.4	34.3	31.9	33.6	31.2	33.1	31.4	30.5	30.6	30.6	30.9
% Lodging	11.90%	9.40%	5.20%	6.90%	1.30%	0.00%	1.00%				
GDUs to 50% Head	2310	2250		2310	2300						
Seed Size	14500	10800	13600	13700	12700	11100	12900	11800	11600	12900	12000
Head Type	awned	awned	awnlett	awned	awnlett	awned	awned	awned	awned	awned	awned
Hessian Fly Biotype L	R	R									
Head Scab	MS	S	S	S	MS	MR	MS				
Powdery Mildew	R	MR	R								
Leaf Rust	MR	MR	MR	MR	R	MS	R	MS	MS	MS	MS
SNB		MS	MR								
Stripe Rust	R	MS	S								
Tan Spot		MS	MR								
Soilborne Wheat Mosaic		MS	MR								
Wheat Spindle Streak		MS	MR								
Barley Yellow Dwarf			MR								

Yield levels, % Yield Difference from Mean, & Top Yield Group highlighted in green above, with darker shades indicating higher values

Items of Note: Selections made here are based first, on their yield performance nearest your location and second, on their corresponding statewide yields. When choosing a hybrid based on performance data, multi-year and multi-location data are a better predictor of long-term hybrid performance. Several of the hybrids in the report have only one-year data available. They are still worth a look on limited acreage if you are looking to try something newer.

Figure 2. Example report from the wheat variety selection tool. The report can be tailored to the specific needs of each grower or growing region for variety characteristics and yields.

The goal of this proposal is the continued support of the Wheat Variety Selection Tool. The money from this proposal would be used to pay for the annual license fee for the tool, including future features within the tool and support in using the tool. Funding the annual license for the Wheat Variety Selection tool would give the NC Small Grain Growers Association an opportunity to guide the development of this tool moving forward.

IMPACTS:

Implementation of the variety selection tool gives growers the ability to quickly tailor their variety selections to the specific needs of their operation, from disease ratings to performance on specific soil types. This resource provides growers with a higher success rate selecting varieties that will perform best in their operation, thus leading to more profitability for those growers. Since releasing the tool in 2020, over 4200 unique visitors have used the tool each year.

RELATIONSHIP TO SIMILAR PROJECTS, IN NC AND OTHER STATES:

The Potato breeding group at North Carolina State University has used the Medius platform for reporting their potato variety data to other groups within the United States. Other state OVT programs are now using our model for delivering variety performance data to growers using the Medius platform, including, but not limited to, Auburn, South Carolina, Virginia, and Maryland.

Similar Variety Selection Tools were developed from NC OVT data for Corn and Soybeans in 2020. Both the Corn Growers Association of NC and the NC Soybean Producers Association are funding the annual license agreement for their respective tools.

FUNDS REQUESTED:

2024-25 ..... **$4,000**

A PROPOSAL TO

NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

FOR RESEARCH OR EDUCATION ENTITLED:

Small Grains Problem Diagnosis Support for Cooperative Extension Agents (2024-2025)

COVERING THE PERIOD FROM **10/01/2024** TO **09/30/2025**

REQUESTING SUPPORT IN THE AMOUNT OF **$2,000**

SUBMITTED BY:

Project Leader	Departmental Affiliation
Matt Bertone	**Entomology and Plant Pathology**
Luke Gatiboni	**Crop and Soil Sciences**

Senior / Key Personnel	Departmental Affiliation
Kristin Hicks	**NC Department of Agriculture & Consumer Services** and Adjunct Faculty: **NCSU Crop and Soil Sciences**

NORTH CAROLINA STATE UNIVERSITY
RALEIGH, NORTH CAROLINA
IRS No. 56-6000-756
Second Congressional District

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Note: This is a fundamental research or scholarly project and, as such, the University shall be free to publish or disseminate the results of this research or otherwise treat such results as in the public domain, and it will conduct the research in an open forum consistent with the University's mission of research, instruction and public service.

OBJECTIVE(S):

1) This project will support efforts by cooperative extension agents to diagnose specific crop nutritional or disease problems in small grains.

2) This project will fund a limited number of samples to be submitted by cooperative extension agents for analysis at the NCDA&CS Agronomic Division plant tissue or nematode lab, and at the NCSU Plant Disease & Insect Clinic.

PROJECT DESCRIPTION AND RELEVANCE:

While most North Carolina producers routinely submit soil samples for predictive or diagnostic purposes (without a user fee except during the peak season), relatively few producers utilize the diagnostic services available from fee-based laboratories such as the NCDA&CS Agronomic Division plant tissue lab, and at the NCSU Plant Disease & Insect Clinic. Problem diagnosis is an important tool that cooperative extension agents use in advising producers to select appropriate corrective management approaches. In the absence of such tools, producers are left to attempt diagnosis based only upon visual symptoms that often can be misleading, and to correct problems by selecting among numerous potential practices, products, and advertising claims.

For decades, the NCSU Plant Disease & Insect Clinic was able to provide cooperative extension agents with a limited number of vouchers, allowing them to submit samples without the standard fee. This provided a learning opportunity for extension agents, and introduced producers to the inherent value of scientific diagnosis. Recent budget constraints have curtailed this program.

Our approach to strengthening crop problem diagnosis efforts is to request funding from each of several commodity groups to fund analysis of samples submitted by cooperative extension agents. This is not intended to cover all analytical needs, but for program support to allow agents to diagnose specific problems important to their region of the state. This project will fund analysis of 200 plant tissue samples and 50 plant insect & disease clinic samples collected from problem small grain fields.

Funds will be managed through a spreadsheet tallying cumulative samples & remaining funds for each commodity involved. Fund availability will be advertised to NCSU and NCA&TSU Cooperative extension agents, as will notification of fund usage & specific problem diagnosis for each crop. Rather than distributing voucher quotas, this will begin as a demand-based system, with future proposals based on actual usage distribution among agents.

Impact:

This program should result in more qualified agricultural agents, and in farmers that better understand their production constraints. Once the value of these diagnostic efforts is better understood, we expect producers will be more willing to pay the standard diagnostic fees themselves. This project will also allow us to monitor problem diagnosis and more formally document the potential crop losses or economic benefits if managed per recommendations.

RELATIONSHIP TO SIMILAR PROJECTS, IN NC AND OTHER STATES:

Funding will also be requested from the North Carolina Cotton Producers Association, the Corn Growers Association of North Carolina, Inc., the North Carolina Soybean Producers Association, Inc., the NC Tobacco Research Commission, and possibly other commodity groups.

FUNDS REQUESTED:

2024-25 ..... **$2,000**

PROGRESS REPORTS
(Including USDA ARS Report)

Progress Report to NC Small Grain Growers Association, 2023-24
Improving Small-Grain Disease Management in North Carolina -- C. Cowger, USDA-ARS

Christina Cowger, USDA-ARS Research Plant Pathologist, appreciates the funds provided to our program for small-grain disease research and education to benefit the North Carolina small-grain industry in 2023-24. Funds were used as follows:

(1) <u>Supported the North Carolina Small Grain Industry</u>

Our program supported the industry with education, diagnostics, and decision support. This past year, we provided:

- **Research-based advice** to county agents, agronomists, crop consultants and growers
  - Sent out 3 timely updates on scab risk, which remained low in central and eastern NC due to dry weather in April and early May, by email and text via national website (April 9, April 16, and April 23)
  - Provided diagnosis and decision support by phone, email and in person to ~20 county agents, NCDA specialists, and private crop consultants regarding biotic and abiotic problems, fungicide & other management decisions for specific farms and fields across the state
  - Visited Union County May 13 to help extension agents diagnose and distinguish multiple wheat diseases in various fields
- **Talks** on profitable small-grain disease management and fungicide decision-making
  - Spoke at Union County Field Day (Feb. 21, ~100 people)
  - Spoke at Piedmont Field Day (Mar. 14, ~50 people)
- **Diagnosis and recommendations** to clients of the NCSU Plant Disease & Insect Clinic (PDIC).
  - Diagnosed 44 wheat, barley, and oat samples submitted to PDIC; provided explanations and management recommendations
- **Article in Wheat Beat** on "Scab Fungicide Decision-Making" (April 19)

(2) **<u>Screened wheat and barley for resistance to Fusarium head blight (FHB) and Septoria nodorum blotch (SNB).</u>**

- Compared Miravis Ace to Prosaro and Caramba at early, normal and late timings. Results show that all products are most effective against FHB and the mycotoxin DON when applied at or shortly after flowering (wheat) or at 6 days after full heading (barley), and not at 50% head emergence as is claimed by a manufacturer.
- Provided breeders with Septoria nodorum blotch (SNB) resistance ratings for 381 advanced experimental lines from wheat breeding programs in NC, VA, SC, GA, and surrounding states. These are generally breeders' only SNB data, and allow them to choose lines for release that have good levels of resistance to leaf and glume blotch.

(3) **<u>Coordinated a multi-year field experiment on barley yellow dwarf virus</u>**, comparing wheat genetic resistance to insecticide application in fall or spring (working with Drs. Murphy, Reisig and Huseth).

- Experiment uses 2 NCSU advanced experimental lines containing the highly effective *Bdv2/3* resistance gene, and also SS8641 as a susceptible control.
- So far, we have obtained complete datasets from 3 environments. The results indicate genetic resistance of the two lines with *Bdv2/3* protects yield as well as insecticide applications on the susceptible line, saving money.

2024 Northeast Ag Expo
Small Grains Field Day Impact Report

February 7, 2024 - Cherry Glade Road
Elizabeth City, NC

The Partners

The North Carolina Cooperative Extension Centers of Camden, Chowan, Currituck, Gates, Pasquotank, and Perquimans, NC State Extension Specialists, North Carolina Small Grain Growers Association, as well as farmers, other commodity groups, and agribusinesses.

The Objective

To provide growers and other members of the agricultural community up-to-date information on crops, technologies, and crop production related practices.

Topics Covered

- Nitrogen Fertilization
- Disease management
- Marketing for Milling Quality
- Insect Management

Participant Comments

- Thanks for all the help NE Ag Expo agents do for the farmers in the area.
- Learned some things I didn't know.
- I learn something every time I attend.

NC COOPERATIVE EXTENSION
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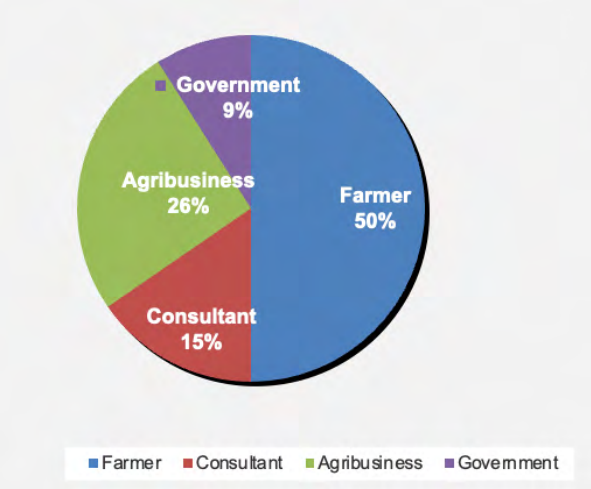
North Carolina Small Grain Growers Association Inc 1986

NORTHEAST AG EXPO

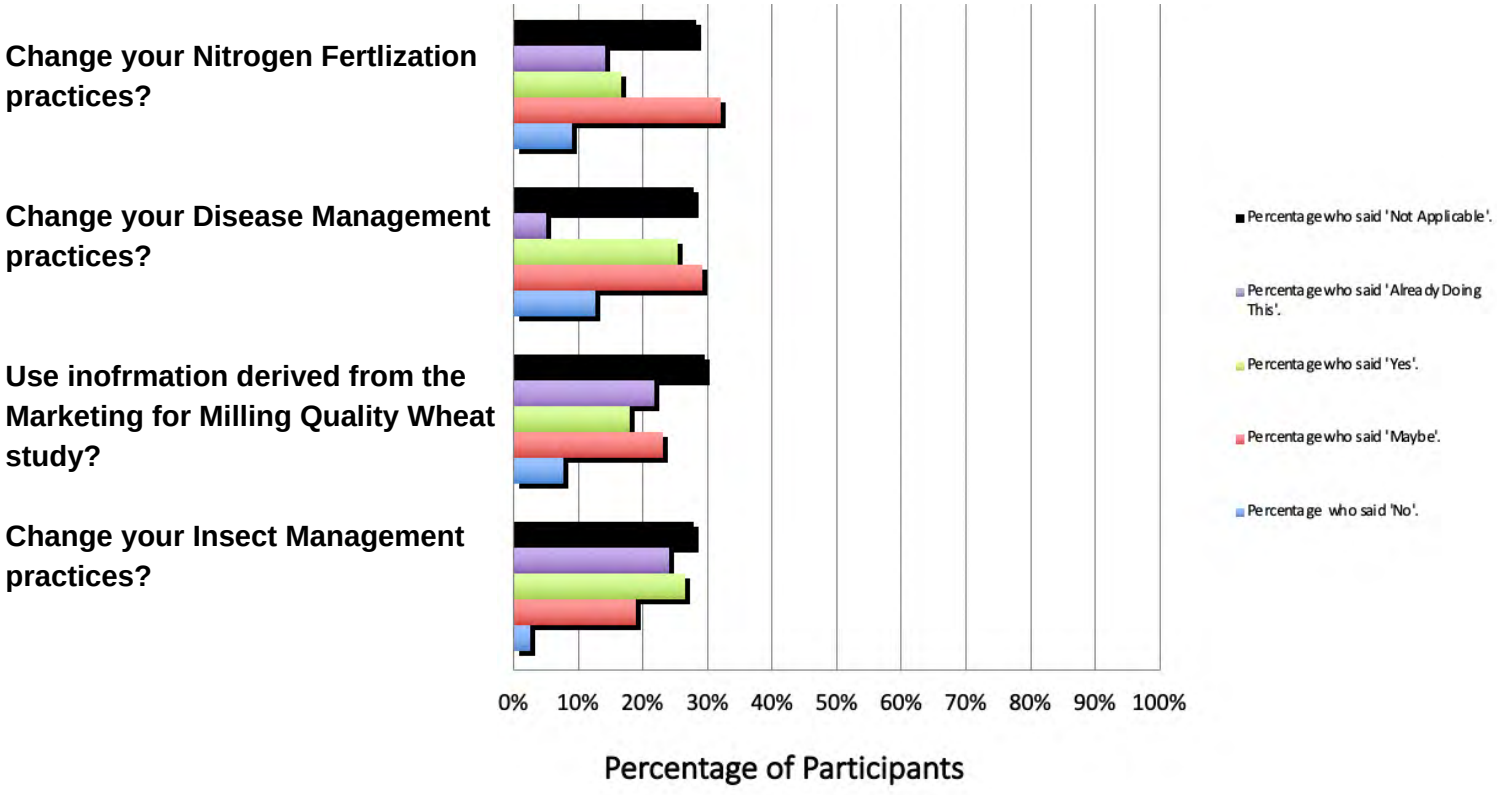
The Participants

- 103 in attendance with a total of 36,131 acres of wheat farmed or overseen.
- 44 commercial pesticide applicators received a total of 88 credits, which preserved a total of $374,000 in wages and saved them $1,320 in registration fees.
- Estimated pounds/acre wheat yield increases from attending previous small grains field days resulted in a $1,217,210 benefit from attending/or economic value

Distribution of Participants by Occupation



Adoption of Information



The charts and data are based on 80 evaluations completed out of 103 participants, which is a return rate of 78%.

ANNUAL PROGRESS REPORT
TO
NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION, INC.

TITLE:	**Identifying Economically Beneficial Disease Management Strategies in North Carolina Wheat – 2023-2024 (Year 4)**
LEADER(S):	**Jenny Carleo[1] and Christina Cowger[2]**
DEPARTMENT(S):	**NC Cooperative Extension,[1] Entomology and Pathology/USDA-ARS[2]**
Plant Date:	**25-Oct-2023 and due to a germination issue with one variety was re-planted on 7-Nov-2023**
Harvest Date:	**31-May-2024**
Location:	**NCDA&CS Caswell Research Station in Kinston, NC**

Report of Progress / Activity:

Objective 1: ***"****Evaluate efficacy of mode-of-action combinations and application timing on wheat yield and quality given different levels of fungal disease pressure."*

The field research was performed as proposed. The replicated small plot research examines the effects of the following treatment factors in a split-split plot design including non-treated controls:

1. Varieties Croplan 9606 and USG 3536 which are susceptible and moderately resistant, respectively, to common wheat fungal diseases in NC,
2. Fungicide 1 (propiconazole), Fungicide 2 (propiconazole+pydiflumetofen), Check (no fungicide),
3. Application timings at top-dress (before GS 30), flowering (GS 60) and top-dress & flowering (two applications).

Fungicide applications were made on 26-Feb-2024 (GS 26, Feekes 3) and flowering 18-April-2024 (GS 10.51, Feekes 60). Powdery mildew was present in March at minimal levels and leaf rust was severe enough to be rated on 10-May-2024 (GS 77, Feekes 11). FHB was detected in very minor levels in May which resulted in some DON/vomitoxin at levels considered "no concern" (<0.5 ppm) in the untreated plots. We will be performing DON analysis on the remaining samples in July.

Crop production results
Yield: Average 79.9, low 50.0, high 115.5 bu/A
Test Weight: Average 57.9, low 55.9, high 61.0 lbs./bu
Moisture: Average 12.2%
Falling Number: Average 295.97, low 177.0 (outlier), high 368.5 sec
Protein: Average 9.22%
Preliminary DON: Untreated control average 0.21, low 0.00, high 0.5 ppm

Objective 2: ***"****Determine the overall economic benefit of the disease management options when weighing input costs against fungicidal treatments"*

Fungicide plus application costs in 2024 for the treatments used ranged from $17.44 to $63.32 per acre, not including $0.00 for the untreated controls. The May 2024 wheat price for feed wheat from the local elevator in La Grange was $5.15 per bushel. The effects of fungicide treatments and interactions between treatments will be compared against the economic input data on: 1) Yield, 2) Quality, 3) Input costs, including fungicide product and application costs, 4) Average market price range earned for the crop. Dr. Quentin Read, Statistician, USDA-ARS will assist with a comprehensive analysis of the data, including economics, after all the DON results have been received.

Extension Education

Educational efforts of the project in 2024 include invited presentations at farmer winter meetings and field days in Duplin, Iredell, Cleveland and Rowan counties reaching 399 growers. Optimal fungicide application timing and cultural methods of disease prevention were addressed in these presentations. This content was also used in a NC Cooperative Extension Crop $ense podcast.

Research based information was also used to author a timely, educational website post "What Are the Pale Patches in Wheat Fields This Year?" go.ncsu.edu/readext?1003717 which has been accessed 572 times.

Our scientific poster won first place in the applied research category at the NC Association of County Agricultural Agents annual meeting in Wrightsville Beach in June 2024. It will be displayed at the National Association of County Agricultural Agents Annual Meeting in Dallas, TX in July 2024 (attached).

Conclusions / Findings (emphasizing value for growers, thus far):

Unanticipated levels of DON/vomitoxin in commercial from parts of North Carolina in 2024 have revealed the need for additional educational resources for farmers on fungicide timing, fungicide types, behavior of head scab in our environment, cultural control recommendations and prevention techniques. Ongoing research from this project has provided the researchers with insight and tools that are beneficial to understanding how and why this has happened in 2024. Corn residue management in the Piedmont region appears to be at the center of this issue. We are currently surveying grain growers in the state on their production practices to identify trends that may lead to, or assist in preventing, head scab/DON to include in our recommendations. It is also our intent to send information on any newly found trends to the U.S. Wheat and Barley Scab Initiative, in order to enhance performance and accuracy of the online FHB Risk Tool for the benefit of NC small grain growers.

Budget / Financial Status Update (by expense category):

Funds Awarded	9,800.00
Materials & Supplies	2,226.46
Travel Costs	1,261.32
Other Costs (explain as needed, below)	3,126.58
Total Spending through June 30, 2024	**6,614.36**
Funds remaining (forecast remaining expenditures below)	**3,185.64**

Budget Notes:

Materials & Supplies - Fungicides, application supplies, field supplies, sample containers, printing of disease education books for NC small grain growers.

Travel Costs - 8 hotel nights and per diem meals (field site is 230 miles from PIs home/office, mileage sponsored by NC State).

Other Costs - Sample testing by labs and shipping to labs of 96 samples.

Funds Remaining: We are continuing work on the project including expenditures for additional lab supplies, sample shipping and analysis.

Image(s) or graphs/charts

Scientific Poster presenting the 2022-2023 results for presentation in 2024. Earned State Award for Applied Research Poster:

NC COOPERATIVE EXTENSION

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Optimizing Wheat Fungicide Management

Jenny Carleo - Area Specialized Agent, NC State Extension; jenny_carleo@ncsu.edu
Dr. Christina Cowger - USDA-ARS Small Grains Pathologist, NC State University

QUESTIONS

1. Timing: When should we apply fungicides?
2. Cost: How much expense is worth it?
3. Should we spray when there is no disease?

ANSWERS SO FAR

1. Timing: In Kinston, NC in 2023 under high disease pressure, applying fungicides in both February and April was the most profitable but was not statistically different from the control.
2. Costs: The resistant line didn't need fungicide to be profitable, even with two fungal diseases present. The susceptible line did need protective fungicide applications to be profitable.
3. It is not economically beneficial to apply fungicides in the absence of fungal disease.

Powdery Mildew

Found in February with a resurgence in April

Leaf Rust

Found in April, spread to flag leaf by May

Septoria Nodorum Blotch (SNB)

Begins on leaves and can reduce grain quality if heads are infected

Head Scab (FHB)

Fusarium head blight can develop vomitoxin causing wheat to be rejected for DON

PROJECT SUMMARY

This study investigates different fungicide application timings and modes of action to identify which fungicide approach is most cost-effective.

The project was planted in 2022 at the Caswell Research Station in Kinston, NC.

MATERIALS & METHODS

The replicated (n=4) and randomized small plot research included these combinations:

2 Varieties

- USG 3536 (Moderately resistant to scab and powdery mildew)
- Croplan 9606 (Susceptible to scab, moderately susceptible to powdery mildew)

3 Fungicides

- None (check)
- Miravis Ace – pydiflumetofen+propiconazole
- Tilt – propiconazole

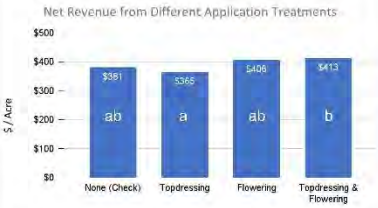
3 Application Timings

- Top-dress (before GS 30)
- Flowering
- Top-dress & Flowering

RESULTS

In both 2021 and 2022 in the Piedmont, no significant fungal diseases appeared in the test. There were no significant yield or quality improvements from fungicide applications that covered the costs of the applications in those years.

In 2023 in Kinston, NC we observed powdery mildew, leaf rust and SNB in the plots. Disease severity was documented for each plot before fungicide applications and three weeks after. No FHB was present. When examining revenue, the only significant factor was timing (P=0.01).



In a year of moderate foliar disease pressure, applications at topdressing or topdressing+flowering generated the numerically highest net revenues, but they were not statistically different from the unsprayed check.

ECONOMICS

"Revenue" is calculated using:

- Yield in bushels / acre x market price of $5.94 (grain quality did not qualify for milling wheat).
- Drive-down of the wheat (2.8% with a 90' boom sprayer) was subtracted from the yield for treatments at flowering when plants are lost due to tire tracks.
- Application cost of $12/acre per pass
- Dockage for test weight below 54 lbs./bushel according to local grain discount schedules
- Fungicide costs were based on the labeled rate and the price paid for the product:
  - Miravis Ace - $19.00/A per application
  - Tilt - $3.05/A per application

Typical input and overhead costs were omitted from the analysis for the purpose of comparing only the treatments.

Plots in Kinston on harvest day 06-Jun-2023

This experiment is being repeated in the 2023-2024 season in Kinston, NC.

ACKNOWLEDGEMENTS

Project funded by the NC Small Grain Growers Association. Thanks to Andrew Baucom and Mikayla (Graham) Berryhill for their contributions to year-one of the project and NCDA&CS station staff for their work. Ryan Heiniger for harvesting help. Brian Moore and Scott Lee for seed donations. Graduate Committee: Rachel Vann, Christina Cowger, Heidi Schweizer and Charlie Cahoon.

NC STATE UNIVERSITY N.C. Plant Sciences Initiative

ANNUAL PROGRESS REPORT
TO
NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION

TITLE: **Support of the NC OVT Wheat Variety Selection Tool**

LEADER(S): **Ryan Heiniger and Angela Post**

DEPARTMENT(S): **Crop and Soil Sciences**

REPORT: Thanks to the funds awarded through this proposal, the NC OVT Wheat Variety selection tool (VST) continued to be supported through 2024. Funds were applied to the quarterly maintenance fees for the tool in 2023-24, with $1,303 left to be spent (see below). This will be spent in August to complete the annual funding cycle for the wheat tool.

In 2023, we linked the wheat variety selection tool for North Carolina to similar tools run by Clemson University (South Carolina) and Auburn University (Alabama). With this linkage, growers can now look across additional environments for variety performance, particularly for those growers in southern North Carolina. Additional work is underway to streamline filtering for data within the tool and data reporting from the tool. We are continuing to host a wheat data webinar via Zoom after data is uploaded to the variety selection tool. During this webinar, I use the tool to highlight variety performance across environments and years, with the goal of giving growers a head start on their variety selections for the next growing season.

Data from 2023-24 tests were loaded to the tool on July 1, with a complete set of FHB ratings and GDU values to 50% heading data for ALL varieties. Grain analysis is underway for samples pulled from three OVT locations (Union, Robeson, and Perquimans). Our goal is to upload % protein and FN values from those locations to the tool by mid-August.

Funds Awarded: $4,000
Spent (as of 06/30/24): $2,697
Remaining: $1,303

IMPACT STATEMENT

We continue to support the combined approach of uploading data to the VST, while also posting reports from the VST to the OVT website (www.ncovt.com) along with the finalized data tables. This approach, along with the data webinar after uploading the data, provides the most flexibility to the grower for searching the data to find the best variety matches for their operation. The response to this approach has been positive, demonstrated by the number of visits to both the VST and the OVT website. For the reporting period from July 2023 to June 2024, we averaged 324 unique users per month to the VST and 273 users per month to the OVT website on small grains specific data pages. This is equivalent to 4 large-scale field days each month.

ANNUAL PROGRESS REPORT
TO
NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION, INC.

TITLE: **Statewide sampling and screening of Italian ryegrass populations to ALS, ACCase, flumioxazin, and pyroxasulfone**

LEADER(S): **Wesley Everman**

DEPARTMENT(S): **Crop and Soil Sciences**

Plant Date: **Multiple**

Harvest Date: **Multiple**

Location: **Raleigh, NC greenhouse**

Report of Progress / Activity:

Objective 1: Determine the statewide response of Italian ryegrass to POST applications Axial and Osprey.

Objective 2: Establish the statewide response of Italian ryegrass to PRE treatments of Zidua and Valor.

Conclusions / Findings (emphasizing value for growers, thus far):

Resistant weed species continue to be one of the greatest challenges facing growers in North Carolina. Although new technologies are on the horizon, no silver bullets exist for current resistant weed problems such as Italian ryegrass. While alternative control methods continue to be investigated, we continue to investigate additional tactics to manage Italian ryegrass in North Carolina.

Over-the-top grass weed control in wheat has been an effective means to control most weed species in North Carolina. However, the continued spread of resistance is a real threat to postemergence Italian ryegrass control. In the Fall 2020, several populations of Italian ryegrass were identified which survived applications of paraquat. In 2021, studies confirmed paraquat resistance as well as ALS-, ACCase-, and glyphosate-resistance in the same populations. These populations also showed elevated tolerance to glufosinate applications.

To preserve and ensure continued use of postemergence grass herbicides, it will be important to establish baseline and distribution of resistance for Italian ryegrass found in production fields. A student has been funded to collect and screen populations from across the state to glyphosate, glufosinate, and paraquat in addition to studies to determine cultural control practices in our cropping systems. In order to understand what is occurring with our other herbicides, we would like to hire a student to work on the remaining herbicide options, especially the PRE herbicides we rely heavily on in wheat production. There has been increasing concern about the use of pyroxasulfone in wheat production in North Carolina, and in the past 2 season we have received complaints of control failure. While there is no confirmed resistance to pyroxasulfone to date in North Carolina, resistance has been confirmed in a rigid ryegrass in Australia. It is a matter of time before resistance occurs here in our state. In hopes of catching resistance early, we propose to survey sites from across the state for resistance to Zidua, Valor, Axial, and Osprey.

The research questions are:

1) What is the statewide response of Italian ryegrass to POST applications Axial and Osprey?

2) What is the statewide response of Italian ryegrass to PRE treatments of Zidua and Valor?

Results: Italian ryegrass populations were collected from 118 fields across the state of North Carolina in 2022 during the month of June. A Delorme North Carolina Map was used to draw latitudinal and longitudinal points across the state of North Carolina to determine where to sample for weeds. The same points were used in this study as were collected in past historical ryegrass samples (Taylor et al. 2020). Upon arrival to each point, if there was no field available to sample or if there were no observed Italian ryegrass within the field, roads near the site were driven in an attempt to find a field with samples. Collecting samples of Italian ryegrass within fields included avoiding headlands by going at least 40 feet out into the field, then at least 30 seed heads were collected and placed into a brown paper sack to be taken back to be processed. Samples were processed by placing seed heads in black tubs containing a rubber mat. Another rubber handle was used to apply pressure to the seed heads to get the seeds off the stem. After the samples were threshed, they were stored in a freezer until planting.

Each population was seeded into pots to germinate, then individual plants were transplanted into 2-inch containers. The plants were grown to the 4 leaf stage when they were treated with POST products including Axial and Osprey at labeled field use rates. The study was repeated and each run of the study contained four replications. Plants were rated for control at 7, 14, 21, and 28 days and biomass was collected at the final rating. For determination of resistance, if the average control was 50% or greater, we marked the population susceptible. If control was lower than 50%, we marked the population resistant. The demarcation tends to underestimate the level of resistance, but gives greater confidence that variability or environment did not affect results.

Results of this study indicate widespread ALS-resistance in North Carolina, with an increase in frequency compared to the 2012 and 2013 survey. Additionally, there was a marked increase in ACCase-resistance in the current survey as well. The distribution of Axial resistant Italian ryegrass spread northward and eastward when compared to the survey conducted 10 years prior. While there is an increase in the number of resistant populations statewide, there are still a majority of populations which are controlled with Axial, giving us a postemergence option for control. Additionally, Osprey and Powerflex continue to control Italian ryegrass in areas of the state, and the two products should be rotated where no resistance has been detected.

In addition to investigating postemergence wheat herbicides in the screen, as part of another grant proposal, we treated the same populations with glyphosate, glufosinate, and paraquat. We wanted to include the results in this report because we know it is of interest to the small grain growers. We only identified two glyphosate resistant Italian ryegrass populations, one paraquat resistant population, and 45 glufosinate resistant populations. Glufosinate has never been considered a strong herbicide for Italian ryegrass, so these results are not surprising. What is more surprising is that we only identified two glyphosate resistant populations. We expected to identify more, however the low number could be due to our collection method only targeting small grain fields in June. Of great concern is the data in Figure 5, showing 3-way resistance to two sets of different herbicides, most important to small grain growers is the presence of 9 populations resistant to both Axial and Osprey as well as glufosinate.

Preliminary data for Objective 2 are also important for Small Grain Growers and may more importantly highlight the greater concern we have as we move forward with fewer herbicide options. A preliminary study was conducted on Italian ryegrass populations collected in 2012

and 2013, prior to use of pyroxasulfone or flumioxazin in most of the state, to determine a biologically effective rate in order to screen the populations in the current survey. A dose response study was conducted and replicated twice to determine the LD90, or lethal dose necessary to control 90% of the plants, which was then used in the screen of samples. It is important to use a biologically effective rate, such as the LD90, in a preemergence herbicide screen as the labeled rate may be magnitudes greater than the effective rate, and can mask any shifts in response that are occurring. All populations were planted into 3 inch pots filled with a field soil/sand mix, ensuring the seed were covered, then watered to saturation. Once the pots were prepared, flumioxazin, pyroxasulfone, and a non-treated control were applied to each population, with 4 replications, and the screen was repeated in an adjacent greenhouse. Each pot was rated at 7, 14, 21, and 28 days after treatment to determine control of each population with each herbicide.

Results from the preemergence herbicide screen are quite concerning. We identified 6 populations which survived flumioxazin and 4 populations which survived pyroxasulfone, both applied at a biologically effective rate (LD90). These populations are being further screened to determine if they are resistant, or if they are still developing resistance. While potential resistance is concerning with these herbicides, what is of greatest concern from our perspective is the widespread decrease in control signified by the orange symbols on each map in Figure 8 and 9. Blue symbols indicate greater than 80% control, what we would expect to observe in a susceptible population. The majority of populations are in the below 80% control for both flumioxazin and pyroxasulfone, which indicates we are shifting toward resistance in many of our populations. While this was conducted with a “reduced rate”, the LD90 rate is indicating what lies ahead if we rely primarily on these herbicides for control in wheat.

Overall implications of this research show we are heading past the tipping point with our herbicides labeled for Italian ryegrass control in wheat. This highlights the need for alternative management practices to take selection pressure off our current herbicides in wheat, to preserve activity in the future.

Table 1. Total number of resistant populations identified for each herbicide tested out of 118 samples.

Glufosinate	Glyphosate	Mesosulfuron	Paraquat	Pinoxaden	Flumioxazin	Pyroxasulfone
45	2	114	1	18	6	4

Table 2. Instances of multiple resistance to POST herbicides identified in Italian ryegrass.

Number of modes of action	**Herbicide**	**Number of populations**
3-way Resistance	ALS, ACCase, Glufosinate	9
3-way Resistance	ALS, Glyphosate, Glufosinate	1
5-way Resistance	ALS, ACCase, Glyphosate, Glufosinate, Paraquat	1

Budget / Financial Status Update (by expense category):

Funds Awarded	$20,000
Personnel Costs (including fringe benefits)	(below by category)
Technical Support (full-time workers)	$14,658
Graduate Student Stipend	
Part-time / hourly / undergraduate workers	
Materials & Supplies	
Travel Costs	
Other Costs (explain as needed, below)	
Total Spending through June 30, 2024	**$14,658**
Funds remaining (forecast remaining expenditures below)	**$5,342**

Budget Notes: All remaining funds will be expended by the project's end.

Image(s) or graphs/charts

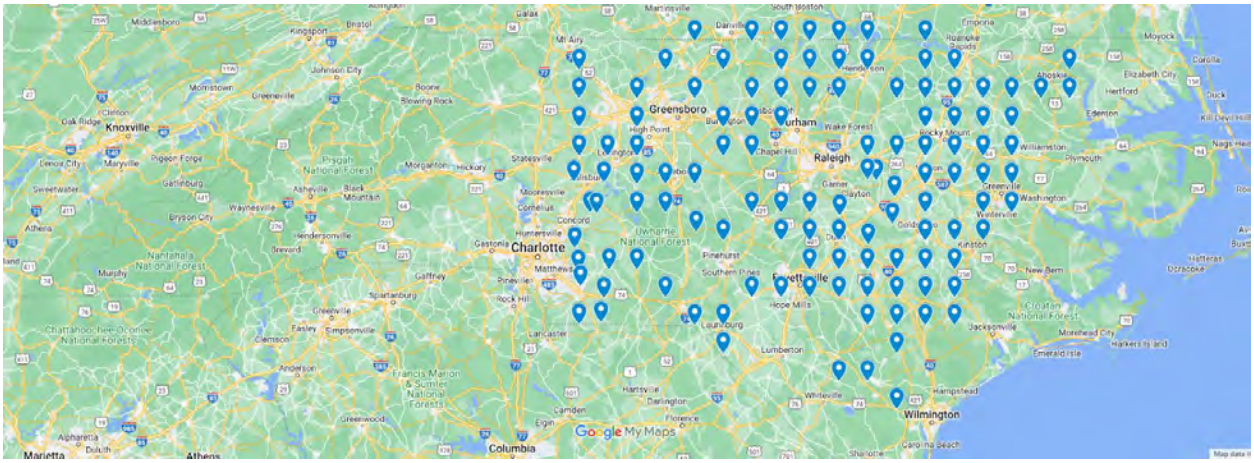


Figure 1. Survey points collected across the state of North Carolina.

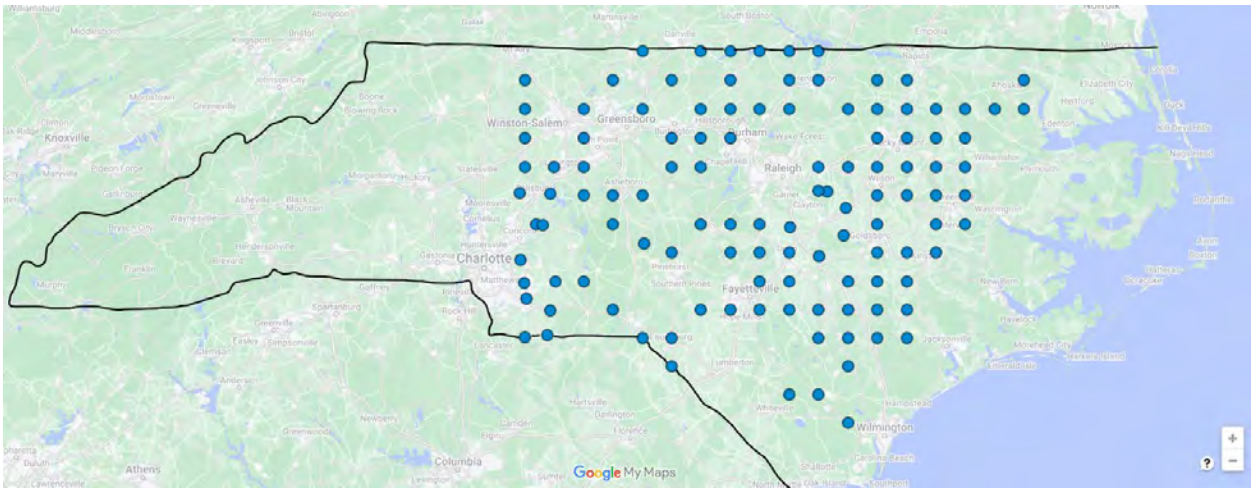


Figure 2. Distribution of Osprey (mesosulfuron) resistant populations.

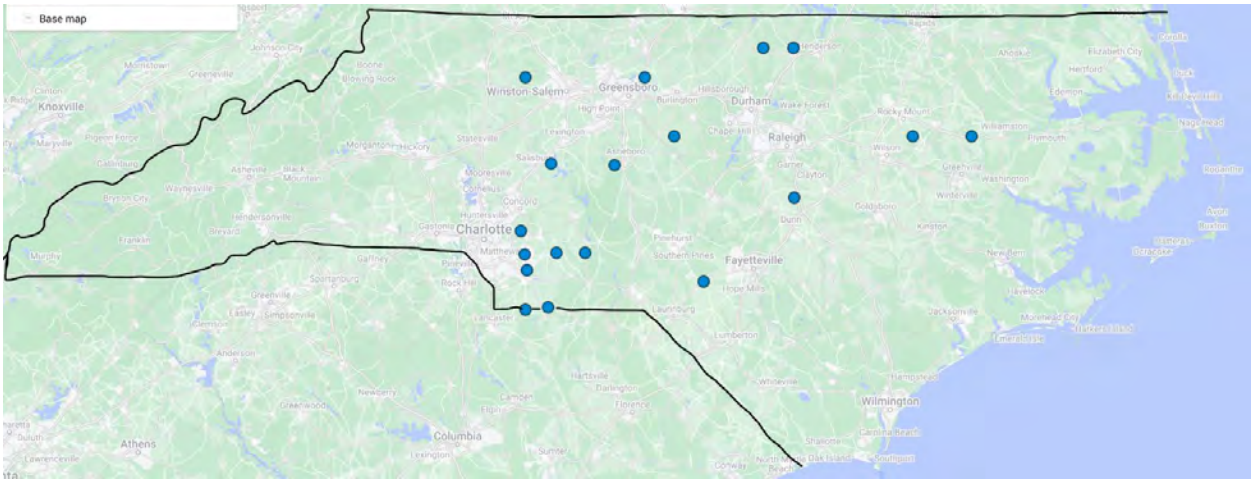


Figure 3. Distribution of Axial (pinoxaden) resistant populations.

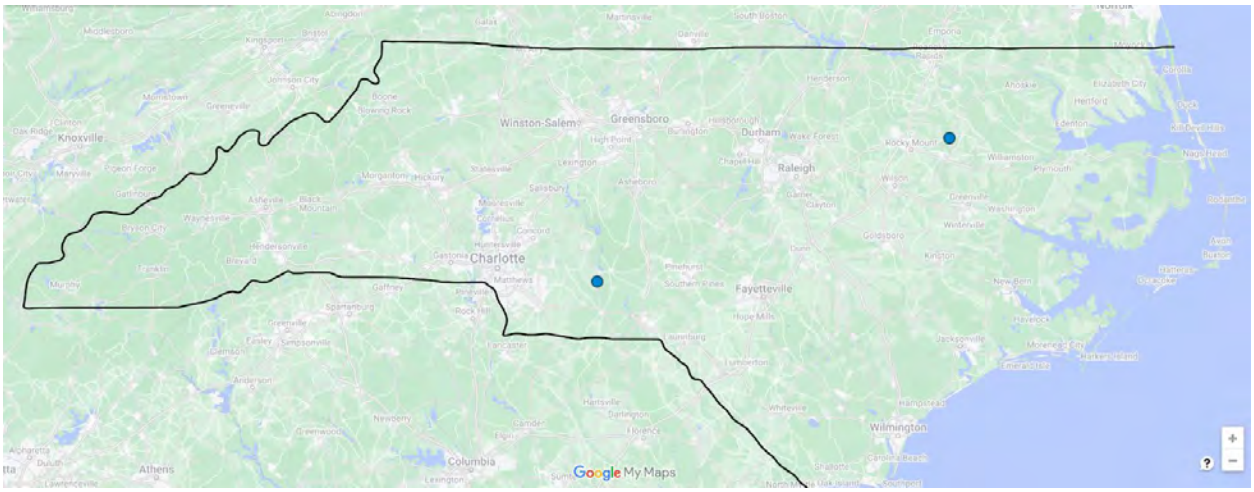


Figure 4. Distribution of glyphosate resistant Italian ryegrass.

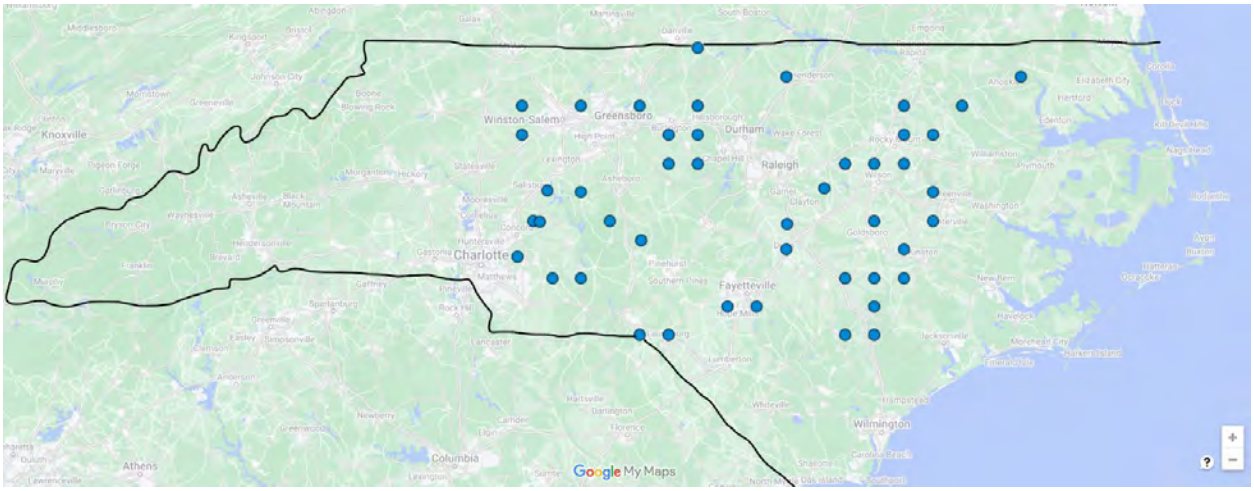


Figure 5. Distribution of glufosinate resistant Italian ryegrass.

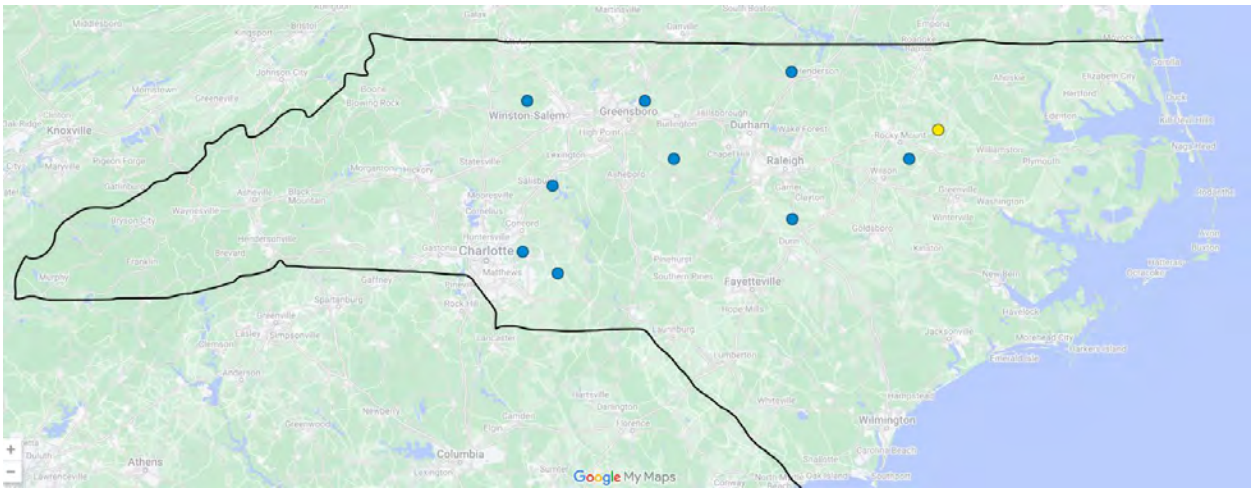


Figure 6. Distribution of 3 way resistance populations. BLUE (Glufosinate, Mesosulfuron, Pinoxaden), Yellow (Glufosinate, Glyphosate, Mesosulfuron)

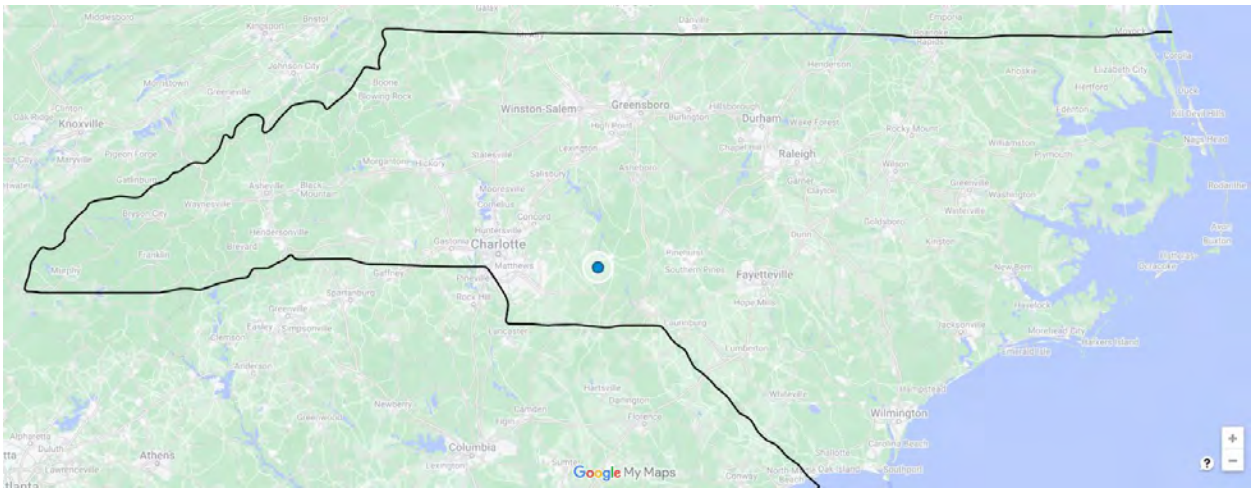


Figure 7. Distribution of paraquat resistant Italian ryegrass, which is also a 5 way resistant population.

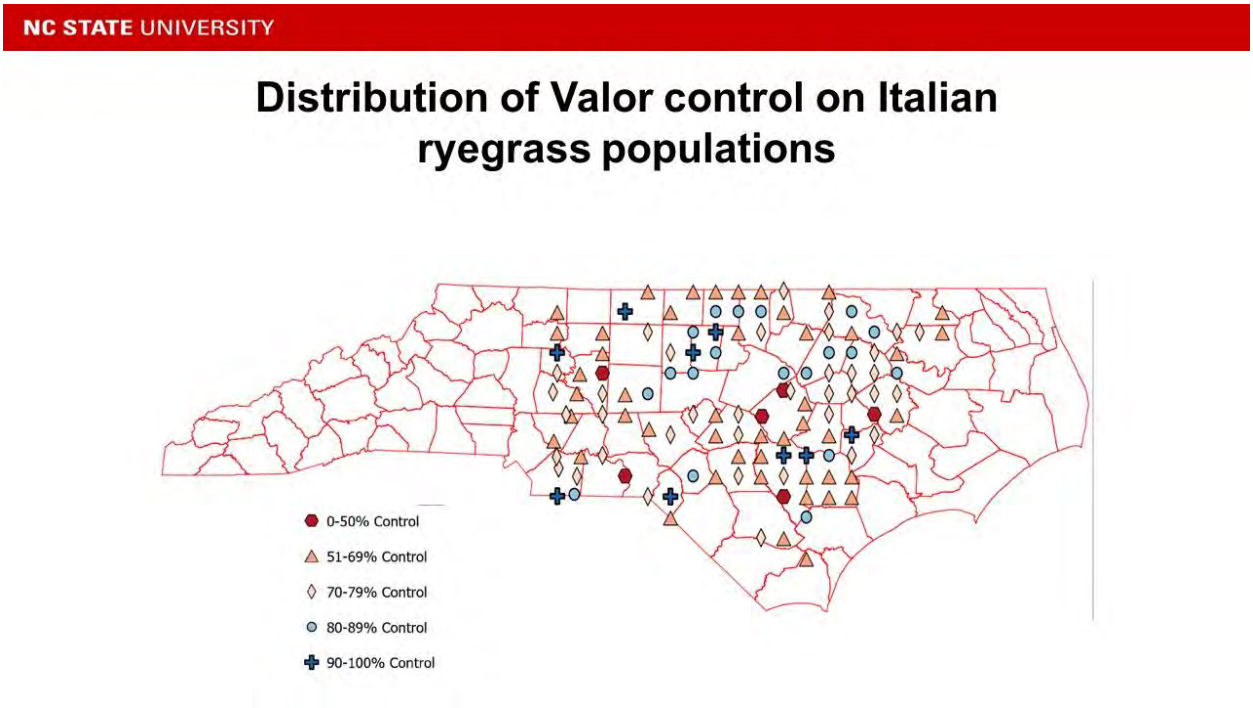


Figure 8. Response of surveyed Italian ryegrass populations to flumioxazin applied at a biologically effective rate.

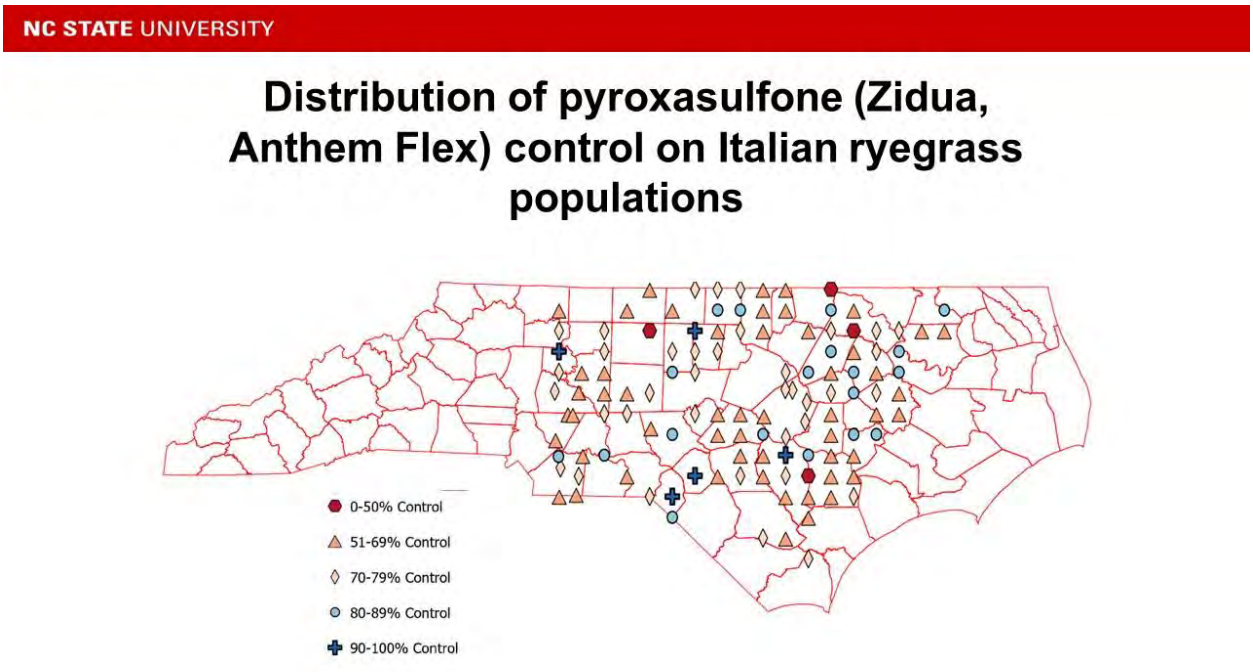


Figure 9. Response of surveyed Italian ryegrass populations to pyroxasulfone applied at a biologically effective rate.

ANNUAL PROGRESS REPORT
TO
NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION, INC.

TITLE:	**Small Grains Problem Diagnosis Support for Cooperative Extension Agents**
LEADER(S):	**Matt Bertone, Luke Gatiboni, Kristen Hicks**
DEPARTMENT(S):	**Entomology and Plant Pathology, Crop and Soil Sciences, NCDA&CS**
Plant Date:	**N/A**
Harvest Date:	**N/A**
Location:	**NCSU Main Campus**

Report of Progress / Activity:

Objective 1: This project will support efforts by cooperative extension agents to diagnose specific crop nutritional or disease problems in small grains.

Objective 2: This project will fund a limited number of samples to be submitted by cooperative extension agents for analysis at the NCDA&CS Agronomic Division plant tissue or nematode lab, and at the NCSU Plant Disease & Insect Clinic.

Conclusions / Findings (emphasizing value for growers, thus far):

During the funding period, 44 small grain crop samples (wheat, oats, and barley) were submitted to the Plant Disease and Insect Clinic (PDIC); all were submitted in 2024. Of these, 25 qualified for coverage by this commodity funding as they were submitted through the county extension offices. Overall, samples of small grains came from 26 counties (Alexander, Beaufort, Camden, Cumberland, Duplin, Franklin, Gates, Granville, Greene, Hertford, Hyde, Johnston, Lenoir, Northampton, Pamlico, Pasquotank, Perquimans, Person, Pickens, Pitt, Robeson, Robeson, Union, Wake, Wayne, and Yadkin).

The following are the diagnoses made on all of the samples submitted to the PDIC:

- Abiotic disorders were diagnosed 25 times, most of which were nitrogen deficiency (8) or other nutrient-related disorders; following these were freeze damage (3) and low pH (2)
- For diseases, the following were found: powdery mildew (*Blumeria graminis*) (2), head blight (*Fusarium graminearum*) (1), take-all (*Gaeumannomyces graminis*) (1), Barley yellow dwarf (BYDV) Luteovirus (1), and loose smut (*Ustilago avenae*) (1)
- As far as arthropod pests, Hessian flies (Cecidomyiidae: *Mayetiola destructor*) were diagnosed three times, while aphids (*Rhopalosiphum*) were diagnosed once.

Budget / Financial Status Update (by expense category):

Funds Awarded	**$2,000**
Personnel Costs (including fringe benefits)	(below by category)
Technical Support (full-time workers)	
Graduate Student Stipend	
Part-time / hourly / undergraduate workers	
Materials & Supplies	$460
Travel Costs	
Other Costs (explain as needed, below)	
Total Spending through June 30, 2024	**460***
Funds remaining (forecast remaining expenditures below)	**$1,540**

Budget Notes: *I do not have the figures from NCDA&CS for their billing of samples submitted to their services. No travel was made during the project.

ANNUAL PROGRESS REPORT
TO
NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION, INC.

TITLE: **Determining the impact of resistant wheat varieties and foliar insecticides on aphid populations, YDV incidence, and yield**

LEADER(S): **Dominic Reisig,[1] Christina Cowger,[1,2] Anders Huseth,[1] J. Paul Murphy[3]**

DEPARTMENT(S): **Entomology and Plant Pathology,[1] USDA ARS Plant Sciences Research Unit,[2] and Crop and Soil Sciences[3]**

Plant Date: **2021-2024**

Harvest Date: **Variable**

Location: **Plymouth, Raleigh, Kinston**

Report of Progress / Activity:

Objective 1: Barley yellow dwarf virus (BYDV) is a viral disease of small grains that is transmitted by aphids feeding on the plants. It can cause major losses through stunting and yield reduction. Until recently, there was little to no effective wheat resistance to BYDV, but the *Bdv2* gene has been introgressed into wheat varieties in the mid-Atlantic region.

Our objective was to determine the value of wheat varieties containing the *Bdv2* resistance gene and foliar insecticide sprays to reduce aphid numbers, yellow dwarf virus incidence, and protect yield.

Progress / Activity: We planted 3 wheat lines, two containing the *Bdv2* gene and one without the gene as a susceptible control, in a randomized complete block experiment with four replicates at each of two locations per year. Insecticide treatments compared were:

* Seed treatment prior to planting;

* November spraying;

* February spraying; and

* An unsprayed control treatment.

Data collected from the field experiments were: BYDV symptoms, grain yield, test weight, and aphid counts. So far, we were able to obtain a complete set of data in three environments: Plymouth 2022, Raleigh 2022, and Kinston 2024. The other three experiments (year*location) were rendered unusable due to animal damage or, in one case, human error. We plan to plant the experiment again in fall 2024 in Kinston and Raleigh.

So far, the results indicate that the *Bdv2* gene provides protection against BYDV that is equivalent to that provided by insecticidal sprays used to control aphids. More work must be done to analyze and summarize the results before more detailed conclusions can be drawn.

Conclusions / Findings (emphasizing value for growers, thus far): Assuming that the *Bdv2* gene continues to show high levels of efficacy in protecting wheat against BYDV, the use of this gene in eastern soft red winter wheats is a major advance. For decades, there has been debate about whether protection via insecticide application as a foliar spray was more effective in the fall or in the spring. Such foliar applications have a limited period of efficacy. It seems likely that

in some years and/or environments, fall aphid flights are the problem, while in others, spring aphid flights transmit BYDV. The advantage of resistance conferred by *Bdv2* is that the protection is available at all times, so advance knowledge of when aphid pressure will occur is not needed.

Budget / Financial Status Update (by expense category):

Funds Awarded **$17,500**

Expenditures in support of this project are being moved to the project account from other default sources used.

Budget Notes: It is expected that all remaining funds will be spent.

ANNUAL PROGRESS REPORT
TO
NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION, INC.

TITLE: **Small Grains Extension and Outreach**

LEADER(S): **Angela R. Post**

DEPARTMENT(S): **Crop and Soil Sciences**

Plant Date: **Not Applicable**

Harvest Date: **Not Applicable**

Location: **Multiple Locations**

Report of Progress / Activity:

Objective 1: Continuing education training for agents through Small Grains Short Courses.

Objective 2: Incorporate complete datasets into consumable products for online and in-person dissemination

Objective 3: Support education efforts to supplement in-person training for farmers and agricultural agents (virtual and in-person)

Objective 4: Complete the planning stage for a 2025 international extension exchange with other top wheat producing countries: options include Australia, Canada, India, Pakistan, Germany or France among many others.

Conclusions / Findings (emphasizing value for growers, thus far):

Under Objective 1, we completed a basic agent training following the Union County field day. Dr. Angela Post, Official Variety Testing (OVT) Director Ryan Heiniger, Dr. Christina Cowger, and County Extension Director Andrew Baucom offered training to new agents at this event. We provided materials to these agents including Disease Scouting and Identification guides, production guides, fungicide tables and several handouts specific to variety selection. We offered some weed identification training, wheat growth and development, disease identification as well as identification and troubleshooting for abiotic disorders. Seven agents received basic small grains training at this event.

Under Objective 2, we developed materials to disseminate at Whistle Stop Tours this season including a Hessian Fly Resistance factsheet (available on the small grains portal, in print and disseminated in Wheat Beat). Three other items are being developed from datasets completed this year: population by maturity by intensity of management work has been completed over three seasons; 2024 grain quality analysis for all commercial varieties in the OVT, and three trials evaluating Proven N will be summarized. Each set will have a factsheet and additions to the Small Grain Production guide will be completed where appropriate.

Six small grains presentations were presented at the 2023 International CSSA/ASA/SSSA meeting and are available as video content online (complete links in end notes):

1. Evaluating the Safety and Efficacy of Poultry Litter As a Full Topdressing for Soft Red Winter Wheat in North Carolina [i]
2. Optimizing Ground Control Point Placement for Improving Accuracy of Drone-Based Data Collection [ii]
3. Developing Nitrogen Rate Recommendations for Malting Barley [iii]
4. Optimizing Malting Barley Production in the Southeast [iv]
5. Modeling Wheat Jointing to Assist Producers in Identifying Proper Timing of Spring Topdressing [v]
6. Utilizing Soft Red Winter Wheat Mixtures to Mitigate Risk of Yield Loss Due to Biotic and Abiotic Factors [vi]

Under Objective 3, we offered twelve monthly zoom meetings for Ag Agents to attend in order to better their understanding of the crop condition throughout the state and have individual problems evaluated by multiple professionals at a time. Each one was attended by approximately 20 agents and several specialists also attend to offer advice and troubleshooting for on-farm problems. Several of these events are followed up by on-farm visits to evaluate problem fields and collect samples for testing. On-farm site visits this year included Union, Pasquotank, Perquimans, Gates, Caldwell, Franklin, Beaufort, Catawba and Cumberland counties.

The OVT offers a webinar following data release for both agents and farmers to learn about the best performing varieties for each crop. I attend this webinar for the wheat data release to support agents and farmers in making variety selections for the following year.

This season we held three field days and twelve whistle stop tours. See Table 1 for a summary of the Whistle stop tour sites and topics of discussion. We reached 263 participants with the whistle stop tour this year and had several stops in new locations.

Under Objective 4 We completed the domestic extension exchange portion of the proposal visiting The Ohio State University and the USDA Soft Wheat Quality Lab (SWQL) in Wooster, OH in May 2024. We took one graduate student, one county extension director and three extension agents. At the USDA SWQL we met with Dr. B. Lee and Dr. Bryan Penning. There were a couple of important research takeaways from this exchange. 1) With Dr. Penning's suggestion and help with methodology, we were able to start a new screening method for pre-sprouting in wheat. We will use this method to evaluate commercially available lines and their resistance to pre-sprouting after grain maturity and under the pressure of repeated wetting events. We selected 10 varieties with a wide range of falling numbers to evaluate this season and we collected samples from two locations: Union and Person Counties to test the procedure. The trials are underway in the laboratory right now (Figure 1). 2) We were able to see several different types of baking demonstrations for soft wheat including cookie, sponge cake, cracker, tortilla and steamed bun. Taylor Brinkley who is working on improvement of milling quality of wheat with her Master's research was able to get a first-hand look at the cracker baking protocol which is still in development, but will be a valuable tests for NC growers selling to the milling market. She will consider a biscuit test development for NC as well. Taylor will be part of a future exchange where she goes up to work on-site in the SWQL for several weeks for method development and lab analysis of her grain samples.

In addition to the SWQL lab, we also visited an Italian Bakery to see a large baking operation for sub rolls, buns, and pizza dough. We toured the Northeast Ohio Research and Education Center with Small Grains Extension specialist Dr. Laura Lindsey, area agent Stephanie Karhoff and faculty agent Dr. Ed Lentz. Our NC agents were able to ask lots of questions to learn about soft wheat production and farmer sentiment in Ohio and also see a different funding and retention model for extension in another state. Overall the Domestic exchange trip was successful and we brought home some immediate transferrable tools to assist NC farmers with wheat at home.

We planned to make a trip to Australia in summer 2024 to make contacts with University, industry and growers and plan for a group extension exchange in 2025. However, the NCSGGA did not select the Domestic and International Extension exchange in their priorities for 2025, so we elected not to make the initial trip.

Budget / Financial Status Update (by expense category):

Funds Awarded	**$33,000**
Personnel Costs (including fringe benefits)	(below by category)
Technical Support (full-time workers)	
Graduate Student Stipend	$515.23
Part-time / hourly / undergraduate workers	
Materials & Supplies	10,563.73
Travel Costs	11,935.55
Other Costs (explain as needed, below)	5,292.41
Total Spending through June 30, 2024	**$28,306.92**
Funds remaining (forecast remaining expenditures below)	**$3,041.63**

Budget Notes:

$1,733.28 in charges are being moved to this account because they hit our default accounts. We will not execute the International Extension Exchange part of this proposal so any funds remaining will be returned to the NCSGGA at the end of the grant cycle.

Image(s) or graphs/charts

Table 1. Whistle Stop Tour Summary.

Dates (12)	Location	Agent	Crop Focus Topic	Attendees
April 25	Johnston County	Tim Britton	Maturity x Planting Date Intensity of Management	32
April 25	Rowan County	Jenny Carleo & Morgan Watts	Wheat-varieties	58
April 29	Cumberland County	Connor Peacock	Farmer Wheat Field Evaluation	6
April 30	Robeson County	Mac Malloy	Wheat-Varieties	7
May 2	Kinston, NC	GrowPro	Wheat-Varieties & PGRs	35
May 7	Franklin County: 1769 NC 39 Hwy, Louisburg, NC	Matthew Place	Wheat Yield Potential and Harvest Management	25
May 8	Union County: 34.8595580, -80.5132520 Jack Davis Rd Monroe NC	Morgan Menaker	Fungicide, Nitrogen, Boron, Varieties	45
May 9	Cleveland & Catawba Counties: 35.368379, -81.648483	Heather Schronce	Yield Potential and Plant Growth Regulators	9
May 10	Caldwell County: 2167 Satterwhite Cir Granite Falls NC	Seth Nagy	Wheat Yield Potential and Harvest Management	5
May 14	Lower Coastal Research Station 35.377135, -77.557330	Phillip Winslow	AGS Varieties; Nitrogen Carryover; Hessian Fly	14
May 15	Beaufort County: Circle Grove 35.559019, -76.567092	Rod Gurganus	Wheat-Varieties	22
May 16	Pasquotank County: 36.2929708, -76.3736966	Al Wood	Wheat-Varieties Population and Nitrogen Rate	5
			Total Participants:	263

Figure 1. Images from pre-sprouting screening for ten commercial varieties from the OVT in Person and Union counties.

[i] https://scisoc.confex.com/scisoc/2023am/a2/papers/index.cgi?username=152696
[ii] https://scisoc.confex.com/scisoc/2023am/a4/papers/index.cgi?username=152984
[iii] https://scisoc.confex.com/scisoc/2023am/s8/papers/index.cgi?username=152774
[iv] https://scisoc.confex.com/scisoc/2023am/a2/papers/index.cgi?username=152790
[v] https://scisoc.confex.com/scisoc/2023am/s8/papers/index.cgi?username=152729
[vi] https://scisoc.confex.com/scisoc/2023am/c3/papers/index.cgi?username=152759

ANNUAL PROGRESS REPORT
TO
NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION, INC.

TITLE: **Small Grains Program Data Collection and Harvest Support 2023-24**

LEADER(S): **Angela R. Post**

DEPARTMENT(S): **Crop and Soil Sciences**

Plant Date: **Not Applicable – Multiple Locations**

Harvest Date: **Multiple Locations**

Location: **Multiple Locations**

Report of Progress / Activity:

Objective 1: Execute a statewide agronomic research testing program evaluating best management practices for NC wheat producers

Objective 2: Support County level testing efforts for planting, harvest, and data analysis in cooperation with the State Specialist

Conclusions / Findings (emphasizing value for growers, thus far):

Under Objective 1 the Small Grains Extension program executed 20 wheat and barley research trials throughout the state. We also maintained or harvested 4 trials for research cooperators including Jenny Carleo, David Suchoff, and Dominic Reisig. Two of these projects are supported by the Small Grain Growers Association including Jenny Carleo and Christina Cowger's fungicide research and Dominic Resig's Hessian fly research. See linked extension publication from the Hessian Fly research (Table 1).

Three graduate students are working on research projects in wheat and barley in North Carolina. They include:

Taylor Brinkley: Improving the milling quality of wheat through the use of plant growth regulators and potassium application timing and source. Taylor executed trials at three locations: Rowan, Union and Pasquotank where the use of plant growth regulators is common. She will continue her research for two more wheat seasons. Grain from her trials is currently being analyzed in the quality analysis laboratory for differences in protein and falling number. She is also evaluating all treatments for increased resistance to pre-sprouting.

Marco Granadino: Evaluating nitrogen stabilizers for improvement in wheat yield and evaluating nitrogen carryover in wheat cropping systems. Marco executed three locations of nitrogen stabilizer work in 2023-24 evaluating five N-stabilizer products with and without the addition or starter fertilizer. Data analysis is still in progress for this research. He also surveyed 58 farmer fields of wheat following corn (38), tobacco (8), soybean (11) and cotton (1). We are still awaiting final yield data from farmers but are analyzing soil residual nitrogen from three time points in the season from each field and crop residue samples.

Khadeja Sathi: Screening wheat varieties for seedling tolerance to waterlogging stress (Image 1 & 2) and screening barley lines for tolerance to salinity stress. Screening of 72 commercial wheat lines has been completed with 28 more to go to complete the first set. In fall 2024, selected lines will be planted in the field under waterlogged conditions induced by irrigation to identify lines best suited to escape waterlogged conditions through root architecture.

The maintenance and harvest of their trials including sample analysis is included under this proposal as a part of the overall Small Grains Extension program because their data will have direct relevance to growers. However, only a partial stipend and tuition for Marco Granadino was supported by this grant for 2024.

The majority of funds go to equipment maintenance and repairs and consumable field and lab materials to execute all trials.

Under Objective 2: Utilizing these funds we also assisted in planting, maintenance, harvest, grain analysis and data analysis for 10 research trials initiated by county agents including Tim Britton, Andrew Baucom, Morgan Menaker, Rod Gurganus, Al Wood, Adam Formella, Austin Brown and Paul Smith.

Trials included:

Trial Description	**County**
Population by Nitrogen Management	Pasquotank County
Maturity by Management by Planting Date	Johnston County
Foliar Boron Applications	Union County
NE Ag Expo Variety Trial	Pasquotank County
Barley Varieties for Johnston County	Johnston County
Proven N	2 locations (Union and Johnston)
Plant Growth Regulator Use	Union County
Wheat-Soybean Intercropping	Beaufort County
Large Scale NUE Evaluation	Union County

These trial data and grain samples are in the process of being analyzed in the grain quality analysis lab. The Northeast Ag Expo Variety trial data and yields for the wheat-soybean intercropping trial have already been released to agents or farmers in those areas. As data analysis are completed, items will be immediately released through agents in their counties and on the small grains portal. Wheat Beat articles will go out for those relevant for the whole state. All data are projected to be ready by the end of August so that farmers have between six and eight weeks to evaluate any new information as they make variety selections and prepare for the upcoming season.

Budget / Financial Status Update (by expense category):

Funds Awarded	**$90,000**
Personnel Costs (including fringe benefits)	(below by category)
Graduate Student Stipend	$22,829.94
Materials & Supplies	44,902.61
Travel Costs	214.00
Other Costs (explain as needed, below)	22,648.95
Total Spending through June 30, 2024	**$90,381.50**
Funds remaining (forecast remaining expenditures below)	**-(381.50)**

Budget Notes:

This account is currently slightly overspent. Overage charges will be moved to bring the account to a zero balance.

Image(s) or graphs/charts

Table 1. Snapshot of the Hessian Fly factsheet. For the full news article and publication see the following website: https://smallgrains.ces.ncsu.edu/2024/02/wheat-variety-resistance-ratings-for-hessian-fly/

NC STATE UNIVERSITY

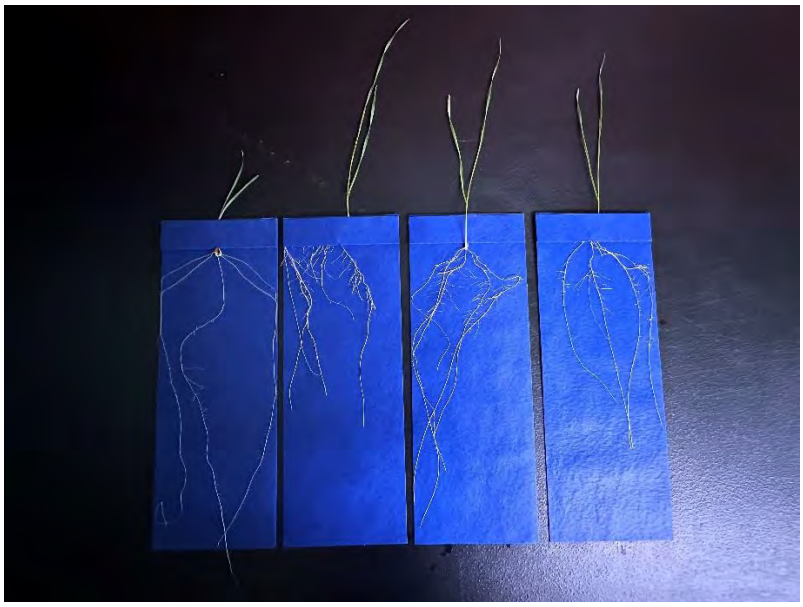
Wheat variety resistance ratings for Hessian fly

Dominic Reisig, Ryan Heiniger, Angela Post, David Buntin (U of GA)

Varieties planted in Lenoir County during 2023 and may not reflect resistance profiles of Hessian flies in all areas of North Carolina. Caution should also be used since this is a single rating. Percent infested tillers ranged from 0 to 70% (0 to 12.5% = good; 15 to 27.5% = fair; 30-70% = poor). Number of pupae ranged from 0 to 2.3 per tiller, on average (0 to 0.275 = good; 0.3 to 0.575 = fair; 0.6 to 2.3 = poor). Georgia ratings are a combination of visual ratings, infested tiller and larval/pupal counts. Scab = also scab-resistant.

		Fall 2023- Lenoir County			Georgia
Brand	Variety	% infested tillers	# of pupae	Overall	2023 spring ratings
AgriMAXX	AgriMaxx 481	--	--	--	Good
	AgriMaxx 502	Good	Good	Good	--
	AgriMaxx 503	Fair	Fair	Fair	Fair
	AgriMaxx 505	Good	Fair	Good - Fair	--
	AgriMaxx 513	Poor	Poor	Poor	Poor
	AgriMaxx 516	Fair	Fair	Fair	Fair
	AgriMaxx 535	Good	Good	Good	Fair
AgriPro	GP381	Fair	Fair	Fair	--
	GP543	Poor	Poor	Poor	--
	GP747	Poor	Poor	Poor	--
	GP282	Poor	Poor	Poor	--
	GP717	Poor	Poor	Poor	--
	GP348	Fair	Fair	Fair	--
AGSouth Genetics	AGS2024	Poor	Poor	Poor	Poor
	AGS3026	Poor	Poor	Poor	Poor
	AGS4023	Fair	Fair	Fair	Good-Scab
	AGS4043	Good	Good	Good	Good-Scab
	Experimental	Good	Good	Good	--
Dyna-Gro	Shirley	Poor	Poor	Poor	--
Featherstone	Featherstone 3000	Poor	Poor	Poor	--

Image 1 & 2. We are already seeing differences in root and shoot architecture development by variety in laboratory waterlogging trials where seedlings are waterlogged beginning at 3, 5, and 7 days after germination. Upper image is USG 3451 and lower image is DG9172 var. Left to right is control, waterlogged after 3, 5, and 7 days following germination and remaining waterlogged through day 21 for each treatment. The control received adequate water but no waterlogging throughout the 21 days.



ANNUAL PROGRESS REPORT
TO
NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION, INC.

TITLE: **Varietal Screening for Hessian Fly Resistance**

LEADER(S): **Dominic Reisig,[1] Ryan Heiniger,[2] and Angela Post[2]**

DEPARTMENT(S): **Entomology and Plant Pathology[1] and Crop and Soil Sciences[2]**

REPORT:

Our objective was to determine the susceptibility of popular commercial wheat varieties grown in North Carolina to Hessian fly. We planted 44 varieties in Hugo, NC during 2023. Hessian fly pressure was exceptionally high, providing us an excellent opportunity to screen varieties. We evaluated the trial in late-December 2023, when both larvae and pupae were still present, and some tillers had died. We counted the number of infested tillers in 10 tillers per plot and the number of larvae and pupae in those tillers.

We split the rating up into three categories. Varieties with less than 15% infested tillers were considered as good resistance, varieties 15-27.5% infested tillers were considered as fair resistance, and varieties with over 30% infested tillers were considered as poor resistance. Varieties ranged from 0-70% infested tillers and ranged from 0-2.3 larvae and pupae per tiller.

We created a printable handout based on this information and posted it on the small grains extension portal and shown on the following pages.[1]

Budget / Financial Status Update (by expense category):

Funds Awarded	$10,000
Personnel Costs (including fringe benefits)	(below by category)
Part-time / hourly / undergraduate workers	$1,072
Materials & Supplies	2,577
Travel Costs	436
Other Costs (explain as needed, below)	11
Total Spending through June 30, 2024	**$4,096**
Funds remaining (forecast remaining expenditures below)	**$5,903**

Budget Notes: It is expected that all the remaining funds will be spent by the project's end.

IMPACT STATEMENT:

There are no findings or impact to report at this time, but we hope growers are able to use this resource to select resistant varieties in 2024.

[1] https://smallgrains.ces.ncsu.edu/wp-content/uploads/2024/02/Wheat-HF-resistance-NC-GAratings.pdf?fwd=no

Image(s) or graphs/charts

NC STATE UNIVERSITY

Wheat variety resistance ratings for Hessian fly

Dominic Reisig, Ryan Heinger, Angela Post, David Buntin (U of GA)

Varieties planted in Lenoir County during 2023 and may not reflect resistance profiles of Hessian flies in all areas of North Carolina. Caution should also be used since this is a single rating. Percent infested tillers ranged from 0 to 70% (0 to 12.5% = good; 15 to 27.5% = fair; 30-70% = poor). Number of pupae ranged from 0 to 2.3 per tiller, on average (0 to 0.275 = good; 0.3 to 0.575 = fair; 0.6 to 2.3 = poor). Georgia ratings are a combination of visual ratings, infested tiller and larval/pupal counts. Scab = also scab-resistant.

		Fall 2023- Lenoir County			Georgia
Brand	Variety	% infested tillers	# of pupae	Overall	2023 spring ratings
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	AgriMaxx 502	Good	Good	Good	--
	AgriMaxx 503	Fair	Fair	Fair	Fair
	AgriMaxx 505	Good	Fair	Good - Fair	--
	AgriMaxx 513	Poor	Poor	Poor	Poor
	AgriMaxx 516	Fair	Fair	Fair	Fair
	AgriMaxx 535	Good	Good	Good	Fair
AgriPro	GP381	Fair	Fair	Fair	--
	GP543	Poor	Poor	Poor	--
	GP747	Poor	Poor	Poor	--
	GP282	Poor	Poor	Poor	--
	GP717	Poor	Poor	Poor	--
	GP348	Fair	Fair	Fair	--
AGSouth Genetics	AGS2024	Poor	Poor	Poor	Poor
	AGS3026	Poor	Poor	Poor	Poor
	AGS4023	Fair	Fair	Fair	Good-Scab
	AGS4043	Good	Good	Good	Good-Scab
	Experimental	Good	Good	Good	--
Dyna-Gro	Shirley	Poor	Poor	Poor	--
Featherstone	Featherstone 3000	Poor	Poor	Poor	--
Harvey's	AP1983	--	--	--	Good
	AP1987	Good	Good	Good	--
	AP1991	Fair	Poor	Fair - Poor	--
	AP1995	Poor	Fair	Fair - Poor	--
	AP2000	Poor	Poor	Poor	--
Pioneer	25R94	--	--	--	Poor
	26R33	Poor	Poor	Poor	--
	26R45	--	--	--	Good
	26R59	Poor	Fair	Fair - Poor	Poor
	Experimental	Poor	Poor	Poor	--
Progeny	#Buster	Poor	Poor	Poor	Fair
	#Bingo	Poor	Poor	Poor	Poor
	#Chad	Poor	Poor	Poor	--
	Experimental 1	Good	Good	Good	--
	Experimental 2	Fair	Poor	Fair - Poor	--
	PGX20-15	--	--	--	Good
Revere Seed	Revere 2169	Good	Good	Good	--
	Revere 2277	Poor	Poor	Poor	--
	Revere 2347	Fair	Poor	Fair - Poor	--
Southern Harvest	SH7200	Good	Good	Good	Good
	SH4222	Fair	Poor	Fair - Poor	--
	SH5123	Good	Good	Good	--
	SH7222	Fair	Poor	Fair - Poor	Poor

NC STATE UNIVERSITY

Wheat variety resistance ratings for Hessian fly

Dominic Reisig, Ryan Heinger, Angela Post, David Buntin (U of GA)

	SH9520	Poor	Poor	Poor	--
UniSouth Genetics	USG3354	Poor	Poor	Poor	Poor
	USG3463	Poor	Poor	Poor	--
	USG3661	Poor	Poor	Poor	--
	USG3783	Poor	Poor	Poor	Poor
VA Tech	VA13W-75	--	--	--	Good
	VT Pittman	Good	Good	Good	--