Research Results from Projects Conducted in 2018

The goal of agronomic research is to explore new ideas and methods for improving crop production. With the arrival of spring another growing season begins with the promise of the opportunity to use the lessons learned from corn research to adjust and refine corn management. These reports highlight research projects conducted at North Carolina State University in 2018. These summaries are intended to provide you with some information on topics ranging from starter fertilizer to water management to genetic improvements in corn.

Perhaps some of this information will help you as you make decisions about managing corn in 2019 or perhaps these summaries will stimulate more questions about problems you have seen in your area.

Either way, why not take a few moments to let us know what you found to be helpful in these projects or what additional problems you would like to see solved. Working together we can be successful!

Evaluating Irrigation Strategies of Water-Efficient Corn Production in Eastern North Carolina

NCARS/NCCES Code 16-07

Principles: Mahamed Youssef, Gail Wilkerson, Ron Heiniger, Jeffrey White, Michael Kudenov
This research focused on technologies to more quickly and reliably identify genotypes with enhanced yield potential using three irrigation regimes. Two maize genotypes were tested in 2016, then in 2017 and 2018 the research was modified to test the effects of population and two side-dress placement methods on corn growth, yield, and plant nutrient sufficiency indicators.

2018 Key Findings

Stand, Phenology, and Vegetation indices were with irrigation, phenological differences were detected between 35 days (one day after side dressing) and 52 days after planting in the growth staging period. No phenological differences were detected prior.

Yield Response

Grain yield under full and critical stage irrigation was approximately equal, 160 bu/a over 130 yield bu/a, with no irrigation, showing a gain of 23.1%. Side-dress nitrogen rate and placement affected yield, favoring the 2x rate with 40,000 plants per acre compared with 1x 30,000 plants per acre. However, the 15 bu gain was small relative to doubling the side-dress N rate, indicating that that increasing fertilizer N beyond 200 lb per acre, even with the higher plant population provided little further yield benefit.

Impact Statement

This three-year study clearly demonstrates the corn yield benefits of supplemental irrigation during the dry periods of the growing season. The average gain in the three-year study period was 23.2%, and 17.4% respectively, with full and critical stage irrigation. The yield gains were obtained by applying a few inches of irrigation water between mid-June and early August.

Novel Agricultural Water Management Systems for Increasing the Production and Consistency of Corn Yields in North Carolina NCARS/NCCES Code 18-01

Leaders: Mahamed Youssef, Chad Poole, Lamyaa Negm

Experimental Component:

The planting of BATH 1 field was delayed due to a prolonged wet early growing season in 2018, creating an excessively high-water table. The field was planted to Pioneer 1870 on May 4th when the water table fell to 24" below soil level.

The automated system remained in controlled drainage with a riser setting at 24". However, the weather conditions turned unfavorable for proper root establishment late May through most of June.

The crop yield responded to the automated system vs the conventional drainage system. There was a significant increase in corn yield of 12.1 bu/a or an 8% increase in yield. The conventional free drainage treatment yields 149.7 bu/a on average and the automated system yields were 161.9 bu/a.

Impact Statement:

The results in year one of the project have demonstrated the ability to increase corn yields on poorly drained soils even in extremely wet growing seasons. The active water management increased corn yield by over 8% utilizing the automated drainage and irrigation. The fact that the system was able to achieve yield increases in a year with excessive precipitation and high- water tables demonstrates the importance of managing water throughout the growing season with systems that have the ability to monitor field conditions and make automated changes based on the circumstances observed in the field. A 12 bu/a increase in corn yield would have grossed $48.00 ac more revenue than the conventional system with $4.00 corn. This increase in yield and revenue was significant and cannot be ignored.

Corn Problem Diagnosis Support for Cooperative Extension Agents

NCARS/NCCES Code 11-09

Leaders: C. Crozier, L. Thiesen, K. Hicks, Ron Heiniger, Kristin Hicks
This project funded analysis of plant tissue samples at the NCDA&CS Agronomic Division Laboratory and the plant and soil samples at the NCSU Plant Insect & Disease Clinic that were collected from problem fields. The study was 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.
Diagnostic samples of corn plants were analyzed at NCDA&CS labs from 24 counties. When pooled with funds provided by other commodity groups, samples from a total of 42 counties were analyzed. Problem corn sampled diagnosed by the NCDA&CS lab in 2016 identified low or deficient levels of the following nutrients; P(42%), N(39%), B(27%), Mg(26%), and Zn(25%).
This project thus represents a personal training resource for a substantial portion of the agricultural extension agents of the state. Program results are also used in support of other training events related to crop nutritional problem diagnosis. Events held in 2016-17 included both CCA and Cooperative Extension Agent training sessions.

Impact Statement:

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. This project will offer the ability to monitor problems and more formally document the potential crop losses or economic benefits if managed per recommendations.

Support for a Small Plot Combine for Corn
NCARS/NCCES Code: 16-02
Leader: R.W. Heiniger
A Kincaid 8-XP research combine was purchased in July 2016. This combine featured modification such as center fill bin extension, in-cab sampling, extended sieve area, which makes it suitable to handle high-yield corn. The combine was purchased with two corn heads, 30 and 22 inch, which allow for research over both intermediate and narrow row spacings.
The grain collection and measuring system is the most accurate equipment on the market, capable of measuring grain weight, moisture, and test weight within 0.01% accuracy. This combine was used to harvest the fall's corn plots across the state from Belhaven to Monroe to Mt. Airy. This capability improved the accuracy of the data, improved the timeliness of providing data reports and allowed assistance to agents in Tyrell, Hyde, and Surry Counties by harvesting their plots, help NCDA and other specialist collect plot data, and to assist the North Carolina Official Variety Testing Program harvest wheat, corn, and soybean plots resulting in better data and quicker information to the growers.

Impact Statement:

This plot combine improved the ability to harvest more plots oat different locations with greater accuracy outstanding data fidelity and better timeliness resulting in more information for corn growers and quicker response to requests for information.
Starter Fertilizer: Is Nitrogen, Phosphorous, or Both Needed?
NCARS/NCCES Code 17-02
Leaders: C. Crozier, D. Osmond, S. Tilley
The objective of this research is twofold: 1) determine if nitrogen(N) alone or N and Phosphorous (P) starter fertilizers are necessary for corn, and 2) determine if the placement (surface dribble, or a banded 2x2 placement) of either N or N and P effects the efficacy of starter fertilizer.
The 2017 experiments were conducted at four sites in North Carolina and a fifth site in South Carolina. The 2018 experiments were conducted at five sites with only three resulting in successful stand establishments due to flooding.
Significant crop yield response to treatments was found at only one of those site, Tyrrell County in 2017. Crop yields were highest with the treatment #4 which applied N+P in a 2x2 injected band placement (20-19-0 to supply 30 lb N/ac).

Table 1. Simple ANOVA results for grain yield indicating the probability of significance based on F test. Includes all treatments, for Union Co. site 4 plots with herbicide damage were excluded.

Site	Treatment	Replication	Site mean yield (bu/ac)	Soil test P-Index

2017				
Perquimans (NE Ag Expo)	0.53	0.13	121	144
Tyrrell (BFMA tour)	0.002	0.01	169	22
Union	0.99	0.08	232	112
Washington (Tidewater Res Sta)	0.99	0.82	252	50
South Carolina (B. Farmaha)	0.78	0.84	148	35*
2018				
Beaufort (BFMA tour)	0.26	0.26	136	112
Pamlico	0.39	0.71	104	183
Washington (Tidewater Res Sta)	0.13	0.13	124	72

* The South Carolina sample was analyzed using the Mehlich I extractant at the Clemson University Agricultural Service Laboratory with a result of 74 lb/ac of P, approximately equivalent to a Mehlich III extractable P-Index of 35.

Table 2. Tyrrell Co. site treatment comparisons. Yields not followed by the same letter differed significantly, LSD 0.05.

Trt #	Trt Description	Grain Yield (bu/ac)
1	No starter	165 bc
2	N only, 2x2 band	168 b
3	N only, surface band	155 c
4	N+P, 2x2 band	183 a
5	N+P, surface band	175 ab

Our treatment design included a factorial treatment arrangement, which enhances the ability to detect statistically significant specific effects of either the starter material or the mechanical placement. As in the 1st analysis, this technique only found significant treatment effects at the Tyrrell Co. site (both fertilizer source and fertilizer placement, Tables 3 & 4). Grain yields were 17 bu/ac higher with both N+P than with N alone, and were 11 bu/ac higher with the 2x2 band placement than with the surface band (Table 4).

Table 3. Factorial ANOVA results for grain yield (excluding control plots with no starter), indicating the probability of significance based on F test.

Site	Fertilizer Source	Placement	Source x Placement	Replication
2017				
Perquimans (NE Ag Expo)	0.28	0.71	0.60	0.09
Tyrrell (BFMA tour)	0.0012	0.02	0.42	0.03
Union	0.79	0.83	0.89	0.22
Washington (Tidewater Res Sta)	0.58	0.97	0.99	0.92

South Carolina (B. Farmaha)	0.79	0.40	0.97	0.42
2018				
Beaufort (BFMA tour)	0.99	0.20	0.12	0.72
Pamlico	0.85	0.11	0.56	0.90
Washington (Tidewater Res Sta)	0.86	0.67	0.20	0.10

Table 4. Tyrrell Co. site factorial effect comparisons. Yields not followed by the same letter differed significantly, LSD 0.05.

Fertilizer Source comparison		Placement comparison	
Source	Grain Yield (bu/ac)	Placement	Grain Yield (bu/ac)
N	162 b	2 x 2 band	176 a
N+P	179 a	Surface band	165 b

Impact Statement:

These data demonstrate that grain yield response to starter fertilizer was limited to one of the eight field sites in this study. When responses do occur they can be substantial (18 bu/a, or approximately 10% yield increase in this case) and likely to be profitable. When the significant grain yield response occurred both the N+P ingredient combination and the 2x2 injected band placement led to higher yields.

Validation of Soil Test Potassium Recommendations and Plant Tissue Analysis to Optimize Corn Yield in North Carolina Cropping Systems
NCARS/NCCES Code 17-03

Leaders: C. Crozier, D. Hardy, K. Hicks, J. Smyth
Ten sites North Carolina were chosen in each year, 2017, and 2018 that were identified as promising based on initial soil test results, likelihood of high yields, irrigation or low drought risk, and cooperators. Sites were followed through grain yield.
Crop yield, final stalk diameter, soil sample K from three upper layers, both before and after fertilization, and leaf K at approximately the V5-7 and VT growth stages were determined at all of the sites. Additional experimental sites were identified, then abandoned due to issues with stand or lack of harvest data.

Significant crop yield response to K treatments (i.e. probably level <0.05) was found at two sites in 2017, Henderson and Tyrrell Counties, and at two sites in 2018, Beaufort-Haslin and Camden Counties. Initial oil test K levels in surface soils at the two 2017 sites were as low or lower than all the other sites at both sampling stages.   Leaf K concentrations at these two sites were as low or lower than at all other sites at both sampling stages.

Impact statement:

These data demonstrate that response to K fertilizer does occur at sites with very low initial K levels, <25K-index for two sites in 2017, and for two sites in 2018 in the current study. Fertilization at the rates recommended with standard soil test interpretation, 100 lb K2O per acre, was sufficient to obtain maximum crop yields for three of these responsive sites, and with 150 lb K2O per acre at the fourth responsive site. At one of these sites, 50 lb K2O per acre was sufficient to obtain maximum crop yields.

Developing GLS-Resistant Female Lines
NCARS/NCCES Code 17-04

Leader: MM Goodman

Mostly wet weather patterns in 2018 made it a good year to screen for GLS-resistance (gray leaf spot). Locations at Salisbury and Laurel Springs were particularly helpful, Waynesville, less so. When contrasted with rating for the same hybrids evaluated under relatively dry conditions in 2017, the 2018 scores are generally lower (i.e. more disease) hybrid scores below 8 (9=immune, 1=dead scale) suggests susceptibility to GLS. Familiar hybrids are highly resistant, including NC experiementals and such stalwarts as DeKalb 689.

Top performers were:

Hybrid	**Rating**
NC258xNC296	9
Pioneer 30F33	8.9
DeKalb 689	8.8
Pioneer 3085	8.8
Augusta A5465GTCBL	8.8
down to Pioneer PHX5352	6.6

The inbreds were successfully tested at all three locations and, as with the hybrids, scores were generally lower as compared with 2017. Again, inbred scores lower than 8 (on a 1-9 score, with 9 being essentially immune) suggest susceptibility to GLS. Virtually all of the scores in the top 20% belonged to NC lines or experimentals, with KD8M116 being the exception.

Hybrid	Rating	Hybrid	Rating	Hybrid	Rating
NC258 x NC296	9.0	DeKalb C66-75	7.9	Pioneer 1870AM	7.3
Pioneer 30F33	8.9	Dow MY09V41	7.9	LH283 x LH287	7.3
DeKalb 689	8.8	MC4377	7.9	Pioneer 1870YHR	7.3
Pioneer 3085	8.8	DeKalb C67-57	7.8	DeKalb 697	7.2
Augusta A5465GTCBL	8.8	Dow MY15J45	7.8	DeKalb C67-14	7.2
NC320 x NC368	8.7	Dow X12725PW	7.8	Pioneer 1184	7.2
NC320 x NC474	8.7	Pioneer 1498	7.8	AV 8714YHB	7.1
NC300 x NC296	8.6	Pioneer 1745R	7.8	Pioneer 31P41	7.1
NC464 x NC520	8.6	Pioneer 2088R	7.8	AV 6705AM	7.0
AV RL9583YHB	8.4	AV 7408YHB	7.8	DynaGrow 56VC46	7.0
Augusta A6867GTCBL	8.4	DeKalb C62-53	7.8	B73 x LH287.LH283	6.8
DeKalb 683	8.4	Pioneer 31D58	7.8	DynaGrow 57VC51	6.8
DeKalb XL212	8.4	Pioneer 31R87	7.8	Pioneer 31G66	6.8
DeKalb C70-27	8.3	Doebler 561XY	7.7	MC4178	6.7
Dow 2c788	8.3	DeKalb C65-18	7.7	DeKalb C66-59	6.7
Stine 9815-0	8.3	AV EXP1648YHB	7.6	Pioneer PHX5352	6.6
DeKalb 687	8.3	AV 8614YHB	7.6	Pioneer 31G65	6.5
NK N8811	8.3	Dow MY11C27RA	7.6	Augusta 2956C	6.4
(NC320.NC368) x (DK_HBA1.PHN47)	8.2	Dow MY13M87RA	7.6	NC476 x DK_HBA1	6.4
Dow CNX157144S3	8.2	Pioneer 2160YHR	7.6	Pioneer 31G98	6.4
AV 8915AM	8.1	DeKalb C65-20	7.5	LH132 x LH51	6.3
Dow 2J794	8.1	DeKalb C65-95	7.5	Dow X15635VH	6.2
NC474 x LH283.LH287	8.1	DeKalb C68-04	7.5	B73Ht x Mo17Ht	6.2
DeKalb C64-35	8.0	Dow X13652VH	7.5	DeKalb C64-69	6.1
DeKalb C65-94	8.0	Pioneer 1197R	7.5	MC3966	6.1
Dow CNX166200S2	8.0	DeKalb C67-72	7.4	HC33 x TR7322	5.7
MC4457	8.0	DeKalb C69-16	7.4	Mo17 x FR1064.LH132	5.7
AV EXP1398YHB	7.9	Dow MY13K77RAa	7.4	Dow MY12G35RA	5.6
AV EXP1508YHB	7.9	Pioneer 1637R	7.4	LH132 x PHG39	5.4
Asgrow RX953W	7.9	Pioneer 1794VYHR	7.4	Pioneer 3394	4.9
Dow 2C799	7.9	DeKalb C66-29	7.4	LH132 x FR1064	4.6
Dow MY10Z28RA	7.9	DeKalb C67-44	7.4	Gerrish Coroico	4.1
Gerrish HawSyn3	7.9	DeKalb C67-99	7.3	Gerrish Cuzco	4.0
AV RL9583VYHB	7.9	Dow CNX157122PW	7.3	Painted Mountain	2.2
AV EXP1578YHB	7.9			Overall Mean	7.4

The inbreds were successfully tested at all three locations and, as with the hybrids, scores were generally lower as compared with 2017. Again inbred scores lower than 8 (on a 1 to 9 score, with 9 being essentially immune) suggest susceptibility to GLS. Virtually all of the scores in the top 20% belonged to NC lines or experimentals, DK_8M116 being the exception.

Inbred	Rating	Inbred	Rating	Inbred	Rating
NC396	9.0	NC528	8.0	PHKW3	6.3
NC302	8.9	NC380	7.9	PHTE4	6.1
NC536	8.9	NC354	7.9	PHNJ2	6.1
NC390	8.8	1497-002	7.8	DK_85CSO1	6.0
NC258	8.8	NC368	7.7	UAS_CQ702rc	6.0
NC522	8.8	NC382	7.7	PHPP8	6.0
NC552	8.8	PHWG5	7.7	LH200	5.8
NC524	8.7	PHG84	7.7	PHVJ5	5.8
1274-001/02	8.7	PHVB2	7.7	LH176	5.7
NC320	8.7	PHK46	7.6	PHW61	5.6
NC446	8.7	NC548	7.5	Dow_NS815	5.6
NC508	8.7	NC378	7.5	PHWRZ	5.6
NC398	8.6	PHN47	7.5	PHP38	5.5
NC336	8.6	NC386	7.4	KW7691	5.4
NC534	8.6	NC400	7.3	LH188	5.3
NC374	8.6	NC394	7.3	2350-1*2 298	5.2
SA Photoperiod Insensitive Composite II	8.5	PHMK0	7.3	NK_991	5.2
NC388	8.5	NC290	7.3	PHN46	5.2
NC526	8.5	NC358	7.1	LH271	5.1
NC416	8.5	PHGF5	7.1	DK_6M502A	5.1
DK_8M116	8.4	LH252	7.1	PHRD6	5.1
NC296	8.4	PHG39	7.0	ZS1022	5.1
NC532	8.4	PHAP1	6.9	PHPM0	5.1
NC300	8.4	PHJJ3	6.8	ZS1284	5.0
NC384	8.4	PHBV8	6.7	NP899	4.9
NC376	8.3	LH189Ht	6.7	PHTE7	4.8
NC520	8.3	Mo17	6.6	NP901	4.7
NC542	8.3	PHBR2	6.6	Dow_OQ414	4.7
NC348	8.2	LH233	6.5	LH175	4.7
NC474	8.2	LH284	6.5	ZS1202	4.6
NC530	8.2	LH260	6.5	PHRF5	4.6
NC546	8.2	LH280	6.5	LH227	4.4
NC544	8.2	PHBG4	6.5	UAS_MQ306	4.4
NC392	8.1	PHTV7	6.4	PHDP0	4.3
2664-1/06 P492*2S6	8.0	PH5HK	6.4	B73	4.2
NC538	8.0	DK_HBA1	6.3	DKFBPN	4.2
NC540	8.0	LH262	6.3	PHAJ0	3.6
P4639*8Tcb	8.0	NC476	6.3	PHKM5	3.3
PHNB7	8.0	ZS0541	6.3	ZS01250	3.1

Impact statement:

This work with GLS has had a great influence on the male side of hybrid corn breeding, with NC258 and NC300 probably having the greatest impact, both as male parents or parents of male lines. The number of NC releases, planned releases, and experimentals with near immunity to GLS is impressive. This is probably the most extensive GLS-resistance breeding program in the country. Work is ongoing to provide resistance on the female side, with the NC320 derivatives showing the most promise.
(For complete tables see NC Corn Growers.com)

Are Nutrient Deficiencies Limiting High Yield? Tissue and Soil Analyses of NC Corn Yield Contest
Entries
NCARS/NCCES Code 17-10

Leaders: J.G. White, R.W. Heiniger, G.G. Wilkerson

NC Department of Agriculture & Consumer Services soil test values for phosphorus (P), Potassium (K), sulfur (S), manganese (Mn), zinc, (Zn), and copper (Cu) were relatively consistent at four sampling times over the season, (younger than V6) at V7+ at VT-R1, and at R6, indicating that soil sampling and analysis for these nutrients can probably be carried out anytime during this period.

NCDA&CS soil tests indicated a likelihood of fertilizer response to only K and S and not the other nutrients analyzed. Tissue analyses indicate that nitrogen (N), P, K, and S, were adequate early in the season but trended toward deficient later in the season, although sufficiency ranges are less reliable late in the season. Tissue Mg appeared deficient early to mid-season. Tissue B was low to deficient. Tissue Mn and Zn were at the le end of sufficiency, while calcium (ca), iron (Fe) and copper (Cu) were generally sufficient all season.

For 2017, the Diagnosis and Recommendation Integrated System (DRIS) showed that tissue N, P, and K were generally sufficient through VT-R1, but also tended toward deficient by R6. Sulfur appeared deficient all season long.

Impact statement:

This study of tissue and soil nutrient levels in high-yield contest entries provided valuable information either in support of current soil test calibrations and corn tissue sufficiency ranges, or in deciding whether recalibrations and adjustments are needed and for which nutrients so that research can be prioritized appropriately. The emphasis here is on ‘study’ rather than experiments or trials, and does not aim to recalibrate current soil test recommendations. It can, however determine whether and to what extent high yields can be achieved despite tissue and/or soil test levels that appear deficient.

Unique Inbred Line Development for Central and Eastern North Carolina

NCARS/NCCES Code 18-03

Leaders: M.M. Goodman, M.D. Krakowsky
NC524, NC526, NC528, NC530, NC532, and NC534 will be released this spring (2019). Half (NC524, NC526, NC528) are from NC320 crosses. Half (NC530, NC532, NC534) are improved NC296 types. NC296 itself is a high-yielding, temperate-adapted, all-tropical line. Release of NC536, NC538, NC540, and NC542, depends on results of more *per se* nursery performance. The yield data for NC536 are impressive, but NC536 is late and tall. NC538 a second 50%-NC320, 50% tropical line that is notably earlier than NC536.
There are several other lines that could be released in late 2019, depending on further evaluation of their line *per se* performance in the nursery. These include lines we have tentatively labeled NC540 and NC542, both all-tropical TROPHY materials; NC544, closely related to NC296, and NC546, closely related to NC320.

As can be seen in these and other recent releases, the focus of the breeding program over the last several years has been on NC320 and tropical materials, and these are now reaching release stage. These have yielded well and have done well under stress. NC 320 materials perform well as females; most of the tropically-derived lines are male.

Impact Statement:

Lines developed and released using unique germplasm have made NC State the leading public institution in the temperate world for new, useful and unique sources of corn germplasm. Line releases and germplasm development have made NC State the leading US public corn breeding program. The unique combination of line development and germplasm enhancement (Matt Krakowsky) combined with strong field programs in maize genetic (Jim Holland) and plant pathology (Peter Balint-Kurti) make NC State the leading US institution in corn breeding.

Support from the Corn Growers Association of North Carolina has allowed field-oriented corn research to persist at NC State; at most other land grant universities corn research has all but evaporated.

Developing Techniques for Measuring Emergence and Early Growth on Corn Hybrids in North Carolina NCARS/NCCES Code 18-04

Leaders: Ronnie W. Heiniger and Ryan W. Heiniger

Four sites were utilized for this research in 2018, two sites, 3B Farms in Beaufort County and the Tidewater Research Station in Washington County were used to test the use of aerial sensors in measuring corn emergence and growth. The other two locations, Haslin Farm in Beaufort County and another field on the Tidewater Research Station were sites where the North Carolina Official Variety Trials were conducted. These two NCOVT trials were used to measure emergence on all of the corn hybrids tested in the NCOVT. All four sites had similar soil types; Portsmouth silt loam, and tillage and conventional tillage.

Testing the Use of Aerial Sensors in Measuring Corn Emergence and Growth

The experimental design for this study at both locations was split-split-split plot with three replications.

Measuring Plant Emergence

Starting 10 days after planting, field observations were made daily for five days. Observed spikes were counted and marked with a color-coded tee to signify date of emergence. The same day, an unmanned aerial vehicle (UAV) was flown at 30 meters to photograph the plot. The UAV was equipped with a Zenmuse X5S camera, and Sequoia Multispectral sensor.

Emergence data were gathered from the resulting orthomosaic using Corel Draw. Data from the processed orthomosaic were compared to the spikes observed. The accuracy of this counting method using a red-edge orthomosaic image was measured.

Impact Statement:

Research in the first year of this project has shown that aerial sensors are effective in quantitatively measuring emergence and early growth in corn. Data showed that hybrids such as P 1879 and Augusta 7767 had more uniform emergence resulting in better early growth and canopy cover. Yield results show that these hybrids also produced the highest yield of any in this test.

Rapid Cycling Selection for Resistance to Fusarium Ear Rot and Fumonisin Accumulation in Corn NCARS/NCCES Code 18-05

Leaders: Crop and Soil Sciences and J. Holland
Objective 1. Optimize a protocol for rapid high throughput genotyping for corn, and 2. Use high throughput genotyping to select corn populations for resistance to Fusarium ear rot and fumonisin contamination two generations per year.

Impact Statement:

The most desirable control strategy for Fusarium ear rot and Fumonisin contamination is the use of resistant corn genotypes, but most commercial hybrids lack adequate resistance. The research should lead to the development of inbred lines with improved resistance to Fusarium and will be useful for the development of more resistant corn hybrids by commercial seed companies.

Validation, Characterization and Precise Mapping of Genes Associated with Resistance to Multiple Diseases in Maize NCARS/NCCES Code 18-06

Leaders: Peter Balint-Kurti, Eric Davis
This project undertook to identify genes that confer resistance to multiple fungal diseases. The concentration was on resistance to three foliar diseases; northern leaf blight (NLB), southern leaf blight (SLB) and gray leaf spot (GLS) as well as Fusarium ear rot.
First, several "multiple disease resistant" (MDR) lines were identified which had extremely high levels of resistance to all three foliar diseases, and conversely, several 'multiple disease

susceptible" (MDS)lines which are extremely susceptible to all three diseases. Several sets of "near isogenic lines" (NIL's) in which small portions of the genomes of MDR lines were introduced (or "introgressed") into several of the MDS lines.

Impact Statement:

The impact of this project should be increasingly evident as the results are published and disseminated. Two collaborators are currently using some of the lines developed in other

experiments related to disease resistance. Results have been published recently of the initial DRIL project (which formed the basis of this project) in the international Journal *G3* (Genes, Genomes, Genetics). These new results will be prepared for publication in the coming year.

Deposition of Populations Designed for the Identification of Disease Resistance Genes with Maize Genetics Stock Centers NCARS/NCCES Code: 18-07

Leaders: Peter Balint-Kurti, Eric Davis
Over the past 10 years, supported in part by consistent funding from Corn Growers Association of North Carolina, the leaders have undertaken a project to identify genes that confer resistance to multiple fungal diseases. The concentration was on resistance to three foliar diseases; northern leaf blight (NLB), southern leaf blight (SLB) and gray leaf spot (GLS) as well as Fusarium ear rot.
A set of 1749 lines were produced across the ten populations designed for the identification of genes conferring multiple disease resistance. After analysis, several loci (regions of the genome) were identified associated with high levels of resistance to one or more diseases.
The populations produced are an important resource for the maize breeding and genetics community. They can be used to identify important genes for resistance to other diseases as well as genes important for other agronomic traits. Some of the populations have been sent to collaborators in Illinois and New York and requests have been made from Mississippi and China.

Impact Statement:

the impact of this project should be increasingly evident as the results are published and disseminated. Two collaborators are currently sing some of the lines developed in other experiments related to disease resistance.

Measuring Rate and Efficacy of Fungicides Using Traditional Using vs. Under Canopy Placement

NCARS/NCCES Code: 18-11

Leaders: M. Scott Tilley, Kent R. Gurganus, Lindsey D. Thiessen
Two locations were chosen using a randomized complete block design, four reps in Pinetown and three in Bath. Treatments included two spray techniques, traditional over-the-top vs. the UnderCover 360 with three volumes of water (15 gal, 10 gal, and 5 gal) used as a carrier, giving a total of six individual treatments. All plots were sprayed at both locations when corn reached late R1 stage with Headline Amp at 10 fl oz/acre. A total of 12 water sensitive moisture cards were placed within each individual plot. Four plants chose at random had a card placed two leaves above the ear leaf (ear leaf +2), one card placed on the ear leaf, and on card placed two leaves below the ear leaf (ear leaf -2). A factorial was run to evaluate impact individual spray patterns may have had on yield. Moisture cars were scanned using a high-resolution scanner.

When evaluating the UnderCover treatments, leaf coverage at ear leaf +2 never reached above 2% for all volumes of water used. Ear leaf coverage ranged from 31% at 15 gal to 11% coverage at 5 gal. Ear leaf -2 ranged from 30% coverage at 15 gal to 10% coverage at 5gal. Traditional over-the-top spry patterns showed a significant increase in coverage at ear leaf +2 compared to the UnderCover treatments ranging from 48% at 15 gal to 25% at 10 gal.
In contrast, the UnderCover treatments had a higher percent leaf coverage at the ear leaf compared to the traditional over-the-top. Traditional over-the-top coverage of the leaf ear reach only 14% coverage at 15 gal to 11% at 10 gal. ear leaf coverage at 5 gal averaged to be the same for both UnderCover and traditional spray treatments. Ear leaf -2 showed 30% leaf coverage but dropped significantly as water volume decreased. The traditional spray pattern was not able to penetrate the canopy at ear leaf or ear leaf -2 compared to UnderCover patterns. However, the UnderCover pattern was never able to reach the upper canopy adequately.
No significant differences were found when comparing spray pattern methods among yield. Plots sprayed with the traditional spray pattern averaged 156 bu/a with the UnderCover pattern averaging 155 bu/a. Plots designated for checks received no applications but still yielded 141 bu/a.

Impact Statement:

It is yet to be determined what percentage of leaf coverage is considered adequate for control of foliar diseases. Through one year of conducting this research, it is concluded that no matter what

spray method of application is used, current water volume recommendations for fungicide applications still hold true in order to reach adequate coverage.
The only advantage to the UnderCover 360 offered was the ability to deliver product in higher concentrations which brought better leaf coverage to the center of the canopy, which in turn brought no yield advantage.

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