Managing Thrips in Cotton: Research in the Southeast Region

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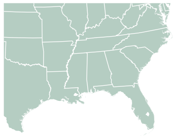

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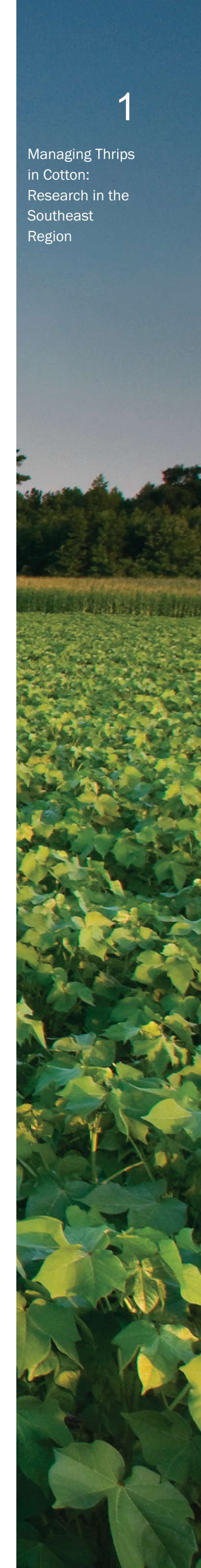


Introduction

Thrips are widely recognized as one of the most important economic groups of pests challenging southeastern U.S. cotton production. From 2012 to 2014, thrips infested more than 97 percent of cotton seedlings in the Southeast and claimed an average of nearly 50,000 bales of cotton. Injury and damage symptoms can range from leaf curling to delays in crop maturity, stand loss, and reduced lint yield. Research in Virginia and North Carolina documented lint losses as high as 400 to 660 pounds per acre, or 34 to 43 percent of the total yield, when thrips were not properly managed. A complex of thrips species has been identified in southeast cotton, including tobacco thrips, *Frankliniella fusca* (Hinds); onion thrips, *Thrips tabaci Lindeman*; western flower thrips, *Frankliniella occidentalis* (Pergande); flower thrips, *Frankliniella tritici* (Fitch); and soybean thrips, *Neohydatothrips variabilis* (Beach). However, in most fields and years, tobacco thrips is the predominant pest species.

Historically, the application of aldicarb insecticide was the primary option used by cotton producers in the Southeast to reduce both thrips and nematodes to sub-economic levels. With changes in availability, in recent years cotton growers have turned to alternative insecticides delivered as seed treatments, in-furrow liquids, and foliar sprays.

Although seed, in-furrow and foliar insecticide applications are now widely used by growers, until this project was completed, there had been no controlled, collaborative efforts across the region to evaluate and compare them. More recently, growers and crop consultants have expressed concerns about the effectiveness of some of these options. In addition, there is increasing evidence of resistance to insecticides in the neonicotinoid class by tobacco thrips.

In the spring of 2013, cotton growers in the Midsouth reported extensive damage by tobacco thrips to cotton planted with neonicotinoid-treated seed (e.g., Gaucho 600FS, Bayer CropScience; Cruiser 5FS, Syngenta Crop Protection). In response to reports of unsatisfactory thrips control, industry researchers and Extension scientists conducted a regional survey of the resistance of tobacco thrips to neonicotinoid insecticides. Entomologists at North Carolina State University developed a discriminating dose bioassay in which adult female thrips fed a diet containing the insecticide were assessed for survivorship. Populations of thrips with elevated levels of insensitivity to the neonicotinoids could be reliably differentiated from those that were fully susceptible. This distinction is important because the duration of control resulting from a neonicotinoid seed treatment declines as the level of insensitivity increases.

Photo by D. Steinkraus

In 2014 and 2015, scientists from across the U.S. cotton belt and from Syngenta Crop Protection collected 98 populations of tobacco thrips from a variety of different host crops, including cotton, peanut, and weeds in 10 different cotton-producing states (Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, and Virginia). Preliminary results from discriminating dose bioassays averaged across these populations showed that the mean survival for imidacloprid was 17.6 ± 13.7 percent (mean ± SD, range 0 to 60.9 percent), compared to thiamethoxam at 21.4 ± 15.8 percent (mean ± SD, range 0 to 66.2 percent). Survival of a fully susceptible population of tobacco thrips was only 3.3 ± 1.7 percent for imidacloprid and 1.8 ± 3.0 percent for thiamethoxam. These results showed that both high and low survivorship to each insecticide was observed in these populations (fig. 1).

The consequences of high survivorship following exposure to neonicotinoid insecticides could be difficult to recognize in the field because the timing of thrips infestations, insecticide concentration in the cotton plant, seedling vigor, varietal tolerance, and environmental conditions (e.g., rain events, temperature accumulation) can all interact to influence the magnitude of seedling injury observed in any given situation. Moreover, increasing use of foliar-applied insecticides likely masks potential injury that thrips insensitive to neonicotinoids could have on a stand-alone seed treatment.

Further investigation into the factors (e.g., neonicotinoid use in multiple crops, long-term reliance on seed treatments) responsible for decreases in neonicotinoid efficacy will be an important component of a comprehensive plan to manage resistance of tobacco thrips to insecticides in the southeastern cotton crop.

It is now clear that exclusive reliance on neonicotinoid seed treatments for thrips control is not sustainable. A multifaceted management approach system is needed to ameliorate this almost guaranteed yield-robbing threat of early season thrips pressure. To that end, a collaborative, five-year (2011-15), multistate (Alabama, Georgia, South Carolina, North Carolina, Virginia) project investigated a full suite of tactics for managing thrips in cotton, including

- **Determining the effectiveness of manipulating systems of tillage and cover crops to reduce thrips injury.**
- **Establishing the effectiveness of starter fertilizers to hasten seedling growth through the period of heightened susceptibility to thrips.**
- **Evaluating combinations of herbicides and insecticides that can result in additional stress to seedlings.**
- **Evaluating all available insecticide active ingredients as well as some experimental compounds currently being explored by industry and application methods.**
- **Developing models that help predict the onset and magnitude of thrips populations in the spring and early summer, with the ultimate goal of providing cotton growers in the Southeast with the most effective and affordable recommendations for managing thrips.**

This publication provides a summary of research into this suite of tactics.

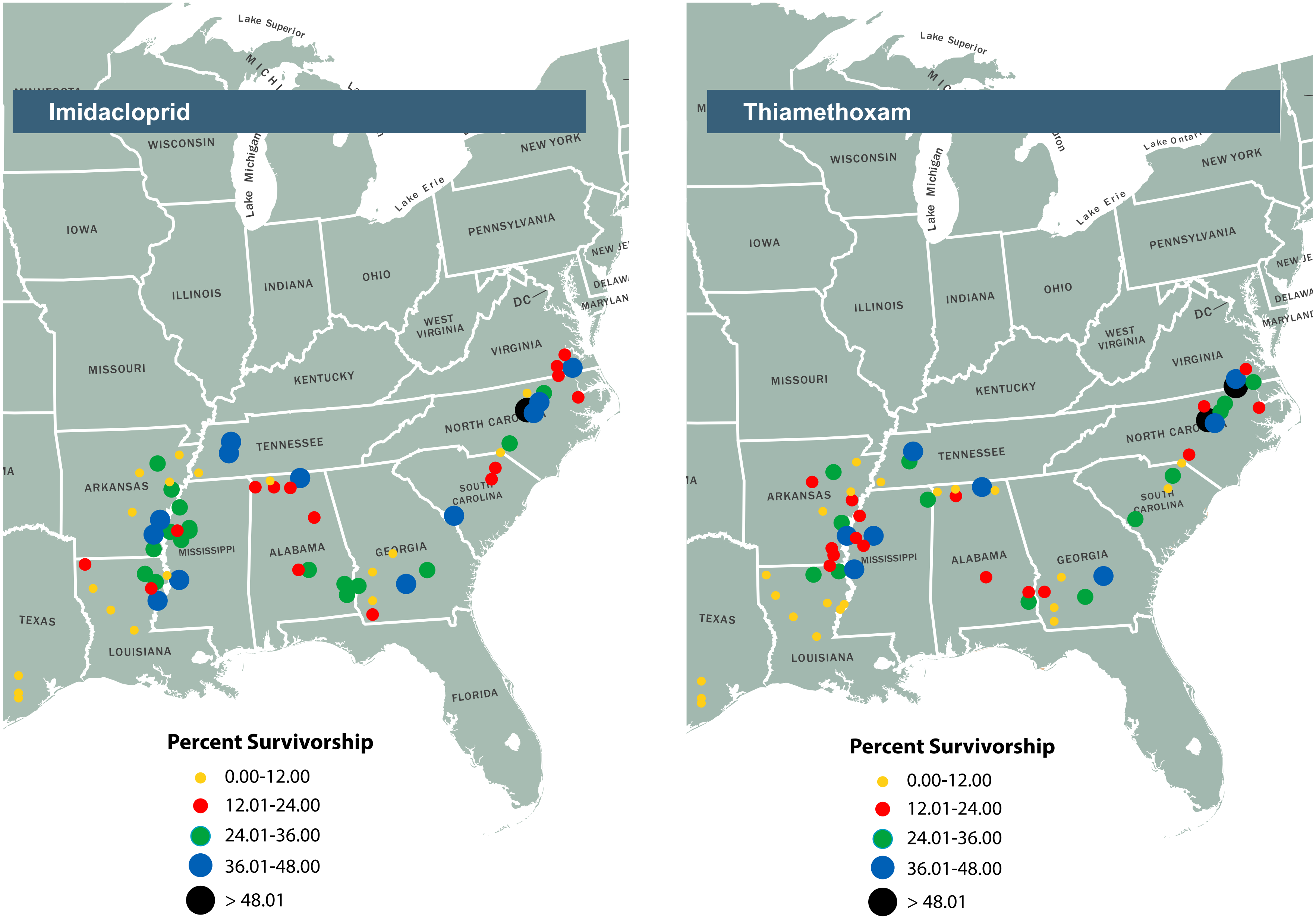


Figure 1. Percent survivorship of tobacco thrips populations collected in 2015 from cotton, peanut, and weeds and then exposed to imidacloprid and thiamethoxam in laboratory bioassays. Survivorship of a fully susceptible tobacco thrips population averaged 3.3 percent for imidacloprid and 1.8 percent for thiamethoxam. (Figure by George Kennedy, North Carolina State University.)

Effects of Tillage and Cover Crops on Thrips

Conservation or reduced tillage practices are prevalent in cotton production in the Southeast. There is currently increased interest in the use of rolled high-residue cover crop systems to suppress herbicide-resistant weeds through mulching effects. In addition, thrips populations can be reduced on cotton seedlings by up to 50 percent when planting into a cover crop (fig. 2) compared with cotton planted without a cover crop. In this project, both tillage and cover were investigated as possible management strategies to reduce thrips populations and seedling injury.

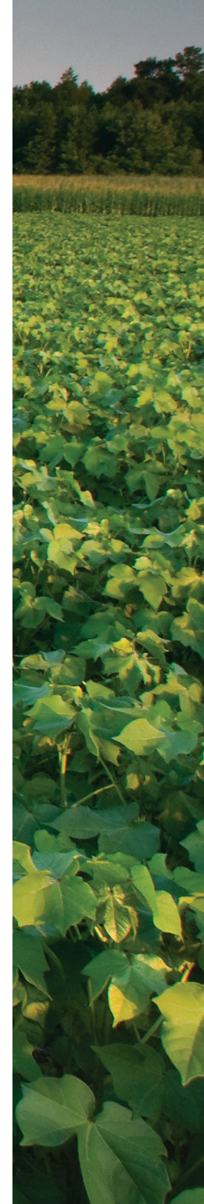
Methods

Field trials were planted in Georgia, South Carolina, and North Carolina during 2013 and 2014 with conventional tillage (disking with or without bedding), no tillage (no-tilled into fall-planted rye), or strip tillage (deep tillage shank used to penetrate hard pan layer on furrow only). Three cover crop systems were used: winter-planted rye mowed before planting, winter-planted rye rolled down before planting, or no cover. Aeris (imidacloprid, Bayer CropScience) or Avicta CP (thiamethoxam, Syngenta Crop Protection) was applied as a seed treatment, and foliar Orthene 97 (acephate, AMVAC) was applied at the first-leaf stage as designated. Thrips populations were sampled weekly beginning at the cotyledon stage through the fourth-leaf stage. Thrips injury to seedlings was rated weekly using a 0-5 scale, where 0 = no injury and 5 = dead plants (fig. 3). Seedling stands, plant heights, dry plant biomass, and seed cotton yields were also measured.

Results

In South Carolina, thrips numbers were lowest in strip-tilled plots planted into rye established as a cover crop and rolled down prior to planting of cotton; they were highest in the conventionally tilled plots that did not incorporate the use of rye as a cover (fig. 4). In North Carolina, numbers of thrips larvae (fig. 5) and seedling injury were lower in plots with reduced or strip tillage than in conventionally tilled cotton. Relay intercropping of cotton into wheat two to three weeks before wheat harvest also reduced thrips populations (fig. 6). The suppression of thrips is correlated with the amount of cover; as residue increases, suppression of thrips increases. Yields with these practices were usually similar to those from conventional cotton; therefore, they offer alternative strategies for minimizing the impact of thrips on the cotton. It is important to add that weed populations can also be lower in reduced tillage fields, an added benefit to adopting these practices.

Figure 2. Residue from winter-planted rye used as a cover crop for cotton. (Photo by Mike Toews, University of Georgia.)



Seeding Injury Rating Scale

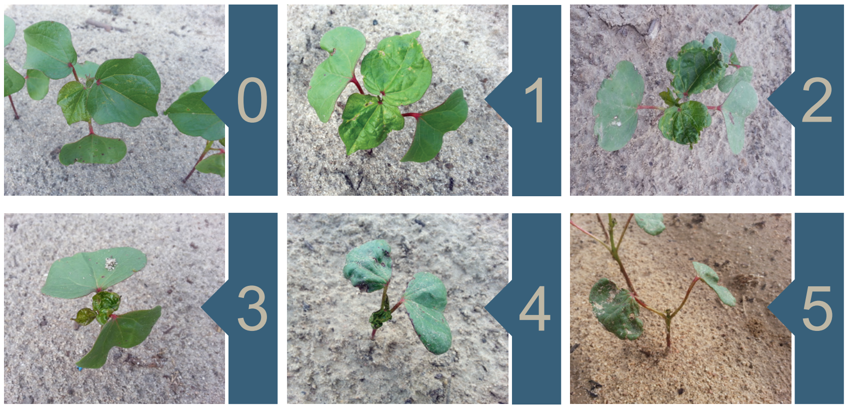


Figure 3. Thrips injury rating scale: 0-5, where 0 = no injury and 5 = dead plants. (Photos by Jeremy Greene, Clemson University.)

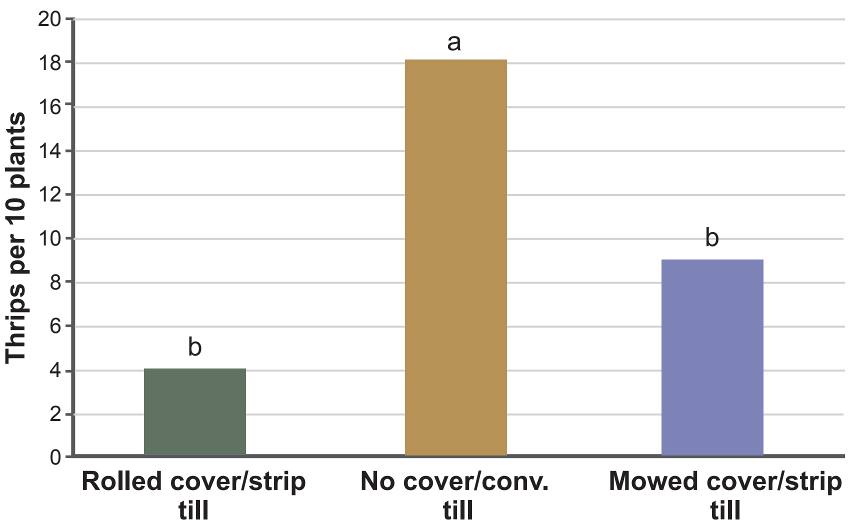


Figure 4. Numbers of thrips (adults and larvae) in strip- or conventionally tilled cotton planted with or without cover crop (rye) residue (rolled or mowed) in South Carolina, 2014.

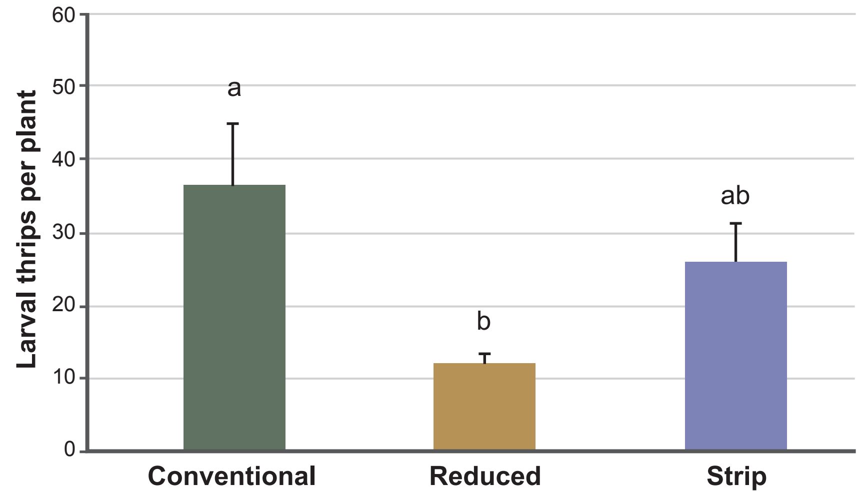


Figure 5. Numbers of larval thrips in conventionally, reduced, or strip-tilled cotton at five weeks after planting in North Carolina, 2014.

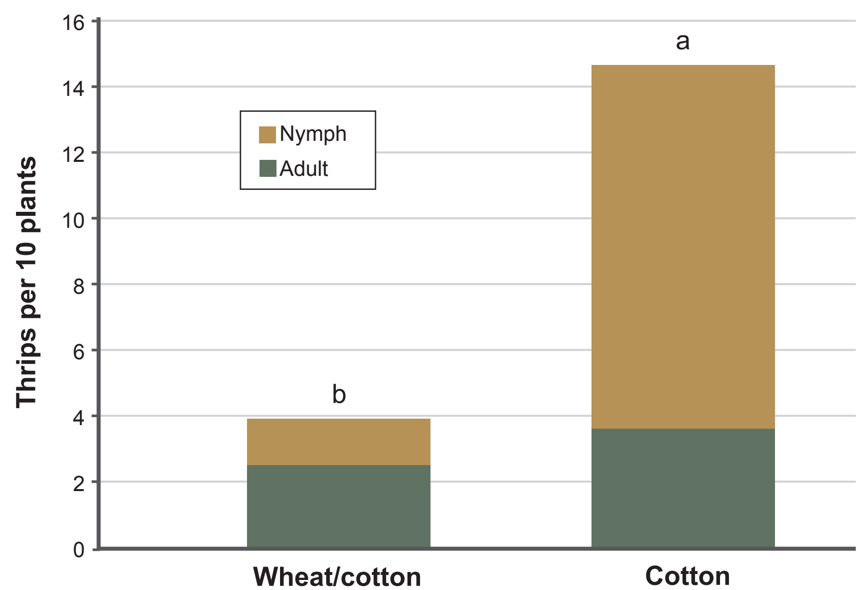


Figure 6. Numbers of thrips (adults and larvae) in strip-tilled cotton planted alone or relay intercropped into wheat in South Carolina, 2014.

Starter Fertilizer and Optimal Timing of a Supplemental Foliar Insecticide Application

Liquid starter fertilizer is recommended by agronomists as a safe, convenient, and inexpensive method of applying phosphorus and/or preplant nitrogen. Although variable, benefits can include increased seedling vigor — especially in cool environments — which could complement thrips management efforts by enabling rapid seedling growth, thereby decreasing the time cotton seedlings are susceptible to thrips. In this project, we examined how the addition of starter fertilizer and the timing of a supplemental foliar insecticide application can reduce thrips injury on seedling cotton in both irrigated and dryland production systems.

Seedling cotton is immediately colonized by dispersing adult thrips as soon as plants emerge through the soil surface. Adult thrips feed and deposit eggs inside the leaf; the eggs hatch into larvae that feed on or very near the apical terminal of the seedling. Although insecticide seed treatments can provide early protection, insecticide concentration in the plant can decrease enough in 14 to 21 days to require supplemental application of foliar insecticide. For the best results, foliar applications should be targeted at developing larval populations to provide the seedlings with the opportunity to rapidly grow until reaching a growth stage when they are less susceptible to thrips injury.

Economic injury from thrips rarely occurs once seedlings reach the fourth-leaf stage and are growing rapidly. The timing of the application of a supplemental foliar insecticide is critical. If applied too early, the insecticide will have minimal impact; conversely, if applied too late, the economic injury inflicted from developing thrips has already occurred and cannot be reversed.

Methods

Twelve field trials under irrigated conditions and four additional trials under dryland conditions were coordinated across Alabama, Georgia, South Carolina, North Carolina, and Virginia to evaluate starter fertilizer and timing of foliar insecticide applications. Preplant fertility was adjusted to local Cooperative Extension recommendations, and all trials were planted with Cruiser-treated PhytoGen 375WRF (Dow AgroSciences) cotton. At planting, half of the plots received no starter fertilizer and half received 10 gallons of 10-34-0 (nitrogen-phosphorus-potassium) per acre (plots that received starter fertilizer at planting received 10 pounds less nitrogen at sidedress than the remaining plots). Plots were treated with Orthene 97 (3 ounces per acre in Alabama, Georgia, and South Carolina or 6 ounces per acre in North Carolina and Virginia) at one of two timings — at first-leaf (fig. 7) or second-leaf — and an untreated control was included. Aboveground dry plant biomass, as a relative measure of seedling size, and lint yields were collected.

Results

Irrigated cotton plants that received starter fertilizer accumulated 20 percent more biomass at six weeks after planting than plants that did not (fig. 8); dryland plants did not have the same response. Lint yield was similar with or without starter fertilizer in both the irrigated and dryland environments. Although starter fertilizer did not result in higher yields, the authors contend that starter fertilizer enabled rapid seedling growth and, thereby, decreased the period of time when the plants were most susceptible to thrips injury.

The first-leaf stage was the optimal time for applying a supplemental foliar insecticide treatment, regardless of irrigation. Plants in irrigated and dryland plots that received a supplemental foliar insecticide treatment at first-leaf accumulated nearly 15 and 20 percent more biomass, respectively, than untreated plots and nearly 5 and 7 percent more biomass than plots treated at the second-leaf stage (fig. 9). Under irrigated conditions, supplemental foliar insecticide applied at first-leaf contributed 50 pounds more lint per acre compared with untreated plots or plots treated at the second-leaf stage (fig. 10). There were no yield differences in lint yield among the treatments under dryland conditions.

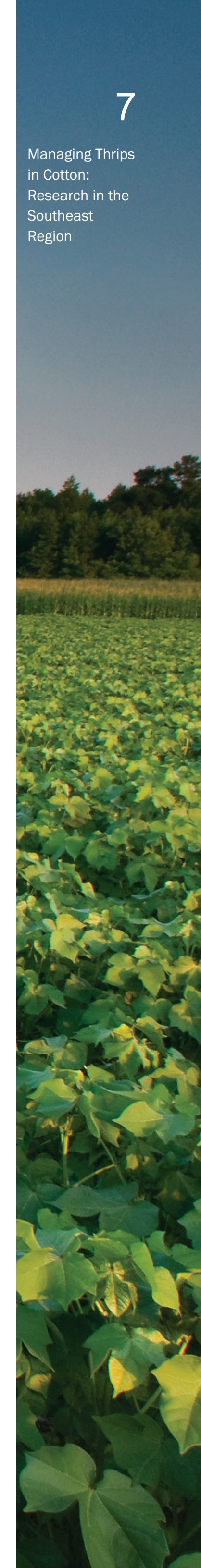


Figure 7. A first-leaf stage seedling with visible presence of the first true leaf bud located in the terminal — the ideal time for applying a foliar insecticide treatment if needed. (Photo by Mike Toews, University of Georgia.)

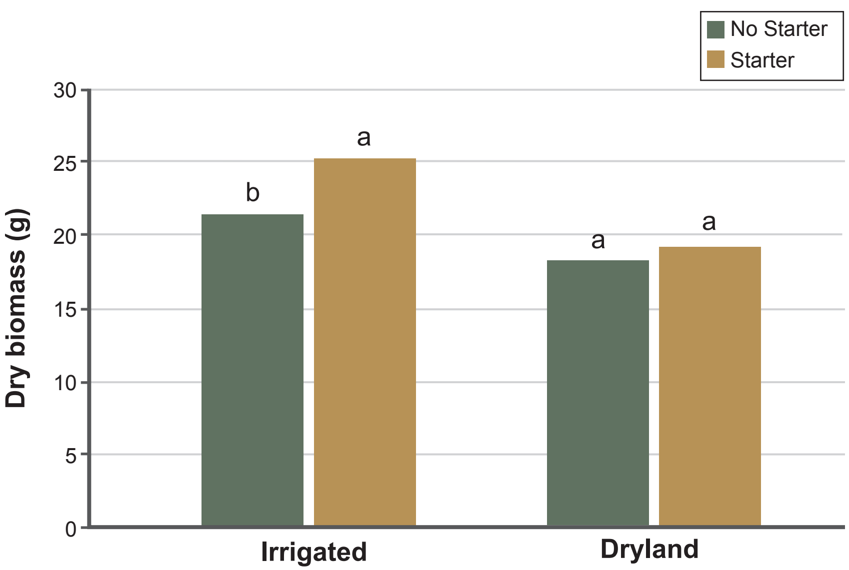


Figure 8. Mean dry plant biomass (grams per five plants) at 42 days after planting with and without starter fertilizer under irrigated or dryland production environments.

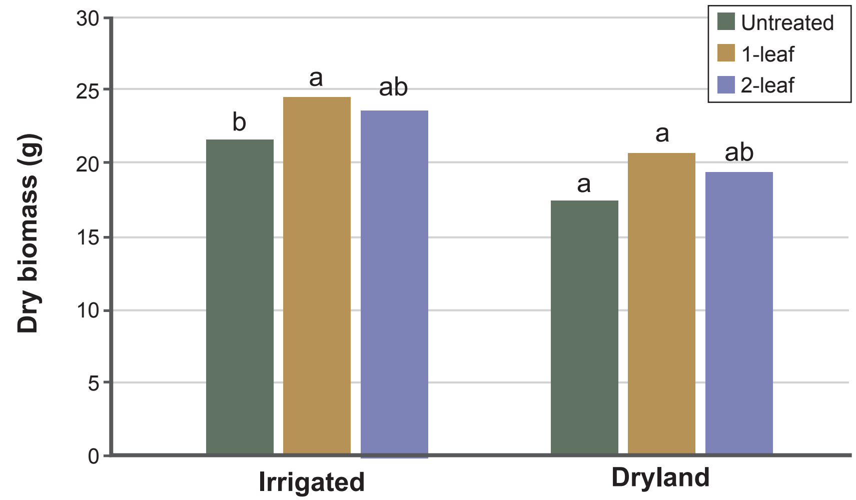


Figure 9. Mean dry plant biomass (grams per five plants) at 42 days after planting when foliar acephate was applied at first-leaf and second-leaf growth stages under irrigated or dryland production environments.

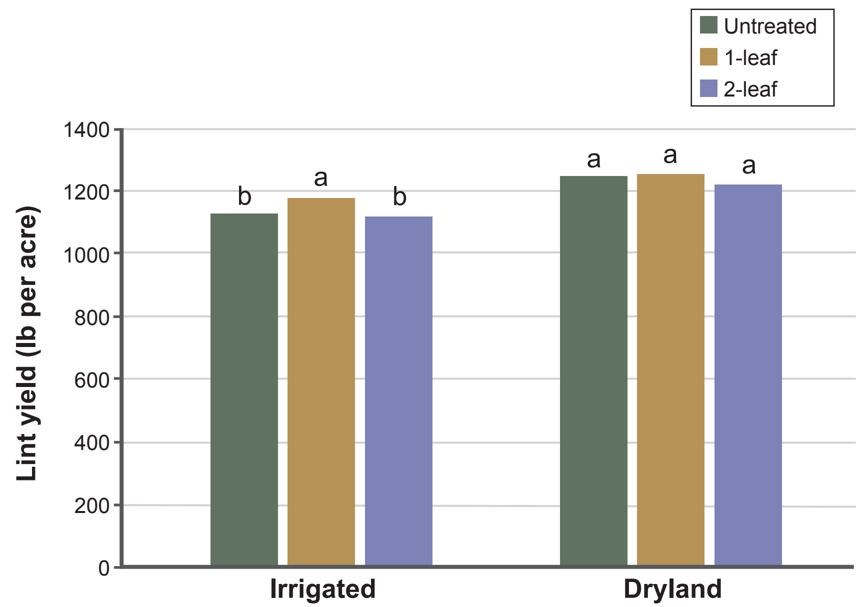


Figure 10. Mean lint yield (pounds per acre) when foliar acephate was applied at first-leaf and second-leaf growth stages under irrigated or dryland production environments.

Herbicide/Insecticide Interactions

In response to increasing glyphosate-resistant Palmer amaranth and other weed species, southeastern cotton growers have greatly increased the use of pre-emergence (PRE) herbicides. Unfortunately, these PRE herbicides can injure cotton seedlings depending on environmental conditions such as soil type, moisture, and temperature. Although cotton can recover, PRE herbicide injury can delay seedling growth and prolong the period of susceptibility to thrips. The combination of both thrips and herbicide injury can put fields at very high risk to yield reductions. In this project, we quantified differences and potential interactions of programs for managing thrips with and without PRE herbicide injury.

Methods

Eleven field trials were conducted across Alabama, Georgia, South Carolina, and Virginia in 2013 and 2014. Treatments for managing thrips included (1) no at-plant insecticide, (2) Cruiser seed treatment, and (3) Cruiser seed treatment + Orthene 97 applied as a foliar application at the first-leaf stage. Treatments of pre-emergence (PRE) herbicides included (1) no PRE herbicide, (2) PRE herbicide at 1X rate (local standard, which varied by location), and (3) PRE herbicide at 2X rate to create stress. Thrips injury to cotton seedlings and lint yields were measured.

Results

In all herbicide systems, there was a trend for lower seedling injury ratings as thrips management inputs increased (untreated > seed treatment > seed treatment + foliar). Ratings of injury to seedlings caused by thrips increased as herbicide rates increased (PRE at 2X > PRE at 1X > no PRE; fig. 11). The seed treatment provided acceptable control of thrips where no PRE herbicide was used (damage rating <3*), whereas seedling injury was unacceptable in the PRE at 1X and PRE at 2X herbicide treatments. Inclusion of a first-leaf application of foliar insecticide provided acceptable control of thrips in the PRE at 1X treatment, but no thrips management program provided acceptable control of thrips in the PRE at 2X herbicide treatment.

Trends in yield were inversely related to ratings of seedling injury, so as ratings of seedling injury increased, yield was reduced (fig. 12). Seed treatments alone increased yield by 15, 18, and 24 percent compared with the untreated control in the no PRE, PRE at 1X, and PRE at 2X herbicide treatments, respectively. The percent yield increase of the seed treatment + foliar treatment compared with the untreated control was 18, 25, and 47 percent in the no PRE, PRE at 1X, and PRE at 2X treatments, respectively. When looking at the percent yield increase over the untreated control for the seed treatment and the seed treatment + foliar treatment, the mean response for thrips management treatments tended to be greatest in the PRE at 2X herbicide treatment. Overall, the differences between yield responses of the seed treatment alone compared with the seed treatment + foliar treatment tended to increase as the PRE herbicide rate increased, showing that yield loss potential is increased as plant stresses due to thrips and PRE herbicide increase.

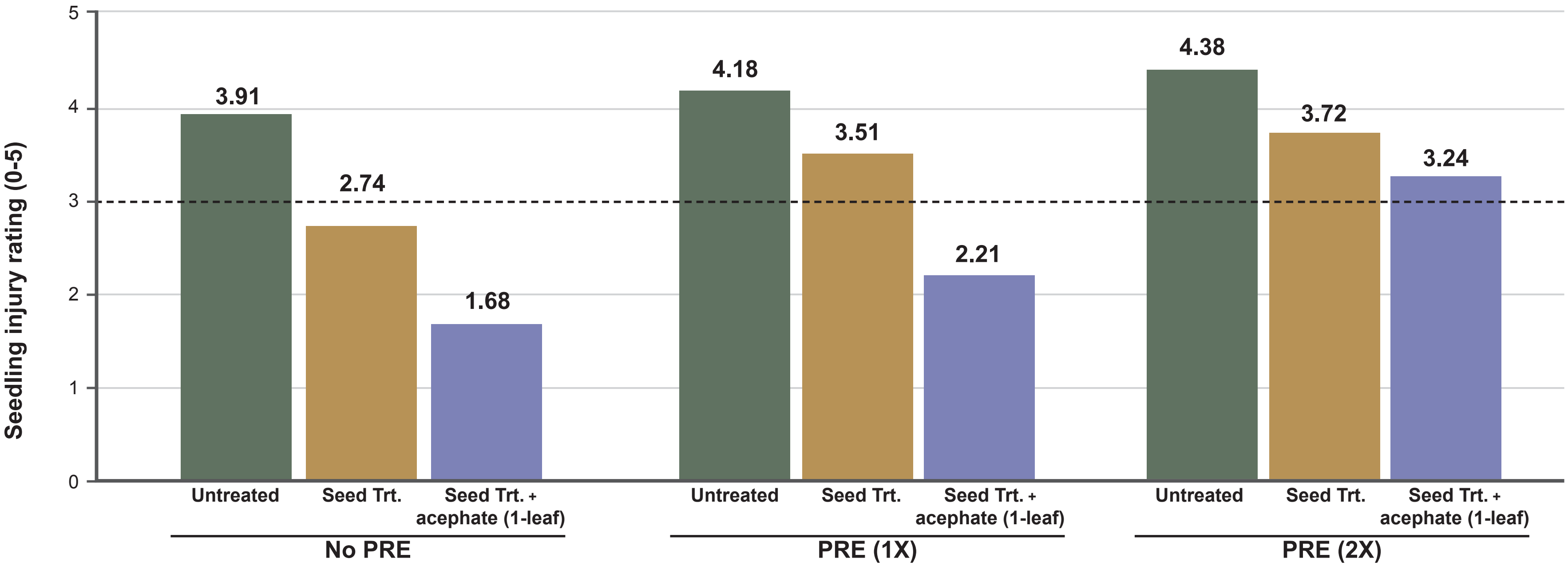


*Figure 11. Mean ratings of injury to cotton seedlings from trials with moderate to high infestations of thrips, 2013 and 2014. *Note: A seedling injury rating of 3 on the 0-5 thrips injury scale is considered the point above which lint yields will be reduced if additional control treatments are not applied.*

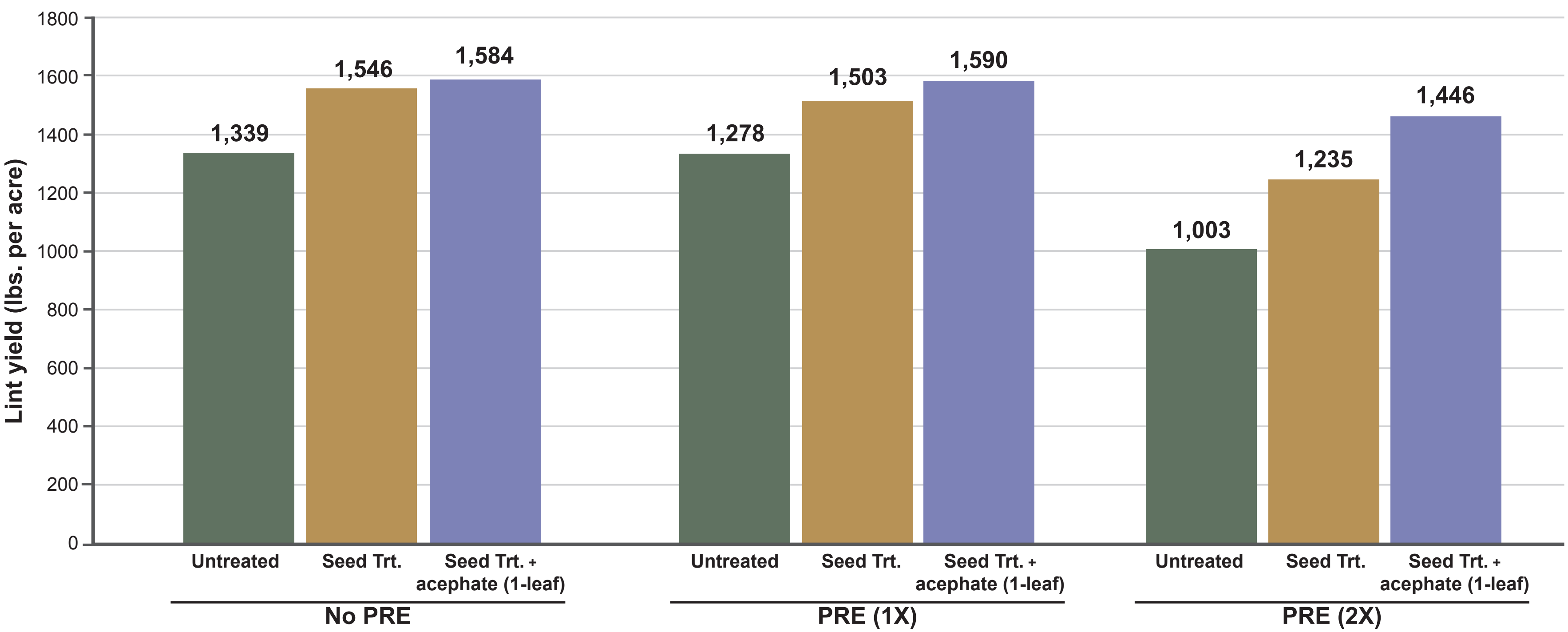


Figure 12. Mean lint yields from trials with moderate to high thrips infestations, 2013 and 2014.

Novel Insecticide Types and Application Methods

Neonicotinoid seed treatments offer unsurpassed convenience and a reduced risk to applicators compared with in-furrow insecticides, which require hopper boxes, insecticide handling, and proper calibration. However, previous research in the Southeast strongly suggests that to maximize thrips control and yield potential, seed treatments often need to be supplemented with additional in-furrow or foliar-applied treatments of insecticide. This project evaluated efficacy of (1) insecticide seed treatments alone or in combination with liquid or granular in-furrow insecticides and (2) insecticide seed treatments alone or in combination with foliar applications of insecticides.

Methods

Twelve field trials were conducted in Alabama, Georgia, South Carolina, North Carolina, and Virginia to evaluate insecticide seed treatments with and without additional liquid or granular in-furrow treatments (table 1). In 2013, six trials were planted with PHY 367WRF (Dow AgroSciences), and in 2014, six trials were planted with ST 4946GLB2 (Bayer CropScience). An additional 12 trials were conducted to evaluate seed and foliar treatments (table 2). Thrips injury to seedlings and lint yields were measured (only seedling injury is reported and only from trials with significant treatment differences).

Results

In trials comparing seed and in-furrow treatments, no single treatment outperformed the others in every location. However, some treatments were consistently better than others. The top two performers were Aeris seed treatment + Admire Pro at 7.2 ounces, and Aeris seed treatment + Orthene 97 at 8 ounces in-furrow (table 1).

In trials comparing combinations of seed treatments and foliar applications of insecticide, performance of the seed treatments was generally improved with the addition of foliar applications of insecticide (table 2). There were trends for a rate response with the foliar treatments, with higher rates providing better protection compared with lower rates. The top performer was Avicta CP, followed by a foliar application of Orthene 97 at 6 ounces.

Our conclusions from these 24 field trials are that there is value to using nearly any labeled insecticide as a seed treatment or in-furrow application at planting. Performance will vary with cultural differences (e.g., planting date, soil type, irrigation, fertility) and environmental conditions (e.g., rainfall, temperature) that influence cotton seedling growth and thrips populations, as evidenced by differences in our results among locations and years. In general, a thrips management program that combines two methods of delivering insecticide (seed + foliar, seed + in-furrow, or in-furrow + foliar) will provide better protection to seedlings for a longer period of time. However, growers should be aware that there are very few insecticide classes (organophosphates Group 1B, neonicotinoids Group 4A, and spinosyns Group 5) currently available for control of thrips in cotton, so chemistries should be rotated to minimize more widespread development of insecticide resistance.

Table 1. Percentage of times each treatment was rated first (least seedling injury), second (second-least seedling injury), or third (third-least seedling injury) in 12 field trials in Alabama, Georgia, South Carolina, North Carolina, and Virginia, 2013 and 2014, where seed and in-furrow insecticide treatments were compared for control of thrips.

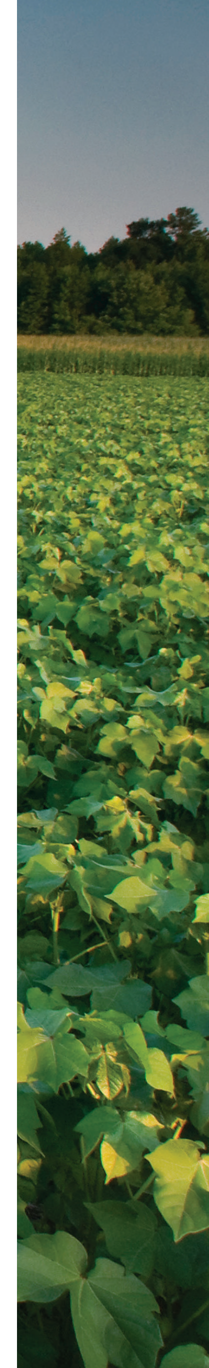
Treatment*	1st place	2nd place	3rd place	1st + 2nd + 3rd places
Aeris seed + Admire Pro, 7.4 oz	58	8	17	83
Aeris seed + Orthene 97, 8 oz	0	67	17	83
Avicta CP seed + Admire Pro, 7.4 oz	17	25	33	75
Temik 15G, 5 lb	33	25	8	67
Orthene 97, 16 oz	25	0	33	58
Admire Pro, 9.2 oz	25	25	0	50
Thimet 20G, 5 lb	17	17	17	50
Avicta CP seed + Orthene 97, 8 oz	0	25	8	33
Velum Total, 14 oz	0	17	17	33
Aeris seed	8	8	17	33
Poncho VOTiVO/Aeris seed	0	8	17	25
Avicta CP seed	0	0	8	8
Untreated	0	0	0	0

**Aeris (imidacloprid, Bayer CropScience), Avicta CP (thiamethoxam, Syngenta Crop Protection), Poncho VOTiVO (clothianidin + Bacillus firmus I-1582, Bayer CropScience), Temik 15G (aldicarb, Bayer CropScience), Thimet 20G (phorate, AMVAC), Admire Pro (imidacloprid, Bayer CropScience), Velum Total (imidacloprid + fluopyram, Bayer CropScience), and Orthene 97 (acephate, AMVAC).*

Table 2. Percentage of times each treatment was rated as first (least seedling injury) or second (second-least injury) in 12 field trials in Alabama, Georgia, South Carolina, North Carolina and Virginia, 2013 and 2014, where seed and foliar insecticide treatments were compared for control of thrips.

Treatment*	1st place	2nd place	1st + 2nd places
Avicta CP seed + Orthene 97, 6 oz	31	33	64
Avicta CP seed + Radiant SC, 3 oz	38	8	46
Avicta CP seed + Radiant SC, 1.5 oz	19	25	44
Avicta CP seed + Orthene 97, 3 oz	13	25	38
Avicta CP seed	0	8	8
Untreated	0	0	0

**Avicta CP (thiamethoxam, Syngenta Crop Protection), Orthene 97 (acephate, AMVAC), Radiant SC (spinetoram, Dow AgroSciences).*



Predictive Modeling for Thrips Infestations

The severity of thrips injury to the cotton crop can range widely from location to location and from year to year. Several factors, such as geographical location, temperature, and rainfall, influence thrips abundance and/or the severity of the injury they cause to seedlings and can create a low- or high-risk environment for cotton. For example, because of cooler conditions, early planted cotton is generally at higher risk.

A model for predicting tobacco thrips infestation intensity in the tobacco crop was developed using the factors mentioned above (www.nc-climate.ncsu.edu/thrips/). It has been successful in enabling tobacco producers to predict their risk for tomato spotted wilt virus transmitted by thrips. Our goal was to develop a similar model for predicting the severity of infestation of tobacco thrips in cotton.

Methods

In this project, we developed a large data set from previous field trials from across the Southeast (828 observations from seven years, 12 locations, and five states — Alabama, Georgia, South Carolina, North Carolina, and Virginia) that included thrips abundance data and seedling injury ratings from cotton grown with various varieties, tillage types, and moisture and temperature levels. These data were used to develop a preliminary model for cotton similar to the one developed for tobacco.

Results

Results showed a strong relationship between thrips injury to seedlings and factors that influence seedling growth and thrips infestation pressure. It predicted the level of thrips pressure that can be expected while cotton is in a susceptible growth stage for a given year and location, essentially pinpointing the level of risk for a given field. Further work is planned to test this model on growers' fields throughout the region, with the expectation that — like the model for the tobacco crop — this model will allow cotton growers to be more prescriptive with their insecticide programs for thrips by targeting higher inputs to fields where the risk is high and reducing inputs where the risk is low.

Summary

From 2011 to 2015 our group collaborated to develop improved practices and recommendations for managing thrips in cotton in the Southeast. Our research led to the following findings:

- **Creating high crop residue via strip tillage, rolled down or mowed rye, or relay intercropping into wheat is an effective strategy for minimizing the impact of thrips on seedling cotton.**
- **Under irrigation, starter fertilizer can enable more rapid seedling growth and decrease the period of time when seedlings are most susceptible to thrips injury.**
- **Insecticide seed treatments provide control of thrips and increased lint yield, but supplementing seed treatments with in-furrow or foliar treatments can often improve control, seedling size, and lint yield.**
- **The first-leaf stage is the optimal time for applying a supplemental foliar insecticide treatment.**
- **The combination of injury caused by thrips and some pre-emergence herbicide programs puts fields at very high risk for yield reductions. This should be avoided by altering the herbicide program, or if this cannot be done and while maintaining effective weed control, thrips scouting and additional management inputs should be a priority.**
- **There is value to using nearly any labeled insecticide as an in-furrow application or seed treatment at planting, and management programs that combine two insecticide treatment strategies (seed + foliar, seed + in-furrow, or in-furrow + foliar) will provide the best protection from thrips injury and resulting yield loss.**
- **A preliminary model was developed that predicts the level of thrips pressure that can be expected for a given year and location, essentially pinpointing the level of risk for a given field. When finalized, this model will allow cotton growers and consultants to be more prescriptive with their insecticide programs to manage thrips.**

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Commercial products are named in this publication for informational purposes only. Virginia Cooperative Extension does not endorse these products and does not intend discrimination against other products which also may be suitable.

Note: Always read and follow the current pesticide label.

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