THE UNIVERSITY OF GEORGIA
COLLEGE OF AGRICULTURAL & ENVIRONMENTAL SCIENCES

Tobacco Research Report

2014

2014 Tobacco Research Report
(Summary Report of 2014 Data)

Edited by Anna K. Watson

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Forward

On the farm in Tennessee where I grew up, we produced two saleable products: milk and tobacco. As a child I took part in all the steps necessary to produce burley tobacco, from planting to market and everything in between. I have quite a mental library of memories in the tobacco field, with my grandfather, my dad, and friends we would hire to work. It is an important part of my upbringing.

As assistant dean of the University of Georgia Tifton Campus, I still have the opportunity to be associated with tobacco. At the UGA College of Agricultural and Environmental Sciences we continue to commit resources to conduct research with this Southern crop, and I am glad that we provide the tobacco industry with research and educational programs to enhance production and maintain competitiveness of the industry.

Research by University of Georgia scientists investigating soil fertility, growth control, new varieties, control of spotted wilt virus and other projects is summarized here for your use. We hope that you find this new information useful in meeting challenges and finding opportunities. We also welcome you to our research farms to see this work in the field and underway.

Joe W. West
Assistant Dean
University of Georgia Tifton Campus
College of Agricultural and Environmental Sciences

Introduction

In the 2013 Farm Gate Value Report (UGA-CAES Center for Agribusiness & Economic Development, AR-14-01, October 2014), tobacco ranked 34th in the top 60 commodities produced in Georgia with a farm gate value of $52,674,042 from production on 13,560 acres with an average yield of 1845 pounds per acre. Since 2010, the farm gate value of tobacco has steadily increased from $46,364,983. The overall farm gate value of tobacco was 0.39% of Georgia's total farm gate value of just over $13 billion in 2013.

In 2014, a wet spring that delayed planting and heavy weed pressure were some of the challenges producers faced in addition to the usual myriad of diseases and pests in growing tobacco. The continued profitability of tobacco in Georgia results from the dedication of the personnel involved in research and extension programs undertaken in the University of Georgia College of Agricultural and Environmental Sciences. The following reports represent efforts of scientists to find the best production practices to improve the quality and enhance the profitability of tobacco grown in Georgia.

In addition to the information provided herein, there are a variety of opportunities such as tobacco meetings, Good Agricultural Practices Certification Meetings, Field Days and Tours that have already been scheduled for 2015 (see http://caes.uga.edu/commodities/fieldcrops/tobacco/) for those seeking timely and relevant information.

Advances in disease and pest management, and improved agronomic practices, will continue to facilitate the profitable production of this historically and currently important keystone crop to Georgia's agriculture and economy.

John Sherwood
Department Head
Plant Pathology
University of Georgia

Integrated Management of Thrips and Tomato Spotted Wilt Virus in Tobacco

R. Srinivasan and A.S. Csinos

Tomato Spotted Wilt Virus (TSWV) has been a chronic constraint to tobacco production in Georgia and elsewhere in the Southeast. TSWV is transmitted by thrips. In Georgia, both tobacco thrips (*Frankliniella fusca* and western flower thrips (*Frankliniella occidentalis*) are known to transmit TSWV to tobacco. However, tobacco thrips are considered more important than western flower thrips, as they tend to occur early in the season when tobacco plants are at a very susceptible stage to TSWV.

Lack of genetic resistance against the virus and/or the vector has only made tobacco production even more challenging. Available common management options include usage of plant defense regulators such as acibenzolar-S-methyl (Actigard®) and insecticides such as imidacloprid. Imidacloprid is used extensively in tobacco production. However, thrips are known for their ability to develop resistance to insecticides (including imidacloprid) rather rapidly. The resistance status of thrips to imidacloprid in Georgia is unknown. But it is wise to be proactive and identify alternatives to usage of imidaloprid in tobacco production. Over the last two years, we have been involved in testing numerous insecticides as alternatives.

Cultural practices could also play a key role in the reduction of TSWV incidence in tobacco. In 2013, we noticed heavy thrips populations especially early in the season. In the same year, we conducted experiments to assess the effect of planting date of thrips and TSWV incidence. Results showed that planting early in the season reduced TSWV incidence. Temporal thrips monitoring, through setting up yellow sticky card traps clearly indicated that increased TSWV incidence was in correlation with a period of increased thrips activity. Further, we noticed numerous volunteer peanuts infested heavily with thrips. Our previous research has demonstrated that weeds or alternate hosts could function as thrips and TSWV reservoirs and influence TSWV incidence in crops. Peanuts are regularly planted in proximity to tobacco, as it is a key crop in the rotation schedule in the southeast. In 2014, we conducted experiments to assess the effect of crop and non-crop vegetation on thrips and TSWV incidence in tobacco. Using the information gained, our goal is to contribute to develop an integrated management package that is aimed at increasing the sustainability and profitability of tobacco production.

Our research in 2014 focused on several aspects of thrips and TSWV management in tobacco. The results are described below for each objective.

Thrips population dynamics

Thrips populations were monitored using yellow sticky cards (15x10 cm^2). Six cards were set up along the perimeter of a tobacco field in the Bowen farm. The cards were sampled from April to July. The cards were replaced weekly. Upon collection, the cards were taken to the vector biology laboratory, and thrips were identified using standard taxonomic keys. Thrips were placed in two categories: tobacco thrips and other thrips. The cumulative counts of thrips are presented below in Figures 1 and 2.

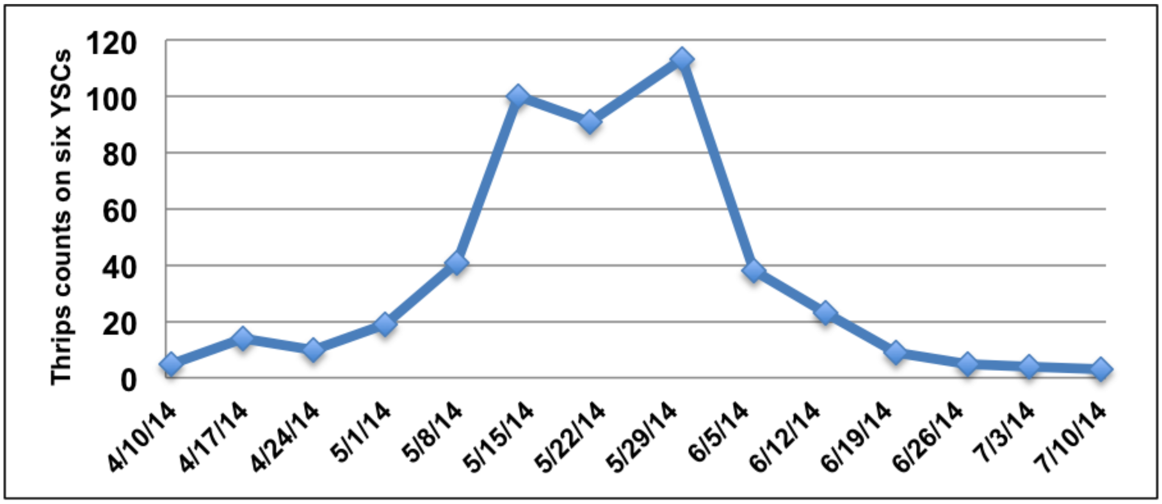


Figure 1. Tobacco thrips counts on yellow sticky cards (YSCs) from April to July of 2014. Six cards were sampled at each time point. The counts presented are totals from six cards at each time point.

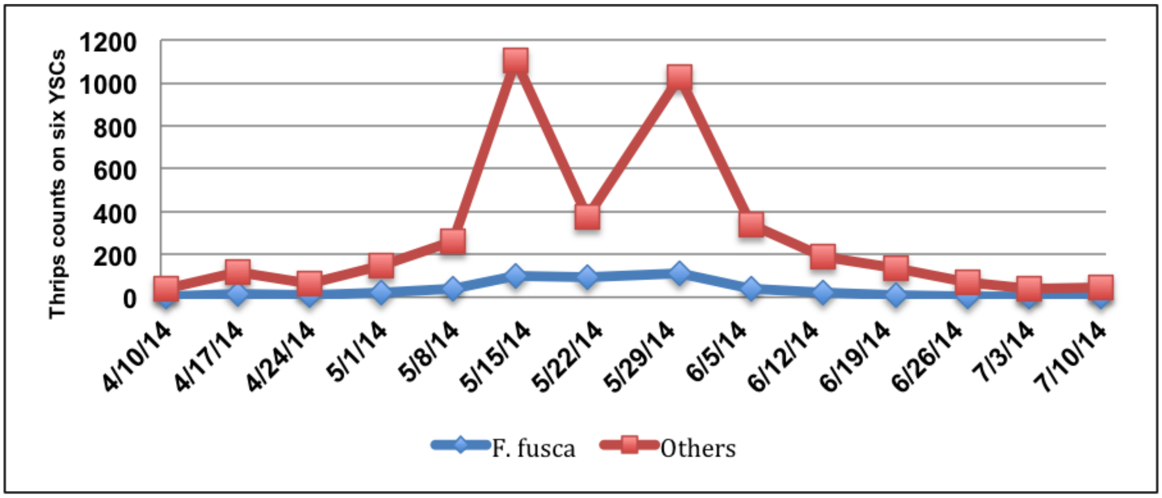


Figure 2. Total thrips counts on yellow sticky cards (YSCs) from April to July of 2014. Six cards were sampled at each time point. The counts presented are totals from six cards at each time point.

Thrips counts indicate that thrips populations peaked from May 15 to the 29. Also, at every sampling point, other thrips typically outnumbered *F. fusca* by several folds. The others included *F. occidentalis* and *F. tritici.*

Planting date and insecticide effects on thrips

Tobacco transplanting was undertaken at three planting intervals categorized as early (April 1), mid (April 14), and late (April 28) planting, respectively. In all three cases, three treatments were included. Tobacco seedlings were subjected to acibenzolar-S-methyl (Actigard®) with and without the presence of alternative insecticides spirotertamat (Movento®) and spinetoram (Radiant®). Both insecticides were applied @ 6ml/ seedling tray. The insecticides were also sprayed once in the field at two to three weeks after planting @ 6 to 10 oz/ac. All production practices were followed as per routine at the Bowen farm at UGA. The treatments were replicated four times in a split plot design. Each plot had three rows, and the rows were approximately 40 ft in length. TSWV count data were subjected to linear mixed models using Proc GLIMMIX in SAS (SAS Enterprise Version 2). The thrips counts are illustrated below in Figures 3 and 4.

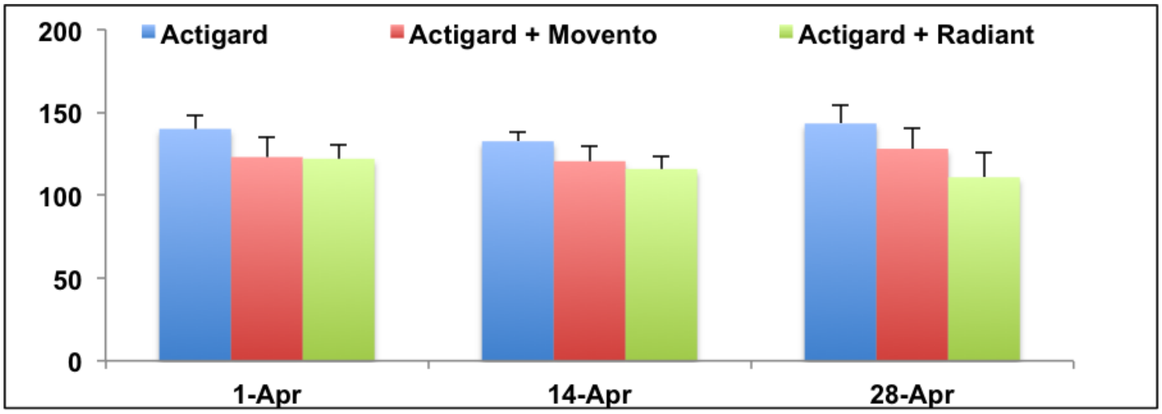


Figure 3. Tobacco thrips counts on tobacco plots with three planting dates and various insecticide treatments. Counts were obtained by placing at least one yellow sticky card in each plot.

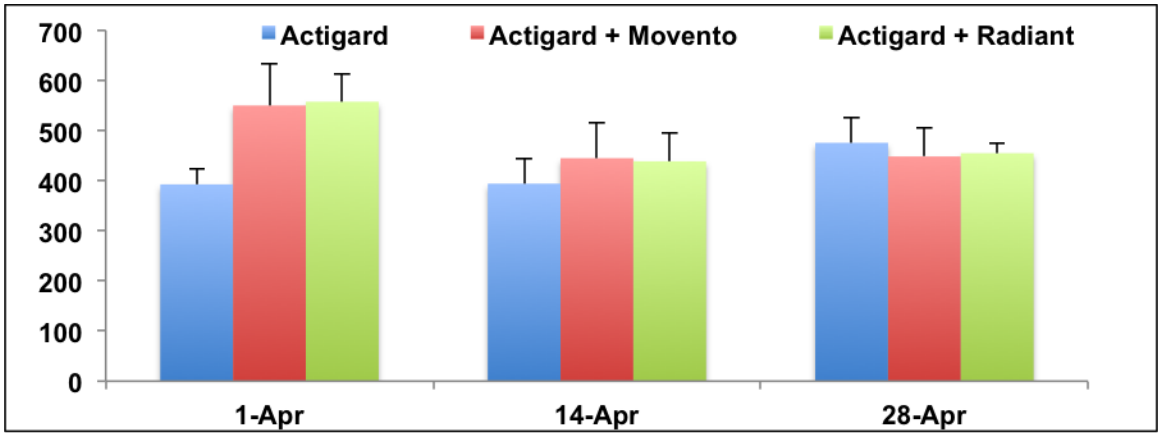


Figure 4. Total thrips counts on tobacco plots with three planting dates and various insecticide treatments. Counts were obtained by placing at least one yellow sticky card in each plot.

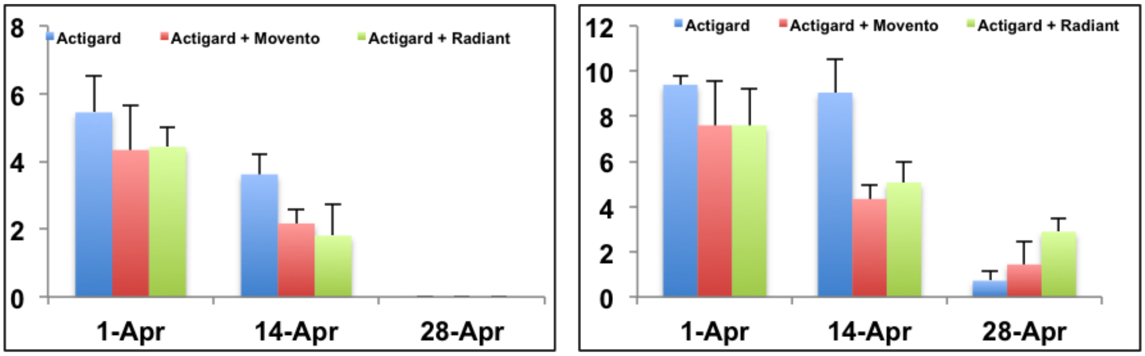
Results indicated that neither planting date nor insecticide treatments affected thrips populations. This suggested that adding an insecticide in addition to Actigard® did not offer any additional protection against thrips.

Planting date and insecticide effects on TSWV incidence

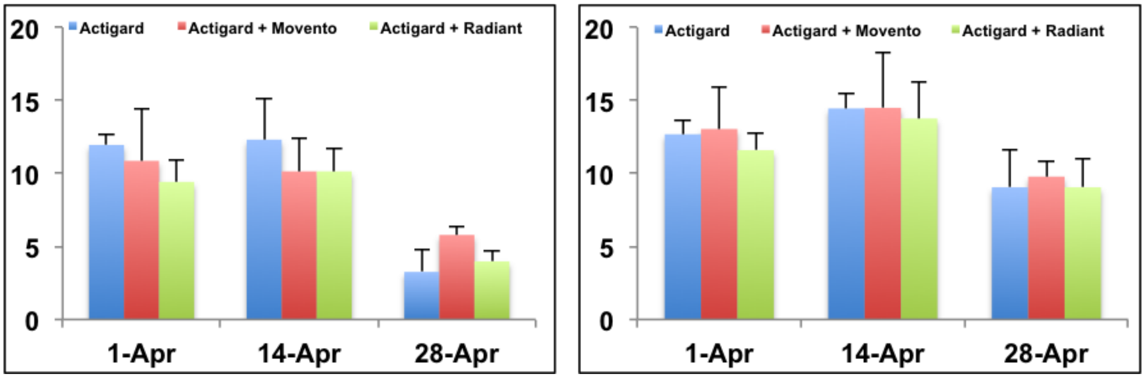
TSWV incidences taken at various time intervals are given below in Figure 5. Percent TSWV infection data also were subjected to linear mixed models using Proc GLIMMIX in SAS.

Results indicated that TSWV incidences varied with planting date on May 22 ($P < 0.0001$), May 30 ($P < 0.0001$), and June 06 ($P < 0.0001$). The data indicated that TSWV incidence in late-planted plots was lower than in early-planted tobacco. Since the peak of thrips appeared in mid to late

May, our hypothesis was that late-planted tobacco plants were more susceptible stage than early-planted tobacco. However, the early-planted tobacco plants were taller and could have influenced thrips landing on taller plants than on shorter plants. Thereby the landing thrips could have transmitted more TSWV to early-planted tobacco than to late-planted tobacco plants. The infection rates on nearby plots that received no Actigard or insecticide treatment ranged from 58 to 62%. These plots had volunteer peanuts. This could have also played a significant role in increasing TSWV incidence.



May 22 May 30



June 6 June 20

Figure 5. Percent TSWV incidence in tobacco at four time intervals. Tobacco plants were transplanted at three intervals along with Actigard® and/or insecticide.

Observed thrips and TSWV incidence in relation to risk prediction

Our peak thrips populations were observed from mid to late May. The risk prediction model (Developed by NCSU) available online indicated that peak thrips populations would occur around May 18. Also, the observed TSWV incidence was ~15%. The predicted TSWV incidence according to forecasting model was 9.8%. These results indicated that the observed and predicated thrips peak occurrences and TSWV incidences were not drastically different.

Planting date and insecticide effects on plant height

Plant height data were analyzed in SAS as described earlier. Plant heights observed on June 06 (Figure 6) indicated that early-planted plants were taller than late-planted plants as expected. However, no differences were observed with respect to insecticide treatments.

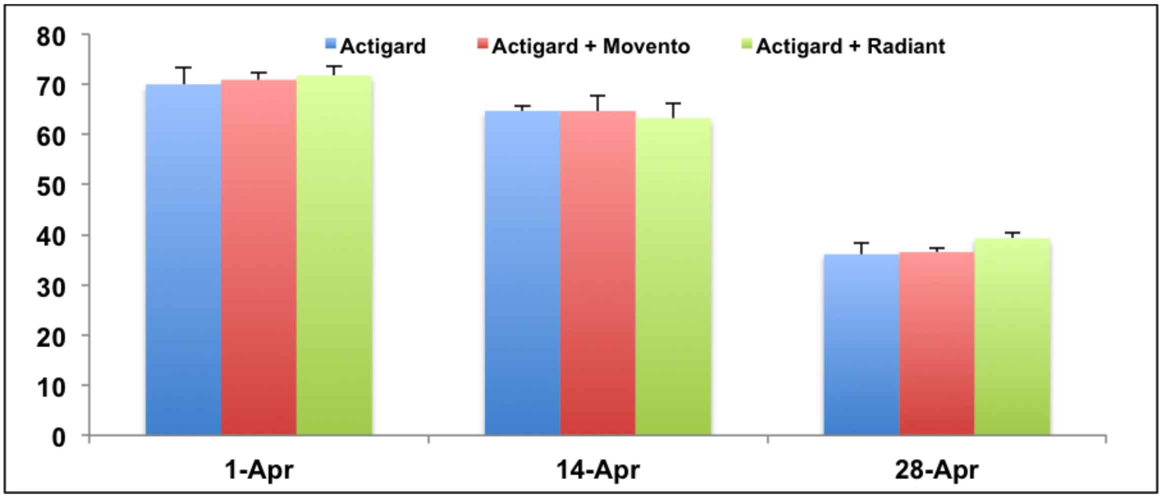


Figure 6. Tobacco plant heights in inches as observed on June. Plant heights were obtained from plots with different planting dates and insecticide treatments. Counts are based on plants in one row per plot.

Planting date and insecticide effects on yields

Yield data were analyzed in SAS as described earlier. The variations in TSWV incidence, planting dates, and insecticides did not influence plant yields. TSWV incidence in early-planted tobacco was greater than percent incidence observed on late-planted tobacco. However, this difference did not translate into yield reduction in the case of early-planted tobacco.

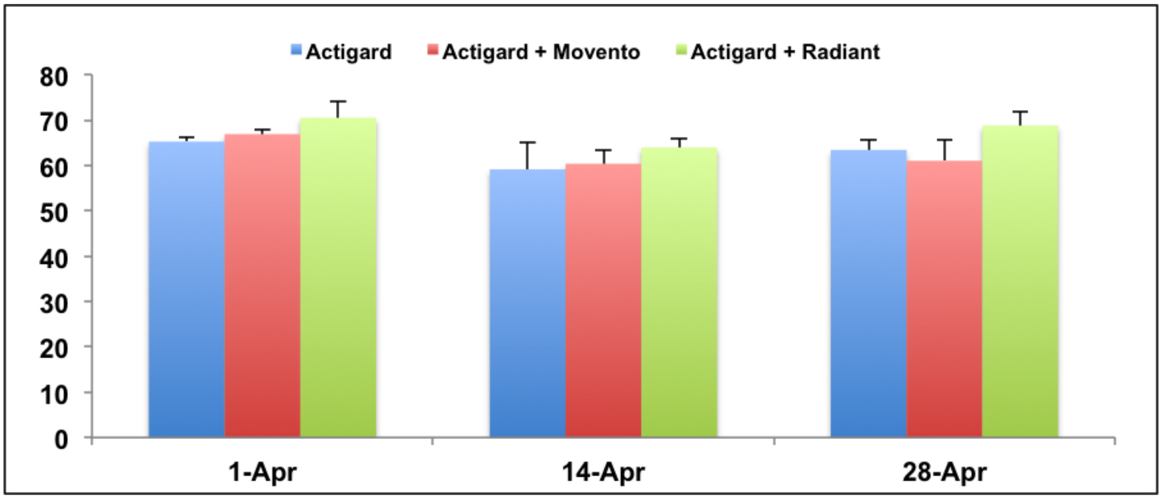


Figure 7. Yield weights in pounds at harvest. Weights were obtained from plants in plots planted at different dates and treated with Actigard® and/or insecticides. Weights are based on plants in one row per plot.

Interpretations and future research

Thrips populations were not influenced by insecticide applications early on in the season. The reason could be that the thrips peak appeared in mid-to-late May. Transplant drench and a field spray two weeks later might not have had enough residual activity against thrips appearing much later.

TSWV incidences were affected by planting date rather than insecticide treatments. TSWV incidences in early-planted tobacco were higher than in late-planted tobacco. Plant growth patterns and thrips peak activity could have contributed to the observed outcome. More research needs to be conducted to address these effects in greater detail.

Thrips peak occurrence and TSWV incidences were not drastically different from the predictions by the risk assessment model developed in North Carolina. The model could be used for early in the season for predictions. Such predictions could be useful to improve TSWV management. Additional research is required to optimize management options based on risk predictions.

TSWV incidences were, however, lower in Actigard® treated plots when compared with plots that received no treatments.

High TSWV incidence was found on plots that had volunteer peanuts prior to planting. The role of volunteer plants and alternate host still has to be studied in detail to assess their contributions to TSWV epidemiology in tobacco in Georgia.

Evaluation of Fluopicolide for Tobacco Black Shank Management

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**Valent, USA*

Introduction

Tobacco Black Shank incited by *Phytophthora nicotianae* continues to be a serious soil borne disease in Georgia. Although cultural practices such as use of resistance in tobacco cultivars and crop rotations are being used, the use of fungicides may be required for adequate disease management. Ridomil Gold has been the standard fungicide for Black Shank management since the early 1980s, but poor control of the disease and some failures along with high cost have contributed to its unpopularity. Georgia has two races of *P. nicotianae*, Race 0 and Race 1, likely as mixtures in Georgia fields. The use of *Nicotianae plumbaginfolia* resistance found in NC 71 has allowed the shift from Race 0 to Race 1, and thus NC 71 (although a very good agronomic cultivar) is susceptible to Black Shank generally in all fields in Georgia.

A relatively new fungicide, Fluopicolide, (Presidio, Valent, USA) has been evaluated for management of several Oomycete incited diseases and has been labeled for disease management in vegetables.

This study evaluates the use of Fluopicolide (Presidio) for management of Tobacco Black Shank in a heavily infested disease nursery on K 326 (not resistant to Black Shank) and SP 225 (resistance to Race 0, tolerance to Race 1). Both cultivars are commercially available in Georgia and have good agronomic characteristics.

Materials and Methods

The trial was two tests using a randomized complete block design with five replications. One trial used K 326, which has no resistance to Race 0 or Race 1 of *P. nicotianae,* and SP 225, which has resistance to Race 0 but is only tolerance to Race 1. Each trial consisted of four treatments: 1) Non-treated control; 2) Presidio 4 SC applied at 4 oz/A in the transplant water on April 23, 4 oz/A at first cultivation as a directed spray May 14, and 4 oz/A again as a directed spray at layby June 4; 3) Presidio 4 SC applied at 4 oz/A April 23, QUG 42 (experimental) at 19 oz/A as a directed spray at first cultivation on May 14, and another application of Presidio 4 SC at 4 oz/A at layby on June 4; and 4) Ridomil Gold 4 SL in the transplant water at 0.5 pt/A on April 23, Ridomil Gold 4 SL at 1 pt/A as a directed spray at first cultivation on May 14, and again at 1 pt/A at layby on June 4.

The University of Georgia Cooperative Extension recommendations for crop fertilization and other pest control were followed.

Results and Discussion

All of the treatments showed good vigor and height measurements on all dates for both K 326 and SP 225 (Table 1, Table 4). No separation among treatments or between cultivars was noted.

Black Shank for cultivar SP 225 first occurred on June 17 and resulted in 50.8% disease in the non-treated plots by the end of the season. Treatment 2, Presidio alone, had only 6.8% disease as compared to Ridomil Gold which had 28% disease.

In K 326, Black Shank was detected by May 28 and by the end of the season the non-treated control had 97.3% disease. Treatment 2, Presidio alone, had 53.6% disease as compared to Ridomil Gold which had 87.2%, statistically the same as the non-treated.

TSWV levels ranged from a high of 10.7% to a low of 1.6% across all treatments and both cultivars. Generally, a level of 10% or less does not greatly affect yields.

This trial demonstrated the superiority of Presidio in the management of Tobacco Black Shank over Ridomil Gold and also the advantage of using a cultivar with both Race 0 resistance and Race 1 tolerance to P. nicotianae under Georgia conditions.

Acknowledgment

The authors would like to thank Valent, USA, and the Georgia Agricultural Commodity Commission for Tobacco for financial support.

Table 1. Evaluation of Fluopicolide for Tobacco Black Shank Management. Vigor.

Treatment	SP 225	K 326	SP 225	K 326	SP 225	K 326
	Vigor	Vigor	Vigor	Vigor	Vigor	Vigor
	5/5/2014	5/5/2014	5/14/2014	5/14/2014	6/2/2014	6/2/2014
1. Non-treated	8.8^{a}	9.0^{a}	8.8^{a}	8.6^{a}	9.8^{a}	9.2^{a}
2. Presidio 4 SC (4 oz/A x 3)	8.4^{a}	9.0^{a}	8.4a^{b}	8.8^{a}	9.6^{a}	9.6^{a}
3. Presidio 4 SC (4 oz/A) QUG 42 (19 oz/A) Presidio 4 SC (4 oz/A)	8.8^{a}	9.0^{a}	7.4^{b}	9.0^{a}	9.4^{a}	9.6^{a}
4. Ridomil Gold 4 SC	8.8^{a}	9.0^{a}	7.8^{ab}	8.4^{a}	9.8^{a}	9.4^{a}

Means followed by the same letter are not significantly different from each other at P = 0.05.
Vigor is based on a scale of 0-10, where 10 is the most vigorous.

Table 2. Evaluation of Fluopicolide for Tobacco Black Shank Management. Percent Black Shank Over Time for Cultivar SP 225.

Treatment Number	Percent Black Shank (%)					
	6/17/2014	6/25/2014	7/7/2014	7/21/2014	8/8/2014	8/13/2014
1.	0.8^{a}	5.7^{a}	19.8^{a}	32.6^{a}	41.0^{a}	50.8^{a}
2.	0^{a}	0.8^{b}	0.8^{b}	0.8^{b}	3.0^{c}	6.8^{c}
3.	0^{a}	0.0^{b}	0.0^{b}	0.0^{b}	0.0^{b}	0.9^{c}
4.	0^{a}	0.0^{b}	1.7^{b}	10.6^{b}	21.4^{b}	28.1^{b}

Means followed by the same letter are not significantly different from each other at P = 0.05.
Black Shank is expressed as a % of the plants killed by P. nicotianae in each plot.

(continued on next page)

Table 3. Evaluation of Fluopicolide for Tobacco Black Shank Management. Percent Black Shank Over Time for Cultivar K 326.

Treatment Number	Percent Black Shank (%)								
	5/28/14	**6/4/14**	**6/11/14**	**6/17/14**	**6/25/14**	**7/6/14**	**7/26/14**	**8/4/14**	**8/13/14**
1.	0.8^{a}	10.6^{a}	21.9^{a}	41.6^{a}	70.3^{a}	88.3^{a}	95.6^{a}	97.3^{a}	97.3^{a}
2.	0^{a}	1.6^{b}	2.3^{b}	7.4^{b}	10.2^{b}	19.3^{c}	33.3^{c}	43.6^{b}	53.6^{b}
3.	0^{a}	4.0^{ab}	5.6^{b}	7.1^{b}	9.5^{b}	18.8^{c}	22.9^{c}	40.5^{b}	46.0^{b}
4.	0^{a}	0.0^{b}	0.0^{b}	0.0^{b}	7.2^{b}	53.8^{b}	74.2^{b}	85.5^{a}	87.2^{a}

Means followed by the same letter are not significantly different from each other at P = 0.05.
Black Shank is expressed as a % of the plants killed by *P. nicotianae* in each plot.

Table 4. Evaluation of Fluopicolide for Tobacco Black Shank Management. TSWV and Plant Height for K326 and SP 225.

Treatment Number	TSVW % Total		Plant Height (cm) on 6/3/2014	
	K 326	SP 225	K 326	SP 225
1.	5.9^{b}	3.3^{a}	63.2^{a}	70.7^{a}
2.	10.7^{a}	2.6^{a}	65.2^{a}	67.8^{a}
3.	3.2^{b}	3.5^{a}	64.2^{a}	66.8^{a}
4.	1.6^{b}	5.9^{a}	66.2^{a}	70.1^{a}

Means followed by the same letter are not significantly different from each other at P = 0.05.

Evaluation of Nimitz For Management of Root Knot Nematode on Tobacco

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Introduction

Three species of root knot nematode, *Meloidogyne incognita*, *M. arenara*, and *M. javanica*, are major pathogens of tobacco in the Coastal Plain of Georgia. Most tobacco cultivars of tobacco have resistance to *M. incognita*, the Southern root knot nematode. However, their resistance to *M. arenara* and *M. javanica* are not incorporated in or are not available for tobacco. Several of the cross creek cultivars have good tolerance to *M. arenara* and reduced infection occurs. These cultivars are not as popular with growers as are the NC 71 and K 326 cultivars, primarily because of agronomic characteristics.

Nematicides for management of root knot nematodes are currently non-existent, except for the Telone II fumigant. Telone II is recommended at the rate of 6 gal/A chiseled in row several weeks prior to transplanting. Although Telone II is the only nematicide recognized to be effective on nematodes of tobacco, the application of a fumigant in the spring months of the year can be complicated with weather events.

Nimitz (fluensulfone) is a nematicide being developed by ADAMA. Fluensulfone belongs to a new class of chemistry with favorable toxicological and ecotoxicological profiles. No other plant protection product has the same mode of action or classification. Nimitz is a contact nematicide and does not have the complex procedures required of fumigant materials.

This trial evaluates the efficacy of Nimitz on flue cured tobacco in fields heavily infested with *M. arenara,* the peanut root knot nematode.

Materials and Methods

The test was established at the Bowen Farm (Ocilla Loamy Sand) in an area heavily infested with *M. arenara* root knot nematode. Plots were 35 feet long, 44 inches wide single rows in a randomized complete block design and 6 replications.

Treatments 1, 2, 3, 4, 5, and 6 were applied as a pre-plant incorporated (PPI) with a 3-point hitch mounted sprayer-rototiller in a 12-16 inch band, using three 8002 nozzles, and incorporated to a depth of 6 inches. Treatment 7, Temik, was also applied as a PPI by pre-weighing the Temik, spreading it on a 16 inch band and rototilling to a depth of 6 inches.

Plot maintenance for insects, weeds, suckers, and fertilization followed the University of Georgia Cooperative Extension recommendations.

Data

Vigor ratings were made on a scale of 0-10, where 10 is the most vigorous, on 4-9-14, 4-16-14, 4-22-14, 5-2-14, and 5-7-14.

Mid-season root gall ratings were made on 5-20-14, using the 0-10 Zeck's scale, where 0 = no galls and 10 = plants killed by nematodes. Plant heights were taken on 10 plants per plot on 6-4-14, by measuring the plant from the soil surface to the tip of the longest leaf in cm.

A second mid-season root gall rating was made on 6-25-14 using the 0-10 Zeck's scale. Tobacco harvests were made on 7-3-14, 7-17-14, and 7-31-14 by removing 1/3 of the leaves at a time, starting at the bottom and moving up the stalk for each successive harvest. Leaves were weighed for each plot, and total weight per plot converted to lb/A dry weight.

Summary

Plant vigor was very good in the early part of the season and no phytotoxicity from any of the treatments was observed. In addition, plant height measurements made at mid-season indicated that no phytotoxicity was present with any of the treatments. All of the treatments were taller than the non-treated control for both cultivars.

TSWV ranged from a high of 5.5% to a low of 0% across both cultivars and even though significant differences in TSWV were detected, disease levels were low and did not severely affect the outcome of the trial.

Root gall indices started out low in the end of May (Table 2) and gradually increased over time. Even at the earliest rating (May 20), all of the treatments had significantly less RGI's than the non-treated control for both tobacco cultivars.

By the June 25 RGI, both the Temik standard and the non-treated control had at least 2X-3X higher RGI's than the Nimitz treated plots. By final harvest the non-treated control plots had 6.5 and 9.4 RGI's for CC 35 and NC 71, respectively.

No significant differences in yield among treatments were detected in CC 35. However, in NC 71 all of the treatments except Temik increased yield over the non-treated control. Yields were increased from 635 lb/A to 3215 lb/A for the 3 pt/A rate. Interestingly, the 3 pt/A rate in CC 35 was also numerically the highest yield in that cultivar. This may suggest that the rate of 3 pt/A may be the optimum rate for root knot nematode management on tobacco.

Soil nematode populations at harvest ranged from 225 to 8 larval/150 cc for CC 35 with no significant difference among treatments. In NC 71, treatment 1 and 2 had the highest nematode population, with treatment 5 having the lowest.

Acknowledgment

Authors thank ADAMA and the Georgia Agricultural Commodity Commission for Tobacco for financial aid to complete this trial.

(continued on next page)

Table 1. Vigor, Plant Height, and TSWV on Tobacco Treated with Nimitz for Management of Root Knot Nematode, 2014.

	Vigor (0-10 Scale)		**Plant Height (cm)**		**TSWV (%)**	
Treatment	**CC 35**	**NC 71**	**CC 35**	**NC 71**	**CC 35**	**NC 71**
1. Nimitz, 2 pt/A	8.3^{a}	8.8^{ab}	60^{a}	46^{a}	3.7^{a}	3.0^{ab}
2. Nimitz, 3 pt/A	8.3^{a}	8.5^{bc}	61^{a}	47^{a}	0.0^{a}	0.0^{b}
3. Nimitz, 4 pt/A	7.3^{bc}	8.7^{bc}	59^{a}	48^{a}	3.7^{a}	2.8^{ab}
4. Nimitz, 5 pt/A	7.3^{bc}	8.8^{ab}	62^{a}	48^{a}	2.4^{a}	0.7^{b}
5. Nimitz, 6 pt/A	7.7^{abc}	9.2^{a}	62^{a}	48^{a}	2.9^{a}	3.5^{ab}
6. Nimitz, 7 pt/A	8.1^{ab}	8.8^{ab}	63^{a}	44^{ab}	0.7^{a}	0.0^{b}
7. Temik 15G, 20 lb/A	7.5^{ab}	8.3^{c}	62^{a}	40^{b}	3.9^{a}	5.5^{a}
8. Non-treated	6.8^{c}	8.5^{bc}	54^{b}	30^{c}	4.2^{a}	5.2^{a}

Means followed by the same letter are not significantly different from each other at P = 0.05.
Vigor scale is 0-10, where 10 is most vigorous, plant height is in cm from ground to tip of longest leaf.
TSWV is % of plants infected.

Table 2. Root Gall Indices of Tobacco Treated with Nimitz for Management of Root Knot Nematode, 2014.

	Root Gall Index (0-10) 5-20-2014		**Root Gall Index (0-10) 6-25-2014**		**Root Gall Index (0-10) 8-7-2014**	
Treatment	**CC 35**	**NC 71**	**CC 35**	**NC 71**	**CC 35**	**NC 71**
1. Nimitz, 2 pt/A	0.2^{b}	0.7^{c}	1.2^{c}	3.3^{c}	3.6^{b}	4.7^{b}
2. Nimitz, 3 pt/A	0.2^{b}	0.3^{c}	1.2^{c}	3.1^{c}	3.9^{b}	4.0^{b}
3. Nimitz, 4 pt/A	0.1^{b}	0.3^{c}	1.4^{c}	3.1^{c}	3.2^{b}	4.0^{b}
4. Nimitz, 5 pt/A	0.2^{b}	0.2^{c}	1.3^{c}	3.7^{c}	3.5^{b}	4.2^{b}
5. Nimitz, 6 pt/A	0.2^{b}	0.4^{c}	1.7^{c}	2.6^{c}	3.6^{b}	3.3^{b}
6. Nimitz, 7 pt/A	0.3^{b}	0.4^{c}	1.2^{c}	2.4^{c}	4.0^{b}	3.4^{b}
7. Temik 15G, 20 lb/A	0.5^{b}	1.9^{b}	3.1^{b}	7.0^{b}	5.7^{a}	8.3^{a}
8. Non-treated	1.2^{a}	3.6^{a}	4.3^{a}	8.5^{a}	6.5^{a}	9.4^{a}

Means followed by the same letter are not significantly different from each other at P = 0.05.
RGI are root gall indices based on a scale of 0-10 where 0 is no damage and 10 is plants killed by nematodes.
NC 71 has no resistance to *M. arenaria* and CC 35 has tolerance to *M. arenaria* nematode.

Table 3. Yield and Nematode Numbers of Tobacco Treated with Nimitz for Management of Root Knot Nematode Larval Counts.

	Yield (lb/A)		**No./150 cc soil @ final harvest**	
Treatment	**CC 35**	**NC 71**	**CC 35**	**NC 71**
1. Nimitz, 2 pt/A	2961^{a}	2360^{b}	122^{a}	528^{a}
2. Nimitz, 3 pt/A	3411^{a}	3215^{a}	15^{a}	516^{a}
3. Nimitz, 4 pt/A	2903^{a}	2881^{ab}	10^{a}	163^{ab}
4. Nimitz, 5 pt/A	3044^{a}	2862^{ab}	225^{a}	117^{ab}
5. Nimitz, 6 pt/A	2814^{a}	2784^{ab}	93^{a}	67^{b}
6. Nimitz, 7 pt/A	3399^{a}	2953^{ab}	58^{a}	160^{ab}
7. Temik 15G, 20 lb/A	2912^{a}	1283^{c}	40^{a}	232^{ab}
8. Non-treated	3080^{a}	635^{c}	8^{a}	145^{ab}

Means followed by the same letter are not significantly different from each other at P = 0.05.
RGI are root gall indices based on a scale of 0-10 where 0 is no damage and 10 is plants killed by nematodes.
NC 71 has no resistance to *M. arenaria* and CC 35 has tolerance to *M. arenaria* nematode.

Flue Cured Tobacco Variety Evaluation in Georgia

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The University of Georgia

Introduction

Tobacco varieties play a pivotal role in yield and quality improvement programs. Moreover, a vital part of any breeding program is the appropriate testing and evaluation of new tobacco varieties. Important characteristics of these varieties are yield, disease resistance, desirable plant qualities, curing, ease of handling, and market acceptability. For a variety to be recommended it must be superlative in one or more and contain a balance of the remainder of the factors. For instance, for a variety to have an excellent yield and poor disease resistance or to yield well and have poor cured leaf quality is unacceptable. In addition, every growing season presents these varieties with new challenges, which require documentation so growers can make informed decisions.

As a result, Regional Variety Tests are conducted to obtain data on yield, disease resistance, and quality as judged by physical appearance and chemical analysis. These tests consist of a small plot test and subsequently a farm test where desirable varieties from the small plot test are grown in larger plots and receive additional evaluation. Once this information is analyzed, the desirable varieties and breeding lines from these tests advance to the Official Variety Test for further evaluation under growing and marketing conditions in Georgia.

In addition, we have included data from the Regional Farm Test so when varieties are released from this test the extension service will have an additional data set to use in making recommendations to growers.

Materials and Methods

The 2014 Official Variety Test and Regional Small Plot Test consisted of 32 and 27 entries respectively while the Farm Test had 15 entries. These tests were conducted at the University of Georgia Bowen Farm on Ocilla loamy coarse sand. All transplants were treated in the greenhouse with imidacloprid (0.8 oz Admire Pro per 1000 plants) and followed with a field spray (May 9) of Actigard applied at 0.5 oz/A for Tomato spotted wilt virus (TSWV). The Official Variety and Regional Small Plot Tests were mechanically transplanted on April 9. The Regional Farm Test followed on April 11. All tests were transplanted with 22-24 plants per field plot and replicated three times. Fertilization consisted of 6 lb/A of 9-45-15 in the transplant water (200gal. /A), 500 lbs/acre of 6-6-18 at first cultivation, 500 lbs/acre 6-6-18 at second cultivation, and an additional 120 lbs/acre of 15.5-0-0 at lay-by for a total of 79 lbs/acre of nitrogen.

Cultural practices, harvesting, and curing procedures were uniformly applied and followed the current University of Georgia recommendations. Data collected included plant stand, yield in lbs/A, value/A in dollars, dollars per hundred weight, grade index, number of leaves per plant, plant height in inches, days to flower, and percent TSWV. In addition, leaf chemistry determinations consisted of total alkaloids, total soluble sugars, and the ratio of sugar to total alkaloids.

Results and Discussion

The 2014 Official Variety Test and Regional Farm Test produced good yields and average quality. All tests benefited from the application of Telone II, applied at the recommended rate, in October 2013 with good soil conditions which kept nematode pressure to a minimum. In addition, a field spray of Actigard combined with the standard tray drench treatment of Admire resulted in a test average of around 3% TSWV symptomatic plants. Cool early season temperatures followed by a hot and dry mid-season hampered maturity. As a result, the crop matured late and leaf maturity was negatively affected.

In the Official Variety Test, yield ranged from 2164 lbs/A for NC 2326 to 3741 lbs/A for NC 92. Value of released varieties ranged from 2692 dollars/A for CC 67 to 5511 dollars/A for CC 1063. Both price and grade index data were based on 2012 data due to lack of new data for 2014 at the time of publication. Price and grade data were below average for all varieties due to the early harvest of an immature crop. As a result, prices ranged from $114/cwt for Speight 168 at the low end while PVH 2310 at $171 had the best price per cwt for the released varieties. Grade index ranged from 57 for Speight 168 to 85 for NC 2326. Later maturing varieties did not grade as well as the earlier maturing ones. Plant heights averaged around 42 inches while leaf numbers per plant were close to 20. Flowering dates were later than normal with NC 2326 at 74 days while some varieties were chemically topped with growth regulators before flowering. Leaf chemistry was generally good considering the immaturity of the crop with alkaloids slightly above 2% and sugars averaging above 17%. The ratio of sugars to alkaloids ranged from 5.78 for NC 939 to 11.1 for CC 143. Generally, a value of 10 is desirable for this ratio. The Official Variety Test data are displayed in Table 1. Two and three year averages for selected varieties are found in Table 2.

The 2014 Regional Farm Test yielded and graded similar to the other variety tests. In the Farm Test (Table 3), NC 2326 had the lowest yield at 2181 lb/A. NC EX 40 yielded the highest at 3756 lbs/A. Value differed slightly with NC 2326 bringing in 2650 dollars/A and PXH 16 providing 5076 dollars/A. Also, PXH 16 graded the best at $146/cwt and having a grade index of 72. The lowest, CU 45 had a grade index of 55 with a price of $111/cwt. Once again, later maturing varieties did not grade as well as the earlier maturing ones. Generally, leaf chemistry was similar to the Official Variety Test, with sugars in the upper teens and alkaloids around 2%.

Acknowledgments

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(continued on next page)

Table 1. Yield, Value, Price Index, Grade Index, and Agronomic Characteristics of Released Varieties Evaluated in the 2014 Official Flue-Cured Variety Test at the University of Georgia, Tifton, GA.

Variety	Yield (lb/A)	Value ($/A)	Price Index[1]	Grade Index[2]	Leaves/ Plant (number)	Plant Ht. (in)	Days to Flower	Total Alkaloids (%)	Reducing Sugars (%)	Ratio RS/TA
NC2326	2164	3674	170	86	20	41.1	74	2.80	16.7	5.96
NC 95	2448	4020	164	83	22	45.5	85	2.04	17.7	8.68
K 326	2679	4473	167	84	21	39.7	86	2.36	17.3	7.33
K 346	3089	3838	123	61	19	38.9	75	2.17	17.2	7.95
NC 71	2727	4553	167	84	21	39.3	87	2.30	19.0	8.25
NC 72	3158	3597	114	57	21	43.4	85	2.16	18.5	8.55
NC 92	3741	4266	114	57	20	43.0	85	2.53	17.7	6.99
NC 196	3391	4155	122	61	22	47.2	83	1.98	18.2	9.18
NC 297	2885	3603	122	61	20	39.1	80	2.42	16.7	6.89
NC 925	3107	3750	120	61	20	37.3	83	2.29	17.4	7.57
NC 938	3505	4266	122	61	20	40.1	88	2.01	17.2	8.55
NC 939	3566	4424	124	62	20	41.3	82	2.36	13.6	5.78
CC 13	3377	4552	134	68	22	42.7	78	2.30	17.2	7.48
CC 27	3372	4414	132	66	20	41.0	78	2.49	18.6	7.47
CC 33	2676	3351	127	64	19	38.0	91	2.10	16.2	7.73
CC 35	3041	3975	128	62	21	44.2	ND	2.32	16.8	7.21
CC 37	2922	4065	137	66	20	39.8	82	2.14	18.6	8.70
CC 67	2217	2692	121	60	19	36.9	77	2.41	15.5	6.41
CC 143	3530	5057	145	72	22	43.9	80	1.67	18.6	11.10
CC 700	3287	4340	132	66	19	39.5	78	2.27	15.7	6.90
CC 1063	3464	5511	160	77	21	43.2	77	2.39	16.2	6.78
PVH 1452	3116	4490	146	71	21	43.7	80	2.09	17.3	8.27
PVH 2110	3520	5223	148	73	22	42.9	83	2.19	17.6	8.02
PVH 2254	3350	5169	152	75	21	43.9	83	1.88	20.0	10.63
PVH 2275	3418	5087	148	73	21	43.4	79	2.62	16.4	6.25
PVH 2310	3167	5398	171	82	22	46.4	81	2.08	16.0	7.67
SP 168	3357	3852	114	57	19	39.2	78	2.32	17.7	7.63
SP 225	3097	4407	140	70	21	43.5	79	2.32	16.3	7.03
GL 338	3187	4337	136	67	19	41.6	70	2.62	15.2	5.81
GL 395	3398	4664	137	69	20	41.7	79	2.66	15.9	5.98
GL 398	3445	4251	120	61	21	41.2	ND	1.85	19.5	10.54
GF 318	3671	4360	119	60	20	38.8	81	2.22	19.5	8.79
LSD - 0.05										

[1] Price Index based on two year average (2011-2012) prices for U.S. government grades.

[2] Numerical values ranging from 1-99 for flue-cured tobacco based on equivalent government grades - higher the number, higher the grade.

Table 2. Comparison of Certain Characteristics for Released Varieties Evaluated in the 2014 Official Flue-Cured Tobacco Variety Test at the University of Georgia, Tifton, GA.

Variety	Yield (lb/A)	Value ($/A)	Price Index[1]	Grade Index[2]	Leaves/ Plant (number)	Plant Ht. (in)	Days to Flower	Total Alkaloids (%)	Reducing Sugars (%)	Ratio RS/TA
3 Year Average 2012, 2013, and 2014										
NC2326	2296	3446	151	76	18	39.3	68	2.54	17.2	6.99
NC 95	2685	3957	149	75	20	43.9	77	2.55	16.9	7.32
K 326	2869	4599	161	79	20	39.8	77	2.10	18.1	8.72
K 346	2837	4105	144	71	19	41.3	72	2.09	17.8	8.54
NC 71	2747	4486	160	81	20	39.7	78	2.01	18.8	9.51
NC 72	2997	4282	143	71	19	42.2	78	1.93	18.4	9.57
NC 92	3260	4122	127	63	20	42.6	77	2.31	18.0	7.86
NC 196	2894	4247	149	74	21	43.6	78	1.87	18.6	10.00
NC 297	2854	4051	140	70	20	40.2	75	2.15	17.6	8.37
NC 925	2901	4110	142	71	18	39.0	74	2.17	17.4	8.15
CC 27	3007	4376	146	72	20	41.6	76	1.96	17.3	9.06
CC 33	2750	4191	152	75	19	40.7	79	1.92	17.5	9.66
CC 35	2934	4364	148	72	20	44.1	81	2.00	17.2	8.87
CC 37	2916	4284	145	71	19	40.3	77	1.93	17.6	9.16
CC 67	2598	4065	154	76	19	40.4	72	2.20	15.6	7.36
CC 700	3170	4903	154	77	19	40.7	73	1.96	16.7	8.65
CC 1063	2913	4732	163	80	19	41.2	73	2.23	17.3	7.85
PVH 1452	2972	4755	161	79	20	42.1	75	2.06	16.7	8.13
PVH 2110	3118	5082	164	81	21	44.3	79	1.90	17.8	9.63
PVH 2254	3038	5073	166	81	20	43.1	77	1.80	19.6	10.90
PVH 2275	2943	4760	162	80	20	41.6	74	2.21	16.6	7.73
SP 168	3097	4424	144	72	19	39.1	77	2.19	17.7	8.19
GL 338	2976	4703	159	78	19	41.5	70	2.22	16.7	7.89
GL 395	2916	4393	153	76	20	41.8	73	2.16	16.1	7.69
GF 318	3303	4846	147	74	20	41.8	74	1.99	18.9	9.61
2 Year Average 2013-2014										
NC2326	2258	3834	170	86	18	41.5	68	2.36	16.8	7.39
NC 95	2555	4195	164	83	20	45.2	77	1.98	17.5	8.84
K 326	2796	4668	167	84	20	40.9	76	2.09	17.6	8.58
K 346	3068	4505	146	71	20	41.9	70	2.03	17.4	8.64
NC 71	2846	4751	167	84	20	40.4	78	1.95	18.6	9.84
NC 72	3060	4410	144	71	21	44.3	79	1.97	18.1	9.26
NC 92	3477	4574	133	67	20	43.7	77	2.25	17.2	7.75
NC 196	3092	4402	144	72	22	46.6	76	1.79	18.0	10.16
NC 297	2905	4247	144	72	21	42.2	74	2.10	17.7	8.74
NC 925	2957	4148	141	71	19	38.6	74	2.03	16.9	8.41
NC 938	3177	4389	141	70	19	40.4	76	1.78	16.8	9.55
NC 939	3485	5133	148	73	20	42.4	75	1.97	15.8	8.55
CC 13	3121	4713	152	75	21	44.1	71	1.90	17.7	10.00
CC 27	3196	4777	151	74	20	42.8	76	2.02	17.4	8.97
CC 33	2762	4022	146	72	20	41.5	80	1.74	17.3	10.55

Table 2 (cont). Comparison of Certain Characteristics for Released Varieties Evaluated in the 2014 Official Flue-Cured Tobacco Variety Test at the University of Georgia, Tifton, GA.

Variety	Yield (lb/A)	Value ($/A)	Price Index[1]	Grade Index[2]	Leaves/ Plant (number)	Plant Ht. (in)	Days to Flower	Total Alkaloids (%)	Reducing Sugars (%)	Ratio RS/TA
2 Year Average 2013-2014										
CC 35	2920	4250	145	70	21	46.0	80	1.92	16.6	9.05
CC 37	3048	4630	150	73	19	41.4	76	1.89	17.0	9.00
CC 67	2587	3962	149	74	19	40.6	71	2.05	16.0	8.14
CC 700	3263	4884	149	75	20	41.4	72	1.97	16.1	8.42
CC 1063	3071	5009	164	80	20	42.8	72	2.14	16.8	8.01
PVH 1452	3116	4973	160	79	21	43.4	73	1.94	16.2	8.34
PVH 2110	3314	5198	158	79	22	46.3	77	1.87	18.3	10.18
PVH 2254	3212	5273	163	79	21	45.0	76	1.72	18.6	10.82
PVH 2275	3120	5085	164	80	20	43.0	74	2.17	16.4	7.94
SP 168	3235	4530	141	70	19	39.2	76	2.10	18.0	8.70
GL 338	3147	4885	156	77	19	42.9	68	2.14	16.4	8.18
GL 395	3151	4661	150	75	20	43.4	73	2.22	16.1	7.55
GF 318	3467	5082	148	74	20	42.7	73	1.95	19.0	9.87

[1] Price Index based on two year average (2011-2012) prices for U.S. government grades.

[2] Numerical values ranging from 1-99 for flue-cured tobacco based on equivalent government grades - higher the number, higher the grade.

Table 3. Yield, Value, Price Index, Grade Index, and Agronomic Characteristics of Varieties Evaluated in the 2014 Regional Farm Test at the University of Georgia, Tifton, GA.

Variety	Yield (lb/A)	Value ($/A)	Price Index[1]	Grade Index[2]	Leaves/ Plant (number)	Plant Ht. (in)	Days to Flower	Total Alkaloids (%)	Reducing Sugars (%)	Ratio RS/TA
NC 2326	2181	2650	124	60	18	38.8	67	2.97	15.3	5.15
NC 95	2872	3695	129	66	20	47.3	85	2.65	17.8	6.72
K 326	2909	3575	123	62	19	37.7	86	2.10	17.4	8.26
CU 45	3112	3447	111	55	21	45.6	80	2.56	19.2	7.49
NC EX 68	3108	3804	123	61	20	39.5	78	2.38	17.3	7.28
GL EX 309	3311	4096	125	63	22	46.8	85	1.96	17.7	9.04
PXH 12	3623	4785	134	68	21	44.7	77	2.35	16.7	7.09
NC EX 36	3246	3900	122	61	20	42.7	87	2.22	17.8	8.00
CU 185	3682	4499	123	63	22	50.3	80	1.93	17.0	8.78
GL EX 394	3562	4208	120	60	22	46.9	ND	1.64	18.4	11.23
CU 208	3020	4299	142	71	20	43.9	73	3.12	13.7	4.40
CU 204	3200	4287	134	67	20	42.9	78	2.36	15.3	6.49
NC EX 69	3499	4615	132	67	19	40.1	78	2.31	18.0	7.79
NC EX 40	3756	4582	123	63	21	43.7	80	2.09	17.9	8.54
PXH 16	3508	5076	146	72	20	44.5	76	1.98	18.0	9.05
LSD -0.05	360.1	651.3	18.0	8.9						

[1] Price Index based on two year average (2011-2012) prices for U.S. government grades.

[2] Numerical values ranging from 1-99 for flue-cured tobacco based on equivalent government grades - higher the number, higher the grade.

Regional Chemical Sucker Control Test

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Introduction

Chemical growth regulators are extensively used by tobacco growers in Georgia to control sucker growth. These materials are an essential component of the production process because they increase yield and reduce labor costs. The need for more effective materials and methods continues because of the necessity of reducing residues, specifically maleic hydrazide (MH). Some foreign markets require maleic hydrazide residues of 80 ppm or less. Since exports are a major outlet for the Georgian crop, MH residues above 100 ppm must be reduced.

The tobacco season has lengthened because currently used cultivars benefit from irrigation and higher nitrogen rates. Moreover, the incidence of Tomato Spotted Wilt Virus (TSWV) in Georgia causes additional sucker pressure and difficulty in control due to variability in stands and flowering. The use of dinitroanalines (DNA) in combination with maleic hydrazide have shown success in controlling suckers over the lengthened season while a third or even fourth contact has dealt with the variable stand due to TSWV. These problems can be managed while reducing MH residues.

The purpose of this year's study is to report the effectiveness of some new combinations of existing materials used in combination (sequential) with fatty alcohols (a contact) and the potassium salt of maleic hydrazide (a systemic) with and without the added benefit of dinitroanalines. These treatments are compared with topped but not suckered and the standard treatment of three contacts followed by the recommended rate of maleic hydrazide in a tank mix with one of the dinitroanalines. Each treatment is analyzed with respect to agronomic characteristics and chemical properties of the cured leaf.

Materials and Methods

The field experiment was conducted at the University of Georgia Tifton Campus Bowen Farm. All cultural practices, including harvesting and curing procedures were uniformly applied and follow current University of Georgia recommendations. Fertilization consisted of 6 lb/A of 9-45-15 in the transplant water, 500 lb/A of 6-6-18 at first cultivation, 500 lb/A of 6-6-18 at second cultivation, and an additional 120 lb/A of 15.5-0-0 at lay-by for a total of 79 lb/A of nitrogen. Irrigation was applied as needed throughout the growing season. Plots consisted of two rows of 30 plants each. Ten uniform plants were sampled from each plot for sucker data. Residue samples were pulled from cured yield samples and consisted of 25 leaves from each plot from the last three harvests. The test involved four replications randomized with 15 sucker control treatments as follows:

1. TNS — Topped Not Suckered.

2. Sucker Plucker / Sucker Plucker / (Sucker Stuff + Prime+) — One treatment of the fatty alcohol contact Sucker Plucker (Drexel Chemical Company) at 4% solution followed in five days with a treatment of 5% solution. Five days later a tank mix of Sucker Stuff (2.25lbai/gal) (Drexel Chemical Company) potassium maleic hydrazide at the labeled rate of 1.0 gal/A and Prime+

dinitroanaline (Syngenta Corporation) at 0.5 gal/A was applied. All applications for all treatments utilized a standard three nozzle configuration (TG3-TG5-TG3) applying 52 gal/A at 20 psi.

3. Sucker Plucker / Sucker Plucker / (Sucker Stuff + Butralin) — Two treatments of contact as in treatment 2 followed in 5 days with a tank mix of Sucker Stuff (0.66 gal/A) and dinitroanaline Butralin (Chemtura) (0.75gal/A).

4. Sucker Plucker / Sucker Plucker / Prime+ / Butralin — Two treatments of contact as in previous treatments were applied. The third treatment was Prime+ (0.5gal/A) applied 5 days later. Six days later Butralin (0.75 gal/A) was applied.

5. Sucker Plucker / Sucker Plucker / Sucker Stuff / (Prime+ + Butralin) — Two treatments of contact as in previous treatments was followed in 5 days by Sucker Stuff (0.66gal /A). Six days later a tank mix of Prime+ (0.25gal/A) and Butralin (0.375 gal/A) was applied.

6. Sucker Plucker / Sucker Plucker / (Sucker Stuff + Prime+) — Two treatments of contact as in previous treatments followed in 5 days with a tank mix of Sucker Stuff (0.66 gal/A) and Prime+ (0.5 gal/A).

7. Sucker Plucker / Sucker Plucker / (Sucker Stuff + Butralin) — Two treatments of contact as in previous treatments followed in 5 days with a tank mix of Sucker Stuff (1.0 gal/A) and Butralin (0.75 gal/A).

8. Sucker Plucker / Sucker Plucker / Plucker Plus — Two treatments of contact as in previous treatments followed in 5 days with Plucker Plus (Drexel Chemical Company) (2.5 gal/A).

9. Sucker Plucker / Sucker Plucker / Plucker Plus / Sucker Stuff — Two treatments of contact as in previous treatments followed in 5 days with Plucker Plus (2.5 gal/A) followed by Sucker Stuff (0.66 gal/A) after first harvest.

10. Sucker Plucker / Sucker Plucker / Plucker Plus / Plucker Plus — Two treatments of contact as in previous treatments followed in 5 days with Plucker Plus (2.5 gal/A) with another treatment of Plucker Plus (1.25 gal/A) in 6 days.

11. Sucker Plucker / Sucker Plucker / Drexalin Plus / Drexalin Plus — Two treatments of contact as in previous treatments followed in 5 days with Drexalin Plus (Drexel Chemical Company) at 0.5 gal/A. The final treatment consisted of another treatment of Drexalin Plus (0.25 gal/A) applied in 6 days.

12. Sucker Plucker / Sucker Plucker / Plucker Plus / Plucker Plus — Two treatments of contact as in previous treatments followed in 5 days with Plucker Plus (2.5 gal/A) with another treatment of Plucker Plus (2.5 gal/A) in 6 days.

Results and Discussion

Due to historically high TSWV incidence at the Bowen Farm location, c.v. K 326 was treated in the greenhouse with the labeled rate of imidicloprid (0.8 oz Admire Pro per 1000 plants) for TSWV suppression and transplanted on March 31. In addition, a field spray (May 9) of Actigard (0.5oz/A) was applied for additional TSWV suppression. Cool conditions followed transplanting suppressing initial plant growth. TSWV counts indicated an infection rate below 3% in the test. Generally, the crop was free of disease with an excellent plant stand.

The first contact was applied on June 19, and the second on June 24. The third application was applied on June 29. The final application for treatments 4, 5, and 9 through 12 was applied on July 5. All treatments were applied with a standard 3 nozzle arrangement on a high clearance sprayer at constant speed and pressure delivering slightly over 50 gal/A. The weather for all treatments was favorable with partly sunny skies and no rain. The final harvest was on August 12, with the test concluding after the suckers were pulled, counted, and weighed off 10 plants from each plot on August 14.

Cool early season temperatures followed by a hot and dry mid-season hampered maturity. As a result, the crop matured late and leaf maturity was negatively affected. However, sucker pressure was average and sufficient for comparing the treatments.

For 2014, yield and quality data varied little between treatments with the exception of treatment 1(TNS). Test yields were average with the TNS having the lowest yield at 2,542lb/A. Treatment 12 yielded the highest at 3,135lb/A and had the highest value bringing in $3,354/A. All chemical treatments increased yields 300-600 lb/A over the TNS. The standard treatment 2 brought in $3,271/A as compared to the lowest of $2,963/A for treatment 1. The price and grade indices were consistent and slightly below average for all treatments due to leaf immaturity.

Sucker control was excellent with sucker number per plant low with a mean value of 1.0 or less for all chemical treatments. Green weight per plant was higher for treatment 11 than all other treatments. Green weight per sucker was higher for treatment 11 and treatment 9 where MH was applied after the first harvest. Percent control was excellent (>94%) for all chemical treatments with or without MH. Treatment 12 had comparable control to treatments which incorporated MH. As a result, increasing spray applications, including a dinitroanaline product, and reducing or eliminating MH provided adequate control and should reduce MH residues.

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(continued on next page)

Table 1. 2014 Regional Tobacco Growth Regulator Test, Effects of Advanced Growth Regulating Material on Sucker Growth, Cured Leaf Yields, and Value of Flue-Cured Tobacco.

Treatments[1]	Sucker Growth					Cured Leaf			
	% Control	Green Wt./ Plant (g)	No./ Plant	Green Wt./ Sucker (g)	Plant Injury[2]	Yield (lbs/A)	Value ($/A)	Price Index[3] ($/cwt)	Grade Index[4]
1. Topped-Not-Suckered	0	390.4	4.2	93.0	0	2542	2963	117	57
2. SP/SP/SS (1.0 GPA) & PRIME+ (0.5 GPA)	99.5	3.4	0.8	4.5	1	3087	3271	106	55
3. SP/SP/SS (0.66 GPA) & BUTRALIN (0.75 GPA)	98.9	7.9	0.8	10.2	1	2980	3264	110	55
4. SP/SP/PRIME+ (0.5 GPA)/ BUTRALIN (0.75 GPA)	98.9	8.0	0.6	14.5	1	2863	3064	106	53
5. SP/SP/SS (0.66 GPA)/ PRIME+ (0.25 GPA) & BUTRALIN (0.375 GPA)	98.5	10.5	0.8	12.7	1	2954	3400	115	59
6. SP/SP/SS (0.66 GPA) & PRIME+ (0.5 GPA)	98.9	7.6	0.7	11.2	1	2931	3089	106	52
7. SP/SP/SS (1.0 GPA) & BUTRALIN (0.75 GPA)	99.1	6.6	0.6	11.4	1	3008	2966	99	49
8. SP/ SP / PP (2.5 GPA)	98.5	10.2	0.4	29.1	1	2852	3089	109	55
9. SP/ SP / PP (2.5 GPA)/ SS (0.66 GPA) after first harvest	97.5	17.6	0.4	43.9	1	3020	3169	105	51
10. SP/SP / PP (2.5 GPA)/ PP (1.25 GPA)	99.1	6.4	0.4	14.9	1	2822	2931	104	51
11. SP/SP / DP (0.5GPA)/ DP (0.25GPA)	94.0	42.1	1.0	43.2	1	2900	3102	107	52
12. SP/SP / PP (2.5 GPA)/ PP(2.5 GPA)	99.2	5.7	0.2	25.1	1	3135	3354	108	54
LSD-0.05						239.6	479.7	17.1	9.6

[1] All treatments received initial contact application with Sucker Plucker (SP) at 4% (2.0 GPA), subsequent application was at 5% (2.5 GPA). Sucker Stuff (SS), Plucker Plus (PP), and Drexalin Plus (DP) were also abbreviated for table simplification.

[2] Injury rating on a scale of 0-10 with 0 = no damage and 10 = plant killed.

[3] Price Index based on two year average (2011-2012) prices for U.S. government grades.

[4] Grade Index is a 1-99 rating based on government grade. High ratings are best.

*Mention of a trade name does not constitute a guarantee or warranty of a product by the University of Georgia and does not imply its approval to the exclusion of other products.

Evaluation of Tobacco Cultivars for Tolerance and/or Resistance to Nematodes

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Introduction

Many crops in Georgia that are rotated with tobacco are susceptible to root knot nematode. Cotton is susceptible to *M. incognita* race 3 and 4, and peanuts are susceptible to *M. arenaria* race 1. Tobacco is susceptible to race 2 and race 4 of *M. incognita*, both races 1 and 2 of *M. arebaria*, *M. javanica*, and *M. hapla*. Vegetables are generally susceptible to all root knot species in Georgia. All species are capable of infecting tobacco. Without resistance to these pests, the use of rotation, crop destruction and nematicides are the only means to manage the problem.

The use of Temik was recommended for management of root knot nematode in Georgia in past years and since weather did not permit the use of Tellone II for this trial. Temik the former standard for control of root knot nematode was substituted in the test.

Method and Materials

This trial was conducted at the Bowen Farm-CPES, Tifton, Ga., in a field with a history of corn, peanuts, tobacco, and soybean production. The trial was set up in a field with a strong population of *Meloidygne arenaria* nematodes. The trial was set up in a randomized complete block design (RCBD) with six replications. Each plot was 32 feet long, 44-inch-wide beds with 10-foot alleys.

Crop maintenance was achieved by using University of Georgia Cooperative Extension recommendations for the control of weeds, suckers, and insects. Chemicals used for maintenance of the crop were Orthene 97 at 0.75lb/A for insect control, Prowl 3.3 EC at 1 qt/A for weeds control, and Royal MH-30 Extra at 1.5 gal/A for sucker control.

Total rainfall recorded at the Bowen Farm during this period (March through August 2013) was 13.96 inches, based on environmental data requested from Georgia Automated Environments monitoring Network. The trial was supplemented with irrigation as required.

Greenhouse and Field Treatments

On 27 March, pre-plant application of Temik 15 G was applied to Treatment 11 and 12 trial plots. Temik 15 G was applied 20 lb/A in a 16 inch band and rototilled into the soil.

Tobacco transplants were treated in the greenhouse on 31 March with Admire Pro at 1 fl oz/1000 plants. Plants were pre-wet with material being washed in after spraying.

Tobacco varieties K 326, CC 13, CC 33, CC 35, CC 65, NC 297, NC 196, PVH 2275, K 326 with Temik, and CC 35 with Temik were transplanted on 02 April on 44-inch-wide rows with a 18-inch plant spacing.

Field Trial Data

A stand count was conducted on 6 April to establish a base count. Stand counts were conducted thereafter every one-two weeks beginning 14 May and ending 11 June to monitor loss of plants.

Vigor ratings were conducted on 9 April (approximately one week post plant), 16 April (approximately two weeks post plant), 22 April (approximately 3 weeks post plant), and 23 May (approximately 8 weeks post plant). Plant vigor was rated on a scale of 1-10, with 10 representing live and healthy plants and 1 representing dead plants.

Height measurements were conducted on 3 June. Plants were measured individually from the soil level to the tip of the longest leaf and recorded in centimeters.

Three harvests were conducted: on 3, 17, and 31 July. Harvests were done by collecting 1.3 of plant leaves at one time and weighing each plat in pounds.

Two mid-season root fall ratings were conducted on 25 May and 26 June on 8 plants per plot using the Zecks's scale of 0-10, whereby 0=no galls, 1=very few small galls, 2=numerous small galls, 3=numerous small galls of which some are grown together, 4=numerous small galls and some big galls, 5=25% of roots severely galled, 6=50% of roots severely galled, 7=numerous 75% of roots severely galled, 8=no healthy roots, but plant is still green, 9=roots rotting and plant dying. 10=plant and roots dead. A third root gall rating was conducted following the final harvest on 7 August, rating 10 plants per plot utilizing the same scale.

Nematode soil samples were pulled from plots on 7 August. Eight to 10 cores of soil equaling about 300 mls, were collected from each plot randomly. Nematodes were extracted from a 100-cm^3 soil sub-sample using a centrifugal sugar flotation technique.

Summary

CC 35 had significantly the highest average vigor rating. K326, NC 297, NC 196, and PVH 2275 had significantly the lowest vigor ratings of the Trial. CC 35 plus Temik had a significantly better height measurement then all other treatments. NC 196 had the lowest height measurement in the trial.

Yield of cultivars ranged from a low of 2,228.4 lb/A (NC 196) to a high of 3,688.7 for CC 35. Tobacco cultivar CC 35 was the only one that had a yield significantly higher than the standard K 326 with Temik 15 G.

Root gall rating by the first rating were all significantly low with minimal damage. At harvest rating K 326 had the highest overall rating with CC 33, CC 35, and CC 35 with Temik having significantly the lowest ratings.

Nematode populations ranged from 41.7 to 766.7. With CC 65 having significantly the highest population. All other tobacco cultivars had lower nematode numbers then CC 65 and were not different then K 326 treated with Temik.

Several tobacco cultivars, notably CC 35 and CC 33, had high yields, and reduced populations of root knot nematode when compared to the standard K 326 and K 326 treated with Temik. As the price of nematicides increase, and their availability decreases, nematode-tolerant cultivars for management of tobacco root knot nematode will increase in popularity.

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Evaluation of Tobacco Cultivars for Tolerance and/or Resistance to Nematodes

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Cultivar[1]	Treatment	Product Rate	Application Schedule	Vigor[2] (0-10 scale)	Height Measurement[3] (centimeters)	Dry Weight Yields[4] (pounds per acre)
1. K 326	NT			8.08b	43.13de	2,228.4c
2. CC 13	NT			8.25ab	45.12de	3,195.1ab
3. CC 33	NT			8.71a	48.32cd	3,316.5ab
4. CC 35	NT			8.33ab	54.97abc	3,688.7a
5. CC 65	NT			8.23ab	55.63ab	3,028.3b
6. NC 297	NT			7.79b	42.77de	2,778.8bc
7. NC 196	NT			8.08b	38.69e	2,345.8c
8. XXX[5]	NT					
9. XXX[5]	NT					
10. PVH 2275	NT			8.13b	43.82de	2,945.2b
11. K 326 & Temik	Temik 15 G	20 lb/A	16 March	8.33ab	49.23bcd	2,772.8bc
12. CC 35 & Temilk	Temik 15 G	20 lb/A	16 March	8.25ab	57.96a	3,164.3ab

[1] Data are means of five replications. Means in the same column followed by the same letter are not different (P=0.05) according to Fisher's LSD test. No letters signify non-significant difference.

[2] Vigor was done on a 1-10 scale, with 10=live and healthy plants and 1=dead plants, on 9, 16, and 22 April and 2 May.

[3] Height Measurements were done in centimeters from the soil level to the tip of the longest leaf on 3 June.

[4] Dry weight yield was calculated by multiplying green weight totals of tobacco by 0.20. Pounds per acre was calculated by multiplying dry weight conversion per plot by 1,452 divided by the base stand count.

[5] Candidate was eliminated by sponsor.

Cultivar[1]	Treatment	Root Gall Ratings[2] (Zeck's Scale 0-10) Mid-season 20 May	Root Gall Ratings[2] (Zeck's Scale 0-10) Mid-season 26 June	Root Gall Ratings[2] (Zeck's Scale 0-10) At Final Harvest August	Number of *Meloidogyne sp.* Per 100cc soil[3]
1. K 326	NT	2.94a	7.4a	8.1a	81.7b
2. CC 13	NT	1.61bcd	6.43cd	6.55c	66.7b
3. CC 33	NT	0.72de	5.01e	4.98d	315b
4. CC 35	NT	0.61e	4.83e	4.78d	210b
5. CC 65	NT	1.28bcde	6.13d	6.7c	766.7a
6. NC 297	NT	1.78bc	6.6abcd	7.03abc	146.7b
7. NC 196	NT	2.22ab	7.27ab	7.82ab	90b
8. XXX[4]	NT				
9. XXX[4]	NT				
10.PVH 2275	NT	1.67bcd	6.53bcd	6.8bc	41.7b
11. K 326 & Temik	Temik 15 G	1.06cde	7.01abc	7.31abc	95b
12. CC 35 & Temilk	Temik 15 G	0.55e	4.87e	4.58d	200b

[1] Data are means of five replications. Means in the same column followed by the same letter are not different (P=0.05) according to Fisher's LSD test. No letters signify non-significant difference.

[2] Gall ratings were done on a scale of 0-10, with 10=dead plants and roots and 0=no galls and a healthy plant. An average was taken of the gall ratings on 20 May and 26 June (Mid-season), rating 3 plants per plot, and again on 7 August (at final harvest), rating 10 plants per plot.

[3] At final harvest soil samples were collected on 7 August Root Knot Nematode (*Meloidogyne sp.*).

[4] Candidate was eliminated by sponsor.

Evaluation of Tobacco Host Resistance to *Phytophthora nicotianae* Races 0 and 1

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Introduction

Tobacco Black Shank incited by the pathogen *Phytophthora nicotianae* is a serious and persistent soil-borne disease. Often, disease will reoccur in a field even after several years of rotation away from tobacco. Chemical control is variable and expensive. Other means of management of the disease would be the use of host resistance.

This trial evaluates several tobacco cultivars that have reported resistance to Tobacco Black Shank, in a disease nursery that has both race 0 and race 1 of *Phytophthora nicotianae*.

Method and Materials

The study was located at the University of Georgia's Black Shank Nursery in Tifton, Ga., in a field with a continuous history (since 1962) of Black Shank of tobacco. The plot design was a randomized, complete block consisting of single row plots and replicated five times. Each plot was a single row, 35 feet long, with an average of 23 plants per test plot.

On 24 January, tobacco varieties were seeded into 242 cell flats. Selected tobacco varieties for field evaluation were CC 143, SP 225, NC 71, K 346, SP 168, NC 92, NC 925, NC 471, and K 326.

The field was prepared on 10 April by disk harrowing the area. Fertilizer 10-10-10 at 500lb/A was broadcast in plot area and incorporated into the soil on 10 April. The plots were sub-soiled and bedded on 17 April.

On 10 April, an application of Prowl 1 pt/A and Lorsban 2 qt/A was incorporated and tilled into the plot area.

Tobacco transplants were treated in the greenhouse on 18 April with Admire Pro at 1fl oz/1,000 plants for insect control. Plants were pre-wet with tap water and treatment materials were washed in with additional water after spraying.

Tobacco was transplanted on 23 April on 48-inch wide rows with and 18-inch plant spacing. Cultivation and side-dress fertilizer was as follows: 150 lbs/A 15.5-0-0 calcium nitrate on 22 April, 8 May, 29 May, and 5 June.

Additional pesticide applications on tobacco were applied uniformly over the entire test as follows: Sprayed Coragen at 5 oz/A in a 16-inch band, 3 nozzles over row in 20 gal/A H2O on 30 April; Lannate at 16 oz/A in a 16-inch band, 3 nozzle over row in 20 gal/A H2O on 8 May; Lannate at 16 oz/A plus Actigard 0.5 oz/A was applied in a 16-inch band, 3 nozzle over row in 20 gal/A H2O on 22 May; Orthene 97 at 1lb/A plus Actigard 0.5 oz/A in a 16 inch band, 3 nozzle over row in 20 gal/A H2O was applied on 4 June and 18 June; Prime+ was applied 1 gal in 50 GPA of H2O on 12 June; Offshoot T was applied 2 gal/A in 50 GPA H2O on 26 June for sucker control; and Royal MH 30 was applied 1.5 gal in 50 GPA H2O on 26 June.

Stand counts were conducted every 2 weeks beginning 14 May through 4 August, noting percent disease from TSWV and Black Shank

Total rainfall recorded at the Black Shank Nursery during this period (April through August 2014) was approximately 23.29 inches. Rainfall was determined by accessing the database of the Georgia Environmental Monitoring Network from the weather station located at the Tifton-CPES location.

Summary

The Black Shank Nursery has a mixture of race 0 and race 1 of *P. nicotianae*. The crop year 2014 was cool, which delayed the onset of black shank; however, as the temperature rose, the level of black shank increased, with the susceptible standard K 326 having 88% disease by the end of the season. Cultivars NC 92, NC 71, NC 471, and SP 168 showed the same level of susceptibility as K 326. Cultivars CC 143, SP 225, K 346, and NC 925 demonstrated a significant (P=0.05) level of resistance/tolerance to the disease. In a field with history of severe tobacco black shank, these cultivars may prove to be economically feasible to use with or without a chemical partner. Vigor rating in the field was similar with no significant difference of varieties. Vigor ratings were done on a 0-10 scale, with 0 being dead and 10 being a healthy vigorous plant. Tomato Spotted Wilt ratings were done every other week from 14 of May until the 17 of June. There were no significant differences in the percent of occurrences among the different varieties.

Lowest % of Black Shank to Highest % of Black Shank Occurrence in the Field:

1. SP 225 – Pedigree (SP 168 X K 346)(SPA 95 X SP 168). This variety has the FL 301 gene that was introduced likely from K 346. The Fl 301 gene gives it tolerance to race 1 and race 0.
2. CC 143 – Pedigree is F1 hybrid. This variety has the PHP gene that has resistance to race 0.
3. K 346 – Pedigree (McNair 926 x 80241). This variety does not have the PHP gene, so it has no resistance to race 0. It does contain the FL 301 gene so it has tolerance to race 1 and race 0.
4. NC 925 – Pedigree is F1 hybrid. This variety has no PHP gene, but it does contain the Fl 301 gene with tolerance to race 1 and race 0.
5. NC 471- Pedigree is F1 hybrid. This variety contains the PHP gene for resistance to race 0. Also contains the FL 301 gene to have tolerance to race 1 and race 0.
6. SP 168 – Pedigree is (Coker 371 Gold x SPG 118). The Coker 371 Gold variety contains the PHP gene and has resistance to race 0. SP 168 contains the PHP gene along with having the FL 301 gene, so it has tolerance to race 1 and race 0.
7. NC 71 – Pedigree is F1 hybrid. It contains the PHP gene along with some tolerance to race 1.
8. K 326 – Pedigree is McNair 225 (McNair 30 x NC95). This variety has no resistance to race 0. It does have a tolerance to both race 0 and race 1 from the FL 301 gene.
9. NC 92 – Pedigree is F1 hybrid. It contains the PHP gene with resistance to race 0 and also has tolerance to race 1. Even with having both genes, it had next to the highest occurrence of Black Shank in the field. It was the first variety to show symptoms of Black Shank in the field.
10. K 326 with Ridomil Gold Treatment – This treatment had the highest percent of Black Shank disease in the trial. This goes to demonstrate if a variety has little to no tolerance to Black Shank, then chemical treatments do not help control the rate of disease.

The relative level of Black Shank may change from field to field and season to season, but the relative disease severity will generally be constant among these cultivars.

Resistance to Race 0 (PHP gene) is qualitative, while Fl 301 gene is quantitative, and levels of tolerance to race 0 and race 1 defer and are cultivar dependent.

Acknowledgment

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Evaluation of Tobacco Cultivars with Reported Resistance to Both Race 0 and Race 1 of Black Shank (*Phytophthora nicotianae)*

University of Georgia-CPES Tifton-Black Shank Nursery 2014

Cultivar[1]	Treatment	Product Rate	Application Schedule	Vigor[2]	Height Measurement[3]	% Symptomatic TSWV[4]
1. CC 143	NT			7.7ab	65.84ab	4.8a
2. SP 225	NT			7.7ab	70.92a	8.8a
3. NC 71	NT			7.8ab	64ab	5.5a
4. K 346	NT			7.6ab	65.52ab	9.6a
5. SP 168	NT			6.7b	62.38ab	5.1a
6. NC 92	NT			7.8ab	64.1ab	6.1a
7. NC 925	NT			7.5ab	55.58b	6.2a
8. NC 471	NT			7.6ab	67.9a	11.6a
9. K 326	NT			8.9a	68.14a	8.7a
10. K 326	Ridomil Gold	0.5 pt/A 1 pt/A	At Plant 1st Cultivation At Layby	7.7ab	63.56ab	7.6a

[1] Data are means of five replications. Means in the same column followed by the same letter are not different (P=0.05) according to Fisher's LSD test. No letters signify non-significant difference.

[2] Vigor was done on a 1-10 scale, with 10= live and healthy plants and 1=dead plants, on 7 and 21 May.

[3] Height Measurements were done in centimeters from the soil level to the tip of the longest leaf on 4 June.

[4] Percent TSWV symptomatic plants were calculated by using stand counts that were made from 14 Mat to 17 June with TSWV being flagged every week.

[5] Percent Death by Black Shank was calculated by subtracting the number of plants infected at each count from the original base count. The numbers of plants flagged with TSWV were subtracted from the total to get the number of plants killed by Black Shank. That number was then divided by the original base count and multiplied by 100.

Cultivar	Treatment	% Death by Black Shank^5	% Death by Black Shank^5	% Death by Black Shank^5	% Death by Black Shank^5	% Death by Black Shank^5	% Death by Black Shank^5	% Death by Black Shank^5	% Death by Black Shank^5
		5/28/2014	6/4/2014	6/11/2014	6/17/2014	6/25/2014	7/6/2014	7/21/2014	8/4/2014
1. CC 143	NT	0b	0b	0b	2.61d	18.29e	42.44cd	55.30ef	63.99cd
2. SP 225	NT	0b	0b	0.87b	2.65d	11.7e	36.17d	48.50f	53.00d
3. NC 71	NT	0b	3.684b	7.20b	19.13bc	49.12bc	75.73a	81.40abc	86.31ab
4. K 346	NT	0b	1.779b	3.48b	4.35cd	20.30de	47.1bcd	59.41def	67.36cd
5. SP 168	NT	0b	1.667b	4.20b	10.91cd	36.20cd	62.54abc	77.07abcd	78.77abc
6. NC 92	NT	0.8696a	15.733a	30.62a	37.90a	68.29a	85.2a	89.49a	90.40ab
7. NC 925	NT	0b	0b	0b	1.74d	21.46de	47.55bcd	63.33cdef	69.63c
8. NC 471	NT	0b	0.833b	4.17b	12.06cd	36.79cd	62.26abc	70.39bcde	75.80bc
9. K 326	NT	0b	3.27b	11.76b	28.94ab	62.16ab	85.22a	87.83ab	87.83ab
10. K 326	Ridomil Gold	0b	0b	0b	1.82d	24.86de	67.72ab	86.51ab	92.55a

Cultivar[1]	Pedigree
1. CC 143	F1. Hybrid
2. SP 225	(SP 168 X K 346) (SPA 95 X SP 168)
3. NC 71	F1. Hybrid
4. K 346	McNair 926 X 80241
5. SP 168	Coker 371 Gold X Speight G-118
6. NC 92	F1. Hybrid
7. NC 925	F1. Hybrid
8. NC 471	F1. Hybrid
9. K 326	McNair 225 (McNair30 X NC95)

Soil Fertility Levels Associated with Levels of Tomato Spotted Wilt in Tobacco

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Introduction

Disease incidence and severity are the result of an interaction known as the "disease triangle." The three arms of the disease triangle are a susceptible host, a virulent pathogen, and a favorable environment. In order for disease to develop, all three components of the disease triangle have to be present. The level of disease severity is dependent upon the degree of virulence of the pathogen, the susceptibility of the host, and how favorable the environment is. The soil environment, including nutrient levels, can interact with the disease triangle by affecting host susceptibility or by affecting growth of the pathogen. A favorable balance of soil nutrients can lower disease incidence or severity, whereas an unfavorable balance can increase disease levels. As such, we have been investigating an association of soil fertility with Tomato Spotted Wilt (TSW) severity in tobacco.

Materials and Methods

Data were collected from field plots at the University of Georgia Bowen Farm in Tift County, Ga., in the winter of 2013-14. Composite soil samples were taken at an approximate 6-inch depth from multiple locations on the farm. Soil samples were sent to the UGA Plant and Soil Analysis Laboratory in Athens for analysis. Levels of phosphorus, potassium, calcium, magnesium, sulfur, boron, copper, iron, manganese, zinc, and sodium were determined for each soil sample and recorded as parts per million (ppm). These values and key ratios of one value to another, e.g. Cu:Fe ratio, were plugged into a multiple regression model developed previously (Equation 1).

Equation 1.

$$\% \text{ TSW} = -5.6 \text{ CuFe} + 0.1 \text{ Cu} - 0.002 \text{ Fe} + 1.15$$

Based on the results of this screening, the sites with the highest and lowest predicted levels of percent Tomato Spotted Wilt were selected as planting sites for the following spring and labeled as the "High Risk Site" and the "Low Risk Site." Tobacco was transplanted into these fields and managed by standard management practices recommended by the Georgia Cooperative Extension. In addition, split-plot treatments were established in a randomized complete block design to evaluate supplemental addition of copper and iron chelates to affect the Cu to Fe ratio. Untreated control plots were also used to compare TSW severity in the high risk and low risk sites. Treatments are listed in Table 1.

Plants were rated for TSW severity from June 3 to June 24 on a scale of 0-10, with 0= no disease, 1= trace, … , and 10 = completely dead. Leaf tissues were sampled from both the low risk and high risk sites and analyzed for activity of Cu-ZnSOD, FeSOD, and MnSOD genes, which are related to the detoxification of reactive oxygen species (ROS) formed during the infection process, and the activity of the NPR1 gene which regulates downstream events of the systemic acquired resistance (SAR) pathway.

Table 1. Treatments at the predicted high risk and low risk planting sites at the Bowen Research Farm, near Tifton, GA.

Treatment #	Additives	Rate
1	Fe	Standard Tobacco Fertility + 2 qt Fe/A
2	Fe	Standard Tobacco Fertility + 4 qt Fe /A
3	Cu	Standard Tobacco Fertility + 4 lb Cu /A
4	Cu	Standard Tobacco Fertility + 6 lb Cu/A
5	Control	Standard Tobacco Fertility
6	Fe + Actigard	Standard Tobacco Fertility + 2 qt Fe/A + Actigard
7	Fe + Actigard	Standard Tobacco Fertility + 4 qt Fe /A + Actigard
8	Cu + Actigard	Standard Tobacco Fertility + 4 lb Cu /A + Actigard
9	Cu + Actigard	Standard Tobacco Fertility + 6 lb Cu/A + Actigard
10	Control	Standard Tobacco Fertility + labeled rate of Actigard

Twenty soil samples were collected along an X pattern going from corner to corner (10 samples from each bar of the X). Soil cores were collected from an approximate 6" depth. All 20 samples/plot were pooled and mixed together to make one composite sample for each replicate.

Results

Based on the predicted percent TSW severity, two sites were selected for planting of tobacco on the Bowen Farm in the winter of 2013. When TSW severity at the low risk site was compared with TSW severity at the high risk site, the high risk site had a mean of 33.1% TSW of tobacco and the low risk site had a level of 4.4 % TSW on June 5, 2014 (Figure 1a). Relative activity of the MnSOD gene in tobacco leaves from the high risk site was 0.42 compared to 2.33 from the low risk site (Figure 1b). When the effects of fertility treatments were analyzed, all treatments that included Actigard (acibenzolar–S-methyl) were not significantly different from one another. However, in plots not treated with Actigard but receiving either supplemental iron or copper, significant differences were observed. Increased TSW severity occurred in tobacco plants treated with higher levels of iron (Table 2). Interestingly, plants receiving the lower rate of copper had lower levels of TSW when compared to the higher rate of copper in both the high and low risk sites.

Table 2. Effects of supplemental iron or copper upon TSWV severity in predicted high risk and low risk field sites in 2014.

Treatment	Rate	% TSWV High Risk Site	% TSWV Low Risk Site
Iron Chelate	2 qt/A	37.5a	4.4b
Iron Chelate	4 qt/A	30.0ab	9.6a
Copper Sulfate	4 lb/A	17.5b	0.1c
Copper Sulfate	6 lb/A	33.8a	3.4bc
Control*	-	27.5ab	3.1bc

* All treatments received standard N-P-K fertilizer and rates as recommended by the UGA Cooperative Extension.

Discussion

Levels of TSWV severity in the predicted high and low risk sites fit the model very well as the high risk site had a mean value of 33.1% TSWV vs. only 4.4% in the predicted low risk site (Figure 1a). In addition, the relative activity of MnSOD gene was over five times higher in tobacco leaves harvested from the low risk site compared to gene activity in leaves from the high risk site.

The MnSOD gene regulates one of the superoxide dismutase enzymes, which detoxifies reactive oxygen species (ROS) that form during the infection process with many plant pathogens. One of the intermediary products that forms from that reaction is salicylic acid (SA). SA has been referred to as a plant defense hormone, and the commercial product Actigard is a chemical analog of SA, which activates the systemic acquired resistance (SAR) pathway downstream.

Thus, the increased activity of MnSOD and the assumed subsequent increase in SA would activate the systemic acquired resistance pathway in tobacco tissues. The decreased levels of TSWV in the low risk plots with the corresponding increased MnSOD activity would support the premise that SAR was activated with the only difference between the two areas being the soil profile of soil elements. Thus, the predictive model developed from previous data in years past appears to be valid based on this one year of data. However, the model could also be considered validated in a different manner in a previous year by correlating model elements with both the spatial distribution of disease severity and pattern of element concentrations in the soil.

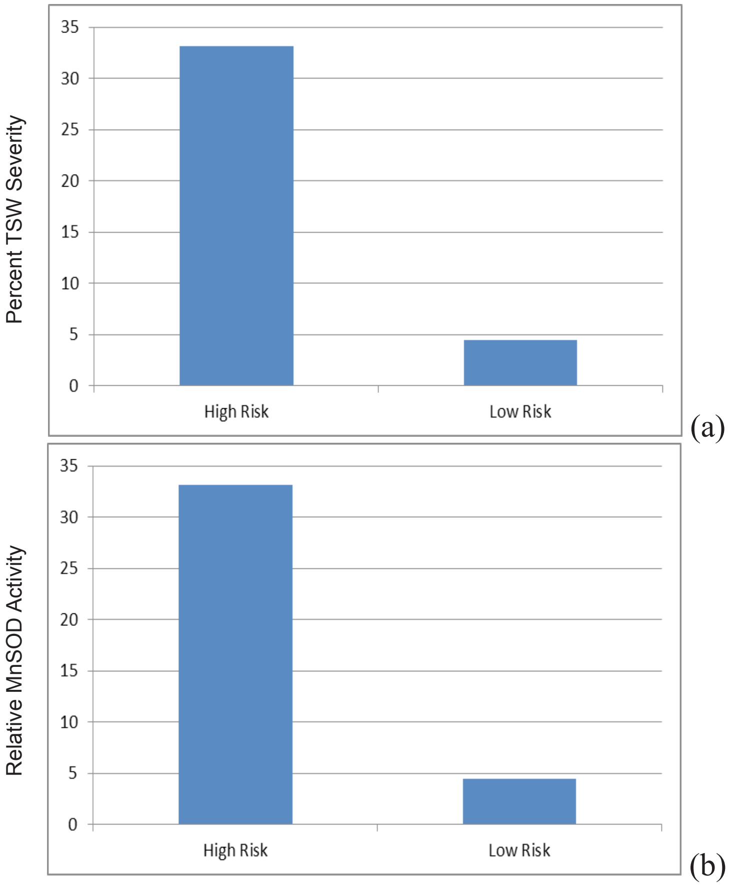

Figure 1. TSWV severity (a) and relative MnSOD activity (b) in the control (untreated) plots from the predicted high risk and low risk field sites in 2014.

Although the prediction made by our model was accurate, there were problems with trying to manipulate soil fertility to recreate conditions that the model indicated would correspond with lower levels of TSW. In that case, the model did not work as well, which demonstrates that there are factors and interactions occurring that we do not fully understand. When we added supplemental iron and copper to adjust the Cu to Fe ratio, the model would have predicted that adding copper would increase disease severity and that adding iron would decrease TSW.

The exact opposite was observed. TSW severity was highest (37.5%) with the 4 qt/A rate of supplemental iron in the high risk site and highest (9.6%) with the 2 qt/A rate of iron at the low risk site. In contrast adding copper at the 4 lb/A rate resulted in the lowest levels of TSW at both the high (17.5%) and low (0.1%) risk sites. Similar results were observed in our studies with pepper and onion, which demonstrates both consistency in our results as well as a complicated interaction of uptake and translocation of nutrients when supplements are added.

In summary, the models developed worked very well as predictive models based on soil analysis. In contrast, although the TSW risk was lowered with the addition of supplemental copper, it was unexpected since we would have predicted an opposite response. Further studies on adjusting fertility to reduce TSW risk need to be done in order to understand why altering soil levels radically affects TSW in the unexpected manner observed.

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