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Tobacco Research Report

2010

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(Summary Report of 2010 Data)

Edited by Stephen W. Mullis

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Foreword

As a child topping tobacco in the fields of southern Maryland and later working in the stripping house, I have always appreciated the unique attributes of tobacco. During the early part of my academic career, I had the opportunity to look at nutrient losses from tobacco and the impact on water quality of the Chesapeake Bay, which expanded my perspective and appreciation of the crop. Tobacco is still the only crop I have worked with where "one plant" is important and makes a difference. I consider tobacco to be the king of Southern crops.

My position in Georgia as Dean of the University of Georgia College of Agricultural and Environmental Sciences has allowed me to learn about a whole different way of production and curing, but my fascination with tobacco has only increased. I am pleased that my college continues to support the industry in a variety of ways. As long as tobacco is grown in this region, we will remain a strong player in the industry. Whether tackling old or new diseases, finding new soil amendments to test, or new ways of controlling growth, we will be here to help the industry.

This report is a summary of the help we provide and is a collection of results and interpretations from studies conducted by several of our research scientists. We hope you find this information useful and invite you to visit our research farms and see this research first-hand.

J. Scott Angle
Dean and Director
College of Agricultural and Environmental Sciences
University of Georgia

Introduction

The U.S. and world economies have faced serious challenges in recent years, and agriculture is adapting to a new economic reality as well, with much greater input costs and wild swings in commodity prices. Like other agricultural enterprises, the tobacco industry has experienced a great deal of change in recent years and continues to evolve. Many challenges exist, including those associated with plant disease, soil fertility, insects, changing markets and global competition, all of which impact profitability. It is the mission of the University of Georgia College of Agricultural and Environmental Sciences to conduct research and education programs that provide science-based information for growers to make informed decisions and enhance profitability.

There is a long history of tobacco research and Extension programming at the University of Georgia Tifton Campus. Dedicated scientists and staff work diligently to deliver the technical information needed by the tobacco industry. Partnerships and financial support from the Georgia Tobacco Commission and from the tobacco industry have helped provide resources necessary to conduct research into issues facing this crop. This report contains the most recent results of tobacco programs at the University of Georgia. We hope you find the information in this report useful in moving the tobacco industry forward.

Joe W. West
Assistant Dean
College of Agricultural and Environmental Sciences
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Flue-Cured Tobacco Variety Evaluation in Georgia

S.S. LaHue, C.E. Troxell and J.M. Moore

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, 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 remaining factors. For a variety to have an excellent yield and poor disease resistance or to yield well and have poor cured quality is unacceptable.

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 then 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 advance to the Official Variety Test for further evaluation under growing and marketing conditions in Georgia.

As in previous years, we have included data from the Regional Farm Test so that when varieties are selected from this test, Extension personnel will have an additional data set to use in making recommendations to growers.

Materials and Methods

The 2010 Official Variety Test and Regional Small Plot Test consisted of 28 and 31 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 with Actigard (1 oz/100,000 cells) and imidacloprid (0.8 oz Admire Pro/ 1,000 plants) for *Tomato spotted wilt virus* (TSWV) and followed with one field spray (April 29) of Actigard applied at 0.5 oz/A at the first sign of TSWV symptoms in non-treated border rows. The Regional Small Plot Test was mechanically transplanted on April 5. The Official Variety Test and Regional Farm Test followed on April 6. All tests were transplanted with 22 plants per field plot and replicated three times. Fertilization consisted of 6 lb/A of 9-45-15 in the transplant water, 500 lbs/acre of 6-6-18 at first cultivation, 600 lbs/acre 6-6-18 at second cultivation, and an additional 163 lbs/acre of 15.5-0-0 at lay-by for a total of 91 lbs/acre of nitrogen. Cultural practices, harvesting and curing procedures were uniformly applied and followed current UGA 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 2010 Official Variety Test and Regional Farm Test produced good yields and quality through an exceptionally hot growing season. However, the test benefitted from the application of Telone II applied at the recommended rate in October 2009 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 and light disease pressure resulted in a test average of 3% TSWV symptomatic plants as compared to 14% to 19% in non-treated checks of adjacent tests. Eight irrigations totaling 5.5 inches supplemented lack of rain in mid-May and June. Overall, the tests received 19.2 inches of rainfall over the 19-week test period.

In the Official Variety Test, yield ranged from 2,178 lbs/A for NC 95 to 3,163 lbs/A for GF 318. Value of released varieties ranged from $2,996/A for NC 95 to $4,843/A for GF 318. Prices were good with CC 27 at $138/cwt at the low end while GF 52 (at $162) had the best price per cwt for the released varieties. Grade index was up from previous years and ranged from 68 for NC 95 to 80 for GF 52. Plant heights averaged in the upper 30s to low 40s with 18 to 20 leaves per plant. Most flowering dates averaged a week later than NC 2326, which was at 67 days. Leaf chemistry was good with sugars averaging in the middle to upper teens and alkaloids generally below 2.7. The Official Variety Test data are displayed in Table 1. Two- and three-year averages for selected varieties are listed in Table 2.

In the Regional Farm Test (Table 3), NC 2326 had the lowest yield at 1,962 lb/A. NC EX 24 yielded the highest at 2,947 lbs/A and had the highest value at $4,600/A. In addition, NC EX 24 graded the best, bringing in $155/cwt and having a grade index of 76. Leaf chemistry was similar to the Official Variety Test, with sugars in the mid- to high teens and alkaloids generally below 3.

Acknowledgments

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

Table 1. Yield, Value, Price Index, Grade Index and Agronomic Characteristics of Released Varieties Evaluated in the 2010 Official Flue-Cured Variety Test at the University of Georgia, Tifton, Ga.

Variety	Yield (lb/A)	Value ($/A)	Price[1] Index ($/cwt)	Grade[2] Index	Number Leaves/ Plant	Plant Height (in)	Days to Flower	Total Alkaloids (%)	Reducing Sugars (%)	Ratio RS/TA
NC 2326	2402	3612	150	75	18	38.0	67	2.47	11.8	4.79
NC 95	2178	2996	138	68	19	40.4	82	2.69	16.0	5.97
K 326	2708	3863	142	70	20	36.6	81	2.94	15.0	5.09
K 346	2501	3891	155	78	18	37.9	72	2.43	14.3	5.87
NC 71	2555	3858	151	75	19	34.1	76	2.38	15.4	6.47
NC 72	2907	4399	153	75	19	38.9	75	2.60	14.3	5.49
NC 297	2433	3611	148	73	19	37.0	77	2.33	16.0	6.89
NC 291	2708	3889	143	72	18	34.1	78	2.60	14.9	5.72
NC 196	2786	4540	162	79	20	40.5	81	2.18	16.4	7.51
NC 299	2387	3682	154	75	19	36.7	82	2.16	15.3	7.11
NC 471	2990	4747	159	78	21	41.5	77	2.28	14.7	6.45
NC 92	2715	3809	140	72	19	40.1	75	2.35	14.5	6.20
CC 27	2900	3998	138	70	21	40.0	76	2.15	14.5	6.77
CC 37	3056	4391	144	72	19	40.8	78	2.39	14.9	6.25
CC 67	2467	3574	144	72	18	35.4	77	2.32	15.9	6.86
CC 700	2706	3974	147	73	19	37.9	78	2.72	16.6	6.08
PVH 1596	2669	4207	158	77	19	38.3	74	2.19	17.0	7.73
PVH 1452	3097	4801	155	76	19	38.7	74	2.58	14.3	5.55
PVH 2277	2334	3771	162	78	18	34.7	78	2.55	17.9	7.02
Speight 168	2779	4201	153	75	18	36.0	75	2.58	14.9	5.79
Speight 225	2460	3866	157	77	18	38.0	78	2.55	15.0	5.89
Speight 236	2817	4080	145	73	19	38.2	70	3.18	16.0	5.03
Speight 227	2885	4310	150	74	18	35.5	ND[3]	3.07	13.8	4.48
GL 368	2630	4169	158	77	17	37.8	72	2.99	15.8	5.29
GL 338	2813	4259	151	74	18	38.3	68	2.70	15.1	5.58
K 399	2552	4014	158	78	19	34.5	80	2.30	17.5	7.63
GF 52	2302	3743	162	80	17	36.9	77	2.67	14.3	5.33
GF 318	3163	4843	153	75	20	43.5	77	3.03	17.0	5.62
LSD@0.05	632.7	1026.3	12.2	5.1						

[1]Price Index based on two-year average (2008-2009) 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.
[3]No Data; this entry was chemically topped with sucker control materials.

Table 2. Comparison of Certain Characteristics for Released Varieties Evaluated in the 2010 Official Flue-Cured Tobacco Variety Test at the University of Georgia, Tifton, Ga.										
Variety	Yield (lb/A)	Value ($/A)	Price[1] Index ($/cwt)	Grade[2] Index	Number Leaves/ Plant	Plant Height (in)	Days to Flower	Total Alkaloids (%)	Reducing Sugars (%)	Ratio RS/TA
3 Year Average (2007, 2008 and 2010)										
NC 2326	2466	2795	114	62	17	37	65	3.5	12.8	3.8
NC 95	2909	3365	118	65	19	40	73	3.3	15.0	4.7
K 326	3345	4674	139	73	20	38	76	2.7	16.3	5.4
K 346	2889	4117	140	74	21	35	71	2.9	13.2	4.7
NC 71	3162	4460	139	72	20	36	73	2.7	14.7	5.5
NC 72	3087	4183	134	70	20	37	72	3.1	14.3	4.7
NC 297	3166	4468	141	72	20	38	73	2.4	16.8	7.0
NC 291	3093	3994	128	69	19	36	74	2.9	14.8	5.1
NC 196	3218	4614	143	75	21	40	76	2.4	16.4	7.0
NC 299	2877	4128	144	74	20	37	76	2.5	16.8	6.7
CC 27	3336	4331	131	70	21	39	72	2.5	15.3	6.1
CC 37	3315	4259	129	68	18	39	76	2.8	13.9	5.0
CC 700	3044	4221	137	73	20	36	73	2.8	15.1	5.4
Speight 168	3133	4361	140	73	19	37	74	2.6	15.7	6.0
Speight 225	2978	4008	134	70	19	37	72	2.7	14.1	5.3
Speight 227	3334	4517	135	71	20	38	72	2.8	14.8	5.3
Speight 236	3180	4513	142	74	20	39	74	3.0	15.3	5.0
NC 2326	2533	3054	121	63	18	38	67	3.5	11.9	3.7
NC 95	2750	3578	131	67	19	39	76	3.2	14.7	4.7
K 326	3271	4893	149	72	22	40	81	2.8	15.8	4.5
K 346	3019	4677	154	76	22	36	75	2.5	13.7	5.4
NC 71	3367	5045	150	74	20	36	74	2.6	15.3	6.0
NC 92	3236	4793	147	73	20	40	76	2.7	15.7	5.9
NC 72	3279	4887	150	74	22	39	74	3.0	13.7	4.7
NC 297	3157	4798	151	74	21	39	75	2.5	15.9	6.4
NC 196	3334	5114	155	77	21	41	78	2.1	16.2	7.7
NC 299	2847	4388	154	74	20	38	79	2.4	16.4	6.8
Speight 225	3000	4638	155	76	19	39	74	2.6	14.7	5.6
Speight 227	3413	5161	151	74	20	38	73	2.8	15.0	5.5
Speight 236	3150	4730	149	74	21	40	75	3.0	15.7	5.3
Speight 168	3198	4695	149	73	19	38	75	2.6	15.0	5.7
CC 700	3068	4579	148	74	20	38	76	2.7	15.7	5.9
CC 37	3251	4434	137	68	17	41	78	2.7	14.1	5.2
CC 27	3248	4497	139	71	22	40	74	2.4	14.7	6.2
GF 52	3194	4782	153	76	19	39	76	2.8	14.5	5.1

[1]Price Index based on two-year average (2008-2009) prices for U.S. government grades.
[2]Numerical values ranging from 1-99 for flue-cured tobacco based on equivalent grades - higher the number, higher the grade.

Table 3. Yield, Value, Price Index, Grade Index and Agronomic Characteristics of Varieties Evaluated in the 2010 Regional Farm Test at the University of Georgia, Tifton, Ga.

Variety	Yield (lb/A)	Value ($/A)	Price[1] Index ($/cwt)	Grade[2] Index	Number Leaves/ Plant	Plant Height (in)	Days to Flower	Total Alkaloids (%)	Reducing Sugars (%)	Ratio RS/TA
NC 2326	1962	2589	133	63	17	36.3	72	2.48	13.6	5.50
NC 95	2860	3739	132	65	21	43.3	72	2.83	14.2	5.00
GL EX 32	2753	4048	147	72	20	39.3	79	2.92	15.7	5.37
CC 304	2771	4040	146	71	19	39.8	74	2.77	11.8	4.26
GL 395	2508	3689	145	70	20	41.0	73	2.09	18.3	8.77
AOV 911	2595	3869	150	72	20	39.9	ND[3]	2.64	17.7	6.72
NC EX 25	2848	4044	141	69	20	37.1	78	2.38	12.1	5.07
NC EX 10	2719	4065	150	73	20	39.5	76	2.48	16.8	6.75
XP 248	2694	4186	155	75	20	43.9	81	2.89	13.4	4.63
CU 110	2678	3987	146	71	21	40.7	73	3.00	15.7	5.23
NC EX 24	2947	4600	155	76	20	39.8	ND[3]	3.43	12.6	3.66
XP 275	2769	4070	146	72	22	43.5	75	2.18	16.8	7.72
CU 75	2658	3714	139	67	19	39.7	74	2.35	12.4	5.28
ULT 142	2887	4401	152	75	20	39.1	74	2.81	14.4	5.14
ULT 112	2749	4173	151	74	21	40.7	79	1.90	18.5	9.73
LSD@0.05	365.3	714.6	13.53	6.68						

[1]Price Index based on two-year average (2008-2009) prices for U.S. government grades.
[2]Numerical values ranging from 1-99 for flue-cured tobacco based on equivalent grades - higher the number, higher the grade.
[3]No Data; this entry was chemically topped with sucker control materials.

Survey of Weeds as Hosts of *Tomato spotted wilt virus* (TSWV) in the Farmscape of Southern Georgia

S.W. Mullis, A.S. Csinos and R.D. Gitaitis

Introduction

Tomato spotted wilt virus has been one of the most devastating diseases in the Georgia agricultural community for the last two decades. Georgia, North Florida and southern South Carolina continue to be the tobacco areas hardest hit by the disease; however, small pockets in North Carolina and Kentucky have also reported high losses. This virus has been variable in its infection patterns and observations have indicated that wild plant hosts may play a vital role in TSWV disease epidemiology.

The fact that TSWV is transmitted by a small, ubiquitous insect called thrips makes detection and management of the disease complicated. Viruses have traditionally been difficult to manage since we do not have materials that kill viruses in a living plant. Control of the major thrips vectors (Frankliniella fusca and Frankliniella occidentalis) is not possible primarily because of the pervasive nature of the insects and their mobility from neighboring vegetation. Thus, the level of disease in tobacco is controlled primarily by the dynamics of thrips populations and level of infection of weed hosts. These weeds may serve as reservoirs for the virus as well as reproductive hosts for the known thrips vectors of the disease.

TSWV is a distinctive disease that threatens the livelihood of all tobacco growers in North Florida, Georgia and South Carolina. In addition, evidence is mounting that the disease is moving north and could become a major problem in North Carolina. Major efforts need to be initiated to first be able to predict outbreaks, and second to be able to develop management programs to reduce losses from the disease. A study of the weeds surrounding tobacco fields began in 2002 with 10 locations in southern Georgia being sampled on a monthly basis to determine levels of TSWV naturally oc¬curring in wild plants. More than 80,000 plants have been sampled over the past nine years to garner an un-derstanding of the general levels of the virus in the farmscape.

Materials and Methods

The sample areas include the Bowen Farm, Blackshank Farm and Blackshank nurseries in the Tifton, Ga., area. Atkinson, Berrien, Burke, Coffee and Tattnall counties are additional ar¬eas under study at this time. A total of 990 plants are screened on a monthly basis for TSWV using Double Antibody Sandwich-Enzyme Linked Immunosorbent Assay (DAS-ELISA) using commercially available kits (Agdia, Elkhart, Ind.). The plants chosen were identified in the first three-year phase of the study as susceptible to the virus and commonly infected with TSWV.

Results to Date

Tomato spotted wilt virus (TSWV) impacts increased dramati¬cally in 2005 and leveled off in 2006. Where statewide incidence of TSWV in 2003 was at relatively low levels (>6%), 2006 saw similar numbers to 2004 and 2005 with yield losses of about 18%; 44% of all plants showed TSWV. Levels of TSWV at our experimental site at the Bowen Farm, CPES-Tifton, Ga., remained higher than the surrounding areas, as expected, at around 45% in 2009 and 2010.

Currently, we are in the ninth year of the overall study of the weed host survey. This study originally started in February 2002, and as of December 2010, 82,681samples had been collected from all locations. Samples are collected from six sites every month.

For 2006-2010, TSWV levels in the weeds remained low (1.12%) during the winter, increasing dramatically to 14.26% during the spring and remaining relatively level throughout the summer months. Fall saw an increase (15.23%) before the levels dropped to negligible for November and December. April (16.1%) and June (19.21%) had the highest incidences of TSWV during the year. Overall, 2010 had a slight increase in TSWV infections in the weeds, which corresponds to the increase in the TSWV seen in tobacco during the 2010 grow¬ing season.

These levels correspond to the levels seen throughout the study. One of the main observations is the dramatic increase in weed infection levels during the late spring and fall. This has been a consistent feature of this study even during the years when levels have spiked higher or been markedly lower. The environmental observations have indicated that there may be an association of the higher incidences of TSWV infections and moderate conditions. Adverse weather, either colder winters or warmer summers, along with increased rainfall patterns may have a depressing effect on the levels on infection seen during the corresponding season. There also seems to be an effect regarding the changeover period of weed species seen from one season to the next.

The higher infection levels observed during the fall preced-ing the spring growing period corresponds favorably to a higher incidence of TSWV at the Bowen Farm. Conversely, the infection levels seen immediately preceding the tobacco growing cycle inversely correspond to the infection levels seen in the field.

Significance of Accomplishments

These studies' findings seem to validate the importance of weeds as natural reservoirs for tospoviruses. These data will allow us to hone the study in the future to further understand the relationship of TSWV levels in weeds with the TSWV levels in tobacco fields. We may be able to elicit an early indication of TSWV incidence in an upcoming growing season by understanding the relationship of winter weed infection levels with spring and summer crop TSWV incidence.

The relationship emerging between weed infection levels and the corresponding growing seasons is a potential tool in the management of TSWV. The establishment of an early indicator of the TSWV pressure during a growing season would be extremely valuable in determining what chemical, cultural or other management practices need to be utilized to lessen the effect that TSWV may impart on a season's tobacco crop. This host study has shown that environment, geography and host species all play a part in the epidemiology of TSWV and they all may be used as a disease indicator model.

Relationship to Programs in Neighboring States
Studies and observations have shown that our location is the epicenter of TSWV. Due to the high disease pressure at our test locations, we are able to observe in detail the interactions of TSWV and the farmscape. This information is important to the region due to the devastating losses that have been attributed to TSWV. Neighboring states can use the information garnered in south Georgia to mitigate possible TSWV losses in their crops.

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The authors want to thank Altria for their support of this valuable study.

Effects of Selected Tray Drench, Transplant Water and Mid-Season Foliar Insecticide Treatments on Suppressing Insect Pests and Tomato Spotted Wilt Symptoms in Flue-Cured Tobacco

R. McPherson, J. M. Moore, W. Stephens, S. S. LaHue and E. Troxell

Introduction

Two thrips species commonly collected on flue-cured tobacco in Georgia are reported as vectors of tomato spotted wilt (TSW): the tobacco thrips, Frankliniella fusca, and the western flower thrips, F. occidentalis. Thrips species are present on tobacco produced in Georgia soon after transplanting, and continue to increase on the foliage until around mid-May, then rapidly decline. TSW is a serious economic problem for Georgia's tobacco producers, causing millions of dollars in losses each year. This study was designed to examine the impact of nine tray drench and transplant water applications of selected insecticides, plus three mid-season foliar insecticide sprays, for suppressing thrips, flea beetle, aphid, tobacco budworm and tobacco hornworm populations, and how these control options directed towards thrips vector suppression impact the incidence of TSW-symptomatic plants in Georgia.

Materials and Methods

Flue-cured tobacco, variety K-326, was transplanted on April 14, 2010 on the Bowen Research Farm in Tift County, Ga., at the rate of 7,000 transplants per acre (rows spaced 44 inches apart and plants spaced 20 inches apart down the row). Production practices were used according to University of Georgia Cooperative Extension guidelines for weed control, disease control, nematode suppression and fertilization.

Forty-eight hours prior to transplanting, five insecticide treatments were applied as tray drench treatments on transplants using 200ml of water per 242-cell tray. Four additional insecticide treatments were applied at transplanting in the transplant water (2 oz of water per transplant (109 gpa)). At transplanting, 39 field plots, three rows wide (44-inch row spacing) by 30 feet long were arranged in a RCBD with three replications of the 13 treatments (12 insecticides plus an untreated control). Three foliar spray treatments were applied on May 18 and June 3, using a CO-2 powered backpack sprayer that delivered 22.8 gpa at 40 psi, with three TX-12 nozzles per row.

The number of live thrips on plants 2, 4, 6 and 8 of the second row of each plot was counted weekly during April and May. All plants in each plot were visually examined weekly for symptoms of TSW during April through mid-June. Symptomatic plants were flagged and dated, and the cumulative percentage of symptomatic plants was determined. The number of live flea beetles, aphids, budworms and hornworms were counted per plot from early May until mid-June. On June 15, each plot was rated for overall aphid infestation using a rating scale from 0 (no aphids observed on any plant) to 5 (all plants heavily infested). Also on this date, all plants in each plot were observed for tobacco splitworm tunnels. During the month of July, a 10-plant sample from row two was harvested a total of three times (first crop the lower leaves on the plant, second crop the middle leaves, and third crop the upper leaves). These harvested leaves were weighed green and then converted to cured weight by multiplying by 0.15. All insect counts plus TSW and yield data were subjected to analysis of variance with P=0.05. Treatment means were separated using the Waller-Duncan K-ratio t Test, P>0.05.

Results and Discussion

Thrips populations were low in all plots until the late May sampling dates, then populations were between seven and 38 thrips per four plants, which is still considered low (Table 1). Tobacco thrips (F. fusca) comprised more than 85% of the thrips species on tobacco foliage at this test site. The Coragen, Admire and Durivo TD insecticide treatments had the lowest incidence of TSW symptomatic plants (5.5%-6.1%), but these levels were not different from the untreated plots, which had only 10.9% (Table 2). The overall low incidence of TSW in the untreated control was probably due to the relatively late transplanting date (April 14). No phytotoxicity, chlorosis or stunting symptoms were observed in any of the plots.

Tobacco hornworm populations were lower in all of the tray drench and transplant water treatments than in the untreated control on May 18, and most of these treatments remained effective through mid-June, when sampling was discontinued (Table 3). Once the foliar insecticide treatments were applied on May 18, they also remained effective through mid-June. Overall, hornworm densities were low in the untreated plots throughout the sampling period. Tobacco budworm populations also were lower in all the tray drench and transplant water treatments, except the Admire treatment, than in the untreated check on May 18 and 25 (Table 4). Once the foliar sprays were applied, they effectively controlled budworms for the remainder of the sampling period. Budworm populations peaked at 17 worms per plot (31% infested plants) in the untreated control on June 15, three times the economic threshold of 10% infestation. The three foliar sprays plus Coragen TPW had budworm populations below 10% infestation (5.4 worms per plot with 54 plants) on June 15 (Table 4). Flea beetle and aphid populations were not different between any of the treatments evaluated in this study, and yields also were not similar between all treatments (Table 1). Tobacco splitworm tunnels were absent in all the treated plots and averaged only 2.3 tunnels per plot (54 plants) in the untreated control.

Suppressing thrips with insecticide treatments can help reduce TSW symptomatic plants in years with relatively high levels of TSW. However, at this test site in 2010, the incidence of TSW was too low in the untreated control to detect treatment differences. Several new insecticide products and new formulations appear to be about as effective as Admire in suppressing TSW, based on numerous entomology trials conducted during the past 10 years. Tray drench applications of effective treatments tend to be more efficient in reducing TSW than TPW applications. Additional studies on rates and usage patterns of these materials are needed under different natural infection rates of TSW to effectively evaluate these new thrips vector/TSW management options. Some of the new TD and TPW insecticide treatments were effective in reducing hornworm and budworm populations for several weeks after transplanting. This is a welcome benefit from materials that are being applied primarily for thrips and TSW suppression.

Acknowledgments

The authors thank the student workers who assisted with field sampling and harvesting, and the Georgia Agricultural Commodity Commission for Tobacco, the Georgia Agricultural Experiment Stations, and DuPont, Bayer and Syngenta Agrichemical companies for financial assistance.

Table 1. Effects of selected tray drench, transplant water and foliar spray insecticide treatments on the abundance of flea beetles and thrips (insects per four plants), aphid infestation ratings and cured yield on flue-cured tobacco, Tift County, Ga., 2010.

Treatment and formulation per acre	6 May FB	13 May Thrips	13 May FB	18 May Thrips	25 May Thrips	Aphid (0-5)*	Yield lbs/acre
Coragen 5.0 oz TPW	4.3a	25.3a	0.7a	54.3a	35.0a	0.67a	2485a
Coragen 7.0 oz TPW	10.3a	15.3a	3.0a	29.0a	9.7a	0.50a	2750a
HGW 86 SC 10.3oz TPW	4.0a	27.3a	1.3a	42.7a	6.7a	0.17a	2520a
Coragen 3.57oz TD	2.7a	31.0a	0.0a	35.0a	22.3a	0.33a	2975a
Coragen 4.76oz TD	5.0a	39.3a	0.7a	65.3a	12.0a	0.42a	2483a
HGW 86 SC 9.45oz TD	2.7a	43.7a	1.7a	30.3a	17.3a	0.37a	2912a
Admire Pro 3.15oz TD	4.0a	45.7a	0.0a	16.7a	6.7a	0.00a	2767a
Durivo 10.0 oz TD	3.3a	53.7a	0.0a	14.3a	14.3a	0.00a	2723a
Durivo 10.0 oz TPW	2.3a	53.3a	0.0a	62.3a	10.7a	0.00a	2573a
Coragen 5.0 oz Foliar	8.7a	22.3a	0.3a	24.0a	12.0a	0.17a	2710a
Belt 4 SC 2.0 oz Foliar	5.7a	57.0a	1.0a	29.0a	8.7a	0.00a	2430a
Durivo 10.0 oz Foliar	3.3a	17.0a	0.3a	21.0a	9.7a	0.00a	2715a
Untreated	3.3a	34.7a	1.7a	73.0a	38.0a	0.62a	2597a

K-326 flue-cured tobacco transplanted on April 14 with 7,000 transplants per acre. Transplant water (TPW) treatments were applied at transplanting in 2 oz of water per transplant (109 gpa) and the tray drench (TD) treatments were applied in the greenhouse 48 hours prior to transplanting in 200 ml of water per 242-cell tray (826 ml per 1,000 cells). Foliar sprays were applied on May 18 and June 3 with a $CO\text{-}_2$ powered backpack sprayer that delivered 22.8 gpa at 40 psi. Column means followed by the same letter are not significantly different, Waller-Duncan K-ratio t Test, P > 0.05.

*Aphid infestation ratings from 0 (no aphids observed on any plant) to 5 (all plants infested).

Table 2. Effects of selected tray drench, transplant water and foliar spray insecticide treatments on the cumulative percent tomato spotted wilt-symptomatic flue-cured tobacco plants, Tift County, Ga., 2010.

Treatment and formulation per acre	24 May	1 June	8 June	15 June
	Cumulative TSW-symptomatic plants			
Coragen 5.0 oz TPW	1.7a	3.5a	4.7a	7.1a
Coragen 7.0 oz TPW	4.0a	4.7a	4.7a	7.2a
HGW 86 SC 10.3oz TPW	2.4a	4.8a	6.0a	8.4a
Coragen 3.57oz TD	2.6a	3.8a	4.4a	5.5a
Coragen 4.76oz TD	4.2a	6.0a	6.0a	9.1a
HGW 86 SC 9.45 oz TD	5.3a	7.1a	9.5a	11.2a
Admire Pro 3.15oz TD	2.4a	3.6a	4.9a	6.1a
Durivo 10.0 oz TD	1.2a	3.0a	3.7a	6.1a
Durivo 10.0 oz TPW	2.9a	4.7a	5.8a	8.2a
Coragen 5.0 oz Foliar	2.4a	6.6a	7.2a	9.5a
Belt 4 SC 2.0 oz Foliar	2.0a	6.0a	8.4a	9.5a
Durivo 10.0 oz Foliar	4.9a	7.3a	8.5a	9.1a
Untreated	4.2a	6.0a	9.7a	10.9a

K-326 flue-cured tobacco transplanted on April 14 with 7,000 transplants per acre. Transplant water (TPW) treatments were applied at transplanting in 2 oz of water per acre (109 gpa) and the tray drench (TD) treatments were applied in the greenhouse 48 hours prior to transplanting in 200 ml of water per 242-cell tray (826 ml per 1,000 cells). Foliar sprays were applied on May 18 and June 3 with a CO-2 powered backpack sprayer that delivered 22.8 gpa at 40 psi. Column means followed by the same letter are not significantly different, Waller-Duncan K-ratio t Test, P > 0.05.

Table 3. Effects of selected tray drench, transplant water and foliar spray insecticide treatments on the abundance of tobacco hornworms on flue-cured tobacco, Tift County, Ga., 2010.

	18 May	25 May	1 June	10 June	15 June
Treatment and formulation per acre	Hornworms per plot (54 plants)				
Coragen 5.0 oz TPW	0.0c	0.0c	0.3b	0.3bc	0.0b
Coragen 7.0 oz TPW	0.0c	0.0c	0.0b	0.3bc	0.0b
HGW 86 SC 10.3oz TPW	0.0c	0.0c	0.0b	0.0c	1.0b
Coragen 3.57oz TD	0.0c	0.0c	0.7b	0.0c	0.0b
Coragen 4.76oz TD	0.0c	1.0bc	0.3b	0.3bc	0.0b
HGW 86 SC 9.45 oz TD	0.0c	0.3c	0.3b	0.3bc	1.3b
Admire Pro 3.15oz TD	0.0c	1.7ab	1.0ab	1.0ab	4.0a
Durivo 10.0 oz TD	0.0c	0.3c	0.3b	1.0ab	0.0b
Durivo 10.0 oz TPW	0.0c	0.0c	0.0b	0.3bc	0.0b
Coragen 5.0 oz Foliar	2.0a	0.0c	0.0b	0.0c	0.0b
Belt 4 SC 2.0 oz Foliar	1.7a	0.0c	0.3b	0.0c	0.0b
Durivo 10.0 oz Foliar	2.0a	0.0c	0.0b	0.0c	0.0b
Untreated	1.3ab	2.7a	2.0a	1.7a	4.0a

K-326 flue-cured tobacco transplanted on April 14 with 7,000 transplants per acre. Transplant water (TPW) treatments were applied at transplanting in 2 oz of water per transplant (109 gpa) and the tray drench (TD) treatments were applied in the greenhouse 48 hours prior to transplanting in 200 ml of water per 242-cell tray (826 ml per 1,000 cells). Foliar sprays were applied on May 18 and June 3 with a $CO\text{-}_2$ powered backpack sprayer that delivered 22.8 gpa at 40 psi. Column means followed by the same letter are not significantly different, Waller-Duncan K-ratio t Test, P > 0.05.

Table 4. Effects of selected tray drench, transplant water and foliar spray insecticide treatments on the abundance of tobacco budworms on flue-cured tobacco, Tift County, Ga., 2010.

	18 May	25 May	1 June	10 June	15 June
Treatment and formulation per acre	Budworms per plot (54 plants)				
Coragen 5.0 oz TPW	0.0b	0.0b	0.3cd	2.3ab	6.7bcd
Coragen 7.0 oz TPW	0.0b	0.7b	0.0cd	1.3b	3.0cd
HGW 86 SC 10.3oz TPW	0.0b	1.0b	2.3ab	0.7b	12.0ab
Coragen 3.57oz TD	0.0b	0.7b	0.3cd	2.3ab	7.0bcd
Coragen 4.76oz TD	0.0b	0.0b	0.3cd	2.7ab	6.0bcd
HGW 86 SC 9.45 oz TD	0.0b	1.3b	2.0abc	3.3ab	10.7abc
Admire Pro 3.15oz TD	1.7a	4.3a	2.7a	5.7a	16.7a
Durivo 10.0 oz TD	0.0b	1.0b	1.0a-d	2.0ab	11.7ab
Durivo 10.0 oz TPW	0.0b	0.0b	0.3cd	1.3b	7.3bcd
Coragen 5.0 oz Foliar	1.3ab	0.0b	0.3cd	1.3b	0.7d
Belt 4 SC 2.0 oz Foliar	2.0a	0.7b	0.7bcd	1.0b	1.3d
Durivo 10.0 oz Foliar	1.0ab	0.3b	0.7bcd	0.7b	0.7d
Untreated	2.0a	4.0a	2.7a	5.7a	17.0a

K-326 flue-cured tobacco transplanted on April 14 with 7,000 transplants per acre. Transplant water (TPW) treatments were applied at transplanting in 2 oz of water per transplant (109 gpa) and the tray drench (TD) treatments were applied in the greenhouse 48 hours prior to transplanting in 200 ml of water per 242-cell tray (826 ml per 1,000 cells). Foliar sprays were applied on May 18 and June 3 with a $CO\text{-}_2$ powered backpack sprayer that delivered 22.8 gpa at 40 psi. Column means followed by the same letter are not significantly different, Waller-Duncan K-ratio t Test, P > 0.05.

Tobacco Budworm and Tobacco Hornworm Control with Foliar Belt Insecticide Treatments Applied at Different Spray Volumes and Pressure

R. McPherson, K. Rucker and W. Stephens

Introduction
Tobacco budworms and hornworms continue to cause annual economic losses to Georgia's flue-cured tobacco crop due to costs of control and reductions in yield. These pests cost Georgia tobacco producers millions of dollars in production costs every year. Insecticides need to continually be evaluated for their effectiveness in controlling these and other tobacco insect pests. New products, either recently labeled or seeking label registration for tobacco insect pest control, need to be examined thoroughly under Georgia growing conditions for assurance of their effectiveness before inclusion into the Georgia Pest Management Handbook once the product label is approved.

This study was conducted in a replicated field trial to evaluate the newly labeled and highly effective Belt 4SC insecticide (Flubendiamide), developed and marketed by Bayer CropSciences for control of tobacco budworms and tobacco hornworms. Belt insecticide was examined for its effectiveness in controlling these two key pests for up to nine days after applying the product. Because previous experience with Belt from Bayer CropScience indicates that increased efficacy has been observed with increasing water volumes and pressures, this trial was set up to test Belt under five different spray volumes using three different spray pressures.

Materials and Methods
Flue-cured tobacco, K-326, was transplanted on April 19, 2010 at the Georgia Coastal Plain Experiment Station Bowen Farm at the rate of 7,000 transplants per acre. Production practices according to University of Georgia Cooperative Extension guidelines included a preplant tank mixture of Prowl and Spartan for weed control, Ridomil for disease control and Lorsban for soil insect control. Fertilizer (6-6-18) was applied in a split application at a total of 1,000 pounds per acre; 100 pounds of 16-0-0 was applied at lay-by. Plots three rows wide (44-inch row spacing) by 30 feet long (50 plants per plot) were arranged in a RCBD with four replications. Plots were separated on each side with an untreated border row and on each end with a 4-foot-wide fallow alley. Belt insecticide treatments, all at the rate of 3 oz. of formulated product per acre, were applied on June 16 using a CO2-powered backpack sprayer equipped with various nozzles, psis and speeds as outlined in the footnote in Table 1. The numbers of live budworms and hornworms per plot (50 plants) were recorded prior to treatment (Pre-t) plus two, six and nine days after the application. All the insect count data were analyzed with an analysis of variance (P=0.05) and means were separated using the Waller-Duncan K-ratio t-test.

Results and Discussion
All of the Belt insecticide treatments had significantly lower budworm populations than in the untreated plots six days after treatment (DAT), and the three higher spray volume Belt treatments remained lower than the control at nine DAT (Table 1). The higher spray volumes (22.8 gpa, 28.5 gpa and 39.2 gpa) were more efficacious than the lower spray volumes (4.9 gpa and 10.4 gpa) at six and nine DAT; however, all the Belt treatments reduced the budworm population densities below the untreated control (Table 1). Hornworm densities also were lower in all of the Belt-treated plots than in the untreated plots on six and nine DAT (Table1). There were essentially no live hornworm larvae in any of the Belt treatments at six and nine DAT compared to 2.3 and 1.5 larvae per plot in the untreated control.

All of the Belt insecticide treatments examined in this study effectively controlled tobacco budworms under heavy infestation pressure. The economic threshold for budworm control is 10% infested plants, or five infested plants per 50-plant plot. At six DAT, all of the Belt treatments had fewer than five infested plants per plot while the untreated control had 17.8 infested plants, or 35.6% infestation. At nine DAT, the three higher spray volume Belt treatments had five to six budworm-infested plants while the control plots had 14.5 infested plants, or 29.0% infestation. The hornworm populations were low at this test site, never reaching the economic threshold of 10% infested plants. However, significant differences were still obtained (more hornworms in the untreated than in any Belt treatment) even under low population pressure. The result of this study documents the effectiveness of Belt insecticide for controlling tobacco budworms and tobacco hornworms on flue-cured tobacco, but also reveals the importance of higher spray volume (22+ gpa) to attain the most efficacious and prolonged control of these worm pests on tobacco.

Acknowledgments

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Table 1. Effects of Belt 4 SC foliar insecticide application (3 oz. of formulated product per acre) at different spray volumes and spray pressures on controlling tobacco budworms and tobacco hornworms on flue-cured tobacco, Tift County, Ga., 2010.

Treatment number, gallons per acre and psi	Budworms per plot				Hornworms per plot			
	Pre-trt	2 DAT	6 DAT	9 DAT	Pre-trt	2 DAT	6 DAT	9 DAT
28. Belt 4.9 gpa @ 30 psi	9.8a	14.5a	4.5b	9.5ab	0.3a	0.3a	0.0b	0.0b
29. Belt 10.4 gpa @ 60 psi	11.5a	13.3a	3.0b	7.5ab	0.3a	0.0a	0.0b	0.0b
30. Belt 22.8 gpa @ 40 psi	11.0a	17.0a	3.3b	6.3b	1.3a	0.0a	0.0b	0.0b
31. Belt 28.5 gpa @ 60 psi	10.3a	17.8a	2.5b	6.5b	0.5a	0.0a	0.3b	0.0b
32. Belt 39.2 gpa @ 60 psi	12.8a	16.3a	3.0b	5.3b	0.5a	0.5a	0.0b	0.3b
33. Untreated control	13.0a	20.3a	17.8a	14.5a	0.5a	0.3a	2.3a	1.5a

K-326 flue-cured tobacco was transplanted on April 19. Plots were three rows wide by 30 feet long (50 plants per plot) with four replications per treatment. Column means followed by the same letter are not significantly different, Waller-Duncan K-ratio t Test, $p > 0.05$.

Each treatment was applied on June 16 with a CO2-powered backpack sprayer as follows:

28. Single 80015E nozzle per row at 30 psi and travelling 50 feet in 11 sec (3.10 mph)
29. Single 80015E nozzle per row at 60 psi and travelling 50 feet in 15 sec (2.27 mph)
30. Three TX-12 nozzles per row at 40 psi and travelling 50 feet in 11 sec (3.10 mph)
31. Three TX-12 nozzles per row at 60 psi and travelling 50 feet in 11 sec (3.10 mph)
32. Three TX-12 nozzles per row at 60 psi and travelling 50 feet in 15 sec (2.27 mph)

Tobacco Insect Pest Control with Selected Foliar Insecticide Applications

R. McPherson and W. Stephens

Introduction

Tobacco budworms and hornworms continue to cause annual economic losses to Georgia's flue-cured tobacco crop due to costs of control and reduction in yields. These pests cost Georgia tobacco producers millions of dollars every year, even though they are effectively controlled with certain pesticides. Tobacco splitworms, also known as potato tuberworms, can cause economic losses in Georgia's tobacco crop; however, damage is sporadic across the state. Insecticides continually need to be evaluated to document their effectiveness in controlling these and other tobacco insect pests. Also, new products and new application rates or use patterns of labeled insecticides need to be examined thoroughly before they can be registered for use and included in the pest control guidelines.

This study was conducted to evaluate numerous products for control of budworms, hornworms and splitworms, and assess the effectiveness of these worm controls on non-target tobacco aphid and thrips infestations. Those reviewing this report are cautioned not to use any unlabeled product on their tobacco, and to review the most current issue of the Georgia Pest Management Handbook for the most up-to-date pesticide recommendations.

Materials and Methods

Flue-cured tobacco, K-326, was transplanted on April 14, 2010 at the Georgia Coastal Plain Experiment Station Bowen Farm at the rate of 7,000 transplants per acre. Production practices were used according to University of Georgia Cooperative Extension guidelines and included a preplant tank mixture of Prowl and Spartan for weed control, Ridomil for disease control and Lorsban for soil insect control. Fertilizer (6-6-18) was applied in a split application at a total of 1,000 pounds per acre; 100 pounds of 16-0-0 was applied at lay-by.

Plots three rows wide (44-inch row spacing) by 30 feet long were arranged in a RCBD with three replications. Plots were separated on each side with an untreated border row and on each end with a 4-foot-wide fallow alley. Fourteen foliar spray treatments were applied on May 18 and June 3 using a CO2-powered backpack sprayer equipped with three TX-12 nozzles directed over a single row, delivering 22.8 gpa at 40 psi. The number of live budworms and hornworms per plot (54 plants) was recorded prior to treatment (Pre-t) plus three, seven and 14 days after the first application and seven and 12 days after the second application. In addition to the worm counts, all plants in each plot were sampled for splitworm damage in mid-June. Thrips populations were counted on May 17, 21 and 25, and aphid infestations were rated on June 15. From mid-June to mid-July, 10 plants on row two were harvested a total of three times. Green weights were obtained and then converted to cured weight (x 0.15). All the insect counts, damage and yield data were analyzed with an analysis of variance (P=0.05) and means were separated using the Waller-Duncan K-ratio t-test.

Results and Discussion

Most of the insecticide treatments had lower budworm populations than in the untreated plots on three, seven and 14 days after the first application and all of the treatments were effective seven and 12 days after the second application (Table 1). Hornworm densities were lower in all of the treated plots than in the untreated plots at three days after the first application (Table 2), but no other treatment differences were observed on any other sampling date due to very low densities of hornworms. Tobacco splitworm damage, thrips populations and aphid damage ratings were low in all the plots at this test site (Table 3). Yields ranged from around 2,500 to 2,900 pounds of cured leaf per acre, but there were no differences between the insecticide treatments (Table 3).

All of the products examined in this study demonstrated effectiveness for controlling tobacco budworms. Hornworm populations were too low at this test site to make valid comparisons between treatments.

Acknowledgments

The authors thank Ed Troxell, Steve LaHue and the student assistants for technical support and Bayer, Syngenta, DuPont, FMC and the Georgia Agricultural Commodity Commission for Tobacco for financial support.

Table 1. Effects of selected foliar insecticide treatments on controlling tobacco budworms on flue-cured tobacco, Tift County, Ga., 2010.						
	17 May	21 May	25 May	1 June	10 June	15 June
Treatment and formulation per acre	Budworms per plot (54 plants)					
Coragen 3.5 oz	1.0a	1.3ab	2.0ab	0.0b	1.3bc	1.0bc
Coragen 5.0 oz	1.3a	0.3b	0.5ab	0.0b	1.3bc	1.0bc
HGW 86 OD 6.75 oz	1.7a	1.0ab	0.0b	0.3b	1.7bc	1.3bc
HGW 86 OD13.5 oz	2.3a	0.7b	0.0b	0.b	1.3bc	1.3bc
Belt 4 SC 2.0 oz	1.7a	1.0ab	0.5ab	1.0ab	0.7c	1.7bc
Belt 4 SC 3.0 oz	1.7a	0.7b	1.0ab	0.0b	0.3c	0.0c
Voliam Flexi 2.5 oz	1.3a	0.7b	2.0ab	0.3b	0.0c	1.3bc
Voliam Flexi 4.0 oz	1.3a	0.0b	2.0ab	0.3b	1.0bc	1.7bc
Voliam Xpress 5.0 oz	1.7a	0.0b	0.0b	0.0b	1.7bc	0.3bc
Voliam Xpress 7.0 oz	2.0a	0.7b	1.0ab	1.0ab	1.0bc	0.7bc
Voliam Xpress 9.0 oz	1.3a	0.3b	1.0ab	0.7b	0.3c	0.0c
Tracer 4 SC 2.5 oz	2.0a	1.0ab	0.0b	0.7b	0.0c	0.0c
Brigade 2 EC 4.0oz	1.0a	0.7b	2.0ab	2.0a	1.0bc	2.3bc
Untreated	2.0a	2.7a	4.0a	1.3a	6.3a	10.3a
Brigadier 2EC 5.0 oz	0.7a	0.3b	0.0b	0.0b	3.3b	5.3b

K-326 flue-cured tobacco transplanted on April 14. Foliar sprays applied on May 18 and June 3 with a CO_2 powered backpack sprayer delivering 22.8 gpa at 40 psi. Column means followed by the same letter are not significantly different, Waller-Duncan K-ratio t Test, $P > 0.05$.

Table 2. Effects of selected foliar insecticide treatments on controlling tobacco hornworms on flue-cured tobacco, Tift County, Ga., 2010.						
	17 May	21 May	25 May	1 June	10 June	15 June
Treatment and formulation per acre	Hornworms per plot (54 plants)					
Coragen 3.5 oz	2.0a	0.0c	0.0a	0.3a	0.3a	0.0a
Coragen 5.0 oz	2.7a	0.0c	0.0a	0.0a	0.3a	0.0a
HGW 86 OD 6.75 oz	1.0a	0.3bc	1.5a	0.0a	0.7a	1.0a
HGW 86 OD13.5 oz	3.0a	0.3bc	0.0a	0.0a	0.0a	0.3a
Belt 4 SC 2.0 oz	2.7a	0.7bc	0.0a	0.3a	0.7a	0.0a
Belt 4 SC 3.0 oz	1.0a	0.3bc	0.0a	0.3a	0.0a	0.0a
Voliam Flexi 2.5 oz	1.7a	1.3ab	0.5a	0.0a	0.3a	0.0a
Voliam Flexi 4.0 oz	1.7a	0.3bc	1.0a	0.0a	0.3a	1.0a
Voliam Xpress 5.0 oz	2.7a	0.0c	0.0a	0.0a	0.3a	0.0a
Voliam Xpress 7.0 oz	2.0a	0.3bc	0.0a	0.7a	0.0a	0.0a
Voliam Xpress 9.0 oz	1.7a	0.0c	0.0a	0.7a	0.0a	0.0a
Tracer 4 SC 2.5 oz	0.7a	0.3bc	0.0a	0.0a	0.3a	0.0a
Brigade 2 EC 4.0oz	1.7a	0.0c	0.0a	0.0a	0.3a	0.7a
Untreated	1.3a	2.0a	2.0a	1.0a	0.3a	1.3a
Brigadier 2EC 5.0 oz	2.0a	0.0c	0.0a	0.0a	0.0a	1.0a

K-326 flue-cured tobacco transplanted on April 14. Foliar sprays applied on May 18 and June 3 with a CO_2 powered backpack sprayer delivering 22.8 gpa at 40 psi. Column means followed by the same letter are not significantly different, Waller-Duncan K-ratio t Test, $P > 0.05$.

Table 3. Effects of selected foliar insecticide treatments on tobacco thrips populations, aphid infestation ratings (0 = none to 5 = all plants infested) and cured yield on flue-cured tobacco, Tift County, Ga., 2010.

Treatment and formulation per acre	17 May	21 May*	25 May	Aphid (0-5)	Yield lbs/acre
	Thrips per four plants				
Coragen 3.5 oz	18.0a	25.0	3.5a	0.00a	2890a
Coragen 5.0 oz	13.0a	15.0	2.5a	0.33a	2614a
HGW 86 OD 6.75 oz	21.7a	57.0	2.0a	0.17a	2929a
HGW 86 OD13.5 oz	22.3a	11.0	2.0a	0.33a	2695a
Belt 4 SC 2.0 oz	23.0a	25.0	2.5a	0.25a	2389a
Belt 4 SC 3.0 oz	12.7a	14.0	9.0a	0.17a	2566a
Voliam Flexi 2.5 oz	9.3a	27.0	12.0a	0.00a	2918a
Voliam Flexi 4.0 oz	26.7a	15.0	0.0a	0.00a	2979a
Voliam Xpress 5.0 oz	16.7a	15.0	0.0a	0.03a	2632a
Voliam Xpress 7.0 oz	24.0a	26.0	2.0a	0.00a	2837a
Voliam Xpress 9.0 oz	10.7a	19.0	1.0a	0.00a	2634a
Tracer 4 SC 2.5 oz	35.0a	12.0	0.0a	0.17a	2581a
Brigade 2 EC 4.0oz	15.7a	28.0	3.5a	0.0a	2739a
Untreated	32.0a	29.0	7.0a	0.25a	2693a
Brigadier 2EC 5.0 oz	9.8a	12.0	0.0a	0.0a	2594a

K-326 flue-cured tobacco transplanted on April 14. Foliar sprays applied on May 18 and June 3 with a CO_2 powered backpack sprayer delivering 22.8 gpa at 40 psi. Column means followed by the same letter are not significantly different, Waller-Duncan K-ratio t Test, $P > 0.05$. Plots examined for tobacco splitworm damage on June 15 with no damage in any of the treated plots and less than two tunnels per plot in the untreated control.

*Only rep 1 counted for thrips on this date.

Regional Chemical Sucker Control Test

S. S. LaHue, C. E. Troxell and J. M. Moore

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 Georgia crop, MH residues above 100 ppm must be reduced.

The tobacco season has lengthened because recent cultivars benefit from irrigation and higher nitrogen use. Moreover, the incidence of *Tomato spotted wilt virus* (TSWV) has increased in Georgia, causing additional sucker pressure and difficulty in control due to variability in stands and flowering. The use of dinitroanalines 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 study is to report the effectiveness of some new combinations and formulations 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 two 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, harvesting and curing procedures were uniformly applied and followed current University of Georgia recommendations. Fertilization consisted of 6 lb/A of 9-45-15 in the transplant water, 500 lbs/acre of 6-6-18 at first cultivation, 600 lbs/acre 6-6-18 at second cultivation and an additional 163 lbs/acre of 15.5-0-0 at lay-by for a total of 91.5 lbs/acre of nitrogen. Plots consisted of two rows of 30 plants each. Ten uniform plants were sampled from each plot for sucker data. The test involved four replications randomized with 12 sucker control treatments as follows:

1. TNS - Topped Not Suckered.

2. Off-Shoot-T/Off-Shoot-T/(RMH-30 + Prime +) - Two treatments of the contact Off-Shoot-T (Chemtura Corporation) at 4% solution then 5% solution three to five days apart followed in five to seven days by a tank mix of RMH-30 Xtra (2.25lbai/gal) (Chemtura Corporation) potassium malic hydrazide at the labeled rate of 1.0 gal/A and /Prime + (Syngenta Corporation) at 0.5 gal/A.

3. Off-Shoot-T/Off-Shoot-T/Flupro - Two treatments of Off-Shoot-T at 4% then 5% three to five days apart followed in five to seven days with Flupro at 0.5 gal/A.

4. Off-Shoot-T/Off-Shoot-T/Prime + - Two treatments of Off-Shoot-T at 4% then 5% three to five days apart followed in five to seven days with Prime + at 0.5gal/A.

5. Off-Shoot-T/Off-Shoot-T/Drexalin Plus- Two treatments of Off-Shoot-T at 4% then 5% three to five days apart followed in five to seven days with Drexalin Plus (Drexel Chemical Corporation) at 0.5gal/A.

6. Off-Shoot-T/Off-Shoot-T/Prime + (2011 Formulation) - Two treatments of Off-Shoot-T at 4% then 5% three to five days apart followed in five to seven days with Prime + (2011 Formulation) at 0.5gal/A.

7. Off-Shoot-T/Off-Shoot-T/(RMH-30 + Prime +) - Two treatments of the contact Off-Shoot-T at 4% then 5% three to five days apart followed in five to seven days by a tank mix of RMH-30 Xtra at the labeled rate of 1.0 gal/A and /Prime + (2011 Formulation) at 0.5 gal/A.

8. Off-Shoot-T/Off-Shoot-T/(RMH-30 + Prime +)/(RMH-30 + Prime +) - Two treatments of the contact Off-Shoot-T at 4% then 5% three to five days apart fol-

lowed in five to seven days by a tank mix of RMH-30 Xtra at 0.17 gal/A and Prime + at 0.5 gal/A. A fourth treatment consisting of a tank mix of RMH-30 Xtra at 0.50 gal/A and Prime + at 0.25 gal/A was applied five to seven days later. All MH treatments were applied after the first harvest.

9. Off-Shoot-T/Off-Shoot-T/(RMH-30 + Prime +)/(RMH-30 + Prime +) - Two treatments of the contact Off-Shoot-T at 4% then 5% three to five days apart followed in five to seven days by a tank mix of RMH-30 Xtra at 0.17 gal/A and Prime + at 0.5 gal/A. A fourth treatment consisting of a tank mix of RMH-30 Xtra at 0.33 gal/A and Prime + at 0.25 gal/A was applied five to seven days later with all MH treatments being applied after the first harvest.

10. Off-Shoot-T/Off-Shoot-T/Prime +/(RMH-30 + Prime +) - Two treatments of the contact Off-Shoot-T at 4% then 5% three to five days apart followed in five to seven days with Prime + at 0.5gal/A. A fourth treatment consisting of a tank mix of RMH-30 Xtra at 0.33 gal/A and Prime + at 0.25 gal/A was applied five to seven days later. All Prime+ treatments were applied after the first harvest.

11. Off-Shoot-T/Off-Shoot-T/Prime +/(RMH-30 + Prime +) - Two treatments of the contact Off-Shoot-T at 4% then 5% three to five days apart followed in five to seven days with Prime + at 0.5gal/A. A fourth treatment consisting of a tank mix of RMH-30 Xtra at 0.67 gal/A and Prime + at 0.25 gal/A was applied five to seven days later. All Prime+ treatments were applied after the first harvest.

12. Off-Shoot-T/Off-Shoot-T/Prime +/RMH-30 - Two treatments of the contact Off-Shoot-T at 4% then 5% three to five days apart followed in five to seven days with Prime + at 0.5gal/A. A fourth treatment consisting of RMH-30 Xtra at 0.67 gal/A was applied five to seven days later. All Prime+ treatments were applied after the first harvest.

Results and Discussion

Due to historically high TSWV incidence at the Bowen Farm location, C.V. NC 297 was treated in the greenhouse with labeled rates of Actigard and Admire for TSWV suppression and transplanted on April 12 in favorable conditions. TSWV counts indicated an infection rate below 5% in tests with treated plants transplanted during the week of April 12. The first contact was applied on June 16, the second on June 21 and the third set of treatments on June 29. The fourth treatment for entries 8, 9, 10, 11 and 12 was applied on July 6. The final harvest was on August 10, with the test concluding after the suckers were pulled, counted and weighed off 10 plants from each plot on August 11.

The 2010 growing season was notable for its favorable transplanting conditions followed by consistently hot summer months. Unfortunately, the original test location was abandoned due to a significant rain event within four hours of the MH application. Subsequently, the test was successfully relocated to another field, which was uniform and slightly less mature. Generally, the crop was free of disease and had uniform growth, which resulted in a successful test.

For 2010, test yields were good with TNS treatment 1 having the lowest yield at 2,097 lb/A. Treatment 4 yielded the highest at 3,675 lb/A. Value, in dollars per acre, followed the same general trend with treatment 1 bringing in $3,067/A as compared to $5,441/A for treatment 4. The price and grade indices were good for all treatments and showed no significant difference between treatments.

Sucker number per plant was low with a mean value of one or less for all chemical treatments. The TNS treatment (1) only averaged four large suckers per plant; however, the individual sucker weight was higher for the treatments that did not incorporate MH. Percent control was excellent for all chemical treatments (>95%) with the dinitroanaline treatments ranging from 1% to 4% less than the treatments that included MH. Among the four dinitroanaline products tested, the Flupro was less efficacious and resulted in a slightly lower yield than the others.

Acknowledgments

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Table 1. 2010 Regional Tobacco Growth Regulator Test, Effects of Advanced Growth Regulating Material on Sucker Growth, Cured Leaf Yields and Value of Flue-Cured Tobacco.

Treatments	Sucker Growth					Cured Leaf			
	% Control	Green Wt./ Plant (g)	No./ Plant	Green Wt./ Sucker (g)	Plant Injury[1]	Yield (lbs/A)	Value ($/A)	Price Index[2] ($/cwt)	Grade Index[3]
1. Topped-Not-Suckered	0.0	736.68	4.00	184.17	0	2097	3067	146	74
2. OST 85/OST 85/(RMH-30 & PRIME+) 2.0 GPA/2.5GPA/(1.0 GPA & 0.5 GPA)	99.5	3.65	0.15	0.55	0	3282	5111	156	76
3. OST 85/OST 85/FLUPRO 2.0 GPA/2.5 GPA/0.5 GPA	95.8	30.80	1.00	30.80	0	3040	4834	159	78
4. OST 85/OST 85/PRIME+ 2.0 GPA/2.5 GPA/0.5 GPA	98.4	12.05	0.35	4.22	0	3675	5441	148	73
5 OST 85/OST 85/DREXALIN PLUS 2.0 GPA/2.5 GPA/0.5 GPA	98.2	13.25	0.30	3.98	0	3140	4745	151	75
6 OST 85/OST 85/PRIME+ (2011 FORMULATION) 2.0 GPA/2.5 GPA/0.5 GPA	98.0	14.40	0.85	12.24	0	3303	4968	151	75
7 OST 85/OST 85/(RMH 30 & PRIME+) 2.0 GPA/2.5 GPA/(1.0 GPA & 0.5 GPA) (P+ 2011 FORMULATION)	99.5	3.80	0.25	0.95	0	3427	5015	148	73
8 OST 85/OST 85- 2.0 GPA/2.5 GPA (RMH 30 & PRIME+) (0.17 GPA & 0.5 GPA) (RMH 30 & PRIME+) (0.50 GPA & 0.25 GPA) MH APPLIED AFTER 1ST HARVEST	99.5	3.40	0.20	0.68	0	3525	5204	148	73
9 OST 85/OST 85- 2.0 GPA/2.5 GPA (RMH 30 & PRIME+) (0.17 GPA & 0.5 GPA) (RMH 30 & PRIME+) (0.33 GPA & 0.25 GPA) MH APPLIED AFTER 1ST HARVEST	99.9	0.55	0.03	0.01	0	3267	4707	145	71

	Treatments	Sucker Growth					Cured Leaf			
		% Control	Green Wt./ Plant (g)	No./ Plant	Green Wt./ Sucker (g)	Plant Injury[1]	Yield (lbs/A)	Value ($/A)	Price Index[2] ($/cwt)	Grade Index[3]
10	OST 85/OST 85/PRIME+/ (RMH-30 & PRIME+) 2.0 GPA/2.5 GPA/0.5 GPA/ (0.33 GPA & 0.25 GPA) PRIME+ APPLIED AFTER 1ST HARVEST	98.6	9.95	0.20	1.99	0	3365	5156	154	76
11	OST 85/OST 85/PRIME+/(RMH 30 & PRIME+) 2.0 GPA/2.5 GPA/0.5 GPA/(0.67 GPA &0.25 GPA) PRIME+ APPLIED AFTER 1ST HARVEST	99.4	4.50	0.18	0.79	0	3006	4289	144	71
12	OST 85/OST 85/PRIME+/RMH 30 2.0 GPA/2.5 GPA/0.5 GPA/0.67 GPA PRIME+ APPLIED AFTER 1ST HARVEST	99.4	4.75	0.25	1.19	0	3085	4384	143	71
	LSD-0.05						388.3	846.9	24.4	12.0

[1]Injury rating on a scale of 0-10 with 0 = no damage and 10 = plant killed.
[2]Price Index based on two-year average (2008-2009) prices for U.S. government grades.
[3]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 MANA Nematicide for Control of Root Knot Nematode on Tobacco 2010 - Bowen Farm - Tifton, Ga.

A.S. Csinos, L.L. Hickman and Steve S. LaHue

Introduction

Root knot nematodes are becoming an increasing problem on commercial tobacco production and can cause significant yield and stand reduction with heavy populations. The primary nematodes that attack tobacco are Meloidogyne incognita, Meloidogyne arenaria Race 2 and Meloidogyne javanica. There currently are no resistant cultivars for M. arenaria Race 2 and M. javanica, which complicates the traditional control method of crop rotation. Loss of the fumigant methyl bromide, a reduced supply of petroleum-based fumigants and general lack of effective nematicides have resulted in a high priority search for finding an effective nematode control. This study evaluates a product from MANA and several industry standards and their effectiveness in reducing nematode damage.

Methods and Materials

The study was located at the Bowen Farm, CPES, Tifton, Ga., in a field with a history of crops such as corn, peanuts, tobacco, soybeans and assorted vegetables. The area was prepared using current University of Georgia Cooperative Extension recommendations. The plot design was a randomized complete block design (RCBD) consisting of single row plots replicated six times. Each plot was 37 feet long with 5-foot alleys between repetitions.

On January 28, 2010, variety K-394 was seeded into 242 cell flats. On April 19, the pre-plant treatments of Admire Pro and Actigard 50WG were sprayed on in 200 ml of water per flat. Admire Pro and Actigard 50WG were tank mixed, then washed in with 0.25 inches of water. Actigard 50WG greenhouse treatments were applied at 2g ai/7,000 plants. Admire Pro greenhouse treatments were applied at 1oz/1,000 plants. The plants were transplanted after nematicide treatments were applied on April 22 in plots on 44-inch rows with 22-inch plant spacing. An average of 20 plants per test plot were planted.

Crop maintenance was achieved by using UGA Cooperative Extension recommendations for the control of weeds, suckers and insects. Chemicals used for maintenance of the crop were Orthene 97 at 0.5lbs/A for insect control, Prowl 3.3EC at 2pts/A for weed control and Royal MH-30 Extra at 1.5 gal/A for sucker control.

Field Treatments

On April 1, Telone II (Treatment 2) was injected into soil approximately 12 to 14 inches using a subsoil bedder with two shanks spaced 12 inches apart. Beds were immediately tilled and sealed using concrete drag. All plots received 0.4 inch of irrigation after fumigant applications to provide a water seal. Nemacur (Treatment 3) was also applied on April 1 by broadcast method and then rototilled to incorporate into the soil.

Replant field treatments 5-8 (MANA product MCW-2) were applied on April 22 using a CO_2 sprayer with one TX-12 tip/row with a 50-mesh ball check screen. Tips were angled at plants and sprayed in a 12-inch band at the rate of 40 PSI for 10.0 gal H_2O per acre. All treatments were mixed in 3 liters of water unless otherwise noted. Treatment 6 (Temik) was applied same-day, but was applied with a handheld applicator that delivered 24.4 grams of material per plot in a linear application. Field treatments were roto-tilled into the soil to a depth of 6 inches and tobacco was transplanted.

Field Data

Tobacco plots were scouted every two weeks beginning May 14 to record the number of plants still living, determine other disease incidence and identify any phytotoxicity problems that may be associated with the various treatment chemicals being applied.

Three harvests were conducted on July 8, 22 and 29. Harvests were done by collecting 1/3 of the plant leaves at one time and weighing each plot in pounds. Stand counts were conducted every 14 days from May 6 through June 20. One height measurement was conducted on May 26. Plants were measured in centimeters from the base of the plant to the tip of the longest leaf. Two vigor ratings were conducted on a 1-10 scale with 10 equaling vigorous healthy plants and 1 equaling poor vigor plants. Vigor ratings were conducted on May 12 and 26.

Soil samples to determine nematode population and genus were taken on March 30 (pre-plant) and again at final harvest on August 4. Eight to 10 cores of soil, 2.5-cm-diam x 25 cm-deep (approximate) were collected from each plot. Nematodes were extracted from a 200 cm2 sifted sub-sample using the centrifugal flotation method. The extracted nematodes were then counted.

On June 17 a mid-season root gall evaluation was conducted on five plants per plot using a 0-10 Zeck's scale (Zeck, 1971), whereby 0 = no galls, 1 = very few small galls, 2 = numerous small galls, 3 = numerous small galls of which some have grown together, 4 = numerous small galls and some big galls, 5 = 25% of roots severely galled, 6 = 50% of roots severely galled, 7 = 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 second root gall rating was conducted August 10 (at final harvest) on 10 plants per plot using the same scale.

Summary

The year 2010 was a relatively good tobacco growing year with a very low incidence of TSWV. Plant heights were greatest in the non-treated and Telone treated plots. The highest rate of MCW-2 caused a reduction on growth of tobacco. Vigor ratings were relatively high with again the highest rate of MCW-2 having the lowest vigor rate. Dry weight (yield) was relatively consistent across the field with only the Telone treatment having a higher yield than the non-treated control. Only the 3.38 liter/A rate had yield levels that were not different from the Telone treatment. Root gall ratings were highest in the non-treated control both at mid-season and at final harvest. Most treatments reduced root knots on plants. Nematicide larval numbers were low to moderate at the beginning of the trial and tended to increase in all treatment except the Telone treated plots by harvest.

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Table 1. Plant height, Plant Vigor and Dry Weight Yield of Tobacco

Treatment	Rate	Plant Height[2] (cm)	Vigor Ratings (1-10 Scale)[3]			Dry weight Yield [4] (lb./Acre)
			12 May	26 May	Average	
1. Non-Treated Control	No treatment	26.6a	8.3	8.0	8.1ab	1404.9b
2. Telone II	6 gal/A	26.2a	8.3	8.8	8.5a	1862.8a
3. Nemacur 3 SC	2 gal/A	20.4bc	8.1	7.8	8.0ab	1405.6b
4. Temik	20 lbs/A	23.6ab	7.5	8.3	7.9ab	1363.5b
5. MCW-2	1.69 l/A	21.5abc	7.6	7.1	7.4bc	1385.9b
6. MCW-2	2.54 l/A	20.5abc	7.6	7.5	7.5abc	1323.7b
7. MCW-2	3.38 l/A	22.2ab	8.5	7.8	8.1ab	1498.6ab
8. MCW-2	6.76 l/A	15.9c	7.0	6.6	6.8c	1365.4b

[1] Data are means of six replications. Means in the same column followed by the same letter are not significantly different (P=0.05) according to Fisher's LSD test.

[2] Height measurement was done in centimeters from the soil level to the tip of the longest leaf. A height measurement was conducted on May 26.

[3] Vigor ratings were done on a 1-10 scale with 10=live and healthy plants and 1= dead plants on May 12 and 26.

[4] Dry weight yield was calculated by multiplying green weight totals by 0.15. Pounds per acre was calculated by multiplying dry weight conversion per plot by 6,491 divided by the base stand count. Tobacco was planted in 44-inch rows, with 22 inches between plants, which equals 6,491 plants/A.

Table 2. Nematode Root Gall Ratings and Number of Plant Parasitic Nematodes

Treatment	Rate	Root Gall Ratings [2] (Zeck Scale 0-10)		Nematodes [3] (# Larva/ 200 cc Soil)	
		Mid season	At final harvest	Pre-plant	At final harvest
1. Non-Treated Control	No treatment	3.8a	3.2a	11.6a	86.6a
2. Telone II	6 gal/A	0.1c	1.2b	18.3a	16.6d
3. Nemacur 3 SC	2 gal/A	1.6b	3.1a	10.0a	56.6b
4. Temik	20 lbs/A	0.5c	0.9b	15.0a	36.6bcd
5. MCW-2	1.69 l/A	0.9bc	1.0b	18.3a	48.3bc
6. MCW-2	2.54 l/A	0.8bc	1.2b	16.6a	51.6bc
7. MCW-2	3.38 l/A	0.03c	2.1ab	16.6a	50.0bc
8. MCW-2	6.76 l/A	0.2c	0.8b	23.3a	33.3cd

[1] Data are means of six replications. Means in the same column followed by the same letter are not significantly different (P=0.05) according to Fisher's LSD test.
[2] Gall Ratings were done using the Zeck's 0-10 scale (Zeck, 1971) where 10=dead plants and roots and 0= no galls and a healthy plant. An average was taken of the gall ratings on June 17 (mid-season) rating three plants per plot and again on August 10 (at final harvest) rating 10 plants per plot.
[3] Soil samples were collected from plots on March 30 and August 4. Root Knot Nematode (*Meloidogyne sp.*)

Nematicides for Control of Peanut Root Knot on Tobacco

2010 University of Georgia, CPES - Black Shank Farm - Tifton, Ga.

A. S. Csinos, L.L. Hickman, S. S. LaHue and U. Hargett

Introduction

Nematicides for tobacco production are very limited. With the shortage and increase in cost of Telone II, other nematicides for tobacco must be evaluated. This trial evaluates potential nematicides in an area infested with Meloidogyne arenaria, peanut root-knot nematode.

Methods 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 Meloidogyne arenaria nematodes and in a randomized complete block design (RCBD) with six replications. Each plot was 30 feet long with 48-inch-wide beds with 10-foot alleys.

Crop maintenance was achieved 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 0.5lbs/A for insect control, Prowl 3.3EC at 2pts/A for weed control and Royal MH-30 Extra at 1.5 gal/A for sucker control.

Tobacco variety K394 was transplanted on April 16 on 48-inch-wide rows with an 18-inch plant spacing. Total rainfall recorded at the Bowen Farm during this period (March through August 19, 2010) was 20.55 inches.

Greenhouse and Field Treatments

Greenhouse and field treatments were applied according to the treatment list in Table 1.

On April 1, Treatment 6, Vapam (metham sodium), was injected into soil approximately 10 to 12 inches using a fumigation rig with four shanks spaced 12 inches apart and soil sealed using a ring roller. Treatment 2, Telone II, was injected into soil approximately 12 to 14 inches using a subsoil bedder with two shanks spaced 12 inches apart. Beds were immediately tilled and sealed using a concrete drag. All plots received 0.4 inch of irrigation after fumigant applications to provide a water seal.

A greenhouse application of Melocon (Treatment 8 - 1lb/7,000 plants, Certis) was made on April 9. Tobacco transplants were treated in the greenhouse on April 15 with Admire Pro at 1fl.oz/1,000 plants and Actigard 50WG @ 4 grams/7,000 plants. Both materials were tank mixed. Plants were pre-wet with materials being washed in after spraying. A second application of Melocon (4 lbs/A in transplant water) was applied by hand by pouring 50 ml of a stock solution into a hole next to the base of each plant in plot at the time of planting.

Devgen (1 qt/A), Treatment 2, was applied April 15 as a pre-plant incorporated treatment and again at four weeks post-plant on May 17 using a CO2 sprayer with one TX-12 tip/row with a 50-mesh ball check screen. Tips were angled at plants and sprayed in a 16-inch band at the rate of 30 PSI. Material D-EXP, Treatment 6, was applied on April 15 as a pre-plant incorporated treatment and again at three weeks post-plant on May 10 using a CO2 sprayer with one TX-12 tip/row with a 50-mesh ball check screen. Tips were angled at plants and sprayed in a 16-inch band at the rate of 30 PSI.

Field Trial Data

A stand count was conducted on April 24 to establish a base count. Stand counts were conducted thereafter every two weeks beginning May 1 and ending July 9 to monitor any loss of plants. Vigor ratings were conducted on April 29 (two weeks post-plant), May 12 (four weeks post-plant) and May 26 (six 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 June 15. Plants were measured individually from the soil level to the tip of the longest leaf and recorded in centimeters. Three harvests were conducted on July 8, 22 and 29. Harvests were done by collecting 1/3 of the plant leaves at one time and weighing each plot in pounds. A mid-season root gall rating was conducted on May 13 on five plants per plot using the Zeck'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 have grown together, 4 = numerous small and some large galls, 5 = 25% of roots severely galled, 6 = 50% of roots severely galled, 7 = 75% of roots severely galled, 8 = no healthy roots but plant is still green, 9 = roots rotting and plants dying, 10 = plants and roots dead. A second root gall rating was conducted following the final harvest on August 9 rating 10 plants per plot utilizing the same scale.

Nematode soil samples were pulled from plots on April 1 (prior to planting and soil treatment) and again on August 4 (at final harvest). Eight to 10 cores of soil, 2.5-cm-diam x 25-cm-deep, were collected from each plot randomly. Nematodes were extracted from 200-cm3 soil sub-sample using a centrifugal sugar flotation technique.

Summary

Vigor ratings for treatments were high and only Melocon treatments were reduced in growth compared to the non-treated plants. Height measurements were not different from the non-treated or the Telone standard for all treatments. Root gall ratings were low early in the season, but by the end of the trial some plots were heavily galled. Many of the treatments had lower gall ratings than the non-treated (Table 2), but none were as low as the Telone standard.

Nematode numbers at pre-plant ranged from a high of 72 to a low of 25 larva/200 cc soil. Larval numbers at harvest ranged from 132 in the non-treated to 15/200 cc soil for the Telone II standard. Yields ranged from a low of 1,709 lb/A for the non-treated to a high of 2,508 lb/A for the Telone II-treated plots. Only Telone II-treated plots were significantly increased yield over the non-treated at P=0.05.

Table 1. Treatment List

Treatment		Rate	Application Schedule
1.	Telone II	6 gal/A	2-3 weeks pre-plant, 2 chisels/row
2.	Devgen	1qt/A	PPI 2 weeks post-plant 4 weeks post-plant, apply in a 16-inch band
3.	Temik	20 lbs/A	Pre-plant incorporated, apply in a 16-inch band
4.	MANA	3.31 lbs/A	Pre-plant incorporated, apply in a 16-inch band
5.	VAPAM	37.5 gal/A	2-3 weeks pre-plant, chisel + rototill + seal soil surface with irrigation water
6.	D-EXP	0.5 lba.i./A	Pre-plant incorporated 3 weeks post-plant
7.	Melocon (Certis)	1 lb/7,000 plants 4lbs/A 4lbs/A	Treat in float tray 2 weeks pre-plant (1 week before GH applications of Actigard /Admire) Transplant water at planting Layby spray
8.	Non-treated	N/A	N/A

Table 1. Plant Vigor, Plant Height and Dry Weight Yield of Tobacco Variety K394

Treatment[1]	Rate/Application Schedule	Vigor Ratings (1-10 scale) [2]				Height Measurements[3]	Dry Weight Yield[4]
		April 29	May 12	May 26	Average		
1. Non-treated	N/A	9.5 ab	8.0 ab	9.1 a	8.8 ab	32.7 a	1709.6 b
2. Telone II	6 gal/A	8.8 b	7.5 ab	9.0 a	8.4 ab	32.6 a	2508.0 a
3. Devgen	1 qt/A	9.6 a	8.5 a	9.0 a	9.0 a	32.7 a	1785.4 b
4. Temik	20 lb/A	8.8 b	7.1 bc	8.3 a	8.1 b	32.4 a	1879.2 b
5. MANA	3.31 lbs/A	9.5 ab	7.5 ab	8.5 a	8.5 ab	36.5 a	2029.5 b
6. VAPAM	37.5 gal/A	9.5 ab	7.8 ab	9.0 a	8.7 ab	32.7 a	2093.6 ab
7. D-EXP	0.5 lba.i./A	9.5 ab	8.0 ab	9.1 a	8.8 ab	31.7 a	1880.7 b
8. Melocon (Certis)	1 lb/7000 plants 4 lb/A 4 lb/A	8.0 c	6.3 c	7.3 b	7.2 c	32.8 a	1786.0 b

[1] Data are means of six replications. Means in the same column followed by the same letter are not different (P=0.05) according to Fishers LSD. No letters indicate non-significant difference.

[2] Vigor was done on a scale of 1-10 with 10 = live and healthy plants and 1 = dead plants, and an average was taken of vigor. Ratings were conducted on April 29 and May 12 and 26.

[3] Height measurements were conducted by measuring each plant from the base of the plant to the tip of the longest leaf. Measurements were taken in centimeters on June 15.

[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 7,260 divided by the base stand count.

Table 2. Nematode Root Gall Ratings and Number Plant Parasitic nematodes

Treatment[1]	**Rate/Application Schedule**	**Root Gall Ratings**[2] **(Zecks Scale 0-10)**		**Number of *Melodogyne sp.* per 200cc soil**[2]	
		Mid season	**At final harvest**	**Pre-plant**	**At final harvest**
1. Non-treated	N/A	0.6 a	7.0 a	58.3 abc	131.6 a
2. Telone II	6 gal/A	0.2 b	0.4 d	71.6 ab	15.0 b
3. Devgen	1 qt/A	0.4 ab	4.1 bc	25.0 c	88.3 ab
4. Temik	20 lb/A	0.3 ab	3.5 c	40.0 bc	120.0 a
5. MANA	3.31 lbs/A	0.2 ab	2.9 c	91.6 a	43.3 ab
6. VAPAM	37.5 gal/A	0.2 b	4.9 abc	68.3 ab	40.0 ab
7. D-EXP	0.5 lba.i./A	0.2 ab	5.8 ab	43.3 bc	96.6 ab
8. Melocon (Certis)	1 lb/7000 plants 4 lb/A 4 lb/A	0.5 ab	6.6 a	25.0 c	101.6 ab

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 Fishers LSD.
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 May 13 (mid-season), rating five plants per plot, and again on August 9 (at final harvest) rating 10 plants per plot.
3. At-planting soil samples were collected on April 1. Soil samples were collected at final harvest on August 4.

Modeling Field Applications of Actigard and Admire Pro for Management of *Tomato spotted wilt virus* in Tobacco

2010 - Bowen Farm, Tifton, Ga.

A. S. Csinos, L. L. Hickman, S. LaHue, S. W. Mullis and R. Srinivasan

Introduction

Tomato spotted wilt virus continues to be of great concern to Georgia tobacco producers. This study was initiated to determine the effects of Actigard and Admire Pro applications in the field for TSWV management. In addition, different timing scenarios were evaluated to determine if the time of application was relative to the initiation of the epidemic and whether there was an influence on disease control and yield.

Methods and Materials

The study was located at the Bowen Farm CPES, Tifton, Ga., in a field with a history of crops such as corn, soybeans, peanuts, tobacco and assorted vegetables. The area was prepared using all current University of Georgia Cooperative Extension recommendations.

The plot design was a randomized complete block design (RCBD) consisting of single row plots replicated five times. Each plot was 37 feet long with 10-foot alleys between repetitions. On January 20, 2010, variety NC-71 was seeded into 242 cell flats. A tray drench treatment of a product from Earth Tech (Trt.14) was applied on March 15 at 6 grams per liter per 242-cell tray. An additional treatment of Earth Tech was made in the field on May 28. On March 26, the pre-plant treatments of Admire Pro and Actigard 50WG were sprayed on in 200 ml of water per flat. Treatments that called for both Admire Pro and Actigard 50WG were tank mixed, then washed in with 0.25 inch of water. Actigard 50WG greenhouse treatments were applied at 2 g ai/7,000 plants. Admire Pro greenhouse treatments were applied at 1 oz/1,000 plants. The tobacco plants were transplanted March 31 in plots on 44-inch rows with a 22-inch plant spacing. An average of 20 plants per test plot were planted.

Crop maintenance was achieved using UGACooperative Extension recommendations for the control of weeds, suckers and insects. Chemicals used for maintenance of the crop were Orthene 97 at 0.5 lbs/A, Belt and Tracer for insect control, Prowl 3.3 EC at 2 pts/A for weed control and Royal MH-30 Extra at 1.5 gal/A and FluPro for sucker control.

Field Treatments

Field treatments were applied using a CO2 sprayer with one TX-12 tip/row with a 50-mesh ball check screen. Tips were angled at plants and sprayed in a 12-inch band at the rate of 40 PSI for 10.0 gal H2O per acre. All treatments were mixed in 3 liters of water unless otherwise noted.

The first symptom of TSWV was noted on April 28. All field applications of Actigard 50WG were made at ½ oz/A (1.1g Actigard 50WG in 3L/H2O). A field treatment schedule and dates that treatments were applied are listed in the following table (Table 1).

Table 1. Application Schedule and Dates of Actigard and Admire Pro Field Treatments

Treatment[1] (Greenhouse)	Field Treatment[2]	Actual Application Date
1. Non treated Control	No field treatment	No field treatment
2. Admire Pro + Actigard	No field treatment	No field treatment
3. Admire Pro + Actigard	+ 14 days post-transplant (DPT)	14 April
4. Admire Pro + Actigard	+ 21 DPT	21 April
5. Admire Pro + Actigard	+ 28 DPT	28 April
6. Admire Pro + Actigard	+ 35 DPT	05 May
7. Admire Pro + Actigard	+ 42 DPT	12 May
8. Admire Pro + Actigard	+ 49 DPT	20 May
9. Admire Pro + Actigard	+ at 1st symptom	28 April
10. Admire Pro + Actigard	+ at 1st symptom + 7 days	28 April and 05 May
11. Admire Pro + Actigard	+ at 1st symptom + 7 days+ 7 days	28 April, 05 May, and 12 May
12. Admire Pro + Actigard	+ at 1st symptom + 7 days + 7 days + 7 days	28 April, 05 May, 12 May, and 20 May
13. Admire Pro + Actigard	14, 21, 28, 35, 42, and 49 days post plant	14 April, 21 April, 28 April, 05 May, 12 May, and 20 May
14. Earth Tech	Tray drench in greenhouse and field treatment	15 March and 28 May

Yellow sticky cards were used for thrips sampling (@ 1 per plot). Sampling was undertaken from April 12 to June 21. Sticky cards were sampled once every two weeks. The cards were retrieved from the field seven days after placement and taken to the vector biology laboratory at Tifton for thrips identification. Voucher specimens of thrips were stored in 70% ethanol.

The tobacco plots were scouted weekly to determine TSWV disease incidence and percentage of infection in non-treated as compared to treated plots. Stand counts were conducted beginning April 14 with a final stand count being done on June 16. Two height measurements were conducted on April 28 and May 26. Plants were measured in centimeters from the base of the plant to the tip of the longest leaf. Two vigor ratings were conducted on a 1-10 scale with 10 equaling vigorous healthy plants and 1 equaling poor vigor plants. Vigor ratings were conducted on April 28 and May 12. Three harvests were conducted on June 30 and July 15 and 29. Harvests were done by collecting 1/3 of the plant leaves at one time and weighing each plot separately in pounds.

Following the final harvest, root samples were collected from 10 plants per plot and an ELISA test was performed to determine TSWV incidence. The screen for TSWV was accomplished by the use of double antibody sandwich-enzyme linked immunosorbent assay (DAS-ELISA) alkaline phosphase antisera kits (Agdia, Inc. Elkhart, IN). Samples of 1.0 gram were subjected to DAS-ELISA, and any sample eliciting an absorbance reading (A405) of three times the average plus two standard deviations of a healthy negative control were considered positive results.

Summary

The 2010 tobacco growing year stared out cool, but turned out to be one of the hottest summers on record; however, adequate rainfall fell to support a record crop. Thrips counts on sticky cards in untreated plots were not different from thrips counts on sticky cards placed in treated plots. Also, no treatment differences were observed (Table 3). TSWV level was moderate in the trial with the non-treated control plots having 26% infected plants. All treatments significantly reduced the percent of TSWV over the non-treated control (Table 4). The lowest disease level was 1.1% in the treatment that received six applications of Actigard in the first field. Low disease levels of 3.4% at 27 days post-plant, and 3.5% at first symptom +7 days can be compared to Admire Pro and Actigard in the float tray (10.5%). Plant height was reduced by six applications of Actigard; however, vigor ratings were consistent across the test, with only the Admire Pro + Actigard float tray treated plants being less vigorous than the non-treated control. Yield was high in the first trial with a range of 3,861 to a low of 3,398 lb/A. Very few statistical differences were noted among treatments. Numerically, treatments receiving Actigard in the field at 28 days, 42 days and at first symptom + 1 week had yields above 3,800 lbs/A.

Acknowledgments

The authors would like to thank the Georgia Agricultural Commodity Commission for Tobacco and Philip Morris International for their support of this work. Thanks are also extended to Holly Hickey, Seth Dale, Chance Anderson, Kitty Loper and Tyler Reeves (UGA Young Scholars Program) for their assistance.

Table 2. Plant Height in Centimeters, Plant Vigor and Dry Weight Yield of Tobacco Leaf Harvests.

Treatment[1] (Greenhouse)	Field Treatment[2]	Plant Height[3]	Vigor Ratings[4]	Dry Weight Yield[5]
1. Non treated Control	No field treatment	39.9a	7.9ab	3567.5abc
2. Admire Pro + Actigard	No field treatment	35.3ab	6.9c	3604.5abc
3. Admire Pro + Actigard	+ 14 days post-transplant (DPT)	38.9ab	7.1bc	3431.6bc
4. Admire Pro + Actigard	+ 21 DPT	36.3ab	7.7abc	3709.8abc
5. Admire Pro + Actigard	+ 28 DPT	37.0ab	7.5abc	3837.9ab
6. Admire Pro + Actigard	+ 35 DPT	35.8ab	7.4abc	3742.7a
7. Admire Pro + Actigard	+ 42 DPT	37.0ab	7.5abc	3861.9a
8. Admire Pro + Actigard	+ 49 DPT	35.1ab	7.5abc	3398.7c
9. Admire Pro + Actigard	+ at 1st symptom	33.6ab	7.3abc	3490.6abc
10. Admire Pro + Actigard	+ at 1st symptom + 1 week	33.6ab	7.4abc	3779.8abc
11. Admire Pro + Actigard	+ at 1st symptom + 1 week + 1 week	34.7ab	7.3abc	3774.5abc
12. Admire Pro + Actigard	+ at 1st symptom + 2 weeks + 2 weeks	40.0a	8.1a	3815.1ab
13. Admire Pro + Actigard	14, 21, 28, 35, 42, and 49 days post planting	32.2b	7.1bc	3761.8abc
14. Earth Tech	Tray drench in greenhouse and	38.0ab	7.9ab	3694.1abc

[1] Data are means of five replications. Means in the same column followed by the same letter are not significantly different (P=0.05) according to Fisher's LSD test.

[2] Treatments consisted of field applications applied weekly beginning at seven days post-transplant and continuing every seven days thereafter up to 49 days post-plant. Other treatments were applied when the first symptom of TSWV was identified through scouting control plots, with some receiving an additional application one week,
two weeks and four weeks afterwards according to the treatment list. All Actigard and Admire Pro treatments were applied as pre-plant treatments in the greenhouse at a rate of 2 gai/7,000 plants-Actigard and 1.0 oz/1,000 plants-Admire Pro.

[3] Height measurements were done in inches from the soil level to the tip of the longest leaf. Two height measurements were conducted on April 28 and May 26.

[4] Vigor ratings were done on a 1-10 scale with 10=live and healthy plants and 1=dead plants on April 28 and May 12.

[5] Dry weight yield was calculated by multiplying green weight totals by 0.15. Pounds per acre were calculated by multiplying dry weight conversion per plot by 6,491 divided by the base stand count. Tobacco was planted in 44-inch rows with 22 inches between plants, which equals 6,491 plants/A.

Table 3. Tobacco Thrips, *Frankliniella fusca*, Count Data on Yellow Sticky Cards Retrieved from Treated and Untreated Tobacco Plots

Treatment[1] (Greenhouse)	Field Treatment[2]	Avg. # of tobacco thrips
1. Non treated Control	No field treatment	88.47a
2. Admire Pro + Actigard	No field treatment	138.13a
3. Admire Pro + Actigard	+ 14 days post-transplant (DPT)	149.90a
4. Admire Pro + Actigard	+ 21 DPT	120.27a
5. Admire Pro + Actigard	+ 28 DPT	100.97a
6. Admire Pro + Actigard	+ 35 DPT	90.30a
7. Admire Pro + Actigard	+ 42 DPT	93.63a
8. Admire Pro + Actigard	+ 49 DPT	108.37a
9. Admire Pro + Actigard	+ at 1st symptom	144.17a
10. Admire Pro + Actigard	+ at 1st symptom + 1 week	86.47a
11. Admire Pro + Actigard	+ at 1st symptom + 1 week + 1 week	97.80a
12. Admire Pro + Actigard	+ at 1st symptom + 2 weeks + 2 weeks	82.20a
13. Admire Pro + Actigard	14, 21, 28, 35, 42, and 49 days post planting	118.43a
14. Earth Tech	Tray drench in greenhouse and	133.57a

[1] Represents various greenhouse treatments applied to tobacco seedlings prior to planting in field plots.

[2] Treatments consisted of field applications applied weekly beginning at seven days post-transplant and continuing every seven days thereafter up to 49 days post-plant. Other treatments were applied when the first symptom of TSWV was identified through scouting control plots, with some receiving an additional application one week,
two weeks and four weeks afterwards according to the treatment list. All Actigard and Admire Pro treatments were applied as pre-plant treatments in the greenhouse at a rate of 2 gai/7,000 plants-Actigard and 1.0 oz/1,000 plants-Admire Pro.

[3] Thrips counts were assessed using yellow sticky cards, the counts were sampled every two weeks for 12 weeks. Data are means of five replications. Means in the same column followed by the same letter are not significantly different (P=0.05) according to Fisher's LSD test.

Table 4. Incidence of TSWV Infection, and % TSWV-Positive Plants as Identified Through ELISA Testing of Root Samples

Treatment[1] (Greenhouse)	Field Treatment[2]	% TSWV[3]	% ELISA (+)Plants[6]
1. Non treated Control	No field treatment	26.1a	12.0 abc
2. Admire Pro + Actigard	No field treatment	10.5b-e	12.0 abc
3. Admire Pro + Actigard	+ 14 days post-transplant (DPT)	9.2b-e	20.0 a
4. Admire Pro + Actigard	+ 21 DPT	5.8cde	16.0 abc
5. Admire Pro + Actigard	+ 27 DPT	3.4de	12.0 abc
6. Admire Pro + Actigard	+ 35 DPT	6.8b-e	8.0 abc
7. Admire Pro + Actigard	+ 42 DPT	10.3b-e	12.0 abc
8. Admire Pro + Actigard	+ 49 DPT	16.0b	16.7 abc
9. Admire Pro + Actigard	+ at 1st symptom	7.9b-e	18.0 ab
10. Admire Pro + Actigard	+ at 1st symptom + 7 days	3.5de	14.0 abc
11. Admire Pro + Actigard	+ at 1st symptom + 7 days + 7 days	13.6bc	6.0 bc
12. Admire Pro + Actigard	+ at 1st symptom + 7 days + 7 days + 7 days	12.4bcd	4.0 v
13. Admire Pro + Actigard	14, 21, 28, 35, 42, and 49 days post planting	1.1e	4.0 c
14. Earth Tech	Tray drench in greenhouse and	12.8bcd	18.0 ab

[1] Data are means of six replications. Means in the same column followed by the same letter are not significantly different (P=0.05) according to Fisher's LSD test.

[2] Treatments consisted of field applications applied weekly beginning at seven days post-transplant and continuing every seven days thereafter up to 49 days post-plant. Other treatments were applied when the first symptom of TSWV was identified through scouting control plots, with some receiving an additional application one week, two weeks and four weeks afterwards according to the treatment list.

[3] Percent TSWV was calculated by using stand counts that were made from April 15 through June 18 with TSWV being recorded and flagged every seven days.

[4.] Cumulative number of TSWV-infected plants that were flagged during weekly stand counts.

[5.] Plants that were flagged as TSWV infected were inspected to determine whether they had harvestable leaves. Those with no harvestable leaves were counted and recorded.

[6] Final harvest testing was completed on August 13. Ten root samples were collected per plot. ELISA testing was performed in the lab using double antibody sandwich-enzyme linked immunosorbent assay (DAS-ELISA) alkaline phosphatase antisera kits. ELISA test results are percent positive plants.

Planting Date, Float House and Field Application of ASM for TSWV Management

Bowen Farm - Tifton, Ga. 2010

A. S. Csinos, L. L. Hickman, S. LaHue, S. W. Mullis and R. Srinivasan

Introduction

Tomato spotted wilt virus on tobacco is a serious problem in Georgia. Currently there are no tobacco cultivars that provide any specific resistances to TSWV; however, there are other means available that may help to manage the disease.

Currently, applications of Admire Pro and Actigard are standard recommendations in the float house. Some positive influence over the control of TSWV has been shown in past studies by applying Actigard to plants in the field after transplant. There is also evidence that planting date may have significant influence on TSWV incidence and severity. This trial evaluates combinations of field and greenhouse applications of Actigard and Admire Pro, application techniques and different planting dates.

Methods and Materials

The study was located at the Bowen Farm, CPES, Tifton, Ga., in a field with a crop rotation history of cotton, peanuts, soybeans, assorted vegetables and tobacco. The area was prepared using all current University of Georgia Cooperative Extension recommendations. The plot design was a randomized complete block design (RCBD) consisting of single row plots replicated five times. Each plot was 37 feet long with 10-foot alleys between repetitions. Three separate trial areas were set up to represent three separate planting dates.

On January 20, 2009, variety NC-71 was seeded into 242-cell flats. Tobacco transplants were treated in the greenhouse with a pre-plant treatment of Actigard 50WG and Admire Pro. The two materials were tank mixed and sprayed on in 200 ml of water per flat then washed in with 0.25 inch of water. Actigard 50WG was applied at 2g ai/7,000 plants. Admire Pro greenhouse treatments were applied at 10 oz/1,000 plants. Plants were transplanted after greenhouse treatments were applied in plots on 44-inch rows with a 22-inch plant spacing. An average of 20 plants per test plot were planted.

Field treatments were applied beginning when the first symptom of TSWV was detected during field scouting. Field treatments were applied using a CO2 sprayer with one TX-12 tip/row with a 50-mesh ball check screen. Tips were angled at plants and sprayed in a 12-inch band at the rate of 40 PSI for 10.0 gal H2O per acre. All treatments were mixed in 3 liters of water unless otherwise noted. All field applications of Actigard 50WG were made at ½ oz/A (1.1g Actigard 50WG in 3 L/H2O).

Yellow sticky cards were used for thrips sampling (@ one per plot). Sampling was undertaken from April 12 to June 21 for tobacco planted on March 30. For tobacco planted on April 13 and 28, thrips sampling was undertaken from April 26 to July 5. Sticky cards were sampled once every two weeks. The cards were retrieved from the field seven days after placement and taken to the vector biology laboratory at UGA, Tifton for thrips identification. Voucher specimens of thrips were stored in 70% ethanol.

Tobacco plots were scouted weekly to determine TSWV disease incidence and percentage of infection in non-treated as compared to treated plots. Following the final harvest, root samples were collected from 10 plants per plot and an ELISA test was performed to determine TSWV incidence. The screen for TSWV was accomplished by the use of double antibody sandwich-enzyme linked immunosorbent assay (DAS-ELISA) alkaline phosphatase antisera kits (Agdia, Inc. Elkhart, IN). Samples of 1.0 gram were subjected to DAS-ELISA, and any sample eliciting an absorbance reading (A405) of three times the average plus two standard deviations of a healthy negative control were considered positive results.

Crop maintenance was achieved using UGA Cooperative Extension recommendations for the control of weeds, suckers and insects. Chemicals used for maintenance of the crop were Orthene 97 at 0.5 lbs/A for insect control, Prowl 3.3EC at 2 pts/A for weed control and Royal NH-30 Extra at 1.5 gal/A for sucker control.

Individual information for each of the three trials is detailed as follows:

Trial 1

Tobacco transplants were treated in the greenhouse with a pre-plant treatment of Actigard 50WG and Admire Pro on March 26. Tobacco was transplanted into field plots on March 30. Stand counts were conducted beginning April 14 with a final stand count being done on June 15. Two height measurements were conducted on April 28 and May 26. Plants were measured in centimeters from the base of the plant to the tip of the longest leaf. Two vigor ratings were conducted on a 1-10 scale with 10 equaling vigorous healthy plants and 1 equaling poor vigor plants. Vigor ratings were conducted on April 28 and May 12. Three harvests were conducted on June 24 and July 8 and 22. Harvests were done by collecting 1/3 of the plant leaves at one time and weighing each plot separately in pounds.

The first symptom field treatment was applied on April 28. A second field treatment one week later was applied on May 5 and the third treatment two weeks after the first symptom was applied on May 12.

Trial 2

Tobacco transplants were treated in the greenhouse with a pre-plant treatment of Actigard 50WG and Admire Pro on April 8. Tobacco was transplanted into field plots on April 13. Stand counts were conducted beginning April 28 with a final stand count being done on June 22. Two height measurements were conducted on May 12 and June 9. Plants were measured in centimeters from the base of the plant to the tip of the longest leaf. Two vigor ratings were conducted on a 1-10 scale with 10 equaling vigorous healthy plants and 1 equaling poor vigor plants. Vigor ratings were conducted on May 26 and June 16. Three harvests were conducted on June 30 and July 15 and 29. Harvests were done by collecting 1/3 of the plants leaves at one time and weighing each plot separately in pounds.

The first symptom field treatment was applied on May 13. A second field treatment one week later was applied on May 20 and the third treatment two weeks after the first symptom was applied on May 27.

Trial 3

Tobacco transplants were treated in the greenhouse with a pre-plant treatment of Actigard 50WG and Admire Pro on April 23. Tobacco was transplanted into field plots on April 28. Stand counts were conducted beginning May 12, with a final stand count being done on June 29. Two height measurements were conducted on June 8 and July 6. Plants were measured in centimeters from the base of the plant to the tip of the longest leaf. Two vigor ratings were conducted on a 1-10 scale with 10 equaling vigorous healthy plants and 1 equaling poor vigor plants. Vigor ratings were conducted on June 8 and July 6. Three harvests were conducted on July 8, 22 and 29. Harvests were done by collecting 1/3 of the plant leaves at one time and weighing each plot separately in pounds.

The first symptom field treatment was applied on May 26. A second field treatment one week later was applied on June 2 and the third treatment two weeks after the first symptom was applied on June 9.

Summary

Tomato spotted wilt virus (TSWV) levels ranged from 15% to 19% in the non-treated treatments across the three planting dates. No significant differences were detected in plant height for the first planting date (Table 1) and third planting date. In the second planting date, the Actigard and Admire Pro float house treatment had the tallest plants and were significantly higher than some of the other treatments (Table 1).

In Planting 1, Admire Pro treatments were more vigorous than the Admire Pro and Actigard float house treatment. No differences in vigor were detected in Trial 3.

Thrips sampling data indicated no statistical differences among treatments within each planting date (Table 2). However, across trials, thrips populations increased with a delay in planting date. More thrips were recovered from yellow sticky cards in the early-season plots than from cards in mid- and late-season plots (Figure 1). These comparisons were statistically invalid as they were made across trials. The data, nevertheless, indicates that early planting of tobacco can help evade peak thrips incidence at the most susceptible crop stage.

In Trial 1, Admire Pro and first symptom prescribed treatment (#6) had significantly lower TSWV than the control. In Trial 2, all treatments except the Admire Pro and Actigard treatment had less TSWV than the control. In Trial 3, only Admire pro in the float house and prescribed first symptom treatment (#6) had lower TSWV than the control.

No significant difference in yield was detected among treatments in Trials 1 or 2. In Trial 3, none of the treatments were significantly higher in yield than the non-treated control.

Table 1. Effects of Actigard and Admire Pro Field and Greenhouse Treatments and Planting Date on Plant Growth and Vigor of Tobacco. Bowen Farm-Tifton, Ga., 2010

Treatment List[1]		Trial 1 Plant Date: March 30		Plant Date Trial 2 Plant Date: April 13		Trial 3 Plant Date: April 27	
Greenhouse Application[2]	Field Application[2]	Height Measurement[3]	Vigor[4]	Height Measurement[3]	Vigor[4]	Height Measurement[3]	Vigor[4]
1. No treatment	No treatment	43.4 a	8.4 abc	36.6 ab	8.7 a	73.7 a	7.4 a
2. Admire Pro	No treatment	42.1 a	9.1 a	34.0 b	9.3 a	74.3 a	7.5 a
3. No treatment	Actigard + 1 week + 1 week	43.4 a	8.6 ab	35.1 b	9.3 a	74.1 a	8.0 a
4. Admire Pro	Actigard + 1 week + 1 week	43.6 a	8.7 a	36.4 ab	8.8 a	73.0 a	7.9 a
5. Admire Pro and Actigard	No treatment	40.7 a	7.6 c	40.6 a	9.0 a	72.3 a	7.9 a
6. Admire Pro and Actigard	Actigard + 1 week + 1 week	40.1 a	7.7 bc	36.4 ab	8.4 a	72.4 a	7.4 a

[1] Data are means of five replications. Means in the same column followed by the same letter are not significantly different (P=0.05) according to Fisher's LSD test.
[2] Treatments consisted of greenhouse applications followed by field applications applied beginning when the first symptom of TSWV was identified through scouting control plots. Some plots received an additional application one week and two weeks afterwards according to the treatment list.
[3] Height measurements were done in inches from the soil level to the tip of the longest leaf. Two height measurements were conducted on each trial.
[4] Vigor ratings were done on a 1-10 scale with 10=live and healthy plants and 1=dead plants.

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The authors would like to thank the Georgia Agricultural Commodity Commission for Tobacco and Philip Morris International for their support of this work. Thanks are also extended to Holly Hickey, Seth Dale, Chance Anderson, Kitty Loper and Tyler Reeves (UGA Young Scholars Program) for their assistance.

Table 2. Tobacco Thrips, *Frankliniella fusca*, Count Data on Yellow Sticky Cards Retrieved from Tobacco Trials with Different Planting Dates.

Treatment List[2]		Trial 1 Plant Date: March 30	Plant Date Trial 2 Plant Date: April 13	Trial 3 Plant Date: April 27
Greenhouse Application[2]	Field Application[2]	Average # of tobacco thrips	Average # of tobacco thrips	Average # of tobacco thrips
1. No treatment	No treatment	60.03a	122.00a	169.67a
2. Admire Pro	No treatment	52.39a	115.68a	199.04a
3. No treatment	Actigard + 1 week + 1 week	65.80a	102.88a	210.44a
4. Admire Pro	Actigard + 1 week + 1 week	66.87a	119.25a	207.08a
5. Admire Pro and Actigard	No treatment	78.90a	108.92a	168.84a
6. Admire Pro and Actigard	Actigard + 1 week + 1 week	77.37a	129.28a	153.63a

[1] Data are means of five replications. Means in the same column followed by the same letter are not significantly different (P=0.05) according to Fisher's LSD test.

[2] Treatments consisted of greenhouse applications followed by field applications applied beginning when the first symptom of TSWV was identified through scouting control plots. Some plots received an additional application one week and two weeks afterwards according to the treatment list.

Table 3. Effects of Actigard and Admire Pro Field and Greenhouse Treatments and Planting Date on Incidence of *Tomato spotted wilt virus* and % TSWV-Positive Plants as Identified Through ELISA Testing of Tobacco Root Samples. Bowen Farm-Tifton, Ga., 2010

Treatment List[1]		Trial 1 Plant Date: March 30		Plant Date Trial 2 Plant Date: April 13		Trial 3 Plant Date: April 27	
Greenhouse Application[2]	Field Application[2]	Percent TSWV[3]	Percent ELISA[4]	Percent TSWV[3]	Percent ELISA[4]	Percent TSWV[3]	Percent ELISA[4]
1. No treatment	No treatment	14.7 a	12.0 a	19.3 a	12.0 ab	19.1 a	16.0 a
2. Admire Pro	No treatment	3.3 b	12.0 a	8.6 bc	6.0 b	9.0 b	12.0 a
3. No treatment	Actigard + 1 week + 1 week	9.0 ab	6.1 a	5.3 c	14.0 ab	10.2 ab	14.0 a
4. Admire Pro	Actigard + 1 week + 1 week	9.1 ab	12.2 a	8.4 bc	16.0 ab	13.3 ab	26.0 a
5. Admire Pro and Actigard	No treatment	8.8 ab	6.0 a	13.7 ab	8.0 ab	15.0 ab	14.3 a
6. Admire Pro and Actigard	Actigard + 1 week + 1 week	4.4 b	14.6 a	5.3 c	18.8 a	6.6 b	18.0 a

[1] Data are means of five replications. Means in the same column followed by the same letter are not significantly different (P=0.05) according to Fisher's LSD test.
[2] Treatments consisted of greenhouse applications followed by field applications applied beginning when the first symptom of TSWV was identified through scouting control plots. Some plots received an additional application one week and two weeks afterwards according to the treatment list.
[3] Percent TSWV was calculated by using stand counts where tobacco plants that exhibited symptoms of TSWV were recorded and flagged every seven days.
[6] Final harvest testing was completed after final harvest of each trial. Ten root samples were collected per plot. ELISA testing was performed in the lab using double antibody sandwich-enzyme linked immunosorbent assay (DAS-ELISA) alkaline phosphatase antisera kits. ELISA test results are percent positive plants.

Table 4. Effects of Actigard and Admire Pro Field and Greenhouse Treatments and Planting Date on Dry Weight Yield of Tobacco. Bowen Farm-Tifton, Ga., 2010

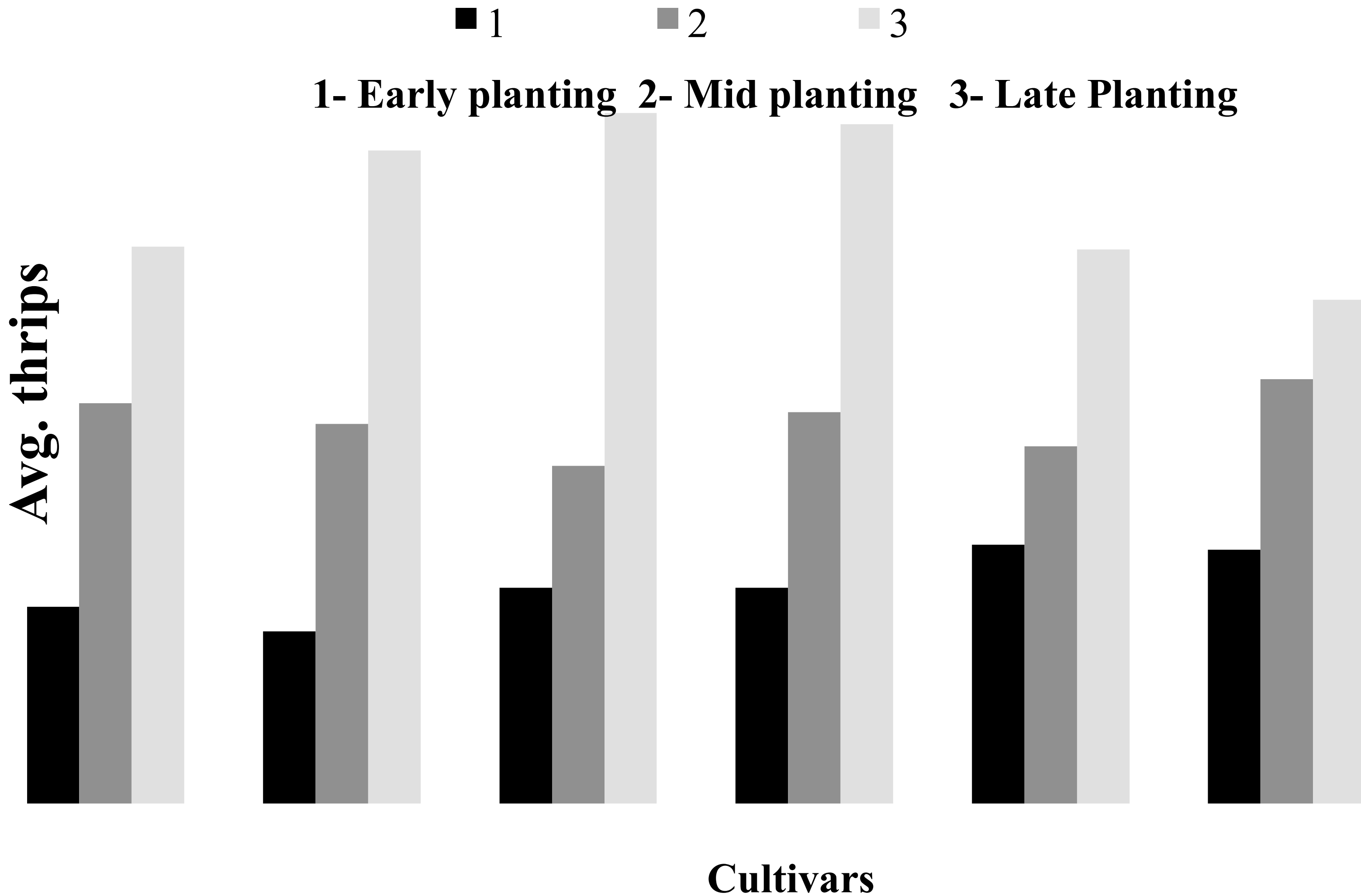
Treatment List[1]		Dry Weight Yield[3]		
Greenhouse Application[2]	Field Application[2]	**Trial 1 Plant Date: March 30**	**Plant Date Trial 2 Plant Date: April 13**	**Trial 3 Plant Date: April 27**
1. No treatment	No treatment	3452.8 a	2722.1 a	2725.2 abc
2. Admire Pro	No treatment	3706.3 a	3151.9 a	2804.6 abc
3. No treatment	Actigard + 1 week + 1 week	3836.3 a	3145.1 a	2675.6 bc
4. Admire Pro	Actigard + 1 week + 1 week	3425.2 a	2985.1 a	2498.0 c
5. Admire Pro and Actigard	No treatment	3405.9 a	3020.4 a	2951.3 ab
6. Admire Pro and Actigard	Actigard + 1 week + 1 week	3434.7 a	3099.2 a	3050.4 a

[1] Data are means of five replications. Means in the same column followed by the same letter are not significantly different (P=0.05) according to Fisher's LSD test.

[2] Treatments consisted of greenhouse applications followed by field applications applied beginning when the first symptom of TSWV was identified through scouting control plots. Some plots received an additional application one week and two weeks afterwards according to the treatment list.

[3] Dry weight yield was calculated by multiplying green weight totals by 0.15. Pounds per acre were calculated by multiplying dry weight conversion per plot by 6,491 divided by the base stand count. Tobacco was planted in 44-inch rows with 22 inches between plants, which equals 6,491 plants/A.

Figure 1. Density of Tobacco thrips, *Frankliniella fusca*, on yellow sticky cards retrieved tobacco trials with different planting dates



Thrips counts were taken from three different trials planted at three different dates. The counts presented are the sum of thrips obtained over six sampling intervals and an average across five replications. No statistical comparisons were made across trials. The purpose of this graph is only to give an indication that early planting of tobacco may help to evade peak thrips incidence at TSWV-susceptible stage.

Evaluation of Tobacco Lines for Resistance to TSWV in Georgia Johnson Selected Variety Tobacco Trial

2010 Bowen Farm, Tifton, Ga.

A. S. Csinos, L. L. Hickman, R. Srinivasan and S. Lahue

Introduction

Tomato spotted wilt virus continues to be of great concern to Georgia tobacco producers. This study evaluates tobacco cultivars that have been selected for insect resistance and have demonstrated resistance to TSWV in the greenhouse. Entries that indicated low levels of TSWV were harvested for comparison with standards.

Methods and Materials

The study was located at the Bowen Farm CPES, Tifton, Ga., in a field with a history of crops such as corn, soybeans, peanuts, tobacco and assorted vegetables. The area was prepared using all current University of Georgia Cooperative Extension recommendations.

The plot design was a randomized split block design replicated five times. Each plot consisted of one row of transplants that had been treated in the greenhouse with Actigard and Admire Pro and one row was planted with transplants that received no greenhouse treatments. Each plot was 37 feet long with 10-foot alleys between repetitions. On January 25, 14 selected tobacco varieties were seeded into 242-cell trays. Tobacco varieties that were evaluated are listed in Table 1.

Table 1.
Selected tobacco varieties

1. H75	7.H128	13. NC71
2. H95	8.H136	14. K326
3.H102	9. H138	
4.H100	10.H139	
5. H106	11. H140	
6. H110	12. H143	

The test was transplanted on March 25 on 44-inch row spacing with 20 inches in row space. An average of 22 plants per row were planted. Crop maintenance was achieved using UGA Cooperative Extension recommendations for the control of weeds, suckers and insects. Chemicals used for maintenance of the crop were Orthene 97 at 0.5 lbs/A for insect control, Prowl 3.3 EC at 2 pts/A for weed control and Royal MH-30 Extra at 1.5 gal/A for sucker control.

Tobacco plots were scouted weekly to determine TSWV disease incidence and percentage of infection in non-treated as compared to treated plots. Stand counts were conducted beginning April 13 with a final stand count being done on June 16. A height measurement was conducted on May 12. Plants were measured in centimeters from the base of the plant to the tip of the longest leaf. Two vigor ratings were conducted on a 1-10 scale with 10 equaling vigorous healthy plants and 1 equaling poor vigor plants. Vigor ratings were conducted on April 29 and May 12. Three harvests were conducted on June 24 and July 7 and 22. Harvests were done by collecting 1/3 of the plant leaves at one time and weighing each plot separately in pounds.

Yellow sticky cards were used for thrips sampling (@ one per plot). Sampling was undertaken from April 12 to June 21. Sticky cards were sampled once every two weeks. The cards were retrieved from the field seven days after placement and taken to the vector biology laboratory at UGA, Tifton for thrips identification. Voucher specimens of thrips were stored in 70% ethanol.

Following the final harvest, root samples were collected from 10 plants per plot and an ELISA test was performed to determine TSWV incidence. The screen for TSWV was accomplished by the use of double antibody sandwich-enzyme linked immunosorbent assay (DAS-ELISA) alkaline phosphatase antisera kits (Agdia, Inc. Elkhart, IN). Samples of 1.0 gram were subjected to DAS-ELISA, and any sample eliciting an absorbance reading (A405) of three times the average plus two standard deviations of a healthy negative control were considered positive results.

Summary

TSWV at the Bowen Farm was at a very low level this year with many treatments having zero disease incidence. Disease in the non-treated plots ranged from zero to 8.5%. Disease in the plots treated with Actigard and Admire in the float house ranged from zero to 5.6%, with most of the treatments having zero or less than 1% disease.

In untreated plots, the average number of thrips retrieved from yellow sticky cards varied with the cultivars planted. Sticky cards placed in H140 had the least number of thrips and cards placed in H100 had the maximum number of thrips recorded in a single plot over six sampling periods (Table 5). No such differences were observed among cultivars planted following Actigard and Admire treatment in the greenhouse (Table 5). Though not statistically different, in most cultivars thrips populations were higher on Actigard and Admire-treated plots than on non-treated plots. This difference was significant only in the case of H143 (Figure 1).

An apparent stunting occurred with the application of Admire and Admire in the float house, which was visible in the vigor, height measurements and yield of the plots. This stunting is only apparent when TSWV levels are as low as they were this year.

Yields in the treated plots ranged from a low of 2,753 lbs/A to a high of 3,450 lbs/A. Yields in the non-treated plots ranged from 3,120 lbs/A to 3,753 lbs/A. Interestingly, K326, a tobacco cultivar not grown any longer, had the highest level of disease while NC71, a popular cultivar, had low disease and a relatively high yield.

Greenhouse TSWV transmission experiment

Six non-treated cultivars (H100, H106, H128, NC71 and K326) were used for the greenhouse transmission experiment. These cultivars were chosen from the available 14 cultivars. Ten seedlings planted in individual pots were placed in thrips-proof cages (47.5 cu. Cm, Megaview® science co, Taichung, Taiwan). Fifty potentially viruliferous thrips reared on TSWV-infected peanut plants were released on the middle of each cage; there were six cages in total (one cage per cultivar). TSWV infection was visually rated three weeks post thrips release and confirmed with DAS-ELISA (Table 2).

Table 2. Cultivar responses to thrips mediated TSWV-inoculation

Cultivar	Percent TSWV-Infection (Visual rating)	Percent TSWV-Infection (ELISA Rating)
H100	20	30
H106	10	0
H128	20	30
NC71	60	60
K326	60	80

Acknowledgments

The authors would like to thank the Georgia Agricultural Commodity Commission for Tobacco and Altria Services (Philip Morris) for their support of this work. Thanks are also extended to Holly Hickey, Seth Dale, Kitty Loper, Gage Greene, Chance Anderson and Tyler Reeves (UGA Young Scholars) for their assistance.

Table 3. Percent TSWV, Percent ELISA TSWV Results and Dry Weight Yield

Variety[1]	Vigor Ratings[2]		Height Measurements[3]		Dry Weight Yield[4] (lbs/A)	
	A Non-treated	B Treated	A Non-treated	Treated	A Non-treated	B Treated
1. H75	8.6 a	7.6 a	31.9 b	28.3 a	3120.8 d	3179.1 ab
2.H95	8.4 ab	7.2 ab	32.8 ab	23.8 abc	3510.1 abc	3027.2 bc
3.H102	8.1 ab	7.3 a	33.0 ab	25.7 abc	3318.9 bcd	3303.8 ab
4.H100	7.9 ab	6.1 d	27.4 b	20.9 c	3309.7 bcd	2753.1 c
5.H106	7.7 b	6.4 cd	32.9 ab	20.7 c	3418.5 bc	3239.5 ab
6.H110	7.9 ab	7.2 ab	28.5 b	27.4 a	3308.4 bcd	3108.6 ab
7.H128	7.8 ab	6.5 bcd	33.0 ab	23.4 abc	3230.6 cd	3202.1 ab
8.H136	8.6 a	7.2 ab	33.0 ab	26.3 ab	3412.8 bc	3450.4 a
9.H138	8.0 ab	7.1 abc	29.8 b	26.5 ab	3267.2 bcd	3244.4 ab
10.H139	8.1 ab	7.4 a	32.0 ab	26.1 ab	3717.4 a	3233.8 ab
11.H140	7.8 ab	7.3 a	31.3 b	27.5 a	3753.8 a	3429.9 a
12.H143	8.1 ab	6.4 cd	40.9 a	21.9 bc	3348.2 bcd	3193.1 ab
13. NC71	8.3 ab	6.5 bcd	34.3 ab	23.9 abc	3532.0 ab	3264.2 ab
14. K-326	8.3 ab	7.3 a	33.8 ab	27.1 a	3406.3 bcd	3372.7 a

[1] Data are means of five replications. Means in the same column followed by the same letter are not significantly different (P=0.05) according to Fisher's LSD test. Twenty-eight treatments consisted of selected varieties of tobacco. Each plot was two rows: one row treated with Actigard and Admire and one row non-treated.

[2] Vigor ratings were done on a 1-10 scale with 10=live and healthy plants and 1=dead plants on April 28 and May 12.

[3] Height measurements were done in inches from the soil level to the tip of the longest leaf. Two height measurements were conducted on April 28 and May 26.

[4] Dry weight yield was calculated by multiplying green weight totals by 0.15. Pounds per acre was calculated by multiplying dry weight conversion per plot by 6,491 divided by the base stand count. Tobacco was planted in 44-inch rows with 22 inches between plants, which equals 6,491 plants/A. Fourteen varieties were selected out of the treatment list to collect yield on. These are highlighted in Table 1.

Table 4. Percent TSWV, Percent ELISA TSWV Results and Dry Weight Yield

Variety[1]	% TSWV Symptomatic[2]		% ELISA TSWV[3]	
	A Non-treated	B Treated	A Non-treated	Treated
1. H75	8.3 a	0.0 b	8.0 de	14.0 b-e
2.H95	1.8 bcd	1.9 b	12.0 b-e	30.0 a
3.H102	4.7 a-d	0.9 b	16.0 b-e	12.0 b-e
4.H100	5.7 abc	0.0 b	4.0 e	12.0 b-e
5.H106	1.9 bcd	0.0 b	6.0 e	14.0 b-e
6.H110	2.7 bcd	0.0 b	12.0 b-e	22.0 abc
7.H128	2.8 bcd	0.9 b	16.0 b-e	24.0 ab
8.H136	4.5 a-d	0.0 b	22.0 abc	16.0 b-e
9.H138	2.7 bcd	0.9 b	10.0 cde	16.0 b-e
10.H139	6.3 ab	0.9 b	16.0 b-e	14.0 b-e
11.H140	3.6 a-d	0.9 b	14.0 b-e	8.0 de
12.H143	0.0 d	0.0 b	10.0 cde	12.0 b-e
13. NC71	0.9 cd	0.0 b	10.0 cde	10.0 cde
14. K-326	8.4 a	5.6 a	20.0 a-d	20.0 a-d

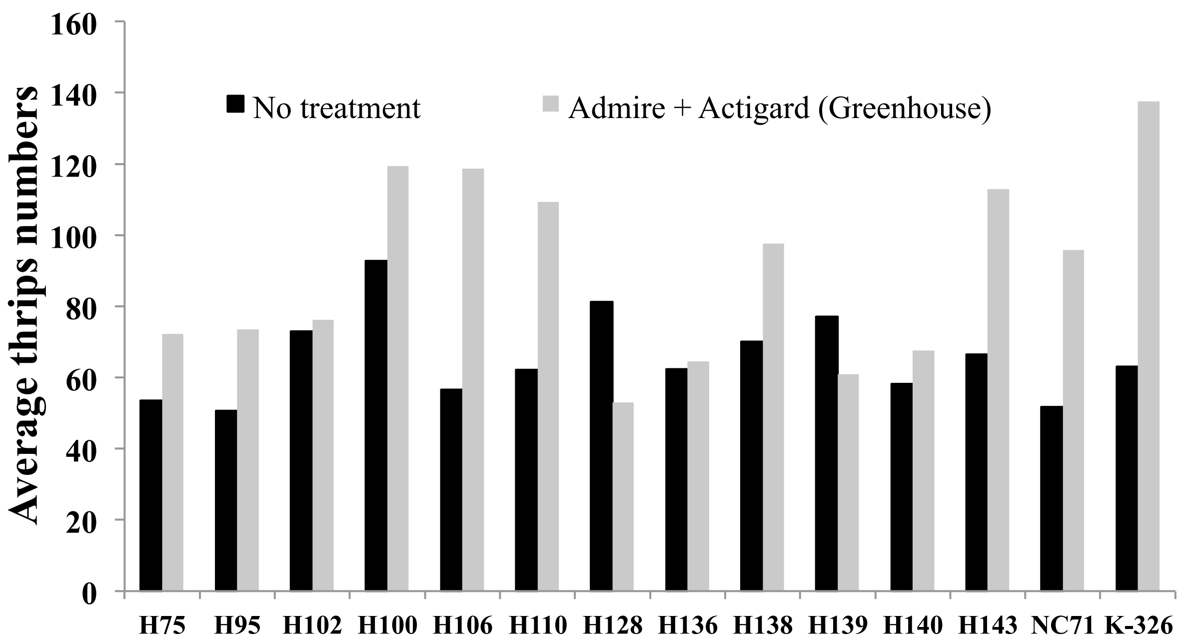
[1] Data are means of five replications. Means in the same column followed by the same letter are not significantly different (P=0.05) according to Fisher's LSD test.
[2] Percent TSWV was calculated using stand counts that were made from April 15 through June 18 with TSWV being recorded and flagged every seven days.
[3] Final harvest testing was completed on July 30. Ten root samples were collected per plot. ELISA testing was performed in the lab using double antibody sandwich-enzyme linked immunosorbent assay (DAS-ELISA) alkaline phosphatase antisera kits. ELISA test results are percent positive plants.

Table 5. Thrips Density on Various Tobacco Cultivars With and Without Greenhouse Treatments (Actigard + Admire).

Cultivar	Non-treated	Actigard + Admire	Non-treated Versus Actigard + Admire *P* values
H75	53.53b	72.30a	0.1503
H95	50.63b	73.53a	0.1339
H102	73.03ab	76.30a	0.8278
H100	92.80a	119.43a	0.1405
H106	56.67b	118.60a	0.1107
H110	62.17b	109.30a	0.1002
H128	52.97ab	81.33a	0.0562
H136	62.33b	64.47a	0.8684
H138	70.07ab	97.63a	0.2326
H139	77.10ab	61.00a	0.3320
H140	58.28b	67.63a	0.3102
H143	66.43ab	112.83a	0.0495*
NC71	51.80b	95.83a	0.0625
K-326	63.07ab	137.60a	0.2426

Data represent mean counts over five replications over a period of 12 weeks. Counts were taken at two-week intervals. Differences among treatments were estimated among treatments using Fisher's LSD at α=0.05. Treatment means followed by the same letters indicate that they are not different. *Indicates significant difference between treatment pairs.

Figure 1

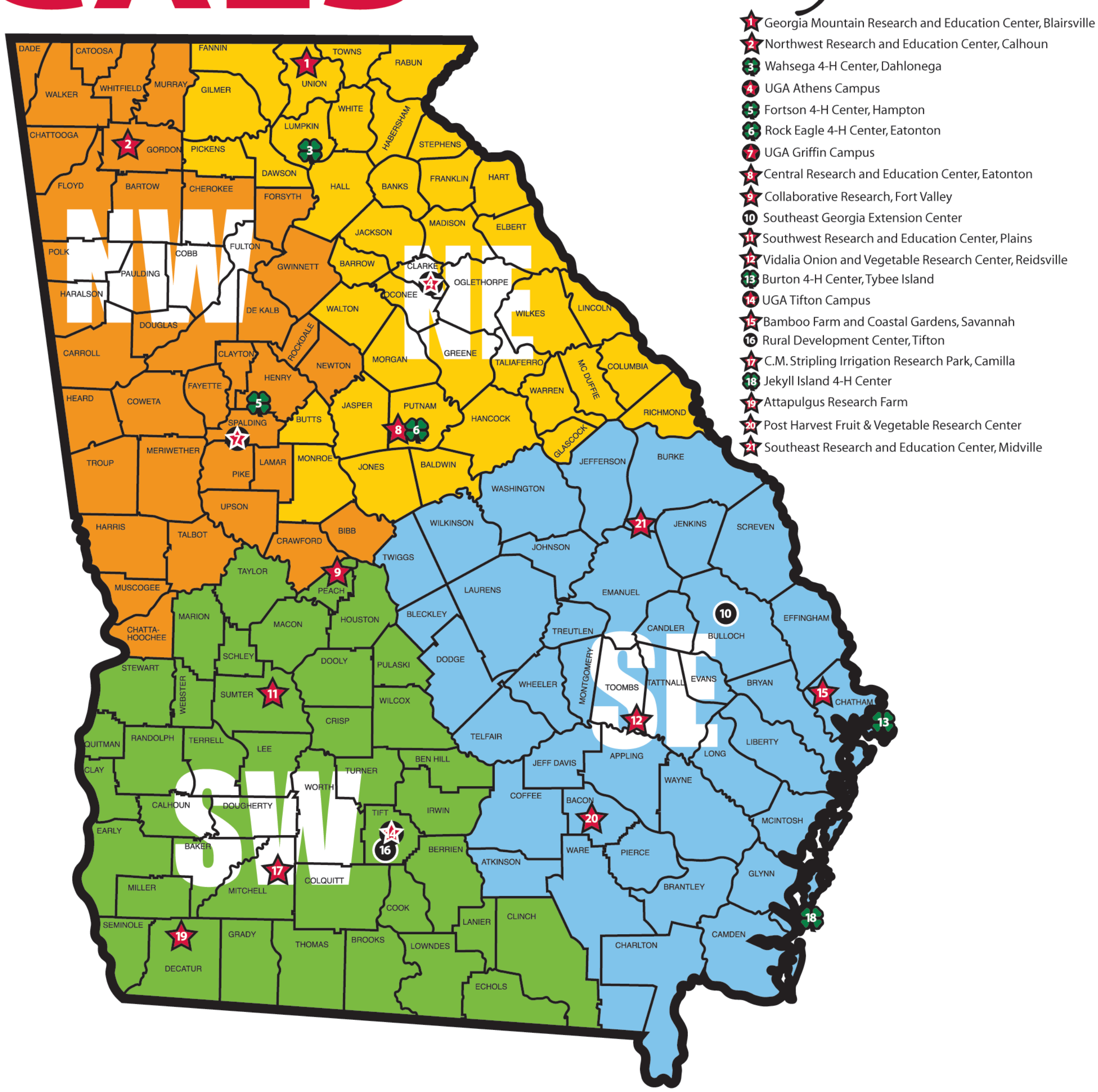


Bars represent treatment means thrips counts on sticky cards retrieved from cultivars. The dark bars represent cultivars that received no treatment in the greenhouse and the light bars represent cultivars that received the Admire + Actigard treatment in the greenhouse. Counts were taken at two-week intervals over 12 weeks and averaged over five replications.

Conversion Table

U.S. Abbr.	Unit	Approximate Metric Equivalent
	Length	
mi	mile	1.609 kilometers
yd	yard	0.9144 meters
ft or ‘	foot	30.48 centimeters
in or “	inch	2.54 centimeters
	Area	
sq mi or mi^2	square mile	2.59 square kilometers
acre	acre	0.405 hectares or 4047 square meters
sq ft or ft^2	square foot	0.093 square meters
	Volume / Capacity	
gal	gallon	3.785 liters
qt	quart	0.946 liter
pt	pint	0.473 liter
fl oz	fluid ounce	29.473 milliliters or 28.416 cubic centimeters
bu	bushel	35.238 liters
cu ft or ft^3	cubit feet	0.028 cubic meter
	Mass / Weight	
ton	ton	0.907 metric ton
lb	pound	0.453 kilogram
oz	ounce	28.349 grams
Metric Abbr.	**Unit**	**Approximate U.S. Equivalent**
	Length	
km	kilometer	0.62 mile
m	meter	39.37 inches or 1.09 yards
cm	centimeter	0.39 inch
mm	millimeter	0.04 inch
	Area	
ha	hectare	2.47 acres
	Volume / Capacity	
liter	liter	61.02 cubic inches or 1.057 quarts
ml	milliliter	0.06 cubic inch or 0.034 fluid ounce
cc	cubic centimeter	0.061 cubic inch or 0.035 fluid ounce
	Mass / Weight	
MT	metric ton	1.1 tons
kg	kilogram	2.205 pounds
g	gram	0.035 ounce
mg	milligram	3.5×10^{-5} ounce

CAES across Georgia



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