UGA extension

2016

TOBACCO
Research Report

2016 Tobacco Research Report

(Summary Report of 2016 Data)

Edited by Anna K. Watson

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Acknowledgements

The tobacco research team would like to express appreciation to the following for their contributions to this research:

Altria Client Services-Phillip Morris USA
FMC. Corp
Syngenta
Du Pont
Dow Agrisciences
Bayer CropScience
Valent BioSciences
Valent USA
MANA
Philip Morris International
Georgia Agricultural Commodity Commission for Tobacco

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Foreword

Welcome to the 2017 Annual Tobacco Report. We hope that you find this information useful as you prepare for the upcoming growing season and the challenges and opportunities that are presented.

It is important to have the latest information in planning for the upcoming crop year. At the University of Georgia, it is our job to provide the latest research and educational results to help growers minimize risk, and improve yield and quality, with greater opportunity for economic sustainability. Agriculture is a dynamic enterprise, and the challenges facing growers change with time. We strive to address the obstacles to production with research using the latest genetics, chemistries, products and practices and to find what works, and equally important, what does not work.

Here you will find research directed to improve pest and disease control, particularly weed, insect and nematode control, diseases including black shank and tomato spotted wilt virus, new tobacco varieties, sucker control, and the latest Extension programming. This is a wealth of research and educational materials geared to give you the latest tools to continue to improve yield and quality of tobacco.

Scientists at the University of Georgia's College of Agricultural and Environmental Sciences are focused on providing the latest research-based findings to the farmers of Georgia. The information in the Annual Tobacco Report is part of that continually growing body of knowledge. We hope that you find this report useful in meeting challenges and finding new opportunities. We also welcome you to visit our research farms to see this work in the field.

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

Introduction

The University of Georgia (UGA) Tobacco Team conducts research and develops educational programs on producing and managing flue-cured tobacco. The team works closely with county agents, researchers, and commodity and agribusiness groups to provide sound, research-based recommendations to help Georgia tobacco growers increase production efficiency, improve pest management, and enhance the economic competitiveness of their farms.

According to the most recent U.S. Department of Agriculture crop survey data, Georgia produced 29.7 million pounds of tobacco in 2016 (down 8.4 percent from the previous year) on 13,500 acres at an average yield of 2,200 pounds/acre. Problems with tomato spotted wilt virus (associated with high early-season thrips populations) and black shank were particularly challenging during the 2016 season. But new, mission-oriented research summarized in this report will help to better understand and manage these problems. As the new head of the Department of Plant Pathology at UGA, I am particularly pleased to see that seven of the nine research summaries deal with the management of plant pathogens and diseases in tobacco. The continued support from the Georgia tobacco industry for applied research in my department and across the College of Agricultural and Environmental Sciences is greatly appreciated.

We hope that you find the information summarized in this volume useful as you prepare for the next season. We look forward to continued collaboration and extend best wishes for success with the 2017 crop.

Harald Scherm
Professor and Head, Department of Plant Pathology
Interim Assistant Dean for Research, College of Agricultural and Environmental Sciences

REGIONAL CHEMICAL SUCKER CONTROL TEST

S. S. LaHue - UGA
J. M. Moore – UGA

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

The purpose of this study is to report the effectiveness of some new combinations of existing materials used in combination (sequential) with fatty alcohols (a contact) and the potassium salt of maleic hydrazide (a systemic) with 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 residues of the cured leaf.

Materials and Methods

The field experiment was conducted at the University of Georgia Tifton Campus Bowen Farm. All cultural practices, including harvesting and curing procedures, were uniformly applied and follow current University of Georgia recommendations. Fertilization consisted of 10 lbs/acre of 9-45-15 in the transplant water, 500 lbs/acre of 6-6-18 at first cultivation, 500 lbs/acre of 6-6-18 at second cultivation, and an additional 120 lbs/acre of 15.5-0-0 at lay-by. Irrigation was applied as needed throughout the growing season. Plots consisted of two rows of thirty plants each. Ten uniform plants were sampled from each plot for sucker data. Residue samples were pulled from cured yield samples and consisted of 1 pound from each plot from each harvest. All treatments with the exception of topped not suckered (treatment 7) received two contacts applied at 4% (2.0gal/A) then 5% (2.5gal/A). All treatments with the exception of the topped not suckered (treatment 7) received the same rate of flumetralin (0.5gal/A) applied before the first harvest. All applications for all treatments utilized a narrow (8 inches) three nozzle configuration (TG3-TG5-TG3) applying 52 gal/A at 20 psi. The test involved four replications randomized with seven Sucker control treatments as follows:

1. 0.5 gal/A flumetralin + 2.0 gal/A MH - Two applications of contact followed in 5 days with a tank mix of flumetralin (0.5 gal/A) and MH (2.0 gal/A) applied before the first harvest.

2. 0.5 gal/A flumetralin + 1.5 gal/A MH - Two applications of contact followed in 5 days with a tank mix of flumetralin (0.5 gal/A) and MH (1.5 gal/A) applied before the first harvest.

3. 0.5 gal/A flumetralin + 1.0 gal/A MH - Two applications of contact followed in 5 days with a tank mix of flumetralin (0.5 gal/A) and MH (1.0 gal/A) applied before the first harvest.

4. 0.5 gal/A flumetralin; 2.0 gal/A MH (split application) - Two applications of contact followed in 5 days with flumetralin (0.5 gal/A). MH (2.0 gal/A) was applied after the first harvest.

5. 0.5 gal/A flumetralin; 1.5 gal/A MH (split application) - Two applications of contact followed in 5 days with flumetralin (0.5 gal/A). MH (1.5 gal/A) was applied after the first harvest.

6. 0.5 gal/A flumetralin; 1.0 gal/A MH (split application) - Two applications of contact followed in 5 days with flumetralin (0.5 gal/A). MH (1.0 gal/A) was applied after the first harvest.

7. TNS - Topped Not Suckered.

Results and Discussion

Due to historically high TSWV incidence at the Bowen Farm location, c.v. K 326 was treated in the greenhouse with the labeled rate of imidicloprid (0.8 oz Admire Pro/ 1000 plants) for TSWV suppression and transplanted on March 31. TSWV counts indicated an infection rate below 7% in the test.

The first contact (2.0gal/A) was applied on June 10 with sunny conditions. The second contact (2.5gal/A) was applied on June 15 in favorable conditions. The third application was applied on the morning of June 20 with partly sunny skies. The first harvest was on the morning of June 22 with the final application for all treatments following that afternoon. High afternoon temperatures were consistent throughout the test period. However, no chemical damage was observed for any of the treatments. The test was harvested on June 22, July 6, July 20, with the final harvest on August 4. The test was concluded after the suckers were pulled, counted, and weighed off 10 plants from each plot on August 11.

For 2016, yield and quality data varied little between treatments with the exception of treatment 7(TNS). Test yields were slightly below average with the TNS having the lowest yield at 1931 lb/A. Treatment 1 yielded the highest at 2821lb/A while treatment 6 had the highest value bringing in $3184/A. All chemical treatments increased yields 600-800 lb/A over the TNS. The price and grade indices were consistent and slightly below average for all treatments.

Sucker control was excellent with sucker number per plant low with a mean value of 1.0 or less for all chemical treatments. Green weight per plant and green weight per sucker was low for all treatments and generally was not affect by MH application timing. Percent control was excellent (>98%) for all chemical treatments.

Acknowledgments

The authors would like to thank the Georgia Agricultural Commodity Commission for Tobacco for financial support. Also, thanks to Michael Bartenfield, Hunter Brannon, Charles Conger, Eric Evans, Coby Griffin, Brooke Hester, Catherine Summers, and Molly Stutsman for dedicated technical assistance.

FLUE CURED TOBACCO VARIETY EVALUATION IN GEORGIA

S. S. LaHue - UGA
J. M. Moore - UGA

Introduction

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

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

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

Materials and Methods

The 2016 Official Variety Test and Regional Small Plot Test consisted of 36 and 20 entries respectively while the Farm Test had 16 entries. These tests were conducted at the University of Georgia Bowen Farm on Ocilla loamy coarse sand. All transplants were treated in the greenhouse with imidacloprid (0.8 oz Admire Pro/1000 plants) for tomato spotted wilt virus (TSWV). The Regional Farm Test and Regional Small Plot were mechanically transplanted on March 31, followed by the Official Variety Test on April 5. All tests were transplanted with 22-24 plants per field plot and replicated three times. Fertilization consisted of 10 lb/A of 9-45-15 in the transplant water (100gal./A), 500 lbs/acre of 6-6-18 at first cultivation, 600 lbs/acre 6-6-18 at second cultivation, and an additional 120 lbs/acre of 15.5-0-0 at lay-by for a total of 85 lbs/acre of nitrogen.

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

Results and Discussion

The 2016 Official Variety Test and Regional Farm Test produced good yields and average quality. All tests benefited from the application of Telone II, applied at the recommended rate, in November 2015 with good soil conditions which held nematode pressure to a minimum. In addition, the standard tray drench treatment of Admire resulted in a test average of around 7% TSWV symptomatic plants. The 2016 growing season was consistently hot. However, the crop provided average cured leaf quality on the first three harvests. The final harvest could have been delayed slightly for optimum maturity.

In the Official Variety Test, yield ranged from 2275 lbs/A for PVH 2275 to 3377 lbs/A for NC 196. Value of released varieties ranged from 2731 dollars/A for CC 700 to 4771 dollars/A for NC 196. Both price and grade index data were based on 2012 data due to lack of new data for 2016 at the time of publication. Price and grade data were slightly below average for all varieties. As a result, prices ranged from \$117/cwt for a number of varieties while PVH 1920 at \$166 had the best price per cwt for the released varieties. Grade indices mirrored price and ranged from 59 to 82 for PVH 1920. As a whole, later maturing varieties did not grade as well as the earlier maturing ones. Plant heights were normal and averaged around 42 inches while leaf numbers per plant averaged above 21 for the test. The days to flower were shorter for 2016 and averaged less than 70 days for all varieties. Leaf chemistry was average with alkaloids less than 3% and sugars averaging above 12%. The ratio of sugars to alkaloids ranged from 3.9 for PVH 2310 to 9.34 for NC 938. Generally, a value of 10 is desirable for this ratio. The Official Variety Test data are displayed in Table 1. Two- and three-year averages for selected varieties are found in Table 2.

The 2016 Regional Farm Test yielded and graded similar to the other variety tests. In the Farm Test (Table 3), ULT 123 had the lowest yield at 2358 lb/A. CU 206 yielded the highest at 2826 lbs/A, but its price of \$123/cwt was insufficient to give it the highest value. Value differed slightly with ULT 123 bringing in 3086 dollars/A and CU 213 providing 3992 dollars/A. CU 213 graded the best at \$145/cwt and having a grade index of 74. NC EX 79 had the lowest price and grade index of \$121/cwt and 63 respectfully. CU 206 also had a low grade index at 63. Generally, leaf chemistry was similar to the Official Variety Test, with sugars in the mid-teens and alkaloids less than 3%.

Acknowledgments

The authors would like to thank the Georgia Agricultural Commodity Commission for Tobacco for financial support. Also, thanks to Michael Bartenfield, Hunter Brannon, Charles Conger, Eric Evans, Coby Griffin, Brooke Hester, Catherine Summers, and Molly Stutsman for technical assistance.

Table 1. Yield, Value, Price Index, Grade Index, and Agronomic Characteristics of Released Varieties Evaluated in the 2016 Official Flue-Cured Variety Test at the University of Georgia, Tifton, GA.

Variety	Yield lb/A	Value $/A	Price Index[1] $/CWT	Grade Index[2]	Leaves/ Plant (number)	Plant Ht. in	Days to Flower	Total Alkaloids %	Reducing Sugars %	Ratio RS/TA
NC 95	2378	3571	150	77	21	42.1	64	2.53	14.2	5.62
K 326	2327	3462	149	77	22	38.9	65	2.22	15.6	6.99
K 346	2770	3245	117	59	21	40.3	62	2.12	14.8	6.97
K 730	2525	3486	138	70	23	41.4	62	1.96	16.4	8.39
NC 71	2798	3309	117	59	22	39.1	64	2.62	13.6	5.19
NC 72	2584	3214	124	62	23	43.5	64	2.25	15.1	6.70
NC 196	3377	4771	142	71	23	43.9	62	2.00	16.4	8.20
NC 606	2711	3465	128	66	22	41.7	62	2.03	14.2	6.97
NC 925	2822	3409	121	61	22	40.4	62	2.31	16.7	7.26
NC 938	2996	3977	134	68	22	42.3	62	1.86	17.4	9.34
NC 940	3056	3988	130	66	23	39.3	62	2.11	16.2	7.68
CC 13	2806	3685	132	66	22	42.0	62	1.87	16.4	8.77
CC 27	2707	3487	129	65	23	42.2	62	2.02	16.8	8.30
CC 35	3325	3878	117	60	23	48.3	66	2.15	13.8	6.43
CC 37	3155	3852	122	61	23	42.1	63	2.18	15.5	7.14
CC 143	3008	4474	148	76	23	42.2	63	2.11	16.4	7.79
CC 700	2247	2731	122	61	21	37.9	62	2.72	14.0	5.17
CC 1063	2782	3508	126	63	22	41.1	62	2.05	12.6	6.17
PVH 1015	2620	3199	123	63	23	42.9	62	2.12	17.2	8.12
PVH 1118	2806	3658	130	66	22	43.3	62	2.61	14.6	5.59
PVH 1452	3107	3855	124	63	22	43.2	62	2.62	11.9	4.54
PVH 1600	2953	4054	137	70	23	42.5	62	2.60	14.1	5.45
PVH 1920	2584	4288	166	82	23	41.0	62	2.31	13.9	6.03
PVH 2110	3191	4698	145	74	25	44.7	64	1.98	16.8	8.47
PVH 2254	2572	3653	143	73	22	45.0	62	1.90	16.9	8.91
PVH 2275	2081	2910	140	70	23	43.4	64	2.84	12.3	4.33
PVH 2310	2521	3664	145	74	22	42.9	62	2.42	9.4	3.90
SP 225	2588	3139	121	60	21	41.9	62	2.11	13.0	6.17
GF 318	3088	3634	118	60	22	42.9	62	2.20	15.5	7.06
GL 394	2862	3356	117	60	23	44.6	63	2.30	14.1	6.14
GL 395	2973	4338	146	73	21	42.3	62	2.32	12.5	5.39
GL 398	3036	3950	130	66	26	46.5	67	2.13	16.1	7.55
NC 970	3028	4051	133	68	23	41.1	64	2.30	12.9	5.60

Table 1. Yield, Value, Price Index, Grade Index, and Agronomic Characteristics of Released Varieties Evaluated in the 2016 Official Flue-Cured Variety Test at the University of Georgia, Tifton, GA (*continued*).

Variety	Yield lb/A	Value $/A	Price Index[1] $/CWT	Grade Index[2]	Leaves/ Plant (number)	Plant Ht. in	Days to Flower	Total Alkaloids %	Reducing Sugars %	Ratio RS/TA
XHN 60	3008	3714	124	61	22	44.1	63	2.57	14.7	5.71

GL 976	3111	4356	141	71	25	40.7	63	2.01	16.1	8.04
CU 201	3084	3565	117	59	23	46.5	66	2.29	14.2	6.21
NC 971	2996	3599	120	61	24	43.2	62	1.97	14.0	7.12
NC 972	3325	4128	124	64	23	41.7	66	2.42	15.5	6.43
LSD - 0.05	635.9	1153.6	27.2	14.3						

[1]Price Index based on two-year average (2011-2012) prices for U.S. government grades.
[2]Numerical values ranging from 1-99 for flue-cured tobacco based on equivalent government grades - higher the number, higher the grade.

Table 2. Comparison of Certain Characteristics for Released Varieties Evaluated in the 2016 Official Flue-Cured Tobacco Variety Test at the University of Georgia, Tifton, GA.

Variety	Yield lb/A	Value $/A	Price Index[1] $/CWT	Grade Index[2]	Leaves/ Plant (number)	Plant Ht. in	Days to Flower	Total Alkaloids %	Reducing Sugars %	Ratio RS/TA
				3 Year Average 2014, 2015 and 2016						
NC 95	2367	3472	146	75	22	46.7	74	2.19	16.9	7.90
K 326	2500	3848	154	78	22	42.2	74	2.10	16.7	8.14
K 346	2737	3762	140	69	20	40.7	67	2.09	17.1	8.24
NC 71	2684	3730	139	70	22	41.7	76	2.27	16.9	7.68
NC 72	2767	3696	135	67	23	46.2	74	2.02	16.6	8.34
NC 196	3126	4386	143	71	23	47.3	73	1.99	17.5	8.80
NC 925	2813	3545	126	64	22	42.9	72	2.16	17.2	8.05
NC 938	3118	4222	137	69	22	45.3	75	1.89	17.1	9.07
CC 13	2936	4214	145	73	22	44.4	69	2.01	17.0	8.57
CC 27	2925	4205	145	73	22	43.7	68	2.15	17.7	8.30
CC 35	2843	3753	135	67	22	49.4	71	2.13	15.8	7.51
CC 37	2836	3925	139	68	22	44.3	73	1.94	17.5	9.35
CC 143	3019	4694	154	78	23	46.1	72	1.83	17.6	9.73
CC 700	2620	3714	143	71	21	41.5	69	2.30	15.4	6.87
CC 1063	2978	4550	153	75	22	45.3	71	2.12	15.4	7.32
PVH 1452	2921	4297	149	74	22	45.2	70	2.18	15.4	7.37
PVH 2110	3004	4602	154	77	24	46.7	73	2.05	17.7	8.63
PVH 2254	2853	4205	147	74	22	47.9	73	1.77	18.6	10.57
PVH 2275	2678	4139	154	76	22	45.6	70	2.77	14.1	5.14

Table 2. Comparison of Certain Characteristics for Released Varieties Evaluated in the 2016 Official Flue-Cured Tobacco Variety Test at the University of Georgia, Tifton, GA (*continued*).

Variety	Yield lb/A	Value $/A	Price Index[1] $/CWT	Grade Index[2]	Leaves/ Plant (number)	Plant Ht. in	Days to Flower	Total Alkaloids %	Reducing Sugars %	Ratio RS/TA
				3 Year Average 2014, 2015, and 2016(*continued*)						
PVH 2310	2640	4384	166	82	22	47.1	73	2.23	12.2	5.54
SP 225	2733	3849	141	70	21	45.6	71	2.10	15.8	7.61
GF 318	3086	4051	134	67	22	43.6	70	2.16	17.7	8.23

GL 395	2871	4239	150	75	21	44.8	69	2.31	15.2	6.70
GL 398	3000	3954	133	67	23	46.4	72	2.06	17.7	8.68
2 Year Average 2015-2016										
NC 95	2327	3198	137	71	22	47.3	69	2.26	16.5	7.50
K 326	2410	3536	147	75	22	43.4	69	1.97	16.4	8.55
K 346	2561	3723	148	73	20	41.6	63	2.05	17.1	8.39
K 730	2335	3440	148	75	23	43.7	65	2.15	16.0	7.51
NC 71	2662	3318	125	63	23	42.9	70	2.25	15.8	7.39
NC 72	2572	3746	145	73	23	47.5	69	1.95	15.6	8.24
NC 196	2994	4501	153	77	23	47.4	68	2.00	17.2	8.61
NC 606	2517	3759	151	76	22	47.6	67	1.94	17.0	8.85
NC 925	2666	3443	129	65	23	45.7	67	2.10	17.2	8.28
NC 938	2925	4199	144	73	23	47.9	69	1.83	17.1	9.33
CC 13	2715	4046	150	75	23	45.3	65	1.86	17.0	9.12
CC 27	2701	4100	152	76	22	45.0	64	1.98	17.2	8.71
CC 35	2745	3641	138	70	23	52.1	71	2.03	15.4	7.66
CC 37	2793	3855	140	70	23	46.6	69	1.84	17.0	9.67
CC 143	2763	4513	158	80	24	47.2	68	1.92	17.1	9.05
CC 700	2286	3401	149	73	21	42.5	64	2.32	15.2	6.85
CC 1063	2735	4069	149	73	23	46.3	68	1.99	15.0	7.59
PVH 1452	2823	4201	151	75	23	46.0	65	2.23	14.5	6.92
PVH 2110	2746	4292	157	79	25	48.6	68	1.98	17.7	8.94
PVH 2254	2605	3723	144	74	23	49.9	68	1.72	17.9	10.54
PVH 2275	2307	3665	157	78	22	46.7	66	2.84	13.0	4.59
PVH 2310	2377	3877	164	82	22	47.5	69	2.31	10.3	4.47
SP 225	2552	3570	141	71	22	46.6	67	1.99	15.5	7.89
GF 318	2794	3896	142	71	23	45.9	64	2.13	16.8	7.95
GL 395	2607	4026	156	78	22	46.3	65	2.14	14.8	7.05
GL 398	2777	3805	139	70	25	49.0	72	2.16	16.7	7.75

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

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

Table 3. Yield, Value, Price Index, Grade Index and Agronomic Characteristics of Varieties Evaluated in the 2016 Regional Farm Test at the University of Georgia, Tifton, GA.

Variety	Yield lb/A	Value $/A	Price Index[1] $/CWT	Grade Index[2]	Leaves/ Plant (number)	Plant Ht. in	Days to Flower	Total Alkaloids %	Reducing Sugars %	Ratio RS/TA
NC 95	2432	3313	136	70	18	41.4	65	3.10	13.6	4.38
K 326	2493	3241	130	67	21	39.6	71	1.90	14.4	7.58
ULT 115	2642	3753	142	73	24	45.4	77	1.92	14.5	7.54
NC EX 78	2707	3761	139	72	21	44.3	74	1.83	12.7	6.95
CU 218	2776	3827	139	71	21	41.1	78	1.88	16.4	8.72
NC EX 79	2691	3222	121	63	22	39.8	67	2.46	12.9	5.22
XHN 65	2552	3651	144	73	21	41.6	74	1.94	17.0	8.79
CU 206	2826	3466	123	63	20	42.3	64	2.12	16.9	7.99
ULT 123	2358	3086	130	68	23	43.3	78	1.36	14.4	10.59
XHN 58	2445	3283	135	69	21	39.8	78	1.69	17.4	10.26
CU 220	2786	3925	141	73	22	40.7	66	2.03	14.6	7.19
CU 213	2743	3992	145	74	22	43.7	67	2.47	13.4	5.42
GL EX 365	2757	3735	136	70	25	44.3	77	2.19	15.4	7.05
NC EX 73	2782	3828	137	71	24	45.4	73	1.91	12.1	6.32
CU 219	2402	3485	144	73	22	42.3	78	2.46	13.3	5.40
CU 214	2564	3296	128	67	22	44.9	68	2.11	15.2	7.20
LSD -0.05	406.9	724.3	16.1	7.3						

[1]Price Index based on two-year average (2011-2012) prices for U.S. government grades.
[2]Numerical values ranging from 1-99 for flue-cured tobacco based on equivalent government grades - higher the number, higher the grade.

ADDRESSING ISSUES WITH THRIPS AND TOMATO SPOTTED WILT VIRUS (TSWV) IN TOBACCO

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Overview of work conducted in 2016

In the 2016 field season we monitored thrips and TSWV incidence in tobacco by conducting trials at the Bowen Tobacco Research Farm in Tifton. In addition, we also evaluated the presence of peanut in the nearby vicinity of tobacco as an inoculum source of TSWV. Further the impact of insecticide application (particularly imidacloprid), as well as Actigard application and its variations on TSWV incidence were evaluated both under field situations as well as in the greenhouse.

Results

Thrips and TSWV incidence

Thrips were monitored in field perimeters in the Bowen farm using yellow sticky cards. The sticky c ards were replaced at bi-weekly intervals. The retrieved sticky cards were taken to the vector biology l aboratory and identified to species using standard taxonomic keys. The samples were sorted as tobacco thrips (*Frankliniella fusca*) and others. The counts are presented below.

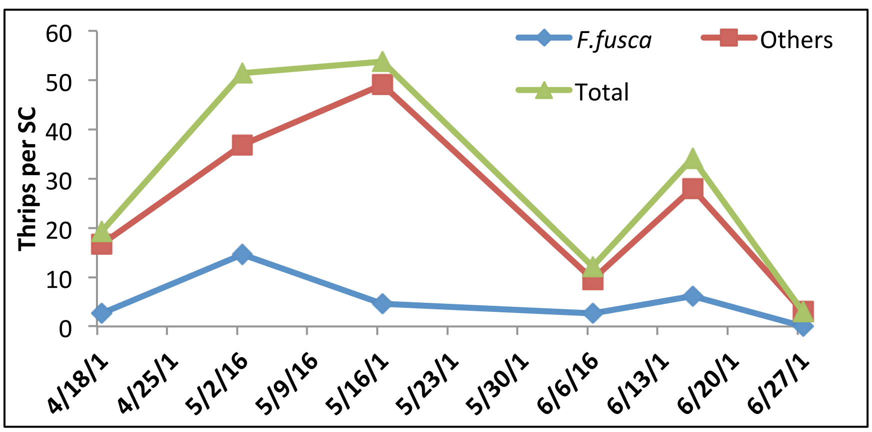

Figure 1. Thrips counts from field perimeter at the Bowen Tobacco Research Farm in 2016.

In general fewer *F. fusca* were observed when compared with other thrips species. The others commonly found included *F. occidentalis*, *F. tritici*, and *F. bispinosa*. It is traditionally been assumed that *F. fusca* is probably more important than other thrips species when it comes to TSWV transmission. It is possible that some of the other species noted could have also influenced TSWV infection. Transmission capabilities of these thrips species have not been studied in detail with reference to tobacco, and it needs to be examined in greater detail. Percentage of TSWV infection in tobacco plants was visually assessed by inspecting plants when the sticky cards were retrieved. The percentage of TSWV infection in plots that received no insecticide as well as Actigard treatments was around 20% towards the last sampling date.

A trial was conducted to assess the impact of imidacloprid and Actigard applications with and without the presence of peanut crop nearby. Peanut crop allows thrips colonization and is a host of TSWV; whereas, tobacco rarely allows colonization of thrips. Therefore, the impact of peanut on TSWV incidence in tobacco was assessed, and the results are presented below.

Thrips counts

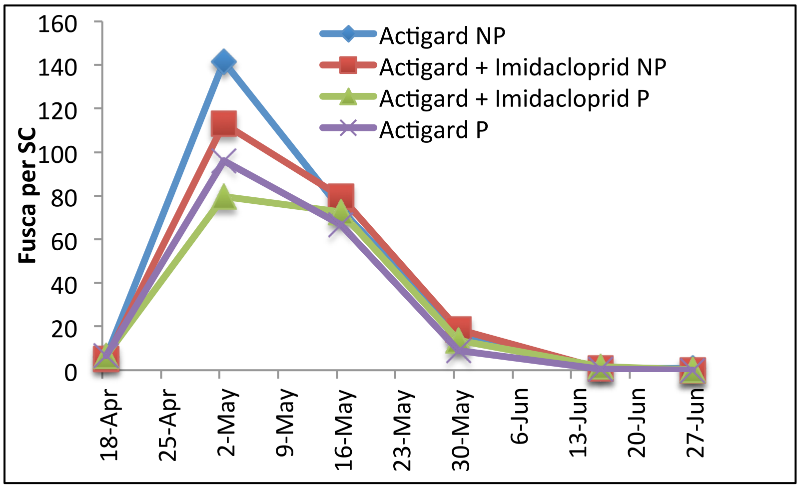

Figure 2. *F. fusca* counts from sticky cards with and without Actigard and Inidacloprid. P and NP indicate peanuts and no peanuts.

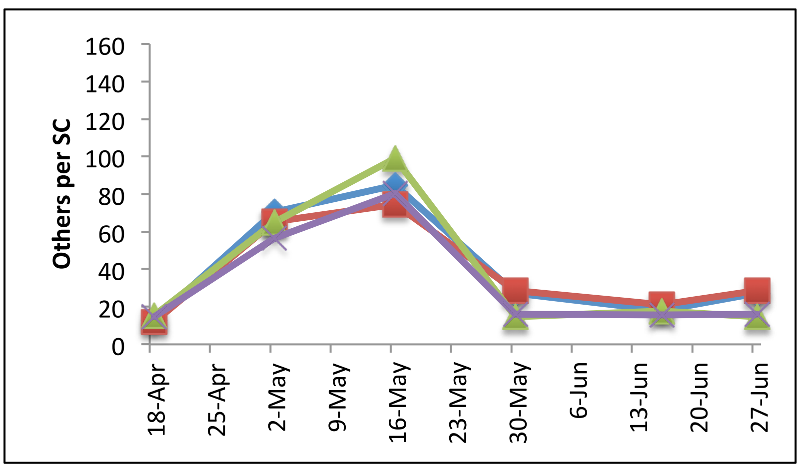

Figure 3. Thrips counts from sticky cards with and without Actigard and Inidacloprid. P and NP indicate peanuts and no peanuts. The legend is the same as in Figure 2.

The results indicate that *F. fusca* and other thrips species peaks are not at the same time. The *F. fusca* peak seems to appear earlier than others. This information is critical because the younger tobacco seedlings are much more susceptible to TSWV than older seedlings.

TSWV incidence

TSWV incidence was monitored every two weeks, but only the final counts obtained on June 27 are alone presented here. The incidence of TSWV infection ranged from 11 to 18% among the treatments and non-treated. The incidence of TSWV infection was slightly lower in plots that at least received imidacloprid application (11 vs 18%; 14 vs 18%). The presence of peanut in the nearby vicinity did slightly increase TSWV incidence in tobacco plants especially when no imidacloprid was applied. These results reiterate insecticide applications and the nearby host's susceptibility to thrips and/or TSWV could have an effect of TSWV incidence in the crop host such as that of tobacco and it needs to be examined in greater detail.

The results on heights and weights are included below.

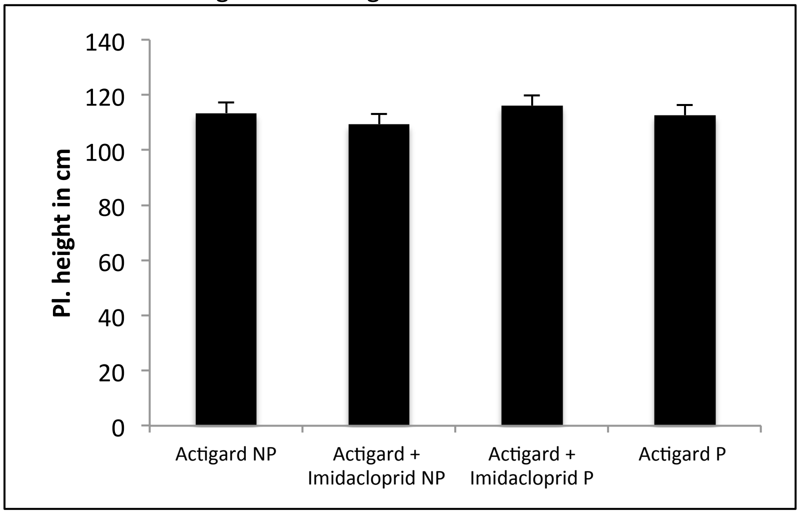

Figure 4. Plant heights with and without Actigard and Inidacloprid. P and NP indicate peanuts and no peanuts.

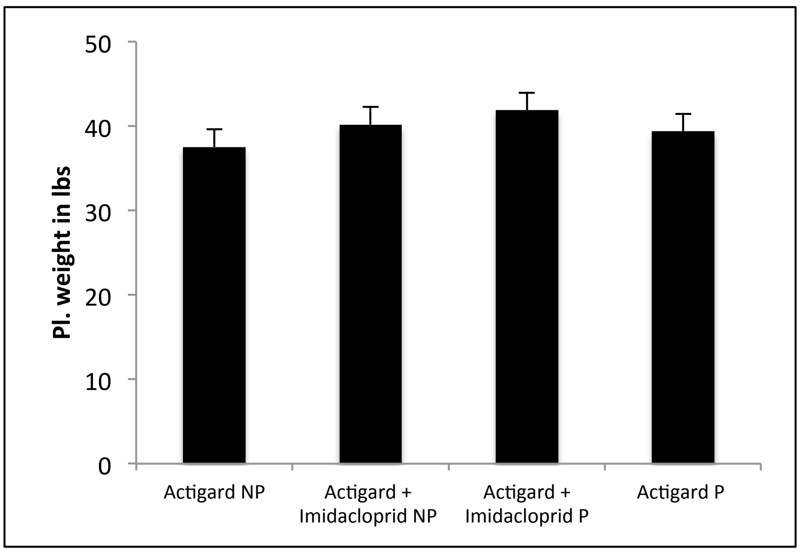

Figure 5. Plant weights with and without Actigard and Inidacloprid. P and NP indicate peanuts and no peanuts.

The results indicated that plant fitness measurements such as heights and weights were not influenced by the addition of imidacloprid and also whether a TSWV and thrips reservoir such as peanut was present in the nearby vicinity or not.

The results, in general, reiterate that Actigard application could have a role in the reduction of TSWV incidence. However, such an effect does not seem to translate into yield benefits given the moderate TSWV pressure that was encountered in 2016. The application of imidacloprid also does not seem to offer any realizable benefits at the end of the season. More research on pesticide residual toxicity and resistance to insecticides in thrips needs to be evaluated in detail to comprehend the effects of imidacloprid in thrips and TSWV suppression.

Greenhouse experiment

A greenhouse experiment was conducted in 2016 to assess the timing of plant defense regulator Actigard and its usefulness in suppressing TSWV incidence in terms of inoculation percentage as well as severity of symptoms. This research was warranted, as initial Actigard drenching in seedling trays seem to have a growth stunting effect. In recent years, the practice has switched to applying Actigard as sprays. The issue with that practice is that it is not clear if spraying would kick in plant defenses prior to inoculation of TSWV by thrips; in the event that the inoculation has already occurred, would Actigard offer any potential benefits in suppressing TSWV symptom severity? The experiment in the greenhouse was conducted with tobacco seedlings and mechanical inoculation of TSWV. Those results are presented below.

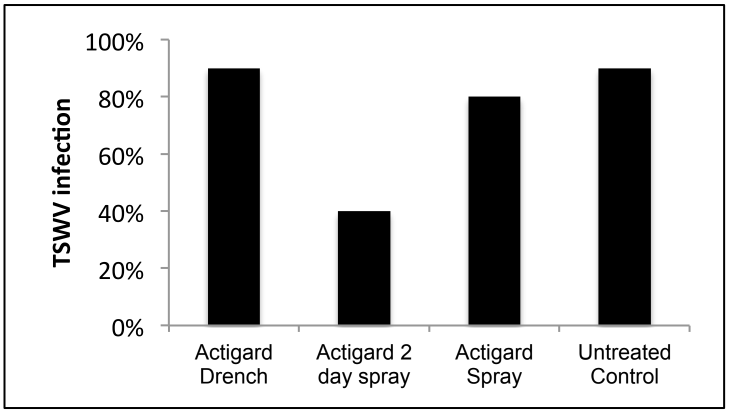

Figure 6. TSWV infection percentages following multiple modes of Actigard application and mechanical inoculation of TSWV.

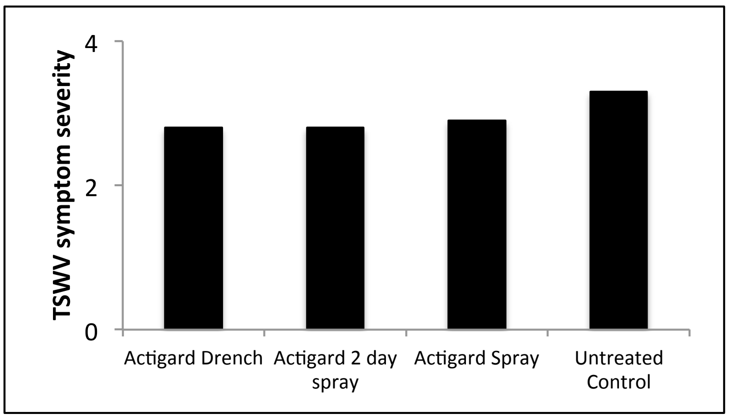

Figure 7. TSWV infection severity following multiple modes of Actigard application and mechanical inoculation of TSWV. Severity was assessed using a 1 to 5 scale with 5 being the most severe.

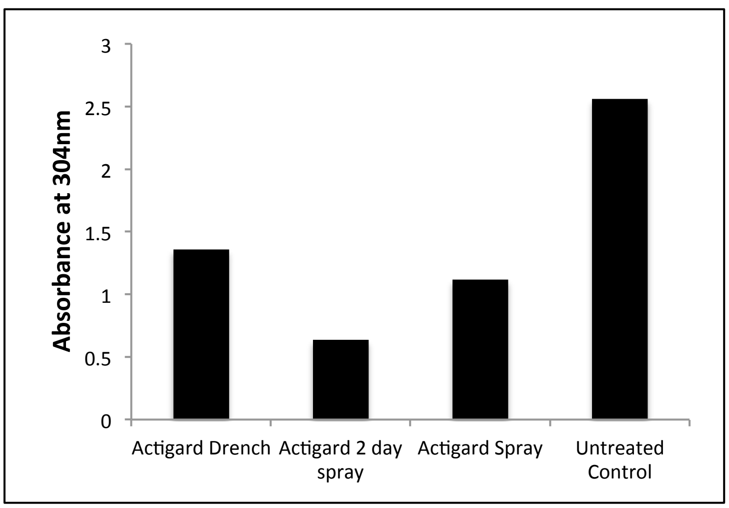

Figure 8. TSWV accumulation indirectly measured through intensity of absorbency values using a spectrophotometer.

Interpretations

Applications of Actigard at 2 days post inoculation seems to be more effective at suppressing TSWV infection, symptom severity, and TSWV accumulation (as measured by absorbance) than other methods of Actigard application including tray drenching and spraying. Overall, application of Actigard does seem to reduce virus accumulation, but does not seem to impact symptom severity overall.

FERTILITY ASSOCIATED WITH LEVELS OF TOMATO SPOTTED WILT VIRUS (TSWV) IN TOBACCO

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Introduction

Previously we demonstrated that tomato spotted wilt (TSW) severity was related to soil mineral levels, and a large proportion of the plant's response was correlated with the copper to iron ratio (Cu:Fe). Using Cu:Fe values we successfully predicted high risk and low risk sites on the University of Georgia Bowen Research Farm near Tifton, Ga in 2014 and 2015, where levels of TSW were significantly higher in the high risk sites in both years. In addition, chelated formulations containing copper, iron, manganese or zinc were applied with and without acibenzolar-S-methyl (actigard) to determine if the plant's response could be manipulated. Although these treatments failed to improve levels of constitutive resistance, an interesting observation was made. In both years, tobacco plants treated with zinc + actigard experienced significantly more TSW than plants treated with actigard alone (**Fig. 1**).

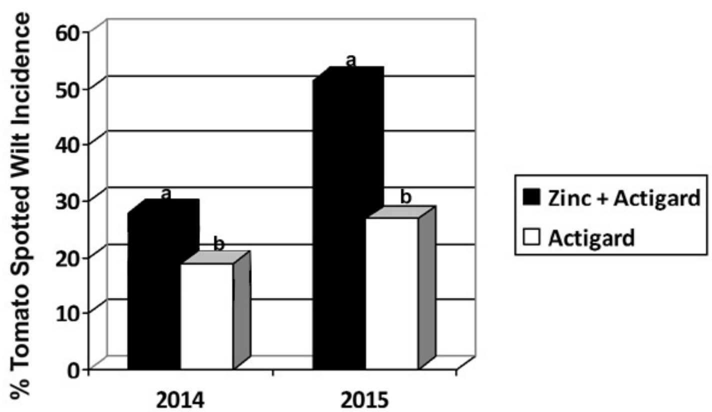

Figure 1. Percent tomato spotted wilt (TSW) incidence in tobacco with two treatments, zinc + actigard and actigard alone, in 2014 and 2015.

If true, the implication that nutrition can affect the efficacy of actigard is significant and could lead to improved activity in the use of actigard. Thus, one of the objectives for 2016 was to verify that systemic acquired resistance activated by actigard is indeed affected by applications of zinc.

Materials and Methods

The same high risk site used in 2014 and 2015 were used to apply zinc + actigard or actigard alone as previously described (Selph et al. 2015). Foliar treatments of tobacco plants with zinc + actigard (three application, two-weeks apart) or actigard alone (three application, two-weeks apart) were made under field conditions. Plots not treated with either of the treatments served as a negative control. Three weeks after last application, tobacco leaves (n=3) from each plot were harvested and analyzed as described below. RNA was extracted using RNeasy Plus Mini Kit

(Qiagen, Germantown, MD 20874) and stored at -80 C. The extracts were shipped on dry ice to Science Exchange (Palo Alto, CA) for transcriptome analysis. Results of transcriptome analysis were sent to the Georgia Advanced Computing Resource Center (GACRC) and Dr. Walter Lorenz, Assistant Research Scientist Institute of Bioinformatics, University of Georgia, Athens, GA for preliminary analysis using a supercomputer. Transcriptome was further analyzed in Tifton by screening for known mRNA transcripts related to plant disease resistance pathways and searching mRNA sequences decoded to constituent amino acids using online BLAST search in GenBank (National Center for Biotechnology Information, Bethesda, MD).

Remnant RNA samples from tobacco tissues from the same treatments were used to conduct qPCR for relative activity of MnSOD, NPR1, and PR1 genes. A template of cDNA was prepeared from the RNA using iScript cDNA synthesis kit (Biorad, Hercules, CA 94547). PCR was conducted using a Smart Cycler System (Cepheid, Sunnyvale, CA 94089). The enzyme MnSOD is a superoxide dismutase that detoxifies reactive oxygen species (ROS) resulting in formation of hydrogen peroxide (H_2O_2). H_2O_2 is known to stimulate the production of salicylic acid a signaling compound which binds with NPR1 resulting in activation of PR1, a plant resistance gene which is also activated by actigard (Durrant and Dong, 2004) .

Results and Discussion

Comparing the transcriptome of tobacco tissues treated with zinc + actigard, actigard alone, or untreated control, over 2×10^7 (20 million) mRNA transcripts were identified. Results provided by the GACRC narrowed down the number of possible transcripts of interest to 9,301. To date, we have identified 421 transcripts in 33 different classes of proteins known to be involved in plant disease resistance. Of these, 331 (78 %) transcripts were down-regulated in the zinc + actigard treatment compared to tobacco treated with actigard alone. Furthermore, 32% of the transcripts that were up-regulated in the zinc + actigard treatment are known to be up-regulated in plants expressing greater susceptibility. Together nearly 86% of the transcripts identified, belonged to pathways related to plant resistance indicating a factor in decreasing resistance in the zinc + actigard treated plants. Pathways affected by these transcripts leading decreased resistance in the zinc + actigard treated tobacco include serine-threonine leucine-rich repeat kinases (known effector receptors), mitogen-activated kinase (MAPK) cascade, redox homeostasis, lipid metabolism, carbohydrate metabolism, molecule transport, transcription factors and pathogenesis-related genes (**Fig. 2**). The most important of these were the down-regulation of myb, bHLH and WRKY and up-regulation of zinc-finger transcription factors in the plant nucleus. These are transcription factors that regulate the plant defense genes and was reflected as down regulation of 19 plant resistance proteins in the zinc + actigard treatment compared to actigard alone.

Activity of NPR1 and PR1, perhaps the two key most genes in the defense pathway activated by actigard, was repressed in tobacco tissue samples (**Figs. 3 & 4**). Since salicylic acid binds to NPR1 and that is necessary to activate PR1, this is evidence that gene regulation governing the expression of systemic acquired resistance is affected when zinc is applied. These data support the field observations of both the spray trial in which actigard was evaluated alone or in combination with heavy metal cations such as zinc. It also offers an explanation of why there was less disease in the predicted low risk zone compared to the high risk zone because risk predictions were based on heavy metal cation concentrations in the soil. Further research needs to be conducted as to how zinc is exactly governing these events. For one thing, tissue analysis indicated earlier that there were no significant differences in zinc levels in tobacco tissues treated with zinc + actigard vs actigard alone. However, there were significantly higher levels of iron (Fe) in tobacco tissues treated with the zinc. One possible explanation is that there is a feedback mechanism of zinc increasing Fe uptake. Increased levels of Fe in tobacco tissues that experienced higher levels of TSW more readily fit into our risk prediction models. But it is not fully understood how these events all occur. Finally, the key to controlling the regulation of plant disease resistance pathways through nutrition appears to lie in finding the key to unlock the appropriate signal or regulator. From our data, it would appear that this lock is up-stream from H_2O_2. Since so many directions are affected at the junction box of H_2O_2, it would be simpler and more efficient if the control was up-stream from H_2O_2 and then governed the levels of H_2O_2 in the system.

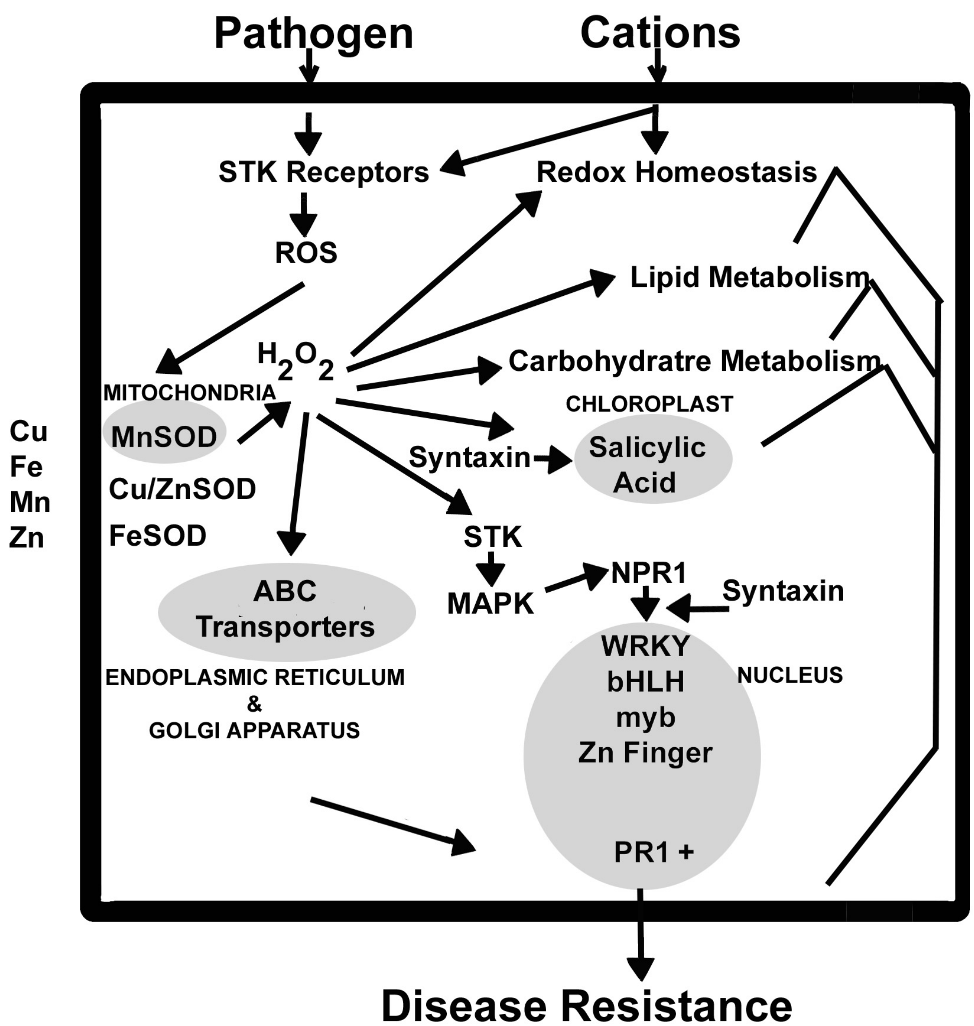

Figure 2. Defense-related pathways identified by tobacco transcriptome as being down-regulated in tobacco treated with zinc + actigard compared to tobacco treated with actigard alone. Arrows indicate direction of the pathway. Lines without arrowhead are speculative in their direction.

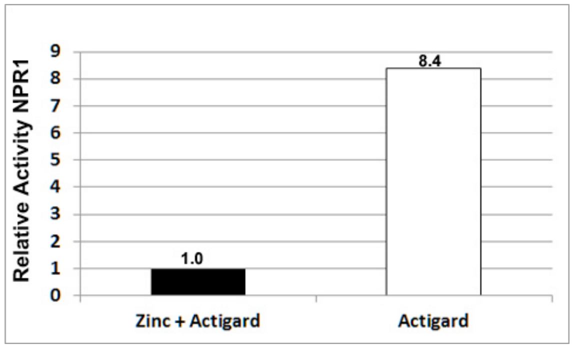

Figure 3. Relative activity of NPR1 in tobacco tissues treated with either zinc + Actigard or Actigard alone in 2015.

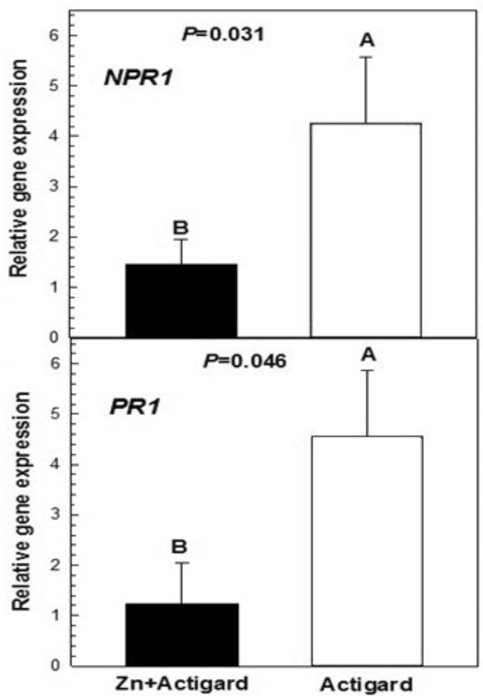

Figure 4. Relative activity of NPR1 and PR1 in tobacco tissues treated with either zinc + Actigard or Actigard alone in 2016.*

*** RNA extracts sampled from the same leaves used for transcriptome analysis**

References:
Durrant, W.E. and X. Dong. 2004. Systemic Acquired Resistance. Annu. Rev. Phytopathol. 42:185-209.

Selph, A., B. Dutta, S. Rooks, A.S. Csinos, S.S. LaHue, and R.D. Gitaitis. 2015. Soil Fertility Levels Associated with Levels of Tomato Spotted Wilt in Tobacco. pp 36-39 in: Tobacco Research Report 2014. University of Georgia Special Bulletin 63-8, January 2015.

EVALUATION OF TOBACCO CULTIVARS AND NEMATICIDES FOR ROOT KNOT MANAGEMENT IN GEORGIA – 2016

Alex Csinos, Unessee Hargett, and Steve LaHue, Coastal Plain Experiment Station, University of Georgia, Tifton, GA

Introduction:

Many crops in Georgia that are rotated with tobacco are susceptible to root knot nematode. Cotton is susceptible to *M. incognita*, peanuts are susceptible to *M. arenaria*, and *M. javanica*. Tobacco and vegetables in general are susceptible to all root knot species with a few exceptions. Several species of root knot nematodes are found in Georgia, *Melodogyne arenaria*, *M. incognita*, and *M. javanica*. All species are capable of infecting tobacco. Most commercial tobacco cultivars have resistance to Race 1 and Race 3 of *M. incognita* (Southern RKN), but have no resistance to Race 2 and Race 4 of *M. javanica* (Japanese RKN), or *M. arenaria* (peanut RKN). Without resistance to these pests, the use of rotation, crop destruction, and nematicides are the only means to manage the problem.

Several tobacco cultivars were evaluated for tolerance to *M. arenaria* (peanut root knot nematode) in 2011-2013 with very favorable results. NC-71, the standard, was out performed by several tobacco cultivars up to 600 pounds per acre.

The use of Telone II is recommended for management of root knot nematode in Georgia. However, Telone II has become expensive ($17 per gallon +) and at times is difficult to obtain. In addition, special precautions are required for the use of fumigants. Several new contact nematicides are being evaluated by chemical companies and a few of them show promise on tobacco.

In 2013, we evaluated MANA MC W-2 (Nimitz) fluensulfone for management of peanut root knot nematode using both the NC-71 standard cultivar and CC-35, a nematode tolerant cultivar. In general all rates of Nimitz were equivalent to Temik and Telone in the NC-71 cultivar. However, Nimitz outperformed Telone in the trial with CC-35. In general CC-35 outperformed NC-71 by 800+ pounds/acre in the absence of a nematicide and had three times less nematode root knot damage. Data is 2014 demonstrated excellent results with Nimitz in both CC-35 and in particular with NC-71. In 2014 and 2015 Nimitz was applied in a concentrated 12-16 inch band as compared to the previous year. Results from 2014 were remarkably better than 2013. Bayer has been evaluating a new product, Velum Total (fluopyiam and imidacloprid) for management of nematodes. Early trials on tobacco have demonstrated positive results and evaluation of Velum Total on tobacco. This study evaluates tobacco cultivars in Georgia with varying levels of tolerance to root knot nematode with and without Luna Privilege plus imidacloprid (Velum Total).

Materials and Methods:

This study was conducted at the Bowen Farm in Tifton, GA, in a field infested with Melodogyne arenaria nematode (peanut root knot nematode). Tobacco cultivars used were K-394, NC-196, K-326, and CC-35. The cultivar CC-35 has been demonstrated to exhibit high tolerance to *M. arenaria*. The other cultivars have *M. incognita* resistance, but show little resistance to *M. arenaria*. The test was a split plot design evaluating tobacco cultivar tolerance and the experimental nematicide “flupyram” as formulated in the product “Luna Privilege”. Since the data secured to date used imidacloprid (Admire) as a partner “Velum Total”, we added Admire to “Luna Privilege” to make comparisons to previous year’s data.

Plots were 3 feet long, 44 inches wide, and replicated 6 times. Plots were planted on April 19. TSWV plants were counted weekly and infected plants removed from calculation of yield. Root gall ratings were made on June 1 and August 3 at final harvest. Application of Velum Privilege plus Admire were made by transplant water applications, (200 gal/A), at the time of planting on April 19. The nematicide was applied by a CO_2 sprayer mounted on the transplanter and spray directed into the transplanter water stream in the planter shoe. Plots were harvested three times, June 29, July 11, and July 28. Dry weight yields per acre were calculated by eliminating plants killed by TSWV. Root gall rating was on a scale of 0-10 where 0 = no damage and 10 = plants killed by nematodes.

Results:

Root galling in the plot area was relatively high, with non-treated plots having a RGI rating of 8-9 out of 10.At mid-season (Table 1), all of the non-treated cultivars except CC-35 had higher RGI ratings than the same cultivar that was treated with Velum Privilege plus Admire. The same trend was true for ratings that were taken after harvest (Table 1). All cultivars except CC-35 had very high ratings (8-9) when un-treated, but were significantly reduced in nematode damage when treated with Luna Privilege plus Admire. The cultivar CC-35 showed a much reduced damage from nematodes even when not treated with Luna Privilege plus Admire.

Yields of tobacco cultivars ranged from a low of 1701 pounds per acre to a high of 3737 pounds per acre. All cultivars except CC-35 had significantly higher yields when treated with Luna Privilege plus Admire. Most increases were around 900-1200 pounds per acre increases. The cultivar CC-35, which has high tolerance to *M. arenaria*, only increased from 3450 pounds per acre for the non-treated to 3737 pounds per acre for the treated. This study demonstrates the high level of tolerance CC-35 has for *M. arenaria* nematode.

Summary:

This study demonstrates that Luna Privilege plus Admire has good activity on peanut root knot nematode on tobacco. All of the popular cultivars, NC-196, K-326, and K-394, were increased in yield with the application of Luna Privilege plus Admire. These cultivars have resistance to *M. incognita* but do not have resistance (tolerance) to *M. arenaria*, the peanut root knot nematode.

Acknowledgements:

The author would like to thank Sarah Beth Michael, Wil Bently, John Whitaker, Matt Carver, and Scott Birchell for assistance in establishing and maintaining research plots and assistance in collection of data. The author would also like to thank the Georgia Agricultural Commodity Commission for Tobacco in providing funding for the research and to Altria Client Services – Philip Morris USA for funds to assist student workers.

Table 1. Tobacco Cultivars With and Without Luna Privilege + Admire -- 2016			
Treatment	Rate (oz/A)	Root Gall Index	
		June 1	August 3
NC-196	---	3.25[a]	9.3[a]
K-326	---	3.17[a]	9.0[a]
K-394	---	3.67[a]	8.3[a]
CC-35	---	1.75[b]	3.7[c]
NC-196 + Luna Privilege + Admire	6.5 + 4.0	0.91[bc]	5.9[b]
K-326 + Luna Privilege + Admire	6.5 + 4.0	1.58[b]	6.7[b]
K-394 + Luna Privilege + Admire	6.5 + 4.0	1.58[b]	6.8[b]
CC-35 + Luna Privilege + Admire	6.5 + 4.0	0.5[c]	1.2[d]

Means followed by the same letter are not statistically different from each other at P. = 0.1. Root gall index on a scale of 0-10.

Table 2. Tobacco Cultivars With and Without Luna Privilege + Admire -- 2016.		
Treatment	Rate (oz/A)	Yield (lb/A)
NC-196	---	2,038[b]
K-326	---	2,038[b]
K-394	---	1,701[b]
CC-35	---	3,450[a]
NC-196 + Luna Privilege + Admire	6.5 + 4.0	2,977[a]
K-326 + Luna Privilege + Admire	6.5 + 4.0	3,144[a]
K-394 + Luna Privilege + Admire	6.5 + 4.0	2,994[a]
CC-35 + Luna Privilege + Admire	6.5 + 4.0	3,737[a]
Means followed by the same letter are not statistically different from each other at P. = 0.1.		

Evaluation of Tobacco Cultivars and Nematicides for Root Knot Management.
2016.

Skip Row									Skip Row
	601-A	601-B	603-B	603-A	602-A	602-B	604-B	604-A	
	503-A	503-B	504-B	504-A	501-A	501-B	502-B	502-A	
	404-A	404-B	401-B	401-A	402-A	402-B	403-B	403-A	
	302-A	302-B	304-B	304-A	303-A	303-B	301-B	301-A	
	201-A	201-B	203-B	203-A	202-A	202-B	204-B	204-A	
	103-A	103-B	102-B	102-A	104-A	104-B	101-B	101-A	

Treatment

Planted March 30, 2016

1-A. NC-196
2-A. K-326
3-A. K-394
4-A. CC-35

1-B. NC-196 + Luna Privilege + Admire 6.5 + 4.0 oz
2-B. K-326 + Luna Privilege + Admire 6.5 + 4.0 oz
3-B. K-394 + Luna Privilege + Admire 6.5 + 4.0 oz
4-B. CC-35 + Luna Privilege + Admire 6.5 + 4.0 oz

Plots 30 ft long, 15 ft alley ways, single row with 20 plants, 6 replications -- paired plot trial.

02/22/2016

EVALUATION OF TOBACCO CULTIVARS AND NEW FUNGICIDES FOR MANAGEMENT OF TOBACCO BLACK SHANK, 2016

Alex Csinos, Plant Pathologists, Unessee Hargett, and Steve LaHue, Coastal Plain Experiment Station, UGA Tifton Campus, Tifton, GA.

Introduction:

Tobacco black shank caused by *Phytophthora nicotianae* (Pn) has two races, Race 0 and Race 1, in all tobacco growing areas of the USA including the Florida and Georgia area. The introduction of the Ph gene into tobacco cultivars has provided resistance to Race 0 but not Race 1. This has caused a shift in the race make up of Ppn to shift primarily to Race 1 of the pathogen. We have no commercial cultivars with resistance to Race 1 available to growers. However Florida 301 resistance, which is a non-specific general resistance to Pn, does exist. Thus to manage Ppn, we must rely on the use of chemical treatments, rotations, and sanitation. Even with rotations away from tobacco and sanitation to stop the spread of the pathogen, growers can sustain high losses to the disease.

Both Cross Creek Seed and Rickard Seeds list flue-cured tobacco cultivars with moderate to high levels of resistance to Race 0 and Race 1 of *Phytophthora nicotianae*. Wild type resistance to Race 1 of Ppn is not known, thus the apparent reduction in loss to Race 1 may be tolerance to the pathogen. In 2012 we evaluated SP-225 and found exciting results which demonstrated a significant reduction in disease with that cultivar.

Within the last few years, several companies have introduced oomycete specific fungicides for control of Pythium and Phytophthora diseases in vegetables. Many of these materials are currently available for use on vegetables, while others are still under evaluation.

In 2013, D EXP also known as QGU 42 has been named "ZORVEC" and has the common chemical name of Oxathiapiprolin. Syngenta has purchased the USA sale rights and has renamed D EXP QU 42, Orondis (Oxathiapiprolin). Persidio (Valent), Zorvec (DuPont), and Ridomil Gold (Syngenta) were evaluated on K-326 (black shank susceptible), NC-71 (Race 0 resistant), and SP-225 (Race 0 and 1 tolerant) tobacco cultivars. All of the fungicides demonstrated good activity on management of black shank, but performed better on resistant or tolerant cultivars. Management of black shank appears to be fungicide-cultivar related. This would suggest that certain cultivar-fungicide combinations may manage black shank better than others. This study continues to evaluate combinations of fungicides and tobacco cultivar resistance to black shank.

Materials and Methods:

This study was conducted at the Black Shank Nursery at the Coastal Plain Experiment Station, which has a history of continuous black shank since 1962.

Tobacco cultivars were planted on April 19 in split plot design evaluating tobacco cultivar resistance and fungicides for management of black shank. Cultivars used were SP-225, NC-71, K-326, and NC-19 (see tables for resistance characteristics). Plots were single rows, 4 feet wide, 30 feet long, and replicated 5 times. Treatments receiving transplant water treatments (TPW) received the fungicide in the TPW at the time of transplanting, April 19. Treatments that received a layby treatment were applied on May 4, using a backpack CO_2 sprayer making a banded spray over the plants using a 3 nozzle spray boom.

TSWV infected plants were counted weekly and those plants removed from consideration in determining yield. Stand counts were made on a bi-weekly basis to calculate black shank infected plants. Three harvests were made, July 5, July 15, and July 29, green leaves weighed and converted to yield in pounds per acre.

Results:

K-326 (Table 2) is the most susceptible of all the cultivars evaluated. Yield in the non-treated was only 125 pounds per acre and even with the best treatments had only a little over 1200 pounds per acre yield. Black Shank levels were very high with the non-treated having 71% dead plants at harvest.

NC-196 (Table 3), a popular cultivar in Georgia, has resistance to Race 0 but not Race 1. Black shank levels were high in most of the treatments with the non-treated having 68% dead plants. Yields were somewhat higher than K-326, with 261 pounds per acre in the non-treated and 1853 pounds per acre with the best chemical treatment.

NC-71 (Table 4) is also a popular tobacco cultivar in Georgia with resistance very similar to NC-196. Non-treated NC-71 plots yielded 752 pounds per acre and had 80% plants killed by black shank. The best chemical treatment yielded 1757 pounds per acre similar to that of NC-196.

SP-225 (Table 5) has both the Ph gene for resistance to Race 0 and resistance from Florida 301, resulting in the best resistance to tobacco black shank. The non-treated SP-225 plots had 50% dead plants at harvest and yielded 1449 pounds per acre. The best chemical treatment on this cultivar was 2367 pounds per acre.

Summary:

Tobacco black shank levels were fairly high in 2016. All of the chemical combinations reduced black shank and increased yield. However, certain chemical combinations tended to perform better on some cultivars than others. This was most pronounced with NC-71 and NC-196. The two cultivars have nearly identical resistance sources and pedigree backgrounds, but seem to respond to chemical treatments differently with respect to increasing yield. This same trend was noted in earlier trials.

Yields of SP-225 that were not treated were similar to yields of NC-71 and NC-196 that were treated with fungicides, underscoring the innate resistance found in that cultivar. This data would suggest that the use of cultivars with more than one source of resistance may be beneficial for areas experiencing high black shank levels.

Table 1. Source of resistance for tobacco cultivars.

CULTIVAR	RESISTANCE
SP-225	Ph gene + Fl.301
NC-71	F 1 Hybrid (Ph gene Race 0)
K-326	Low Resistance
NC-196	F 1 Hybrid (Ph gene Race 0)

Table 2. Tobacco black shank cultivars and chemical control. % BLACK SHANK				
K-326				
Chemical Treatment	Rate	Application	Black Shank (%)	Yield (lb/A)
1. Non-treated	---	---	71^{abc}	125^{h}
2. Ridomil Gold	8.0 oz + 16.0 oz	TPW + Layby	72^{ab}	886^{efgh}
3. Ridomil Gold Presidio	8.0 oz 4.0 oz	TPW Layby	58^{bcdef}	1237^{cdef}
4. Orondis Gold Presidio	13.7 oz 4.0 oz	TPW Layby	56^{cdefg}	558^{fgh}

Table 3. Tobacco black shank cultivars and chemical control. % BLACK SHANK				
NC 196				
Chemical Treatment	Rate	Application	Black Shank (%)	Yield (lb/A)
1. Non-treated	---	---	68[abc]	261[gh]
2. Ridomil Gold	8.0 oz + 16.0 oz	TPW + Layby	66[abc]	1060[defg]
3. Ridomil Gold Presidio	8.0 oz 4.0 oz	TPW Layby	45[efgh]	1853[abcd]
4. Orondis Gold Presidio	13.7 oz 4.0 oz	TPW Layby	48[defgh]	993[defgh]

Table 4. Tobacco black shank cultivars and chemical control.				
% BLACK SHANK				
NC 71				
Chemical Treatment	Rate	Application	Black Shank %	Yield (lb/A)
1. Non-treated	---	---	80[a]	752[fgh]
2. Ridomil Gold	8.0 oz + 16.0 oz	TPW + Layby	64[bcd]	1034[defgh]
3. Ridomil Gold Presidio	8.0 oz 4.0 oz	TPW Layby	40[gh]	1252[cdef]
4. Orondis Gold Presidio	13.7 oz 4.0 oz	TPW Layby	44[efgh]	1757[abcde]

Table 5. Tobacco black shank cultivars and chemical control.

% BLACK SHANK

SP 225				
Chemical Treatment	Rate	Application	Black Shank %	Yield (lb/A)
1. Non-treated	---	---	59[bcde]	1449[bcdef]
2. Ridomil Gold	8.0 oz + 16.0 oz	TPW + Layby	42[fgh]	2367[a]
3. Ridomil Gold Presidio	8.0 oz 4.0 oz	TPW Layby	43[fgh]	2329[ab]
4. Orondis Gold Presidio	13.7 oz 4.0 oz	TPW Layby	32[h]	2050[abc]

EVALUATION OF TOBACCO CULTIVARS AND NEW FUNGICIDES FOR MANAGEMENT OF TOBACCO BLACK SHANK, 2016

502 A	**502 B**	**502 C**	**502 D**	**501 A**	**501 B**	**501 C**	**501 D**	**503 A**	**503 B**	**503 C**	**503 D**	**504 A**	**504 B**	**504 C**	**504 D**
404 A	**404 B**	**404 C**	**404 D**	**402 A**	**402 B**	**402 C**	**402 D**	**401 A**	**401 B**	**401 C**	**401 D**	**403 A**	**403 B**	**403 C**	**403 D**
302 A	**302 B**	**302 C**	**302 D**	**301 A**	**301 B**	**301 C**	**301 D**	**303 A**	**303 B**	**303 C**	**303 D**	**304 A**	**304 B**	**304 C**	**304 D**
203 A	**203 B**	**203 C**	**203 D**	**204 A**	**204 B**	**204 C**	**204 D**	**202 A**	**202 B**	**202 C**	**202 D**	**201 A**	**201 B**	**201 C**	**201 D**
101 A	**101 B**	**101 C**	**101 D**	**103 A**	**103 B**	**103 C**	**103 D**	**104 A**	**104 B**	**104 C**	**104 D**	**102 A**	**102 B**	**102 C**	**102 D**

TREATMENTS:

1. SP-225
2. NC-71
3. K-326
4. NC-196

A = NON-TREATED
B = RIDOMIL GOLD (1/2 PT TPW + 1 PT LAYBY)
C = RIDOMIL GOLD + PERSIDIO (1/2 PT TPW + 4 OZ LAYBY)
D = ORANDIS GOLD + PERSIDIO (13.7 OZ TPW + 4 OZ LAYBY)
(A21723)

04/20/2016

EVALUATION OF EXPERIMENTAL NEMATICIDES – 2016

A. S. Csinos, Steve LaHue, and Unessee Hargett, Coastal Plain Experiment Station, Tifton, GA 31794

Introduction:

Root knot nematodes are becoming a serious problem for tobacco growers in the southern states. Melodogyne incognita, southern root knot nematode, is widespread in Georgia and other species such as M. arenaria (peanut root knot), and M. javanica are becoming growing concerns in Georgia. Most tobacco cultivars have resistance to M. incognita but do not have resistance or tolerance to M. arenaria, the peanut root knot nematode. Recommendations for nematode control in tobacco incorporate the use of Telone II chiseled in the row at 6 gallons per acre. Telone II is a fumigant and requires 2-3 weeks pre-plant application time to properly fume and kill nematodes. Often times the weather conditions are too cool and too wet to either make the application or for the fumigant to vaporize and move through the soil air space. The use of a contact that could be applied just prior to planting would be a benefit to growers, allowing them to apply nematicides where they could not normally make an application and also not have to deal with precautionary actions required by fumigant materials.

This study evaluated new contact fungicides, Nimitz and Velum Total (Luna Privilege + Admire), in an area heavily infested with peanut root knot nematode.

Materials and Methods:

This trial was conducted at the Bowen Farm in an area heavily infested with Melodogyne arenaria, the peanut root knot nematode. K-394 was transplanted on April 13 into beds 44 inches wide and 30 foot long rows. The test was arranged as a randomized complete block design, with six replications. Plants exhibiting symptoms of TSWV were counted weekly and plants killed by TSWV were removed from the initial stand count for calculation of yield. Plots were evaluated for root knot damage on June 14 and August 3. Plots were harvested two times, July 11 and July 28. Total green weight per plot was converted to dry weight by multiplying by 0.2.

Results:

The cultivar K-394 performed very poorly in this trial. Plants were slow to grow and stayed stunted during the entire trial when compared to other cultivars next to this trial. Root gall damage was fairly high in this trial with early root gall damage reaching a high of 4.2 out of 10 at mid-season (Table 1). Telone II had the least damage and treatments of Luna Privilege + Admire and Nimitz TPW + Lay By (Treatment 3) have low levels of damage. At harvest untreated plots had a RGI of 9.0. Luna Privilege + Admire and Telone II had similar RGI at harvest.

Yield of the non-treated plot was 375 pounds per acre (Table 2). Luna Privilege + Admire, Nimitz TPW + Lay By and Telone II treatments all had similar yields. These data suggest that Luna Privilege + Admire and Nimitz TPW + Lay By, two contact materials may compare favorably with Telone II fumigant in control of nematodes on tobacco.

Acknowledgement:

The authors would like to thank the Georgia Agricultural Commission for Tobacco for funding, Altria Services for assistance in funding student labor, and Sarah Beth Michael, John Whitaker, Will Bently, Matt Carver, and Scott Birchell for technical assistance.

Table 1. Evaluation of Experimental Nematicides - 2016.

Treatment	Rate	Root Gall Rating	
		June 14	August 3
1. K-394	-----	3.2[b]	9.0[a]
2. K-394 + Luna Privilege + Admire	6.5 oz + 4.0 oz TPW	1.4[c]	5.2[b]
3. K-394 + Nimitz	TPW 0.5 pt + 0.5 pt (2-3 wks)	1.5[c]	6.1[b]
4. K-394 + Telone II	6 gal/A in row (2 wks PPI)	0.7[c]	5.2[b]
5. K-394 + Nimitz	1 1/4 pt 12" band (PPI)	4.2[a]	7.9[a]

Root gall rating on a scale of 0-10. Means followed by the same letter are not significantly different from each other at P. = 0.1.

Table 2. Evaluation of Experimental Nematicide - 2016.

Treatment	Rate	Yield (lb/A)
1. K-394	-----	375[c]
2. K-394 + Luna Privilege + Admire	6.5 oz + 4 oz TPW	1,292[ab]
3. K-394 + Nimitz	TPW 0.5 pt + 0.5 pt (2-3 wks)	1,392[ab]
4. K-394 +Telone II	6 gal/A in Row (2 wks PPI)	1,643[a]
5. K-394 + Nimitz	1 1/4 pt 12" Band (PPI)	576[bc]

Means followed by the same letter are not significantly different from each other at P. = 0.1.

Evaluation of Experimental Nematicides. 2016. Planted April 13

604	605	601	602	603
502	501	505	503	504
401	404	403	405	402
303	302	304	301	305
205	203	202	204	201
104	105	101	103	102

1. K-394
2. K-394 + Luna Privledge + Admire (6.5 oz + 4.0 oz) at Plant TPW
   + 6.5 oz + 4.0 oz (2-3 wks)
3. K-394 + Nimitz TPW 0.5 pt + 0.5 pt (2-3 wks)
4. K-394 + Telone 6 gal/A in row 2 wks PPI - Applied March 22
5. K-394 + Nimitz 1 ¼ pt 12” band PPI

Single row plots, 30 ft long, 15 ft ally, replicated 6 times.

6/7/2016

NIMITZ FOR NEMATODE CONTROL IN TOBACCO – 2016

A. S. Csinos, Steve LaHue, and Unessee Hargett, Coastal Plain Experiment Station, University of Georgia, Tifton, GA

Introduction:

Most commercial tobacco cultivars have resistance to only *Melodogyne incognita*, the southern root knot nematode. In the Southern USA many crops are rotated with tobacco, including peanut, one of the largest crops in Georgia. Peanut root knot nematode has many hosts including most vegetables and tobacco. In general, the damage of peanut root knot nematode on tobacco is greater than *M. incognita*. Most tobacco cultivars do not have resistance or tolerance to peanut root knot nematode.

Growers use both rotation and nematicide applications for management of root knot nematode. This study evaluated rates of Nimitz and methods of application for efficacy against *M. arenaria*, peanut root knot nematode.

Materials and Methods:

This study was conducted at the Bowen Farm in an area heavily infested with peanut root knot nematode. K-394 tobacco was used for this study and plants were transplanted on April 13, 2016. Plots were 44 inches wide and 30 feet long, and treatments were arranged in a random complete block design and replicated six times. Plots were counted for TSWV weekly and plants killed by TSWV were removed for calculation of yield. Root gall ratings were made on June 8 and a final root gall rating after harvest on August 3. Root gall ratings were performed on a scale of 0-10, where 0 is no galling and 10 is plants killed by nematodes. Plots were harvested three times, June 29, July 11, and July 28. Total green weight was converted to dry weight by multiplying by 0.2.

Results:

Root Gall Indices:

Mid-season root gall indices ranged from a high of 3.6 (on a scale of 1-10) to a low of 0.5 for the Telone II treatment. Most of the banded applications were numerically lower than treatments that were applied in a broadcast at the same rates. The narrow band, rolling cultivator application was one of the treatments that had a low RGI at mid-season.

Root gall indices at harvest ranged from a high of 8.2 (on a scale of 1-10) to a low of 1.8 for the Telone II. Most treatments had root gall indices that ranged from 6-7 (1-10 scale). This would suggest that a single application of Nimitz may not be enough to provide season long nematode control under Georgia conditions. None of the treatments caused phytotoxicity and vigor was similar for all treatments.

Yield:

Tobacco yielded well in 2016 with the top treatment, Telone II at 6 gal in row, having 3,476 pounds dry weight/acre. This treatment was almost 800 pounds greater than the best Nimitz treatment (2,608 pounds/A) which was 1.75 pint Nimitz in a 12 inch band applied PPI. The narrow band rolling cultivator application (Treatment #9) also performed well and was statistically similar to the same rate, 1.25 pint/acre in a narrow band rototiller incorporated. The trend was for all of the narrow band width applications to out-perform the broadcast applications. All of the applications out-performed the non-treated control by almost 400 pounds/acre (non-statistical).

Conclusions:

Nimitz applied to tobacco as a PPI decreased early season root gall ratings. Yield was significantly increased in only the narrow band applications, including the rolling cultivator application, as compared to the control. Telone II, the standard fumigant significantly out yielded all Nimitz treatments. Narrow band incorporation treatments, including the rolling cultivator treatment tended to perform better than the broadcast incorporation treatments.

Acknowledgements:

The author would like to thank Adama for financial assistance and Will Bentley, John Whitaker, Scott Birchell, Sara Beth Michael and Matt Carver for technical assistance.

Table 1. Nimitz Root Knot Nematode on Tobacco - 2016. Root Knot Indices.

Treatment	Rate/A	Application Time	Application Code	Root Gall Indicies*	
				June 8	August 3
1. Nimitz 480 EC	1.75 pt	7 day PPI	PPI Broadcast	3.6[a]	8.2[a]
2. Nimitz 480 EC	2.50 pt	7 day PPI	PPI Broadcast	2.5[bc]	6.6[b]
3. Nimitz 480 EC	3.50 pt	7 day PPI	PPI Broadcast	3.3[ab]	7.2[ab]
4. Nimitz 480 EC	0.875 pt	7 day PPI	PPI 12" Band (Rototiller)	1.6[c]	6.8[ab]
5. Nimitz 480 EC	1.25 pt	7 day PPI	PPI 12" Band (Rototiller)	1.8[c]	7.1[ab]
6. Nimitz 480 EC	1.75 pt	7 day PPI	PPI 12" Band (Rototiller)	2.6[abc]	7.3[ab]
7. Telone II	6.0 gal	21 day PPI	Chisel in Row	0.5[d]	1.8[c]
8. Non-treated	---	---	---	2.3[bc]	7.0[ab]
9. Nimitz 480 EC	1.25 pt	7 day PPI	PPI 12" Band (Rolling Cultivator)	1.8[c]	6.1[b]

* Root gall rating on scale of 0-10. Means followed by the same letter are not statistically different from each other at P. = 0.1.

Table 2. Nimitz Root Knot Nematode on Tobacco -- 2016. Yield.

Treatment	Rate/A	Application Time	Application Code	Yield (lb/A)*
1. Nimitz 480 EC	1.75 pt	7 day PPI	PPI Broadcast	2,039[bc]
2. Nimitz 480 EC	2.50 pt	7 day PPI	PPI Broadcast	2,297[bc]
3. Nimitz 480 EC	3.50 pt	7 day PPI	PPI Broadcast	2,074[bc]
4. Nimitz 480 EC	0.875 pt	7 day PPI	PPI 12" Band (Rototiller)	2,608[b]
5. Nimitz 480 EC	1.25 pt	7 day PPI	PPI 12" Band (Rototiller)	2,277[bc]
6. Nimitz 480 EC	1.75 pt	7 day PPI	PPI 12" Band (Rototiller)	2,666[b]
7. Telone II	6 gal	21 day PPI	Chisel in Row	3,476[a]
8. Non-treated	---	---	---	1,658[c]
9. Nimitz 480 EC	1.25 pt	7 day PPI	PPI 12" Band (Rolling Cultivator)	2,437[b]

*Means followed by the same letter are not statistically different from each other at P. = 0.1.

ADAMA - Nimitz Root Knot Nematode on Tobacco, 2016. BOWEN FARM

506	**508**	**507**	**509**	**505**	**504**	**501**	**503**	**502**
401	**402**	**405**	**407**	**408**	**406**	**409**	**404**	**403**
303	**304**	**307**	**306**	**309**	**302**	**308**	**301**	**305**
209	**205**	**204**	**201**	**207**	**203**	**202**	**206**	**208**
108	**101**	**106**	**103**	**102**	**105**	**104**	**107**	**109**

TREATMENT	RATE/A	SPRAY INTERVAL	APPLICATION CODE
1. Nimitz	1.75 pt	7-14 days before transplant	A-PPI broadcast
2. Nimitz	2.50 pt	7-14 days before transplant	A-PPI broadcast
3. Nimitz	3.50 pt	7-14 days before transplant	A-PPI broadcast
4. Nimitz	0.875 pt	7-14 days before transplant	B-PPI 12" banded (rototiller)
5. Nimitz	1.25 pt	7-14 days before transplant	B-PPI 12" banded (rototiller)
6. Nimitz	1.75 pt	7-14 days before transplant	B-PPI 12" banded (rototiller)
7. Telone II	6 gal	21 days before transplant	Fumigation March 22
8. Untreated	---	---	---
9. Nimitz	1.25 pt	7-14 days before transplant	B-PPI 12" banded rolling cultivator)

(Rates are already adjusted to 48 inch beds.) Effective rates: 3.5 - 7 pt/acre.

A=Broadcast, cultivate in 6-8 inch deep, then form the beds. Adjust broadcast rate down to "treated acre" based upon bed width.

B=If applying in a band, use proportionally less product. For example use 1/4 of broadcast rate when treating a 12 inch band where the row spacing is 48 inch. Applications should be made as customary for the crop. Do not concentrate treated soil into beds when rows are being formed. Cultivate 6-8 inches deep.

SUPPLEMENTAL IRRIGATION: All application methods require supplemental irrigation 3-5 days after the application, 0.5 inch-1 inch of irrigation is desired.

PRE-PLANT INTERVAL: 7-14 days.

Crop: Tobacco	Crop Destruct: Yes	Planted April 13, 2016
Pest: Root Knot Nematode	Replication: 5	
Experimental Design:RCBD	Telone applied March 22	
Plot Size: 1 row X 30 ft	(Planted April 13)	4/4/2016

ORONDIS GOLD EVALUATED FOR BLACK SHANK MANAGEMENT

A. S. Csinos, Unessee Hargett, and Steve LaHue, Coastal Plain Experiment Station, University of Georgia, Tifton, GA 31794

Introduction:

Tobacco black shank incited by the soil borne pathogen, *Pythophthora nicotianae* continues to be a problem for Georgia tobacco growers. The fungus is a persistent soil borne problem and requires growers to employ cultural methods, cultivar resistance and the use of oomycete specific fungicides. Most fields in Georgia have both Race 0 and Race 1 of the pathogen and no commercially available cultivars have resistance to Race 1 of the pathogen.

Syngenta has recently purchased the rights to market Oxathiapiprolin (formerly Dupont QUG 42) in the US and has been named "Orondis Gold" for the tobacco market. QUG-42 has performed very well for the management of tobacco black shank and this trial evaluated the performance of Orondis Gold with different partners such as Ridomil Gold and Presidio.

Materials and Methods:

This trial was conducted at the Black Shank Nursery at the Coastal Plain Experiment Station, Tifton, GA. The area has been in continuous tobacco black shank since 1962. This area has both Race 0 and Race 1 of *P. nicotianae* and is highly infected with the pathogen.

The cultivar K-326, which is susceptible to both Race 0 and Race 1 of the pathogen, was transplanted on April 18, 2016. Plots were 1 row (4 feet x 30 feet) replicated five times in a random complete block design. Transplant water treatments were made at the time of transplanting, by directing a spray into the transplanter water stream in the planter shoe. The spray was powered by CO_2 sprayer mounted on the transplanter with the nozzle directing into the transplanter water stream. A single hollow cone nozzle at 20 psi delivering 16 gallons per acre was used. Treatments receiving an application at first cultivation (1^{st} cultivation) were made on May 10, using a CO_2 sprayer with a three nozzle arrangement at 40 psi and delivering 22 gallons per acre.

Treatments receiving an application at layby had materials delivered by a CO_2 back pack sprayer delivering 22 gallons per acre at 40 psi using a three nozzle arrangement. Layby treatments were made on May 25, 2016.

Plants killed by black shank were counted every 2 weeks and plants killed by TSWV were counted weekly. Plants that were killed by TSWV were subtracted from the stand per plot for yield determinations.

Plots were harvested 3 times, July 5, July 15, and July 29. Green weight was converted to dry weight by multiplying by 0.20.

Results:

Black shank was severe in this trial and all plots regardless of treatment had 50% or more plants killed by black shank. None of the treatments had significantly less black shank (P. = 0.1) than the non-treated K-326 plots (Table 1).

Yield of tobacco was severely reduced by black shank. The non-treated K-326 had only 314 pounds per acre while the best treatment, A21723 + Ridomil Gold + Presidio had 1,644 pounds per acre yield. Treatments number 5, 6, 7, and 8 had yields significantly greater than the non-treated plots (P. = 0.1).

Acknowledgement:

The author would like to acknowledge the assistance of Syngenta, and thank Sara Beth Michael, Will Bently, John Whitaker, Scott Birchell, and Matt Carver for technical assistance.

Table 1. Tobacco Black Shank Orondis Gold - 2016. Black Shank Percentages.

TREATMENTS	RATE OZ/A	APPLICATION	BLACK SHANK %
1. Non-Treated			65[AB]
2. A21723	9.8	TPW	
Ridomil Gold	8.0	Lay By	62[AB]
3. A21723	13.7	TPW	
Ridomil Gold	8.0	Lay By	63[AB]
4. A21008	4.8	TPW	
Ridomil Gold	6.0	TPW	
Ridomil Gold	8.0	Lay By	77[A]
5. A21723	9.8	TPW	
Ridomil Gold	8.0	1st Cultivation	
Ridomil Gold	8.0	Lay By	62[AB]
6. A21723	9.8	TPW	
Ridomil Gold	8.0	1st Cultivation	
Presidio	4.0	Lay By	50[B]
7. Ridomil Gold	8.0	TPW	
A21723	13.7	1st Cultivation	
Presidio	4.0	Lay By	70[A]
8. A21723	13.7	TPW	
Presidio	4.0	Lay By	69[A]

Table 2. Tobacco Black Shank Orondis Gold - 2016. Yield (lbs/A).

TREATMENTS	RATE OZ/A	APPLICATION	YIELD/LB DRY WEIGHT
1. Non-Treated			314 C
2. A21723	9.8	TPW	
Ridomil Gold	8.0	Lay By	796 BC
3. A21723	13.7	TPW	
Ridomil Gold	8.0	Lay By	924 BC
4. A21008	4.8	TPW	
Ridomil Gold	6.0	TPW	
Ridomil Gold	8.0	Lay By	520 BC
5. A21723	9.8	TPW	
Ridomil Gold	8.0	1st Cultivation	
Ridomil Gold	8.0	Lay By	1121 AB
6. A21723	9.8	TPW	
Ridomil Gold	8.0	1st Cultivation	
Presidio	4.0	Lay By	1644 A
7. Ridomil Gold	8.0	TPW	
A21723	13.7	1st Cultivation	
Presidio	4.0	Lay By	1008 AB
8. A21723	13.7	TPW	
Presidio	4.0	Lay By	1086 AB

Syngenta Tobacco -- Black Shank Orondis Gold. 2016.
Protocol FOP48A3 - 2016 USA Planted April 18, 2016

505	**507**	**502**	**504**	**506**	**501**	**503**	**508**
406	**408**	**407**	**402**	**401**	**404**	**405**	**403**
302	**301**	**303**	**305**	**307**	**306**	**308**	**304**
208	**203**	**205**	**206**	**204**	**202**	**207**	**201**
104	**105**	**108**	**101**	**103**	**107**	**102**	**106**

Treatments	**Rate oz/A**	**Application**
1. Non-treated		
2. A21723	9.8	TPW
Ridomil Gold	8.0	Band Lay By
3. A21723	13.7	TPW
Ridomil Gold	8.0	Band Lay By
4. A21008	4.8	TPW
Ridomil Gold	6.0	TPW
Ridomil Gold	8.0	Band Lay By
5. A21723	9.8	TPW
Ridomil Gold	8.0	1st Cultivation
Ridomil Gold	8.0	Lay By
6. A21723	9.8	TPW
Ridomil Gold	8.0	1st Cultivation
Presidio	4.0	Lay By
7. Ridomil Gold	8.0	TPW
A21723	13.7	1st Cultivation
Presidio	4.0	Lay By
8. A21723	13.7	TPW
Presidio	4.0	Lay By

Plot Size: 1 row - 30 feet (4 feet wide) - 5 replications. RCBD
DATA: Stand Counts, Vigor, Phyto, TSWV, Black Shank, Yield.
24-Mar-16

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Special Bulletin 63-10 **March 2016**

Published by the University of Georgia in cooperation with Fort Valley State University, the U.S. Department of Agriculture, and counties of the state. For more information, contact your local UGA Cooperative Extension office.
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