the presence of 10 - 15 unique begomoviruses. We have also found evidence for the presence of new strains of TYLCV, which have not been reported before from any location.

Discovery of Satellites of Begomoviruses in Florida

In addition to discovering the presence of many new begomoviruses, we found eight unique satellites of begomoviruses. Satellites are parasites of a virus, they rely on the "helper" virus for their continued existence. They are much smaller than begomoviruses, their helper virus but like begomoviruses they do have a circular ssDNA genome. They are completely dependent upon begomoviruses for their replication, movement and transmission, and are encapsulatedin the virus coat protein produced by begomoviruses. Their genome sequence is very different from that of any begomovirus. In some cases they play significant roles in disease development and the appearance of new diseases. The satellites we found are very different in sequence and size from any reported anywhere in the world, but are closest in size to a satellite reported in tomato from Australia. This is the first finding of any begomovirus satellites in the US. We are currently working on these satellites to determine which viruses they are associated with and what role they play in disease in tomato in Florida.

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Insecticides and Resistant Varieties for Management of Whiteflies and TYLCV

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Tomato yellow leaf curl virus (TYLCV) has been a major concern for Florida tomato growers ever since its first appearance in 1994. Yield losses are correlated with earliness of symptom expression and may reach 90% if symptoms appear within the first few week of transplanting (Schuster et al., 1996). Important cultural controls include use of clean transplants, crop removal and field sanitation followed by a crop free period between crops to reduce vector and virus inoculum. Insecticidal control of the whitefly vector, *Bemisia tabaci*, is usually effective but not always sufficient to avoid losses. The use of TYLCV-resistant (R) varieties provides added insurance against virus-induced losses that can be critical during a high whitefly/TYLCV year.

Making the correct choice of which varieties to plant each year is a cornerstone of a successful tomato industry. The University of Florida/SWFREC TYLCV-R variety testing program provides unbiased information about the adaptability and performance of tomato varieties in Florida's diverse environments, thereby allowing growers to make informed decisions (http://www.imok.ufl.edu/vegetable_hort/variety_testing/tylcv/). There have been several TYLCV-R variety evaluations in Florida (Gilreath et al., 2000; Scott 2004 and Cushman and Stansly, 2006). The TYLCV-R varieties evaluated produced comparable yields to traditional varieties under low virus pressure and greater yields under high virus pressure (Gilreath et al., 2000; Scott, 2004, Cushman and Stansly, 2006) and more recently by Ozores-Hampton et al., 2008 and 2010. However, resistant varieties have yet to be widely grown in Florida, probably due to a perception of lower fruit quality compared with traditional varieties such as 'Florida 47' and 'Sebring'. Additionally, TYLCV-R varieties should also have resistance to other common diseases such as fusarium crown rot (*Fusarium oxysporum* f.sp. *radicis-lycopersici*) and bacterial spot caused by Xanthomonas species (X. *vesicatoria*, X. *euvesicatoria*, X. *perforans* and X. *gardneri*) prevalent in tomato producing areas. The variety testing program has evaluated the horticultural performance of TYLCV-R tomato varieties available in the USA market today (Ozores-Hampton et al., 2008 and 2010).

Here we report on three field experiments conducted to evaluate the relative contributions of insecticidal control and a resistant variety in managing TYLCV.

Materials and Methods

Variety x Insecticide Trial 2010. Seedlings of a TYLCV resistant variety 'Tygress' and a susceptible variety "BHN-602" obtained from a commercial greenhouse were transplanted at the Southwest Florida Research and Education Center in Immokalee Florida on 23-Mar. Plants were spaced 18-in apart on 2 sets of 3 beds 235 ft in length covered with black polyethylene film mulch after incorporating approximately 25% of the fertilizer (13-2-13 NPK) with the rest injected later as liquid 8-0-8 through drip tape with 4 inch emitter spacing. The center row was left untreated throughout the trial with 8 treatments arranged on the other 4 beds in a randomized complete block (RCB) design. Plots in the four treated rows contained 19 plants, with a single plant left between plots as a buffer. Plots were

Table 1. Treatments and application dates, 2010 trial.

		Application Dates			
Product	Rate (oz/ac)	24-Mar Drench (120 ml/plant)	4-May Foliar (60 GPA)	18-May Foliar (60 GPA)	3-Jun Foliar (80 GPA)
Untreatead	-				
Admire Pro	7.0	X			
Fulfill	2.75		X		
Courier	9.0			X	X
Thionex	21.0			X	
Coragen	5.0	X			
Fulfill	2.75		X		
Courier	9.0			X	X
Thionex	21.0			X	
Coragen	7.0	X			
Fulfill	2.75		X		
Courier	9.0			X	X
Thionex	21.0			X	
Scorpion	10.3	X			
Fulfill	2.75		X		
Courier	9.0			X	X
Thionex	21.0			X	
Admire Pro	7.0	X			
Movento	5.0		X	X	
Admire Pro	7.0	X			
Oberon	8.5		X	X	
Admire Pro	7.0	X			
Rimon	12.0		X	X	X

Table 2. Treatments and application dates for 2011 foliar trial.

Product	Rate/ac	7-Mar	21-Mar	22-Mar	28-Mar	29-Mar	4-Apr	5-Apr	11-Apr	18-Apr	25-Apr	4-May	9-May
Untreated	-	-	-	-	-	-	-	-	-	-	-	-	-
Venom	4.0 oz			X		X		X					X
Admire Pro Fulfill Baythroid Thionex 3ec	10.5 oz 2.75 oz 2.8 oz 21 oz	X	X		X		X		X	X		X	
Admire Pro Fulfill Baythroid Thionex 3ec Movento Induce	10.5 oz 2.75 oz 2.8 oz 21 oz 5.0 oz 0.25%	X	X		X		X X X		X	X X X		X	
Fossil Care	8.0 lbs			X		X		X	X	X	X	X	
Scorpion	3.0 oz		X			X		X			X		X
Scorpion	5.0 oz		X			X		X					X
BYI02960 Induce	8.6 oz 0.25%		X X			X X	X X						
BYI02960 Induce	10.5 oz 0.25%		X X			X X	X X						
BYI02960 Induce	12.0oz 0.25%		X X			X X	X X						
BYI02960 Induce	14.0 oz 0.25%		X X			X X	X X						
Admire Pro Pyrifluquinazon Induce	10.5 oz 3.2 oz 0.25%	X			X X		X X		X X	X X		X X	

Table 3. Drench and drip applications in 2011.

Product	Rate oz/ac	Applied			
		Method	7-Mar	8-Mar	30-Mar
Untreated	-	-	-	-	-
Venom	6.0	Drip	X		
Venom	6.0	Drench	X		
Admire Pro	10.5	Drench	X		
Admire Pro	10.5	Drench	X		
Durivo	13.0	Drip			X
BYI02960	14.0	Drip		X	
BYI02960	21.0	Drip		X	
BYI02960	28.0	Drip		X	
BYI02960	21.0	Drench	X		

split into two subplots of 9 TYLCV susceptible ('BHN-602') and a resistant ('Tygress') plants separated by a TYLCV symptomatic plant from a local farm to provide virus inoculum.

Applications of Scorpion, Coragen and Admire were made 24-Mar by delivering a 120 ml suspension on the base of the plant using an EZ-Dose® sprayer operating at a pressure of 45 PSI and a flow rate of 3.7 gallons per minute. Foliar sprays (Table 1) were applied with a single row high clearance sprayer operating at 180 psi and 2.3 mph provided with two vertical booms fitted with yellow Albuz® hollowcone nozzles, each delivering 10 gpa. Total spray volume increased as nozzles were added to accommodate plant growth. A standard used for 4 of the treatments consisted of 2.75 oz of Fulfill on 4 May, 9 oz of Courier and 21 oz of Thionex on 18 May, and 9 oz of Courier on 3 Jun.

Whitefly adults were evaluated weekly from 8-April to 9-June on five leaflets from one mid-canopy level true leaf on 4 plants per subplot. Immature stages from 3 plants in each subplot were counted on 4,17,31-May under a stereoscopic microscope from eight 0.5 sq inch discs cut from each of three leaflets of one terminal 7th node trifoliate. Samples on 9 Jun (adults) and 9 and 14 Jun (nymphs) were only obtained from 'Tygress' plants due to severe leaf distortion on TYLCV-infected 'BHN-602' plants. All plants were inspected weekly and the date of symptom appearance recorded. Fruit of marketable size was harvested from 6 plants in each sub-plot on 2 and 16-Jun. Fruit was culled for defects due to stink bug damage, bacterial spot and surface deformities such as shoulder cracking and zippering, number, size, and weight of marketable fruit recorded.

2011 foliar trial — Experimental design and procedures were much the same as the previous year except for some details: the susceptible variety was 'Florida 47', 21 transplants per plot (10 of each variety + one infected plant in the middle) were set 2 Mar, in a RCB design with 12 treatments in 4 beds, each with two lines of drip type dry fertilizer was 10-2-10 NPK and liquid 7-0-7, drenches were applied 7 Mar, and sprays as indicated in Table 2. Adults were evaluated weekly from 23 Mar to 11 May and nymphs on 6, 20 Apr and 4 May. All fruit on 6 plants per plot were harvested 16-May

2011 drench/drip trial — Design was identical to 2011 foliar trial except 9 treatments in four replicates were spread across three beds. Drenches were again applied in a 120 ml suspension using an EZ-Dose® sprayer operating at a pressure of 45 PSI and a flow rate of 3.7 gallons per minute (Table 3). Drip tape was sectioned off within each treated plot, pressurized using a 12 volt pump at 0.23 gpm with 2 L water, followed by 3 L of the appropriate suspension and finally a 3 L water chase. Adults were evaluated weekly from 23 Mar to 11 May and nymphs at 13, 27 Apr and 11 May. All fruit on 6 plants per plot were harvested 13-May.

TYLCV-R variety trial — Seven field variety evaluations were conducted in South Florida during a spring season from 2006 to 2011 (Table 4). TYLCV-R variety evaluations were conducted under commercial growing conditions in multiple locations: Estero, Immokalee and Homestead, with a completely randomized block design. In addition to yields and post-

Table 4. Summary of cultural practices used in tomato leaf curl virus (TYLCV) resistant variety trials from spring 2006 to 2011.

Cultural practices	2006	2007	2008	2009	2010	----------2011----------	
Location	Immokalee	Immokalee	Immokalee	Immokalee	Estero	Estero	Homestead
Experimental Design	CRBD (4 reps)	CRBD (4 reps)	CRBD (3 reps)	CRBD (3 reps)	CRBD (4 reps)	CRBD (4 reps)	CRBD (3 reps)
Irrigation	Drip	Drip	Seepage	Seepage	Seepage	Seepage	Drip
Plot size (ft)	21	21	36	37	37	37	37
Harvest unit (ft)	15.0	15.0	18.3	18.3	18.3	18.3	18.3
Planting date	24-Feb-06	20-Feb-07	4-Jan-08	8-Jan-09	7-Jan-10	7-Jan-11	7-Jan-11
Fumigation	MeBr/CP	MeBr/CP	MeBr/CP	MeBr/CP	MeBr/CP	MeBr/CP	MIDAS
Mulch	Black	Black	Black	Metalized/Silver	Metalized/Silver	Black	Black
Linear ft per acre	7,260	7,260	7,260	7,260	7,260	7,260	7,260
Bed height (in)	8	8	9	8	8	8	6
Bed width	32	32	36	32	32	32	35
Bed spacing (ft)	6	6	6	6	6	6	6
Plant spacing (in)	18	18	22	22	22	22	22
Plant population	4,840	4,840	3,967	3,967	3,967	3,967	3,967
Harvest date							
1st	10-May-06	7-May-07	7-Apr-08	21-Apr-09	3-May-10	13-Apr-11	6-Apr-11
2nd	24-May-06	22-May-07	21-Apr-08	6-May-09	18-May-10	26-Apr-11	20-Apr-11
3rd	6-June-06	29-May-07	30-Apr-08	20-May-09	-	4-May-11	29-Apr-11
Planting to last harvest (weeks)	13	13	16	19	17	17	16

Table 5. Number of adult whiteflies per 5 tomato mid-canopy terminal leaflets in 2010 trial.

Products /Rate/ac	Adult whiteflies/five leaflets							
	8-Apr	5-May	12-May	19-May	25-May	1-Jun	9-Jun	ALL DATES
Untreated	0.63 a	2.09 a	2.63 a	1.84 a	3.44 a	4.66 a	3.28 a	1.99 a
Admire Pro + Std	0.09 c	1.56 abc	1.81 b	0.59 c	1.75 bc	1.31 cde	1.21 bc	0.96 bc
Coragen 5.0 oz + Std	0.41 ab	1.47 abc	1.78 b	0.88 bc	2.25 b	1.75 bcd	2.38 ab	1.19 b
Coragen 7.0 oz + Std	0.50ab	1.66 abc	1.72 b	0.56 c	2.34 b	2.28 b	1.81 bc	1.21 b
Scorpion + Std	0.03 c	1.94 ab	1.53 b	0.69 c	1.47 c	1.78 bc	2.38 ab	1.10 b
Admire Pro + Movento	0.41 ab	1.13 c	1.19 b	1.03 bc	1.38 c	0.81 e	1.06 c	0.78 c
Admire Pro + Oberon	0.28 bc	1.28 bc	1.72 b	0.53 c	1.38 c	0.90 de	0.78 c	0.81 c
Admire Pro + Rimon	0.22 bc	1.09 c	1.60 b	1.38 ab	1.41 c	1.66 bcde	0.84 c	0.95 bc

Table 6. Number of nymphs at the 7th node terminal leaflets and TYLCV incidence on 27, May 2010.

Products used/Rate/ac	Nymphs/4 in2				BHN-602 symptomatic for TYLCV (%)
	4-May	17-May	31-May	14-Jun	27-May
Untreated	9.30 ab	33.58 a	51.4 a	50.33 a	86.11 ab
Admire Pro + std	9.08 abc	23.38 ab	24.68 c	23.17 bcd	83.33 ab
Coragen 5.0 oz + std	7.17 abc	26.71 ab	37.00 b	36.58 abc	91.32 ab
Coragen 7.0 oz + std	6.00 c	25.83 ab	27.79 c	37.50 ab	91.67 a
Scorpion + std	2.42 d	11.46 c	12.54 d	34.50 abcd	51.39 c
Admire Pro + Movento	6.63 bc	12.17 c	5.67 d	16.33 cd	63.89 bc
Admire Pro + Oberon	10.04 a	11.67 c	9.50 d	17.33 bcd	75.00 abc
Admire Pro + Rimon	8.71 abc	18.79 bc	21.29 c	14.58 d	63.89 bc

Means followed by the same letter within a column are not statistically different (LSD P> 0.05)

Table 7. Yield in 25-lb boxes per acre from treated and untreated 'Tygress' and 'BHN-602' tomatoes, spring 2010.

Cultivar	Treated (Boxes/acre)		Untreated (Boxes/acre)	
Tygress	613	± 31.6	429	± 73.8
BHN-602	1,174	± 51.5	678	± 195.5

harvest quality, we monitored pest and disease incidents.

Results

Variety x Insecticide Trial 2010. Whitefly infestation was initially light due to cold weather including freezes. Fewer adults than the check were seen with all treatments on 8 Apr. except for Coragen drenches and AdmirePro + Movento, whereas only AdmirePro + Movento, Oberon or Rimon provided significant control on 5 May (Table 5). All products provided significant control of adults for the next 5 weeks, although Scorpion and the low rate of Coragen both with the standard sprays failed to do so on 9 Jun. Over all dates, fewest adults were seen with AdmirePro + either Movento or Oberon, although these were not significantly different from AdmirePro + the standard or + Rimon. Nymphs were most reduced on 4 May before sprays were applied by Scorpion, followed by the high rate of Coragen which was not different from one of the 7 oz AdmirePro treatments (Table 6). On 17 May, only applications of Scorpion + the standard or AdmirePro + Movento, Oberon or Rimon provided control. AdmirePro + Rimon provided best con-

Table 8. Number of adult whiteflies per 5 mid-canopy terminal leaflets in 2011 foliar tomato trial.

Product	Rate/ac	Adults/five leaflets							
		23-Mar	30-Mar	6-Apr	13-Apr	20-Apr	27-Apr	4-May	11-May
Untreated	-	0.50 abcde	0.55 a	0.33 a	0.75 a	1.25 b	1.85 a	2.38 ab	0.83
Venom	4.0 oz	0.73 ab	0.33 abcd	0.10 bc	0.33 bcde	1.05 bc	0.78 de	1.75 bcde	1.03
Admire Pro Fulfill Batythroid Thionex 3ec	10.5 oz 2.75 oz 2.8 oz 21 oz	0.15 f	0.25 bcd	0.05 c	0.15 de	0.48 def	0.98 cde	1.08 e	0.65
Admire Pro Fulfill Baythroid Tiohnex 3ec Movento Induce	10.5 oz 2.75 oz 2.8 oz 21 oz 5.0 oz. 0.25%	0.53 abcd	0.23 bcd	0.15 bc	0.18 de	0.10 f	1.03 cde	1.48 cde	0.65
Fossil Care	8.0 lbs	0.75 a	0.55 a	0.40 a	0.40 bcd	1.40 b	1.68 ab	2.05 abcd	0.68
Scorpion	3.0 oz	0.30 def	0.45 ab	0.25 ab	0.55 abc	2.03 a	1.53 abc	2.68 a	0.73
Scorpion	5.0 oz	0.65 abc	0.35 abc	0.10 bc	0.30 cde	0.73 cd	1.40 abc	1.48 cde	0.48
BYI02960	8.6 oz	0.33 def	0.20 bcd	0.05 c	0.43 bcd	0.58 cdef	0.63 e	1.73 bcde	1.33
Induce	0.25%								
BYI02960 Induce	10.5 oz 0.25%	0.20 ef	0.15 cd	0.10 bc	0.43 bcd	0.63 cde	1.13 bcde	2.48 ab	0.93
BYI02960 Induce	12.0 oz 0.25%	0.38 cdef	0.05 d	0.00 c	0.60 ab	0.95 bcd	1.25 abcd	2.13 abcd	1.13
BYI02960 Induce	14.0 oz 0.25%	0.28 def	0.15 cd	0.00 c	0.43 bcd	0.65 cd	1.00 cde	2.23 abc	0.73
Admire Pro Pyrifluquinazon Induce	10.5 oz 3.2 oz 0.25%	0.43 bcdef	0.33 abcd	0.03 c	0.10 e	0.13 ef	1.13 bcde	1.40 de	0.68

Table 9. Number of nymphs per 4 in² 7th node terminal leaflets in 2011 foliar tomato trial.

Product	Rate/ac	Nymphs/4 in²		
		6-Apr	20-Apr	4-May
Untreated	-	7.42 a	12.00 a	24.54 a
Venom	4.0 oz	3.21 cd	6.42cd	24.92 a
Admire Pro Fulfill Baythroid Thionex 3ec	10.5 oz 2.75 oz 2.8 oz 21 oz	2.42 d	5.17 de	15.08 bcd
Admire Pro Fulfill Baythroid Thionex 3ec Movento Induce	10.5 oz 2.75 oz 2.8 oz 21 oz 5.0 oz 0.25%	1.29 d	4.28 de	7.08 de
Fossil Care	8.0 lbs	6.13 ab	9.17 bc	18.79 abc
Scorpion	3.0 oz	2.88 d	9.29 ab	22.88 ab
Scorpion	5.0 oz	5.04 bc	5.54 b	21.00 abc
BYI02960 Induce	8.6 oz 0.25%	2.13 d	5.63 d	14.42 cd
BYI02960 Induce	10.5 oz 0.25%	3.17 cd	5.96 d	25.50 a
BYI02960 Induce	12.0 oz 0.25%	2.67 d	5.42 d	20.04 abc
BYI02960 Induce	14.0 oz 0.25%	2.08 d	5.25 d	17.83 abc
Admire Pro Pyrifluquinazon Induce	10.5 oz	1.58 d	2.38 e	5.33 e

trol on 14 Jun although not different the other treatments that included AdmirePro. The other 3 treatments were not different from the check. Only Scorpion + the standard, or AdmirePro + either Movento or Rimon resulted in significant reduction of virus symptoms in the susceptible BHN-602 variety on 27 May. None of the other treatments resulted in lower incidence of TYLCV on that or any other date.

Surprisingly, higher yields of marketable fruit were seen from the susceptible 'BHN-602' plants due to excessive cracking and zippering of 'Tygress' fruit. Greater yields were seen from all treated plants compared to the check, with no differences among insecticide treatments regardless of variety (Table 7).

2011 Foliar Trial: By 6 April, all effective treatments were working, including rotations with AdmirePro, AdmirePro + pyrifluquinizon and BYI02960 . Three oz of Scorpion was not effective against adults though 5 oz was better and about equivalent to 4 oz of Venom except on 27 Apr (Table 8). Two applications of Movento did not improve adult suppression with AdmirePro followed by rotations of Thiodan and Baythroid but did improve control of nymphs (Table 9). Similar levels of control were obtained with Admire followed by pyrifluquinizon and with BYI102960 except for the latter on 4 May. Incidence of TYLCV rose from an average 1.5% on 31 Mar to 98% on 11 May with no significanct differences among any treatments on any one date. No significant treatment effects were seen on yield, although production of 'Tygress' 9582

Table 10. Number of adult whiteflies per 5 mid-canopy terminal leaflets in 2011 drench and drip tomato trial.

Product	Rate oz/ac	Method	Adult Whitefly/five leaflets						
			23-Mar	30-Mar	6-Apr	13-Apr	20-Apr	27-Apr	4-May
untreated	-	-	0.35 a	0.58 ab	0.35 ab	0.73 a	1.45 a	2.03 a	2.38 a
Venom	6.0	Drip	0.33 ab	0.55 abc	0.15 bc	0.45 abc	1.43 a	1.83 ab	1.18 bc
Venom	6.0	Drench	0.23 abc	0.23 cd	0.13 c	0.28 bc	1.13 ab	1.43 abc	1.60 b
Admire Pro	10.5	Drench	0.35 a	0.30 bcd	0.15 bc	0.48 ab	1.08 ab	1.93 a	1.50 b
Admire Pro Durivo	10.5 13.0	drench Drip	0.30 abc	0.58 ab	0.18 bc	0.35 bc	1.28 ab	1.95 a	1.30 bc
BYI02960	14.0	Drip	0.23 abc	0.65 a	0.48 a	0.70 a	0.98 abc	1.10 cd	1.53 b
BYI02960	21.0	Drip	0.15 abc	0.53 abc	0.23 bc	0.25 bc	0.80 bcd	1.18 bcd	1.53 b
BYI02960	28.0	Drip	0.10 bc	0.45 abcd	0.20 bc	0.38 bc	0.45 cd	1.38 abc	1.05 bc
BYI02960	21.0	Drench	0.08 c	0.15 d	0.03 c	0.15 c	0.38 d	0.58 d	0.83 c

Table 11. Number of nymphs per 4 in² 7th node terminal leaflets in 2011 drench/drip tomato trial.

Product	Rate/ac	Method	Number of whitefly nymphs/4 in2		
			13-Apr	27-Apr	11-May
Untreated	-	-	10.83 a	15.67 a	25.71 a
Venom	6.0 oz	Drip	7.13 b	15.79 a	22.79 ab
Venom	6.0 oz	Drench	3.79 de	11.71 ab	24.83 a
Admire Pro	10.5 oz	Drench	6.50 bc	13.13 ab	17.54 bc
Admire Pro Durivo	10.5 oz 13.0 oz	Drench Drip	4.59 cd	11.83 ab	23.54 ab
BYI02960	14.0 oz	Drip	5.21 bcd	14.71 a	22.71 ab
BYI0–2960	21.0 oz	Drip	2.17 ef	7.21 bc	19.42 ab
BYI02960	28.0 oz	Drip	3.13 def	3.88 c	11.92 cd
BYI02960	21.0 oz	Drench	1.38 f	2.33 c	7.50 d

Table 12. Incidence of TYLCV symptomatic plants during 2011 drip/drench trial.

Product	Rate (oz/ac)	Method	% of plants with TYLCV					
			30-Mar	6-Apr	13-Apr	20-Apr	27-Apr	4-May
untreated	-	-	2.5	7.5	20.0 bcd	70.0 ab	90.0	97.5 ab
Venom	6.0	drip	0.0	10.0	32.5 abc	53.8 bc	87.5	90.0 ab
Venom	6.0	drench	0.0	5.0	17.5 cd	40.0 cd	75.0	92.5 ab
Admire Pro	10.5	drench	5.0	13.8	26.9 abc	55.3 bc	73.6	76.7 bc
Admire Pro Durivo	10.5 13.0	drench drip	7.5	17.5	40.0 a	52.5 bc	80.0	90.0 ab
BYI02960	14.0	drip	2.5	17.5	37.5 ab	77.5 a	92.5	100.0 a
BYI02960	21.0	drip	2.5	17.5	32.5 abc	47.5 bc	75.0	95.0 ab
BYI02960	28.0	drip	7.5	10.0	25.0 abc	42.5 c	57.5	77.5 bc
BYI02960	21.0	drench	0.0	0.0	5.0 d	17.5 d	52.5	62.5 c

± 30.2 boxes/ac) was greater than FL-47 (450 ± 26.4 boxes/ac), reflecting the high incidence of TYLCV compared to the previous year.

2011 Drip/Drench: The drench application of BYI02960 at 21 oz was generally the best treatment for controlling adults, even compared to the 28 oz rate applied through drip (Table 10). However, no differences were seen between Venom treatments applied by drip or drench. Drip application of Durivo following the AdmirePro drench did not improve adult control obtained with the drench alone. By 13-Apr, all treatments significantly reduced the number of nymphs when compared to the untreated control, with the Venom drench application outperforming the Venom drip application (Table 11). Likewise, the BYI02960 drench application resulted in fewest nymphs. On 27 Apr, only the 21 oz drench and 28 oz drip applications of BYI02960 were providing significant levels of control. These two were joined by the drench application of AdmirePro on 11-May. Incidence of TYLCV mirrored the foliar trial except for plants treated with the 28 oz drip rate or 21 oz drench rate of BYI02960 which were significantly lower on 2 or 3 sample dates respectively, including the last on 4 May (Table 12). Due to poor weather conditions near harvest and the general health of the plants, most fruit in both varieties were culled, but the total weight was again greater for 'Tygress', 606 ± 31.2 boxes per acre, compared to 466 ± 22.1 boxes per acre for FL-47 with no differences among insecticide treatments.

TYLCV-R Variety Trials: No clear advantage was found by using TYLCV-R varieties under low TYLCV pressure (Ozores-Hampton et al., 2008 and 2010).In contrast, TYLCV-R varieties were observed to produce a high percentage of unmarketable fruit due to blossom end scar, zippering, catfacing, sunscald, yellow shoulders, odd shapes, and radial or concentric cracking compared to susceptible varieties. 'Tygress', 'SVR 200', 'Security 28', 'Charger' and grafted varieties ('BHN 833'/'Tygrees') have proved to be among the best TYLCV-R varieties for the South Florida Spring tomato market (Table 13). These varieties have high marketable x-large fruit and total marketable yield and tower unmarketable fruits, better fruit firmness and intense red color.

Discussion

We saw in 2011, that drench applications of insecticides protected plants from whiteflies and even virus better than drip applications, which in turn were better than foliar sprays. This has been a consistent pattern in our trials over a number of years. Contrasting results from the insecticide x variety trials run in 2010 and 2011 illustrate the different outcomes that can occur depending on growing conditions and their effect on disease incidence. In 2010 virus movement was relatively slow such that many plants escaped infection until late in the season. Furthermore, a wet spring caused high levels of bacterial spot to which 'Tygress' is more susceptible that 'BHN-602'. Consequently, yield from the susceptible variety was better than the TY-resistant variety that year. In contrast, virus incidence rose quickly in 2011 and consequently, 'Tygress' yielded better than the susceptible

Table 13. Best TYLCV-resistant varieties from South Florida during spring 2006 to 2011.

2006 Low TYLCV Pressure	2007 High TYLCV Pressure	2008 Low TYLCV Pressure	2009 Low TYLCV Pressure	2010 Low TYLCV Pressure	2011 Low TYLCV Pressure
Best Varieties					
Immokalee: HA 3075 (Hazera), S-50257, VT-60774, and VT-60780 (Zeraim Gerdera).	Immokalee: 3078, 3074 (Inbar) and 3075 (Ofri) (Hazera) Roma: Shanty (Hazera).	Immokalee: Tygress (Seminis) & 3074 (Inbar) (Hazera). Roma: 5080 (Sakata).	Immokalee: Tygress & SVR200 (Seminis).	Immokalee: Security 28 (Harris Moran) & Charger (Sakata).	Homestead: SVR 200 (Seminis) Estero: SVR (Seminis), Tygress (Seminis,) Grafting BHN 833/ Tygress (BHN/Seminis).
Good Varieties					
Immokalee: BHN 745 & Tygress (Seminis).	Immokalee: Tygress (Seminis).	Immokalee: Security 28 (Harris Moran), BHN 745 and 764, 3091 & 3075 (Ofri) (Hazera), and 5443 (Sakata).	Immokalee: BHN 765, 8845 (Harris Moran).	Immokalee: Katana (Takii) Tygress and SVR 200 (Seminis).	Homestead: Tycoon (Hazera) Estero: RFT 9773 (Syngenta).

variety, FL-47. We know that TYLCV can be managed with resistant varieties; however the lack of consistent fruit quality is a major factor holding back adoption of TYCLV-R varieties by the Florida tomato industry.

Literature cited

Cushman, K and P. A. Stansly. 2006. TYCLV-resistant tomato cultivar trial and whitefly control. Proceedings: Florida Tomato Institute. P. Gilreath [Ed.], Vegetable Crops Special Series, IFAS, U. of Florida, Gainesville, pp. 29-34.

Gilreath, P., K. Shuler, J. Polston, T. Sherwood, G. McAvoy, P. Stansly, and E. Waldo. 2000. Tomato yellow leaf curl virus resistant tomato variety trials. Proc. Fla. State Hort. Soc. 113:190-193.

Schuster, D. J., P. A. Stansly, and J. E. Polston. 1996. Expressions of plant damage Bemisia, pp. 153-165. In D. D. Gerling and R. T. Mayer [eds.], Bemisia 1995: Taxonomy, Biology, Damage, Control, and Management. Intercept Andover, Hants, UK.

Scott J.W. 2004. Tomato Yellow Leaf Curl Resistant Varieties Available Now and Future Outlook from IFAS. P. Gilreath and W. Stall (Eds.). Vegetable Crop Special Series, IFAS, U. of Florida. Gainesville, PRO 521 pp. 15-17.

Ozores-Hampton M.P., E. J. McAvoy, S. Sargent and P. Roberts. by 2010. Evaluation of tomato yellow leaf curl virus (TYLCV) and Fusarium crown rot (FCR) resistant tomato variety under commercial conditions in Southwest Florida. Fla. Tomato Inst. Proc. PRO 527, pp.11-15.

Ozores-Hampton, M.P., G. McAvoy, E.H. Simonne, and P. Stansly. 2008. Evaluation of TYLC virus-resistant varieties under commercial conditions in Southwest Florida. Fla. Tomato Inst. Proc. PRO525, pp.12-17.

Tracking disease and insect pests using Smartphone technology: a new approach for regional (and local) pest management

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Introduction

In early 2007, a meeting of growers, industry representatives, extension agents, and University of Florida faculty was convened to discuss research ideas that would lead to a better understanding and management of Tomato yellow leaf curl virus (TYLCV). A project was initiated to characterize regional patterns of whitefly density and virus incidence in southwest Florida tomato production. In 2008, we received funding through the Specialty Crop Research Initiative (SCRI) to support this effort and, in addition, provided funds that allowed us to develop a decision support system designed to optimize decisions regarding the management of whiteflies and TYLCV. For more information on the project, follow the link to the SCRI Home Page (www.nifa.usda.gov/fo/specialtycropresearchinitiative.cfm) and click on the 'Abstracts of Funded Projects' (#2008-04890).

The Problem

For the past four growing seasons, cooperating growers provided us with their scouting reports of whitefly and TYLCV occurrence. The data obtained from the reports covered approximately 24,000 acres of tomato and vegetable production.

The data were used to track and identify regional hot spots with the idea that more intensive scouting could be applied to these areas to identify environmental, geographical and/or management practices that may be linked to TYLCV epidemics as well as to identify alternate hosts that may exist in neighboring fallow fields, hedge rows, or unmanaged fields and forests. The data showed that the severity of TYLCV closely followed the increase in mean whitefly density, as well as the average age of the fields in production. Most importantly, the data showed a strong correlation between both disease and insect pressure of neighboring fields, including 2nd and 3rd order neighbors (i.e., your neighbor's neighbor and their neighbors!). In terms of distance, the data showed that a "hot field" can affect fields within a 1.5 mile radius. Moreover, spatial analysis of the surveyed region showed the existence of hot spots for both whiteflies and virus. But, the whiteflies and virus were not necessarily associated with each other or with a single grower or farm. A prominent hot spot was associated with the central growing area, which is typical given the concentration of production. Smaller hot spots were located around the edges or perimeters of farms and would be good areas to concentrate future surveys of the plant population.

Working Towards a Solution

The spatial analysis of the TYLCV epidemics argues for a greater regional effort in managing whiteflies and TYLCV. To this end, we hired ZedX Inc., (www.zedxinc.com) to develop the technology portion of our so-called decision support system. This decision support system encompasses a web-based and mobile technology platform (WMTP). Users of the WMTP will use their mobile device (i.e., smartphone) to collect and upload GPS-labeled scouting data (insect, disease, and production information) to a central server where it is processed and then delivered as real-time reports and management recommendations to growers and/or their