Variety Trials

Evaluation of Round and Roma-type Tomato Varieties and Advanced Breeding Lines Resistant to *Tomato Yellow Leaf Curl Virus* in Florida

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ADDITIONAL INDEX WORDS. *Bemisia*, sweetpotato whitefly, tomato fruit quality, tomato virus

SUMMARY. *Tomato yellow leaf curl virus* (TYLCV) is considered to be the most damaging tomato (*Solanum lycopersicum*) virus worldwide. Management of TYLCV has relied primarily on insecticidal control targeting the vector sweetpotato whitefly [SPW (*Bemisia tabaci*)]. However, resistance of the SPW to insecticides; increased length of the growing season, due in part to increased plantings of grape tomato; and asymptomatic hosts of TYLCV such as pepper (*Capsicum annuum*) have increased the need for wider use of TYLCV-resistant (TYLCV-R) varieties. The objective of this study was to evaluate horticultural characteristics of commercially available TYLCV-R varieties/advanced breeding lines of round and Roma-type tomato varieties in Florida. Sweetpotato whitefly populations and incidence of TYLCV were greater in 2007 than 2008. Under high TYLCV pressure, most of the TYLCV-R varieties/advanced breeding lines produced higher yield than susceptible varieties. In contrast, no clear advantage was found by using TYLCV-R varieties under low TYLCV pressure. Additionally, TYLCV-R varieties produced a high percentage of unmarketable fruit due to rough blossom end scars (BES), zippering, catfacing, sunscald, yellow shoulders, off shapes, and radial or concentric cracking compared with susceptible varieties in both years. Visual assessment of TYLCV-R varieties/advanced breeding lines for horticultural traits showed that ‘Security 28’, Sak 5443, and ‘Shanty’ were the best overall varieties/advanced breeding lines based on participants combined score rating, although ‘Tygress’ and Sak 5808 performed best based on empirical evaluation (numerical data) of total marketable yields and low unmarketable yield.

Tomato yellow leaf curl virus, a begomovirus, was first described in Israel in 1939 (Picó et al., 1996), and subsequently became a major constraint to tomato production in the entire Mediterranean basin (Czosnek et al., 1990). TYLCV is transmitted by the SPW and considered the most damaging virus of tomato worldwide (Picó et al., 1996). After acquiring the virus, the SPW remains viruliferous for life, with symptoms appearing ≈2 to 3 weeks after inoculation (Lapidot and Polston, 2006). In the western hemisphere, TYLCV was first detected in Cuba in 1990, the Dominican Republic in 1992, and Florida in 1997 (Polston et al., 1999). TYLCV is now endemic throughout most of the southern tier of the United States, including Florida, Georgia, North Carolina, Louisiana, Texas, and California (Isakeit et al., 2007; Moriones and Navas-Castillo, 2010; Polston and Schuster, 2000; Rojas et al., 2007). Symptoms of TYLCV infection include dwarfed leaves that are up-curved, thick and crumpled, and have chlorotic margins. Up to 90% of flowers may abscise after infection, resulting in poor fruit set and yield, especially when infections occur early in the season (Schuster et al., 1996).

Tomato growers in Florida have largely focused on controlling the SPW vector to reduce yield losses from TYLCV (Polston, 2003; Schuster et al., 1996). Management of SPW and TYLCV can be achieved through applications of insecticides, particularly systemic neonicotinoids. However, SPW resistance has developed to this class of insecticides in Florida (Schuster et al., 2008, 2010) and elsewhere (Horowitz et al., 2007). An effective cultural control program would include reduction of vector populations by initiating timely crop destruction after harvest followed by maintenance of a host-free period over one or more SPW generations (Hilje et al., 2001;

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.4047	acre(s)	ha	2.4711
0.3048	ft	m	3.2808
2.54	inch(es)	cm	0.3937
1.1209	lb/acre	kg-ha ⁻¹	0.8922
1	ppm	μL-L ⁻¹	1
2.2417	ton/acre	Mg-ha ⁻¹	0.4461
(°F - 32) ÷ 1.8	°F	°C	(°C × 1.8) + 32

Table 1. Tomato varieties/advanced breeding lines, seed sources, pruning, *Tomato yellow leaf curl virus* (TYLCV) symptomatic incidence and severity and bacterial leaf spot (BLS) severity during Spring 2007 and 2008 at Immokalee, FL.

Variety or advanced breeding line	Source ^z	Suckers and grounds suckers pruned (no.)	TYLCV incidence (%) ^y	TYLCV-severity rating (0–3 scale) ^x	BLS rating (1–5 scale) ^w
<i>Spring 2007, Round tomato</i>					
'BHN 745'	BHN	2–3	33.9 cd ^y	0.5c	n/d
FLA 8576	UF	2–3	39.3 c	0.8bc	n/d
FLA 8579	UF	2–3	32.1 cd	0.5c	n/d
FLA 8580	UF	2–3	62.5 b	1.1b	n/d
HA 3074 ('Inbar')	Hazera	2–3	21.4 cd	0.3d	n/d
HA 3075 ('Ofri')	Hazera	2–3	35.7 cd	0.4c	n/d
HA 3078	Hazera	2–3	28.6 cd	0.4c	n/d
'Tygress'	Seminis	2–3	16.1 d	0.2d	n/d
'Florida 47' (control)	Seminis	2–3	94.6 a	2.5a	n/d
Significance	—	—	*	*	—
<i>Spring 2007, Roma-type tomato</i>					
'Shanty'	Hazera	2–3	23.2	0.3	n/d
HA 3811 (control)	Hazera	2–3	91.1	2.0	n/d
Significance ^v	—	—	**	**	—
<i>Spring 2008, Round tomato</i>					
'BHN 765'	BHN	None	0.0 b	—	4.0 a
'BHN 745'	BHN	None	0.0 b	—	2.0 bc
FLA 8579	UF	None	0.0 b	—	2.0 bc
FLA 8632	UF	None	0.0 b	—	1.3 c
FLA 8633	UF	None	0.0 b	—	2.7 abc
HA 3074 ('Inbar')	Hazera	4–5	0.0 b	—	3.3 ab
HA 3075 ('Ofri')	Hazera	2–3	0.0 b	—	2.0 bc
HA 3091	Hazera	2–3	0.0 b	—	3.0 ab
Sak 5421	Sakata	None	0.0 b	—	2.0 bc
Sak 5443	Sakata	None	0.0 b	—	2.7 abc
'Security 28'	Harris Moran	2	0.0 b	—	3.0 ab
'Tygress'	Seminis	2–3	0.0 b	—	3.3 ab
'Sebring' (control)	Syngenta	2–3	11.5 a	—	3.0 ab
'Florida 47' (control)	Seminis	2–3	6.3 a	—	2.7 abc
Significance	—	—	**	—	*
<i>Spring 2008, Roma-type tomato</i>					
'Shanty'	Hazera	None	0.0 b	—	0.1
Sak 5808	Sakata	4–5	0.0 b	—	0.1
'Mariana' (control)	Sakata	None	10.0 a	—	0.1
Significance	—	—	**	—	NS

^zBHN = BHN Seed (Immokalee, FL), UF = University of Florida Tomato Breeding Program (Balm, FL), Hazera = Hazera Seeds (Coconut Creek, FL), Seminis = Seminis Vegetable Seeds (Oxnard, CA), Sakata = Sakata Seeds (Morgan Hill, CA), Harris Moran = Harris Moran Seed (Modesto, CA), Syngenta = Syngenta Co. (Golden Valley, MN).

^yPercentage of TYLCV-affected plants at end of trial, after third harvest. Values are means of four and three replications of 10 and 20 plants during Spring 2007 and 2008, respectively.

^x0 = no symptoms, 3 = severe symptoms.

^w1 = low at third harvest, 5 = severe at third harvest, n/d = not determined.

^vMeans separation by Duncan's multiple range test, $P \leq 0.05$, means followed by the same letter are not significantly different, except Student's *t* test was used in Roma-type tomato Spring 2007. Round and Roma-type tomato were compared separately in both years.

**Significant at $P \leq 0.01$; *Significant at $P \leq 0.05$; ns = not significant.

Polston, 2003). The effective use of a host-free period to manage TYLCV in the Dominican Republic was studied by monitoring TYLCV levels in SPW using polymerase chain reaction with TYLCV-specific primers (Salati et al., 2002). The incidence of TYLCV decreased markedly during the host-free period, and then gradually increased during the tomato-growing season. In contrast, TYLCV persisted in SPW and tomato plants in an area in which the host-free period was not

implemented. Unfortunately, the length of the growing season in southern and central Florida has been increasing due to higher market prices and increased production of grape tomato and alternate hosts of TYLCV such as pepper. As a result, the tomato-free planting period is generally not long enough to eliminate the problem of TYLCV (Polston, 2003). These deficiencies in the present management system are posing a serious threat to the 32,000 acres of round

and Roma-type tomato in Florida valued at \$564 million [U.S. Department of Agriculture (USDA), 2013]. Therefore, viable alternative management tools are needed.

Tomato varieties resistant to TYLCV could obviate or reduce the necessity of pesticide applications and/or plant seclusion (greenhouses or shadehouses) and could provide a stable and sustainable management alternative (Polston, 2003). Progress in breeding for TYLCV resistance was

initially slow, due in part to the complex genetics of resistance and the presence of interspecific barriers between the wild and domesticated tomato species (Brunetti et al., 1997). Furthermore, until recently, most of the improved genetically resistant material has come from Israel. It is important for southern Florida to have a breeding and variety testing program under local environmental conditions and directed at existing market requirements. TYLCV-R varieties and germplasm adapted to the hot and humid Florida environment are now being developed by BHN Seed (Immokalee, FL), Harris Moran Seed Co. (Modesto, CA), Seminis Vegetable Seeds (Oxnard, CA), Syngenta Co. (Golden Valley, MN), University of Florida Tomato Breeding Program (Balm, FL), Sakata Seeds (Morgan Hill, CA), Hazera Seeds (Coconut Creek, FL), and others.

Evaluations of TYLCV-R varieties and germplasm have been conducted in Florida (Cushman and Stansly, 2006; Gilreath et al., 2000; Scott, 2004); however, this study provides information needed to revise current recommendations including new varieties and breeding lines previously not evaluated under low and high TYLCV pressure. Relative to susceptible varieties, such as Florida 47, Sebring (round), and Mariana (Roma-type), TYLCV-R varieties evaluated produced comparable yields under low virus pressure and greater yields under high virus pressure. 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 leaf spot [BLS (*Xanthomonas vesicatoria*, *Xanthomonas euvesicatoria*, *Xanthomonas perforans*, and *Xanthomonas gardneri*)]. The goal of this study was to compare the yield and quality of round and Roma-type tomato varieties/advanced breeding lines with resistance/tolerance to TYLCV to the current industry standards.

Materials and methods

Two field experiments were conducted in Immokalee, FL, one at the University of Florida's Southwest

Florida Research and Education Center (UF/SWFREC) in 2007 on Immokalee fine sand and the other on a commercial tomato farm in 2008 on Eau Gallie fine sand. Ten (2007) and 14 (2008) TYLCV-R varieties/advanced breeding lines were evaluated in a completely randomized block design with four and three replications, respectively (Table 1). TYLCV-R varieties/advanced breeding lines that did not perform satisfactorily or had been sufficiently tested were eliminated in the 2008 trial and new TYLCV-R varieties/advanced breeding lines were introduced to the program to meet the objective of revising current recommendations.

CULTURAL PRACTICES. Seed was planted in 200-cell polystyrene foam transplant flats and grown in a commercial greenhouse for 6 weeks (Redi Plants Corp., Naples, FL). In 2007 and 2008, seepage irrigation systems were used, which supplies water to the root zone through upward capillary movement (upflux) from an artificially regulated shallow water table. Fields were rototilled, and all fertilizers were applied preplant [nitrogen (N), phosphorous (P), potassium (K), and micronutrients] before placement of low-density black polyethylene mulch over raised beds. Fertilizer was applied as a bottom mix (broadcast and incorporated in the bed) and as a top mix in two grooves on the edge of the bed from which fertilizer is slowly solubilized as water moves up by capillary action of the seepage irrigation system (Olson et al., 2006).

Total fertilizer application supplied 243 lb/acre N, 28 lb/acre P, and 219 lb/acre K in 2007 and 300 lb/acre N, 27 lb/acre P, and 383 lb/acre K in 2008. Fertilizer sources were ammonium nitrate, potassium sulfate and nitrate, and triple superphosphate for N-P-K in both years, respectively. Fertilizer application rates used in Spring 2007 and 2008 were based on soil analysis for P and K and are within the standard range employed by the tomato industry in southern Florida in sandy soils using seepage irrigation (Ozores-Hampton et al., 2008). Beds were 32 inches wide and 8 inches high in 2007, and 36 inches wide and 9 inches high in 2008, and were formed on 6-ft centers both years. Beds were fumigated upon formation with methyl bromide and chloropicrin (67%:33% by weight) at the rate of 350 lb/acre in 2007, and (50%:50% by weight) at the rate of 200 lb/acre in 2008. After fumigation, all beds were immediately covered with the black plastic film mulch. Transplants were established in the field at a within-row spacing of 18 inches (20 Feb. 2007) and 22 inches (4 Jan. 2008), which created a stand of ≈ 4840 and 4033 plants/acre, respectively. Plot lengths were 21 ft (14 plants) and 36 ft (20 plants) in 2007 and 2008, respectively. Each tomato variety was pruned, staked, and tied 28 d after transplanting (DAT) according to the supplying seed company's specifications (Table 1). Tomato plants were treated for pests and diseases according to UF Institute of

Table 2. Summary of mean, minimum, and maximum air temperature, and total rainfall during Spring 2007 and 2008 at Immokalee, FL.^z

Period	Air temp (°F) ^y			Total rainfall
	Mean	Minimum	Maximum	(inches) ^y
2007				
February	66.6	53.3	83.4	0.0
March	68.6	54.3	83.9	0.2
April	71.7	56.7	87.6	0.9
May	75.0	62.4	90.1	0.8
Avg/Total	70.5	56.7	86.2	1.9
2008				
January	64.4	51.2	79.5	0.8
February	68.4	56.5	82.6	2.3
March	68.8	55.9	82.4	2.8
April	71.4	57.3	86.0	2.5
Avg/Total	68.2	55.2	82.6	8.5

^zWeather data obtained from Florida Automated Weather Network from University of Florida/Institute of Food and Agriculture Science, Southwest Florida Research and Education Center in Immokalee, FL.

^y(°F - 32) ÷ 1.8 = °C, 1 inch = 2.54 cm.

Food and Agriculture Science pesticide recommendations and in response to scouting reports (Olson et al., 2006). No insecticides to control SPW were used in 2007 to allow SPW populations to buildup. Ten tomato plants were selected randomly and harvested from the center part of the plot three times on 7, 22, and 29 May 2007 (66, 91, and 98 DAT) and 7, 21, and 30 Apr. 2008 (93, 107, and 116 DAT).

EVALUATIONS. Sweetpotato whitefly populations were monitored weekly in 2007 and 2008 by carefully inverting the leaf on the sixth node from the top on four plants and counting adult SPW. Disease severity of TYLCV symptomatic plants was rated weekly over 7 weeks in 2007 beginning 22 Mar. through third harvest (29 May 2007) on a 0–3 scale where 0 = no symptoms; 1 = very slight yellowing of leaf margins on apical leaf; 2 = some yellowing and minor curling of leaflet ends; and 3 = stunted plants with severe dwarfing and cupping of leaves, shortened internodes, and aborted blooms. These ratings correspond respectively to examples 1, 2, and 3 + 4 in Lapidot and Friedman (2002). Tomato TYLCV disease severity ratings were not taken in 2008 due to low field virus pressure. Bacterial leaf spot disease severity was rated on a 1-to-5 scale (1 = low and 5 = high) at the third harvest 30 Apr. 2008, but not in 2007 due to the prevalence of TYLCV symptoms.

A visual assessment was administered by 28 participants during a field day at first harvest 7 Apr. 2008 (Spring 2008 season) to evaluate earliness, plant vigor, fruit size, firmness, fruit quality (color and shape), potential yield, and overall plant rating using a 1-to-5 scale (1 = very poor, 5 = very good). The visual assessment was not administered in Spring 2007 due to high TYLCV incidence. TYLCV-R varieties were coded and the names were not known to the participants making the ratings. The participants in the visual assessment had experience evaluating tomato varieties/advanced breeding lines, including tomato growers, breeders, tomato seed sales representative, extension agents, etc.

Tomato fruit were harvested from mature-green and breaker to ripe according to industry standards (USDA, 1997). Yield measures included marketable tomato that were graded in the field according to USDA

Table 3. First harvest, first and second harvest and total marketable fruit yield categories for selected tomato varieties/advanced breeding lines grown in Spring 2007 at Immokalee, FL.

Variety or advanced breeding line	First harvest			Yield (tons/acre) ²					
	First harvest			First and second harvest			Total harvest		
	XL ¹	L ²	M ³	Total	XL	L	M	Total	Unmarketable
<i>Round tomato</i>									
'BHN 745'	7.9 cd ^x	0.9 abc	0.5	9.3 bcd	9.1 bc	1.3	1.0 c	11.4 d	17.9 a (57.1%)
FLA 8576	5.5 cd	0.49 c	0.61	6.62 cd	7.1 bc	1.2	1.8 bc	10.0 bcd	13.7 bc (52.7%)
FLA 8579	8.7 bc	1.0 abc	0.5	9.9 bc	10.4 bc	1.6	1.6 bc	13.6 bcd	12.8 bc (43.8%)
FLA 8580	7.4 cd	1.3 a	0.4	9.1 cd	9.5 bc	3.0	1.9 a	14.4 ab	8.7 d (32.5%)
HA 3074 ('Inbar')	12.4 ab	0.8 abc	0.4	13.6 ab	16.9 a	2.1	1.9 ab	21.0 a	10.4 cd (29.2%)
HA 3075 ('Ofir')	9.1 bc	1.2 ab	0.7	11.0 bc	12.0 ab	2.6	1.9 abc	16.6 abc	8.8 d (31.1%)
HA 3078	14.0 a	0.9 abc	0.6	15.5 ab	17.9 a	1.7	2.0 bc	21.5 a	13.7 bc (34.6%)
'Tygress'	9.0 bc	0.7 bc	0.7	10.4 bc	12.1 ab	1.9	1.7 abc	15.7 abc	14.3 b (42.9%)
'Florida 47'	4.1 d	0.5 c	0.7	5.4 d	5.3 c	1.8	1.9 abc	9.0 cd	7.4 d (40.1%)
Significance	**	*	NS	**	**	NS	*	**	**
<i>Roma-type tomato</i>									
'Shanty'				7.5				12.9	8.6 (40.0%)
HA 3811				2.0				7.7	3.9 (33.6%)
Significance ^w				*				*	*

¹1 ton/acre = 2.2417 Mg·ha⁻¹.

²XL = extra-large [5x6 (minimum 2-25/32 inches)], L = large [6x6 (2-17/32 inches minimum, 2-29/32 inches maximum)], M = medium [6x7 (2-9/32 inches minimum, 2-19/32 inches maximum)]; 1 inch = 2.54 cm.

³Means separation by Duncan's multiple range test, $P \leq 0.05$, means followed by the same letter are not statistically different. Round and Roma-type tomato were compared separately in both years.

^wStudent's *t* test.

**Significant at $P \leq 0.01$; *Significant at $P \leq 0.05$; NS = not significant.

specifications for extra-large [5×6 (minimum 2-25/32 inches)], large [6×6 (2-17/32 inches minimum, 2-29/32 inches maximum)], and medium [6×7 (2-9/32 inches minimum, 2-19/32 inches maximum)] fruit categories (USDA, 1997). Numbers of total unmarketable tomato fruit were recorded and categorized based on the incidence of BES, zipper and catface (Zip/Catf), sunscald and yellow shoulders (SS/YS), off-shape fruit (OS), radial and concentric cracking (CRK), and gray wall as described by Gilreath et al. (2000). After harvest in both years, tomatoes were placed in 25-lb boxes and transported to a commercial packing house in Immokalee, FL, for fruit ripening. After 12 d in 2007 and 10 d in 2008 of ethylene ripening treatment at 20 °C with 85% to 90% relative humidity and 150 ppm of ethylene (Sargent et al., 2005), postharvest fruit skin color was rated on 15 uniform tomato of each variety. Color was measured subjectively using a 1-to-6 scale rating where 1 = green and 6 = red (USDA, 1997). Tomato skin color is an important attribute in determining quality for the green-ripe harvested tomato industry due to the long period between harvest and final sale.

Tomato yellow leaf curl virus incidence and severity, BLS severity,

yield components, fruit color, and visual assessment data were analyzed using analysis of variance and Duncan's multiple range test at $P \leq 0.05$ and Student's t test (SAS version 9.1; SAS Institute, Cary, NC). Proportions of plants symptomatic for TYLCV, BLS, and fruit defects were normalized for analysis by arcsine transformation, although data are reported in percentages.

Results

Overall, weather conditions were cool and dry throughout the spring season (Table 2). However, Spring 2008 had higher total rainfall than 2007. Sweetpotato whitefly pressure was 10-fold greater in Spring 2007 than in Spring 2008. These two spring seasons created the contrast between high and low TYLCV pressure due in part to the later planting in 2007 compared with 2008 (data not shown).

Spring 2007

PESTS AND DISEASES. In 2007, there were no significant differences among varieties/advanced breeding lines in SPW counts ($F = 1.85$, $P = 0.9$, $df = 10.30$), with (mean $\pm$ SE) 42.4 ± 3.2 , 36.9 ± 2.0 , and 17.2 ± 1.6 SPW adults per four leaves at 38, 42, and 55 DAT, respectively. Symptoms of TYLCV in 2007 were evident in

the susceptible 'Florida 47' by the first evaluation at 37 DAT (data not shown) and TYLCV incidence was near 100% by the end of the trial and most plants were severely stunted (Table 1). Roma-type HA 3811 was also susceptible. Lowest incidence and severity of TYLCV symptoms 79 DAT occurred in 'Tygress', although not significantly different in terms of rating from HA 3078, 'Ofri', 'Inbar', 'BHN 745', or FL 8579. Bacterial leaf spot was not rated at third harvest because of the prevalence of TYLCV symptoms. There was no *Fusarium* crown rot found during the season (data not shown).

YIELDS. First harvest yields of extra-large fruit and total marketable fruit (all size categories combined) were higher in most of the round TYLCV-R varieties/advanced breeding lines than the susceptible control 'Florida 47' [$P \leq 0.05$ (Table 3)]. However, there were no significant differences among 'Florida 47' and the TYLCV-R varieties/advanced breeding lines 'BHN 745', FLA 8576, and FLA 8580. First plus second harvests of extra-large fruit and total marketable harvest (all size categories combined) were higher for 'Inbar', HA 3078, and FLA 8580 compared with 'Florida 47', which did not yield significantly lower than those of 'BHN

Table 4. Unmarketable tomato fruit by defect with: rough blossom end scar (BES), zipper and catface (Zip/Catf), sunscald and yellow shoulder (SS/YS), radial and concentric cracking (CRK), off shape (OS), and other cull categories (Other) grown Spring 2007 at Immokalee, FL.

Variety or advanced breeding line	Total unmarketable (tons/acre) ^z	Unmarketable by defect (%) ^y					
		BES	Zip/Catf	SS/YS	CRK	OS	Other
Round tomato							
‘BHN 745’	17.9 a ^x	4.6 b	8.6 c	49.7 ab	22.5 b	12.6 cde	2.0
FLA 8576	13.7 bc	5.0 b	26.8 a	46.6 abc	11.4 cd	7.5 de	2.7
FLA 8579	12.8 bc	7.8 b	9.2 c	37.8 bcd	16.1 bc	24.9 ab	4.2
FLA 8580	8.7 d	4.7 b	13.7 bc	41.8 abc	16.4 bc	17.1 bcd	6.3
HA 3074 (‘Inbar’)	10.4 cd	5.5 b	17.2 b	34.3 bcd	18.9 bc	15.7 bcde	8.4
HA 3075 (‘Ofri’)	8.8 d	9.8 b	7.7 c	56.5 a	3.7 d	20.0 abc	2.3
HA 3078	13.7 bc	21.7 a	7.7 c	27.7 cd	8.7 cd	26.9 a	7.3
‘Tygress’	14.3 b	3.2 b	11.2 bc	49.3 ab	26.7 b	7.9 de	1.7
‘Florida 47’	7.4 d	4.4 b	10.4 c	19.2 d	58.0 a	6.3 e	2.0
Significance	**	**	**	**	**	**	NS
Roma-type tomato							
‘Shanty’	8.6	1.7	4.5	30.0	1.2	57.9	4.7
HA 3811	3.9	0.0	48.2	13.6	16.8	17.6	3.8
Significance	*	NS	*	*	*	*	NS

^z1 ton/acre = 2.2417 Mg·ha⁻¹.

^yReported as percentage of the total number of unmarketable fruit.

^xMeans separation by Duncan's multiple range test, $P \leq 0.05$, means followed by the same letter are not statistically different. Round and Roma-type tomato were compared separately in both years.

**Significant at $P \leq 0.01$; *Significant at $P \leq 0.05$; NS = not significant.

745', FLA 8576, FLA 8579, FLA 3075, and 'Tygress'. Total marketable yields (all size categories and harvests combined) ranged from 10.7 to 25.9 tons/acre. Total extra-large fruit and total marketable yield were higher for 'Inbar' and 'Ofri', HA 3078, and 'Tygress' than 'Florida 47'. However, yields of 'Florida 47' were not significantly less for 'BHN 745' and FLA 8576 in both total extra-large fruit and total marketable yield.

Total yield of all unmarketable categories was greater for most TYLCV-R varieties/advanced breeding lines than the susceptible control 'Florida 47', except for FLA 8580, 'Inbar' and 'Ofri' (Table 3). The most common types of defect among TYLCV-R varieties/advanced breeding lines expressed as percentages of unmarketable yield were 56.5% to 19.2% SS/YS, 26.7% to 3.7% CRK, 26.9% to 6.3% OS, and 7.7% to 26.8% Zip/Catf (Table 4). 'Florida 47' was among the lowest in SS/YS and OS, but was the highest in CRK fruit.

With Roma-type tomato varieties/advanced breeding lines, production of marketable fruit by 'Shanty' was greater than the susceptible HA 3811 ($P \leq 0.05$; Table 3). Total marketable yields from 'Shanty' ranged from 7.5 to 12.9 tons/acre. However, more unmarketable fruit were harvested from 'Shanty' than HA 3811. The most common defect types for Roma-type varieties/advanced breeding lines were Zip/Catf and CRK for HA 3811 and SS/YS and OS for 'Shanty' (Table 4).

POSTHARVEST EVALUATION. In Spring 2007, most of the TYLCV-R varieties/advanced breeding lines had a higher color rating than 'Florida 47' (Table 5). However, 'Tygress' was not different from 'Florida 47' and 'Inbar' and 'Ofri' had significantly lower color ratings than 'Florida 47'. The advanced breeding line with the highest color rating was FLA 8576. Among Roma-type tomato varieties/advanced breeding lines in Spring 2007, HA 3811 had a higher color rating than 'Shanty'.

Spring 2008

PESTS AND DISEASES. Only 0.8 ± 1.04 adult whiteflies were observed per leaf over the season. The only tomato plants showing TYLCV symptoms were 'Florida 47', 'Sebring', and 'Mariana' varieties with less than 12% incidence (Table 1). In 2008, there

were generally no differences in BLS ratings at the third harvest of TYLCV-R varieties/advanced breeding lines as compared to 'Sebring' and 'Florida 47', except that FLA 8632 showed lower disease than 'Sebring' (Table 1). The highest incidence of *Fusarium* crown rot was in 'Inbar' with 18.5% of the tomato plants affected by the disease (data not shown). The remaining TYLCV-R varieties/advanced breeding lines ranged from 0% to 5%. Differences in BLS or *Fusarium* crown rot (data not shown) among Roma-type varieties were not significant.

YIELDS. No differences between TYLCV-R and susceptible round tomato varieties/advanced breeding lines were indicated comparing the yield of extra-large fruit and total marketable fruit at the first harvest or the first plus second harvests, except for FLA 8632 and 8633 that had the lowest yields [$P \leq 0.05$ (Table 6)]. However, FLA 8633 was not different from FLA 8579 and 'Sebring' at first extra-large harvest and FLA 8633 was not different from FLA 8579 and 'Inbar' at first plus second harvests. Total production of marketable fruit ranged from 36.5 to 27.3 tons/acre, with no significant differences among TYLCV-R or susceptible round varieties ($P > 0.05$). More unmarketable tomato were harvested from TYLCV-R varieties/advanced breeding lines compared with both of the susceptible varieties except for FLA 8579, FLA 8632, 'Inbar', 'Ofri', and 'Tygress'. The most common defect types among TYLCV-R varieties/advanced breeding lines were 47.6% to 20.3% scars (SC), 55.6% to 15.6% OS, 54.9% to 1.2% Zip/Catf, and 20.6% to 3.3% BES (Table 7). No TYLCV-R variety/advanced breeding line had a greater percentage of fruit affected by BES compared with 'Florida 47', but FLA 8633 and Sak 5443 had greater percentages compared with 'Sebring'. Conversely, no TYLCV-R variety/advanced breeding line had a greater percentage of fruit with SC compared with 'Sebring', but 'BHN 765' had a greater percentage compared with 'Florida 47'. No TYLCV-R variety/advanced breeding line had greater percentage of OS compared with either susceptible variety.

Among Roma-type tomato varieties/advanced breeding lines, there were no differences in yield of extra-large fruit or of total marketable

Table 5. Field Tomato yellow leaf curl virus-resistant round and Roma-type tomato varieties postharvest evaluation and exterior fruit color during Spring 2007 and 2008 at Immokalee, FL.

Variety or advanced breeding line	Exterior fruit color (1–6 scale) ^a
<i>Spring 2007, Round tomato</i>	
'BHN 745'	6.0 b ^y
FLA 8576	7.0 a
FLA 8579	5.5 b
FLA 8580	6.0 b
HA 3074 ('Inbar')	5.0 d
HA 3075 ('Ofri')	5.0 d
HA 3078	6.0 b
'Tygress'	4.0 c
'Florida 47'	5.5 c
Significance ^y	**
<i>Spring 2007, Roma-type tomato</i>	
'Shanty'	5.0
HA 3811	7.0
Significance	**
<i>Spring 2008, Round tomato</i>	
'BHN 745'	5.0 d
'BHN 765'	5.0 d
FLA 8632	5.0 d
FLA 8579	4.5 e
FLA 8633	6.5 a
HA 3091	5.5 c
HA 3074 ('Inbar')	6.0 b
HA 3075 ('Ofri')	4.5 e
Sak 5421	5.0 d
Sak 5443	6.0 b
'Security 28'	4.0 f
'Tygress'	4.5 e
'Sebring'	5.0 d
'Florida 47'	5.0 d
Significance	**
<i>Spring 2008, Roma-type tomato</i>	
'Shanty'	6.0 a
Sak 5808	5.5 b
'Mariana' (control)	5.0 c
Significance	**

^aAfter 12 d in 2007 and 10 d in 2008 of ethylene ripening treatment at 20 °C (68.0 °F) with 85% to 90% relative humidity and 150 ppm ($\mu\text{L}\cdot\text{L}^{-1}$) of ethylene (Sargent et al., 2005) color was evaluated: 1 = green, 6 = red (USDA, 1997).

^yMeans separation by Duncan's multiple range test, $P \leq 0.05$, means followed by the same letter are not statistically different. Round and Roma-type tomato were compared separately in both years.

**Significant at $P \leq 0.01$; *Significant at $P \leq 0.05$; ns = not significant.

yield at first harvest or of first and second harvests combined [$P \leq 0.05$ (Table 6)]. Marketable yields of extra-large totaled overall harvests were greater from 'Mariana' than Sak 5808 but did not differ between 'Mariana' and 'Shanty' ($P \leq 0.05$). Total marketable yield from Roma-type varieties/advanced

Table 6. First harvest and second harvest and total marketable fruit yield categories for selected tomato varieties and breeding lines grown in Spring 2008 on a commercial farm at Immokalee, FL.

Variety or advanced breeding line	Yield (tons/acre) ^z											
	First harvest			First and second harvest			Total harvest					
	XL ^y	L ^y	M ^y	Total	XL	L	M	Total	XL	L	M	Total
<i>Round tomato</i>												
'BHN 745'	11.9 ab ^x	2.5 bc	1.1 bcd	15.6 a	17.5 abc	5.3 cde	2.0 ef	24.8 abc	19.9 ab	9.8	4.1 cd	33.8
'BHN 765'	12.1 ab	2.7 bc	1.02 bcd	15.8 a	18.5 ab	7.1 abc	4.0 bcde	29.6 a	19.7 ab	9.3	5.4 bcd	34.4
FLA 8579	7.8 cd	5.3 a	2.0 bcd	15.1 a	10.3 ef	9.1 a	4.9 bcd	24.3 abc	11.1 d	11.3	7.2 bc	29.6
FLA 8632	1.8 e	2.6 bc	4.1 a	8.6 c	2.0 g	4.0 de	8.6 a	14.6 d	2.1 e	7.2	17.9 a	27.3
FLA 8633	5.8 d	2.2 bc	0.9 bcd	8.9 bc	9.0 f	6.1 bcd	3.8 bcde	18.9 cd	10.6 d	10.6	7.3 bc	28.6
HA 3074 (Inbar)	9.8 abc	2.1 bc	2.1 bcd	14.0 abc	12.3 def	4.1 de	5.5 b	21.9 bc	13.6 cd	6.4	7.5 bc	27.5
HA 3075 (Ofri)	12.1 ab	2.5 bc	1.8 bcd	16.4 a	14.8 bcd	4.6 cde	2.9 def	22.3 bc	17.1 abc	9.1	5.4 bcd	31.7
HA 3091	12.8 ab	1.4 c	0.53 d	14.7 ab	19.0 a	3.2 e	1.7 f	23.9 abc	20.4 a	7.4	2.7 d	30.5
Sak 5421	10.3 abc	2.1 bc	1.7 bcd	14.1 abc	13.3 de	4.0 de	3.3 def	20.7 bc	15.6 bc	8.1	6.7 bc	30.4
Sak 5443	11.1 abc	2.1 bc	0.7 cd	13.9 abc	17.4 abcd	5.08 cde	2.0 ef	24.5 abc	19.6 ab	8.8	4.19 cd	32.6
'Security 28'	13.2 a	1.6 c	0.4 d	15.2 a	19.0 a	4.2 de	1.5 f	24.7 abc	20.8 a	6.1	2.9 d	29.9
'Tygress'	12.7 ab	3.8 ab	2.8 ab	19.3 a	15.0 abcd	6.4 dce	5.7 b	27.1 ab	15.8 bc	9.0	7.5 bc	32.2
'Sebring'	9.0 bcd	3.8 ab	2.5 abc	15.4 a	13.7 cde	7.8 ab	5.1 bc	26.6 ab	16.4 abc	12.1	7.8 b	36.5
'Florida 47'	11.5 abc	2.8 bc	1.0 bcd	15.3 a	18.0 ab	6.1 bcd	2.8 def	27.0 ab	20.3 a	9.6	4.6 bcd	34.5
Significance	**	**	**	*	**	**	**	*	**	NS	**	NS
<i>Roma-type tomato</i>												
'Shanty'	6.3	0.2 b	0	6.5	7.6	3.6	6.4	13.1	9.4 ab	7.8 b	3.2 b	21.0 b
Sak 5808	4.2	3.8 a	0	8.0	6.6	10.3	3.3	20.2	8.2 b	20.7 a	8.2 a	37.8 a
'Mariana'	9.7	0.9 b	0	10.6	12.1	5.7	3.6	22.3	13.5 a	10.6 b	8.9 a	36.0 a
Significance	NS	*	NS	NS	NS	NS	NS	NS	*	*	*	*

^z1 ton/acre = 2.2417 Mg·ha⁻¹.^yXL = extra-large [5 × 6 (minimum 2-25/32 inches)], L = large [6 × 6 (2-17/32 inches minimum, 2-29/32 inches maximum)], M = medium [6 × 7 (2-9/32 inches minimum, 2-19/32 inches maximum)]; 1 inch = 2.54 cm.^xMeans separation by Duncan's multiple range test, $P \leq 0.05$, means followed by the same letter are not statistically different. Round and Roma-type tomato were compared separately in both years.**Significant at $P \leq 0.01$; *Significant at $P \leq 0.05$; NS = not significant.

Table 7. Unmarketable tomato fruit by defect with: blossom end scar (BES), zipper (Zip), scarring (SC), off shape (OS), graywall (GW), and radial and concentric cracking (CRK) grown in Spring 2008 on a commercial farm in Immokalee, FL.

Variety or advanced breeding line	Total unmarketable (tons/acre) ^z	Unmarketable by defect (%) ^y					
		BES	Zip	SC	OS	GW	CRK
<i>Round tomato</i>							
‘BHN 745’	13.6 ab ^x	4.6 b ^y	4.6 cde	43.6 ab	44.9 ab	0.5	1.8
‘BHN 765’	14.4 ab	6.0 b	3.9 cde	47.6 a	31.7 bc	3.3	7.5
FLA 8579	8.2 cde	3.9 b	3.3 cde	38.1 abcd	47.8 ab	3.5	3.4
FLA 8632	6.9 def	6.3 b	54.9 a	20.3 e	15.6 c	0.9	2.0
FLA 8633	10.5 bcd	20.6 a	4.8 cde	22.4 de	41.4 ab	1.7	9.1
HA 3074	6.5 def	13.4 ab	18.7 b	37.8 abcd	27.4 bc	0.5	2.2
(‘Inbar’)							
HA 3075	8.5 cde	14.0 ab	4.9 cde	44.8 ab	33.9 bc	2.4	0.0
(‘Ofri’)							
HA 3091	16.6 a	5.3 b	9.9 cd	43.2 ab	36.4 abc	4.4	0.8
Sak 5421	16.5 a	13.8 ab	1.2 e	41.3 abc	41.8 ab	1.6	0.3
Sak 5443	12.6 abc	21.1 a	4.8 cde	40.0 abc	31.4 bc	0.5	2.0
‘Security 28’	12.4 abc	7.3 b	10.4 cd	25.0 cde	55.6 a	1.2	0.5
‘Sebring’	2.9 f	1.9 b	11.3 bcd	44.8 ab	36.5 abc	2.5	3.0
‘Tygress’	6.1 def	3.3 b	12.4 bc	33.0 abcde	47.2 ab	0.0	4.1
‘Florida 47’	5.6 ef	9.1 ab	7.4 cd	29.0 bcde	47.9 ab	4.0	2.6
Significance	**	*	**	**	*	NS	NS
<i>Roma-type tomato</i>							
‘Shanty’	27.2 a	0.9	14.8 a	24.9 b	58.9 a	0.0	0.5 b
Sak 5808	3.7 b	2.0	23.2 a	33.5 a	29.8 b	0.0	11.5 a
‘Mariana’	4.9 b	0.0	4.2 b	30.6 a	65.2 a	0.0	0.0 b
Significance	**	NS	**	**	**	—	**

^z1 ton/acre = 2.2417 Mg·ha⁻¹.

^yReported as percentage of the total number of fruit unmarketable.

^xMeans separation by Duncan's multiple range test, $P \leq 0.05$, means followed by the same letter are not statistically different. Round and Roma-type tomato were compared separately in both years.

**Significant at $P \leq 0.01$; * Significant at $P \leq 0.05$; NS = not significant.

breeding lines ranged from 21.0 to 37.8 tons/acre and was greater for 'Mariana' and Sak 5808 than 'Shanty' ($P \leq 0.05$). Yields of unmarketable fruit among Roma-type tomato were greater from 'Shanty' than Sak 5808 and 'Mariana' [(control) $P \leq 0.05$]. The most common defect type among TYLCV-R Roma-type tomato varieties/advanced breeding lines was OS and SC and in Shanty (Table 7).

POSTHARVEST EVALUATION. Many of the TYLCV-R round varieties/advanced breeding lines had a similar or higher color rating than the susceptible varieties Florida 47 and Sebring (Table 5). However, 'Security 28', 'Ofri', 'Tygress', and FLA 8579 had lower color ratings than the susceptible varieties while the highest color rating among TYLCV-R breeding line was FLA 8633 (Table 5). Among Roma-type tomato varieties, Shanty had the highest color rating, with the lowest being that of Mariana.

FIELD VISUAL ASSESSMENT EVALUATIONS SPRING 2008. Participants in the visual assessment rated 'BHN 765', FLA 8579, FLA8632, FLA 8633, HA 3091, Sak 5421, and 'Security 28' as being earlier than both 'Sebring' and 'Florida 47' (Table 8). Only FLA 8632 was given a vigorous plant rating greater than both susceptible varieties, while FLA 8579, HA 3091, 'Inbar', 'Ofri', and 'Tygress' were rated as less vigorous. 'BHN 765', HA 3091, 'Ofri', Sak 5443, and 'Security 28' were rated as having fruit larger than fruit of either 'Sebring' or 'Florida 47'. The fruit of 'Security 28' and Sak 5443 were rated as being more firm than those of the susceptible varieties. The lowest fruit quality was from 'BHN 765', FLA 8633, HA 3091, and SAK 5421 than 'Sebring' or 'Florida 47'. Sak 5443, 'Security 28', 'BHN 765', HA 3091, and Sak 5421 were rated as having a greater yield potential than either 'Sebring' or

'Florida 47'. Variety Security 28 and advanced breeding line Sak 5443 received the highest overall ratings as compared with others varieties and breeding lines including the susceptible control varieties.

Of the TYLCV-R Roma-type tomato varieties, Shanty was rated higher than the susceptible variety Mariana for earliness, plant vigor and yield potential and equal to Mariana for fruit size and firmness. However, participants gave 'Shanty' a lower overall rating compared with 'Mariana' due to low fruit quality rating.

Discussion

Sweetpotato whitefly pressure was greater in Spring 2007 than in Spring 2008, higher SPW pressure was due in part to the later planting in 2007 compared with 2008, but more importantly because whiteflies were not controlled for the 2007 UF/SWFREC trial to purposely increase TYLCV pressure. In contrast, the cooperating grower aggressively controlled SPW (weekly spray program) in the commercial tomato trial in 2008. Under high virus pressure (Spring 2007) TYLCV-R varieties/advanced breeding lines had plants with mild TYLCV symptoms, with incidence ranging from 16% to 63%; however, severity was markedly lower than the susceptible varieties. Similarly, Gilreath et al. (2000) observed under high TYLCV pressure that almost 100% of the plants of susceptible varieties Sanibel, Florida 47, and Leila had symptoms of infection within 8 weeks after transplanting. However, of six TYLCV-R varieties/advanced breeding lines tested, symptomatic plants were observed only for the breeding line HA 3044 at first harvest, with no impact on marketable yield. In Spring 2008, no plants with symptoms of TYLCV infection were seen in resistant varieties under low TYLCV pressure. Similarly, Cushman and Stansly (2006) observed under low TYLCV pressure that only 5% of the plants of the susceptible control 'Florida 47' and none of the plants of all but one of the TYLCV-R varieties had symptoms of TYLCV infection.

Under high virus pressure, TYLCV-R varieties/advanced breeding lines had higher or equivalent yields of extra-large and total marketable fruit than susceptible varieties in 2007. Similarly, a variety evaluation

Table 8. Field *Tomato yellow leaf curl virus*-resistant variety visual assessment evaluation of tomato plants and fruit grown in Spring 2008 on a commercial farm at Immokalee, FL.

Variety or advanced breeding line	Tomato plant and fruit evaluation (1–5 scale) ^a						
	Earliness	Plant vigor	Fruit size	Firmness	Fruit quality	Yield potential	Overall rating
<i>Round tomato</i>							
‘BHN 745’	2.8 cfg ^y	3.7 c	3.1 cd	3.6 abcd	3.4 bcd	3.6 de	3.2 b
‘BHN 765’	3.5 c	3.3 d	3.6 b	2.9 ef	3.1 de	4.4 ab	3.1 bc
FLA 8579	4.1 b	2.6 e	2.2 e	2.8 f	3.2 cd	3.6 de	2.4 de
FLA 8632	3.4 cd	4.7 a	1.3 f	2.7 f	3.2 cd	1.8 h	1.8 f
FLA 8633	4.4 a	4.2 b	2.3 e	2.2 g	2.5 f	2.8 fg	2.2 ef
HA 3091	3.7 c	2.7 e	4 a	3.0 ef	3 de	4.2 abc	2.7 cd
HA 3074 (‘Inbar’)	2.9 ef	2.6 e	3.3 c	3.7 abc	3.7 ab	2.6 g	2 bc
HA 3075 (‘Ofri’)	2.4 h	2.7 e	4.1 a	3.2 def	3.2 cd	3.9 cd	3.2 bc
Sak 5421	3.6 c	4.1 b	3.4 bc	2.8 f	2.7 ef	4.1 bc	3.1 bc
Sak 5443	3.1 de	4.3 b	4.1 a	3.9 ab	3.6 abc	4.5 a	3.7 a
‘Security 28’	3.5 c	3.9 bc	4.2 a	4.1 a	3.4 bcd	4.4 ab	3.8 a
‘Tygress’	2.5 hg	2.4 e	2.8 d	3.7 abc	3.8 ab	2.9 f	2.9 bc
‘Sebring’	2.8 efg	4.3 b	3.1 cd	3.3 cde	3.9 a	3.4 e	3.1 bc
‘Florida 47’	2.6 fgh	3.3 d	3.2 c	3.5 cde	3.5 abc	3.7 de	3.2 b
Significance	**	**	**	**	**	**	**
<i>Roma-type tomato</i>							
‘Shanty’	3.9 a	3 a	3.9 a	3.6	1.8 b	4.5 a	2.2 b
Sak 5808	2.0 c	2.1 b	2.7 b	3.4	3.8 a	2.9 c	2.6 b
‘Mariana’ (control)	3.5 b	2.1 b	3.9 a	3.5	3.8 a	3.8 b	3.6 a
Significance	**	**	**	NS	**	**	**

^aTomato plant and fruit evaluation was calculated from the contribution of 28 participants: 1 = very poor, 5 = very good. Earliness defined higher rating early fruit production and fruit size was defined a higher rating bigger fruit.

^yMeans separation by Duncan’s multiple range test, $P \leq 0.05$, means followed by the same letter are not statistically different. Round and Roma-type tomato were compared separately in both years.

**Significant at $P \leq 0.01$; *Significant at $P \leq 0.05$; NS = not significant.

during Spring 2000 under high virus pressure resulted in greater yield of extra-large fruit and greater total marketable yield for six TYLCV-R varieties compared with the susceptible controls Sanibel, Florida 47, and Leila (Gilreath et al., 2000). Gilreath et al. (2000) found that susceptible plants were almost 100% infected within 8 weeks after transplant, due in part to a TYLCV-infected plant being placed in the middle of each plot. Important differences that we observed in this study with high TYLCV pressure were the high percentage of unmarketable fruit ranging from 57% to 29% of the total marketable yields for the TYLCV-R varieties tested during the 2007 season. In contrast with high TYLCV pressure, less than 1% and 4% to 9% unmarketable fruit as a percentage of the marketable yield were reported by Scott (2004) and Gilreath et al. (2000), respectively. The differences between these latter studies and the

present study may have resulted because of different environmental conditions in 2007, including cold weather with minimum night temperatures in February, March, and April of 56.8, 57.6, and 61.4 °F, respectively. Tomato fruit disorders can be exacerbated by temperatures under 60 °F during flowering (Olson, 2009).

Cushman and Stansly (2006) found no benefit by using TYLCV-R varieties under low virus pressure during a spring evaluation in southern Florida. Similarly, under low TYLCV pressure during Spring 2008 in the present study, there was no difference in total marketable yield among TYLCV-R and susceptible varieties. However, there was a high percentage of unmarketable fruit in some of the TYLCV-R varieties, between 19.1% and 35.2%, except for Tygress with 8.0% (marketable and unmarketable combined) compared with the controls Sebring and Florida 47 (≈14%).

Cushman and Stansly (2006) and Gilreath et al. (2000) found no differences under low TYLCV incidence in total marketable yields, but found higher percentages of unmarketable fruit (5% to 35%) among TYLCV-R compared with the susceptible varieties. This confirms that the lack of consistency among TYLCV-R varieties/advanced breeding lines in fruit quality is a major factor in the lack of acceptance of TYLCV-R varieties by the Florida tomato industry. TYLCV-R varieties/advanced breeding lines are based on Ty-1 gene, which comes from a wild relative of cultivated tomato, *Solanum chilense* (accession LA1969). Therefore, these varieties/advanced breeding lines will be expected to have some genes from wild tomato species which are tightly linked with the Ty-1 gene and transferred into the genetic background of the inbred parent lines used to make the TYLCV-R hybrids. However, the breeders can potentially sort these “negative traits” from the background by making recombination and break the linkage. In favorable weather seasons, these traits may not be evident and can blind the breeders selecting on phenotype. However, with unfavorable weather (higher or lower temperature for plant development/plant stress) conditions the genetic predisposition can be manifested. Therefore, results an informal survey based on 65% of the tomato acreage during the 2009–10 tomato season indicated that only 5% of 34,000 acres of tomato in Florida had been planted with TYLCV-R varieties. As a result, growers continue to risk loss from TYLCV by planting susceptible varieties.

Survey participants (visual evaluation) in 2008 selected ‘Security 28’ and Sak 5443 as the best round varieties and ‘Shanty’ as the best Roma-type variety. In contrast, the empirical evaluation (numerical data) found that round ‘Tygress’ and Roma Sak 5808 performed the best in terms of highest marketable yield and fewest culls, although they had the lowest color rating. In this case, visual evaluation of plant and fruit quality indicated different results from the empirical evaluation.

In conclusion, reduction in yield from susceptible round and Roma-type varieties was significant under higher virus pressure during 2007 but not under lower virus pressure in Spring

2008. Lack of consistency in fruit quality is a major factor slowing adoption of TYLCV-R varieties by the Florida tomato industry. Insecticidal control is clearly a critical element of TYLCV management although resistant varieties are still a valuable component of an integrated system under conditions of high SPW pressure (Cushman and Stansly, 2006). Therefore, growers are urged to consider using the better TYLCV-R varieties when and where virus and SPW pressure is expected to be high.

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