

er than tomato itself appeared to be important from an epidemiological point of view. In general, plants testing positive for TYLCV were found late in the tomato production season and in close proximity to tomato plantings with a high incidence of TYLCV. Those plants of the same species when sampled at other times of the year, when the incidence of TYLCV was low, were generally negative for the virus.

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TOMATO YELLOW LEAF CURL VIRUS RESISTANT TOMATO VARIETY TRIALS

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Abstract. Six of the most promising tomato yellow leaf curl virus (TYLCV) resistant hybrids currently available were evaluated in trials conducted in the fall, winter and spring of 1999-2000. In the Palmetto/Ruskin production area, two observational trials were planted on commercial farms in Ruskin and Bradenton, and one trial was conducted for harvest at the Gulf Coast Research and Education Center in Bradenton. In Palm Beach County, one trial was conducted for harvest on a commercial farm in Boynton Beach. An additional trial was conducted at the Southwest Florida Research and Education Center in Immokalee. At all locations, six TYLCV-resistant varieties were compared to at least 2 standard varieties. Virus pressure was light at the 4 sites in Manatee and Palm Beach

counties. Silverleaf whitefly numbers and virus pressure were very high in Immokalee. All plants of the standard cultivars, which showed symptoms of TYLCV-Is, exhibited 100% infection by 8 weeks after transplanting, whereas resistant varieties were only 0 to 3% symptomatic, with the exception of HA3044 which reached 54% during the same period. Total marketable yield ranged from 1881 to 2899 25-lb cartons per acre in Manatee, from 1577 to 2300 cartons per acre in Palm Beach county, and from 343 to 2658 cartons per acre in Immokalee. All top yielding varieties had acceptable horticultural characteristics. Fruit quality parameters, such as catfacing, scars and zippers, also were evaluated.

Since its first occurrence in Florida in July 1997, tomato yellow leaf curl virus (TYLCV-Is) has caused major economic damage to Florida's \$420 million tomato crop (Polston, McGovern and Brown, 1999). Symptoms occur within 2 to 3 weeks after infection and include stunting, reduction in leaf size, chlorosis, mottling and upward curling of leaves, flower abscission and significant yield reduction (Polston, et. al., 1994). The virus has a broad host range including crop and weed species (Polston, Reif and Foley, 1999). Control has centered primarily around management of the vector, the silverleaf whitefly (SLWF), by both chemical and cultural methods. Even with widespread use of the soil applied systemic insecticide imidacloprid (Admire 2F, Bayer Corp.) and diligent roguing of symptomatic plants in commercial fields, TYLCV-Is has continued to spread geographically and is still causing significant economic losses for tomato producers in Florida (Polston et. al., 1999). There also is concern about potential resistance problems which may develop in the future as a result of widespread use of imidacloprid (Schuster, 1999). The use of resistant varieties is one of the newest of several potential tools growers can use to combat TYLCV-Is in Florida. Five

variety trials were conducted during the fall, winter, and spring of 1999/2000 to evaluate 6 tomato cultivars for resistance to TYLCV-Is and horticultural characteristics, including yield. The cultivars evaluated in these trials were selected because they have reported tolerance or resistance to TYLCV-Is and horticultural characteristics that make production in Florida feasible.

Materials and Methods

Observational trials. Two observational trials were conducted on commercial farms in Ruskin and Bradenton in fall 1999. Varieties included 4 lines from Hazara, HA3017A, HA3017B, HA3044 and HA3048, 2 lines from Petoseed, Px150420 and Ps150535, and 2 grower standard cultivars, 'Sanibel' (Petoseed) and 'FL47' (Asgrow). Both trials were transplanted on September 9, 1999, and the 10 plant plots were replicated 4 times in a randomized complete block design. Seepage irrigation was used in the Ruskin trial and drip was utilized in the Bradenton trial. Standard production practices were followed, including the use of imidacloprid (Admire) in the transplant house and in the plant hole. Plants were evaluated for virus incidence two times during the season, once approximately 8 weeks after transplanting and again just prior to first harvest.

Bradenton. The trial at the Gulf Coast Research and Education Center in Bradenton was transplanted on September 9, 1999, with 16 plants in each of 4 blocks using a randomized complete block design. Varieties planted were the same as in the observational trials. Plants were spaced 2 ft apart on raised, fumigated, polyethylene-covered beds on 5 ft centers with seepage irrigation. Plants were treated with imidacloprid in the transplant house and in the field at the time of planting

Table 1. Early and season total fruit yield of tomato yellow leaf curl virus resistant tomato varieties at Gulf Coast Research and Education Center, Bradenton in fall 1999.

Cultivar	Early yield (25 lb cartons/A ²)				
	Extra Large	Large	Medium	Total Marketable ³	Culls
HA3017A	552 b*	171	26	746	92 d
HA3017B	889 a	153	31	1074	172 cd
HA3044	800 a	205	26	1032	207 cd
HA3048	891 a	173	73	1136	280 abc
Px150420	701 ab	244	47	992	162 cd
Ps150535	825 a	243	96	1162	317 ab
'Sanibel'	642 ab	140	44	827	423 a
'FL47'	752 ab	247	45	1042	392 a
		NS	NS	NS	
Cultivar	Season total yield (25 lb cartons/A)				
	Extra Large	Large	Medium	Total Marketable ³	Culls
HA3017A	994 ⁴	644 C	244 C	1881 E	329 C
HA3017B	1328	572 C	249 C	2149 DE	322 C
HA3044	1745	962 AB	332 C	2589 ABC	465 BC
HA3048	1359	600 C	223 C	2182 CDE	461 BC
Px150420	1054	1119 A	666 A	2838 AB	546 B
Ps150525	2292	991 AB	513 B	2899 A	764 A
'Sanibel'	985	618 C	472 B	2078 DE	837 A
'FL47'	1023	889 B	529 B	2443 BCD	863 S
	NS				

²Acre = 8712 linear bed ft; 4356 plants.

³Total marketable fruit includes extra large, large and medium size fruit.

⁴Means within columns separated by Duncan's Multiple Range Test, lower case for 5% level; upper case for 1% level; NS = no significance.

Table 2. Classification of cull tomatoes from tomato yellow leaf curl virus resistance trial at the Gulf Coast Research and Education Center, Bradenton in fall, 1999

Cultivar	Percent culls by type					
	Small	Scars	Zippers	Misshapen	Worm Holes	Catface
HA3017A	52	23	7	4	9	5
HA3017B	38	24	14	6	9	9
HA3044	27	37	11	5	9	11
HA3048	28	23	22	8	10	9
Px150520	13	10	40	18	11	8
Ps150535	19	17	201	1	24	9
'Sanibel'	11	22	23	12	18	14
'FL47'	13	17	15	9	28	18

(16 oz product/A). They were sprayed once each with Lan-nate and Thiodan, and twice with Knack. Other production practices were standard. Plots were harvested three times on December 2, December 16, 1999 and January 3, 2000, and separated as to marketable and cull on the basis of size, shape or defects.

Palm Beach County: This trial was transplanted on a commercial farm in Boynton Beach on October 8, 1999, with 8 plants per plot, replicated 3 times in a randomized complete block design. Varieties were similar to the Bradenton trial with the addition of 'Leila' from Rogers Seed. Leila was included because in previous grower field trials some tolerance to TYLCV-Is had been reported. Spacing was 2 ft between plants on raised, fumigated, polyethylene-covered beds on 5.25 ft centers. Standard production practices were followed, including the use of Admire in the transplant house and in

the field as a drench after transplanting. Plots were harvested on January 7, January 18, January 28, and February 11, 2000, and separated as to marketable and cull on the basis of size, shape or defects.

Immokalee. In this trial at the Southwest Florida Research and Education Center in Immokalee, nine varieties were transplanted on March 15, 2000, with an average of 17 plants per plot, replicated 4 times in a randomized complete block design. Spacing was 1.5 ft between plants on raised, polyethylene-mulched beds on 6 ft centers. Varieties were the same as in the Palm Beach trial. Drip irrigation was utilized along with standard production practices. Admire was not used in either the transplant house or in the production field. On March 16, one tomato plant of the variety 'Neptune' was transplanted into the center of each plot to serve as an innoculum source of TYLCV-Is. The infected plants had been exposed to viruliferous whiteflies in the greenhouse for 21 days prior to transplanting and all were showing symptoms of TYLCV-Is. Evaluations for symptoms of TYLCV-Is were made twice weekly beginning on March 31. Red fruit were harvested on May 25 and the remainder of the fruit was harvested on May 31/June 1, graded and sized.

Results and Discussion

Observational trials. Both SLWF and virus pressure were very low in both observational trials conducted on grower farms in Bradenton and Ruskin. Although there were scattered TYLCV-Is infected plants on both farms, there were no TYLCV-Is infected plants in the Bradenton trial plots. In the Ruskin trial, two 'FL 47' plants and one 'Sanibel' plant showed TYLCV-Is symptoms at 8 weeks after transplanting.

Table 3. Early and season total fruit yield of tomato yellow leaf curl virus resistant tomato cultivars at Palm Beach County in fall/winter, 1999-2000.

Cultivar	Early yield (25 lb cartons/A ^a)				
	Large	Extra Large	Medium	Total Marketable ^b	Culls
HA3017A	61 DE ^x	187 D	160	519 CD	50 b
HA3017B	79 CDE	306 ABC	186	641 BC	43 b
HA3044	120 BCD	248 CD	146	580 BCD	110 a
HA3048	47 E	165 D	152	425 D	46 b
Px150420	107 BCDE	290 BC	170	632 BC	36 b
Ps150535	206 A	408 A	155	815 A	54 b
'Sanibel'	160 AB	369 AB	129	711 AB	67 b
'FL47'	145 ABC	349 ABC	186	726 AB	42 b
'Leila'	129 BCD	325 ABC	147	654 AB	32 b
			NS		
Cultivar	Season total yield (25 lb cartons/A)				
	Large	Extra Large	Medium	Total Marketable ^b	Culls
HA3017A	76 D ^y	432 D	529	1735 BC	110 C
HA3017B	86 D	590 CD	600	1845 BC	151 BC
HA3044	139 CD	546 CD	474	1577 C	286 A
HA3048	68 D	430 D	588	1768 BC	197 B
Px150420	153 BCD	709 BC	558	1893 B	135 BC
Ps150535	283 A	981 A	558	2300 A	136 BC
'Sanibel'	312 A	881 AB	468	2178 A	123 BC
'FL47'	235 AB	693 BC	486	1877 BC	89 C
'Leila'	186 BC	710 BC	472	1817 BC	101 C
			NS		

^aAcre = 8297 linear bed ft; 4149 plants.

^bTotal marketable fruit includes extra large, large, medium and small size fruit.

^cMeans within columns separated by Duncan's Multiple Range Test, lower case for 5% level; upper case for 1% level; NS = no significance.

Table 4. Season total fruit yield of tomato yellow leaf curl resistant tomato varieties at Immokalee in Spring, 2000.

Cultivar	Yield (25 lb cartons/A ²)				Culls		
	Extra Large	Large	Medium	Total Marketable ²	Insect	Disease	Catface
HA3017A	1721 a*	347 ab	394 a	2658 a	37	27 bc	35 bcd
HA3017B	1948 a	297 bc	235 b	2580 ab	43	27 bc	70 b
HA3044	1515 a	357 a	264 b	2309 bc	31	45 ab	175 a
HA3048	1531 a	385 a	351 a	2464 abc	50	25 bc	60 bc
Px150420	951 b	182 c	157 c	1337 d	43	70 a	12 cd
Ps150535	1705 a	291 bc	161 c	2231 c	52	12 a	23 bcd
'Sanibel'	274 c	78 d	101 cd	530 e	195	2 ab	27 bcd
'FL47'	289 c	64 d	64 d	458 e	39	29 bc	6 d
'Leila'	208 c	58 d	41 d	343 e	37	39 bc	8 d
					NS		

¹Acre = 7,260 linear bed ft; 4840 plants.

²Total marketable fruit includes extra large, large, medium and small size fruit.

*Means within columns separated by Duncan's Multiple Range Test, 5% level, NS = no significance.

Growers were able to observe these cultivars under commercial conditions and larger trials of selected cultivars have since been initiated by growers.

Bradenton. Low whitefly and virus pressure was also a factor in this trial. Two 'FL 47' plants tested positive for TYLCV-Is and one 'Sanibel' plant was also infected. The only virus that was observed in the resistant cultivars was in one HA 3048 plant which was infected with tomato mottle virus. There were no significant differences in early yield of large, medium or total marketable fruit (Table 1). Production of extra large early fruit was lowest for HA3017A, but was not significantly different from Px150420, 'Sanibel' or 'FL47'. Season total yield of marketable fruit ranged from 1881 to 2899 25-lb cartons per acre for HA3017A and Ps150535, respectively. Total marketable yield was highest with Ps150535, but was not significantly different from HA3044 or Px150420. There were no differences in season total yield of extra large size fruit. Cull fruit were separated by type as indicated in Table 2. The majority of the fruit culled were generally small, scarred or zippered. Catfacing was most notable with 'FL47' and 'Sanibel'.

Palm Beach County. Virus pressure was very low at this site; thus, data are only presented for yield (Table 3). Highest early yield of extra large fruit was produced with Px150535, but was not different from 'Sanibel' or 'FL47'. Total marketable early yield was also highest with Ps150535 at 815 25-lb cartons per acre, but was not significantly different from 'Sanibel',

'FL47' or 'Leila'. Ps150535 also produced the highest yield of season total marketable fruit at 2300 25-lb cartons per acre, although it was not significantly different from 'Sanibel'. Ps150535 and 'Sanibel' also produced the largest total yield of extra large fruit at 283 and 312 25-lb cartons per acre, respectively, but that yield did not differ significantly from 'FL47'.

Immokalee. Highest yielding cultivars of season total extra large fruit were HA3017B, HA3017A, Ps150535, HA3048 and HA3044 (Table 4). Results for total marketable fruit yield were similar. These findings were somewhat unexpected since approximately 60% of the HA3044 plants were showing symptoms of TYLCV-Is by first harvest (Table 5). Lowest yielding cultivars in this trial were the grower standard cultivars 'Sanibel', 'FL47' and 'Leila'. This would be expected since they were showing high incidences of TYLCV-Is symptoms by 4 weeks after transplanting and were almost 100% infected within 8 weeks after transplanting.

Based on these results, additional trials of TYLCV-Is resistant tomato varieties on commercial farms are warranted. Depending on location, one or more resistant varieties performed as well or better than commercially accepted grower standard cultivars with regard to yield in the absence of TYLCV-Is. In the presence of TYLCV-Is, all resistant varieties performed much better than the susceptible varieties. With one exception, the resistant cultivars also demonstrated excellent resistance to expression of symptoms of TYLCV-Is. Both Hazera and Petoseed have limited quantities of seed available for growers to trial, and some trials have already been initiated. Growers should contact their Hazera or Petoseed representative for availability information.

Table 5. Incidence of tomato yellow leaf curl virus symptoms in tomato varieties at Immokalee in Spring 2000.

Cultivar	% Plants with TYLCV-Is symptoms		
	4 weeks ¹	8 weeks	First harvest
HA3017A	0	0	0
HA3017B	0	0	0
HA3044	19	54	60
HA3048	2	3	3
Px150420	0	2	2
Ps150535	0	0	0
'Sanibel'	73	99	100
'FL47'	96	100	100
'Leila'	90	100	100

¹weeks after transplanting.

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