commercial producers. Data indicate that several commercially available hybrid rootstocks have high levels of bacterial wilt resistance. 'Cheong Gang', 'BHN 1054', and 'BHN 998' were the most adapted rootstocks with respect to bacterial wilt resistance and resulting tomato fruit yield in field studies conducted at Florida and Virginia.

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.

Choosing the correct varieties is a cornerstone of a successful tomato industry. The University of Florida/ Southwest Florida Research and Education

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Choosing the correct varieties is a cornerstone of a successful tomato industry. The University of Florida/ Southwest Florida Research and Education Center (UF/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 and Cushman and Stansly, 2006; 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, the grower should confirm that TYLCV-R varieties 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*) that are 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 SWFREC Immokalee FL. on 23-Mar. Plants were spaced 18-in apart on two sets of three beds 235 ft long covered with black polyethylene film mulch. After incorporating approximately 25% of the fertilizer (13-2-13 N-P-K), the remaining fertilizer was injected later as liquid 8-0-8 through drip tape with 4-in emitter spacing. The center row was left untreated throughout the trial with eight treatments arranged on the other four beds in a randomized complete block design(RCBD). Plots in the four treated rows contained 19 plants, with a single plant left between plots as buffers. Plots were split into two subplots of 9 TYLCV susceptible (BHN-602) and 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 using an EZ-Dose® sprayer operating at a pressure of 45 PSI and a flow rate of 3.7 gal per minute (Fig. 1). Foliar sprays 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® hollow cone nozzles, each delivering 10 gpa (Fig. 2). Total spray volume increased as nozzles were added to accommodate plant growth. A standard used for four 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 four plants per subplot. Immature stages from three plants in each subplot were counted on 4,17,31-May under a stereoscopic microscope from eight, 0.5-in^2 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 six plants in each sub-plot on 2 and 16-Jun. Fruit was culled for defects due to stink bug damage, bacterial spot (Xanthomonas species (X. *vesicatoria, X. euvesicatoria, X. perforans and X. gardneri*) and surface deformities such as shoulder cracking and zippering and 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 RCBD with 12 treatments in four beds, each with two lines of drip, the dry fertilizer was 10-2-10 N-P-K and liquid 7-0-7, drenches were applied 7 Mar, sprays/adults were evaluated weekly from 23 Mar to 11 May, and nymphs on 6, 20 Apr and 4 May. All fruit on six plants per plot were harvested 16 May.

2011 drench/drip trial Design was identical to 2011 foliar trial except nine 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 gal per minute. 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 a finally a 3 L water chase (Fig. 3). Adults were evaluated weekly from 23 Mar to 11 May and nymphs at 13, 27 Apr and 11 May. All fruit on six plants per plot were harvested 13-May.

TYLCV-R variety trials: Seven field variety evaluations were conducted in South Florida during a spring season from 2006 to 2011. TYLCV-R variety evaluations were conducted under commercial growing conditions in multiple locations Estero, Immokalee and Homestead with a RCBD . In addition to yields and post-harvest quality,

Results

Variety x Insecticide Trial 2010. Whitefly infestation was initially light due to cold weather including freezes. Nevertheless, most BHN-602 (susceptible) plants eventually showed symptoms of TYLCV (Fig. 4). 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. 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. On 17 May, only applications of Scorpion + the standard or AdmirePro + Movento, Oberon or Rimon provided control. AdmirePro + Rimon provided best control 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 date 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 treatments regardless of variety.

2011 Foliar Trial: By 6 April, all effective treatments were working, including the 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. Two applications of Movento (in

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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. 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. 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 two or three sample dates respectively, including the last on 4 May. 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 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 South Florida Spring tomato market. These varieties have high marketable x-large fruit and total marketable yield and lower unmarketable fruits, fruit firmness and high intense red color.

Summary

During 2011. drench applications of insecticides protected plants from whiteflies and even virus better than drip applications and 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 that year. In contrast, virus incidence rose quickly in 2011 and consequently, 'Tygress' yielded better than the susceptible variety, FL-47. We know that these diseases can be managed with resistant varieties; however the lack of consistent fruit quality is a major factor that limits adoption of TYCLV-R varieties by the Florida tomato industry.

Figure 1. EZ-Dose ® sprayer 45 PSI delivering 3.7 gpm for drench application

Figure 2. High clearance sprayer 200 psi 2.3 mph with 2 vertical booms delivering 10 gpa through each nozzle

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Minimum wages and implications on agricultural piece rates

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Figure 3. Injection into drip using a 12 V pump and bladder tank

Fig. 4. Field trial 2010 showing original TYCLV inoculum plant with resistance BHN-602 plants on the left and resistant TYgress plants on the right.