TOMATO: *Lycopersicon esculentum* Miller

AN EVALUATION OF ACTIGARD® FOR THE CONTROL OF TOMATO YELLOW LEAF CURL IN WEST CENTRAL FLORIDA TOMATO PRODUCTION, FALL 2007

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Silverleaf whitefly: *Bemisia argentifolii*; *Xanthomonas axonopodis* pv. *vesicatoria*; *Ralstonia solanacearum*; *Tomato yellow leaf curl virus*

In August 2007, plots were established in the fall to assess the effect of Actigard on the incidence and severity of tomato yellow leaf curl (TYLC) on tomato, as caused by the whitefly vectored *Tomato yellow leaf curl virus*. Transplants of the TYLC resistant cultivars Inbar (HA3074) and Tygress, and the TYLC susceptible cultivars Florida 47, Florida 91, Sebring, and Sanibel were transplanted at 18" spacing to 20 ft plots along 300 ft long, raised beds with 5 ft center-to-center bed spacing. Beds were covered with white virtually impermeable mulch and irrigated with a drip system. Foliar spray treatments included a standard treatment, consisting of Cuprofix Ultra 40D (3 lbs/Acre) + Penncozeb 75 DF (3 lbs/Acre), an Actigard treatment (0.75 oz/A), and a non-treated control. Actigard was initially applied (0.32g/640 plants) to a subset of seedlings 4 days prior to transplanting. Treatments were arranged in a randomized complete block design with spray treatments as the main plot factor and cultivar as the subplot factor; each combination was repeated 4 times. The three experimental spray treatments were applied once a week. Plots were monitored weekly, and rated for the incidence and severity of several diseases, including TYLC. Leaf samples were also collected from symptomatic plants to verify the presence of TYLCV via PCR.

Bacterial leaf spot (BLS) caused by *Xanthomonas campestris* pv. *vesicatoria* was observed within plots shortly after transplants were set. At 28 days after transplant (DAT), severity of BLS across plots ranged from 3 to 6 on the Horsfall-Barratt scale. Spray treatment ($P < 0.0001$) in addition to cultivar ($P = 0.0016$) had a significant effect on the severity of BLS, but no interaction of spray treatment by cultivar was detected ($P = 0.4717$). Using a nonparametric analysis of mean rankings to generate relative treatment effects (RTE), 'Inbar' was the most susceptible to BLS, while 'Tygress' was the least susceptible of the 8 hybrid cultivars. Among spray treatments, the RTE of 0.69 for the control was significantly higher than 0.37 and 0.44 for the Actigard and standard treatments. Interestingly, 'Florida 91' and 'Inbar' did not exhibit a significant reduction in BLS severity in response to the Actigard treatment. In contrast, there was no significance in the effect of spray treatment ($P = 0.3993$) or with the effect of susceptible cultivars ($P = 0.2490$) on the incidence of TYLC. However, there was a significant effect of cultivar x treatment ($P < 0.0001$), time ($P < 0.0001$), cultivar x time ($P < 0.0001$), and cultivar x

treatment x time ($P < 0.0001$). The incidence of TYLC increased significantly at each subsequent rating, from 5.5% at 36 DAT to 10.7% at 42 DAT to 43.8% at 54 DAT. Significant differences between treatments among some cultivars were observed at 36 DAT. However, no consistent pattern was present among treatments, suggesting that the differences were probably the result of the initial patchy distribution of TYLC. There were no significant differences in the effects of treatment, cultivar, time, or interactions among the main effects on the severity of TYLC based on the analysis of mean rankings. At 42 DAT, bacterial wilt caused by *Ralstonia solanacearum* was observed at 8% incidence in the trial and by 67 DAT reached 32% interfering with the rating of TYLC. The incidence of bacterial wilt reached a high of 42% incidence at 75 DAT when the trial concluded, a significant ($P < 0.0001$) increase over time. Unfortunately, the high incidence of bacterial wilt prevented the collection of meaningful yield data. There was no significance in the effect of treatment ($P = 0.3161$) or interaction of treatment with time ($P = 0.1662$) on the incidence of bacterial wilt. However, the effect of cultivar was significant ($P < 0.0001$) with 'Florida 91' exhibiting the lowest incidence of 12% relative to 'Tygress' at 47% incidence. In summary, while Actigard conferred a level of protection equivalent to a standard pesticide treatment, there was no observable impact to the incidence and severity of TYLC or in the incidence of bacterial wilt.

Table 1. Chemical application schedule for the 2007 fall trial in Wimauma, FL.

Treatment - Formulation	Rate	Tray app. 26 Aug	Foliar spray applications: 4 Sep	11 Sep	19 Sep	25 Sep	3 Oct	9 Oct	16 Oct	23 Oct	30 Oct
Actigard											
- Actigard 50WG	0.32g/640 plants	X									
- Actigard 50WG	0.75 oz/A		X	X	X	X	X	X	X		
Standard											
- Penncozeb 75 DF	3 lbs/A		X	X	X	X	X	X	X		
- Cupprofix Ultra 40D	2 lbs/A		X	X	X	X	X	X	X	X	X

Table 2. Statistical analyses of variance based on the effect of cultivar, treatment and time on the severity of bacterial leaf spot (BLS) and the incidence of tomato yellow leaf curl (TYLC) in the 2007 fall trial.

	ANOVA-type statistic (ATS)			
Isolate Effect[x]:	df_{Num} [z]	df_{Den}	ATS	*P* value
BLS severity:				
Treatment (Trt)	1.97	33.2	3.91	< 0.0001
Cultivar (Cv)	4.91	∞	21.12	0.0016
Cv x Trt	8.07	∞	0.95	0.4717
	ANOVA *F*-statistic (*F*)			
	df_{Num}	df_{Den}	*F*	*P* value
TYLC incidence[y]:				
Treatment	2	10	1.01	0.3993
Cultivar	5	45	1.38	0.2490
Cv x Trt	10	45	77911.10	< 0.0001
Time	2	18	100.50	< 0.0001
Trt x Time	4	18	0.76	0.5622
Cv x Time	10	90	20592.10	< 0.0001
Trt x Cv x Time	20	90	197129.00	< 0.0001
Bact. Wilt incidence:				
Treatment	2	10	1.29	0.3136
Cultivar	7	63	125.88	< 0.0001
Cv x Trt	14	63	1945724.0	< 0.0001
Time	3	27	68.93	< 0.0001
Trt x Time	6	27	1.69	0.1622
Cv x Time	21	189	456694.00	< 0.0001
Trt x Cv x Time	42	189	158146.00	< 0.0001

Table 3. Median (Med.) and relative marginal effect (RME) calculated for the severity of bacterial leaf spot on eight cultivars of tomato in the 2007 fall trial.

	Control		Actigard		Standard	
Cultivar	Med.[y]	RME (95% CI)[z]	Med.	RME (95% CI)	Med.	RME (95% CI)
Florida 47	6.0	0.69 (0.29 - 0.92)	4.0	0.21 (0.09 - 0.45)	4.5	0.31 (0.15 - 0.54)
Florida 91	5.0	0.60 (0.41 - 0.76)	5.0	0.50 (0.45 - 0.55)	5.0	0.50 (0.45 - 0.55)
Inbar	6.0	0.79 (0.55 - 0.91)	5.5	0.60 (0.26 - 0.85)	5.0	0.50 (0.45 - 0.55)
Mt. Crest	5.0	0.60 (0.41 - 0.76)	4.5	0.31 (0.15 - 0.54)	5.0	0.40 (0.24 - 0.59)
Mt. Spring	5.5	0.69 (0.46 - 0.85)	5.0	0.40 (0.24 - 0.59)	5.5	0.69 (0.46 - 0.85)
Sanibel	6.0	0.88 (0.84 - 0.91)	4.5	0.40 (0.15 - 0.74)	5.0	0.50 (0.45 - 0.55)
Sebring	6.0	0.79 (0.55 - 0.91)	4.5	0.31 (0.15 - 0.54)	5.0	0.50 (0.24 - 0.76)
Tygress	5.0	0.50 (0.45 - 0.55)	4.0	0.21 (0.09 - 0.45)	4.0	0.12 (0.09 - 0.16)
Combined	6.0	0.69 (0.63 – 0.74)	4.5	0.37 (0.31 – 0.44)	5.0	0.44 (0.38 – 0.50)

[y] Median of disease severity rating based on the Horsfall-Barratt scale for estimating the percentage of foliar affected by bacterial leaf spot.
[z] RME = [(R - 0.5) / N]; R = mean ranking of the severity of bacterial leaf spot; N = total experimental units in the analysis (N= 96). The 95% confidence intervals (CI) are in parenthesis.

Table 4. LS means and 95% confidence intervals calculated for the effect of treatment x cultivar on the incidence of tomato yellow leaf curl across time in the 2007 fall trial.

	Treatment:			
Cultivar	Control	Actigard	Standard	$P > F$
Mt. Crest	0.17 (0.02 - 0.32)	0.20 (0.11 - 0.29)	0.36 (0.28 - 0.44)	0.0126
Florida 47	0.20 (0 - 0.42)	0.03 (0.02 - 0.38)	0.22 (0.06 - 0.39)	0.9762
Florida 91	0.22 (0.11 - 0.33)	0.13 (0.02 - 0.25)	0.26 (0.14 - 0.39)	0.2793
Inbar	n.d.	n.d.	n.d.	-
Sanibel	0.10 (0.06 - 0.13)	0.13 (0.01 - 0.24)	0.19 (0.03 - 0.36)	0.5073
Sebring	0.31 (0.14 - 0.48)	0.10 (0 - 0.25)	0.21 (0 - 0.46)	0.1904
Mt. Spring	0.17 (0.03 - 0.31)	0.26 (0.21 - 0.30)	0.17 (0.05 - 0.28)	0.2019
Tygress	n.d.	n.d.	n.d.	-
Combined	0.19 (0.10 - 0.29)	0.17 (0.14 - 0.20)	0.24 (0.13 - 0.34)	

Table 5. LS means and 95% confidence intervals calculated for the effect of treatment x cultivar on the incidence of bacterial wilt across time in the 2007 fall trial.

	Treatment:			
Cultivar:	Control	Actigard	Standard	*P* > F
Mt. Crest	0.10 (0 - 0.20)	0.27 (0.11 - 0.42)	0.13 (0 - 0.26)	0.1805
Florida 47	0.30 (0 - 0.63)	0.20 (0.02 - 0.39)	0.11 (0 - 0.23)	0.4518
Florida 91	0.13 (0 - 0.28)	0.11 (0 - 0.26)	0.10 (0 - 0.23)	0.9674
Inbar	0.35 (0.13 - 0.58)	0.39 (0.25 - 0.53)	0.40 (0.06 - 0.73)	0.9601
Sanibel	0.41 (0.20 - 0.62)	0.26 (0 - 0.61)	0.16 (0 - 0.36)	0.2264
Sebring	0.20 (0.03 - 0.36)	0.25 (0.05 - 0.45)	0.17 (0 - 0.42)	0.8773
Mt. Spring	0.17 (0.05 - 0.29)	0.11 (0 - 0.24)	0.11 (0.02 - 0.21)	0.7160
Tygress	0.57 (0.35 - 0.78)	0.66 (0.56 - 0.77)	0.17 (0.09 - 0.25)	< 0.0001
Combined	0.28 (0.17 - 0.39)	0.28 (0.19 - 0.37)	0.17 (0.03 - 0.31)	