

**TOMATO:** *Lycopersicon esculentum* Miller

**EVALUATION OF BIOPESTICIDES FOR BACTERIAL LEAF SPOT CONTROL ON TOMATO, FALL 2009**

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*Xanthomonas perforans*

On 4 Sep 2008, plots were established at the University of Florida's Gulf Coast Research and Education Center in Balm, FL to assess the effect of several biopesticides on the severity of bacterial leaf spot (BLS) caused by *Xanthomonas perforans* on tomato in Florida. Transplants of the TYLCV resistant cultivar SecuriTY 28 were transplanted at 18" spacing to 21 ft plots along 300 ft long, raised beds with 5 ft center-to-center bed spacing. Beds were covered with a silver virtually impermeable mulch and irrigated with a drip system. Treatments (Tables 1 and 2) were applied on a weekly basis, beginning 28 Aug with transplants and continuing the day after transplanting on 5 Sep, 12 Sep, 17 Sep, 23 Sep, 3 Oct, 10 Oct, 16 Oct, 23 Oct, 30 Oct, 7 Nov, 13 Nov, and 18 Nov. A CO<sub>2</sub> back pack sprayer calibrated to deliver 60 gal/A for the first seven applications, and 90 gal/A for the subsequent applications at 40 psi. Biopesticides were applied along with low label rates of copper (Cuprofix Ultra 40D, 1.5 lbs/A) and mancozeb (Penncozeb 75DF, 2 lbs/A); a copper-mancozeb treatment (Trt 14) was included as a standard. A non-treated control (Trt 15) was also included to measure disease pressure. Treatments were arranged in a randomized complete block design with each treatment repeated 4 times. The experiment was inoculated 17 Sep and 30 Sep with a suspension (10<sup>6</sup> cfu/ml) of *Xanthomonas perforans*. Plots were monitored, and rated using the Horsfall-Barratt scale to assess the percentage of canopy affected by bacterial leaf spot. Disease ratings on 9 Oct and 15 Oct assessed the entire plant canopy, while later ratings on 27 Oct and 13 Nov only assessed the top half of the canopy. Marketable yield was assessed from two separate harvests of the center 10 plants in each plot. Only extra large and ripe fruit were harvested on 14 Nov followed by a complete harvest of all fruit on 2 Dec.

Weather conditions were favorable for disease development with 11 rain events of 0.1 inches or greater during the trial. Inoculations on 17 Sep and 30 Sep coincided with rain events. The average severity of BLS ranged from 5.6% (Trt 3) to 13.8% (Trt 15, non-treated control) on 9 Oct and ranged from 18.5% (Trts 8 and 14) to 32.8% (Trt 11) on 15 Oct, but differences among treatments were not statistically significant for either date ( $P = 0.1731$  and  $P = 0.7117$ , respectively). The severity of BLS in the top half of the tomato canopy was assessed on 27 Oct and 13 Nov, and ranged from 0% (Trt 13) to 16% (Trt 1) and from 8.4% (Trt 3) to 39.0% (Trt 14), respectively. Significant differences ( $P = 0.0839$ ) in the severity of BLS were observed

among treatments on 13 Nov, but only treatment 3 exhibited less disease than the copper-mancozeb standard (Trt 14). However, spray programs that included Kasumin (Trt 10), Citrex (Trt 9), HMO 736 (Trt 8), SeaCide (Trt 7), Omega Grow Plus (Trt 6), and Actigard (Trts 2 – 4) exhibited less disease over the entire trial, as expressed by the area under disease progress curve (AUDPC), relative to the copper-mancozeb standard (Trt 14).

The treatment effect was significant on the marketable yield of total ( $P = 0.0340$ ) and extra large fruit ( $P = 0.0429$ ) based on weight; expressed as the number of 25 lb cartons/A. Lower yields and greater disease severity was mostly associated with the non-treated control (Trt 15). However, improved disease control with biopesticides didn't necessarily improve marketable yield. The best marketable yields were associated with Serenade Max (Trt 5) and Taegro (Trt 12), which statistically yielded better than the copper-mancozeb standard (Trt 14). Treatments that included Actigard (Trts 2 – 4) typically yielded lower, but only Trt 3 was significantly less than the copper-mancozeb standard (Trt 14). Overall, spray programs that included HMO 736 (Trt 8), Citrex (Trt 9), and Kasumin (Trt 10) gave the best level of BLS control without compromising yield.

**Table 1.** Effect of treatments on the LS Mean (95% confidence interval) tomato yield by market class and culled fruit.

TRT	Treatments, rates, and application timing <sup>z</sup>	Marketable Yield (25 lb cartons/A)		Marketable Yield (1,000 fruit/A)		Extra Large Fruit	Culls
		Total	Extra Large	Total	Extra Large	(% of total by no.)	% of total by weight
1	Prophyt 2 pt (1 - 6), Prophyt 4 pt (7 - 12), Cuprofix Ultra 40D 1.5 lbs (5 - 13), Penncozeb 75DF 2.0 lbs (2 - 13)	1018 (822 - 1213)	478 (289 - 668)	70.9 (57.4 - 84.5)	22.8 (13.8 - 31.9)	32.5 (21.1 - 44)	9.6 (4.4 - 14.9)
2	Actigard 0.25 oz (1 - 8), Prophyt 2 pt (1 - 6), Prophyt 4 pt (7 - 12), Cuprofix Ultra 40D 1.5 lbs (5 - 13), Penncozeb 75DF 2.0 lbs (2 - 13)	1106 (911 - 1302)	515 (325 - 704)	79.2 (65.7 - 92.7)	26.5 (17.4 - 35.5)	34.8 (23.4 - 46.2)	10.7 (5.4 - 15.9)
3	Actigard 0.25 oz (1 - 8), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	968 (773 - 1163)	473 (283 - 663)	66.1 (52.6 - 79.7)	23.8 (14.8 - 32.9)	34.9 (23.5 - 46.3)	13.7 (8.5 - 19)
4	Actigard 0.75 oz (1 - 8), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	1198 (1003 - 1393)	729 (539 - 918)	77.8 (64.2 - 91.3)	34.9 (25.8 - 43.9)	45.9 (34.4 - 57.3)	13.4 (8.2 - 18.6)
5	Serenade Max 1 lb (1 - 13), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	1417 (1221 - 1612)	818 (628 - 1008)	91.9 (78.3 - 105.4)	36.3 (27.3 - 45.4)	39.8 (28.4 - 51.2)	11.5 (6.2 - 16.7)
6	Omega Grow Plus 2% v/v (1 - 13), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	1104 (909 - 1300)	547 (357 - 736)	74.3 (60.7 - 87.8)	28.6 (19.6 - 37.7)	38.2 (26.8 - 49.7)	8.9 (3.7 - 14.2)
7	SeaCide 1% v/v (1 - 13), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	1131 (936 - 1326)	636 (447 - 826)	76.7 (63.2 - 90.3)	29.8 (20.7 - 38.9)	39.5 (28 - 50.9)	9.6 (4.3 - 14.8)
8	HMO-736 14 oz (1 - 13), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	1285 (1089 - 1480)	751 (561 - 941)	80.5 (67 - 94)	33.7 (24.7 - 42.8)	42.1 (30.6 - 53.5)	7.6 (2.4 - 12.8)
9	Citrex 1.5 lbs (1 - 13), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	1297 (1102 - 1493)	789 (599 - 979)	82.3 (68.7 - 95.8)	34.6 (25.5 - 43.6)	41.4 (29.9 - 52.8)	9.4 (4.2 - 14.7)
10	Kasumin 1 qt/ 50 gal (1,3,5,7,9), Transfix 3 oz/50 gal (1,3,5,7,9), Cuprofix Ultra 40D 1.5 lbs (2,4,6,8,10 - 13), Penncozeb 75DF 2.0 lbs (2 - 13)	1281 (1085 - 1476)	721 (531 - 910)	83.1 (69.6 - 96.7)	35.6 (26.6 - 44.7)	43.4 (31.9 - 54.8)	8.3 (3 - 13.5)
11	Tiadanil 250 ppm (1 - 13), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	1245 (1050 - 1440)	596 (406 - 786)	83.3 (69.8 - 96.8)	25.4 (16.4 - 34.5)	30.7 (19.2 - 42.1)	10.5 (5.3 - 15.7)
12	Taegro 1.5 lbs (1 - 13), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	1310 (1115 - 1505)	838 (649 - 1028)	82 (68.5 - 95.5)	41.6 (32.5 - 50.6)	51.3 (39.9 - 62.8)	15.2 (10 - 20.5)
13	Gentamycin 3.5 lbs (1 - 13), GWN6500 8 oz/50 gal (1 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	1244 (1049 - 1439)	740 (551 - 930)	77.5 (63.9 - 91)	35.5 (26.4 - 44.5)	46.3 (34.9 - 57.8)	12.8 (7.6 - 18.1)
14	Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	1189 (993 - 1384)	661 (471 - 851)	81.4 (67.9 - 94.9)	33.6 (24.5 - 42.6)	40.9 (29.5 - 52.3)	8.9 (3.6 - 14.1)
15	Non-Treated Control	1071 (876 - 1266)	465 (275 - 655)	80.4 (66.9 - 93.9)	23.8 (14.8 - 32.9)	30.5 (19.1 - 41.9)	10 (4.8 - 15.2)
<i>P &gt; F</i>		<b>0.0340</b>	<b>0.0429</b>	<b>0.4094</b>	<b>0.1187</b>	<b>0.3631</b>	<b>0.6961</b>

<sup>z</sup> Treatments (TRT) were applied on 28 Aug, 5 Sep, 12 Sep, 17 Sep, 23 Sep, 3 Oct, 10 Oct, 16 Oct, 23 Oct, 30 Oct, 7 Nov, 13 Nov, and 18 Nov, corresponding with applications 1 to 13, using a backpack sprayer calibrated initially for 60 and then 90 gallons per acre after 10 Oct. Listed treatment rates are on a per acre basis unless noted otherwise. Seedlings were transplanted 4 Sep.

**Table 2.** Effect of treatments on the LS Mean (95% confidence interval) severity of bacterial leaf spot by individual dates and area under disease progress curve (AUDPC).

TRT	Treatment <sup>x</sup>	Rating Dates: <sup>y</sup>				AUDPC <sup>z</sup>	
		9-Oct	15-Oct	27-Oct	13-Nov		
1	Prophyt 2 pt (1 - 6), Prophyt 4 pt (7 - 12), Cuprofix Ultra 40D 1.5 lbs (5 - 13), Penncozeb 75DF 2.0 lbs (2 - 13)	9.0 (5.4 - 12.6)	29.5 (18.0 - 41.0)	16.0 (7.9 - 24.1)	19.0 (1.6 - 36.4)	817 (612 - 1021)	
2	Actigard 0.25 oz (1 - 8), Prophyt 2 pt (1 - 6), Prophyt 4 pt (7 - 12), Cuprofix Ultra 40D 1.5 lbs (5 - 13), Penncozeb 75DF 2.0 lbs (2 - 13)	6.8 (3.2 - 10.3)	20.9 (9.3 - 32.4)	1.1 (0 - 9.2)	19.8 (2.3 - 37.2)	490 (286 - 694)	
3	Actigard 0.25 oz (1 - 8), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	5.6 (2.0 - 9.2)	28.0 (16.5 - 39.5)	1.1 (0 - 9.2)	8.4 (0 - 25.8)	438 (234 - 642)	
4	Actigard 0.75 oz (1 - 8), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	8.0 (4.4 - 11.6)	20.9 (9.3 - 32.4)	0.0 (0 - 8.1)	21.4 (3.9 - 38.8)	510 (305 - 714)	
5	Serenade Max 1 lb (1 - 13), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	9.0 (5.4 - 12.6)	28.0 (16.5 - 39.5)	0.8 (0 - 8.9)	30.8 (13.3 - 48.2)	682 (478 - 886)	
6	Omega Grow Plus 2% v/v (1 - 13), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	6.8 (3.2 - 10.3)	28.0 (16.5 - 39.5)	0.4 (0 - 8.5)	15.0 (0 - 32.4)	503 (299 - 707)	
7	SeaCide 1% v/v (1 - 13), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	6.8 (3.2 - 10.3)	20.9 (9.3 - 32.4)	0.4 (0 - 8.5)	12.6 (0 - 30.1)	419 (215 - 623)	
8	HMO-736 14 oz (1 - 13), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	9.0 (5.4 - 12.6)	18.5 (7.0 - 30.0)	0.8 (0 - 8.9)	19.5 (2.1 - 36.9)	501 (296 - 705)	
9	Citrex 1.5 lbs (1 - 13), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	9.0 (5.4 - 12.6)	23.3 (11.7 - 34.8)	1.5 (0 - 9.6)	17.4 (0 - 34.8)	536 (332 - 740)	
10	Kasumin 1 qt/ 50 gal (1,3,5,7,9), Transfix 3 oz/50 gal (1,3,5,7,9), Cuprofix Ultra 40D 1.5 lbs (2,4,6,8,10 - 13), Penncozeb 75DF 2.0 lbs (2 - 13)	7.9 (4.3 - 11.5)	23.3 (11.7 - 34.8)	0.4 (0 - 8.5)	19.8 (2.3 - 37.2)	520 (316 - 725)	
11	Tiadanil 250 ppm (1 - 13), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	9.0 (5.4 - 12.6)	32.8 (21.2 - 44.3)	0.8 (0 - 8.9)	35.5 (18.1 - 52.9)	765 (561 - 969)	
12	Taegro 1.5 lbs (1 - 13), Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	11.4 (7.8 - 15.0)	23.3 (11.7 - 34.8)	1.1 (0 - 9.2)	23.3 (5.8 - 40.7)	622 (418 - 826)	
13	Gentamycin 3.5 lbs (1 - 13), GWN6500 8 oz/50 gal (1 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	10.3 (6.7 - 13.8)	28.0 (16.5 - 39.5)	0.0 (0 - 8.1)	28.0 (10.6 - 45.4)	669 (465 - 874)	
14	Cuprofix Ultra 40D 1.5 lbs (2 - 13), Penncozeb 75DF 2.0 lbs (3 - 13)	11.4 (7.8 - 15.0)	18.5 (7.0 - 30.0)	0.8 (0 - 8.9)	39.0 (21.6 - 56.4)	708 (504 - 912)	
15	Non-Treated Control	13.8 (10.2 - 17.3)	25.6 (14.1 - 37.2)	0.7 (0 - 8.9)	29.3 (11.8 - 46.7)	731 (527 - 935)	
		<i>P &gt; F</i>	<b>0.1731</b>	<b>0.7117</b>	<b>0.4845</b>	<b>0.0839</b>	<b>0.0823</b>

<sup>x</sup> Treatments (TRT) were applied on 28 Aug, 5 Sep, 12 Sep, 17 Sep, 23 Sep, 3 Oct, 10 Oct, 16 Oct, 23 Oct, 30 Oct, 7 Nov, 13 Nov, and 18 Nov, corresponding with applications 1 to 13, using a backpack sprayer calibrated initially for 60 and then 90 gallons per acre after 10 Oct. Listed treatment rates are on a per acre basis unless noted otherwise. Seedlings were transplanted 4 Sep.

<sup>y</sup> Trial was inoculated 17 Sep and 30 Sep with a Log 6 suspension of *Xanthomonas perforans*. Disease severity was assessed as the percentage of the entire canopy (9 Oct & 15 Oct) or top-half of the canopy (27 Oct & 13 Nov) affected by bacterial leaf spot using the Horsfall-Barratt scale. Values were converted to mid-percentages prior to statistical analyses.

<sup>z</sup> Area under disease progress curve (AUDPC) was calculated using the trapezoidal method with the mid-percentage values.