

**TOMATO:** *Lycopersicon esculentum* Miller

**EVALUATION OF COPPER-BASED FUNGICIDES FOR FOLIAR DISEASE CONTROL IN TOMATO PRODUCTION IN FLORIDA, SPRING 2009**

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*Xanthomonas axonopodis* pv. *vesicatoria*

On 10 Apr. 2009, plots were established at the University of Florida's Gulf Coast Research and Education Center in Balm, FL to assess the effect of several copper-based fungicides on the severity of bacterial spot on tomato. Raised beds, 300 ft in length, were prepared on 5 ft center-to-center spacing, covered with black virtually impermeable mulch and irrigated with a drip system. Plots consisted of 3 adjacent 21 ft bed sections transplanted with the TYLC resistant cultivar SecuriTY28 at 18" spacing along beds skipping a 6 ft section between plots as a buffer. Fungicide treatments were applied on 13 May, 20 May, 28 May, 3-Jun, and 12-Jun with a tractor sprayer calibrated to deliver 60 to 120 gal/A at 200 psi. A non-treated control was included to measure disease pressure. Treatments were arranged in a randomized complete block design with each treatment repeated 4 times. Alternating applications of Revus Top (5.5 floz/A) and Quadris F (5 floz/A) were made to minimize the impact of fungal foliar diseases, like early blight and target spot, when conducive conditions occurred in May and June.

The south bed of each plot was inoculated 28 May with a suspension ( $10^6$  cfu/ml) of *Xanthomonas perforans* using a backpack sprayer. Plots were monitored, and rated using the Horsfall-Barratt scale to assess the percentage of canopy affected by bacterial leaf spot.

Environmental conditions during the beginning of the trial were unusually dry. Only 1.42 inches of rain was recorded for the month from the start of the trial until 17 May, while 12.67 inches was recorded for the remaining duration of the trial. Symptoms of bacterial spot were first observed in plots on 4-May, but were confined to the outer inoculated row. Plots were rated 6 Jun and 17 Jun after disease reached acceptable levels across the trial. Because of heavy rains in early June and forecasted heavy rains from a sub-tropical system, Marketable yields were assessed with a complete harvest of plots on 22 June instead of the usual assessment across 2 to 3 separate harvests.

The severity of bacterial spot was rated using the Horsfall-Barratt scale on 6 Jun, 57 days after planting (DAP), and ranged from 7 to 10 corresponding to mid-percentage values of 18.5 and 95.5%, respectively. By 17 Jun, 68 DAP, disease severity values ranged from 4 to 9 corresponding to 81.5 and 98.5%, respectively. Significant differences were detected among

treatments on both dates (Table 1). Area under disease progress curves (AUDPC) were also calculated using the trapezoidal method and also revealed significant differences among treatments (Table 1). Based on AUDPC values, all treatments with the exception of TRT 3 reduced disease significantly relative to the non-treated control (TRT 15; Table 1). Standards consisted of copper sulfate and mancozeb applied at a high rate (3lb & 2lb, respectively; TRT 6) and a low rate (1.5lbs & 1.25lbs, respectively; TRT 7), and finally a low rate combined with Actigard (0.75oz; TRT 14). All three standards reduced the severity of bacterial spot to levels that were statistically less than the control. Treatment 14 gave the greatest level of control (43% reduction), followed by TRT 6 (29% reduction) and TRT 7 (15% reduction), based on mean AUDPC values (Table 1).

Treatments 3 through 7 were designed to test the effectiveness of a new sticker-spreader (PDS) to improve leaf fastness of fungicides. Statistically, PDS alone did not differ significantly from the non-treated control. Based on AUDPC and individual disease severity ratings, the addition of PDS to copper sulfate and mancozeb applications did not improve the control of bacterial spot. Numerically, the addition of PDS tended to increase disease severity ratings on high rate applications of copper sulfate + mancozeb, but decreased disease severity with low rate applications. The difference between the high application rates of copper sulfate + mancozeb with (TRT 4) and without PDS (TRT 6) on 17 Jun were significant.

Both experimentals performed well in this trial, especially on the initial rating when copper-sensitive isolates predominated. However, by the second rating, it was apparent that a copper-tolerant isolate had been introduced into plots as only those applications that included mancozeb were effective at reducing disease severity.

As typical for most bacterial spot trials, no statistical differences were observed among treatments. No phytotoxicity was observed among treatments.

Table 1. Effect of copper-based fungicides on the LS Mean (95% confidence interval) severity of bacterial spot on tomato during spring 2009 field trial at GCREC, Wimauma, FL.

TRT	Treatment, rate/acre <sup>x</sup>	Disease Severity <sup>y</sup>			Diseased Fruit <sup>z</sup>		% Diseased Fruit (by weight)	
		6-Jun	17-Jun	AUDPC	No. fruit	Weight (lbs)		
1	GWN-4620, 64 floz/100gal	56.3 (39.3 - 73.2)	96.3 (92.4 - 100)	7330 (6140 - 8520)	6 (1 - 11)	1.7 (0.2 - 3.2)	10.7 (4.1 - 17.3)	
2	GWN-4620, 64 floz/100gal;	56.3 (39.3 - 73.2)	86.3 (82.4 - 90.1)	6960 (5770 - 8150)	7 (2 - 12)	2.1 (0.6 - 3.6)	10.1 (3.6 - 16.7)	
3	Penncozeb 75DF, 2 lb PDS (250:1)	89.8 (72.8 - 100)	93.3 (89.4 - 97.1)	9464 (8273 - 10654)	9 (4 - 14)	2.5 (1.0 - 4.0)	14.2 (7.6 - 20.7)	
4	PDS, 250:1; Cuprofix 40D, 3lb;	62.5 (45.5 - 79.5)	92.1 (88.3 - 96.0)	7596 (6406 - 8786)	12 (7 - 17)	3.0 (1.5 - 4.5)	18.5 (11.9 - 25.1)	
5	Penncozeb 75DF, 2lb PDS, 250:1; Cuprofix 40D, 1.5lb;	65.8 (48.8 - 82.7)	93.3 (89.4 - 97.1)	7856 (6665 - 9046)	9 (4 - 14)	2.6 (1.1 - 4.1)	11.8 (5.2 - 18.3)	
6	Penncozeb 75DF, 1.25lb Cuprofix 40D, 3lb; Penncozeb	51.5 (34.5 - 68.5)	87.4 (83.5 - 91.2)	6683 (5493 - 7874)	8 (3 - 12)	2.6 (1.1 - 4.1)	12.6 (6.0 - 19.2)	
7	75DF, 2lb Cuprofix 40D, 1.5lb; Penncozeb	67.3 (50.3 - 84.2)	95.1 (91.3 - 99.0)	8025 (6835 - 9216)	8 (3 - 13)	2.3 (0.8 - 3.8)	9.9 (3.3 - 16.4)	
8	75DF, 1.25lb BX-09, 3pt	67.3 (50.3 - 84.2)	95.1 (91.3 - 99.0)	8025 (6835 - 9216)	11 (6 - 15)	3.7 (2.2 - 5.2)	15.6 (9.1 - 22.2)	
9	BX-09, 2pt	70.8 (53.8 - 87.7)	96.3 (92.4 - 100)	8302 (7111 - 9492)	8 (3 - 12)	2.1 (0.6 - 3.6)	10.3 (3.7 - 16.9)	
10	BX-09, 1pt	54.8 (37.8 - 71.7)	95.1 (91.3 - 99.0)	7188 (5998 - 8378)	6 (1 - 11)	1.5 (0 - 3.0)	9.8 (3.2 - 16.4)	
11	BX-09, 3pt; Penncozeb 75DF, 2lb	63.4 (46.4 - 80.3)	89.8 (85.9 - 93.6)	7567 (6377 - 8757)	11 (6 - 16)	3.4 (1.9 - 4.9)	18.5 (12 - 25.1)	
12	BX-09, 2pt; Penncozeb 75DF, 2lb	65.8 (48.8 - 82.7)	92.1 (88.3 - 96.0)	7814 (6624 - 9004)	13 (8 - 17)	3.7 (2.2 - 5.2)	15.0 (8.5 - 21.6)	
13	BX-09, 1pt; Penncozeb 75DF, 2lb	54.8 (37.8 - 71.7)	95.9 (92.0 - 99.7)	7216 (6025 - 8406)	9 (4 - 13)	2.7 (1.2 - 4.2)	13.2 (6.7 - 19.8)	
14	Actigard, 0.75oz; Cuprofix 40D,	32.8 (15.8 - 49.7)	86.3 (82.4 - 90.1)	5386 (4195 - 6576)	8 (3 - 13)	2.8 (1.2 - 4.3)	15.1 (8.5 - 21.6)	
15	1.5lb; Penncozeb 75DF, 1.25lb Control	87.4 (70.4 - 100)	97.0 (93.2 - 100)	9443 (8253 - 10633)	9 (4 - 14)	2.7 (1.2 - 4.2)	10.1 (3.5 - 16.6)	
		<i>P &gt; F</i>	<i>0.0007</i>	<i>&lt; 0.0001</i>	<i>0.0003</i>	<i>0.7316</i>	<i>0.7231</i>	<i>0.5864</i>

<sup>x</sup> Treatments (TRT) were applied 13 May, 20 May, 28 May, 3-Jun, and 12-Jun, using a tractor sprayer calibrated initially for 60 and 90 gallons per acre at 200 psi. Listed treatment rates are on a per acre basis unless noted otherwise. Plots transplanted 10-Apr and harvested 22-Jun.

<sup>y</sup> The severity of bacterial spot was assessed as the percentage of canopy affected. The Horsfall-Barratt scale was used for all ratings, but values were converted to mid-percentages prior to statistical analyses. Area under disease progress curve (AUDPC) was calculated for each treatment using the trapezoidal method. Values in parentheses represent *t*-type confidence intervals ( $\alpha = 0.95$ ) for each mean.

<sup>z</sup> Culled diseased fruit with symptoms typical of bacterial spot were not included in marketable yields.

Table 2. Effect of copper-based fungicides on the LS Mean (95% confidence interval) marketable tomato yields during spring 2009 field trial at GCREC, Wimauma, FL.

	Treatment, rate/A <sup>y</sup>	Marketable weight (lbs/trt) <sup>z</sup>						Avg. XL Frt. Wt.	% Marketable (by weight)
		Total	Small	Medium	Large	X-Large	Culls		
1	GWN-4620, 64 floz/100gal	16.7 (11.4 - 21.9)	1.2 (0.6 - 1.7)	2.3 (1.4 - 3.3)	2.8 (1.2 - 4.4)	5.2 (2.5 - 7.9)	3.5 (2.0 - 4.9)	0.44 (0.37 - 0.52)	68.5 (59 - 78.1)
2	GWN-4620, 64 floz/100gal; Penncozeb 75DF, 2 lb	20.6 (15.3 - 25.8)	1.7 (1.2 - 2.2)	2.3 (1.4 - 3.3)	3.9 (2.4 - 5.5)	8.4 (5.7 - 11.1)	2.1 (0.7 - 3.5)	0.46 (0.38 - 0.54)	79.5 (70.0 - 89.1)
3	PDS (250:1)	18.7 (13.5 - 24.0)	1.1 (0.5 - 1.6)	2.2 (1.3 - 3.1)	3.3 (1.7 - 4.8)	6.5 (3.8 - 9.2)	3.2 (1.8 - 4.6)	0.46 (0.38 - 0.53)	68.3 (58.7 - 77.8)
4	PDS, 250:1; Cuprofix 40D, 3lb; Penncozeb 75DF, 2lb	17.0 (11.7 - 22.2)	1.1 (0.6 - 1.6)	1.8 (0.9 - 2.7)	2.6 (1.1 - 4.2)	5.8 (3.1 - 8.5)	2.6 (1.2 - 4.0)	0.45 (0.38 - 0.53)	67.3 (57.8 - 76.9)
5	PDS, 250:1; Cuprofix 40D, 1.5lb; Penncozeb 75DF, 1.25lb	19.3 (14.1 - 24.5)	0.9 (0.4 - 1.5)	2.4 (1.5 - 3.3)	2.4 (0.8 - 3.9)	7.1 (4.4 - 9.8)	3.9 (2.5 - 5.3)	0.49 (0.42 - 0.57)	68.3 (58.8 - 77.9)
6	Cuprofix 40D, 3lb; Penncozeb 75DF, 2lb	19.9 (14.7 - 25.2)	1.2 (0.6 - 1.7)	1.9 (1.0 - 2.8)	2.6 (1.1 - 4.2)	8.8 (6.1 - 11.5)	2.8 (1.4 - 4.2)	0.50 (0.43 - 0.58)	72.5 (63.0 - 82.1)
7	Cuprofix 40D, 1.5lb; Penncozeb 75DF, 1.25lb	23.1 (17.8 - 28.3)	1.2 (0.7 - 1.7)	1.7 (0.8 - 2.6)	4.6 (3.1 - 6.2)	8 (5.3 - 10.7)	5.2 (3.8 - 6.6)	0.49 (0.41 - 0.56)	67.2 (57.7 - 76.8)
8	BX-09, 3pt	23.6 (18.4 - 28.9)	0.7 (0.1 - 1.2)	1.7 (0.7 - 2.6)	4.6 (3.1 - 6.2)	8.8 (6.1 - 11.5)	4.3 (2.8 - 5.7)	0.47 (0.39 - 0.54)	66.5 (57.0 - 76.0)
9	BX-09, 2pt	19.7 (14.4 - 24.9)	1.0 (0.5 - 1.5)	1.5 (0.6 - 2.4)	3.5 (1.9 - 5.0)	8.2 (5.5 - 10.9)	3.4 (1.9 - 4.8)	0.49 (0.41 - 0.56)	73.0 (63.5 - 82.5)
10	BX-09, 1pt	15.3 (10.1 - 20.6)	0.9 (0.4 - 1.4)	1.3 (0.3 - 2.2)	2.8 (1.2 - 4.4)	6.0 (3.3 - 8.7)	2.9 (1.4 - 4.3)	0.45 (0.37 - 0.52)	70.9 (61.4 - 80.4)
11	BX-09, 3pt; Penncozeb 75DF, 2lb	19.2 (13.9 - 24.4)	1.0 (0.4 - 1.5)	1.6 (0.7 - 2.5)	3.1 (1.5 - 4.7)	7.7 (5.0 - 10.4)	2.4 (1.0 - 3.9)	0.42 (0.35 - 0.5)	68.0 (58.5 - 77.6)
12	BX-09, 2pt; Penncozeb 75DF, 2lb	24.5 (19.3 - 29.8)	0.9 (0.4 - 1.4)	2.0 (1.1 - 2.9)	5.4 (3.8 - 6.9)	8.5 (5.8 - 11.2)	4.1 (2.7 - 5.5)	0.49 (0.42 - 0.57)	68.0 (58.5 - 77.5)
13	BX-09, 1pt; Penncozeb 75DF, 2lb	20.0 (14.8 - 25.2)	1.0 (0.5 - 1.6)	2.0 (1.1 - 2.9)	2.7 (1.1 - 4.2)	8.1 (5.4 - 10.8)	3.6 (2.2 - 5.0)	0.48 (0.4 - 0.55)	69.3 (59.8 - 78.8)
14	Actigard, 0.75oz; Cuprofix 40D, 1.5lb; Penncozeb 75DF, 1.25lb	18.3 (13.1 - 23.5)	1.0 (0.5 - 1.5)	1.5 (0.6 - 2.4)	3.6 (2.1 - 5.2)	5.1 (2.4 - 7.8)	4.3 (2.9 - 5.8)	0.35 (0.28 - 0.43)	60.6 (51.1 - 70.1)
15	Control	22.7 (17.5 - 27.9)	1.5 (1.0 - 2.1)	2.8 (1.8 - 3.7)	4.7 (3.1 - 6.3)	7.9 (5.2 - 10.6)	3.1 (1.7 - 4.5)	0.44 (0.37 - 0.52)	75.8 (66.3 - 85.4)
	<i>P &gt; F</i>	0.4331	0.4471	0.5280	0.1669	0.5150	0.1505	0.3907	0.3651

<sup>y</sup> Treatments (TRT) were applied 13 May, 20 May, 28 May, 3-Jun, and 12-Jun, using a tractor sprayer calibrated initially for 60 and 90 gallons per acre at 200 psi. Listed treatment rates are on a per acre basis unless noted otherwise. Plots transplanted 10-Apr and harvested 22-Jun.

<sup>z</sup> Values in parentheses represent *t*-type confidence intervals ( $\alpha = 0.95$ ) for each mean. Average X-large fruit weight (Avg. XL Frt. Wt.) was calculated from the total weight of X-Large fruit divided by the total number of X-Large fruit.