

Evaluation of copper and non-copper bactericides for the management of bacterial spot of tomato, spring 2011.

On 15 Mar 2011, plots were established at the University of Florida's Gulf Coast Research and Education Center in Balm, FL to assess the effect of various copper and non-copper bactericides on the control of bacterial spot of tomato. Plots consisted of 25 ft-long bed sections within 300 ft-long, raised beds with 5 ft center-to-center bed spacing. Beds were covered with black virtually impermeable mulch and irrigated with a drip system. Tomato seedlings (cv SecuriTY 28) were transplanted at 18-in spacing along beds skipping a 4-ft alley between plots as a buffer. Foliar treatments including a water-treated control, were arranged in a completely randomized design with each treatment repeated six times. The treatments were applied on 13 Apr, 21 Apr, 28 Apr, 5 May, 12 May, 19 May, and 25 May (corresponding with applications 1 to 7 below). Foliar treatments were applied with a CO₂ back pack sprayer calibrated to deliver 60 (apps. 1,2,3,4), and 90 gal/A (apps. 5,6,7) at 40 psi. Plots were inoculated on 27 Apr with a suspension (10⁶ cfu/ml) of *Xanthomonas perforans* race 4 using a backpack sprayer. Plots were monitored regularly for bacterial spot, and rated on 2 May, 16 May, and 3 Jun after disease reached appreciable levels. Marketable yield was assessed from a single hand harvest on 7 Jun. A preventative program that included alternating applications of Revus Top (7.7 fl oz/A), Endura (12.5 oz/A)-Bravo WeatherStik (1 pt/A), and Quadris Top (8 fl oz/A) was established across the trial to minimize the impact of early blight, target blight, or late blight.

Weather at the beginning of the trial was wet and unsettled with two rain events in late March bring well over 6 inches of rain to the site, accompanied with strong winds. The unsettled weather damaged plants, led to moderate levels of bacterial spot prior to inoculation, and delayed initiation of protective treatments. The rest of the trial period from April through June was unusually hot and dry (< 2 inches of rainfall), resulting in poor fruit set and lower than average tomato yields. Disease severity ratings on 2 May ranged from 16.4% for Firewall to 44.5% for MBI-106020B, and at the end of the trial on 3 Jun ranged from 90.1% for Firewall to 98% for the Control. The following programs statistically suppressed bacterial spot relative to the control, based on the area under disease progress curves (AUDPC): Actigard + Firewall, Actigard + Nordox, Firewall, Kocide 3000 + Penncozeb 75DF, Kocide 3000 + Penncozeb 75DF + Firewall, Quintec at 8 floz, Regalia + Kocide 3000, Regalia + Kocide 3000 + Penncozeb 75DF, Regalia + Penncozeb 75DF, and NAI-5750 at 16.7 ml/L. Of these treatments, 7 day applications of Kocide 3000 + Penncozeb 75DF with 14 day applications of Firewall reduced bacterial spot severity over the trial period by 37% based on AUDPC. The addition of Firewall improved bacterial spot management by 18% over the standard Kocide 3000 + Penncozeb 75DF treatment, which was equivalent to 14 day applications of Firewall alone. Several recent *X. perforans* strains with increased virulence on fruit were used in this trial resulting in minor fruit damage. Of all the treatments, only Nordox 75WG reduced the average number of infected fruit relative to the control at $P = 0.0862$ level of significance, and also the highest percentage of marketable fruit. Due to the usually hot, dry spring weather, only crown fruit developed that led to reduced tomato yields in a single harvest.

Treatment	Bacterial Spot Severity (%):						Diseased Fruit:				
	2-May		16-May		3-Jun		AUDPC		Number		Weight (lbs)
Actigard, 0.5 oz (1-7)	29.6	cd	57.4	ab	91.5	efg	2760	d-h	4.9	cde	1.96
Actigard, 0.5 oz (1-7); Firewall, 16 oz/100 gal (1,3,5,7)	20.8	ef	48.4	a-d	87.7	h	2275	ij	8.7	a-d	2.92
Actigard, 0.5 oz (1-7); Nordox 75WG, 2lb (1-7)	23.4	ed	36.3	c-f	95.2	a-d	2253	j	4.0	de	1.21
Control, water (1-7)	33.3	bc	57.4	ab	98.0	a	2934	bcd	7.8	a-d	2.73
Firewall, 16 oz/100 gal (1,3,6)	23.4	ed	48.4	a-d	90.1	fgh	2388	g-j	5.6	b-e	1.85
Kocide 3000, 1.5 lb (1-7); Penncozeb 75DF, 2 lb (1-7)	26.3	cde	36.3	c-f	94.7	bcd	2352	hij	5.7	b-e	2.06
Kocide 3000, 1.5 lb (1-7); Penncozeb 75DF, 2 lb (1-7); Firewall, 16 oz/100 gal (1,3,6)	16.4	f	25.5	g	94.0	cde	1838	k	5.6	b-e	2.46
MBI-106020B, 1.25 g/L (1-7)	44.5	ab	62.5	a	97.5	ab	3410	abc	6.4	a-e	2.08
Nordox 75WG, 2 lb (1-7)	33.3	bc	52.7	ab	96.0	abc	2853	c-f	2.6	e	1.04
Nordox 75WG, 2 lb (1-7); Firewall, 16 oz/100 gal (1,3,6)	26.3	cde	48.4	a-d	89.3	gh	2480	d-j	5.0	c-e	1.85
Quintec, 16 floz/100 gal; Surfix, 0.125% v/v (1-7)	26.3	cde	44.5	b-e	96.0	abc	2484	d-j	8.2	a-d	3.31
Quintec, 4 floz/100 gal; Surfix, 0.125% v/v (1-7)	29.6	cd	43.0	b-e	92.5	def	2563	d-j	7.6	a-d	2.60
Quintec, 8 floz/100 gal; Surfix, 0.125% v/v (1-7)	23.4	ed	44.5	b-e	95.5	abc	2366	g-j	8.4	a-d	2.83
Regalia, 0.5% v/v (1-7)	32.3	bcd	50.6	ab	95.7	abc	2803	d-h	8.7	a-d	3.65
Regalia, 0.5% v/v (1-7); Kocide 3000, 1.5 lb (1-7)	26.3	cde	35.0	def	96.5	abc	2386	g-j	8.3	a-d	2.38
Regalia, 0.5% v/v (1-7); Kocide 3000, 1.5 lb (1-7); Penncozeb 75DF, 2 lb (1-7)	26.3	cde	28.7	fg	94.0	cde	2221	jk	9.3	abc	3.02
Regalia, 0.5% v/v (1-7); Penncozeb 75DF, 2 lb (1-7)	29.6	cd	32.3	efg	96.5	abc	2414	e-j	12.0	a	3.56
Regalia, 0.5% v/v (1-7); Tanos, 8 oz (1-7)	33.3	bc	52.7	ab	97.0	ab	2860	c-f	10.0	abc	2.96
Regalia, 0.5% v/v (1,3,5,7); Quintec, 6 floz/100 gal (2,4,6)	26.3	cde	49.0	abc	95.5	abc	2584	d-j	8.8	a-d	2.71
Regalia MAXX (MBI-10620), 0.125% v/v (1-7)	26.3	cde	46.9	a-d	97.0	ab	2556	d-j	9.4	abc	2.77
NAI-5750, 0.2 ml/L (1-7)	29.6	cd	52.7	ab	97.5	ab	2736	d-i	7.3	a-d	2.08
NAI-5750, 1.7 ml/L (1-7)	33.3	bc	57.4	ab	96.0	abc	2919	b-e	6.0	b-e	2.02
NAI-5750, 16.7 ml/L (1-7)	23.4	ed	48.4	a-d	92.5	def	2410	f-j	10.9	ab	4.19
NAI-5750, 3.3 ml/L (1-7)	33.3	bc	57.4	ab	94.7	bcd	2909	b-f	8.1	a-d	2.62

P < 0.0001 *P* < 0.0001 *P* < 0.0001 *P* < 0.0001 *P* = 0.0862 *P* = 0.4995

Bacterial spot severity was assessed as the percentage of total leaf area affected by disease using the Horsfall-Barratt scale; values were converted to mid-percentages and fit to a lognormal distribution for final statistical analysis. Area under the disease progress curves (AUDPC) was calculated using the formula: $\sum[(x_i+x_{i+1})/2](t_i-t_{i-1})$ where x_i is the rating at each evaluation time and (t_i-t_{i-1}) is the time between evaluations. Means followed by the same letter are not significantly different at $\alpha=0.05$.

Treatment	Number of fruit by market type:				Total Fruit	Marketable Fruit:		
	Small	Medium	Large	X. Large		Number	% of total	
Actigard, 0.5 oz (1-7)	21.0	16.0	19.4	36.4	100.7	95.7	0.952	a-e
Actigard, 0.5 oz (1-7); Firewall, 16 oz/100 gal (1,3,5,7)	22.4	16.8	24.1	43.0	117.8	108.4	0.926	b-g
Actigard, 0.5 oz (1-7); Nordox 75WG, 2lb (1-7)	16.5	16.7	19.8	44.5	104.6	100.3	0.961	ab
Control, water (1-7)	13.4	15.7	20.0	35.4	95.9	87.4	0.918	c-g
Firewall, 16 oz/100 gal (1,3,6)	18.6	18.2	24.6	39.2	108.2	102.3	0.948	a-f
Kocide 3000, 1.5 lb (1-7); Penncozeb 75DF, 2 lb (1-7)	16.9	16.8	20.7	49.2	114.3	107.3	0.946	a-f
Kocide 3000, 1.5 lb (1-7); Penncozeb 75DF, 2 lb (1-7); Firewall, 16 oz/100 gal (1,3,6)	22.7	16.1	18.9	56.5	123.3	115.9	0.957	abc
MBI-106020B, 1.25 g/L (1-7)	19.2	17.1	22.6	33.0	103.0	96.5	0.938	a-f
Nordox 75WG, 2 lb (1-7)	17.2	17.7	18.4	32.8	90.3	87.6	0.972	a
Nordox 75WG, 2 lb (1-7); Firewall, 16 oz/100 gal (1,3,6)	20.8	20.1	21.6	39.2	110.0	104.2	0.955	a-d
Quintec, 16 floz/100 gal; Surfix, 0.125% v/v (1-7)	19.3	15.9	20.0	52.2	121.7	112.4	0.931	b-f
Quintec, 4 floz/100 gal; Surfix, 0.125% v/v (1-7)	13.8	15.5	14.7	46.3	100.6	92.5	0.927	b-g
Quintec, 8 floz/100 gal; Surfix, 0.125% v/v (1-7)	15.4	16.8	19.6	43.7	106.6	97.7	0.921	b-g
Regalia, 0.5% v/v (1-7)	22.8	20.8	16.6	39.2	112.9	103.3	0.925	b-g
Regalia, 0.5% v/v (1-7); Kocide 3000, 1.5 lb (1-7)	20.2	16.6	19.8	49.1	116.5	107.8	0.927	b-g
Regalia, 0.5% v/v (1-7); Kocide 3000, 1.5 lb (1-7); Penncozeb 75DF, 2 lb (1-7)	16.7	17.7	18.2	59.4	125.4	115.7	0.924	b-g
Regalia, 0.5% v/v (1-7); Penncozeb 75DF, 2 lb (1-7)	19.8	20.1	21.7	55.5	129.9	117.6	0.905	f-g
Regalia, 0.5% v/v (1-7); Tanos	17.0	20.9	26.1	40.9	117.2	107.2	0.916	d-g
Regalia, 0.5% v/v (1,3,5,7); Quintec, 6 floz/100 gal (2,4,6)	23.4	15.8	21.3	48.6	120.7	92.9	0.927	b-g
Regalia MAXX (MBI- 10620), 0.125% v/v (1-7)	17.5	21.4	17.4	33.6	102.9	111.5	0.909	e-g
NAI-5750, 0.2 ml/L (1-7)	27.9	23.5	25.0	39.8	128.0	120.2	0.944	a-f
NAI-5750, 1.7 ml/L (1-7)	19.1	17.6	23.8	28.7	98.7	91.9	0.940	a-f
NAI-5750, 16.7 ml/L (1-7)	23.0	17.1	17.9	51.0	125.0	113.1	0.912	d-g
NAI-5750, 3.3 ml/L (1-7)	21.2	20.7	22.8	42.9	118.4	109.6	0.928	b-g
	<i>P = 0.9391</i>	<i>P = 0.2164</i>	<i>P = 0.1722</i>	<i>P = 0.3293</i>	<i>P = 0.7049</i>	<i>P = 0.7565</i>	<i>P = 0.0407</i>	

Yields are based on a single harvest. Means followed by the same letter are not significantly different at $\alpha=0.05$.

Treatment	Fruit weight (lbs) by market type:				Total Fruit	Marketable Fruit:	
	Small	Medium	Large	X. Large		Weight	% of total
Actigard (weekly)	3.4	4.2	7.6	21.2	38.3	36.3	0.953
Actigard + Firewall	4.0	4.6	8.4	24.4	44.3	41.3	0.940
Actigard + Nordox	2.9	4.5	7.4	25.4	41.3	40.1	0.970
Control	2.4	4.5	7.3	21.1	38.1	35.3	0.932
Firewall (14 day app.)	3.2	5.0	9.2	23.6	42.9	41.0	0.959
Kocide 3000 + Penncozeb	3.0	4.7	8.0	28.7	46.4	44.3	0.963
Kocide 3000 + Penncozeb + Firewall	3.6	4.3	6.7	34.2	51.2	48.8	0.969
MBI-106020B	3.3	4.7	8.9	19.3	38.4	36.3	0.948
Nordox	2.8	4.9	7.2	20.3	36.3	35.2	0.973
Nordox + Firewall	3.6	5.6	8.3	23.0	42.4	40.5	0.963
Quintec (16 floz) + Surfix	3.2	4.5	6.8	31.1	49.0	45.7	0.943
Quintec (4 floz) + Suffix	2.1	4.0	5.7	26.5	41.0	38.4	0.942
Quintec (8 floz) + Surfix	2.8	4.9	7.4	27.0	44.8	42.0	0.939
Regalia	3.8	5.9	6.5	24.4	44.2	40.5	0.936
Regalia + Kocide 3000	3.4	4.7	7.5	28.0	46.0	43.6	0.944
Regalia + Kocide 3000 + Penncozeb	3.1	5.0	6.6	34.5	52.2	49.2	0.942
Regalia + Penncozeb	3.3	5.3	9.0	35.2	56.4	52.8	0.931
Regalia + Tanos	3.3	5.7	9.4	23.0	44.4	41.4	0.939
Regalia alt. Quintec (6 floz)	3.5	4.1	7.9	26.5	44.8	37.0	0.940
Regalia MAXX (MBI-10620)	3.1	6.0	7.1	20.8	39.7	42.1	0.937
Tiadinil (0.16ml/L)	4.4	6.2	9.5	23.0	45.1	43.1	0.958
Tiadinil (1.67ml/L)	3.2	5.2	8.9	17.3	36.5	34.5	0.950
Tiadinil (16.67ml/L)	3.8	4.6	6.4	29.7	48.6	44.5	0.920
Tiadinil (3.32ml/L)	3.2	6.0	9.1	24.7	45.5	42.9	0.942
	<i>P = 0.9278</i>	<i>P = 0.1124</i>	<i>P = 0.2345</i>	<i>P = 0.1844</i>	<i>P = 0.5178</i>	<i>P = 0.5222</i>	<i>P = 0.2007</i>

Yields are based on a single harvest. Means followed by the same letter are not significantly different at $\alpha=0.05$.