

**TOMATO:** *Lycopersicon esculentum* Miller

**EVALUATION OF FUNGICIDES FOR FOLIAR DISEASE CONTROL IN TOMATO PRODUCTION IN FLORIDA, SPRING 2008**

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*Xanthomonas axonopodis* pv. *vesicatoria*; *Alternaria solani*; *Corynespora cassiicola*, *Sclerotium rolfsii*

On 29 Feb. 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 fungicides on the incidence and severity of foliar diseases caused by fungal pathogens common to tomato production in Florida. Transplants of the TYLC resistant cultivar SecuriTY28 were transplanted at 18" spacing to 24 ft plots along 300 ft long, raised beds with 5 ft center-to-center bed spacing. Beds were covered with silver virtually impermeable mulch and irrigated with a drip system. Treatments (Table 1) were applied with a CO<sub>2</sub> back pack sprayer calibrated to deliver 60 gal/A for the first six applications, and 90 gal/A for the subsequent applications, both at 40 psi. Foliar applications of Cuprofix Ultra 40D (2 lb/A) + Penncozeb 75 DF (3 lbs/A) or Cuprofix Ultra 40D (2 lb/A) + Bravo Weatherstik (2pt/A) were used as the standard fungicide treatment. An Actigard treatment was initially applied (0.32g/640 plants) to a subset of seedlings 4 days prior to transplanting and then at a weekly rate of 0.75 oz/A with the standard chemical treatment afterwards. 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. The trial was inoculated 21 April with a suspension of conidia (approximately 10<sup>2</sup> conidia/ml) and mycelia of *Alternaria solani*. Plots were monitored, and rated (2 May, 8 May, 28 May) for several foliar diseases, including bacterial leaf spot (caused by *X. c. pv. vesicatoria*), early blight (*Alternaria solani*), and target spot (caused by *Corynespora cassiicola*). Marketable yield was assessed from two separate harvests of the center 10 plants in each plot on 20 May 2008 and 30 May 2008.

Overall, the environmental conditions for this trial were not favorable for severe disease development. While plots received 2.33 in. of rain on March 6 to 8 and another 0.9 in. on March 20 to 23, which helped establish several foliar diseases, no appreciable rain occurred again until the 19 May. Early blight and late blight (caused by *Phytophthora infestans*) also occurred naturally in the weeks following these initial rain events. The early blight inoculation on 21 April coincided with cool night temps and heavy morning dews that persisted for several days afterwards. However, none of the foliar diseases ever reached severe levels, but persisted at a moderate level throughout the trial with the aid of heavy morning dews.

Total foliar disease was rated 2 May, 54 days after transplant (DAT), and included early blight, target spot and some bacterial leaf spot, since separating the diseases was impractical. The severity ranged from 4 to 6 on the Horsfall-Barratt scale. The next disease severity ratings at 60 and 80 DAT ranged from 5 to 7 on the Horsfall-Barratt scale. Foliar disease data was analyzed by calculating the area under disease progress curve (AUDPC) for each treatment and through the use of ranked treatment means over time; a significant treatment effect was observed for both analyses ( $P < 0.0001$  for both analyses; Table 2). Based on ranked treatment means, a significant effect was also detected for time ( $P < 0.0001$ ), but no interaction between treatment and time was detected ( $P = 0.1341$ ; Table 2). Based on AUDPC, all treatments performed similar or better than the standard fixed copper with mancozeb or chlorothalonil. Actigard, AEC656948-250, USF2015A, USF2016A, and Topsin + Quadris performed better than the standard fungicide treatment (Table 3). Similar results were observed with the ranked treatment means over time, with USF2015A and USF2016A giving the most consistent control over time (Table 3).

Fruit yield was assessed in two separate harvests on 20 May and 30 May. The first harvest was of medium sized fruit and larger, while the second was a complete harvest of all fruit. A combined analysis of both harvests did not detect a significant effect of treatment on the yield of total marketable fruit ( $P = 0.3642$ ), but there was a significant effect on the yield of extra large marketable fruit ( $P = 0.0085$ ) and on the number of total fruit ( $P < 0.0001$ ), small ( $P = 0.0199$ ), medium ( $P = 0.0049$ ), large ( $P = 0.0025$ ) and extra large ( $P = 0.0085$ ) sized fruit harvested per plot (Table 4). Plants treated with Quadris produced the highest total marketable yields, while those plants treated with the standard fungicide treatment gave the highest yield of extra large fruit. Plants treated with Actigard yielded the second highest yield of total marketable fruit, but yielded the lowest percentage of extra large sized fruit of all the fungicide treatments. Plants treated with Topsin yielded the highest percentage of extra large fruit. No fruit were culled for bacterial leaf spot. There was treatment effect on the percentage of fruit culled for fungal rots associated with *Corynespora cassiicola* and *Alteranaria alternata* (Table 4).

An epidemic of southern blight caused by the soilborne fungus *Sclerotium rolfsii* occurred at the end of the trial. While plants exhibiting symptoms of southern blight were excluded from the harvest, it is difficult to ascertain the impact of this disease on yields, since many of the plants succumbed to the disease shortly after harvest. Therefore, yield data should be interpreted with caution.

Table 1. Chemical application schedule for the 2008 spring IR-4 trial in Wimauma, FL.

		Spray applications:										
Treatment		12 Mar	20 Mar	25 Mar	1 Apr	8 Apr	16 Apr	22 Apr	29Apr	6 May	13 May	22 May
- Formulation	Rate/A											
Actigard	0.75 oz	X	X	X	X	X	X	X	X	X		
AEC656948-250	10 oz		X		X		X		X		X	
AEC656948-500	5 oz		X		X		X		X		X	
USF2015A	4 oz		X		X		X		X		X	
USF2016A	5 oz		X		X		X		X		X	
Quadris	15.4 oz							X			X	X
Topsin	1 lb							X			X	X
	1lb +											
Topsin + Quadris	15.4oz							X			X	X
<b>Standard:<sup>z</sup></b>												
Cuprofix40D +	3 lb/A +	X	X	X	X		X	X		X		X
Penncozeb 75DF	3 lb/A											
Cuprofix 40D +												
Bravo	3 lb/A +					X			X		X	
Weatherstik	2 pt/A											

<sup>z</sup> Standard treatment was also applied in rotation with other products in fungicide treatments. The actigard treatment included the products applied in the standard treatment.

Table 2. Statistical analyses of variance based on the effect of treatment and time on the severity of early blight (EB), and target spot (TS) in the 2008 spring trial.

Effect	ANOVA-type statistic (ATS)			
	$df_{Num}$	$df_{Den}$	ATS	<i>P</i> value
BLS+ EB severity:				
Treatment (Trt)	5.32	30.7	7.63	< 0.0001
Time	1.67	$\infty$	38.27	< 0.0001
Trt x Time	8.57	$\infty$	1.53	0.1341
ANOVA <i>F</i> -statistic ( <i>F</i> )				
	$df_{Num}$	$df_{Den}$	<i>F</i>	<i>P</i> value
BLS + EB AUDPC <sup>y</sup> :	9	27	7.44	< 0.0001

Table 3. Analysis of area under disease progress curve (AUDPC), and the mean, median (Med.) and relative effect (RE) of treatment on the severity of early blight and target spot in the 2008 spring trial.

Treatments	<u>AUDPC</u>	<u>2-May (54 DAT)<sup>y</sup></u>			<u>8-May (60 DAT)</u>			<u>28-May (80 DAT)</u>			
	RE (95% CI) <sup>z</sup>	Mean	Med	RE (95% CI)	Mean	Med	RE (95% CI)	Mean	Med	RE (95% CI)	
Actigard	275.8 (259.4 - 292.1)	5.0	5.0	0.22 (0.18 - 0.26)	5.3	5.0	0.33 (0.16 - 0.56)	5.8	6.0	0.54 (0.33 - 0.74)	
AEC656948-250	275.8 (259.4 - 292.1)	5.0	5.0	0.22 (0.18 - 0.26)	5.3	5.0	0.33 (0.16 - 0.55)	5.8	6.0	0.54 (0.34 - 0.73)	
AEC656948-500	313.0 (296.6 - 329.4)	5.8	6.0	0.54 (0.35 - 0.72)	6.0	6.0	0.61 (0.33 - 0.83)	6.3	6.0	0.72 (0.57 - 0.83)	
USF2015A	270.0 (253.6 - 286.4)	5.0	5.0	0.22 (0.18 - 0.26)	5.0	5.0	0.22 (0.18 - 0.26)	5.5	5.5	0.43 (0.23 - 0.67)	
USF2016A	281.5 (265.1 - 297.9)	5.3	5.0	0.33 (0.17 - 0.54)	5.5	5.5	0.43 (0.23 - 0.66)	5.3	5.0	0.33 (0.17 - 0.54)	
Quadris	301.3 (284.9 - 317.6)	5.3	5.0	0.33 (0.16 - 0.55)	6.3	6.0	0.72 (0.57 - 0.83)	6.3	6.0	0.72 (0.56 - 0.84)	
Topsin	305.5 (289.1 - 321.9)	5.5	5.5	0.43 (0.23 - 0.67)	6.0	6.0	0.65 (0.60 - 0.70)	6.3	6.0	0.72 (0.57 - 0.83)	
Topsin + Quadris	284.8 (268.4 - 301.1)	5.0	5.0	0.22 (0.18 - 0.26)	5.8	6.0	0.54 (0.34 - 0.73)	6.0	6.0	0.65 (0.60 - 0.70)	
Standard	289.8 (273.4 - 306.1)	5.0	5.0	0.22 (0.18 - 0.26)	5.8	5.5	0.50 (0.21 - 0.79)	6.5	6.5	0.79 (0.60 - 0.90)	
<b>Control</b>	341.0 (324.6 - 357.4)	6.0	6.0	0.65 (0.60 - 0.70)	7.0	7.0	0.93 (0.91 - 0.95)	7.0	7.0	0.93 (0.91 - 0.95)	
	<b><i>P &gt; F</i></b>	<b>&lt; 0.0001</b>									

<sup>y</sup> DAT = days after transplant.

<sup>z</sup> RE = relative effect, based on mean rankings of disease severity using the Horsfall-Barrett scale. The overall effect of foliar symptoms caused by early blight, target spot and bacterial leaf spot over time was analyzed by the analysis of variance type statistic of ranked data using the PROC Mixed procedure in SAS (version 9.1; SAS Institute Inc., Cary, NC) to generate relative effects (RE), and the LD\_CI macro to generate 95% confidence intervals.

Table 4. Effect of treatments on the LS Mean (95% confidence interval) tomato yield by market class, culled fruit, and disease.

Treatment	<u>Marketable yield (25 lb cartons/A)</u>		<u>Marketable yield (fruit/plot)</u>				Extra large	Culls	Fruit Rot
	Total	Extra large	Total	Extra large	Large	Medium	(% by number)	(% by weight)	(% by number)
Actigard	1625 (1113 - 2137)	339 (259 - 419)	412 (375 - 449)	49 (38 - 61)	68 (56 - 80)	158 (136 - 180)	11.7 (8.4 - 15.3)	6.4 (3.8 - 9.1)	0 (0 - 0.20)
AEC656948-250	1333 (821 - 1846)	355 (276 - 435)	360 (323 - 397)	54 (42 - 65)	64 (53 - 76)	131 (109 - 153)	15.1 (11.6 - 18.5)	4.6 (1.9 - 7.2)	0 (0 - 0.20)
AEC656948-500	1195 (682 - 1707)	305 (225 - 384)	323 (286 - 360)	46 (35 - 57)	61 (50 - 73)	127 (105 - 148)	14.1 (10.6 - 17.5)	7.1 (4.5 - 9.8)	0.07 (0 - 0.27)
USF2015A	1292 (780 - 1804)	366 (287 - 446)	351 (314 - 388)	56 (44 - 67)	59 (47 - 71)	131 (109 - 153)	15.8 (12.4 - 19.3)	6.6 (3.9 - 9.3)	0.21 (0 - 0.41)
USF2016A	1319 (807 - 1831)	375 (295 - 455)	340 (303 - 377)	59 (47 - 70)	65 (53 - 77)	133 (111 - 155)	17.4 (14.0 - 20.9)	6.4 (3.7 - 9.1)	0.32 (0.12 - 0.53)
Quadris	1859 (1347 - 2371)	326 (247 - 406)	305 (268 - 342)	48 (37 - 59)	60 (48 - 72)	109 (87 - 131)	15.9 (12.4 - 19.3)	7.3 (4.6 - 10.0)	0.30 (0.09 - 0.5)
Topsin	1211 (698 - 1723)	397 (317 - 476)	298 (261 - 335)	57 (46 - 69)	55 (43 - 66)	94 (72 - 115)	19.4 (15.9 - 22.8)	8.2 (5.5 - 10.9)	0.23 (0.03 - 0.44)
Topsin + Quadris	1175 (663 - 1687)	281 (202 - 361)	311 (274 - 348)	40 (28 - 51)	63 (51 - 74)	122 (100 - 144)	12.7 (9.2 - 16.1)	7.2 (4.5 - 9.9)	0.15 (0 - 0.35)
Standard	1415 (903 - 1927)	404 (325 - 484)	341 (304 - 378)	58 (47 - 70)	52 (40 - 64)	139 (118 - 161)	17.2 (13.7 - 20.6)	5.8 (3.1 - 8.5)	0 (0 - 0.20)
<b>Control</b>	887 (375 - 1399)	173 (93 - 253)	245 (208 - 281)	27 (16 - 39)	38 (26 - 49)	95 (73 - 116)	10.9 (7.4 - 14.3)	6.0 (3.3 - 8.6)	0 (0 - 0.20)
<b><i>P</i> &gt; <i>F</i></b>	0.3642	0.0099	< 0.0001	0.0085	0.0025	0.0049	0.0295	0.7995	0.1319

<sup>z</sup> Area under the disease progress curve (AUDPC) for foliar diseases (bacterial leaf spot, early blight and target spot) on 23 April, 2 May, 7 May, and 14 May using the Horsfall-Barratt scale.