TOMATO: *Lycopersicon esculentum* Miller

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

Gary E. Vallad
University of Florida,
Gulf Coast Research & Education Center
14625 CR 672
Wimauma, FL 33598
Phone: 813-633-4121
Fax: 813-634-0001
Email: gvallad@ufl.edu

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

On 24 Mar. 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_2 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 of Cuprofix Ultra 40D (3 lb/A) + Penncozeb 75 DF (2 lbs/A) alternated with Cuprofix Ultra 40D (3 lb/A) + Bravo Ultrex (2.6 lb/A) were used as the standard fungicide treatment. 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 24 April with conidia (approximately 10^2 condia/ml) and mycelia of *Alternaria solani*. Plots were monitored, and rated (9 May and 28 May) for 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 9 Jun 2008 and 19 Jun 2008.

Initially, the environmental conditions for this trial did not favor rapid disease development. Plots only received 0.05 in. of rain from 24 March to 18 May. Fortunately, the cool night temps and heavy morning dews were ideal for the early blight inoculation on 24 April, and allowed the disease to slowly develop and persist until more favorable conditions prevailed. Another 3.33 inches from 10 separate rain events with totals greater than 0.1 inches was received from 19 May to just prior to the last harvest on 18 Jun.

Total foliar disease was rated 9 May, 46 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 1 to 4 on the Horsfall-Barratt scale. The next disease severity ratings at 65 DAT ranged from 2 to 5 on the Horsfall-Barratt scale. Foliar disease data was analyzed through the use of ranked treatment means over time and detected a significant treatment effect ($P <$

0.0001; Table 2). 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). All treatments performed similar or better than the standard fixed copper with mancozeb or chlorothalonil rotation. Treatments that included Revus Top and experimental compound A13703 gave the most consistent disease control over time (Table 3).

Fruit yield was assessed in two separate harvests on 9 Jun and 19 Jun. The first harvest was of large and extra large sized fruit, 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 ($P = 0.3642$) or extra large ($P = 0.7443$) marketable fruit. Plants treated with Endura and Kocide gave the highest marketable yields of 25 lb cartons per acre and one of the lowest percentages of culled fruit in the trial. No treatment effect was found for 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 fungicide trial in Wimauma, FL.

		Spray applications:									
TRT	**Formulation (Rate)**	**9 Apr**	**16 Apr**	**22 Apr**	**29 Apr**	**6 May**	**14 May**	**21 May**	**27 May**	**4 Jun**	**11 Jun**
1	A) Revus Top 4.17SC (6 oz/A) + Bravo Weather Stik 720SC (2 pt/A) + Endura 70WG (3 oz/A) B) Standard	B	B	B	B	A	A	A	A	B	B
2	A) Revus Top 4.17SC (7 oz/A) + Bravo Weather Stik 720SC (2 pt/A) + Endura 70WG (3 oz/A) B) Standard	B	B	B	B	A	A	A	A	B	B
3	A) A13703 (10 oz/A) + Endura 70WG (3 oz/A) B) Standard	B	B	B	B	A	A	A	A	B	B
4	A) Pristine 38WG (12.5 oz/A) B) Standard	B	B	B	B	A	A	A	A	B	B
5	A) LEM17 SC (2.0 oz/A) + Kocide 3000 (1.3 lb/A); B) Kocide 3000 (1.3 lb/A) + Tanos 50WG (8 oz/A)	A	B	A	B	A	B	A	B	A	B
6	A) LEM17 SC (3.5 oz/A) + Kocide 3000 (1.3 lb/A); B) Kocide 3000 (1.3 lb/A) + Tanos 50WG (8 oz/A)	A	B	A	B	A	B	A	B	A	B
7	A) LEM17 SC (5.0 oz/A) + Kocide 3000 (1.3 lb/A); B) Kocide 3000 (1.3 lb/A) + Tanos 50WG (8 oz/A)	A	B	A	B	A	B	A	B	A	B
8	A) Kocide 3000 (1.3 lb/A); B) Kocide 3000 (1.3 lb/A) + Tanos 50WG (8 oz/A)	A	B	A	B	A	B	A	B	A	B
9	A) Endura 70WG (2.5 oz/A) + Kocide 3000 (1.3 lb/A); B) Kocide 3000 (1.3 lb/A) + Tanos 50WG (8 oz/A)	A	B	A	B	A	B	A	B	A	B
10	A) Endura 70WG (3oz/A) + Cuprofix Ultra 40D (3 lb/A) B) Standard	B	B	B	B	B	A	B	A	B	A
11	A) CPD-20 (1 lb/A) + Cuprofix Ultra 40D (3 lb/A)	A	A	A	A	A	A	A	A	A	A
12	A) CPD-20 (1 lb/A) + Cuprofix Ultra 40D (3 lb/A); B) Bravo Ultrex (2.6 lb/A) + Cuprofix Ultra 40D (3 lb/A)	A	B	A	B	A	B	A	B	A	B
STD	**Standard:** A) Cuprofix40D (3 lb/A) + Penncozeb 75DF (2 lb/A) B) Cuprofix 40D (3 lb/A) + Bravo Ultrex (2.6 lb/A)	A	B	A	B	A	B	A	B	A	B

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.

	ANOVA-type statistic (ATS)			
Effect	df_{Num}	df_{Den}	**ATS**	***P* value**
EB + TS severity:				
Treatment (Trt)	9.33	29.5	10.15	< 0.0001
Time	1.00	∞	88.18	< 0.0001
Trt x Time	9.50	∞	1.53	0.1341

Table 3. The mean, median (Med.) and relative marginal effect (RME) of treatment on the severity of early blight and target spot in the 2008 spring trial.

		9 May (46 DAT)			28 May (65 DAT)		
TRT	**Treatments**	**Mean**	**Med.**	**RME (95% CI)**	**Mean**	**Med.**	**RME (95% CI)**
1	Revus Top 4.17SC (6floz/A) + Bravo Weather Stik 720SC (2pt/A) + Endura 70WG (3oz/A)	1.5	1.5	0.12 (0.06 - 0.28)	2.8	3.0	0.49 (0.32 - 0.66)
2	Revus Top 4.17SC (7floz/A) + Bravo Weather Stik 720SC (2pt/A) + Endura 70WG (3oz/A)	1.5	1.5	0.12 (0.06 - 0.28)	2.8	3.0	0.49 (0.32 - 0.66)
3	A13703 (10floz/A) + Endura 70WG (3oz/A)	1.5	1.5	0.12 (0.06 - 0.28)	2.3	2.0	0.31 (0.17 - 0.51)
4	Pristine 38WG (12.5oz/A)	2.3	2.0	0.31 (0.17 - 0.50)	2.8	3.0	0.49 (0.33 - 0.65)
5	LEM17 SC (2.0 oz/A) + Kocide 3000 (1.3 lb/A); alt. with Kocide 3000 (1.3 lb/A) + Tanos 50WG (8 oz/A)	2.3	2.0	0.31 (0.17 - 0.50)	3.0	3.0	0.58 (0.54 - 0.62)
6	LEM17 SC (3.5 oz/A) + Kocide 3000 (1.3 lb/A); alt. with Kocide 3000 (1.3 lb/A) + Tanos 50WG (8 oz/A)	2.5	2.5	0.40 (0.23 - 0.60)	3.0	3.0	0.58 (0.54 - 0.62)
7	LEM17 SC (5.0 oz/A) + Kocide 3000 (1.3 lb/A); alt. with Kocide 3000 (1.3 lb/A) + Tanos 50WG (8 oz/A)	2.5	2.5	0.40 (0.23 - 0.60)	3.8	4.0	0.79 (0.63 - 0.89)
8	Kocide 3000 (1.3 lb/A); alt. with Kocide 3000 (1.3 lb/A) + Tanos 50WG (8 oz/A)	2.8	3.0	0.49 (0.32 - 0.66)	3.5	3.5	0.72 (0.54 - 0.85)
9	Endura 70WG (2.5 oz/A) + Kocide 3000 (1.3 lb/A); alt. with Kocide 3000 (1.3 lb/A) + Tanos 50WG (8 oz/A)	2.3	2.0	0.31 (0.16 - 0.51)	3.0	3.0	0.56 (0.31 - 0.78)
10	Endura 70WG (3 oz/A) + Cuprofix Ultra 40D (3 lb/A)	2.3	2.0	0.31 (0.17 - 0.50)	4.3	4.0	0.89 (0.83 - 0.93)
11	CPD-20 (1 lb/A) + Cuprofix Ultra 40D (3 lb/A)	2.5	2.5	0.40 (0.23 - 0.60)	4.0	4.0	0.86 (0.84 - 0.88)
12	CPD-20 (1 lb/A) + Cuprofix Ultra 40D (3 lb/A); CPD-20 alternated w/ Bravo Ultrex (2.6 lb/A) + Cuprofix Ultra 40D (3 lb/A)	2.8	2.5	0.47 (0.22 - 0.74)	3.0	3.0	0.58 (0.54 - 0.62)
STD	**STANDARD**: Cuprofix Ultra 40D (3 lb/A) + Penncozeb (2 lb/A); alt. with Bravo Ultrex (2.6 lb/A) + Cuprofix Ultra 40D (3 lb/A)	2.3	2.0	0.31 (0.17 - 0.50)	4.3	4.0	0.89 (0.83 - 0.93)
CTL	**CONTROL**	3.5	3.5	0.72 (0.55 - 0.84)	5.0	5.0	0.97 (0.95 - 0.98)

[y] DAT = days after transplant.

[z] RME = relative marginal 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 RME, and the LD_CI macro to generate 95% confidence intervals (CI).

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

	Marketable yield (25 lb cartons/A)		Marketable yield (fruit/plot)			Extra large	Culls	Fruit Rot
Trt	**Total**	**Extra large**	**Total**	**Extra large**	**Large**	**(% by number)**	**(% by weight)**	**(% by number)**
1	1127 (850 - 1405)	693 (443 - 943)	229 (187 - 271)	97 (70 - 124)	43 (31 - 55)	42.6 (35.1 - 50.2)	16.1 (11.3 - 20.9)	0 (0 - 0.50)
2	1321 (1005 - 1638)	762 (475 - 1048)	262 (214 - 310)	110 (79 - 142)	71 (57 - 85)	41.8 (33.1 - 50.6)	15.0 (9.6 - 20.4)	0.88 (0.31 - 1.46)
3	1497 (1219 - 1774)	904 (654 - 1154)	297 (255 - 339)	122 (94 - 149)	61 (49 - 73)	41 (33.4 - 48.6)	10.3 (5.4 - 15.1)	0.16 (-0.34 - 0.66)
4	1299 (1022 - 1577)	813 (563 - 1063)	253 (211 - 295)	113 (85 - 140)	61 (49 - 73)	44.6 (37.1 - 52.2)	15.6 (10.8 - 20.4)	0.23 (0 - 0.73)
5	1429 (1152 - 1706)	920 (670 - 1170)	282 (239 - 324)	136 (109 - 163)	63 (50 - 75)	48.2 (40.6 - 55.7)	15.3 (10.5 - 20.1)	0 (0 - 0.50)
6	1395 (1118 - 1673)	856 (606 - 1106)	268 (226 - 310)	125 (98 - 152)	72 (59 - 84)	46.6 (39 - 54.1)	13.6 (8.8 - 18.5)	0.50 (0 - 0.99)
7	1318 (1041 - 1596)	783 (533 - 1033)	269 (227 - 311)	110 (83 - 137)	56 (43 - 68)	40.9 (33.3 - 48.4)	10.3 (5.5 - 15.1)	0.09 (0 - 0.59)
8	1396 (1118 - 1673)	849 (599 - 1099)	275 (232 - 317)	122 (95 - 149)	64 (52 - 76)	45 (37.4 - 52.5)	14.5 (9.7 - 19.3)	0.08 (0 - 0.58)
9	1574 (1297 - 1852)	1066 (816 - 1316)	279 (236 - 321)	138 (111 - 165)	62 (49 - 74)	49.6 (42 - 57.2)	10.6 (5.8 - 15.4)	0.15 (0 - 0.65)
10	1223 (945 - 1500)	753 (503 - 1003)	243 (201 - 285)	111 (83 - 138)	52 (40 - 64)	45.4 (37.8 - 52.9)	17.1 (12.3 - 22)	0.28 (0 - 0.77)
11	1224 (947 - 1501)	762 (512 - 1012)	238 (196 - 280)	105 (78 - 132)	52 (40 - 64)	43.5 (36 - 51.1)	18.6 (13.7 - 23.4)	0.25 (0 - 0.74)
12	1065 (748 - 1381)	682 (395 - 968)	200 (152 - 248)	89 (58 - 121)	47 (33 - 61)	42.6 (33.9 - 51.4)	18.3 (12.9 - 23.8)	0 (0 - 0.57)
STD	1202 (925 - 1479)	748 (498 - 998)	227 (185 - 269)	101 (73 - 128)	55 (43 - 67)	44.2 (36.7 - 51.8)	18.9 (14.1 - 23.7)	0 (0 - 0.50)
CTL	1324 (1047 - 1602)	839 (589 - 1089)	263 (221 - 305)	125 (98 - 152)	58 (46 - 70)	47.7 (40.1 - 55.2)	16.6 (11.8 - 21.4)	0 (0 - 0.50)
P > F	0.3601	0.7443	0.1199	0.4015	0.0810	0.9046	0.0459	0.5866

Weekly treatments: 1) standard treatment with four sequential applications of Revus Top 4.17SC (6floz/A) + Bravo Weather Stik 720SC (2pt/A) + Endura 70WG (3oz/A); **2)** standard treatment with four sequential applications of Revus Top 4.17SC (7floz/A) + Bravo Weather Stik 720SC (2pt/A) + Endura 70WG (3oz/A) **3)** standard treatment with four sequential applications of A13703 (10floz/A) + Endura 70WG (3oz/A); **4)** standard treatment with four sequential applications of Pristine 38WG (12.5oz/A); **5)** LEM17 SC (2.0 oz/A) + Kocide 3000 (1.3 lb/A) alternated with Kocide 3000 (1.3 lb/A) + Tanos 50WG (8 oz/A); **6)** LEM17 SC (3.5 oz/A) + Kocide 3000 (1.3 lb/A) alternated with Kocide 3000 (1.3 lb/A) + Tanos 50WG (8 oz/A); **7)** LEM17 SC (5.0 oz/A) + Kocide 3000 (1.3 lb/A) alternated with Kocide 3000 (1.3 lb/A) + Tanos 50WG (8 oz/A); **8)** Kocide 3000 (1.3 lb/A) alternated with Kocide 3000 (1.3 lb/A) + Tanos 50WG (8 oz/A); **9)** Endura 70WG (2.5 oz/A) + Kocide 3000 (1.3 lb/A) alternated with Kocide 3000 (1.3 lb/A) + Tanos 50WG (8 oz/A); **10)** standard treatment alternated with three applications of Endura 70WG (3oz/A) + Cuprofix Ultra 40D (3 lb/A); **11)** CPD-20 (1lb/A) + Cuprofix Ultra 40D (3lb/A); **12)** CPD-20 (1 lb/A) + Cuprofix Ultra 40D (3 lb/A) alternated with Bravo Ultrex (2.6 lb/A) + Cuprofix Ultra 40D (3lb/A); **13)** standard (STD) treatment of Cuprofix Ultra 40D (3 lb/A) + Penncozeb (2 lb/A) alternated with Bravo Ultrex (2.6 lb/A) + Cuprofix Ultra 40D (3lb/A); and **14)** a non-treated control (CTL).