**TOMATO:** *Lycopersicon esculentum* Miller

## EVALUATION OF DRIP-APPLIED BIOPESTICIDES FOR BACTERIAL LEAF SPOT 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 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 biopesticides applied through drip irrigation on the incidence and severity of foliar diseases typical of tomato in Florida. Transplants of the TYLC resistant cultivar Tygress 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 silver virtually impermeable mulch and irrigated with a drip system. Drip-applied treatments (Table 1) were injected weekly through a single drip tape (0.45 gal/100ft/min) in 0.05 Acre-inch of water using a model DI 16 Injector (Dosatron, Clearwater, FL). An additional 0.025 Acre-inch of water was applied between after each treatment to flush the irrigation system. Foliar applications of Cuprofix Ultra 40D (1 lb/A) + Penncozeb 75 DF (1.5 lbs/A) or Cuprofix Ultra 40D (1 lb/A) + Bravo Weatherstik (1pt/A) were applied on a weekly basis to the drip treatments and as a standard chemical treatment without biopesticides. 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. All foliar treatments were applied with a $CO_2$ back pack sprayer calibrated to deliver 60 gal/A for the first four applications, and 90 gal/A for the subsequent applications, both at 40 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. Experiment was inoculated 21 March with a suspension ($10^6$ cfu/ml) of *Xanthomonas campestris* pv. *vesicatoria*. Plots were monitored, and rated (23 Apr, 2 May, 7 May, 14 May, 29 May) for several diseases, including bacterial leaf spot (caused by *X. c.* pv. *vesicatoria*), early blight (*Alternaria solani*), target spot (caused by *Corynespora cassiicola*), and southern blight (caused by Sclerotium rolfsii) at the conclusion of the trial. 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. The bacterial leaf spot inoculation coincided with the rain event on 23 March.

Early blight and late blight (caused by *Phytophthora infestans*) also occurred naturally in the following weeks. However, none of the foliar diseases ever reached epidemic levels, but persisted throughout the trial with heavy morning dews.

Bacterial leaf spot was rated 23 April, 54 days after transplant (DAT). The severity ranged from 1 to 3 on the Horsfall-Barratt scale. The next three disease severity ratings at 63, 68 and 75 DAT included early blight, target spot and bacterial leaf spot, since separating the diseases was impractical. Disease severity in the last three ratings ranged from 2 to 5 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; however, no treatment effect was observed with either analysis (Table 2). Based on ranked treatment means, a significant increase in disease occurred with time ($P < 0.0001$), but no interaction with treatment was detected ($P = 0.605$).

Moderate to high weed pressure was observed early in the trial, and was the first indication that the soil fumigation during bed preparation was inadequate. Plots were weeded by hand over the season to control weeds. However, an epidemic of southern blight caused by the soilborne fungus *Sclerotium rolfsii* occurred at the end of the trial. Plots were rated for incidence on 29 May, prior to the final harvest. Because inoculum was not evenly distributed, the variation for disease incidence was high among treatments. Disease incidence analyzed by ranked treatment means detected a treatment effect ($P = 0.1134$) below marginal significance (Table 2). However, individual contrasts of Actigard and K-Phite treatments with the control plots were significant ($P < 0.0001$ and $P = 0.0003$, respectively; Table 3) indicating that these treatments consistently ranked better than the control. These results, while promising, require further testing.

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 failed to detect a significant effect of treatment on total marketable yield ($P = 0.1611$; Table 4), or on the total number or weight of culls, small, medium or large sized fruit (data not shown). However, a significant treatment effect was found for the total number ($P = 0.0147$), total weight ($P = 0.0231$) and number of 25 lb cartons ($P = 0.0231$) of extra large fruit (Table 4). Marketable yields of large fruit were 82% and 66% higher in plots treated with Sonata and Actinovate, respectively, than in the control; similar trends were observed for total fruit yields (Table 4). Plots treated with Actigard produced the highest percentage of extra large fruit by numbers, followed closely by Sonata, Taegro and Serenade ASO. Actinovate and K-Phite also reduced the percentage of fruit culled for fungal rots associated with *Corynespora cassiicola* and *Alteranaria alternata* ($P = 0.0050$ and $P = 0.0192$, respectively).

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

| Treatment - Formulation | Rate | Drip applications: 21 Mar | 27 Mar | 3 Apr | 11 Apr | 18 Apr | 23 Apr | 28 Apr | 5 May | 16 May | 22 May |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tiadanil | 1000 ppm | X | X | X | X | X | X | X | X | X | |
| Actinovate | 5 oz/A | X | X | X | X | X | X | X | X | X | |
| K-Phite | 5 qt/A | X | X | X | X | X | X | X | X | X | |
| Serenade ASO | 4 pt/A | X | X | X | X | X | X | X | X | X | |
| Sonata | 4 pt/A | X | X | X | X | X | X | X | X | X | |
| Taegro | 3.5 oz/A | X | X | X | X | X | X | X | X | X | |
| | | 20 Mar | 25 Mar | 1 Apr | 8 Apr | 16 Apr | 22 Apr | 29 Apr | 6 May | 14 May | 22 May |
| Actigard | 0.75 oz/A | X | X | X | X | X | X | X | X | | |
| Cuprofix40D + Penncozeb 75DF | 1 lb/A + 1.5 lb/A | X | X | X | | X | X | | | X | |
| Cuprofix 40D + Bravo Weatherstik | 1 lb/A + 1 pt/A | | | | X | | | X | X | | X |

Table 2. Statistical analyses of variance based on the effect of treatment and time on the severity of bacterial leaf spot (BLS) and early blight (EB), and on the incidence of southern blight (SB) and marketable yield in the 2008 spring trial.

| | ANOVA-type statistic (ATS) | | | |
|---|---|---|---|---|
| Effect[x] | $df_{Num}$ [z] | $df_{Den}$ | ATS | *P* value |
| BLS+ EB severity: | | | | |
| Treatment (Trt) | 6.26 | 107 | 0.62 | 0.7243 |
| Time | 2.47 | ∞ | 23.46 | < 0.0001 |
| Trt x Time | 11.40 | ∞ | 0.84 | 0.6058 |
| SB incidence: | 4.03 | 16.2 | 2.21 | 0.1134 |
| | ANOVA *F*-statistic (*F*) | | | |
| | $df_{Num}$ | $df_{Den}$ | *F* | *P* value |
| BLS + EB AUDPC[y]: | 8 | 24 | 0.55 | 0.8054 |

Table 3. Median (Med.) and relative effect (RE) of treatment on the incidence of southern blight in the 2008 spring trial.

| Treatment | Range | Med. | RE (95% CI) [y] | $P > F$ [z] |
|---|---|---|---|---|
| Actigard | 0 - 0.2 | 0.07 | 0.23 (0.14 - 0.37) | < 0.0001 |
| Actinovate | 0 - 0.5 | 0.18 | 0.45 (0.20 - 0.74) | 0.1933 |
| K-Phite | 0 - 0.3 | 0.04 | 0.25 (0.11 - 0.53) | 0.0003 |
| Serenade ASO | 0.2 - 0.6 | 0.50 | 0.73 (0.50 - 0.86) | 0.6524 |
| Sonata | 0 - 0.7 | 0.32 | 0.54 (0.20 - 0.84) | 0.5257 |
| Standard | 0.1 - 0.5 | 0.32 | 0.62 (0.45 - 0.75) | 0.4087 |
| Taegro | 0.1 - 0.4 | 0.29 | 0.56 (0.37 - 0.73) | 0.2207 |
| Tiadanil | 0 - 0.8 | 0.18 | 0.45 (0.19 - 0.76) | 0.2306 |
| **Control** | 0.2 - 0.8 | 0.39 | 0.68 (0.46 - 0.83) | – |

[y] RE = [($R$ - 0.5) / N]; R = mean ranking of the severity of southern blight; N = total experimental units in the analysis (N= 36). The 95% confidence intervals (CI) are in parenthesis.

[z] Based on direct linear contrasts of treatments with the non-treated control.

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) | | Extra large | Culls | BLS | Fruit Rot |
|---|---|---|---|---|---|---|
| Treatment | Total | Extra large | (% by number) | (% by weight) | (% by number) | (% by number) |
| Actigard | 1285 (951 - 1619) | 500 (332 - 667) | 26.2 (21.7 - 30.8) | 8.5 (6.0 – 11.0) | 0 (0.0 - 0.2) | 1.1 (0.6 - 1.6) |
| Actinovate | 1617 (1283 - 1951) | 598 (430 - 765) | 21.6 (17.0 - 26.2) | 9.7 (7.2 - 12.3) | 0.1 (0.0 - 0.3) | 0 (0.0 - 0.5) |
| K-Phite | 1402 (1067 - 1736) | 406 (239 - 573) | 17.1 (12.5 - 21.6) | 9.2 (6.7 - 11.8) | 0.1 (0.0 - 0.3) | 0.2 (0.0 - 0.7) |
| Serenade ASO | 1414 (1080 - 1749) | 529 (362 - 696) | 23.9 (19.3 - 28.5) | 8.3 (5.8 - 10.8) | 0.1 (0.0 - 0.3) | 0.4 (0.0 – 1.0) |
| Sonata | 1694 (1360 - 2029) | 657 (490 - 824) | 25.9 (21.4 - 30.5) | 8.1 (5.6 - 10.7) | 0.3 (0.1 - 0.5) | 0.5 (0.0 – 1.0) |
| Standard | 1217 (883 - 1552) | 317 (150 - 485) | 14.8 (10.3 - 19.4) | 8.8 (6.3 - 11.3) | 0.3 (0.1 - 0.5) | 0.6 (0.1 - 1.1) |
| Taegro | 1348 (1013 - 1682) | 524 (357 - 691) | 25.4 (20.8 – 30.0) | 8.2 (5.7 - 10.8) | 0 (0.0 - 0.2) | 0.5 (0.0 – 1.0) |
| Tiadanil | 1066 (732 - 1401) | 276 (109 - 443) | 15.5 (11.0 - 20.1) | 10.6 (8.0 - 13.1) | 0.1 (0.0 - 0.3) | 0.7 (0.2 - 1.3) |
| **Control** | 1188 (854 - 1523) | 361 (194 - 528) | 17.3 (12.7 - 21.8) | 9.3 (6.7 - 11.8) | 0.2 (0.0 - 0.4) | 1.1 (0.6 - 1.6) |
| ***P > F*** | 0.1611 | 0.0231 | 0.0015 | 0.8905 | 0.1642 | 0.0690 |