

Foliar and drip applications of biopesticides evaluated for managing *Phytophthora* blight in cucurbits, 2007.

The objective of this study was to evaluate the efficacy of a combination treatment schedule of foliar and drip applications of EPA-classified biopesticides that are at the demonstration (labeled) level of development for *Phytophthora* blight in cucurbits. Two types of biopesticides, phosphite and thyme oil, were evaluated. For the thyme oil treatment, Promax was applied through the drip and Proud-3 was applied to the foliage. Two phosphorous acid products, ProPhyt and Fosphite, were evaluated alone and applied just through the drip combined with new conventional fungicides applied to foliage. These treatments were compared to a nontreated control and to a conventional 'standard' treatment with several recently-registered fungicides applied in alternation to foliage of acorn squash. Acorn-type winter squash was selected because this type of squash is semi-bush, thus plots are more manageable than with a vining-type pumpkin variety, and because it produces several fruit per plant. A field experiment was conducted at LIHREC on Haven loam soil where *Phytophthora* blight had developed in 1991 to 1993, 1995 to 1999, and 2003 to 2006. Fertilizer (N-P-K 10-10-10) at 1000 lb/A was broadcast and incorporated on 27 Jun. Seven rows of black plastic mulch each with two strips of Aquatraxx™ drip tape were laid on 28 Jun. The 4-ft-wide mulch yielded a 3-ft-wide bed. Two seed of 'Autumn Delight' acorn squash were placed by hand in holes cut in the plastic mulch between the two strips of drip tape every 2 feet in 30-ft long single row plots on 11 Jul. Plots were thinned to 14 plants. A randomized complete block design with five replications was used. Four zucchini and yellow summer squash plants were transplanted into bare ground between plots to serve as spreader plants. Weeds were controlled by applying Strategy (2 pt/A) to bare ground between the plastic strips on 28 Jun, cultivating, and hand weeding. Powdery mildew was controlled with Procure (8 fl oz/A) applied on 17 Aug, 26 Aug, and 22 Sep and Quintec (6 fl oz/A) applied on 1 Sep, 10 Sep, and 28 Sep. Treatment applications were made weekly on a preventive schedule. Drip applications were made on 26 Jul (about 10 days after plant emergence), 8 Aug, 22 Aug, and 4 Sep. The tape had 12-in. emitter spacing and a flow rate of 0.45 gal/min. The injection period for each drip application was 45 minutes using a separate Mazzei® injector for each treatment. Drip tape in the four plots for each treatment was connected with blank irrigation tubing. Drip applications were stopped in mid-September because plants were no longer actively growing and thus assumed no longer capable of taking up adequate quantity of phosphite fungicide. Foliar treatments were applied with a backpack CO₂ pressurized sprayer operated at 40 psi and 60 gal/A. Applications were made on 2 Aug, 15 Aug, 28 Aug, 13 Sep, 20 Sep, 26 Sep, and 4 Oct. A single nozzle (TJ60 8003VS) boom was used while plants were small, then starting on 15 Aug a boom equipped with three (TJ60 8003VS) nozzles was used. Plants in plots receiving the treatment with no biopesticide applied through the drip also were sprayed with foliar fungicide on 26 Jul, 8 Aug, 22 Aug, and 4 Sep. Plants and fruit were examined routinely for symptoms of blight. Fruit with classic symptoms of *Phytophthora* fruit rot that included visible pathogen sporulation were counted separately from fruit that likely were infected but lacked definitive symptoms. Fruit that appeared to have rotted because of another cause were also counted. Average monthly high and low temperatures (°F) were 79/61 in Jun, 82/66 in Jul, 82/65 in Aug, 77/60 in Sep, and 70/56 in Oct. Rainfall (in.) was 3.37, 3.63, 2.60, 1.51, and 1.84 for these months, respectively.

Conditions were dry and unfavorable for *Phytophthora* blight during most of the growing season. Symptoms were first observed on some of the squash spreader plants and also in some plots on 17 Sep. Affected fruit were observed in two nontreated (control) plots and in two plots treated with thyme oil (Promax and Proud 3). Foliar symptoms of *Phytophthora* blight were more common than fruit symptoms on 17 Sep. Most were observed in the nontreated and thyme oil-treated plots, but all treatments had at least 1 affected plant in 1 of the 4 plots. Additional affected fruit were observed on 26 Sep, three weeks after the last drip application. Most were in the nontreated and thyme oil-treated plots: total of 23 and 17 fruit, respectively. There were also 13 affected fruit in the plots treated with just Fosphite and 17 in plots treated with just ProPhyt. No fruit rotting because of *Phytophthora* or another cause were observed in the other three treatments. The thyme oil treatment was ineffective under the conditions of this experiment in which *Phytophthora* blight began developing late in the growing season. This treatment was also ineffective in a similar experiment conducted in 2006 when blight also began developing late in the season. The phosphite treatments were moderately effective. There were no significant differences among the paired treatments with the two phosphite biopesticides. The two treatments consisting of a phosphite product applied through the drip and alternated with foliar applications of the phosphite product + copper fungicide were effective based on the final assessment made on 23 Oct, but not the assessment on 3 Oct, which was made one day before the last application. Control with these treatments was 46% and 55% based on incidence of definitive and suspected *Phytophthora* fruit rot on 23 Oct. Phosphites likely are most effective when applied to actively growing plants. At that time during this experiment environmental conditions were not favorable for *Phytophthora* blight. These biopesticides might be more effective when blight begins to develop earlier in the season. These two phosphite fungicides were ineffective in 2006 when blight also began developing late in the season and a copper fungicide was not included. Excellent control was obtained with the two treatments consisting of drip-applied phosphite alternated with applications of conventional foliar fungicides (Presidio alternated with Revus): 98-100% control of *Phytophthora* fruit rot on 23 Oct. This level of control was not significantly different from that obtained with conventional foliar fungicides (Forum, Ranman, Tanos, Manex, and Cuprofix) applied every 7 days for 10 weeks. Control was also good in 2006 with similar treatments that included copper plus Forum, Tanos, Ranman, Maestro, and/or Revus. Incidence of *Phytophthora* fruit rot was lower in this experiment than in the other two experiments with pumpkin and acorn squash in this research field, which were conducted on bare ground. Many affected fruit were on bare ground in this experiment suggesting that the plastic mulch was providing some protection to the fruit; however, there were enough affected fruit on the mulch to indicate the degree of protection was moderate.

Treatment (drip; foliar applications) ^z	Fruit with Phytophthora rot (%)						Good fruit (%)
	Definitive symptoms		Definitive and suspected symptoms		All rotting fruit (%)		
	3-Oct	23-Oct	3-Oct	23-Oct	3-Oct	23-Oct	
Nontreated	17.9 a ^y	42.4 a	21.1 a	53.9 a	22.9 a	56.7 a	43.3 c
Promax; Proud 3	15.0 a	39.1 ab	16.1 a	42.1 ab	17.8 a	47.7 ab	52.3 bc
Fosphite; Fosphite + Cuprofix	9.5 ab	18.4 bc	15.0 a	28.9 b	16.6 a	30.6 b	69.4 b
ProPhyt; ProPhyt + Cuprofix	10.0 ab	20.6 bc	10.9 ab	24.5 b	15.0 ab	31.0 b	69.0 b
Fosphite; Presidio + Cuprofix alt Revus + Cuprofix	1.1 b	1.0 c	1.1 b	1.0 c	2.8 c	2.7 c	97.3 a
ProPhyt; Presidio + Cuprofix alt Revus + Cuprofix	0.0 b	0.0 c	0.0 b	0.0 c	1.3 c	1.2 c	98.8 a
Forum + Cuprofix alt Ranman + Cuprofix alt Tanos + Manex + Cuprofix ^x ...	0.7 b	0.8 c	0.7 b	0.8 c	3.2 bc	6.3 c	93.7 a
<i>P-value</i>	0.005	0.004	0.0027	0.0001	0.0038	0.0001	0.0001

^z Fungicide formulations and rates used were: Cuprofix Disperss 36.9DF (1.5 lb/A), Forum 4.16SC (6.2 fl oz/A), Fosphite (4 pt/A), Presidio (4 oz/A), Manex 4F (1.6 qt/A), Promax (4 pt/A), ProPhyt (4 pt/A), Proud 3 (4 pt/A), Ranman 400 SC (2.75 fl oz/A) + Silwet (2 fl oz/A), Revus (0.35 lb/A), and Tanos 50 DF (10 oz/A).

^y Means followed by the same letter are not statistically different from each other (Fisher's Protected LSD, $P=0.05$).

^x No applications applied through drip.