

Foliar and drip applications of biopesticides evaluated for managing *Phytophthora* blight on pumpkin, 2006.

The objective of this study was to evaluate the efficacy of a combination treatment schedule of foliar and drip applications of seven EPA-classified biopesticides that are at the advanced or demonstration (labeled) level of development for *Phytophthora* blight on pumpkin. *Phytophthora* blight is a devastating disease for which there have been no adequately efficacious control options, and growers have stated that they would use chemigation as a means to control this pathogen if it was found to be effective. Three biological fungicides, Actinovate (*Streptomyces lydicus* WYEC 108), Kodiak (*Bacillus subtilis* GB03), and Yield Shield (*Bacillus pumilis* GB34), were evaluated along with a combination treatment of Promax (thyme oil) applied through the drip and Proud-3 (thyme oil) applied to the foliage. Two phosphorous acid products, ProPhyt and Fosphite, were also evaluated because a similar product, Phostrol, was found to be effective in controlling *Phytophthora* blight in pumpkin in a previous experiment at LIHREC. All treatments were compared to a current grower standard fungicide program of weekly alternating foliar applications of three EPA-registered, conventional fungicides labeled for this use (Forum, Gavel, and Tanos) and a second combination program with two conventional fungicides not registered that have performed well in other experiments (Maestro 80 DF and Revus 250L) plus two registered, labeled fungicides (conventional Ranman and biopesticide ProPhyt). Some applications in these programs included Cuprofix Dispers for resistance management. 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 2005. The field was plowed on 18 Apr and tilled on 2 May. Fertilizer (N-P-K 10-10-10) at 500 lb/A was broadcast and incorporated on 12 Jun. Eleven rows of black plastic mulch each with two strips of Aquatraxx™ drip tape were laid on 14 Jun. 'Munchkin' pumpkin seed was planted in a greenhouse on 14 Jun and seedlings were transplanted on 30 Jun into the plastic mulch between the two strips of drip tape. On 29 Jun, the day before transplanting, plants to be treated with ProPhyt or Fosphite received a drench application of 20 ml/seedling of a 0.5% solution of each fungicide into their growing cells in the greenhouse. During the season weeds were controlled by cultivation, roto-tilling, and hand weeding. Asana XL (9.6 fl oz/A) was applied for cucumber beetle control on 7 Aug. Plots were single 20-ft rows spaced at least 11 ft apart. There was 5-ft between plots. A randomized complete block design with four replications was used. Average monthly high and low temperatures (°F) were 77/62 in Jun, 84/69 in Jul, 82/67 in Aug, 73/58 in Sep, and 64/48 in Oct. Rainfall (in.) was 5.83, 3.79, 5.48, 3.66, and 5.53 for these months, respectively. Foliar treatments were applied preventatively beginning on 26 Jul and continuing bi-weekly for most treatments on 9 Aug, 23 Aug, 7 Sep, and 21 Sep with a tractor-mounted boom sprayer operated at 120 psi and 85 gal/A and equipped with D5-25 hollow cone nozzles spaced 17 in. apart. Drip applications were applied bi-weekly on alternate weeks of the foliar applications on 2 Aug, 15 Aug, 1 Sep, and 13 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. Since *Phytophthora* blight did not develop on its own, likely due to low rainfall and high temperatures, the field was artificially inoculated with 1 tsp (10-15 seeds) of beet seed infested with *P. capsici* to the soil around the first and last plant in each plot on 15 Aug. All plots were examined on 1 Sep and no infection was found on any plants. On 5 Sep, one orange fruit at the beginning and end of each plot was inoculated with a 1-in.² piece of an infected pumpkin fruit from a neighboring experiment. Plots were examined again on 21 Sep and no infection was found on any fruit. The field was inoculated a third time on 25 Sep by placing one pepper fruit sporulating with *P. capsici* from a neighboring experiment at the beginning and end of each plot. Pumpkin fruit were examined for symptoms of *Phytophthora* fruit rot and other types of fruit rot on 11 Oct. Symptomatic tissue with spores of the pathogen was considered definitive. A square root transformation was used when needed prior to analysis to achieve homogeneity of variance. Fruit were not harvested.

Phytophthora fruit rot was not found until 9 Sep and was rated one time on 11 Oct when more widespread. On this date the only treatments with significant control of definitive plus suspected symptoms of this disease were the standard treatment of weekly foliar applications of conventional fungicides and a second treatment of weekly applications of conventional foliar fungicides applied in addition to bi-weekly applications of ProPhyt through the drip irrigation system. None of the treatments consisting of biopesticides applied alone suppressed *Phytophthora* fruit rot relative to the untreated control. Results from this experiment are not considered definitive because disease began to develop very late in the growing season and was at a low level at the end of the trial. No phytotoxicity was observed.

Treatment and rate/A (application method-date)*	Healthy fruit (%)	Mature fruit with Phytophthora fruit rot (%)	
		Definitive symptoms	All symptoms
Forum 4.16 SC 6.2 fl oz + Cuprofix Disperss 36.9 DF 2.5 lb (foliar-1,4,7) alt. Gavel 75 DF 2 lb (foliar-2,5,8) alt Tanos 50 DF 8 oz + Cuprofix Disperss 36.9 DF 2.5 lb (foliar-3,6,9).....	97.2	0.7 bc**	0.7 cd
Maestro 80 DF 6 lb (foliar-1,5,9) alt. Revus 250 SC 8 fl oz (foliar-2,6) alt. Ranman 2.75 fl oz (foliar-3,7) alt. Cuprofix Disperss 36.9 DF 2.5 lb(foliar-4,8) alt. ProPhyt 4 pt (drip-2,4,6,8)...	98.5	0.0 c	0.0 d
Maestro 80 DF 6 lb (foliar-1,2,3,4,5,6,7,8,9) alt. ProPhyt 4 pt (drip-2,4,6,8).....	94.2	2.2 bc	2.7 bcd
Revus 250 SC 8 fl oz (foliar-1,2,3,4,5,6,7,8,9) alt. ProPhyt 4 pt (drip-2,4,6,8).....	87.8	2.8 bc	6.1 abcd
ProPhyt 4 pt (foliar-1,3,5,7,9) alt. ProPhyt 4 pt (drip-2,4,6,8).....	86.2	4.2 abc	5.5 abcd
Fosphite 4 pt (foliar-1,3,5,7,9) alt. Fosphite 4 pt (drip-2,4,6,8).....	80.4	6.1 ab	7.3 abc
YieldShield 6 oz (foliar-1,3,5,7,9) alt. YieldShield 6 oz (drip-2,4,6,8).....	88.8	3.6 abc	7.1 ab
Kodiak 6 fl oz (foliar-1,3,5,7,9) alt. Kodiak 6 fl oz (drip-2,4,6,8).....	82.1	3.7 abc	10.9 ab
Proud-3 4 pt (foliar-1,3,5,7,9) alt. Promax 4 pt (drip-2,4,6,8).....	71.8	11.6 a	16.1 a
Actinovate SP 6oz (foliar-1,3,5,7,9) alt. Actinovate SP 6 oz (drip-2,4,6,8).....	73.4	13.3 a	16.4 a
Nontreated (control).....	78.0	5.7 ab	12.4 ab
<i>P</i> -value	0.0638	0.0413	0.0088

*Treatments application dates were 1=26 Jul, 2=2 Aug, 3=9 Aug, 4=15 Aug, 5=23 Aug, 6=1 Sep, 7=7 Sep, 8=13 Sep, and 9=21 Sep.

**Numbers in each column with a letter in common are not significantly different according to Fisher's Protected LSD ($P = 0.05$).