

Efficacy of fungicides for managing powdery mildew on pumpkin, 2019.

An experiment with field-grown pumpkins was conducted at the Long Island Horticultural Research and Extension Center (LIHREC) in Riverhead, NY, in a field with Haven loam soil. One objective was to determine if efficacy was lower than expected based on previous results for fungicides at risk for resistance development due to single-site mode of action. These fungicides are critical for successful control of powdery mildew due to their mobility enabling them to move to the lower leaf surface where powdery mildew develops best. In previous years at LIHREC poor control was associated with presence of *Podosphaera xanthii* isolates resistant to FRAC code 3, 7, 11, and/or U6 fungicides. Isolates resistant to FRAC code 1 and 13 fungicides have also been detected. Second objective was to evaluate two new fungicides: Gatten (FRAC Code U13) and pyraziflumid (7), which was tested with and without a non-ionic surfactant. The field was plowed on 20 Apr. For management of Phytophthora blight (caused by *Phytophthora capsici*), a mustard biofumigant cover crop (Caliente 199) was seeded at 10 lb/A by drilling on 25 Apr after applying urea fertilizer (46-0-0) at 163 lb/A (75 lb/A N) on 23 Apr. On 12 Jun the mustard was flail chopped, immediately incorporated by disking, and followed by a cultipacker to seal the soil surface; the field was not irrigated to initiate biofumigation because soil was moist and rain was forecast. Pumpkins were planted with a vacuum seeder at approximately 24-in plant spacing on 27 Jun after disking. The seeder applied fertilizer in two bands about 2 in. away from the seed. Controlled-release fertilizer (N-P-K, 15-5-15) was used at 675 lb/A (101 lb/A N). Strategy 3 pt/A, Sandea 0.5 oz/A, and Roundup PowerMax 22 oz/A were applied prior to seedling emergence for weed control on 29 Jun using a tractor mounted sprayer. During the season, weeds were managed by cultivating and hand weeding as needed. Drip tape was laid down along each row of pumpkin seedlings on 2 Jul. The following fungicides were applied throughout the season to manage Phytophthora blight: Omega 1 pt/A on 17 Jul, Orondis Ultra 7 fl oz/A on 26 Jul, 23 Aug and 6 Sep, Ranman 2.75 fl oz/A on 1, 29 Aug and 15 Sep, and Presidio 4 fl oz/A on 8 and 16 Aug. The primary source of initial inoculum for powdery mildew in this area is considered to be long-distance wind-dispersed spores from affected plants. Plots were three 15-ft rows spaced 68 in. apart. The 20-ft area between plots was also planted to pumpkin. A randomized complete block design with four replications was used. Treatments were applied six times on a 7-day IPM schedule (starting after disease detection) beginning on 8 Aug using a tractor-mounted boom sprayer equipped with twinjet (TJ60-11004VS) nozzles spaced 17 in. apart that delivered 72 gal/A at 50 psi and 2.3 mph. Plots were inspected for powdery mildew symptoms on upper and lower leaf surfaces on 7, 12, 19, and 27 Aug; and 3, 10 Sep. For the first two assessments, 25 old leaves were rated in each plot. For the remaining assessments, an equal number of young, mid-aged, and old leaves (selected based on leaf physiological appearance and position in the canopy) were rated for a total of 15 or 27 leaves in each plot. Powdery mildew colonies were counted; severity was assessed by visual estimation of percent leaf area affected when colonies could not be counted accurately because they had coalesced and/or were too numerous. Colony counts were converted to severity values using the conversion factor of 30 colonies/leaf = 1% severity. Average severity for the entire canopy was calculated from the individual leaf assessments. Area Under Disease Progress Curve (AUDPC) values were calculated from 7 Aug through 10 Sep using the formula: $\sum_{i=1}^{n-1} [(R_{i+1} + R_i)/2] [t_{i+1} - t_i]$, where R = disease severity rating (% of leaf surface affected) at the *i*th observation, *t_i* = time (days) since the previous rating at the *i*th observation, and *n* = total number of observations. Defoliation was assessed on 23 Sep. Fruit quality was evaluated in terms of handle (peduncle) condition for mature fruit without rot on 26 Sep, 4 Oct, and 10 Oct. Handles were considered good if they were green, solid, and not rotting. Data were analyzed with one-way ANOVA and Tukey's HSD to separate means using JMP statistical software. Average monthly high and low temperatures (°F) were 86.3/71.3 in Jul, 82/68.8 in Aug, and 76/66.1 in Sep. Rainfall (in.) was 3.00, 1.52, and 1.83 for Jul, Aug, and Sep, respectively.

Powdery mildew was first observed in this experiment on 7 Aug, found in all 48 plots. No symptoms were found on 30 Jul when a less intensive assessment was done. Treatment application started the day after detection. All of the fungicide treatments significantly reduced severity of powdery mildew on the upper leaf surface compared to the untreated control for all assessments except for both pyraziflumid treatments which were not performing significantly better than the untreated control at the final evaluation of the season, 10 Sep. These treatments were also ineffective at controlling powdery mildew on the lower leaf surface based on the Sep assessments and AUDPC. Efficacy of pyraziflumid likely was compromised by presence of *P. xanthii* isolates resistant to boscalid. They have been shown to exhibit partial resistance to some other FRAC code 7 fungicides. Efficacy of Luna Sensation (FRAC 7+11) was not as evidently affected by resistance. Based on AUDPC values it was more effective than pyraziflumid but less effective than Vivando (50). Quintec (13) was failing to significantly reduce powdery mildew severity on the lower leaf surface compared to the untreated control at the final evaluation date. Like both pyraziflumid treatments, Quintec also failed to prevent fruit quality decline due to powdery mildew compared to the untreated control at the final two handle evaluation dates (all treatments were effective at the first assessment; data not shown). This suggests that resistance to Quintec, which has been detected on Long Island since 2015, impacted its efficacy in 2019. Gatten was as effective as Vivando. Vivando was the most effective single chemistry treatment as it was the only one that did not differ significantly from the grower standard fungicide rotation for all assessments. These three treatments providing best control of powdery mildew were the only ones with significantly less defoliation than the untreated control on 23 Sep (data not shown). No phytotoxicity was observed. This report includes work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, Hatch under NYC-153409.

| Treatment and rate/A (application dates) ^y | Powdery mildew severity (%) ^z | | | | | | Fruit quality (% good handles) ^z | |
|--|--|---------|---------|--------------------|---------|---------|--|---------|
| | Upper leaf surface ^x | | | Lower leaf surface | | | 4 Oct | 10 Oct |
| | 3 Sep | 10 Sep | AUDPC | 3 Sep | 10 Sep | AUDPC | | |
| Untreated | 44.6 a | 71.3 a | 613 a | 68.5 a | 92.6 a | 1068 a | 23 a | 8 a |
| Pyraziflumid 3.1 fl oz (1-6) | 23.4 b | 53.6 a | 368 b | 63.9 a | 89.6 ab | 858 ab | 47 abc | 22 ab |
| Pyraziflumid 3.1 fl oz + Induce NIS 0.125% v/v (1-6) | 17.2 bc | 48.8 a | 301 b | 64.2 a | 88.5 ab | 891 a | 43 ab | 20 ab |
| Quintec 6 fl oz (1-6) | 10.1 cd | 21.0 b | 148 c | 41.3 b | 84.8 ab | 640 bc | 44 ab | 23 ab |
| Luna Sensation 7.6 fl oz (1-6) | 5.4 de | 13.8 b | 89 c | 42.5 b | 65.8 bc | 563 cd | 67 bcd | 43 bc |
| Gatten 6.4 fl oz (1-6) | 1.1 ef | 2.4 c | 19 d | 26.0 bc | 43.9 cd | 374 de | 76 cd | 60 cd |
| Vivando 15.4 fl oz (1-6) | 0.6 f | 2.0 c | 12 d | 18.1 cd | 33.4 de | 271 ef | 76 cd | 63 cd |
| Vivando 15.4 fl oz (1,4), Quintec 6 fl oz (2,5), Proline 5.7 fl oz (3,6) | 0.4 f | 1.0 c | 8 d | 5.8 d | 10.5 e | 89 f | 81 d | 73 d |
| <i>P-value (treatment)</i> | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |

^z Numbers in each column with a letter in common are not significantly different from each other (Tukey's HSD, $P=0.05$).

^y Rate of formulated product/A. Application dates were 1=8 Aug, 2=15 Aug, 3=22 Aug, 4=29 Aug, 5=5 Sep, 6=11 Sep

^x Values were square root transformed before analysis because raw data were not distributed normally. Table contains de-transformed values.