SQUASH, ACORN (*Cucurbita pepo* 'Honey Bear')
Powdery mildew; *Podosphaera xanthii*

M. T. McGrath and Z. F. Sexton
Plant Pathology & Plant-Microbe Biology Section
SIPS, Cornell University, LIHREC
3059 Sound Avenue, Riverhead, NY 11901

**Effectiveness of conventional and organic fungicide programs with biopesticides that induce systemic resistance for control of powdery mildew in acorn squash, 2019.**

An experiment with acorn squash was conducted at the Long Island Horticultural Research and Extension Center (LIHREC) in Riverhead, NY, in a field with Haven loam soil. The main objective of this experiment was to assess benefits of adding a biopesticide that triggers an induced systemic resistance (ISR) response in plants (Regalia or LifeGard) to a conventional fungicide rotation for control of cucurbit powdery mildew. There was a parallel treatment with Serifel, another biopesticide with potential to induce ISR, and a treatment with only fungicides approved for organic production. The cultivar selected has intermediate resistance to powdery mildew. 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. Controlled-release fertilizer (N-P-K, 15-5-15) at 675 lb/A (101 lb/A N) was broadcast over the bed area and incorporated on 24 Jun. Beds were formed with drip tape and covered with black plastic mulch also on 24 Jun. A waterwheel transplanter was used to make planting holes in the beds and apply starter fertilizer. Two seeds were placed by hand in each opening on 28 Jun, plots were thinned to one plant per hole or missing plants replaced with transplants on 5 Jul so that each plot consisted of 12 plants. To separate plots and provide a source of inoculum, there was a single powdery mildew-susceptible zucchini squash plant (cv. Spineless Beauty) between each plot in each row. Weeds were managed between the mulched beds by applying Strategy 3 pt/A, Sandea 0.5 oz/A, and Roundup PowerMax 22 oz/A prior to seedling emergence on 2 Jul using a tractor mounted sprayer. Mechanical cultivation and hand weeding were done as needed. 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 of *Podosphaera xanthii* 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, 12 plants per plot, arranged in a randomized complete block design with four replications. Fungicides were applied on a 7-day schedule 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. Applications of Regalia, LifeGard, and Serifel were begun on 1 Aug, at least two weeks before plants were anticipated to begin producing fruit, which is when powdery mildew typically starts to develop. Plots were inspected for powdery mildew symptoms on upper and lower leaf surfaces on 17, 21 and 29 Aug; 4, 11, and 17 Sep. For each assessment 5 old to middle age leaves and 5 young leaves were evaluated per 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 17 Aug through 17 Sep. Plots were also evaluated for canopy health using a hand-held GreenSeeker crop sensor. The canopy NDVI spectral reflectance index was measured twice per rating in full sunlight, which is appropriate light conditions for these measurements. Greenseeker evaluations were taken on the same day as powdery mildew disease ratings. All mature fruit in each plot were harvested on 7 and 8 Oct, counted, and sorted based on marketability criteria: larger than 3.5 inches in diameter, fully ripe, and no large surface defects. Marketable fruit were counted and weighed. Flesh samples were taken from five representative fruit from each plot, frozen, then thawed to obtain juice to analyze for sugar content using a refractometer to obtain a Brix reading. Data were analyzed with one-way ANOVA and Tukey's HSD to separate means using JMP statistical software. Average monthly high and low temperatures ($^{o}$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 f for Jul, Aug, and Sep, respectively.

Powdery mildew was first observed in this experiment on 14 Aug at low levels and not in all plots (average severity was 0.014% and 0.004% on upper and lower leaf surfaces, respectively). The addition of the plant activator treatments (LifeGard and Regalia) or Serifel between a biweekly rotation of conventional fungicides did not improve control of powdery mildew on either the upper or lower leaf surface compared to the same conventional rotation without the biopesticides. The plant activator treatments were also outperformed by the weekly rotation of conventional fungicides in powdery mildew control. This suggests that the addition of plant activators or other biopesticides is not a substitute for a weekly rotation of conventional fungicides. The organic rotation treatment was only able to significantly reduce powdery mildew severity on the upper leaf surface compared to the untreated control (except at the final assessment). Interestingly, the biweekly conventional rotation with the addition of LifeGard was the only treatment, in addition to the weekly conventional treatment, to significantly improve yield compared to both the untreated control and the organic rotation. This suggests the LifeGard plant activator may have an effect on yield potential. None of the biopesticide treatments increased NDVI values when compared to the conventional rotation treatments, suggesting the biopesticides did not increase leaf greenness. None of the treatments improved fruit quality in terms of sugar content (Brix) compared to the untreated control (data not shown).

| Treatment and rate (application dates) [y] | Powdery mildew severity (%) [z] | | | | | | NDVI leaf greenness measurement [z] | | Yield [z] (Marketable fruit per plot) |
|---|---|---|---|---|---|---|---|---|---|
| | Upper leaf surface | | | Lower leaf surface | | | | | |
| | 11 Sep [x] | 17 Sep | AUDPC [x] | 11 Sep | 17 Sep | AUDPC [x] | 11 Sep | 17 Sep | |
| Untreated | 49.8 a | 63 a | 779 a | 80.8 a | 86.0 a | 1158 a | 0.60 b | 0.39 b | 89.5 c |
| LifeGard 3.5 fl oz/A (1,2)<br>Milstop 3 lb/A (3,6)<br>Serifel 8 oz/A (4,7)<br>Suffoil-X 1% v/v (5) | 20.8 b | 67 a | 435 b | 73.3 a | 87.0 a | 1040 a | 0.63 b | 0.35 b | 95.5 bc |
| Regalia 2 qt/A (1,2,4,6)<br>Vivando 15.4 fl oz/A (3)<br>Quintec 4 fl oz/A (5)<br>Luna Experience 6 fl oz/A (7) | 6.1 c | 23 b | 123 c | 24.8 b | 52.0 b | 390 bc | 0.81 a | 0.67 a | 106.5 abc |
| Serifel 8 oz/A (1,2,4,6)<br>Vivando 15.4 fl oz/A (3)<br>Quintec 4 fl oz/A (5)<br>Luna Experience 6 fl oz/A (7) | 4.7 cd | 18 b | 103 c | 25.8 b | 54.5 b | 462 b | 0.76 a | 0.65 a | 107.0 abc |
| LifeGard 3.5 oz/A (1,2,4,6)<br>Vivando 15.4 fl oz/A (3)<br>Quintec 4 fl oz/A (5)<br>Luna Experience 6 fl oz/A (7) | 4.9 cd | 14 b | 93 c | 30.5 b | 59.9 b | 445 b | 0.79 a | 0.68 a | 113.8 a |
| Vivando 15.4 fl oz/A (3)<br>Quintec 4 fl oz/A (5)<br>Luna Experience 6 fl oz/A (7) | 5.4 c | 13 b | 83 cd | 32.4 b | 53.1 b | 464 b | 0.79 a | 0.66 a | 109.8 ab |
| Vivando 15.4 fl oz/A (3,6)<br>Quintec 4 fl oz/A (5)<br>Luna Experience 6 fl oz/A (4,7) | 0.6 d | 3 c | 30 d | 17.5 b | 19.4 c | 235 c | 0.81 a | 0.69 a | 119.5 a |
| *P-value (treatment)* | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | 0.0003 |

[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=1 Aug, 2=7 Aug, 3=14 Aug, 4=21 Aug, 5=27 Aug, 6=3 Sep, 7=11 Sep.

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