# Long Island Vegetable Pathology Program
# 2017 Annual Research Report

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**Evaluation of Biofence for managing Phytophthora blight in cucurbits**
**Investigators: Margaret T. McGrath and Zachary F. Sexton**
**Location: Long Island Horticultural Research and Extension Center**

The primary objective of this study was to evaluate the soil amendment product Biofence for the control of Phytophthora blight on pumpkins compared to biopesticides. Biofence is an organic fertilizer made from a specially bred brassica crop high in glucosinolate. The field was chosen because it has a history of Phytophthora blight. *Phytophthora capsici* proliferation was encouraged the previous season by growing squash and pumpkin throughout the field with no management practices for Phytophthora blight.

The field was plowed on 25 Jun. Controlled-release fertilizer (N-P-K, 15-5-15) was applied on 28 Jun at 675 lb/A (101 lb/A N), Biofence (6-2-0) was applied to the appropriate plots at the same time at 2000 lb/A to provide 101 lb/A N. Pumpkins were planted with a vacuum seeder at approximately 24-in plant spacing on 7 Jul. 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 7 Jul using a tractor mounted sprayer. During the season, weeds were controlled by cultivating and hand weeding as needed. Moisture was initially provided by overhead irrigation; drip line was laid on 17 Jul and used for the rest of the season. After plants were established drip irrigation was run for extended periods of time in order to over saturate the soil and help encourage the proliferation of *Phytophthora capsici*; this was performed on a semi-weekly basis until plants reached reproductive stages. Plots were two 10-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. All plots received the following fungicide applications to control powdery mildew, Vivando 15 fl oz/A on 7 Aug, Torino 3.4 fl oz/A on 14 Aug, Procure 8 fl oz/A on 21 Aug, and Vivando 15 fl oz/A on 28 Aug. Four applications of biopesticides were made to soil with one before planting, one pre-emergence, and two while plants were small, the treatments were Bio-Tam 4 lbs/A and Taegro 4 oz/A applied on 29 Jun and 20 Jul, and SoilGard 12G 10 lbs/A applied on 13 Jul and 27 Jul. Foliar applications for Phytophthora blight were made five times on a 7-day preventive schedule beginning on 3 Aug and ending on 1 Sep. Actinovate AG 12 oz/A plus Regalia 3 qt/A were applied in rotation with Double Nickel 1.5 lbs/A plus Cueva 2 qt/A plus Regalia 3 qt/A. All nine soil and foliar applications were made 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 evaluated for Phytophthora fruit rot symptoms on 24, 28, and 31 Aug. At each assessment, all fruit within the plot were inspected for rot and recorded as a percentage of the total fruit.

An intensive rainstorm on 18 Aug with 3.28 in. rain likely provided favorable conditions for Phytophthora blight. Symptoms were first observed in this experiment on 24 Aug. Both treatments failed to significantly suppress Phytophthora fruit rot. Average incidence of affected fruit on 31 Aug was 60% for the Biofence soil amendment, 47% for the rotation treatment of biopesticides, and 60% for the untreated control. Disease pressure was high but distribution throughout the field was highly variable. Effective control was achieved with conventional fungicides in an adjacent experiment with the same variety (see following report).

*Acknowledgments*: This project supported by NYS Department of Agriculture & Markets.

**Evaluation of biopesticides for managing Phytophthora blight in cucurbits**
**Investigators: Margaret T. McGrath and Zachary F. Sexton**
**Location: Long Island Horticultural Research and Extension Center**

The primary objective of this study was to evaluate a program with a combination of biopesticide products used alone or added to a conventional fungicide program for control of Phytophthora blight on pumpkins. All products tested are labeled for this disease. Biopesticides were selected to cover the diversity of labeled active ingredients. The field was chosen because it has a history of Phytophthora blight. *Phytophthora capsici* proliferation was encouraged the previous season by growing squash and pumpkin throughout the field with no management practices for Phytophthora blight.

The field was plowed on 25 Jun. Controlled-release fertilizer (N-P-K, 15-5-15) was applied on 28 Jun at 675 lb/A (101 lb/A N). Pumpkins were planted with a vacuum seeder at approximately 24-in plant spacing on 7 Jul. 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 7 Jul using a tractor mounted sprayer. During the season, weeds were controlled by cultivating and hand weeding as needed. Moisture was provided all season using overhead irrigation. Plots were three 12-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. All plots received the following fungicide applications to control powdery mildew: Vivando 15 fl oz/A on 7 Aug, Torino 3.4 fl oz/A on 14 Aug, Procure 8 fl oz/A on 21 Aug, and Vivando 15 fl oz/A on 28 Aug. Four applications of biopesticides were made to soil with one before planting, one pre-emergence, and two while plants were small, the treatments were Bio-Tam 4 lbs/A and Taegro 4 oz/A applied on 29 Jun and 20 Jul, and SoilGard 12G 10 lbs/A applied on 13 Jul and 27 Jul. Foliar applications for Phytophthora blight were made five times on a 7-day preventive schedule beginning on 3 Aug and ending on 1 Sep. Actinovate AG 12 oz/A plus Regalia 3 qt/A were applied on 3 Aug, 17 Aug, and 1 Sep in rotation with Double Nickel 1.5 lbs/A plus Cueva 2 qt/A plus Regalia 3 qt/A applied on 11 and 25 Aug. Applications for the conventional fungicide treatment were also made five times: Revus 8 fl oz/A plus K-Phite 1 qt/A on 3 Aug, 17 Aug, and 1 Sep, and Presidio 4 fl oz/A plus K-Phite 1 qt/A on 11 and 25 Aug. All soil and foliar applications were made 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 evaluated for Phytophthora fruit rot symptoms on 24, 28, and 31 Aug. At each assessment all fruit within the plot were inspected for rot and recorded as a percentage of the total fruit.

An intensive rainstorm on 18 Aug with 3.28 in. rain likely provided favorable conditions for Phytophthora blight. Symptoms were first observed in this experiment on 24 Aug. The rotation treatment of biopesticides failed to suppress Phytophthora fruit rot: there was an average of 38% affected fruit in these plots on 31 Aug compared to 32% in untreated plots. The conventional fungicide treatment was effective: only 1.6% of fruit in these plots had Phytophthora fruit rot symptoms. The conventional fungicide treatment with the additional early-season biopesticide soil treatment had similarly low level of Phytophthora fruit rot incidence (2.5%) but it was not significantly distinguishable from the untreated control due to the high variability of disease occurrence across the field. No benefit of applying biopesticides was documented in this experiment, which could partly be due to disease onset being associated with very favorable conditions.

*Acknowledgments*: This project supported by NYS Department of Agriculture & Markets.

**Evaluation of biopesticides for managing Phytophthora blight in pepper**
**Investigators: Margaret T. McGrath and Zachary F. Sexton**
**Location: Long Island Horticultural Research and Extension Center**

The purpose of this experiment was to evaluate a program with a combination of biopesticide products for the control of Phytophthora blight on peppers when compared to conventional fungicides. All products tested are labeled for this disease. Biopesticides were selected to have a full range of available active ingredients. The field was chosen because it has a history of Phytophthora blight. *Phytophthora capsici* proliferation was encouraged the previous season by growing squash and pumpkin throughout the field with no management practices for Phytophthora blight.

The field was plowed on 25 Jun. Controlled release fertilizer (N-P-K, 15-5-15) was applied on 28 Jun at 675 lb/A (101 lb/A N). Plants were seeded in the greenhouse on 15 May and transplanted into the field on 5 Jul. Prowl H20 2.1 pt/A and Reflex 1 pt/A were applied for weed control on 3 Jul using a tractor-mounted sprayer. During the season, weeds were controlled by cultivating and hand weeding as needed. Moisture was provided all season using overhead irrigation. Plots were five 8-ft rows spaced 34 in. apart with 6 plants per row at 16 in spacing. The 20-ft area between plots was not planted. A randomized complete block design with four replications was used. Four applications of biopesticides were made to soil with one to seedling trays (29 Jun) and three while plants were small (13, 20, and 27 Jul). Those treatments were Bio-Tam 4 lbs/A combined with Taegro 4 oz/A on 29 Jun and 20 Jul, and SoilGard 12G 10 lbs/A on 13 Jul and 27 Jul. Foliar applications for Phytophthora blight were made five times on a 7-day preventive schedule beginning on 3 Aug. Actinovate AG 12 oz/A plus Regalia 3 qt/A were applied on 3 Aug, 17 Aug, and 1 Sep, and Double Nickel 1.5 lbs/A plus Cueva 2 qt/A plus Regalia 3 qt/A on 11 and 25 Aug. Conventional fungicides were applied five times: Revus 8 fl oz/A plus K-Phite 1 qt/A on 3 Aug, 17 Aug, and 1 Sep, and Presidio 4 fl oz/A plus K-Phite 1 qt/A on 11 and 25 Aug. All applications were made 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 evaluated for Phytophthora blight symptoms on 24, 28, and 31 Aug. At each assessment, all plants within the plot were inspected for Phytophthora symptoms and recorded as a percentage of the total plants.

An intensive rainstorm on 18 Aug with 3.28 in. rain likely provided favorable conditions for Phytophthora blight. Symptoms were first observed in this experiment on 24 Aug. Wilt caused by crown rot was the primary symptom seen. No treatment was able to significantly reduce the incidence of Phytophthora blight when compared to the untreated control. The rotation of conventional pesticides was numerically the most effective treatment with 34% of plants affected compared to 57% in the control plots and 51% in the plots treated with biopesticides, but there was a lot of variability among plots. Incidence of affected plants for these treatments ranged from 3% to 64%, 13% to 76%, and 20% to 81%, respectively.

*Acknowledgments*: This project supported by NYS Department of Agriculture & Markets.

**Identification of pathotypes of the cucurbit downy mildew pathogen occurring on LI**
**Investigators: Margaret T. McGrath and Zachary F. Sexton**
**Location: Long Island Horticultural Research and Extension Center**

Cucumber, acorn and butternut squashes, cantaloupe, watermelon and giant pumpkin (*Cucurbita maxima*) were grown in a sentinel plot at LIHREC to determine when the different pathotypes of the cucurbit downy mildew pathogen were successfully dispersed to Long Island. The pathotypes differ in ability to infect the different cucurbit crop types. This pathogen is not known to be surviving in the absence of living host plant tissue; however, it produces spores capable of long-distance movement by wind. Successful dispersal to LI occurs when there is a source of spores (affected cucurbit crops in another region) and conditions are favorable for dispersal (wind currents moving from affected crops to LI at night or during overcast days when spores will be protected from solar radiation), and also for deposition of spores and then for infection (rain is ideal as it moves spores out of the wind currents down to plants and infection occurs when leaves are wet or humidity is high). This can occur any time during the growing season. With knowledge of when downy mildew is occurring on LI and which cucurbit crop types are at risk, growers can target their applications of fungicides with specific activity for downy mildew (oomycete) pathogens. Sentinel plots at LIHREC are being done every growing season as part of the national forecasting program for cucurbit downy mildew (http://cdm.ipmpipe.org/). There are similar sentinel plots at universities throughout the eastern USA each year.

To ensure leaf tissue for infection was present throughout the growing season, seedlings were transplanted into plots at two times, on 12 June and 10 July. The first planting of cucurbits were seeded in a greenhouse on 19 May, and the second on 20 June. Each cucurbit crop type in each planting was grown in a plot with 3 rows of at least 5 plants at 24-inch spacing. Seedlings were transplanted into beds after incorporating controlled release fertilizer, laying drip tape, then covering beds with black plastic mulch. Insecticides and fungicides with targeted activity for powdery mildew were applied: Luna Experience 6 fl oz/A on 11 Jul and 26 Jul, Proline 8 fl oz/A plus Assana XL 9.6 fl oz/A on 19 Jul, Torino 3.4 fl oz/A on 3 Aug, Quintec 6 fl oz on 14 Aug, and Proline 8 fl oz/A on 22 Aug. Champ Flowable 1.3 pt/A was also applied on 3 Jul to help control bacterial leaf spot. Leaves were examined routinely for symptoms of downy mildew.

Downy mildew was first found on 31 July in cucumber, which is the cucurbit type always affected first at this location, and in cantaloupe on 9 Aug. Neither observation was preceded by reports from commercial crops thus these were the first known occurrences on LI in 2017. On 24 July there was predicted high risk at the national forecasting program website for the pathogen to be successfully dispersed to LI from affected cucumber crops in upstate NY when conditions would be favorable for infection. One week is typical latent period between infection and symptom appearance. Thus this is likely when the pathogen that infected cucumber. There were a few days earlier starting on 1 July when high risk was also predicted but did not result in successful dispersal.

Date of first symptoms and cucurbits affected has varied a lot over the years on LI. None of the other cucurbit crop types developed symptoms and there were no reports of downy mildew on these crops in other plantings on LI in 2017, therefore, only pathotypes able to infect cucumber and cantaloupe were dispersed to LI in 2017. Situation was the same in 2016. In contrast, all crop types became infected in 2013 and 2015, whereas only cucumber was affected in 2014. Previous first occurrences at LIHREC were 27 Aug 2008, 27 July 2009, 7 Sept 2010, 1 Aug 2011, 17 July 2012, 22 July 2013, 2 Sept 2014, 10 Aug 2015, and 8 Aug 2016.

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**Evaluation of cucumber varieties resistant to downy mildew**
**Investigators: Margaret T. McGrath, Sandra R. Menasha, and Zachary F. Sexton**
**Location: Long Island Horticultural Research and Extension Center**

The purpose of this experiment was to evaluate cucumber varieties for their ability to suppress downy mildew when used as the sole management program. The following varieties were evaluated by comparing to Straight Eight: Citadel, Bristol, Diamondback, DMR 401, Marketmore 76, Speedway, SV4719CS, and SV3462CS. All are slicing types except Citadel, which is suitable for marketing as a fresh market pickle.

The field was plowed on 11 Apr and prepared for planting on 9 Jun. Controlled release fertilizer (N-P-K, 15-5-15) was broadcast and incorporated into the soil at 675 lb/A (101 lb/A N). Beds were formed, a single line of drip tape was laid over the top, and beds were covered with black plastic mulch in one pass. Holes were punctured through the plastic at 2 ft spacing on 25 Jul. Admire Pro insecticide was applied to the open holes at 10.5 fl oz/A on 26 Jul using a backpack sprayer. Strategy 3 pt/A, Sandea 0.5 oz/A and Roundup PowerMax 22 oz/A were applied prior to transplanting for weed control on 26 Jul using a tractor-mounted sprayer. Cucumbers were seeded in the greenhouse on 5 Jul, and transplanted into the field on 27 Jul. During the season, weeds were controlled by cultivating and hand weeding as needed. The primary source of initial inoculum in this area is considered to be long-distance wind-dispersed spores from affected plants. Plots consisted of one 18-ft row spaced 68 in. apart containing 9 plants. The 6-ft area between plots was not planted. A completely randomized design with four replications was used. Plots were inspected for downy mildew symptoms on 11 and 28 Aug, and 6 and 14 Sep. At each assessment, disease severity was estimated for the entire plot canopy as well as 9 randomly selected symptomatic leaves in each plot. Area Under Disease Progress Curve (AUDPC) values were calculated from 11 Aug through 14 Sep. Yield and fruit quality assessments were taken on 6, 15, and 21 Sep. All fruit was sorted by marketability and weighed per plot.

Downy mildew was first observed in this experiment on 10 Aug, just two weeks after transplanting, in all plots. Disease pressure was very high and symptoms developed quickly, which resulted in severely limited yield and high percentage of misshapen, unmarketable fruit in most varieties in the experiment. Most of the varieties produced less than one marketable fruit per plant throughout the season. Only Citadel, Bristol, and DMR 401 had significantly lower disease severity ratings across all measurements compared to the susceptible variety Straight Eight. These three varieties were also the highest yielding, both in marketable and total fruit. In terms of both yield and disease resistance, DMR 401 was far and away the most successful variety in this experiment. It produced more than twice the fruit of the next highest yielding variety in both marketable and total fruit. AUDPC for the entire canopy was significantly negatively correlated with marketable fruit per plant (Corr = -0.7723, $P<0.0001$).

Mature fruit were collected from each variety and evaluated for overall appearance and size. Only DMR 401, Diamondback, and Marketmore 76 were given above average grades for appearance, 8, 7, and 6 out of 9 respectively. DMR 401 and Diamondback also produced the largest fruit by weight.

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**Fungicide sensitivity of cucurbit downy mildew pathogen population on LI in 2017**
**Investigators: Margaret T. McGrath and Zachary F. Sexton**
**Location: Long Island Horticultural Research and Extension Center**

Knowing whether fungicide resistance is impacting efficacy of fungicides is critical for determining which fungicides to use to manage downy mildew in cucurbit crops. This pathogen already has developed resistance to several fungicides and is expected to continue to do so. A seedling bioassay was used to examine fungicide sensitivity in a cucurbit downy mildew pathogen population.

The bioassay was conducted twice. Cucumber seedlings (cv Silver Slicer) at about the 2-leaf stage were sprayed with various fungicides at full and half label rates with a backpack sprayer operated at 30 psi and 50 gpa. Next day the four groups of seedlings (replications) were put in different areas of a field experiment to evaluate cucumber varieties for resistance to downy mildew (see previous report). No fungicides had been applied in the experiment. Seedlings were left there for two days for infection to occur, then the plants were kept in a greenhouse until symptoms developed. For the first bioassay seedlings were treated on 25 Aug and rated on 1 and 7 Sep. Before the second rating plants were put in plastic bags over night to promote sporulation. The second bioassay conducted four weeks later was unsuccessful suspected due to the fact downy mildew had caused extensive leaf death in the experiment by that time thus there were no longer enough spores being produced.

The most effective fungicides (both doses) were Bravo Ultrex (best), Zing!, Ranman, Zampro, and Previcur Flex. For most ratings there were no significant differences among these, but some shifting in rankings among the last three. Forum and Curzate were effective at the first rating. Presidio, Revus, and Quadris were ineffective including when applied at the full label rate. It is important to note that there had been no fungicides applied to exert selection pressure for resistant isolates in the field.

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**Fungicide sensitivity of cucurbit powdery mildew pathogen isolates on LI in 2016**
**Investigators: Margaret T. McGrath and Zachary F. Sexton**
**Location: Long Island Horticultural Research and Extension Center**

Fungicide resistance can be a major constraint to effectively managing powdery mildew in cucurbit crops. Fungicides that are most effective for managing powdery mildew (because they are mobile and thus can redistribute from where deposited on upper leaf surfaces to the lower surface where powdery mildew develops best) are also more prone to the pathogen developing resistance (because they typically have single site mode of action). The pathogen, *Podosphaera xanthii*, has a long history of developing resistance, being the first pathogen to have been documented to have done so in the USA. Resistance to benomyl (FRAC Code 1), the first at-risk fungicide registered for this use, was detected in 1967. The next chemical class registered for cucurbit powdery mildew was the DMI (demethylation inhibitor) fungicides (FRAC Code 3). Bayleton, the first fungicide in this group labeled for cucurbit powdery mildew, was registered for this use in the USA in April 1984. Just two years later there were the first reported control failures documented through university fungicide efficacy experiments. QoI (quinone outside inhibitor) fungicides (FRAC Code 11) were the next chemical class developed for this disease. Quadris was registered in the USA in spring 1999. Control failures were reported from several states throughout the USA in 2002, and resistance was detected. Pristine, the first SDHI (FRAC Code 7) fungicide, was registered in August 2003. Resistance was detected on LI in 2008. Quintec, the first FRAC Code 13 fungicide, was registered in 2007. Resistance was detected on LI in 2015.

The objective of this study was to determine fungicide sensitivity of pathogen isolates (i.e. individuals) by testing them in the laboratory on treated leaf disks. Isolates of *Podosphaera xanthii* were obtained on 28 Sept and 4 Oct 2016 from three research fields and three commercial plantings, respectively. Most isolates came from pumpkin. This was near the end of the growing season when fungicide programs for powdery mildew were generally complete. Isolates were maintained on leaf tissue on agar media in Petri dishes (culture plates) until tested in 2017. Sixty isolates were tested.

For the leaf disk bioassay, pumpkin seedlings at the cotyledon leaf stage (about seven-days-old) were sprayed with various fungicide doses in a laboratory fume hood, the treated plants were left there to dry overnight, then disks were cut from the cotyledons and placed on water agar in sectioned Petri plates. Each plate has four sections thus there were three treatments per plate plus a nontreated control. Each plate was used to test one isolate. Six disks with the same treatment were placed in each section. Disks were inoculated by transferring spores from culture plates to each disk center. Then plates were incubated at room temperature under constant light.

Amount of pathogen growth on the disks was assessed after 10 days of incubation when the control treatment usually had good growth of the pathogen, with white sporulating pathogen growth covering an average of about 50% of leaf disk area. The percent leaf disk area with symptoms of powdery mildew was recorded for each disk and averaged for each treatment. An isolate was considered to be insensitive (resistant) to a particular fungicide concentration if it was able to grow and produce spores on at least half of the disks. Due to limitations in the number of isolates and fungicide doses that can be done in each bioassay, the procedure was conducted multiple times over many weeks to obtain information on sensitivity to several fungicides.

Boscalid (FRAC 7) resistance was detected in 43% of isolates, which was almost the same as 2015 (41%). 37% and 3% of isolates were resistant to 40 and 200 ppm quinoxyfen (FRAC 13). 20% and 3% were resistant to 40 and 120 ppm myclobutanil (FRAC 3). The most resistant isolate came from plot treated with only Quintec in the fungicide efficacy experiment: it was resistant to boscalid, 120 ppm myclobutanil, and 200 ppm quinoxyfen (Quintec would be ineffective), documenting use of one fungicide can select for isolates resistant to it and other fungicides not used. Also, boscalid-resistant isolates were more common in fungicide-treated than untreated plots (50-100% vs 14%).

*Acknowledgments*: This project is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, Hatch under NYC-153409.

**Fungicide sensitivity of cucurbit powdery mildew pathogen population on LI in 2017**
**Investigators: Margaret T. McGrath and Zachary F. Sexton**
**Location: Long Island Horticultural Research and Extension Center**

Knowing whether fungicide resistance is impacting efficacy of fungicides is critical for determining which fungicides to use to manage powdery mildew in cucurbit crops. This pathogen already has developed resistance to several fungicides and is expected to continue to do so. A seedling bioassay was used to examine fungicide sensitivity in a cucurbit powdery mildew pathogen population.

Pumpkin seedlings (cv. Gold Challenger) were treated on 11 Sep. One, two, or three fungicide doses were used depending on whether resistance had been detected previously. Four replications of seedlings were put for a day (12 Sep) next to plots in an experiment that had been sprayed weekly with single-site mode of action fungicides targeting powdery mildew (8/7 Vivando 15 oz/A, 8/14 Torino 3.4 oz/A, 8/21 Procure 8 oz/A, 8/28 Vivando 15 oz/A, 9/5 Procure 8 oz/A, and 9/11 Quintec 6 oz/A). This location was selected because of the selection pressure for resistant pathogen isolates. There were two additional groups of seedlings with select treatments put in another experiment that received a similar fungicide program and in an experiment where no targeted fungicides were applied. Severity was rated on 21 Sep.

Severity was much lower on the water control plants put in the first experiment, where powdery mildew was being very effectively controlled, compared to the other control plants (mean of 7% versus 75%), reflecting low inoculum levels. Results were similar for all experiments. Topsin M (FRAC Code 1), Flint (11), and Endura (7) were ineffective. Resistance to these are considered common. Rally (3) was effective at both rates tested (highest and lowest label rates); it was anticipated the lowest rate might be ineffective because of resistance. Vivando (U8), Torino (U6), and Luna Privilege (7) were effective at all rates tested (label, half, and quarter rates; hi, low and quarter of hi rates for Luna Privilege). Efficacy of Torino and Luna Privilege is in contrast to their poor control when tested alone on field-grown pumpkin plants at LIHREC (see following report) suggesting that resistance development was successfully managed to these fungicides with the fungicide program used in the field where the bioassay was conducted. Quintec at all rates tested was phytotoxic causing leaves to turn yellow and then die.

*Acknowledgments*: This project is supported by the National Institute of Food and Agriculture Crop Protection and Pest Management Applied Research and Development Program (award number 2015-70006-24277).

**Evaluation of fungicides for powdery mildew on pumpkins**
**Investigators: Margaret T. McGrath and Zachary F. Sexton**
**Location: Long Island Horticultural Research and Extension Center**

The primary objective of this study was to evaluate the efficacy of several fungicides with mobility that enables them to move to the lower surface of leaves where powdery mildew develops best. They have single-site mode of action, which puts them at risk for resistance development. The following products were tested: Pristine, Torino, Luna Sensation, Quintec, Procure, and Vivando. The experiment was conducted in an area where in previous years strains of the pathogen were detected with resistance to FRAC code 1, 7, 11, and 13 fungicides and moderate resistance to FRAC code 3 fungicides.

The field was plowed on 11 Apr. Urea fertilizer (46-0-0) was applied on 14 Apr at 163 lb/A (75 lb/A N). Mustard biofumigant cover crop was seeded at 10 lb/A by drilling on 14 Apr. Caliente 199 was planted in one half of the field and Caliente Rojo in the other. On 15 Jun the mustard was flail chopped, immediately incorporated by disking, and followed by a cultipacker to seal the soil surface. Overhead irrigation was then immediately applied to the field to help seal the soil surface and initiate fumigation. Pumpkins were planted with a vacuum seeder at approximately 24-in plant spacing on 5 Jul. The powdery mildew susceptible variety Gold Challenger was planted. 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 7 Jul using a tractor mounted sprayer. During the season, weeds were managed by cultivating and hand weeding as needed. Initial moisture for seed was provided using overhead irrigation. Drip tape was laid down along each row of pumpkin seedlings on 21 Jul. The following fungicides were applied throughout the season to manage Phytophthora blight (caused by *Phytophthora capsici*): Presidio 4 fl oz/A plus K-Phite 1 qt/A on 27 Jul, Omega 1 pt/A plus K-Phite 1 qt/A on 3 Aug, Omega 1 pt/A on 14 Aug, Forum 6 fl oz/A on 21 Aug, Ranman 2.75 oz/A on 28 Aug, Presidio 4 fl oz/A on 4 Sep, Forum 6 oz/A on 11 Sep, Ranman 2.75 fl oz/A on 18 Sep, Omega 1 pt/A on 25 Sep, and Ranman 2.75 fl oz/A on 2 Oct. The primary source of initial inoculum 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 five 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 4, 17, 23, and 28 Aug; and 5, 11, 18, and 25 Sep. At each assessment, nine young, nine mid-aged, and nine old leaves (selected based on leaf physiological appearance and position in the canopy) were rated in each plot, except at the first assessment when 45 old leaves were examined and the last when five leaves were rated. 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 5 through 25 Sep. Defoliation was assessed on 2, 9, and 16 Oct. Fruit quality was evaluated in terms of handle (peduncle) condition for mature fruit without rot on 3, 9, and 16 Oct. Handles were considered good if they were green, solid, and not rotting.

Powdery mildew was first observed in this experiment on 4 Aug in 17 of the 32 plots on less than 1% of the leaves examined. The fungicides Pristine (FRAC code 7+11), Torino (U6), and Luna Sensation (7+11) failed to control powdery mildew on the underside of leaves beginning with the assessment on 11 Sep. Although not statistically significant, plants treated with these fungicides did have 23%, 19%, and 30% less severe powdery mildew than untreated control based on AUDPC values, respectively. Failure of Luna Sensation was surprising because in laboratory bioassays isolates resistant to boscalid, FRAC 7 active ingredient in Pristine, exhibited sensitivity to fluopyram, FRAC 7 active ingredient in Luna Sensation. All of the fungicide treatments provided better control of powdery mildew on upper leaf surface, except that Pristine and Torino were not effective at the last assessment. Quintec (13), Procure (3), and Vivando (U8), providing 54%, 72%, and 80% control based on AUDPC, respectively, all preformed as well as the grower recommended treatment of a rotation of Vivando, Quintec, and Torino, 71% control. Despite poor powdery mildew control on lower leaf surfaces, Pristine performed well in terms of preserving handle quality, 74% good handles on 16 Oct, as did Procure, 90% good handles, and Vivando, 95% good handles. Typically, the more effectively powdery mildew is controlled, the longer leaves remain alive, and the slower vines die and thus the longer until pumpkin handles shrivel and rot. This was best exemplified by Vivando. Luna Sensation and Torino were the least effective of all the fungicide treatments tested in this experiment: they provided inadequate control on the lower side of the leaf and failed to preserve fruit handle quality through 16 Oct. Their poor control in this experiment is in contrast to their efficacy in the seedling bioassay conducted in another experiment at LIHREC (see previous report) suggesting that resistance development was successfully managed to these fungicides with the fungicide program used in the field where the bioassay was conducted. No phytotoxicity was observed with any fungicides.

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**Evaluation of Halloween pumpkin varieties resistant to powdery mildew**
**Investigators: Margaret T. McGrath, Sandra R. Menasha, and Zachary F. Sexton**
**Location: Long Island Horticultural Research and Extension Center**

The purpose of this experiment was to evaluate pumpkin varieties for their ability to suppress powdery mildew when used as the sole management program and also combined with a fungicide program for powdery mildew. The following varieties were evaluated compared to Gold Challenger: Bayhorse Gold, Eagle City Gold, Eureka F1, Magnum F1, Millionaire, Progress, and Skidoo Gold. Focus was on recently released varieties. Millionaire is an edible ornamental spaghetti-type squash.

The field was plowed on 11 Apr. Urea fertilizer (46-0-0) was applied on 14 Apr at 163 lb/A (75 lb/A N). Mustard biofumigant cover crop was seeded at 10 lb/A by drilling on 14 Apr. Caliente 199 was planted in one half of the field and Caliente Rojo in the other. On 15 Jun the mustard was flail chopped, immediately incorporated by disking, and followed by a cultipacker to seal the soil surface. Overhead irrigation was immediately applied to the field to further seal the soil surface and initiate fumigation. Controlled release fertilizer (N-P-K, 19-10-9) at 525 lb/A (101 lb/A of N) was broadcast over the bed area and incorporated on 4 Jul. Beds were formed, drip tape was laid, and beds were covered with black plastic mulch on 5 Jun. A waterwheel transplanter was used to make planting holes in the plastic and apply insecticide (Admire Pro) prior to seeding. Two pumpkin seeds were placed by hand into the soil for each hole on 6 Jul. After emergence plants were thinned to 1 plant per hole. Plots were three adjacent rows each with four plants spaced 48 in. apart. Rows were spaced 68 in. apart. To separate plots and provide a source of inoculum, two plants of a powdery mildew-susceptible zucchini squash variety (Spineless Beauty) were planted between each plot in each row. Weeds were managed by applying Strategy 3 pt/A, Sandea 0.5 oz/A and Roundup PowerMax 22 oz/A to soil between the mulched beds on 7 Jul using a tractor-mounted sprayer. Additionally, hand weeding was done as needed. During the season, water was provided as needed via drip irrigation. The following fungicides were applied throughout the season to manage Phytophthora blight (caused by *Phytophthora capsici*): Presidio 4 fl oz/A and K-Phite 1 qt/A on 27 Jul, Omega 1 pt/A and K-Phite 1 qt/A on 3 Aug, Omega 1 pt/A on 14 Aug, Forum 6 fl oz/A on 21 Aug, Ranman 2.75 oz/A on 28 Aug, Presidio 4 fl oz/A on 4 Sep, Forum 6 oz/A on 11 Sep, Ranman 2.75 fl oz/A on 18 Sep, Omega 1 pt/A on 25 Sep, and Ranman 2.75 fl oz/A on 2 Oct. The experiment that received a fungicide program for additional control of powdery mildew was sprayed with a tractor-drawn sprayer at weekly intervals starting at first observation of symptoms. The program was: Vivando 15 oz/A on 7 Aug, Torino 3.4 oz/A on 14 Aug, Procure 8 oz/A on 21 Aug, Vivando 15 oz/A on 28 Aug, Procure 8 oz/A on 5 Sep, Quintec 6 oz/A on 11 Sep, and Vivando 15 oz/A on 18 Sep. Plots were inspected for powdery mildew symptoms on upper and lower leaf surfaces on 10, 15, 22 and 30 Aug, and 7, 13, and 22 Sep. At each assessment, nine young, nine mid-aged, and nine old leaves (selected based on leaf physiological appearance and position in the canopy) were rated in each plot, except at the last assessment when five leaves were rated. The primary source of initial inoculum in this area is considered to be long-distance wind-dispersed spores from affected plants. 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 30 Aug through 22 Sep. Defoliation was assessed on 20 and 26 Sep. Fruit quality was evaluated in terms of handle (peduncle) condition for mature fruit without rot on 2, 9, and 17 Oct. Handles were considered good if they were green, solid, and not rotting. Pumpkin weights were taken on 17 Oct by weighing 5 pumpkins per plot and averaging results.

Powdery mildew was first observed on 10 Aug in all plots in both experiments, on 1% of leaves sampled. As expected, disease pressure was higher in the variety assessment with no fungicides applied for powdery mildew control. In the absence of fungicide applications for powdery mildew, Progress was the only pumpkin variety able to significantly reduce powdery mildew severity on both leaf surfaces based on AUDPC values when compared to the susceptible variety Gold Challenger with 37% control on the upper leaf surface and 51% control on the lower leaf surface. Skidoo Gold, Eureka F1, and Magnum F1 were able to suppress powdery mildew relative to Gold Challenger on the lower leaf surface only, providing 49%, 43%, and 28% control respectively. No variety was significantly distinguishable from other varieties in % defoliation, pumpkin weight, or fruit quality, with the exception of Millionaire having less defoliation than Magnum F1. In the second experiment, the same pumpkin varieties were assessed for powdery mildew resistance with a fungicide program for powdery mildew. Disease levels were very low, as expected, especially on the upper leaf surface. Due to the low levels of disease on the upper leaf surface there were no significant differences between any of the varieties in those measurements. Powdery mildew was more severe on the lower leaf surface where Progress, Millionaire, Magnum F1, and Eureka F1 all performed significantly better than the susceptible variety Gold Challenger based on AUDPC. Those varieties had 97%, 88%, 88%, and 87% control respectively. There were no significant differences between pumpkin varieties in this experiment when compared based on defoliation ratings or fruit handle quality. When looking at fruit size, only varieties Progress and Millionaire produced consistently smaller fruit than other varieties, which is expected based on the characteristics of these. Also, fruit were larger in the treated experiment than the untreated experiment. Larger fruit size in the second experiment may be due to the fungicide program improving powdery mildew control.

Mature fruit from the fungicide-treated experiment were collected and evaluated for overall fruit appearance and handle quality. All of the varieties received the highest possible score for handle quality, 9 out of 9. Bayhorse Gold scored the highest based on fruit appearance with a perfect score of 9, Magnum F1 had the lowest score: 7. The rest of the varieties all had scores of 7.5 or 8 out of 9. Overall all of the varieties produced high quality fruit.

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**Evaluation of management programs without chlorothalonil for powdery mildew in pumpkin**
**Investigators: Margaret T. McGrath and Zachary F. Sexton**
**Location: Long Island Horticultural Research and Extension Center**

The purpose of this experiment was to examine means to reduce use of chlorothalonil-based fungicides because of concern about their potential impact on bees. Two alternative multi-site mode of action fungicides, Tritek and Microthiol Disperss, were evaluated on a pumpkin variety resistant to powdery mildew, Bayhorse Gold, as well as a susceptible variety, Gold Challenger. They were compared to Bravo Ultrex used alone and as part of a fungicide program for powdery mildew. Both alternatives are approved for organic production.

The field was plowed on 11 Apr. Urea fertilizer (46-0-0) was applied on 14 Apr at 163 lb/A (75 lb/A N). Mustard biofumigant cover crop was seeded at 10 lb/A by drilling on 14 Apr. Caliente 199 was planted in one half of the field and Caliente Rojo in the other. On 15 Jun the mustard was flail chopped, immediately incorporated by disking, and followed by a cultipacker to seal the soil surface. Overhead irrigation was immediately applied to the field to further seal the soil surface and initiate fumigation. Pumpkins were planted with a vacuum seeder at approximately 24-in. plant spacing on 5 Jul. 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 7 Jul using a tractor mounted sprayer. During the season, weeds were managed by cultivating and hand weeding as needed. Initial moisture for seed was provided using overhead irrigation. Drip tape was laid down along each row of pumpkin seedlings on 21 Jul. The following fungicides were applied throughout the season to manage Phytophthora blight (caused by *Phytophthora capsici*): Presidio 4 fl oz/A and K-Phite 1 qt/A on 27 Jul, Omega 1 pt/A and K-Phite 1 qt/A on 3 Aug, Omega 1 pt/A on 14 Aug, Forum 6 fl oz/A on 21 Aug, Ranman 2.75 oz/A on 28 Aug, Presidio 4 fl oz/A on 4 Sep, Forum 6 oz/A on 11 Sep, Ranman 2.75 fl oz/A on 18 Sep, Omega 1 pt/A on 25 Sep, and Ranman 2.75 fl oz/A on 2 Oct. 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 split plot design with four replications was used with variety as the whole plot factor and treatment as the split plot factor. Natural inoculum was relied on. 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, 14, and 21 Aug, and 1, 8, and 14 Sep. At each assessment, nine young, nine mid-aged, and nine old leaves (selected based on leaf physiological appearance and position in the canopy) were rated in each plot, except the first two assessments when 50 old leaves were examined. 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 21 Aug through 14 Sep. Defoliation was assessed on 29 Sep and 5 Oct. Fruit quality was evaluated in terms of handle (peduncle) condition for mature fruit without rot on 5 and 11 Oct. Handles were considered good if they were green, solid, and not rotting.

Powdery mildew was first observed in this experiment on 7 Aug in 46 of the 48 plots on less than 2% of the leaves examined. Variety did not have a significant effect on any of the measurements taken this season, indicating the resistant variety did not contribute to management of powdery mildew, which is in contrast with a similar experiment conducted in 2016. There also were no significant variety by treatment interactions. Microthiol Disperss was as effective as Bravo Ultrex across all measurements of severity as well as defoliation and fruit handle quality, which are measures of the impact of powdery mildew. Tritek effectively managed powdery mildew, but not quite as well on upper leaf surfaces as Bravo Ultrex or Microthiol Disperss; however, it was effective for powdery mildew on lower leaf surfaces while Bravo Ultrex was ineffective. Obtaining control on lower surfaces with contact fungicides is important for managing resistance to single-site mode of action fungicides, which are inherently more effective due to their ability to move through leaves to the lower surface. However, obtaining adequate coverage with contact fungicides is difficult, especially on large pumpkin leaves. Surprisingly, Tritek was least effective of the three while Microthiol Disperss was best for preserving handle quality. Replacement of Bravo Ultrex, in the grower's standard fungicide program, which included a rotation of Luna Experience, Vivando, and Torino, with less commonly used Tritek and Microthiol Disperss showed no reduction in effective control of powdery mildew across all measurements, including fruit quality. In fact the grower's standard replacement treatment provided significantly more control of powdery mildew on the lower leaf surface when compared to the traditional grower's standard with Bravo Ultrex. These results are promising for growers looking to reduce use of chlorothalonil fungicides due to concerns of potential impact on bees. Chlorothalonil has activity for a broader spectrum of fungal pathogens and thus is a better choice when other diseases are occurring.

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**Monitoring late blight occurrence in tomatoes and potatoes on Long Island**
**Investigators: Margaret T. McGrath and Zachary F. Sexton**
**Location: Long Island Horticultural Research and Extension Center**

Late blight is a very destructive disease of tomatoes and potatoes that has been occurring more regularly on Long Island since 2009, albeit irregularly in terms of location and date of initial occurrence. Growers need to know when late blight is present in the region to be able to effectively manage this disease with judicious use of fungicides, especially products with targeted activity that they would not otherwise need to apply. Additionally there is need to monitor the pathogen for appearance of new genotypes able to overcome resistant varieties with the Ph-2 and Ph-3 genes that have been providing effective control of the pathogen genotypes present since 2009.

Monitoring for late blight occurrence was conducted in coordination with the CCE-Suffolk IPM Program. Potato and tomato crops were scouted weekly for diseases and insect pests at several farms participating in the IPM Program. The information obtained contributes to the national monitoring program, which maps reports at USABlight.org.

A sentinel plot with Mt Fresh Plus (susceptible to late blight) and Mt Magic (Ph-2 and Ph-3 genes conferring resistance) was maintained at LIHREC. Tomatoes were seeded in the greenhouse on 29 May. Controlled release fertilizer (N-P-K, 19-10-9) at 525 lb/A (101 lb/A of N) was broadcast over the bed area and incorporated on 26 Jun. Beds were formed, drip tape was laid, and beds were covered with black plastic mulch on 27 Jun. A waterwheel transplanter was used to make planting holes in the plastic and apply insecticide (Admire Pro) prior to seeding. Weeds were managed by applying Strategy 3 pt/A, Sandea 0.5 oz/A and Roundup PowerMax 22 oz/A to soil between the mulched beds on 27 Jun using a tractor-mounted sprayer. Tomato plants were transplanted into the field on 30 Jun. Stakes and trellis line for plant support were put out on 18 Jul, and additional line was added three more times throughout the growing season. No fungicides were applied.

Late blight was found on 18 Sept in the sentinel plots and another experiment at LIHREC. Symptoms were only in Mt Fresh and at very low levels (<1%). Reports were received of suspected cases in nearby commercial crops that appeared in late Aug. There were no reports from gardeners. The source of the outbreak was not determined. Late blight was not found on LI in 2015 or 2016.

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**Monitoring occurrence of basil downy mildew on Long Island**
**Investigators: Margaret T. McGrath and Zachary F. Sexton**
**Location: Long Island Horticultural Research and Extension Center**

Basil was grown in an observational planting to determine when downy mildew started to develop in the area. The goals were the same as for the sentinel planting of cucurbit crops for monitoring downy mildew affecting those crops and the sentinel planting of tomato for late blight (see other reports): 1) to be able to inform growers when first symptoms were found so they knew when the disease is likely to occur in their crop and 2) to obtain information that adds to knowledge about occurrence of this important disease. The pathogens for all of these diseases produce spores that are dispersed by wind, potentially long distances for some.

Basil was seeded in the greenhouse on 16 Jun. Controlled release fertilizer (N-P-K, 19-10-9) at 525 lb/A (101 lb/A of N) was broadcast over the bed area and incorporated on 26 Jun. Beds were formed, drip tape was laid, and beds were covered with black plastic mulch on 27 Jun. Weeds were managed by applying Strategy 3 pt/A, Sandea 0.5 oz/A and Roundup PowerMax 22 oz/A to soil between the mulched beds prior to transplanting using a tractor-mounted sprayer. A waterwheel transplanter was used to make planting holes in the plastic and apply insecticide

(Admire Pro) prior to seeding. Basil plants were transplanted into the field on 17 Jul. No fungicides were applied. Leaves were examined routinely for symptoms of downy mildew.

Downy mildew was first seen in the observational planting on 4 Aug following rain. No symptoms were found on 31 Jul, which was the previous time the plants were examined. Growers were informed through the Long Island Fruit and Vegetable Update, a weekly newsletter. There was limited increase in symptoms through 14 Aug, then downy mildew developed very rapidly. On 21 Aug leaves had started to turn brown and drop off plants, those remaining were generally yellow, and almost all leaves had some sporulation on the underside rendering them unmarketable. Downy mildew has continued to appear at LIHREC during the first 2.5 weeks in August. Previous first observations were 10 Aug 2010, 19 Aug 2011, 16 Aug 2012, 6 Aug 2013, 18 Aug 2014, 10 Aug 2015, and 15 Aug 2016.

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**Development of a vegetable disease identification website**
**Investigator: Margaret T. McGrath**
**Location: Long Island Horticultural Research and Extension Center**

The goal of this project started in Oct 2014 was to develop a photo gallery web site that would be useful for growers and extension educators, the primary intended audience, as well as gardeners. Numerous photographs had been taken since 1988 of diseases and disorders occurring on Long Island affecting vegetable crops, herbs, and strawberry. This is a potentially valuable resource that needed to be shared.

The web site (http://blogs.cornell.edu/livegpath/gallery/) now has 61 pages with a total of 539 photos plus information about many of the diseases/disorders including their management. It targets the Long Island area but has broader utility. There are links to Vegetable MD Online, another successful Cornell web site geared for production agriculture. The web site has frequently been referenced in weekly newsletter articles in the Long Island Fruit and Vegetable Update. Some of the diseases posted in the Photo Gallery were selected to provide readers of the newsletter with photographs to accompany the symptom descriptions in an article. The webpages at this Photo Gallery web site have each been linked at a webpage of another, popular Cornell web site: http://vegetablemdonline.ppath.cornell.edu/PhotoPages/PhotoGallery.htm.

The expected outcome is to better enable growers, crop scouts, and extension staff to diagnosis diseases that are occurring, and to educate them about these diseases and their management. Accurate diagnosis is important for successful management, which increases crop productivity and profitability. It is anticipated that gardeners will also find the web site useful, therefore the content was written to be suitable for a wide audience. An additional observed impact is that others are finding the photographs useful and have been making requests to use them primarily in extension bulletins and presentations. An unanticipated utility of the web site has been for responding to questions about diseases by providing a link when the information is included on one of the webpages. Google analytics summaries for the photo gallery lists 24,070 users and

29,914 page views in 2017, which is considered a very high number by Cornell Communications Specialist, Craig Cramer. Another measure of success is that several requests were received to use images posted in the photo gallery by extension staff and scientists, including from outside the U.S., which documents that the web site is not only being found but that the content is useful to others.

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**Comparison of winter hardy cover crops for reduced-till organic cabbage**
**Investigators: Margaret T. McGrath and Zachary F. Sexton**
**Location: Long Island Horticultural Research and Extension Center**

The goal of this experiment was to examine various combinations of winter hardy cover crops for use in reduced-till crop production. An actively growing ground cover may provide early spring weed control and the straw mulch following chopping may provide weed control, but the residue could interfere with any shallow tillage done. The addition of various winter hardy legumes may also provide additional fertility benefits. Four different cover crop combinations were planted; rye, rye plus hairy vetch, rye plus crimson clover, and rye plus Austrian winter pea. An additional rye cover crop treatment with an amendment of bloodmeal fertilizer applied as a side-dress (an additional 60 lb/A N) in early August was also evaluated.

The experiment consisted of the 5 treatments described above organized in a randomized complete block design with 4 replications. Cover crops were seeded on 26 Sep 2016 after disking the field. Cover crop biomass was determined on 23 May by cutting plant tissue at ground level in two 0.25 $m^2$ quadrants in each plot. Cover crop leaf tissue was sorted, dried, and weighed for each quadrant. 'Farao' Cabbage were seeded on 24 May in 128-cell trays and placed in the greenhouse. On 20 Jun a Perfecta cultivator was run through all plots to manage weeds (shallow cultivation) followed by an Unverferth zone builder to perform deep zone tillage where rows would be planted in all plots. Cabbage was transplanted into the field using a four-person cabbage transplanter on 21 Jun. During the season, water was initially provided by in row drip line irrigation. Weeds were controlled by cultivation and hand weeding throughout the growing season. Between row weeds were controlled with a hillside cultivator early in the season before cabbage plants became too big to fit the implement. Hand weeding was used to control both in row and between row weeds throughout the growing season. Flea beetles were a significant problem, insecticides were applied to control this pest; Entrust 80W 1.5 oz/A on 27 July, Mycotrol ESO 1 qt/A and Entrust 80W 1.5 oz/A on 24 Aug. Cabbage were harvested in 20-foot sections from the middle row of each plot on 12 Sep. Cabbage plants were counted and weighed as well as cabbage heads. Five cabbage plants from each plot were randomly selected for additional measurements including wet weight of the entire plant. An inch thick wedge of the cabbage heads of these plants was removed, dried in a drying oven, then weighed; the cabbage frame was also dried and weighed.

There were no significant differences between the cover crop treatments in terms of cover crop yield or weed control. The rye and vetch cover crop combination produced significantly more total cover crop biomass, 4.7 dry tons per acre, almost double the next highest treatment, 2.2 dry tons, but this difference did not translate to more effective weed control in the fall after planting or throughout the growing season. There were no significant difference between cover crop treatments in total fall weed biomass or total time spent hand weeding the experiment throughout the growing season. There were also no significant differences among the cover crop treatments in yield parameters.

*Acknowledgments*: Project funded by USDA Organic Research and Extension Initiative.

**Investigation of ground cover tarps in organic reduced tillage beets**
**Investigators: Margaret T. McGrath and Zachary F. Sexton**
**Location: Long Island Horticultural Research and Extension Center**

The goal of this experiment was to investigate the use of ground cover tarps for early season weed control. Reducing the need for early season tillage before and after planting can save growers money and improve soil structure. A research trial was established how different durations of ground cover tarping as well as tillage before planting affected weed control and over all crop yield. Four different durations of cover tarping were used: No tarping at all, three weeks before planting, six weeks before planting, and overwinter, which ended up being 19 weeks before planting on Long Island. These treatments were combined with two different tillage regimes prior to planting; no tillage at all or shallow tillage (approximately 2-3 inches) with a rototiller prior to planting.

The experiment consisted of the 8 treatments described above organized in a randomized complete block design with 4 replications. A cover crop of organic oats (100 lb/A) was seeded on 16 Sep 2016 after disking the field. Oats were used because they winter kill. The first cover tarp treatment was placed in the field on 19 Jan 2017 and secured by placing cinderblocks on top. The second cover tarp treatment was placed in the field on 11 Apr and secured by burying the tarp edges. The third cover tarp treatment was placed in the field on 2 May and secured by burying the tarp edges. All of the tarps were removed from the field 1 Jun. Immediately following tarp removal plots were assessed for percent ground coverage by weeds and oat residue. Soil samples were also taken on 1 Jun to measure soil moisture and nitrogen. Plots that received tillage were prepared for planting on 2 Jun by running a rototiller over the planting area at approximately 2 inch depth. Fertilizer was applied to all plots in the form of Pro-Gro granular fertilizer (5-3-4) at a rate of 1000 lb/A. 'Red Ace' Beets were directly seeded into the ground using a vacuum seeder at a rate of approximately 15 seed per foot. Drip-tape irrigation was placed in beet plots on 14 Jun. Plots were divided into two sections: one to be weeded periodically by hand throughout the growing season and one that was not weeded at all. Weeding started on 15 Jun. Weed biomass was taken in all plots prior to harvest on 28 Jul and dry weight was recorded. Beets were harvested by pulling 2 meters of beet row by hand from both sections of each plot on 1 Aug through 3 Aug. Beets were processed and sorted after harvest by separating beets from greens and sorting the beets by size class, the four size classes being 0 = smaller than 1 inch in diameter, 1 = between 1 inch and 1.75 inches, 2 = between 1.75 inches and 3 inches, and 3 = greater than 3 inches in diameter. Total yield including beet greens was also recorded for each plot.

There were no significant differences in yield data between tarp treatments in the weeded portions of the plots likely due to high variability across all treatments, however numerical trends suggested that yield was improved the longer the tarps were left out in the field, the overwinter tarp treatment produced the most total fresh weight, 2539 grams per plot, total marketable weight, 1259 grams per plot, and largest average beet weight, 21 grams. Also, in the weeded plots, tillage had a statistically significant effect only on the total marketable beet weight, tilled plots produced 1124 grams per plot compared to 625 grams per plot in the untilled plots. In the unweeded plots results were more conclusive: tarping had a significant effect on total fresh weight, with significantly higher yields in the overwinter tarp treatment than the no tarp treatment, 1620 grams per plot and 350 grams per plot respectively. Also, in the unweeded plots, both total fresh weight and total marketable weight were significantly affected by tillage, with the rototilled plot yielding more than the non-tilled plots, 1799 grams per plot compared to 816, and 508 grams per plot compared to 174, respectively. The weed pressure measurements were both significantly affected by tarp treatments, all of the tarped plots required significantly less time weeding, 0.23 man hours per plot for the six week and 3 week tarp treatments and 0.26 man hours per plot for the overwinter tarp treatment, compared to the no tarp plots, 0.61 man hours per plot. There was also a significant interaction between tarp treatment and tillage for both weed pressure measurements, but not for any yield measurements. The six week tarp treatment also had significantly less total weed biomass at the end of the season compared to the no tarp treatment, 100 dry grams per plot and 208 dry grams per plot respectively. Tillage also had a significant effect on overall time spent hand weeding, an average of 0.38 man hours per plot was spent weeding the non-tilled plots compared to 0.26 hours in the tilled plots. Overall it appears that ground cover tarps can be useful in controlling weeds, especially early in the season. The tarps did not have a clear effect on yield. It is still not clear if the amount of time the tarps are covering the ground is important in terms of weed control or yield, but the trends recorded in this experiment suggest that longer could be better.

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**Utility of tillage radish and deep zone tillage for producing peas organically with reduced tillage**
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**Location: Long Island Horticultural Research and Extension Center**

The goal of this experiment was to examine tillage (forage) radish grown as a winter-kill cover crop for preparing soil for reduced-till crop production. The long, large tap root of tillage radish has potential to disrupt compacted soil layers and thus has potential to be used in place of deep zone tillage equipment. Additionally, the channels left after the roots decompose enable subsequent vegetable crop roots to grow through compacted layers. Three different cover crop treatments were planted; oats, tillage radish, and oats combined with tillage radish. Plus there was an unplanted control. These cover crop systems were also tested with two different tillage regimes implemented before seeding peas; shallow conventional tillage alone or combined with deep-zone strip tillage in the planting row. This was done to compare tillage radish to deep zone tillage and to determine if there was benefit to using both.

The experiment consisted of the 8 treatments described above organized in a completely randomized split plot design with 4 replications. Tillage regime was the whole plot factor and cover crop was the split plot factor. Cover crops were seeded on 15 Sep 2016 after disking the field. Biomass was determined on 11 Nov by cutting plant tissue at ground level and pulling radishes in two 0.25 $m^2$ quadrants in each plot. Oat, radish and weed leaf tissue was separated, dried, and weighed for each quadrant. Length of radish roots above and below ground was measured, and then the roots were dried and weighed. On 10 Apr 2017 weeds were assessed by estimating percent of surface area covered by weed growth in each plot, then a Perfecta cultivator was run through all plots to manage weeds (shallow cultivation) followed by an Unverferth zone builder to perform deep zone tillage in the strip till plots. Corn gluten meal fertilizer (8-0-3) was spread on the field at a rate of 375 lb/A prior to planting. 'Sugar Ann' peas were seeded on 12 Apr at 0.5-inch spacing, During the season, water was provided by overhead irrigation. Weeds were controlled by cultivation and hand weeding throughout the growing season. A total of 25 man hours were spent hand weeding the experiment over the entire growing season. Peas were harvested in 10 foot sections from the middle two rows of each plot on 22 Jun through 6 Jul. Pods were removed from plants and sorted based on marketability, immature and severely blemished pods were separated out, then plants and pods were dried and weighed.

Snap pea biomass and yield were not significantly affected by cover crop and tillage regime. Tillage did significantly affect total stand count at harvest, with more plants per acre under conventional tillage production, 139281 plants per acre, compared to deep zone tillage, 106899 plants per acre. Cover crop did not significantly affect any of the yield measurements. Cover crop was highly significant when looking at its effect on weed pressure both in the fall and spring. All three of the cover crop treatments, oats, radish, and oats and radish effectively suppressed weeds in the early spring, 28%, 26%, and 22% weed coverage respectively, compared to the no cover crop treatment, 63%. Oats, radish, and oats and radish also reduced the weed pressure at harvest in the fall: dry weight of weeds removed was 17, 14, and 18 lb/A, compared to 338 lb/A for the no cover crop treatment. Plots were weeded while the pea crop was growing as experiment focus was on impact of reduced tillage practices on yield, thus impact of weeds on yield was not examined. In conclusion, this experiment documented that spring snap peas can be grown successfully without compromising yield using reduced tillage practices in an organic production system. Benefit of cover crops for managing weeds before crop seeding was documented.

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