Long Island Vegetable Pathology Program
2011 Annual Research Report

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Evaluation of Reduced Tillage Production System for Pumpkin
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

The primary goals of this multi-year project underway at LIHREC are to investigate changes in soil health and compare crop growth over successive years of implementing reduced tillage practices. A replicated experiment was conducted in 2011 to compare pumpkin grown under a reduced tillage system with pumpkin grown using conventional tillage in a research field that has only been used to study reduced tillage since 2004. The cover crop in this field was fall-seeded rye. Two timings for killing the cover crop were examined in 2011.

In the reduced-till plots the cover crop was rolled with a coulter packer then sprayed with the herbicide Round-up. This was done on 3 May in replications 1 and 2 when rye was about 24 in tall and on 28 May in replications 3 and 4 when rye was full grown (about 48 in tall) and shedding pollen. A 2-row Unverferth zone builder was used to establish the rows in all replications on 16 Jun. The conventional-till plots were established by mowing the cover crop on 25 May, removing extra straw by baling it, then roto-tilling and disking to prepare the soil for planting. On 28 Jun pumpkin (cv Field Trip) was direct-seeded into all conventional and reduced-till rows with 625 lb/A 19-10-9 controlled release fertilizer applied by the seeder in 2 bands about 2-in from the seed on both sides. Weed control in the pumpkins was accomplished by applying herbicide at planting and using a hand-operated roto-tiller in the conventional-till plots and a hand-operated sickle-bar mower in the reduced-till plots in late July. Strategy (3 pt/A) plus Sandea (0.5 oz/A) were applied immediately after seeding. The field was irrigated the day after applying herbicide. Plots were three approximately 300-ft-long rows at 68-in spacing. Biomass measurements were taken during the season, and yield was measured at maturity. Soil health measurements including infiltration and penetration were taken.

Plant growth was visibly better in the reduced-till plots than the conventional-till plots. Rye was visibly taller in the spring. There was more weed growth in the reduced-till plots where the rye cover crop was killed early than at full growth. Estimated total weight of fruit was numerically greater for both sets of reduced-till plots compared to the conventional-till plots. There were few significant differences in yield. Late in the season, slug and grub pests impacted fruit quality due to feeding damage on the ground-side of fruit, which affected their ability to remain marketable through the fall. The reduced tillage plots had on average 20% insect-damaged fruit, while there were 36% damaged fruit in the conventional till plots. These pest populations may have developed to damaging levels because through the field there are five permanent driveways with grass and clover, which provides favorable habitat for these insects. A very few fruit with Phytophthora fruit rot were observed at the low end of the field in both reduced-till and conventional-till plots.

Project funded by NE SARE.

Evaluation of Reduced Tillage Production System for Butternut Squash
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

The primary goals of this multi-year project are to investigate changes in soil health and compare crop growth during the first years of implementing reduced tillage practices. Before 2010 the field was plowed and conventionally tilled every year.

The field was arranged similar to the other reduced-till field, with tillage plots extending the length of the field (300 ft) and each replication containing a reduced-till and a conventional-till plot. Each plot contains 3 rows spaced 68-in apart. A reduced-till experiment was conducted with crucifers crops transplanted in the fall. Spring cover crops of oats or annual ryegrass were seeded in mid April 2011 after disking in 10-10-10 fertilizer at 500 lb/A. The plots were divided in half (150 ft) with cover crop (oats or ryegrass) randomly assigned to each half.

The amount of cover crop growth obtained was moderate with the oats and less with the ryegrass compared to what can be obtain with a standard rye winter cover crop. The cover crops were rolled 21 Jun. The conventional-till plots were roto-tilled and disked to prepare the soil for planting. A 2-row Unverferth zone builder was used to prepare the rows in the reduced-till plots. On 6 Jul butternut squash (cv Quantum) was direct-seeded into all rows with 625 lb/A 19-10-9 controlled release fertilizer applied in 2 bands by the seeder. Weeds were controlled by applying Strategy (3 pt/A) plus Sandea (0.5 oz/A) immediately after seeding. The field was irrigated after applying herbicide. Soil health measurements including infiltration and penetration were taken. Soil moisture was monitored at 4, 8 and 12 inch depths. Fruit was harvested 10 Oct in a grid of 3 rows by 25 ft.

Although more weeds were observed in the reduced-till plots, there were no statistically significant differences in yield between tillage treatments or spring cover crop. In fact, though not statistically significant (*P-values* greater than 0.05), butternut squash grown with reduced tillage in oat cover crop produced the greatest number of marketable fruit and total fruit.

Project funded by NE SARE.

Evaluation of Biopesticides for Foliar Diseases in Organically-Produced Tomato
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

Tomato is an important crop that is routinely affected by diseases. It is important for both organic and conventional diversified vegetable growers, which are common in the northeastern US. Fresh tomatoes picked ripe are one of the most popular local vegetables during summer. Foliar diseases are a common occurrence wherever tomatoes are grown. All plantings are affected, even those grown under protection (greenhouses and high tunnels) and in small home gardens. Foliar diseases need to be controlled in tomatoes to maintain yield. There are several foliar disease affecting tomatoes, including Septoria leaf spot, early blight, bacterial speck, late blight, powdery mildew and leaf mold. Yield is reduced when foliar diseases are not adequately controlled because the pathogen also infects fruit and/or death of infected leaves reduces fruit production and fruit quality, especially flavor. Diseases are often the reason tomato crops are abandoned before the last fruit are harvested. A long harvest period is needed with fresh market tomatoes for retail marketers because of consumer demand. Organic growers on Long Island have identified tomato as a high priority for research. Therefore tomato is a good crop choice to target for biopesticide evaluations. Most biopesticides are approved for organic production.

The experiment was conducted in a field with Haven loam soil that has been dedicated to research on evaluating fungicides on organically-produced crops. Tomatoes were grown in a reduced-tillage system. Rye cover crop was flail chopped and baled when it was about 4-ft tall and heading. An Unverferth zone builder was used to prepare rows for planting. ProGro 5-3-4 organic fertilizer was banded at 50 lb/A nitrogen in the tilled strips using the fertilizer applicator on a vacuum seeder. Fish emulsion fertilizer was placed in the transplant hole before planting.

Seeds were sown on 6 May in the greenhouse. Seedlings were transplanted on 14 Jun by hand into manually-opened holes. The baled straw was spread around and between the transplants. Plots consisted of 10 plants in a single row with 24-in plant spacing and 68-in row spacing. There was 8-ft spacing between plots in a row. Plots for each of the 4 replications were in 2 adjacent rows. A driveway separated replication 1 from 2 and 3 from 4. A spreader row was planted in the center of the field. Plants were staked and trellised following standard procedure for fresh-market tomato production. Weeds were managed by manually removing in planted rows and mowing between rows.

Serenade Soil was applied on 1 Aug as a drench around the base of plants. Foliar treatment applications were made using a CO_2-pressurized backpack sprayer with a boom that has a single 8006VS nozzle delivering 51 gal/A at 55 psi. Each side of the planted row was treated with the boom held sideways to obtain thorough coverage of foliage mimicking a drop nozzle on a tractor sprayer. A preventive 7-day application schedule was used. Applications were made on 8, 15, 22, and 29 Aug and on 5, 12, and 19 Sep.

Leaves were examined routinely for disease symptoms. Disease severity was assessed by estimating the percentage of leaves in each plot with symptoms (incidence) and the severity of symptoms on these affected leaves. Canopy severity was calculated with these values. Ripe fruit were harvested on 16 and 26 Sep.

Environmental conditions were atypical for the region during late August and September, when this experiment was being conducted, with a hurricane plus rain occurring on many more days than usual. This provided very favorable conditions for disease development but not for applying fungicide treatments or for plant growth. Research plants were damaged by the strong winds and intensive rainfall occurring during the storms, especially during Hurricane Irene on 28 Aug. The main damage was defoliation. Rain fell on 10 days during August, delivering a total of 10.6 inches. Another major rainfall of 3.4 inches occurred over 6-8 Sep. Rainy weather is very favorable for Septoria leaf spot as splashing water disperses pathogen spores and wet leaf tissue is favorable for infection.

Symptoms of powdery mildew were first observed in this experiment on 12 Sep. Septoria leaf spot was observed on 24 Aug. No significant differences were detected among treatments. None of the treatments provided significant suppression of either disease that developed, including Bravo (active ingredient is chlorothalonil), the conventional fungicide included as a check primarily for assessing application timing. These results with Bravo provide support for the conclusions that environmental conditions impacted the success of this experiment. Severity of powdery mildew on 27 Sep was numerically lower than the non-treated control for all treatments. The value was lowest for MilStop (potassium bicarbonate). Bravo was next lowest, then Timorex Gold (new product with tea tree oil not yet registered in the US).

Severity of Septoria leaf spot on 27 Sep was numerically lower than the non-treated control for plants treated with Bravo, Sonata ASO (4 qt/A) alternated with Nordox, and Nordox alone.

There were no significant differences in any yield parameters measured; however, the non-treated control plants produced the fewest number of marketable fruit (average of 8 per plant total for two harvest dates) and the second lowest estimated total weight of fruit (41 lb/plant). The greatest number of marketable fruit were harvested from the plants treated with Serenade Soil and Sonata as well as Sonata alternated with Nordox (16.8 and 16.5 fruit/plant, respectively). Plants treated with Timorex Gold yielded the most based on weight (51.5 lb/plant). Average fruit weight was greatest for plants treated with Milstop (0.6 lb/ fruit).

Other biopesticide treatments evaluated were MilStop alternated with Serenade ASO (4 qt/A), Sonata, and Serenade Soil applied to soil after transplanting followed by Sonata.

Project funded by IR-4 Biopesticide Demonstration Grant Program.

Evaluation of Fungicides for Powdery Mildew in Tomato
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

The rye cover crop in the experiment site was chopped and baled. Ground was tilled several times on 6-7 May and ProGro 5-3-4 organic fertilizer was applied at 2000 lb/A. Seeds were sown on 25 May in the greenhouse. Black plastic mulch and drip tape were laid on 16 Jun. Seedlings were transplanted on 7 Jul using a waterwheel transplanter that put Organic Gem liquid fertilizer at 2 fl oz/gal in each hole before the seedling was placed by hand in the hole. Plots consisted of 10 plants in a single row with 24-in plant spacing and 68-in row spacing. There was 8-ft spacing between plots in a row. Plots for each of the four replications were in four adjacent rows with a driveway separating replication 1 and 2 from 3 and 4. A spreader row was planted between replication 1 and 2 and between replication 3 and 4. Plants were staked and trellised following standard procedure for fresh-market tomato production. Weeds were managed by manually removing along the edge of mulch and in plant holes and by mowing between rows. There was an early outbreak of late blight in the region, which affected this experiment starting in early July. Fungicides were selected with targeted activity for the late blight fungus (*Phytophthora infestans*) to minimize impact on powdery mildew. A mefenoxam-sensitive strain (US-23) was present. Fungicides applied were Ridomil Gold (0.25 pt/A) on 6 Jul and 2 Sep; Previcur Flex (1.5 pt/A) on 6 Jul, 27 Jul, and 4 Aug; Revus (8 fl oz/A) on 6 Jul, 15 Jul, and 20 Aug; Presidio (4 fl oz/A) on 25 Aug; and Ranman (2.75 fl oz/A) on 20 Aug. Fruit were removed from the plants to maintain foliar growth; yield was not assessed. Foliar treatment applications were made using a CO_2-pressurized backpack sprayer with a boom that has a single 8006VS nozzle delivering 51 gal/A at 55 psi. Each side of the planted row was treated with the boom held sideways to obtain thorough coverage of foliage mimicking a drop nozzle on a tractor sprayer. A preventive 7-day application schedule was used. Applications were made on 22, 29 Aug, and 15 Sep. Applications could not be made during the week of 5 Sep due to rain falling everyday resulting from a tropical storm (Lee). Leaves were examined routinely for disease symptoms. Disease severity was assessed by estimating the percentage of leaves in each plot with symptoms (incidence) and the severity of symptoms on these affected leaves. Canopy severity was calculated with these values. Yield was not assessed.

Few symptoms of powdery mildew were observed. This may have been at least partly due to frequent rainfall creating unfavorable conditions for powdery mildew. Fewest symptoms were seen in plants receiving the middle and highest rates of Mettle; however, there were no significant differences among treatments. Mettle is a new DMI fungicide (FRAC code 3) being developed by Isagro-USA. All treatments controlled Septoria leaf spot. Based on severity on 21 Sep, Mettle provided 91-95% control while Rally provided 85% control. Leaves were damaged during Hurricane Irene and tropical storm Lee the following week, which resulted in a lot of defoliation in late September, and additionally late blight re-emerged; consequently canopy severity of Septoria leaf spot and powdery mildew declined.

Evaluation of Late Blight Resistant Tomato Varieties and Experimental Hybrids
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

Tomato is an important crop that is routinely affected by diseases. It is important for both organic and conventional diversified vegetable growers, which are common in the northeastern US. Fresh local tomatoes are one of the most popular items during summer, therefore they are grown by many organic and conventional growers. There are several foliar disease affecting tomatoes, including Septoria leaf spot, early blight, bacterial speck, late blight, powdery mildew and leaf mold. Foliar diseases are a common occurrence wherever tomatoes are grown. All plantings are affected, even those grown under protection (greenhouses and high tunnels) and in small home gardens. Resistant varieties would be a valuable tool for managing these diseases, particularly late blight because it occurs sporadically and can be difficult to control with fungicide applications started after onset. The goals of this experiment, which is part of a multi-year project, were to evaluate new tomato varieties and experimental hybrids with resistance to late blight in terms of 1) susceptibility to naturally-occurring foliar diseases and 2) yield and fruit quality.

The experiment was conducted in a field dedicated to research with organically-produced vegetable crops. Soil type is Haven loam. Tomato seed were sown in an organic seeding mix on 6 May. Rye cover crop was flail chopped and baled on 24 May. Pro-Grow 5-3-4 and Cheep Cheep Poultry Litter 4-3-3 organic fertilizers were both spread at 1100 lb/A and then incorporated by disking on 10 May. Two layers of black plastic mulch were laid for managing yellow nutsedge as well as other weeds. Additionally, on 16 May white clover was spread at 35 lb/A between the rows of plastic by hand and incorporated with a rake to serve as a living mulch for weed management and to improve soil health. Seedlings were transplanted on 8 Jun. Fish emulsion (Neptune's Harvest) was poured into the transplant hole before setting the seedlings. All plots had between 5-10 plants at 2-ft spacing with a yellow cherry type tomato plant separating plots within rows. Rows were spaced 68-in apart. A completely randomized block design with four replications was used. There were four additional entries included for observation and thus not planted in the replicated experiment. Plants were staked and trellised as they grew using the Florida weave trellising system with 4-ft stakes placed between plants. Water was provided as needed through drip tape laid beneath the plastic mulch.

A very early outbreak of late blight in the region, which included this experiment starting in early July, necessitated applying fungicides to minimize impact of unmanaged late blight on other experiments and commercial crops near-by. Fungicides were selected with targeted activity for the late blight fungus (*Phytophthora infestans*) to avoid impacting other foliar diseases. A mefenoxam-sensitive strain (US-23) was present. Fungicides applied were Ridomil Gold (0.25 pt/A) on 6 Jul; Previcur Flex (1.5 pt/A) on 6 Jul, 27 Jul and 4 Aug; Revus (8 fl oz./A) on 6 Jul, 15 Jul and 20 Aug; Presidio (4 fl oz./A) on 25 Aug; Ranman (2.75 fl oz/A) on 20 Aug; and Curzate (5 oz/A) on 2 Sep. Insect pests were controlled with Entrust (2 oz/A) applied on 4, 20, and 25 Aug for lepidopterous larvae and ABBA (16 fl oz/A) plus the adjuvant LI-700 (1 pt/100 gal) applied on 4 Aug for russet mite.

Leaves were examined for disease symptoms three times from 10 Aug to 27 Sep. Incidence of plants with symptoms of late blight was recorded on 14 and 21 Jul. Powdery mildew was assessed by estimating the percentage of leaves in each plot with symptoms (incidence) and the severity of symptoms on these affected leaves. Canopy severity was calculated with these values. Fruit were harvested on 12, 18, 23 and 31 Aug. Fruit quality attributes assessed included Brix (% soluble sugar) measured with a refractometer and taste rated on a 1-9 scale with 9 being excellent. Fruit were also evaluated by gardener and other consumer groups.

There were few symptoms of late blight in July therefore it was assessed as incidence of plants with symptoms. Late blight lesions on varieties were observed on 40% of Mountain Fresh plants on 14 Jul versus on 3-32% of plants of resistant varieties and on 80% versus 8-46% of these plants, respectively, on 21 Jul. Mountain Magic had the fewest affected plants on both dates. All resistant hybrids evaluated have both the *Ph2* and *Ph3* genes for resistance to late blight. The fungicide program used to suppress late blight during the main part of the growing season combined with hot, dry weather during July stopped late blight development even in the susceptible variety. Symptoms of Septoria leaf spot were not observed. Powdery mildew developed to a limited degree late in the growing season. There were no significant differences among varieties. The campari-type varieties (Mountain Magic and Cornell M) produced the greatest number and weight of fruit, and these fruit had the highest taste ratings. These also rated highly among the 122 raters who participated in community tomato evaluation events.

Tomato Variety Fruit Descriptions:

Mountain Fresh: Medium to medium large round red tomato. Some variability in size. Flat blossom end. Some radial cracking and zippering.

Tasti Lee: Medium sized fruit were round and red in color. Slightly flat blossom end. Uniform.

Mountain Merit: Medium to medium large, round fruit were red to orange in color. Rounded blossom end and deep scarring at stem end.

Defiant PhR: Uniform, round fruit were small to medium in size and had a pink to dark red coloring. Flat blossom end. Yellow shoulder and slight zippering.

853 x 426 (Johnny's Selected Seeds): Large to medium, round fruit were orange to red in color. Fruit were a good size and shape with a rounded blossom end. Slight cracking.

Cornell A: Orange to red fruit was medium to large in size and round to oval in shape. Blossom end was round to slightly pointed.

Cornell B: Fruit of this variety was round, small to medium large in size and red to orange in color. Good yields. Round blossom end. Slight zippering and cracking.

Cornell C: Round to oval, medium sized fruit. Light orange to red in color. Slightly flat blossom end. Variable in size and shape. Slight zippering and cracking.

Cornell E: Medium sized, round to oval fruit medium red to orange in color. Slightly pointed blossom end. Radial cracking.

Mountain Magic (Bejo Seeds): Orange to red, small to medium round fruit. Yellow shoulder and cracking.

Mountain Magic (Cornell University): Fruit of this variety were round, small to medium in size with orange to red coloring. Slight cracking.

Cornell J: Fruit of this variety were small, round and red. Very uniform. Rounded blossom end.

Cornell K: Small, oval fruit were red in color with a rounded blossom end. Fruit were variable in size.

Cornell M: Slightly oval to round fruit were small to medium in size and orange to red in color. Good yields.

The 'female pedigree' X 'male pedigree' for the Cornell entries was CU101252 x NC33EB1 for A, CU101253 x NC33EB1 for B, CU101254 x NC33EB1 for C, CU101256 x NC33EB1 for E, CU101262 x NC2Grape for J, CU101263 x NC2Grape for K, and CU101265 x NC2Grape for M.

Project funded by the Friends of Long Island Horticulture Grant Program.

Phytophthora infestans Transmitted to Seedlings Growing from Tomato Fruit Rotted by Late Blight

Investigators: M. McGrath, V. Ferguson, and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

The impetus for this investigation was an outbreak of late blight that appeared to have originated from volunteer tomatoes. This occurred during early spring 2011 in a greenhouse. There were no potatoes growing in or near the greenhouse to serve as a source of inoculum.

This study was conducted with tomato fruit from plants grown outdoors that became naturally infected with *Phytophthora infestans,* the late blight pathogen, genotype US-23 during the 2011 outbreak of late blight on Long Island, NY. Symptomatic fruit were collected from 5 varieties in a garden on 27 Aug and 5 Sep. Late blight symptoms were first observed on 13 Aug on a few leaves there. Most fruit for the first experiment were collected on 27 Aug. They were kept in tubs for 11 days at ambient temperature for further disease development. On 7 Sep the fruit from both collection dates were put on potting mix in trays, then covered with more potting mix. Two duplicate sets of trays were set up. One was placed in a greenhouse where conditions would be favorable for seedling growth while the other went in a dark, unheated trailer. Trays were kept lightly moistened. Seeds of the cherry-type 'Sweet Treats' were the first to germinate. There were many seedlings of this variety at the cotyledon stage on 15 Sep in the greenhouse. On 20 Sep brown stem lesions were observed and confirmed to be caused by *P. infestans* by using an Agdia test kit. All six seedlings with symptoms were removed for testing. About half of the remaining healthy-appearing plants were removed and transplanted as small groups into 11 pots on 20 Sep. Symptoms developed subsequently on a few additional plants, which were then removed. Brown lesions appeared first on the lower stem. Sporangia were observed where the pathogen had progressed into leaf tissue. Fewer seedlings grew from fruit of the other varieties, which are SunGold (cherry), Juliet (large grape), Amish Paste (Roma) and Better Boy (beefsteak). For several fruit this was because the fruit epidermis remained intact. Symptoms of late blight were observed on seedlings of Juliet on 2 Nov, more than two months after the fruit were collected. It is suspected that infection of the volunteer seedlings resulted from pathogen spores (sporangia) surviving in diseased tomato fruit tissue. These spores are not capable of surviving more than a few weeks and thus cannot survive overwinter in affected fruit. It is also not anticipated that *P. infestans* can survive in association with seed separated from fruit if it was not able to produce oospores, which is the type of spore this pathogen produces when it reproduces sexually. Only one strain of the pathogen, and thus only one mating type, was present on LI in 2011, therefore the pathogen could not have produced oospores. However, research was conducted to confirm this with seed obtained from affected tomato fruit using several methods to save seed that are used by gardeners (see following report).

Trays with fruit were kept in the dark, unheated trailer for two months, then they were removed and put in the greenhouse. A few seedlings had grown while the trays were in the trailer. They were removed when they emerged. Some with symptoms of late blight were tested with an Agdia test kit and confirmed to be infected. More seedlings grew after the trays were put in the greenhouse. Several times the trays of seedlings were put in clear plastic bags for a day to increase humidity around the plants thereby creating conditions more favorable for late blight development. None of the seedlings developed symptoms of late blight. Based on these results, *P. infestans* was not able to survive in tomato fruit for two months.

Many volunteer seedlings grew in the garden after removal of the affected tomato plants and most dropped fruit. On 1 Oct symptoms of late blight similar to what developed in the greenhouse were observed on the lower stem of 4 of these seedlings out of 120 examined. Many more had symptoms on 5 Oct (130 out of 223).

Project was supported by the Agriculture and Food Research Initiative Competitive Grants Program Grant 2011-68004-30104 from the USDA National Institute of Food and Agriculture.

Investigation of the Ability of *Phytophthora infestans* to Survive on Tomato Seed and Infect Seedlings

Investigators: M. McGrath, V. Ferguson, and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

The impetus for this investigation was a few reports of late blight starting on tomato grown from saved seed for which a source of the pathogen could not be identified and the successful transmission of *Phytophthora infestans* to seedlings growing from tomato fruit rotted by late blight in a previous study (see previous report).

Seven methods were used to prepare for planting seed that was obtained from fruit affected by late blight. Three types of fruit were used: slicer (Mt Fresh Plus), Roma (Amish Paste), and cherry (SunGold). With three methods the seed was not dried after it was prepared. Seed was either planted immediately after removing it from fruit or it was incubated for 8 or 15 days in juice from the fruit, which potentially contained *Phytophthora infestans*. With the other four methods, seed was dried on paper towel for a week after preparation and then put in seed packages for a short dry storage period before planting. Seed preparation for these methods entailed: 1) just removing seed from fruit, 2) rinsing seed in water before putting on paper towel to dry, 3) incubating seed in water for about 4 days until a white layer formed, and 4) incubating seed in soapy water until layers formed. Seed preparation for these four methods was started on 18 Oct. Seed were planted on 22 Dec.

Seedlings grew from seed prepared with all seven methods. Several times the trays of seedlings were put in clear plastic bags for at least a day to increase humidity around the plants thereby creating conditions more favorable for late blight development. None of the seedlings developed symptoms of late blight. Based on these results, *P. infestans* was not present or able to survive in or on tomato seed removed from fruit affected by late blight, or the pathogen was not able to infect tomato seedlings under the conditions of this experiment.

Project was supported by the Agriculture and Food Research Initiative Competitive Grants Program Grant 2011-68004-30104 from the USDA National Institute of Food and Agriculture.

Powdery Mildew Resistant Muskmelon Variety Evaluation
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

The objectives of this study, which is part of a multi-year variety evaluation project, were 1) to continue to monitor adaptation in the pathogen that has been reducing the effectiveness of powdery mildew resistance and 2) to determine whether varieties with resistance to pathogen races 1 and 2 are better protected against powdery mildew than varieties with resistance to just pathogen race 1.

Controlled release fertilizer (N-P-K, 19-10-9) at 525 lb/A (100 lb/A of nitrogen) was broadcast and incorporated on 31 May in the research site. Beds were formed with drip tape and covered with black plastic mulch on 1 Jun. A waterwheel transplanter was used to make planting holes in the beds and apply starter fertilizer plus insecticide on 7 Jun. Seeds were sown on 31 May in the greenhouse. Seedlings were transplanted by hand into beds covered with black plastic mulch on 10 Jun. During the season, water was provided as needed via drip irrigation lines. Weeds were controlled between the rows of mulch by applying a tank mix of Scythe (1.3 fl oz/gal spray mix), Strategy (3 pt/A) and Sandea (0.5 oz/A) on 7 Jun, and by hand weeding. Cucumber beetles were managed with Admire Pro (7.5 – 10 fl oz/treated A) applied with the transplanter on 16 Jun and Asana XL (9.6 fl oz/A) applied to foliage on 2 Jul. No fungicides were applied to control powdery mildew. The following fungicides were applied preventively for downy mildew (*Pseudoperonospora cubensis*) and Phytophthora blight (*Phytophthora capsici*): ProPhyt (4 pt/A) on 6 Aug; Ranman 400 SC (2.75 fl oz/A) on 18 Aug and 2 Sep; and Curzate (3.2 oz/A) on 26 Aug. Plots were three adjacent rows each with four plants spaced 24 in. apart. Rows were spaced 68 in. apart. Two plants of Multipik, a powdery mildew-susceptible summer squash variety, were planted between each plot in each row to separate plots and provide a source of inoculum. A randomized complete block design with four replications was used. Upper and lower leaf surfaces were assessed for powdery mildew on 21 Jul and on 3, 10 and 17 Aug. Powdery mildew colonies were counted; severity was estimated when colonies had coalesced or were too numerous to count. 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.

Symptoms of powdery mildew were first found on 14 Jul. Only 1 spot was found on 2 of the 120 leaves examined. Severity remained low until 10 Aug in the susceptible variety (Superstar) and through 17 Aug, the last assessment date, for all plots of the resistant varieties except one plot of Eclipse. Fruit ripened and were at full slip stage by 26 Aug. All three resistant varieties (Athena, Eclipse, and Wrangler) provided a very good level of suppression of powdery mildew. Thus there was no evidence from this experiment of a new pathogen race being present. These and other varieties with resistance to races 1 and 2 were similarly effective in previous evaluations at this location in 2008 and 2009. In contrast, powdery mildew was more severe on these varieties in a similar experiment in 2010, suggesting a new race was present. However, symptoms were also more severe that year on Superstar, the susceptible variety included for comparison, indicating highly favorable conditions for powdery mildew. If a new race was present in 2010 on Long Island, there was no evidence from the annual variety evaluation that it had returned in 2011. A new race has been reported in Georgia affecting varieties with resistance to Races 1 and 2.

Project funded by the Friends of Long Island Horticulture Grant Program.

Identification of Races of the Cucurbit Powdery Mildew Pathogen Occurring on LI
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

Races of the powdery mildew pathogen affecting cucurbit crops are defined based on their ability to infect melon varieties and experimentals with different genes for resistance. These melons are considered to be differentials. It is important to know what races are occurring in order to know what resistance genes are needed to effectively suppress powdery mildew in melons.

Seven melon differentials plus two watermelon and cucumber differentials were grown next to the resistant variety evaluations. Seedlings were transplanted into beds covered by black plastic mulch with drip irrigation. Cultural practices were the same and done at the same time as the near-by experiment with melon described in the following report. Powdery mildew severity was evaluated on both leaf surfaces on 30 Aug.

Symptoms were only observed on leaves of differentials lacking genes for resistance, indicating that only Race 1 of the cucurbit powdery mildew fungus (*Podosphaera xanthii*) was present in 2011. This conclusion is in agreement with the melon variety evaluation (previous report) in which all resistant varieties provided equally effective suppression. Race 2 has been detected on LI in other years and also Race 3 in 2008. Although not detected in this planting, it is possible Race 2 was present in 2011 at a low level based on the fact powdery mildew severity values were numerically greater on the variety with resistance to just Race 1 (Eclipse) than the varieties with resistance to Races 1 and 2.

Powdery Mildew Resistant Yellow Summer Squash Variety Evaluation
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

The goals of this experiment, which is part of a multi-year variety evaluation project, were 1) to continue to monitor adaptation in the pathogen that has been reducing the effectiveness of powdery mildew resistance, 2) to determine whether varieties with homozygous resistance (two copies of the major powdery mildew resistance gene; PMRR) are better protected against powdery mildew than varieties with heterozygous resistance (PMR), 3) to investigate the contribution of resistance to an integrated management program, and 4) to evaluate yield.

Procedures for this field experiment were the same as described in a previous report entitled 'Powdery Mildew Resistant Muskmelon Variety Evaluation' with the following exceptions. Two experiments were conducted in separate treatment areas, one receiving a standard commercial powdery mildew fungicide program, and one that did not. The following products were applied to manage cucurbit powdery mildew: Quintec (6 fl oz/A) on 28 Jul, 18 Aug and 3 Sep; Procure 50WS (8 oz/A) on 20 Jul and 26 Aug; Pristine (18.5 oz/A) on 4 Aug; and Actinovate (8 oz/A) on 4 Aug. All fungicide applications were made with a tractor-sprayer equipped with D4 nozzles at 17-in spacing that delivered and 60 gpa operated at 250-275 psi. Seedlings were transplanted on 21 Jun into holes prepared on 16 Jun. Plots were four adjacent rows each with three plants spaced 24-in apart. Rows were spaced 68-in apart.

One plant of Spineless Beauty, a powdery mildew-susceptible zucchini squash variety, was planted between each plot in each row to separate plots and provide a source of inoculum. Squash fruit were harvested and counted on 26 Jul, 2 and 9 Aug.

Symptoms of powdery mildew were observed at a low level on 14 Jul: only 1 of the 120 older leaves examined (0.8%) had symptoms. Disease developed quickly. Symptoms were found on 21 Jul in all except two treated plots of the resistant variety Sunray. The proportion of older leaves examined that day and found to have symptoms was 42% and 52% in the non-treated and fungicide-treated experiments, respectively. Incidence at that time was unusually high for the region. It was 19% on 27 Jul 2010 in a similar experiment with these same varieties. Powdery mildew incidence therefore was substantially above the action threshold of 2% on 20 Jul when the powdery mildew fungicide program was started for assessing integrated management. Both resistant varieties were equally effective for suppressing powdery mildew. There were no significant differences in powdery mildew severity between Cheetah (PMR) and Sunray (PMRR) when evaluated as the sole management practice or as a component of an integrated management program. Therefore these experiments did not demonstrate a benefit of homozygous resistance over heterozygous resistance. Suppression of powdery mildew with genetic resistance was most evident on the lower leaf surface. This is valuable information considering the pathogen develops best on this part of the leaf and controlling it here with fungicides necessitates using targeted fungicides prone to resistance development in the pathogen because targeted fungicides are able to move to the lower surface after being deposited on the upper surface. Based on AUDPC values, resistant varieties provided 51-58% and 79-81% control on upper and lower leaf surfaces, respectively, as the sole management practice and increased control on lower leaf surfaces by 75-84% when treated with targeted fungicides compared to the similarly treated Gentry; however, fungicides provided limited control of powdery mildew on lower leaf surfaces. No significant differences in yield were detected amongst the varieties. All varieties had marketable fruit on the first harvest date.

Project funded by the Friends of Long Island Horticulture Grant Program.

Powdery Mildew Resistant Zucchini Squash Variety Evaluation
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

The objectives of this study, which is part of a multi-year variety evaluation project, were 1) to continue to monitor adaptation in the pathogen that has been reducing the effectiveness of powdery mildew resistance, 2) to investigate the contribution of resistance to an integrated management program, and 3) to evaluate yield.

Procedures for this field experiment were the same as described in a previous report entitled 'Powdery Mildew Resistant Yellow Summer Squash Variety Evaluation' with the following exception. The separator plant between plots was Multipik, a powdery mildew-susceptible summer squash variety.

Symptoms of powdery mildew were observed at a low level on 14 Jul: 2.5% of older leaves examined had symptoms. Disease developed quickly. Symptoms were found on 21 Jul in all except one treated plot of a resistant variety. On that day, the proportion of older leaves examined with symptoms was 46% in both experiments. Incidence at that time was unusually high for the region. It was only 3% on 20 Jul 2010 in a similar experiment with these same varieties. Powdery mildew incidence therefore was substantially above the action threshold of 2% on 20 Jul 2011 when the powdery mildew fungicide program was started for assessing integrated management. When genetic resistance was evaluated as a sole management practice for powdery mildew, only Amatista effectively suppressed powdery mildew and only on the lower leaf surface based on the AUDPC value. Amatista is considered to be more resistant than Envy. Based on AUDPC values, Amatista provided 76% control on lower leaf surfaces. Both Amatista and Envy provided control in a similar experiment conducted in 2010, although Amatista was also more effective in 2010. Envy contributed to control of powdery mildew in 2011 only when it was used as a component of an integrated management program that included weekly applications of a targeted fungicide for powdery mildew (Quintec, Pristine, and Procure). Based on AUDPC values, fungicide-treated Envy provided 46% control on lower leaf surfaces while fungicide-treated Amatista provided 73% control compared to the similarly-treated susceptible variety Spineless Beauty. The fungicide program provided limited suppression of powdery mildew in this experiment. The only significant differences in yield detected among the varieties were for the fungicide treated plots. All varieties had marketable fruit on the first harvest date.

Project funded by the Friends of Long Island Horticulture Grant Program.

Powdery Mildew-Resistant Acorn-Type Winter Squash Variety Evaluation
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

The goals of this experiment, which is part of a multi-year variety evaluation project, were 1) to continue to monitor adaptation in the pathogen that has been reducing the effectiveness of powdery mildew resistance, 2) to determine whether varieties with homozygous resistance (two copies of the major powdery mildew resistance gene; PMRR) are better protected against powdery mildew than varieties with heterozygous resistance (PMR), 3) to investigate the contribution of resistance to an integrated management program, and 4) to evaluate yield and fruit quality.

Procedures for this field experiment were the same as described in a previous report entitled ‘Powdery Mildew Resistant Yellow Summer Squash Variety Evaluation’ with the following exception. Yield assessments were done on 12 Sep.

Symptoms of powdery mildew were observed on 21 Jul in all except one treated plot of a resistant variety. The proportion of older leaves examined with symptoms was 46% in both experiments then. Incidence at that time was unusually high for the region. It was only 3% on 20 Jul 2010 in a similar experiment with these same varieties. Powdery mildew incidence therefore was substantially above the action threshold of 2% on 20 Jul when the powdery mildew fungicide program was started for assessing integrated management. Sweet REBA, the variety evaluated with homozygous resistance (e.g. two copies of the major powdery mildew resistance gene; PMRR), was less severely affected by powdery mildew than Tay Belle PM, which has heterozygous resistance (PMR). Severity was significantly different based on AUDPC values and also many severity assessments. Powdery mildew severity on Sweet REBA and the susceptible variety Table Ace differed significantly for almost all assessments. Thus homozygous resistance was effective when powdery mildew resistance was tested as a sole management program and as a component of an integrated management program that included weekly applications of a targeted fungicide for powdery mildew (Quintec, Pristine, and Procure). Powdery mildew severity on Tay Belle PM and Table Ace never differed significantly. Thus heterozygous resistance was ineffective as a sole management practice as well as when fungicides were also applied. However, effectiveness of the fungicide program may have been compromised by its initiation after recommended using the established action threshold. Based on AUDPC values, Sweet REBA provided 74% and 91% control on upper and lower leaf surfaces, respectively, as the sole management practice and 85% and 53% increased control when treated with targeted fungicides compared to the similarly treated Table Ace. Yield of Sweet REBA did not differ significantly from Table Ace. In conclusion, varieties with homozygous resistance are needed to effectively control powdery mildew in acorn squash. Control can be improved by using an integrated program. Applying fungicides to a resistant variety will also minimize selection pressure for pathogen strains adapted to either resistance genes or targeted fungicides. Blind taste tests were conducted with baked acorn squash, and fruit was rated from 1=poor to 5=best by consumers who participated. None of the varieties ranked better than others in terms of taste, internal and external appearance or overall satisfaction. However, when asked if they would purchase a specific variety, both Table Ace and Sweet REBA received high ratings (80% and 71%, respectively).

Project funded by the Friends of Long Island Horticulture Grant Program.

Powdery Mildew-Resistant Butternut-Type Winter Squash Variety Evaluation
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

The goals of this experiment, which is part of a multi-year variety evaluation project, were 1) to continue to monitor adaptation in the pathogen that has been reducing the effectiveness of powdery mildew resistance, 2) to determine whether varieties with homozygous resistance (two copies of the major powdery mildew resistance gene; PMRR) are better protected against powdery mildew than varieties with heterozygous resistance (PMR), 3) to investigate the contribution of resistance to an integrated management program, and 4) to evaluate yield and fruit quality.

Procedures for this field experiment were the same as described in a previous report entitled 'Powdery Mildew Resistant Yellow Summer Squash Variety Evaluation' with the following exceptions. Seedlings were transplanted on 15 Jun into holes prepared on 7 Jun. Plots were three adjacent rows each with four plants spaced 24-in apart. Rows were spaced 68-in apart. Two plants of Multipik, a powdery mildew-susceptible summer squash variety, were planted between each plot in each row to separate plots and provide a source of inoculum. Yield assessments were done on 16 Sep.

Symptoms of powdery mildew were observed at a low level on 14 Jul: 3% of older leaves examined had symptoms with most of these in a plot of the susceptible variety. Symptoms were found on 21 Jul in most plots. The proportion of older leaves examined that day and found to have symptoms was 22% and 11% in the non-treated and fungicide-treated experiments, respectively. Powdery mildew incidence therefore was above the action threshold of 2% on 20 Jul when the powdery mildew fungicide program was started for assessing integrated management. Incidence at that time was unusually high compared to previous experiments. Symptoms were first observed on 4 Aug in a similar experiment conducted in 2010. Powdery mildew was as effectively suppressed with Metro, which has heterozygous resistance (PMR), as with Geneva, the variety evaluated with homozygous resistance (two copies of the major powdery mildew resistance gene; PMRR). These varieties did not differ significantly when evaluated as the sole management practice or as a component of an integrated management program. Resistant varieties as the sole management practice provided 71-78% and 76-77% control on upper and lower leaf surfaces, respectively, based on AUDPC values, and when treated with targeted fungicides for powdery mildew they increased control by another 60-78% based on severity on 18 Aug compared to the similarly treated susceptible variety Waltham. In contrast, in a similar experiment conducted in 2010 evaluating non-fungicide resistant varieties, Geneva as well as 4 other PMRR and 3 PMR varieties exhibited no suppression of powdery mildew. Bugle (PMRR) was the only variety in the 2010 experiment that was significantly less severely affected by powdery mildew than the susceptible variety Waltham. The resistant varieties tested in 2009 also did not successfully suppress powdery mildew, whereas effective control was achieved in the 2008 experiment conducted at LIHREC. Results suggest performance of powdery mildew resistant genotypes is variable each year. Blind taste tests were conducted with baked butternut squash, and fruit was rated from 1=poor to 5=best by gardeners and other consumers who participated. Waltham ranked highest in all categories (Taste, Internal and External Appearance and Overall Satisfaction) as well as receiving an 80% favorable rating of 'Would You Buy it?' Geneva and Metro ranked similarly, receiving a 62% favorable score.

Project funded by the Friends of Long Island Horticulture Grant Program.

Powdery Mildew Resistant Pumpkin Variety Evaluation
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

The goals of this experiment, which is part of a multi-year variety evaluation project, were 1) to continue to monitor adaptation in the pathogen reducing the effectiveness of powdery mildew variety resistance, 2) to determine whether varieties with homozygous resistance (two copies of the major powdery mildew resistance gene; PMRR) are better protected against powdery mildew than varieties with heterozygous resistance (PMR), 3) to investigate the contribution of resistance to an integrated management program, and 4) to evaluate yield and fruit quality.

Procedures for this field experiment were the same as described in a previous report entitled 'Powdery Mildew Resistant Butternut-Type Winter Squash Variety Evaluation' with the following exception. Seedlings were transplanted on 10 Jun into holes prepared on 7 Jun. Yield assessments were done on 12 Sep.

Symptoms of powdery mildew were observed at a low level on 14 Jul: only 3 of the 120 older leaves examined (2.5%) had symptoms. Symptoms were found on 21 Jul in two of four plots of each resistant variety in each experiment and three of the susceptible plots in each experiment. The proportion of older leaves examined that day and found to have symptoms was 9.2% and 15% in the non-treated and fungicide-treated experiments, respectively. Powdery mildew incidence therefore was above the action threshold of 2% on 20 Jul when the powdery mildew fungicide program was started for assessing integrated management. When genetic resistance was evaluated as a sole management practice for powdery mildew, only the variety with homozygous resistance (Magician) was significantly less severely affected by powdery mildew than the susceptible variety (Sorcerer). Based on AUDPC values, Magician provided 41% and 30% control on upper and lower leaf surfaces, respectively. Although not significant, the variety with heterozygous resistance (Magic Lantern) had numerically lower powdery mildew values for all assessments. Both resistant varieties contributed to control of powdery mildew when used as a component of an integrated management program that included weekly applications of a targeted fungicide for powdery mildew (Quintec, Pristine, and Procure). Based on AUDPC values, the resistant varieties increased control on lower surfaces by 46% for Magic Lantern and 73% for Magician over the degree of control achieved with fungicides alone applied to the susceptible variety. However, the fungicide program provided limited suppression of powdery mildew in this experiment, which was only evident on upper leaf surfaces. While not significantly different, AUDPC values for fungicide-treated upper leaf surfaces was 16% lower for Magic Lantern and 65% for Magician compared to Sorcerer. Significant differences in yield were only detected in the non-fungicide-treated experiment, in which the variety with homozygous resistance produced more marketable fruit than the other varieties.

Project funded by the Friends of Long Island Horticulture Grant Program.

Efficacy of Vivando for Managing Powdery Mildew in Cucurbit Crops
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

A field experiment was conducted to evaluate a new fungicide in three different cucurbit crop types. Vivando has the novel active ingredient metrafenone. It is a FRAC code U8 fungicide. 'U' designation means it is unknown more of action. It was developed by BASF Corporation and registered in the US in 2011 with approval for use on grapes. Additional crops including cucurbits are anticipated to be labeled in 2013.

The field was plowed on 2 May and tilled on 7 Jun. Controlled release fertilizer (19-10-9) at 525 lb/A was broadcast and incorporated on 5 Jun. Beds were formed with drip tape and covered with black plastic mulch on 6 Jun. A waterwheel transplanter was used to make planting holes in the beds for planting in the mulch and to apply starter fertilizer plus insecticide on 22 Jun. Three seeds were placed by hand into each of the holes on 23 Jun. After seedlings were established they were thinned to one plant per hole. All plants in some holes were damaged by herbicide; these were re-seeded on 11 Jul. Weeds were controlled between the rows of mulch by applying a tank mix of Strategy (3.0 pt/A) and Sandea (0.5 oz/A) on 22 Jun, which was followed by 0.4-in rain, and by hand weeding. Cucumber beetles were managed with Admire Pro (7.5 – 10.0 fl oz/treated A) applied with the transplanter. No fungicides were applied to control powdery mildew. The following fungicides were applied to preventively manage downy mildew (*Pseudoperonospora cubensis*) and Phytophthora blight (*Phytophthora capsici*): Presidio (3.5 oz/A) on 28 Jul and 14 Sep; ProPhyt (3 qt/A) on 6 Aug; Curzate (3.2 oz/A) on 26 Aug and 14 Sep; and Ranman 400 SC (2.75 fl oz/A) on 20 Aug and 1 Sep. A randomized complete block design with four replications was used. Treatments were three Vivando applications; none, low and high rates. Plots were three adjacent rows each 22-ft long and separated by 19-ft within the row. Plots were divided into three sections with butternut squash in the north section, acorn squash in the center and muskmelon in the south section. Each section had 12 plants spaced 2-ft apart. Rows were spaced 68-in apart. Treatment applications were made weekly using a tractor-mounted boom sprayer equipped with twinjet (TJ60-11004VS) nozzles spaced 17-in apart that delivered 54 gal/A at 100 psi. Severity of powdery mildew was assessed on upper and lower leaf surfaces on 26 Aug, 2 and 14 Sep. Initially 5 leaves were selected in each section from the oldest part of the foliage based on leaf physiological appearance and position in the canopy. On 14 Sep, when symptoms had become more widespread on plants, mid-aged and young leaves were assessed. Powdery mildew colonies were counted; severity was assessed by visual estimation of percent leaf area infected when colonies could not be counted accurately because they had coalesced and/or were too numerous. Average severity for the entire canopy was calculated from the individual leaf assessments. Area Under the Disease Progress Curve (AUDPC) was calculated by trapezoidal integration for severity from 26 Aug through 14 Sep. Yield was not assessed.

Powdery mildew was first detected on 22 Aug. Vivando applied beginning after disease detection effectively controlled powdery mildew in all three cucurbit crop types. There were no significant differences between the two rates tested. At the 14 Sep assessment, the lowest rate of Vivando was providing 100% and 93% control on upper and lower leaf surfaces, respectively, in muskmelon, 94% and 83% control in butternut squash, and 81% and 55% control in acorn squash. No symptoms of phytotoxicity were observed.

Efficacy of Fungicides for Managing Cucurbit Powdery Mildew
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

The primary objective of this experiment was to evaluate the efficacy of several fungicides with single site mode of action for the control of cucurbit powdery mildew. Both new and currently registered products were tested in an area where in previous years strains of the pathogen were detected with resistance to FRAC code 1, 7, and 11 fungicides and moderate resistance to FRAC code 3 fungicides. The field was plowed on 2 May and tilled on 30 May. Seeds of Sorcerer pumpkin were planted at approximately 24-in plant spacing within rows with a vacuum seeder on 21 Jun. The seeder applied fertilizer in two bands about 2-in away from the seed. Controlled release fertilizer (N-P-K, 19-10-9) was used at 625 lb/A. The herbicides Strategy (3 pt/A) and Sandea (0.5 oz/A) were applied over the entire plot area on 22 Jun, which was followed by 0.52 inches of rain and 2.38 inches on 23 Jun. During the season, weeds were controlled by cultivating and hand weeding as needed. Cucumber beetles were managed by applying the insecticide Admire Pro (7.5 fl oz/treated A) in a narrow band over the planted rows immediately after the herbicide application on 22 Jun. To manage damping-off, Ridomil Gold EC (1 pt/A) was broadcast over the field and incorporated mechanically on 16 Jun. A soil penetrant to increase water penetration, SprayHandler (0.5 pt/A), was applied with Ridomil. The following fungicides were applied to preventively control downy mildew (*Pseudoperonospora cubensis*) and Phytophthora blight (*Phytophthora capsici*): Presidio (3.5 oz/A) on 28 Jul and 14 Sep; ProPhyt (3 qt/A) on 6 Aug; Curzate (3.2 oz/A) on 26 Aug and 14 Sep; and Ranman 400 SC (2.75 fl oz/A) on 20 Aug and 1 Sep. Plots were three 15-ft rows spaced 68-in apart. The plots were 18-ft apart in the row initially until plants began to vine. Vines were moved as needed to maintain plot separation. A randomized complete block design with four replications was used. Treatments were applied five times on a 7- or 14-day schedule beginning on 3 Aug using a tractor-mounted boom sprayer equipped with twinjet (TJ60-11004VS) nozzles spaced 17-in apart that delivered 54 gal/A at 100 psi. Plots were inspected for powdery mildew symptoms on upper and lower leaf surfaces weekly beginning on 1 Aug. Initially the examined leaves were selected from the oldest third of the foliage based on leaf physiological appearance and position in the canopy. Additional powdery mildew assessments were made on 9, 17, 26 and 30 Aug. Mid-aged and young leaves were also assessed beginning on 17 Aug. Eight leaves per age group were examined in each plot initially; fewer leaves were examined as symptoms became more common. Powdery mildew colonies were counted; severity was assessed by visual estimation of percent leaf area infected when colonies could not be counted accurately because they had coalesced and/or were too numerous. Average severity for the entire canopy was calculated from the individual leaf assessments.

Powdery mildew started to develop earlier than expected compared to similar previous experiments with this variety based on both plant growth stage and calendar date. On 1 Aug, two days before treatments were started, powdery mildew was observed on 1 to all 8 older leaves examined in all but 2 of the 64 plots; overall incidence of affected leaves was 75%. Fruit had just started to develop and plant canopy had not closed between rows. Thus when treatments were started on 3 Aug powdery mildew in all plots greatly exceeded the IPM threshold of one affected leaf out of 50 old leaves. In contrast, only 5% of leaves were affected on 2 Aug 2010 in a similar experiment with the same variety planted on the same day. Efficacy of treatments may have been impacted by applications starting after the IPM threshold. Based on AUDPC values for upper leaf surfaces, the most effective fungicides were four new products: Luna Experience, Torino SC, Mervion (higher rate), and Fontelis SC. Treatments with these products had the lowest AUDPC values for lower leaf surfaces. These fungicides were not more effective than currently registered mobile fungicides with single site mode of action: Pristine, Quintec, and Procure.

Project partly funded by Friends of Long Island Horticulture Grant Program.

Fungicide Sensitivity of Cucurbit Powdery Mildew Pathogen Isolates on LI in 2010
Investigators: M. McGrath and L. Hunsberger
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 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*, the fungus that causes powdery mildew in cucurbit crops, were obtained at the end of the growing season in 2010 from commercial pumpkin crops on 21 Sep and from research fields on 13 and 20 Sep. They were maintained on leaf tissue on agar media in Petri dishes (culture plates) until tested.

For the leaf disk bioassay, pumpkin seedlings at the cotyledon leaf stage (about seven-day-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 on a laboratory shelf under constant light supplied by aquarium bulbs. 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 sporulate 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.

Sensitivity to fungicides at risk for resistance development was determined for 96 isolates collected in 2010. Almost all isolates (97%) tested with Topsin M were resistant to this fungicide group (MBC; FRAC code 1). Resistance to QoI fungicides (FRAC code 11) was detected in 98% of the isolates tested. Resistance to both fungicide groups is qualitative, thus pathogen isolates are either sensitive or resistant, and fungicides are ineffective against resistant isolates. These results support the recommendation to no longer use fungicides containing only these chemistries for managing powdery mildew. There is a fungicide (Pristine) with a FRAC code 11 active ingredient that has continued to be recommended because it contains another active ingredient (FRAC code 7). Applying Pristine could select for pathogen strains resistant to FRAC code 11 fungicides, thereby maintaining this resistance in the pathogen population. The very high frequency of resistance to FRAC code 1 fungicides, despite very limited use for other pathogens, indicates that there is no ‘fitness cost’ of this trait that would cause resistant strains to be at a competitive disadvantage with sensitive strains in the pathogen population.

Ability to grow on leaf disks with a high concentration (500 ppm) of boscalid, an active ingredient in Pristine, was detected in 43% of the pathogen isolates tested. This concentration is in the range of what would be in the spray tank when Pristine is applied at labeled rates, therefore isolates tolerating 500 ppm are likely fully resistant to this fungicide, which means they would not be controlled by Pristine. Isolates collected in 2010 were more sensitive to the other fungicides tested, which represent the other two fungicide chemistries recommended for managing cucurbit powdery mildew. Myclobutanil, the active ingredient in Rally, a FRAC code 3 fungicide, at 20 ppm was tolerated by 47% of the isolates. Only 11% were insensitive to 80 ppm myclobutanil. Quinoxyfen, the active ingredient in Quintec, a FRAC code 13 fungicide, at 10 ppm was tolerated by 42% of the isolates. One isolate tested was insensitive to 80 ppm myclobutanil and also to 40 ppm quinoxyfen as well as being fully resistant to boscalid and code 1 and 11 fungicides. Existence of pathogen isolates like this one with resistance or elevated insensitivity (compared to other isolates) to all labeled fungicide chemistries is a concern for continued effective management of cucurbit powdery mildew with currently-registered fungicides. Further evolution could result in development of full (practical) resistance to all fungicides.

Fungicide Sensitivity of Cucurbit Powdery Mildew Pathogen Populations on LI in 2011
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center and Surrounding Farms

Fungicide resistance can be a major constraint to effectively managing powdery mildew in cucurbit crops because the most effective fungicides for this disease are prone to resistance. The goal of this study was to examine pathogen populations to obtain information about sensitivity to fungicides that are currently in use. The seedling bioassay procedure used in this study provides estimates of the proportion of a population able to tolerate fungicides at the concentrations applied to the seedlings. It was conducted in commercial crops and research fields three times during the 2011 season.

Pumpkin seedlings were used in the bioassay to examine fungicide sensitivity of populations of the cucurbit powdery mildew fungus. They were produced in a growth chamber to about the one-leaf stage and then moved to a greenhouse and put in pots. After they had produced at least one more leaf they were treated with various doses of different fungicides applied to coverage with a CO_2-pressurized backpack sprayer, the next day put in the field for at least 4 hours, then kept in a greenhouse at LIHREC for about 10 days until powdery mildew was visible and could be assessed. Amount of mildew on leaves of treated plants was compared with leaves on non-treated plants to estimate the proportion of the pathogen population able to tolerate each fungicide concentration. While the seedlings were in the greenhouse before the treatments were applied, powdery mildew started to develop. These symptoms were marked out with a marking pen. Occurrence of the disease before the bioassays started may have confounded results because these fungicides are not effective for established infections; it is possible there was some additional symptom development after the early symptoms were marked out.

The first bioassay was conducted on 26 Jul in spring-planted summer squash in commercial crops and research fields at LIHREC. The second and third bioassays were conducted on 13 and 21 Sep in commercial pumpkin fields and in research plots of pumpkin and squash.

Resistance to FRAC Code 1 and Code 11 fungicides were detected in all populations examined, typically at high levels. Resistance to these chemistries is qualitative and cross resistance occurs amongst all fungicides in each group; thus a pathogen strain able to tolerate 50 ppm of any fungicide in each group is completely resistant and would not be controllable with any fungicide in the group. The bioassay results supported not recommending Topsin M, Quadris, and other fungicides in these groups in 2011; similar results were obtained in previous years.

Strains of the pathogen were detected able to tolerate 500 ppm boscalid (active ingredient in Pristine), 120 ppm myclobutanil (Rally) and 10 ppm quinoxyfen (Quintec). Ability to tolerate 500 ppm boscalid is of concern because this concentration is in the range of what would be in the spray tank when Pristine is applied. Resistance is common to the other active ingredient in Pristine, which is in FRAC code 11. Therefore Pristine would not be expected to be able to control these strains. On average, a lower proportion of the pathogen populations were able to tolerate 10 ppm quinoxyfen than 500 ppm boscalid or 120 ppm myclobutanil. The proportion was lowest for 10 ppm quinoxyfen. Therefore Quintec was expected to be the most effective fungicide in 2011.

Four FRAC Code 3 (DMI) fungicides were included in the bioassays at the same dose (40 ppm) to assess whether there are inherent differences in activity among fungicides in this chemical group. Only minor differences were detected which were not considered to be important. The fungicides tested were Rally, Procure, Tebuzol and Inspire. There are differences in the dose that can be applied to crops with these. The dose in the spray tank when these fungicides are applied at the highest labeled rate at 50 gpa are 263 ppm for Inspire Super, 300 ppm for Rally, 363 ppm for Tebuzol, and 527 ppm for Procure.

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Identification of Pathotypes of the Cucurbit Downy Mildew Pathogen Occurring on LI
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

Cucumbers, squashes, melons and pumpkins were grown in sentinel plots 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 capable of surviving in the absence of living host plant tissue; however, it produces spores capable of long-distance movement by wind. Successful dispersal to Long Island 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 uv 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 Long Island and which cucurbit crop types are at risk, growers can target their applications of fungicides with specific activity for downy mildew (oomycete) pathogens. This activity is also being done every growing season as part of the national forecasting program for cucurbit downy mildew.

To ensure leaf tissue for infection was present throughout the growing season, seedlings were transplanted into plots at two times, in early June and July. Only fungicides with targeted activity for powdery mildew were applied. Leaves were examined routinely for symptoms.

Symptoms of downy mildew were first observed on cucumber on 1 Aug. This cucurbit type is susceptible to all pathotypes thus it is expected to be affected first. Symptoms were observed on muskmelon on 17 Aug and on butternut squash on 16 Sep. None were seen on watermelon or on *Cucurbita pepo* crop types (which include pumpkin and summer and acorn squashes).

Efficacy of Fungicides for Managing Downy Mildew in Cucumber
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

Seeds of slicing cucumber variety General Lee were direct seeded on 7 Jul into beds with black plastic mulch and drip irrigation in a field with Haven loam soil at LIHREC. A late planting date was used to increase the likelihood of downy mildew developing during the experiment. A waterwheel transplanter was used to make planting holes in the beds and apply starter fertilizer plus insecticide on 7 Jul. During the season, water was provided as needed via drip irrigation lines. Weeds were controlled between mulched rows by applying a tank mix of Strategy (3 pt/A), Sandea (0.5 oz/A), and Scythe (1.3 fl oz/gal spray mix) on 7 Jun and by hand weeding. Cucumber beetles were managed with Admire Pro (7.5 fl oz/A) applied with the transplanter on 7 Jul. Fungicides were applied weekly for 6 weeks beginning on 4 Aug, six days before symptoms were first observed, using a backpack CO_2-pressurized sprayer equipped with a single-nozzle boom and an 8006VS nozzle operated at 55 psi and delivering 51 gal/A. It was intended that the treatments be applied on a preventive schedule. Plots were single 27-ft rows with 18 plants at 18-in spacing. The plots were 9-ft apart initially until plants began to vine. Vines were moved as needed to maintain plot separation. A randomized complete block design with six replications was used. Downy mildew severity was assessed on 10, 17 and 25 Aug, and 1 Sep by estimating incidence of symptomatic leaves in each plot and rating severity on nine representative affected leaves. Incidence and average severity for symptomatic leaves were used to estimate canopy severity. Fruit was removed from plants to maintain plant growth; yield was not assessed.

Symptoms of downy mildew were first observed on 1 Aug in cucumber in the adjacent cucurbit downy mildew sentinel plots and on 10 Aug in this experiment. Conditions were favorable for downy mildew development but not for applying fungicides. Presidio was the only treatment evaluated that provided full-season control of downy mildew. Based on AUDPC values, Presidio provided 85% control and was more effective than both the new fungicide Zampro and an alternation program with Forum and Ranman, which like Presidio are registered fungicides with targeted activity for downy mildew pathogens. Zampro was effective in fungicide evaluations conducted elsewhere in 2011.

Evaluation of Biopesticides For Managing Downy Mildew In Basil
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

Biopesticides were evaluated in a replicated experiment with field-grown basil at LIHREC. To provide a source of natural inoculum within the experimental area, basil was transplanted into spreader rows about 4 weeks before plants were scheduled to be transplanted into the plots. These rows were adjacent to rows of sorghum-sudangrass planted earlier to provide a more favorable environment for downy mildew to become established by creating shade and blocking air movement thereby promoting a more humid area. These plants were not inoculated. Basil for the experiment was seeded on 14 Jul in trays in a greenhouse and transplanted on 10 Aug into black plastic mulch with drip irrigation. A late planting date was used to increase the likelihood of downy mildew developing during the experiment. The primary source of initial inoculum in this area is considered to be wind-dispersed spores from affected plants in another area. Each plot had 17-20 plants in two 10-ft rows on black plastic mulch with 9-in plant spacing and 9-in row spacing. The plots were 6-ft apart in the row. A randomized complete block design with four replications was used. Fungicides were applied weekly on a preventive schedule. Applications were made with a backpack CO_2-pressurized sprayer and a hand-held boom equipped with a single-nozzle boom and an 8006VS nozzle operated at 55 psi and delivering 51 gal/A. A 7-day spray schedule was used for all treatments except Oxidate, which was applied 3 times each week. It was applied twice on the day other treatments were applied, once before the others and about 1 hour later after the other treatments were made, and again about 3 days later. Treatments were applied on 11, 17, 24 and 31 Aug, 7 and 14 Sep. Revus was selected as the conventional fungicide standard because it has provided consistently good suppression in evaluations of conventional fungicides conducted in FL. It is expected to provide a measure of the maximum control achievable under the experiment conditions. This treatment is important to include especially with a disease like basil downy mildew that may be difficult to control. Downy mildew was rated in each plot every week beginning on 19 Aug. The percentage of leaves per plant with symptoms (sporulation of the pathogen visible on the underside) was estimated for 10 plants in each plot. Area Under Disease Progress Curve (AUDPC) was calculated for all assessment dates to obtain a disease severity measurement for the whole period.

Environmental conditions were atypical for the region during late August and September, when this experiment was being conducted, with a hurricane plus rain occurring on many more days than usual. This provided very favorable conditions for disease development but not for applying fungicide treatments or for plant growth. Research plants were damaged by the strong winds and intensive rainfall occurring during the storms, especially during Hurricane Irene on 28 Aug. Rain fell on 10 days during August, delivering a total of 10.6 in. Another major rainfall of 3.4 in. occurred over 6-8 Sep. Rainy weather provided favorable conditions for downy mildew. Symptoms of downy mildew were first observed in this experiment on 19 Aug in the spreader row. Symptoms were not found in plots until 25 Aug, which was after the second application. No significant differences were detected among treatments. Suppression of downy mildew was not detected with any treatment, including the conventional fungicide Revus. These results document the challenges of effectively managing downy mildew in basil when conditions are very favorable. Fungicides were applied on a preventive schedule beginning two weeks before symptoms were observed in plots. Among the biopesticide treatments, the numerically fewest affected leaves were observed in plots treated with ProPhyt. Amount of downy mildew present was similar to plots treated with Revus.

Project funded by IR-4 Biopesticide Demonstration Grant Program.

Monitoring Program for Downy Mildew Occurrence in Basil in the USA
Investigators: M. McGrath
Location: Long Island Horticultural Research and Extension Center

Downy mildew is a new disease of basil in the USA. It was first detected in FL in Oct 2007. There were several reports in the eastern USA in 2008. A monitoring program was started in 2009 to obtain information on occurrence each year in the US, to determine whether this pathogen can move northward through the eastern USA as occurs with the cucurbit downy mildew pathogen, and to assist growers be prepared for downy mildew occurrence in their basil crop by providing information on where the disease is occurring.

Occurrence in 2011 was monitored through sentinel plots planted with the cucurbit downy mildew project plots throughout the eastern USA and a publicly-accessible spreadsheet on the web at https://spreadsheets.google.com/ccc?key=tphmBim45_9rRh31XfV7OeA&hl=en#

Downy mildew was reported in 2011 on basil grown in greenhouses and outdoors, in both commercial crops and gardens, in the field and in containers. A total of 63 reports were logged. The first reported observation was from HA in Jan, which was the first report from that state. Downy mildew was reported in 20 additional states during the year: CA, CT, DE, FL, IL, IN, KS, LA, MA, MD, ME, MN, NJ, NY, PA, RI, TX, VT, WA, and WI. It was also reported in Costa Rico, Puerto Rico, Quebec, and Ontario. An additional report from Baja California has not yet been logged. Not all reports were made by plant pathologists or confirmed by microscopic examination. Entries in the spreadsheet include the reporter's name and method of diagnosis. A few reports were from greenhouses at a time of the season that contaminated seed was the only feasible source.

Downy mildew is now recognized to be established in the USA and is anticipated to continue occurring every year. The need to apply fungicides to control downy mildew has forced a change in the production of a crop that rarely needed pesticide applications previously.

Biofumigant Mustard Cover Crop and Mustard Meal Product Examined for Managing Phytophthora Blight
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

An observational, non-replicated study was conducted to examine Biofence, a mustard meal product, and three varieties of mustard developed for use as biofumigant cover crops. One of the varieties, Caliente 199, was demonstrated to be effective for managing Phytophthora blight through previous projects at LIHREC. Idagold and PacificGold were also grown. If effective, a mustard meal product would be a good alternative when there is not enough time to grow a cover crop before it is time to plant the crop. Biofence (Volunteer Ag Products, LLC.) currently is marketed as an organic fertilizer.

The study was done in a research field dedicated to work on Phytophthora blight. Fertilizer (38-0-0) at 75 lb/A was spread on 3 May and tilled to incorporate where mustard cover crops were to be seeded, which was done on 6 May by drilling. On 30 June mustard was flail-chopped, roto-tilled to incorporate, then irrigated to seal the soil surface. Fertilizer (10-10-10) at 500 lb/A was spread on 17 Jul over rows where mustard was incorporated to augment fertility from the cover crop. Biofence was broadcast at 2000 lb/A (120 lb/A N) on 17 Jul, incorporated by disking, then irrigated to activate. In addition to the 3 sections with mustard cover crop and the section with Biofence, there was a section where Caliente 199 was grown in 2010 and a non-treated section. To ensure the pathogen was present, cucumber fruit that had been inoculated with the pathogen (*Phytophthora capsici*) were placed in each section of the field just before the treatment was incorporated. All sections were seeded to 'Royal Ace PM' acorn squash on 22 Jul.

Unusually intensive rain events created exceptionally favorable conditions for Phytophthora blight throughout LI in 2011, resulting in high incidence of blight in this study as well as in commercial crops. Rainfall amounts for the study site were 2.33 in. on 28 Aug (Hurricane Irene), 1.32 in. on 6 Sept, 1.06 in. on 7 Sept, and 0.98 in. on 8 Sept. When soil is saturated, *Phytophthora capsici* produces and releases spores that are capable of moving to host plants in a directed fashion. Phytophthora blight developed in the research field after this period. Incidence was high when assessed on 15 Sept. Diseases caused by soil-borne pathogens generally, and this disease particularly, can be very difficult to suppress under conditions highly favorable for their development. Therefore, lack of detectable suppression of Phytophthora blight with any treatment in 2011 was not surprising.

Serenade Soil Evaluated for Managing Phytophthora Blight

Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

An experiment was conducted in a research field dedicated to work on Phytophthora blight. There were 3 treatments plus a non-treated control. For two treatments, the new biofungicide Serenade Soil was applied either in-furrow at seeding or broadcast over the plot after seeding 'Royal Ace PM' acorn squash on 22 Jul. These applications were followed by directed sprays to soil at the base of plants made on 12 Aug and 1 Sept using a backpack sprayer with hand boom. The third conventional fungicide treatment consisted of ProPhyt applied in-furrow, followed by foliar applications of Presidio on 25 Aug and Ranman on 2 Sept.

Results were the same as the other study in this field, which are covered in the last paragraph of the previous report.

Efficacy of Biological Products for Fusarium Crown Rot of Pumpkin

Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

Fusarium crown rot and fruit rot have been observed more commonly in pumpkin crops on LI in recent years, especially in fields used for u-pick where there are limited options for rotation to other crops. A series of experiments were conducted under controlled greenhouse conditions to obtain preliminary information on the efficacy of several biological products (biopesticides) for Fusarium crown rot of pumpkins.

Inoculum for the experiments was prepared by infesting Japanese millet seed. Two isolates of the pathogen were used that had been obtained from affected pumpkin fruit on LI and maintained on artificial PDA medium in Petri dishes. Seed were put in a glass flask, moistened, autoclaved twice, then pieces of the medium with the pathogen were added to the flask. After a week with routine shaking, the pathogen was growing on the seed throughout the flask. Following this growth period, the infested seeds were placed in a paper bag and allowed to air dry.

Treatments were applied to soil used to germinate pumpkin in cell packs and to soil along with the pathogen in 8-inch pots. Non-fungicide-treated seed was used. Two weeks after sowing, the pumpkin seedlings were transplanted into the pots with the corresponding treatment, and then the treatment was reapplied. The reason this approach was taken was to provide an incubation period for the biocontrol organisms in the products to interact with the pathogen and with the host plant separately, thereby allowing these organisms to initiate control before the pathogen and plant came into proximity. Biocontrol organisms can function by directly affecting the pathogen and/or by protecting the plant through establishing themselves on the plant surface. Soil for each pot was infested with the pathogen before applying the treatment by mixing into the soil 2 grams of *Fusarium*-infested seed that had been ground using a mortar and pestle to obtain small particles for more even distribution. Each pot had 150 grams of Metro Mix 350, a soilless potting mix not formulated with any beneficial organisms. The following treatments were added to soil in the pots: SoilGard (0.5 lb/cu yd soil mix), Serenade Soil (2 qt/A), RootShield Granular (1.5 lb/cu yd soil mix), RootShield Plus (1.5 lb/cu yd soil mix), Actinovate (2 oz per 100 gallons water), DT-9 (an experimental product) (2 oz per 100 gallons water) and Tenet (7.5 oz/100 gal). These treatments were also applied at these rates to soil in cell packs except that Actinovate and DT-9 were applied at 4 oz per 100 gallons water. All products were watered in. Soil in pots was kept moist by watering as needed. After two weeks, four seedlings were transplanted into each pot. All treatments were reapplied after transplanting at the rate applied to the pots. Serenade Soil, Actinovate, DT-9 and Tenet were reapplied again 2 weeks following transplanting at the same rates. Pots were arranged in a randomized block design with four replications in each experiment. The experiment was conducted twice, starting on 2 June and on 16 Aug.

Symptoms of crown rot included plant wilting, yellowing of leaves and browning at the base of the stem. Wilting of plant leaves was observed first (about 2 weeks after transplanting), while leaf chlorosis and browning at the stem base were often the last symptoms to appear (approximately 5 days later). In the first experiment, which was conducted in June, SoilGard was most effective for delaying appearance of all three symptoms of crown rot. RootShield Plus, Actinovate and Tenet providing the least amount of control. In the August experiment, Actinovate treatment had to be dropped because seed in this treatment did not germinate. DT-9 had the lowest percentage of browning at the base of the stem, but there was no difference in yellowing, wilting or the percent of plants that died, compared to the other treatments while Serenade Soil and SoilGard had the highest percentages of browning of the stem. All of the plants became heavily affected by powdery mildew, which as a foliar disease probably did not interfere with treatments being applied for a root and crown disease. This study is ongoing, and will be repeated during the spring of 2012.

Project funded by IR-4 Biopesticide Demonstration Grant Program.

Ozone Concentration in Riverhead in 2011
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

Ozone reached sufficiently high levels to cause acute, visible injury to leaves of sensitive crops in 2011 as usual on Long Island. Ozone also causes sensitive plants to senesce prematurely. During the growing season (1 May – 30 Sep) in 2011 ozone concentration was ≥80 ppb for at least 48 hours on 13 days: 7 Jun (6 hours), 8 Jun (6), 9 Jun (5), 16 Jun (1), 18 Jun (1), 6 Jul (1), 7 Jul (4), 11 Jul (4), 16 Jul (3), 18 Jul (3), 22 Jul (9), 23 Jul (2), and 1 Aug (3). Ozone was at least 50 ppb on 592 hours on 81 days and at least 60 ppb on 222 hours on 38 days. The highest concentration in 2011 (100 ppb) occurred for one hour on 9 Jun. This was the only date that ozone was at least 100 ppb, in contrast with most previous years. There was only one period of elevated ozone exceeding 90 ppb for at least two consecutive days (7 – 9 June), and it occurred almost one month earlier in the growing season than previous years. Ozone was at least 40 ppb for 87 of 120 hours and at least 70 ppb for 27 hours during the 5-day period of elevated ozone (6 - 10 June). Typically high concentrations occurred between 1200 and 2200, as in previous years. Ozone was ≥80 ppb for 60, 124, 121, 184, 77, at least 67, 94, 40, at least 10, 95, 65, 47, 57, 32, and 48 hrs in 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2010, and 2011, respectively.

Assessment of Ambient Ozone Impact on Plant Productivity Using a Snap Bean Bioindicator System
Investigators: M. McGrath and L. Hunsberger
Location: Long Island Horticultural Research and Extension Center

Research on ozone-sensitive and ozone-resistant snap bean lines was continued in 2011 following procedures used in previous years. The lines, sensitive S156 and resistant (tolerant) R331, were developed at the USDA-ARS Air Quality Research Unit in Raleigh, NC, to be used to investigate the impact of ambient ozone (O_3) on plant productivity. These lines yield similarly under low ozone concentrations. There were 3 successive field plantings (seeded on 13 May, 22 Jun, and 14 Jul) to be able to assess the impact of ambient ozone occurring throughout the growing season. Seed were inoculated with Rhizobia then sown by hand with 2 seeds placed every 9 inches, then thinned to 30 plants per plot in a row with 4 replications. Drip tape was laid next to each row for irrigation. Bean pods were harvested when immature for fresh-market consumption from half the plants repeatedly as they developed. Bean pods were harvested when seed were mature from the rest of the plants. Plants were examined routinely for ozone injury. Injury and defoliation due mainly to ozone injury were rated. Ozone concentration data were obtained from a monitor maintained at LIHREC by the NYS DEC Air Quality Division. The hourly values were used to calculate ozone exposure expressed as AOT40 (accumulated ozone exposure over the threshold of 40 ppb between 8 am and 8 pm). AOT40 is a commonly used measure of ozone exposure.

Findings contributed to the database of plant response to ambient ozone (O_3). An extensive set of data from multiple locations, environmental conditions, and ozone concentrations is needed in order to model ozone impact on plant productivity. As in previous years at the NY location, O_3 reached sufficiently high levels in 2011 to cause acute, visible injury to bean leaves; however, impact on yield was less than in previous years. This was partly due to the second and third plantings being adversely affected by Hurricane Irene on 28 Aug and a tropical storm the following week. From plant emergence (about 7 days after planting) until the end of the plant growing period (standardized at 77 days after planting), bean plants in the three plantings were exposed to O_3 during daytime (0800-2000) that was at least 40 ppb for 629, 645, and 426 hours, respectively. During these growth periods, O3 exposure expressed as AOT40 (Accumulated Ozone exposure over a Threshold of 40 ppb) was 9,994 ppb.h, 8,341 ppb.h, and 4,214 ppb.h, respectively. These values are similar to previous years. The first two values greatly exceed the long-term critical level of ozone exposure for crops of 3,000 ppb.h accumulated over three months. The most elevated period of ozone occurred earlier in the year than usual (6 – 10 Jun) when only the first planting was present.

Exposure to ozone caused acute foliar injury in all three plantings. The visible symptom was bronzing. Severely affected leaves eventually died and dropped. Severity was assessed weekly by estimating the incidence of leaflets with symptoms and the average percentage of leaf tissue with symptoms on affected leaflets. The sensitive line was more severely affected than the tolerant one. In the second planting, severity remained below 10% until 24 Aug when it was 26% for S156 and 9% for R331. Defoliation then was 21% and 13%, respectively. The second of three fresh market harvests was made on that date. In the third planting, severity remained below 10% until 9 Sept when it was 54% for S156 and 7% for R331. Defoliation then was 19% and 6%, respectively. These plants produced few pods thus harvesting was delayed until 15 Sept.

Number and weight of beans picked at the fresh market stage was similar for the O_3-sensitive snap bean line S156 and the tolerant line R331 in all three planting, in sharp contrast with previous years. No significant differences were detected for these yield parameters at any harvest date or totaled over the whole harvest period for each planting. Fresh market beans were harvested 4 times from 8 to 27 Jul for planting 1, 3 times from 17 Aug to 1 Sept for planting 2, and once on 15 Sept for planting 3. In contrast, significant yield differences were detected for mature bean yield, which has been affected more by exposure to ambient O_3 conditions than fresh market yield in previous experiments. Weight of dry pods was 58% and 59% lower for S156 compared to R331 in planting 2 and 3, respectively. This reduction was partly due to there being 35% and 34% fewer pods, respectively. Weight of seeds removed from the pods was 63% and 56% lower, respectively, and number of seeds was reduced 61% and 53%.