# Long Island Vegetable Pathology Program
# 2012 Annual Research Report

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**Evaluation of reduced tillage production system for green beans**
**Investigators: Margaret T. McGrath, Sandra Menasha, and Karen LaMarsh**
**Location: Long Island Horticultural Research and Extension Center**

Snap beans were planted in a field used for comparing reduced and conventional tillage since 2010. 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 6 rows spaced 34 inch apart. Previous crops were brassicas grown in 2010 and butternut squash grown with spring-planted cover crops in 2011.

The conventional-till plots were established by subsoiling then roto-tilling and disking to prepare the soil for planting on 28 May and again on 28 June. The reduced-till plots were established by rolling the rye when at flowering with a cultipacker and then applying Round-up WeatherMAX (32 oz/A) on 15 June. A two-row Unverferth zone-builder was used to prepare rows in the reduced-till strips on 28 June. This unit was set-up with a rolling basket for preparing the bed for one row and a cultipacker wheel for the other bed to compare these two tools. Seeds were planted at 10.5 inch spacing using a vacuum seeder equipped with row cleaners. The center four of the six rows in each strip received a different fertilizer and inoculant treatments. A 2 X 2 factorial design of these treatments was used. A 60% slow-release fertilizer (17-3-10 + micronutrients) was used at two rates, 40 and 80 lb/A of nitrogen. The inoculant treatments were with and without Johnny's Garden Combination Inoculant. Weeds were managed by applying Command 3ME (0.67 pt/A) to all plots on 10 July. Soil moisture was monitored at two depths (6 and 9 inches) in two reduced-till and conventional-till plots. Plant stand was assessed by counting plants in 10-ft row lengths. On 22 August, 10 plants were removed from sub-plots in the conventional-till plots to determine if biomass was affected by the treatments.

Plant stand was similar in all plots and there was no visible difference in plant growth, demonstrating the potential for producing snap beans with reduced-tillage. When the seed was planted it was noted that the row cleaner put on the seeder worked well to ensure a good plant bed without rye straw. While there were some significant difference in plant stand among treatments, the average for the reduced-till and the conventional-till treatments were the same: 18.9 plants in 10-ft row length. Weed control was poor in all plots, thus a pre-emergent herbicide alone was inadequate for managing weeds in snap beans, regardless of the tillage system.

*Acknowledgments*: Project funded by NE SARE.

**Evaluation of reduced tillage production system for pumpkin**
**Investigators: Margaret T. McGrath, Sandra Menasha, and Karen LaMarsh**
**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 over successive years of implementing reduced tillage practices. A replicated experiment was conducted in 2012 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. Pumpkins were grown in at least half of the field in 2004, 2005, 2006, 2007, 2008, 2010, and 2011. Sweet corn is the other crop that has been grown in this field under reduced tillage. The field is set up with 4 replications of adjacent strip plots being managed with conventional and reduced tillage. Strips are 17 ft wide and 300 ft long.

Two timings and methods for killing the cover crop were examined in 2012 for the reduced-till plots. The four strips were split into sub-plots that were assigned randomly. For the early-kill rye, the rye was killed when about 24-30 inch tall by first applying Round-up WeatherMAX (32 oz/A) on 7 May and then rolling it with a cultipacker on 14 May. For the late-kill rye, the rye was killed when at full height and flowering, about 48 inch tall, by first rolling on 15 May and then applying Round-up on 18 May. Round-up was re-applied on 15 June to kill weeds. A 2-row Unverferth zone builder was used to establish the rows in all replications on 18 June. The conventional-till plots were established by subsoiling on 29 May, then roto-tilling and disking to prepare the soil for planting on 30 May and again on 29 June. On 5 July pumpkin (variety Field Trip) was direct-seeded into all conventional and reduced-till rows with 600 lb/A 15-5-15 controlled release fertilizer applied by the seeder in 2 bands about 2-in from the seed on both sides. The next day, Strategy (3 pt/A), Curbit EC (1 pt/A), and Sandea (0.5 oz/A) were applied, then the field was irrigated to activate the herbicide. Slug feeding had damaged fruit the previous two years, therefore Deadline Bullets (slug bait) was spread at 10 lb/A over the plots and driveways using a fertilizer spreader on 9 July. The conventional-till plots were cultivated on 25 July to manage weeds. Yield was assessed in October.

Weed control was better where the late-kill rye method was used than the early-kill rye, but best with conventional tillage. In most previous experiments the late-kill rye method was used to establish the straw mulch. This was done because it was anticipated that it would be possible to obtain better coverage of rye with herbicide applied after rolling, and with the spray boom near the ground it would be easier to reach low growing weeds plus there would be reduced potential for herbicide drift during the application. However, while applying Round-up to the sub-plots it was observed that the spray was penetrating well into the rye canopy, possibly reaching low weeds better than when rye had been rolled on top of them; and with the spray boom placed right at the top of the rye, it appeared that the rye provided some drift protection. However, the observed better weed control with the late-kill rye method suggests that greater amount of straw mulch covering the ground contributed more to full-season weed control than the herbicides. A post-emergence herbicide application might have improved control.

Neither plant stand nor fruit size were affected by tillage. There were no significant differences in plant counts in the sub-plots, which ranged from 190 for the late-kill rye to 196 for the early-kill rye, with convention-till in between. Average fruit weight was 4.2 lb/fruit for the early-kill rye treatment, 4.4 lb/fruit for the late-kill rye, and 4.7 lb/fruit for the convention-till. No fruit were observed with any type of fruit rot, including that caused by the pathogen *Phytophthora capsici*, which affected pumpkin in other experiments conducted at LIHREC in 2012. This pathogen has been seen in this research field in the past, including in 2011 when 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. No damage from slug feeding was observed on any fruit.

*Acknowledgments*: Project funded by NE SARE.

**Evaluation of biopesticides for foliar diseases in organically-produced tomato**
**Investigators: Margaret T. McGrath and Karen LaMarsh**
**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. Pro-Grow 5-3-4 organic fertilizer at 2000 lb/A was spread over rows to be planted, then incorporated. Next, drip tape was laid as the rows were being covered with black plastic mulch. Annual ryegrass was planted between plastic mulch to establish a living mulch by broadcasting seed with a hand-operated spreader, then lightly raking to incorporate. The ryegrass plus weeds that grew were mowed routinely. Some weeds were removed by hand. Seedlings of variety ‘Finishline’ were transplanted on 19 June by hand into holes opened in the plastic mulch by a waterwheel transplanter that also placed in the holes a starter fertilizer, Neptune’s Harvest Benefits of Fish (2-4-1). Plants were staked and trellised. The following fungicides with targeted activity for oomycetes were applied on a 7-day, preventive schedule due to an early outbreak of late blight in the region: Forum on 27 July, 21 September; Presidio on 27 July, 23 August, 7 September; Previcur Flex on 18 July, 8 August; Revus on 14 August, 31 August, 14 September; and Ridomil on 31 July. Late blight was not a target disease for this experiment. Insects were managed by applying Abba on 27 July and Entrust on 31 July and 8 August. 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. A completely randomized block design with four replications was used. Serenade Soil was applied on 2 July as a drench around the base of plants using a $CO_2$-pressurized backpack sprayer with a boom that has a single twin-jet nozzle (TJ60-11003). Foliar treatment applications were made using this sprayer and boom calibrated to deliver 50 gal/A when operated at 54 psi and 2.4 mph. Each side of the planted row was treated with the boom held sideways to obtain thorough coverage of foliage and to mimic the coverage obtained with a drop nozzle on a tractor sprayer. A preventive 7-day application schedule was used. Applications were made on 26 July; 1, 8, 14, 21, and 29 August; and 7, 13, and 26 September. Leaves were examined routinely for disease symptoms. All diseases that occurred started from naturally-occurring inoculum; artificial inoculation was not done. Disease severity was assessed by counting number of leaves with symptoms when incidence was low. When symptoms were more common, estimations were made of the percentage of leaves in each plot with symptoms (incidence) and the severity of symptoms on these affected leaves. Defoliation was assessed as percent of leaves that had died. Ripe marketable and unmarketable fruit were harvested on 20 September and 2 October.

Tomato plants did not grow well perhaps because the fertilizer used did not provide adequate nutrients and/or the ryegrass living mulch was able to utilize fertilizer placed under the plastic mulch. This likely affected disease development. Both Septoria leaf spot and powdery mildew have been severe in previous experiments in this location. However, disease was low during this experiment. Symptoms were not found in several plots at most disease assessments. Late blight was also assessed to determine if control achieved with the conventional fungicides applied to the entire experiment was improved by any of the treatments. No significant differences in disease severity or defoliation were detected among treatments. Disease ratings and defoliation were numerically among the lowest for plants treated with Nordox 75WG (2 lb/A). Disease ratings were also low for plants treated with Regalia (1 qt/A) + Nordox. Disease ratings and defoliation were numerically highest for the Double Nickel (6 qt/A) and Serenade Soil (2 q/A soil drench after planting) + Sonata (4 qt/A). Other treatments (rate/A) evaluated were Regalia (2 qt) alternated with Nordox, Sonata (4 qt), Sonata alt. Nordox, Serenade (4 qt) + MilStop (2.5 lb), Timorex Gold, Badge X2 (1.25 lb), and Bravo Ultrex (conventional standard). Badge and Nordox are copper fungicides. Timorex Gold is the only product evaluated that is not yet registered for use in the USA. There were no significant differences among treatments in yield.

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**Evaluation of fungicides for powdery mildew in tomato**
**Investigators: Margaret T. McGrath and Karen LaMarsh**
**Location: Long Island Horticultural Research and Extension Center**

An experiment was conducted to evaluate Mettle, a new DMI fungicide (FRAC Code 3), compared to Rally, another fungicide in this chemical group that is already registered for this use. The variety and cultural practices used for this experiment were the same as described in the previous two reports. The experiment could not be completed because powdery mildew did not develop, in contrast with 2011 when a similar evaluation was conducted.

**Evaluation of fungicides for controlling white mold in tomato**
**Investigators: Margaret T. McGrath and Karen LaMarsh**
**Location: Long Island Horticultural Research and Extension Center**

New fungicides not registered for white mold (aka timber rot) were compared in an experiment conducted at LIHREC. Pro-Grow 5-3-4 organic fertilizer at 2000 lb/A was spread over rows to be planted, then incorporated. Next, drip tape was laid as the rows were being covered with black plastic mulch. Annual ryegrass was planted between plastic mulch to establish a living mulch by broadcasting seed with a hand-operated spreader, then lightly raking to incorporate. The ryegrass plus weeds that grew were mowed routinely. Some weeds were removed by hand. Seedlings of variety ‘Finishline’ were transplanted on 26 June by hand into holes opened in the plastic mulch by a waterwheel transplanter. Plants were staked and trellised. Fungicides were applied weekly for late blight from 27 July through 14 September (details in previous report). 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. A completely randomized block design with four replications was used. Treatments were applied as soil drench and foliar sprays. Drench applications were made on 12 July and 31 August by pouring 3.38 fl oz of fungicide solution around the base of each plant. Additionally, four foliar applications were made on 30 August; 10, 19, and 20 September, and 1 October using a $CO_2$-pressurized backpack sprayer with a boom that has a single twin-jet nozzle (TJ60-11003) delivering 49 gal/A when operated at 54 psi and 2.4 mph. 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. Plants were inoculated on 7 and 25 September when rain before or afterwards provided conditions favorable for infection. Every other plant was wounded by damaging branches because the pathogen

(*Sclerotinia sclerotiorum*) often infects through wounds, then a solution of spores was sprayed on all plants using a hand-pump sprayer. Plants were examined routinely for symptoms.

Symptoms were first seen on 10 October. Most symptoms observed were at wound sites. No significant differences were detected among treatments. Three treatments (rate/A) had numerically fewer symptoms than the nontreated control: IFK-5411 (13.5 fl oz), Fontelis 200 SC (24.0 fl oz), and Cannonball (0.5 lb). These are listed based on overall disease occurrence beginning with the least. Other treatments were Endura (12.5 oz), Omega 500F (6.45 fl oz), and Aproach (9.0 fl oz). Symptoms were observed on 12 October in all control and Omega plots, but only one of the four plots treated with Fontelis and one plot treated with IKF-5411.

*Acknowledgments*: Project funded by the IR-4 Program.

**Evaluation of late blight resistant tomato varieties conducted with organic practices**
**Investigators: Margaret T. McGrath, Sandra Menasha, and Karen LaMarsh**
**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 and spot, 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. Organic growers on Long Island have identified tomato as a high priority for research. 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 with Haven loam soil that has been dedicated to research on organically-produced crops since 2001. Pro-Grow 5-3-4 organic fertilizer at 2000 lb/A was spread over rows to be planted, then incorporated on 29 June. Next drip tape was laid as the rows were covered with black plastic mulch. Annual ryegrass was planted between rows of plastic mulch to establish a living mulch by broadcasting seed with a hand-operated spreader, then lightly raking to incorporate. The ryegrass plus weeds that grew were mowed routinely. Some weeds were removed by hand. Tomato seed were sown in an organic seeding mix in the greenhouse on 6 June. Seedlings were transplanted by hand on 5 July into holes opened in the plastic mulch by a waterwheel transplanter that also placed in the holes a starter fertilizer, Neptune's Harvest Benefits of Fish (2-4-1). A completely randomized block design with four replications was used. Plots consisted of 10 plants in a single row with 24-in. plant spacing and 68-in. row spacing. A yellow cherry-type tomato plant (variety Sungold) separated plots within rows. Plots for each of the four replications were in three adjacent rows. Plants were staked and trellised as they grew using the Florida weave trellising system with 4-ft stakes placed between plants. Insect pests were managed by applying Entrust (2 oz/A) on 7 August, 14 August, and 7 September. A few symptoms of late blight were found on 31 July. This was considered to be at a time in the growing season that late blight left unmanaged could adversely affect other experiments and commercial crops nearby. Fungicides approved for organic production were applied to all plots to suppress late blight after finding symptoms in the plots. The copper fungicide Badge X2 (1.75 lb/A) was applied with Actinovate AG (12 oz/A) on 14 August and 22

August, and with Regalia (2 qt/A) on 17 August, 31 August and 7 September. Sonata ASO (3 qt/A) was also applied on 7 September. All applications were made using a tractor-mounted boom sprayer equipped with twinjet (TJ60-11004VS) nozzles spaced 17 in. apart that delivered 68 gal/A at 65 psi and 2.3 mph. Leaves were examined for symptoms of any foliar disease eight times from 31 July to 12 October. Late blight and other diseases observed were 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 by multiplying these values. Ripe fruit were harvested on 11, 18, and 27 September and 3 October. Fruit quality attributes assessed included taste rated on a 1-5 scale with 5 being excellent. Yield was not measured for the two entries with cherry-type fruit.

Late blight started to develop early in 2012 in Suffolk County. First symptoms were found on 29 May in a commercial potato crop. Symptoms were found in this experiment on 31 July. US-23 was the only genotype of the pathogen, *Phytophthora infestans* found in the region, including at LIHREC. The fungicide program was started too late to prevent extensive disease development in varieties lacking resistance genes, but their new growth was protected. Excellent resistance was exhibited through 19 September by all entries with the *Ph2* and *Ph3* major genes for resistance, which were Defiant PHR, Mountain Magic, Mountain Merit, and three experimentals from the Cornell University Dept of Plant Breeding (all heterozygous *Ph2* + *Ph3*). There were also very few symptoms on Matt's Wild Cherry (undetermined resistance, possibly *Ph3*) and Jasper (undetermined resistance). Plum Regal and JTO-545, the two entries with just the *Ph3* gene (homozygous and heterozygous, respectively), were numerically more severely affected by late blight than the other resistant entries at all assessments. The difference was significant at the last assessment (12 October), which was 35 days after the last fungicide application for late blight. Legend, the only entry with just the *Ph2* gene, was numerically, but not significantly, more severely affected by late blight than the resistant entries with *Ph3*, except at the last assessment when extensive defoliation may have affected ratings. Late blight became severe in New Yorker (*Ph1*). Late blight in this resistant variety did not differ significantly in severity from any of the varieties without major resistance genes, which were Mountain Fresh Plus, Juliet and Brandywine. Powdery mildew and Septoria leaf spot developed to a very limited extent in this experiment.

In conclusion, best suppression of the US-23 genotype was achieved with tomato plants possessing both the *Ph2* and *Ph3* resistance genes. Only a few fruit with symptoms of late blight were observed on these entries.

Most tomatoes evaluated produce red slicer-type fruit. Juliet, Plum Regal and JTO-545 are plum types. Mountain Magic is a campari type. Matt's Wild Cherry and Jasper are cherry types. These three received the highest taste ratings (4.6-4.7 out of 5). Fruit of Defiant PHR started to ripen before other non-cherry entries. It was the only one with ripe fruit at the first harvest on 11 September with an average of 2.7 fruit/plant. Numerically, but not significantly, more fruit were harvested from Defiant PHR than other entries producing red slicer type fruit.

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**Investigating occurrence and assisting growers manage late blight in tomato and potato**
**Investigators: Amanda Gardner and Margaret T. McGrath**
**Location: North Fork, Long Island**

The two components of this project were monitoring late blight occurrence in commercial and research plantings and using the late blight Decision Support System to guide fungicide applications. The overall goal was to help growers manage late blight while learning about development of this disease under different scenarios. Potatoes and tomatoes were scouted at three organic farms on the North Fork of Long Island, as well as tomatoes grown at Cornell's research facility in Riverhead (LIHREC). The scouting visits started at the end of June and the beginning of July. At that time, late blight had just started to develop in the tomatoes at one of the farms and the potatoes at another. Throughout the summer, plantings at each farm were examined weekly to determine if there were new outbreaks of late blight and to monitor the plantings that were already affected by late blight, to see how well it was being managed. Additionally, each week the late blight DSS (decision support system) was run. The DSS is a computer-based system that utilizes data from local weather stations to predict when conditions are favorable for the first late blight outbreak. The DSS also offers suggestions as to when the next fungicide application should be made. The program allows users to keep a log of fungicide applications and utilizes this log when offering suggestions for the next application. When this project began, the intention was to test how well the DSS's suggestions worked for managing late blight at each of the three farms; however, an easy means to share application records wasn't developed, and these growers had production constraints hindering their ability to implement a DSS spray schedule. One grower makes all his pesticide applications right before the day his workers have off. Another grower treats his flowering crops in sections over several evenings to minimize impact to bees. The DSS was used for research plantings at LIHREC as well as to create a chart with application suggestions to post in the Suffolk county weekly grower newsletter.

At the one farm, where late blight was found on the tomatoes on 28 June, the grower treated his plants regularly with a copper fungicide. After detection, he removed the four most severely affected plants and some leaves on other plants, and started applying a biofungicide with copper, alternating among Regalia and Actinovate. While the pathogen remained present in his field throughout the summer, the management program helped to keep it under control. During the harvest period, the grower did not want to have any residue on the fruit so he stopped treating the plants regularly. It was only at this point that late blight became severe. By the last scouting visit, which was at the end of August, it appeared that all of his tomato plants had late blight. At the second farm, late blight was found in potatoes during the first visit on 2 July. Symptoms were in one area and looked to be the result of recent infection. The potato and tomato fields at this farm were near to each other, and the only separation between them was a small vineyard. Upon hearing the news that his potatoes had late blight, the grower began treating his tomato plants with neem oil. Even with the close proximity between the tomato and potato fields, the tomatoes remained free of late blight for over a month. After late blight was discovered in the tomato field on 3 August, the grower removed the most severely affected plants and continued to treat the tomatoes with neem oil. Late blight remained present in both of the fields for the rest of the summer, but did not kill the plants. Septoria leaf spot was common in these tomatoes. The third farm also had both potatoes and tomatoes. Late blight was never observed on any of the potato plants. By mid July most of the above ground growth on the potatoes had died back and from this point on only the tomatoes were scouted. The tomatoes remained free of late blight until early August. After late blight was discovered on his tomatoes on 9 August, the grower began to treat them with copper, Regalia and Actinovate. Certain parts of the grower's field were hit harder than others, the incidence and severity seemed to change with the variety. Defiant was one of the many varieties of tomatoes grown at this farm. Defiant, which was bred to have both the *Ph2* and *Ph3* late blight resistance genes, remained unaffected by late blight even when neighboring varieties became affected. Overall the second farm had the most success managing late blight. When fungicides were being applied regularly the first farm had good control of late blight. The third farm had the most trouble with management of late blight. At these farms, the late blight outbreaks seemed to appear in clusters. The first cluster of outbreaks appeared sometime during June, before weekly monitoring began. The second cluster of outbreaks occurred at the very end of July and during the first 2 weeks of August. It was during this second cluster of outbreaks that late blight appeared at LIHREC (observed on 31 July).

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**Powdery mildew resistant melon variety evaluation**
**Investigators: Margaret T. McGrath, Sandra Menasha, and Karen LaMarsh**
**Location: Long Island Horticultural Research and Extension Center**

Powdery mildew is a very common disease that can reduce yield (fruit quantity and/or size) and market quality (flavor, color, storability, etc) in melons. Successful control of powdery mildew in melon is critical to ensure leaves remain healthy until fruit mature and obtain high sugar content, which results in good flavor. The goals of this experiment were 1) to continue to monitor adaptation in the pathogen that has been reducing the effectiveness of powdery mildew resistance in cucurbit crops, 2) to determine whether varieties with resistance to races 1 and 2 more effectively suppress powdery mildew than varieties with resistance to only race 1, and 3) to evaluate resistance, fruit quality, and yield of new varieties. This is part of a multi-year study.

Controlled release fertilizer (N-P-K, 19-10-9) at 525 lb/A was broadcast over the bed area and incorporated. Beds were formed with drip tape and covered with black plastic mulch. Seedlings were transplanted by hand on 15 June. No fungicides were applied to manage powdery mildew. The following fungicides were applied preventively for downy mildew and Phytophthora blight: ProPhyt, Presidio, Curzate and Ranman. Plots were three adjacent rows each with four plants spaced 24 in. apart. Rows were spaced 68 in. apart. To separate plots and provide a source of inoculum, two plants of a powdery mildew-susceptible squash variety were planted between each plot in each row. A randomized complete block design with four replications was used. Upper and lower leaf surfaces were assessed for powdery mildew four times from 25 July through 16 August. Powdery mildew colonies were counted; severity was estimated when colonies had coalesced or were too numerous to count. Average severity for the entire canopy was calculated from the individual leaf assessments. Area Under Disease Progress Curve (AUDPC) values were calculated from 25 July through 16 August. These values are a measure of severity over the entire rating period. Ripe fruit were harvested on 6, 10, and 17 August.

Powdery mildew symptoms were first seen on 23 July. Early in disease development, while severity was low (July 25 assessment), no significant differences were detected among any of the varieties. Powdery mildew on Superstar, the susceptible standard cantaloupe variety with no known genes for resistance included for comparison in this experiment, had become significantly more severe than all resistant varieties by the next assessment on 1 August. The resistant varieties provided a high level of suppression, indicating only race 2 and/or race 1 of the pathogen were present. Degree of control relative to Superstar based on AUDPC values on upper and lower leaf surfaces was 99% and 100%, respectively, for Samoa, 98% and 100% for Visa Premium, and 99% and 99% for Cleopatra. Control for the other resistant varieties ranged from 86% to 98% on upper leaf surfaces and 83% and 96% on lower surfaces. Eclipse, which has major-gene resistance only to pathogen race 1, was not significantly more severely affected by powdery mildew than all the varieties with resistance to races 1 and 2, suggesting that race 1 was the dominant race present. The two powdery mildew-resistant honeydew-type melons, Dream Dew and Summer Dew, were numerically but not significantly less severely diseased than Honeydew Green Flesh, a comparable susceptible variety. Dream Dew, with resistance only to race 1, was numerically more severely affected by powdery mildew than Summer Dew, which is resistant to races 1 and 2. Powdery mildew was more severe on resistant varieties in a similar experiment in 2010.

Highest yielding varieties were Visa Premium, Cleopatra, Lilliput and Sugar Cube (last two produce personal-sized cantaloupe fruit)

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

**Identification of races of the cucurbit powdery mildew pathogen occurring on LI**
**Investigators: Margaret T. McGrath and Karen LaMarsh**
**Location: Long Island Horticultural Research and Extension Center**

Races of the powdery mildew pathogen affecting cucurbit crops (*Podosphaera xanthii*) 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. Fifteen melon differentials were grown next to the resistant melon variety evaluation described in the previous report. Seedlings were transplanted into beds covered by black plastic mulch with drip irrigation. Cultural practices were similar to those for the melon variety evaluation. Powdery mildew severity was evaluated on both leaf surfaces on 1 and 22 August.

Symptoms were observed on 1 August only on leaves of a differential lacking genes for resistance (universal susceptible), Iran H, and on Hale's Best Jumbo, which is resistant to race 0. At the next assessment, powdery mildew was moderately severe on the differential resistant to race 1, PMR-45, indicating that another race in addition to race 1 was common in 2012 by late August. Some powdery mildew was seen on Edisto 47, which is reported to be resistant to races 1 and 2, while little was found on PMR 5, which is considered an official differential for resistance to races 1 and 2. None or very few symptoms were found on the other differentials, including MR-1, the official differential for resistance to races 1, 2 and 3. Based on these observations, race 1 of the powdery mildew pathogen was common on Long Island in 2012, race 2 also occurred, and there was some evidence that additional race(s) might have been present at a low level.

**Efficacy of fungicides for managing powdery mildew in pumpkin**
**Investigators: Margaret T. McGrath and Karen LaMarsh**
**Location: Long Island Horticultural Research and Extension Center**

The primary objective of this study 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. An experiment was conducted in a field with Haven loam soil. The field was plowed on 2 May and tilled on 30 May. Seeds were planted at approximately 24-in. plant spacing within rows with a vacuum seeder on 19 June. The seeder applied fertilizer in two bands about 2 in. away from the seed. Controlled release fertilizer (N-P-K, 15-5-15) was used at 675 lb/A (101 lb/A N). The herbicides Strategy (3 pt/A), Curbit EC 1 pt/A, and Sandea (0.5 oz/A) were applied over the entire plot area on 22 June, which was followed by irrigation to activate. During the season, weeds were controlled by cultivating and hand weeding as needed. Cucumber beetles were managed by applying the insecticide Admire Pro (2.8 fl oz/1000 ft) in a narrow band over the planted rows immediately after the herbicide application on 22 June and Asana XL (9.6 fl oz/A) on 31 July. The following fungicides were applied for downy mildew and/or Phytophthora blight beginning before symptoms were seen: ProPhyt (2 qts/A) on 18 July; Curzate 60 DF (5 oz/A) on 31 July and 8 August; Presidio (4 fl oz/A) on 31 July, 23 August, and 7 September; Ranman 400 SC (2.75 fl oz/A) on 31 July; and Revus (8 oz/A) on 8 August, 14 August, 31 August and 14 September. A fungicide application could not be made before a 2.5 in. rain event on 28 July because of sprayer malfunction. Rain also fell on 20 and 24 Juyl. Symptoms of blight were first observed on 30 July. Affected plants were removed, then several oomycete fungicides were applied together on 31 July before resuming a 7-day schedule alternating among individual products. Four plots were lost because of blight. Downy mildew was not seen. Plots were three 15-ft rows spaced 68 in. apart. The plots were 20 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 2 August using a tractor-mounted boom sprayer equipped with twinjet (TJ60-11004VS) nozzles spaced 17 in. apart that delivered 63 gal/A at 65 psi. Plots were inspected for powdery mildew symptoms on upper and lower leaf surfaces weekly beginning on 30 July. 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 7, 14, 21 and 28 August and 6 September. Mid-aged and young leaves were also assessed beginning on 7 August. At least nine leaves were examined in each plot on each assessment date. 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. 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. To obtain a measure of severity over the assessment period, Area Under Disease Progress Curve (AUDPC) values were calculated from 14 August through 6 September. Defoliation was assessed on 17 September and 15 October. Fruit quality was evaluated in terms of handle (peduncle) condition for mature fruit without rot on 17 September and 15 October. Handles were considered good if they were green, solid, and not rotting.

Powdery mildew was first observed in this experiment on 30 July. Most treatments were individual products evaluated alone. This is neither a labeled nor recommended use pattern for growers. Such evaluations, however, identify appropriate rates for new products and monitor efficacy of registered fungicides at risk for resistance development in order to develop management recommendations for growers. Among currently registered fungicides, Pristine (FRAC Code 7 and 11) applied at its highest label rate was ineffective. Powdery mildew severity on leaves treated with Pristine was significantly less than on non-treated pumpkins only on 21 August and only for the upper leaf surface (1.7 and 10%, respectively). In previous years at this location, pathogen isolates resistant to both components of this fungicide have been detected, and the fungicide has exhibited variable performance in previous evaluations. Powdery mildew also was not effectively controlled by Fontelis (FRAC 7), a chemically-related fungicide registered in 2012. This fungicide did suppress powdery mildew through 21 August on both leaf surfaces and 28 August on upper surfaces. Procure (FRAC 3) applied at its highest label rate was effective through 28 August on both leaf surfaces. In contrast with Pristine and Fontelis, Procure was effective based on AUDPC values. Similar control was achieved with Mettle, a new FRAC 3 fungicide not registered yet for use on cucurbits. There were no significant differences between these fungicides or between the two rates of Mettle tested. Quintec (FRAC 13) was highly effective through the last assessment on 6 Sep when the other registered fungicides were no longer effective. IKF-309, an experimental fungicide, was numerically, but not significantly, more effective applied five times on a 7-day than three times on a 14-day schedule. The later treatment was not effective compared to the non-treated control. The higher rate of IKF-309 was numerically, but not significantly, more effective than the lower rate based on most assessments. Similar control was obtained applying IKF-309 alone or in alternation with Rally. There was a trend toward more effective control with the combination on lower leaf surfaces, where powdery mildew is more challenging to control, but the opposite on upper surfaces. Very good to excellent control was achieved with the two programs with multiple fungicides applied in alternation. The program with new fungicides (alternation of Torino, Quintec and Luna Sensation) was numerically but not significantly better, providing 99% and 99% control on upper and lower leaf surfaces, respectively, based on AUDPC values, compared to 82% and 89% control, respectively, achieved with the program with current fungicides (Quintec alternated with Procure and Pristine). Plants receiving these programs had noticeably less defoliation on 17 September than other treatments; however, there were not significant differences among any treatments.

No significant differences were detected amongst treatments in fruit quality.

**Fungicide sensitivity of cucurbit powdery mildew pathogen isolates on LI in 2011**
**Investigators: Margaret T. McGrath and Karen LaMarsh**
**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 cucurbits, were obtained in September 2011 near the end of the growing season from five commercial pumpkin crops (27 isolates), four research fields (26 isolates), and a non-fungicide-treated garden. 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-days-old) were sprayed with various fungicide doses in a laboratory fume hood, the treated plants were left there to dry overnight, then disks were cut from the cotyledons and placed on water agar in sectioned Petri plates. Each plate has four sections thus there were three treatments per plate plus a nontreated control. Each plate was used to test one isolate. Six disks with the same treatment were placed in each section. Disks were inoculated by transferring spores from culture plates to each disk center. Then plates were incubated at room temperature 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 produce spores on at least half of the disks. Due to limitations in the number of isolates and fungicide doses that can be done in each bioassay, the procedure was conducted multiple times over many weeks to obtain information on sensitivity to several fungicides.

Sensitivity to fungicides at risk for resistance development was determined for the 55 isolates collected in 2011. Resistance to QoI fungicides (FRAC code 11) was detected in 79% of the isolates tested (not all isolates were tested with this fungicide). Resistance to this fungicide chemistry is qualitative, thus pathogen isolates are either sensitive or resistant, and fungicides are ineffective against resistant isolates. 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. Resistance to most fungicide chemistry is quantitative, including active ingredients in Pristine, Procure, Rally, and Quintec. With this type of resistance, pathogen isolates exhibit a range in sensitivity. Several concentrations are used in assays to characterize sensitivity. Ability to grow on leaf disks with a high concentration (500 ppm) of boscalid, an active ingredient in Pristine, was detected in only 6% 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. Each of the three isolates were obtained from a different farm. In contrast, 43% of the isolates collected in 2010 from similar locations were resistant. With myclobutanil, the active ingredient in Rally, a DMI (FRAC code 3) fungicide, 4% of isolates tolerated 80 ppm, 33% tolerated 40 ppm, while 16% were sensitive to 10 ppm. The concentration in the spray tank would be 150 ppm for Rally applied at the lowest label rate (2.5 oz/A) and 50 gpa. With quinoxyfen, the active ingredient in Quintec (FRAC code 13) fungicide, 4% of isolates tolerated 80 ppm, 24% tolerated 40 ppm, while 22% were sensitive to 10 ppm. The concentration in the spray tank would be 141 ppm for Quintec applied at the lowest label rate (4 fl oz/A) and 50 gpa. One of the two isolates able to tolerate 80 ppm quinoxyfen was also resistant to boscalid Sensitivity to Topsin M was examined for some isolates to determine if the pathogen is maintaining resistance to this old fungicide. It was found that resistance continues to be common to this fungicide group (MBC; FRAC code 1); however, there were fewer resistant isolates in 2011 (50%) than in previous years when most isolates were resistant (97% in 2010).

**Fungicide sensitivity of cucurbit powdery mildew pathogen populations on LI in 2012**
**Investigators: Margaret T. McGrath and Karen LaMarsh**
**Location: Long Island Horticultural Research and Extension Center and Nearby 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 research fields early in the 2012 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 two true leaves, 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 bioassay was conducted on 17 July in five locations in three research fields at LIHREC. Resistance to FRAC Code 1 fungicide (MBC; Topsin M) was detected in all populations examined at high levels. Resistance to FRAC Code 11 fungicides (QoI) 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 2012; 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. Therefore Quintec was expected to be the most effective fungicide in 2012. Quintec was very effective while Pristine was ineffective in a fungicide efficacy experiment conducted at LIHREC.

**Demonstration of integrated management program for Phytophthora blight in pumpkin**
**Investigators: Margaret T. McGrath and Karen LaMarsh**
**Location: Long Island Horticultural Research and Extension Center**

The goal of this study was to answer a question many asked last fall: can pumpkin be grown successfully the year after a severe outbreak of Phytophthora blight. Many growers on LI, and elsewhere is the northeast, endured extensive losses to this disease especially in Halloween pumpkins due to conditions being especially favorable for this disease during a prolonged period of wet weather with intensive rain brought on by Hurricane Irene followed by Tropical Storm Lee. Following these storms in 2011, the research field used for this study had a high incidence of pumpkin fruit with Phytophthora fruit rot throughout the field.

The management program implemented included growing a mustard biofumigant, subsoiling between rows to improve drainage, weekly applying fungicides with targeted activity for oomycete pathogens, and destroying the first plants affected. Fertilizer (10-10-10) was spread at 400 lb/A then incorporated on 30 March. Mustard variety Caliente 199 was seeded at 10 lb/A on 3 April. Plants had emerged by 13 April and started flowering by 21 May. On 12 June the mustard was flail chopped, immediately disked to incorporate, and then a cultipacker was used to seal the surface. This was an ideal day for this step because there was a high probability of rain occurring afterwards to provide the water needed for the biofumigation. Total of 1.5 inches of rain fell over night and during the day on 13 June. On 3 July the ground was lightly disked, then seeds of pumpkin variety 'Magic Lantern' were sown at approximately 24-in. plant spacing within rows with a vacuum seeder. There were three 500-ft rows spaced 68-in. apart. The seeder applied fertilizer in two bands about 2 in. away from the seed. Controlled release fertilizer (15-5-15) was used at 675 lb/A. The herbicides Strategy (3 pt/A), Curbit EC 1 pt/A, and Sandea (0.5 oz/A) were applied over the entire plot area on 5 July, which was followed by irrigation to activate. On 24 July the soil between pumpkin rows was subsoiled. The following fungicides (listed alphabetically) were applied for Phytophthora blight: Curzate 60 DF (5 oz/A) on 31 July; Forum 4.16SC (6 oz/A) on 7 September and 21 September; Presidio (4 fl oz/A) on 31 July, 17 August, 14 September, and 21 September; ProPhyt (2 qts/A) on 18 July; Ranman 400 SC (2.75 fl oz/A) on 31 July and 24 August; and Revus (8 oz/A) on 8 August and 1 September. Seven applications were made. A fungicide application could not be made before a 2.5 in. rain event on

28 July because of sprayer malfunction. Rain also fell on 20 and 24 July. Symptoms of blight were observed on 30 July in another pumpkin planting at LIHREC, therefore several oomycete fungicides were applied together on 31 July before resuming a 7-day schedule alternating among individual products. Beginning with the application on 8 August, Bravo Ultrex (1.8 lb/A) and/or a copper fungicide were also included as well as a fungicide with targeted activity for powdery mildew: Quintec (6 fl oz/A) on 8 August, 24 August, and 7 September; Rally (5 oz/A) on 17 August and 14 September; and Pristine (18.5 oz/A) on 1 September.

Symptoms of blight were first observed on 16 August in the low end of the field. Affected plants plus a healthy border area were disked on 24 August. A few affected fruit were observed near this area and in the center of the field during September. These fruit were not removed. Of the 1489 fruit counted on 17 October, 91.1% were good with no signs of rot due to Phytophthora or another cause. The integrated program was considered successful. Excellent control of powdery mildew was achieved with the fungicides applied for this disease. Very few symptoms were observed on 19 September. Average severity on upper and lower leaf surfaces was less than 1%.

**Phytophthora blight resistant pepper variety evaluation**
**Investigators: Margaret T. McGrath, Sandra Menasha, and Karen LaMarsh**
**Location: Long Island Horticultural Research and Extension Center**

Two adjacent field experiments were conducted in a field where Phytophthora blight has been observed since 1994 at LIHREC. Soil type is Haven loam. Phytophthora blight was severe and occurred throughout the field in 2011 when conditions were very favorable for the pathogen. A few days before transplanting, herbicide Prowl $H_2O$ at 2 pt/A was applied to the entire experiment area. Controlled release fertilizer (19-9-12 with 60% ESN slow release nitrogen) at 675 lb/A was spread over the rows to be planted. Herbicide and fertilizer were incorporated by cultivation. Seedlings were transplanted on 2 July by hand into holes opened in the bare-ground by a waterwheel transplanter that also placed in the holes a starter fertilizer, 20-20-20 Nutri-Leaf. Plants were irrigated using drip tape laid on the soil surface running down the length of the row next to the plant main stem. A completely randomized block design with four replications was used. Plots consisted of 15 plants in two adjacent rows with 15-in. plant spacing and 34-in. row spacing. There was 60-in. spacing between plots in a row and 68-in. spacing between adjacent plots. Host resistance is only to the crown rot phase in the pepper varieties evaluated. Therefore, all plots in one experiment were treated approximately weekly with fungicides to improve control especially of the aerial phase of Phytophthora blight while the adjacent experiment was not treated. The foliar fungicide applications were made using a tractor-mounted boom sprayer equipped with D5-25 hollow cone nozzles spaced 17 in. apart that delivered 96 gal/A at 100 psi. Plants and their fruit were examined routinely for disease symptoms. Fruit were harvested on 30 August, 4 October, and 18 October.

Phytophthora blight developed slowly in both pepper experiments for this study until late in the growing season. Symptoms were not seen on these plants until 23 August whereas blight was observed on 30 July in pumpkin in another research field at LIHREC. Symptom development was delayed in Revolution. This was the only variety with no symptoms on 23 August (data not shown). While there were no significant differences among varieties in the No Fungicide experiment, the susceptible variety King Arthur had numerically more plants and more fruit affected than the resistant varieties with one exception. Percentage of plants and fruit with symptoms were numerically lower in the Fungicide experiment than the No Fungicide experiment, suggesting that the fungicide program was effective. In contrast with the No Fungicide experiment, King Arthur in the Fungicide experiment did not have more plants or fruit affected by Phytophthora blight than the resistant varieties, thus there was no evident benefit of

using an integrated management program (fungicides applied to a resistant variety) over fungicides alone.
All seven varieties produced green fruit of marketable quality.

*Pepper Variety Mature Green Fruit Descriptions and Assessments:*

King Arthur: Blocky, heavy fruit were medium green in color. Some silvering on skin and dark green/black coloring at blossom end. Overall appearance rating of 8 out of 9.

Archimedes: Fairly uniform, light to medium green fruit were blocky and not as heavy. Very little silvering on skin. Overall appearance of 8.5.

PS-0994 1819: Dark green, blocky fruit were moderately heavy. No silvering and fairly uniform. Overall appearance of 8.5.

Intruder: Fruit were medium green in color and were fairly heavy. Some fruit were blocky and others tapered in shape. Heavy silvering. Overall appearance 7.5 out of 9.

Revolution: Light to medium green fruit was mostly blocky but some fruit had a tapered shape. Moderate silvering. Appearance rating of 8.

Vanguard: Fruit were medium to dark green in color with a squat, blocky shape. Medium to high level of silvering. Medium weight. Some dark green/black coloring near blossom end. Overall appearance of 8 out of 9.

Paladin: Light to medium green fruit were blocky and uniform. Medium weight and medium to high levels of silvering on skin. Appearance rating of 8.

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

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

This experiment was conducted in parallel to a very similar experiment with squash described in the following report. The same treatments were applied to pepper and acorn squash in the two experiments at the same time with the exception of the transplant treatments to pepper. Methods unique to the pepper experiment are as follows. Seeds of bell pepper variety 'King Arthur' were sown on 24 May in the greenhouse. A few days before transplanting, herbicide Prowl H2O at 2 pt/A was applied to the entire experiment area. Controlled release fertilizer (19-9-12 with 60% ESN slow release nitrogen) at 675 lb/A was spread over the rows to be planted. Herbicide and fertilizer were incorporated by cultivating. Seedlings were transplanted on 3 July by hand into holes opened in the bare-ground by a waterwheel transplanter that also placed in the holes a starter fertilizer, 20-20-20 Nutri-Leaf. Plots consisted of 20 plants in a single row with 15-in. plant spacing and 68-in. row spacing. There was 8-ft spacing between plots in a row. Some biopesticides were applied to plants before and/or after transplanting following treatment protocol. Pre-transplant treatments were drenches to seedling trays done on 2 July, 1 full day before transplanting, and drenches in the transplant hole the afternoon before transplanting.

Symptoms were not seen in this experiment until 23 August whereas blight was observed on 30 July in pumpkin in another research field at LIHREC. Disease development was slow. Incidence of affected fruit remained low. For some plots, it appeared that the treatment applied to the plot had less of an affect on occurrence of Phytophthora blight than the location of the plot being in a section of the field where conditions appeared to be more favorable that elsewhere for this disease. No symptoms were seen in some plots. Symptoms were not observed until 1 October for three treatments. At the last assessment on 12 October, while there were no significant differences among any treatments, incidence was numerically greatest for non-treated peppers and lowest for peppers treated with the program of SoilGard (2 qt/100 gal) applied 4 times as a soil drench followed by the copper fungicide Badge X2 (1.25 lb/A) applied 7 times. Incidence on 12 October was 10% or less for four other treatments: the conventional standard (Revus + Badge applied in alternation with Presidio + Badge), the two programs that started with 3 soil drenches of Serenade Soil (1 gal/100 gal) followed by weekly applications of Badge or the conventional standard program, and Actinovate (12 oz/A) applied weekly 11 times. Other treatments in this experiment were three with Regalia plus Badge or the conventional standard program and Badge used alone.

*Acknowledgments*: Project funded by IR-4 Biopesticide Demonstration Grant Program.

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

The objective of this study was to evaluate the efficacy of EPA-classified biopesticides used in combination treatment schedules with applications to soil and foliage. All biopesticides tested are labeled for this use and approved for organic production. Some treatments included foliar applications of a copper fungicide approved for organic production. One treatment included oomycete-targeted fungicides for conventional production. These treatments were compared to a nontreated control, a conventional 'standard' treatment with oomycete-targeted fungicides applied to foliage, and an organic 'standard' treatment with copper fungicide applied to foliage. The experiment was conducted at LIHREC in a field with Haven loam soil where Phytophthora blight has developed most years since 1994. Phytophthora blight was severe and occurred throughout the field in 2011 when conditions were very favorable for the pathogen. A parallel experiment was conducted with pepper next to the experiment with squash (see following report). The same treatments were applied to pepper and squash in the two experiments at the same time with the exception that pepper received transplant treatments. Seeds of acorn winter squash variety 'Royal Ace PM' were planted at approximately 24-in. plant spacing within rows with a vacuum seeder on 3 July. During seeding, fertilizer was applied in two bands about 2 in. away from the seed. Controlled release fertilizer (15-5-15) was used at 625 lb/A. The herbicides Strategy (3 pt/A), Curbit EC (1 pt/A) and Sandea (0.5 oz/A) were applied over the entire plot area after seeding. Powdery mildew was managed by selecting a resistant variety and routinely applying fungicides with targeted activity for this disease, alternating among Pristine (18.5 oz/A on 25 August and 1 September), Quintec (6 fl oz/A on 31 August), and Nova (5 oz/A on 7 September). Plants were irrigated using drip tape laid on the soil surface running down the length of the row next to the plant main stem. During the season, weeds in the plots were controlled by hand weeding while weeds between rows were mowed. A completely randomized block design with four replications was used. Plots consisted of 10 plants in a single row at 68-in. row spacing. There was 8-ft spacing between plots in a row. Squash plants received their first directed spray to soil at emergence. Two more soil applications were made along the rows directed at the base of the plants. They were done using a CO2-pressurized backpack sprayer with a boom equipped with a single Twin-jet nozzle (TJ60-11003) delivering 57 gal/A at 54 psi. Drip irrigation was run after each soil application to incorporate. Foliar applications also were made with a backpack sprayer using a single TJ60-8006vs nozzle delivering 50 gal/A operated at 54 psi and 2.4 mph. When plants became too large to be covered by spray from the nozzle held over the top of the plant, each side of the plots was sprayed in two passes mimicking coverage achieved with a two-nozzle boom. Plants and their fruit were examined routinely for disease symptoms.

Symptoms of Phytophthora blight were first observed in this experiment on 23 August in non-treated control plants and some of the treatment plots, including both the organic standard (copper fungicide Badge applied weekly to foliage) and the conventional fungicide program (copper applied weekly with fungicides with targeted activity for oomycetes, Revus alternated with Presidio). Disease development was slow and incidence of affected fruit remained low. For some plots, it appeared that the treatment applied to the plot had less of an affect on occurrence of Phytophthora blight than the location of the plot being in a section of the field where conditions appeared to be more favorable that elsewhere for this disease. No symptoms were seen in some plots. Foliar symptoms were not observed until 1 October in plots receiving the organic standard, the conventional standard, or either of the Serenade Soil treatments (3 soil drenches at 1 gal/100 gal followed by foliar applications same as the 2 standards). Symptoms of Phytophthora fruit rot were not seen on 23 August. Most treatments had symptoms on 12 September, with the exception of one of the Regalia treatments, the SoilGard treatment, and the organic standard. Incidence of fruit with symptoms remained low for these three treatments. On 12 September, incidence of Phytophthora fruit rot was 26-44% in three plots in the fourth replication: non-treated control, Regalia + Serenade Soil + Badge, and conventional standard. This replication was nearest the low end of the field. Affected fruit were seen in five additional plots on 12 September. No symptoms were observed through the last assessment date in 20 of the 40 plots. Symptoms were observed in all four replications only for the Regalia + Serenade Soil + Badge treatment. Significant differences were detected among treatments only for incidence of affected plants on 23 August.

*Acknowledgments*: Project funded by IR-4 Biopesticide Demonstration Grant Program.

**Identification of pathotypes of the cucurbit downy mildew pathogen occurring on LI**
**Investigators: Margaret T. McGrath and Karen LaMarsh**
**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, 1 June and 12 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 16 July. The pathogen likely was dispersed to Long Island on 3-4 July when there was a low to moderate risk predicted for the area by the Cucurbit Downy Mildew *ipm*PIPE forecasting system. Cucumber is susceptible to all pathotypes, thus it is expected to be affected before other cucurbit types. Symptoms were observed on muskmelon on 13 August, on giant pumpkin (*Cucurbita maxima*) on 23 August, and on butternut squash on 31 August. None were found on watermelon or on *Cucurbita pepo* crop types (which include Halloween pumpkin and summer and acorn squashes) in the sentinel plots. However, downy mildew was seen on a commercial crop of pumpkin in Brookhaven on 22 August.

**Efficacy of fungicides for managing downy mildew in cucumber**
**Investigators: Margaret T. McGrath and Karen LaMarsh**
**Location: Long Island Horticultural Research and Extension Center**

The experiment objective was to compare Zampro, a new fungicide not yet registered in NYS, to other mobile fungicides for managing downy mildew, an important disease affecting cucumbers every year on LI. Other cucurbit crops are also often affected depending on the pathotype of the pathogen that occurs. Foliage can be killed quickly in the absence of management, leading to loss of yield and/or fruit quality.

A field experiment was conducted at LIHREC. Fertilizer (10-10-10) at 1000 lb/A was broadcast over the bed area and incorporated. Beds were formed with drip tape and covered with black plastic mulch. Seedlings were transplanted on 21 June by hand into holes made with a waterwheel transplanter in beds covered with black plastic mulch. Plots were single 18-ft rows with 12 plants at 18-in. spacing. Rows were 8.5 ft apart. The plots were 9 ft apart within the row. A randomized complete block design with four replications was used. Fungicides were applied weekly for 5 weeks beginning on 18 July, one day after symptoms were first observed, using a backpack $CO_2$-pressurized sprayer equipped with a single-nozzle boom and an 8006VS nozzle delivering 50 gal/A operated at 54 psi and 2.4 mph. It was intended that the treatments be applied on a preventive schedule. Downy mildew severity was assessed on five dates 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. To obtain a measure of severity over the assessment period, Area Under Disease Progress Curve (AUDPC) values were calculated from 23 Jul through 21 Aug. Percentage of leaves that died was assessed on 6 to 21 August. Fruit was removed from plants to maintain plant growth; yield was not assessed.

Downy mildew developed naturally in this experiment. Treatments were started the day after symptoms were first seen. Low in the canopy of a few plots there were 1-2 severely affected leaves on 17 Jul suggesting 1-2 disease cycles had occurred already. Infection likely occurred on 3-4 July when there was a low to moderate risk predicted for the area by the Cucurbit Downy Mildew *ipm*PIPE forecasting system. The fungicide treatments evaluated consisted of at least one mobile fungicide with targeted activity for the cucurbit downy mildew pathogen tank mixed with Bravo, a broad-spectrum fungicide for managing resistance development in the pathogen. All three treatments were effective based on severity on 6 August and AUDPC values. The treatment with Zampro was significantly more effective than the treatment with Ranman alternated with Forum, providing 71% control compared to 41% control based on AUDPC values. Except on 1 August, severity values were always numerically lower for plants treated with Zampro than with Presidio. Percentage of leaves that were necrotic paralleled the degree of control of downy mildew achieved with the treatments; on 21 August, 12 – 21% leaves were dead in fungicide-treated plots versus 76% in non-treated plots. Zampro was the only fungicide evaluated that was not registered for this use when the experiment was conducted.

**Evaluation of downy mildew resistance in experimental hybrids of cucumber**
**Investigators: Margaret T. McGrath, Sandra Menasha, and Karen LaMarsh**
**Location: Long Island Horticultural Research and Extension Center**

Downy mildew has been a major problem in cucurbit crops, especially cucumbers, since a new pathogen strain appeared in the US around 2004. The downy mildew fungus exists as pathotypes varying in ability to infect the various cucurbit types. Cucumber is susceptible to all pathotypes and thus usually is the first and most severely affected crop in an area. Premature death of leaf tissue results in reduced fruit quality and quantity. Loss can be quite extensive in cucumber as fruit production declines substantially in severely affected plants, much of the fruit produced is misshapen, and plants die prematurely. Most cucumber varieties have resistance to the old strain of the pathogen. This resistance provides limited suppression of the new strain.

The goal of this evaluation was to compare new downy mildew-resistant cucumber varieties to standard varieties in terms of yield, fruit quality and ability to resist downy mildew. Slicer-type cucumber varieties with resistance to the new downy mildew pathogen strain are been developed by plant breeders at Monsanto Vegetable Seeds (formerly Seminis Seeds).

A field experiment was conducted at LIHREC. Fertilizer (10-10-10) at 1000 lb/A was broadcast over the bed area and incorporated. Beds were formed with drip tape and covered with black plastic mulch. A waterwheel transplanter was used to make planting holes in the beds and apply starter fertilizer (20-20-20 Nutri-Leaf) plus insecticide. Seeds were sown on 29 May in the greenhouse. Seedlings were transplanted on 21 June by hand into the holes. Quintec (6 fl oz/A) and Rally (5 oz/A) were applied to manage powdery mildew because one variety, Straight Eight, does not have resistance. Plots were single 18-ft rows with 12 plants at 18-in. spacing. Rows were 68 in. apart. The plots were 9 ft apart within the row. A randomized complete block design with four replications was used. Downy mildew severity was assessed on 24 July, 6 August, and 14 August 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 of marketable size were harvested on 18 July, 25 July, 8 August, and 16 August.

Downy mildew developed naturally in this experiment. Symptoms were first seen on 18 July. Infection likely occurred on 3-4 July when there was a low to moderate risk predicted for the area by the Cucurbit Downy Mildew *ipm*PIPE forecasting system. The experimental hybrids, reputed to contain a new source of resistance to downy mildew, were not able to effectively suppress the strain of *Pseudoperonospora cubensis* present. With the exception of incidence on 6 August, there were no significant differences in any downy mildew assessments for these new hybrids compared to Speedway, an old resistant variety bred to be resistant to pathogen strains present before 2004. Compared to Straight Eight, a variety with no known genes for resistance, they did have significantly lower severity on affected leaves on 14 August and numerically lower canopy severity values on all dates. With the exception of 14 August, these values were also numerically lower than those for Speedway. This unexpected result may reflect challenges of incorporating genes for disease resistance plus good horticultural characteristics into a variety using conventional breeding. The unexpected result with these new varieties may reflect challenges of incorporating genes for disease resistance plus good horticultural characteristics into a variety using conventional breeding.

Straight Eight produced fewer fruit than all other entries. Fruit of the new varieties were rated higher than the others in evaluations conducted with public groups.

*Cucumber Variety Fruit Descriptions and Assessments:*

Straight Eight: Very light green fruit with a lot of yellow/white flecking. Crunchy skin and smooth flesh. Very small seeds. Good cucumber flavor. Overall taste rating of 7.5 out of 9 and appearance rating of 6 out of 9. Skin was too light.

Speedway: Long, dark green fruit with slight ridging and few spines. Overall appearance of 8. Fruit had a crunchy skin and smooth flesh. Taste was slightly bitter but still sweet and had a good cuke flavor. Slightly larger seeds. Overall taste rating of 7.5 out of 9.

SVR 3462: Dark green, long fruit with smooth skin with very few light green streaks. Overall appearance rating of 8. The fruit was very crunchy but the skin was slightly bitter tasting. Few, small seeds and a mild cucumber flavor. Taste rating of 6.5.

SVR 4719: Very dark green fruit with smooth skin. Overall appearance rating of 8 out of 9. Fruit was crunchy and flesh was slightly sweet with a mild cucumber flavor. Very few small seeds internally. Taste rating of 7 out of 9.

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

**Evaluation of fungicides and biopesticides for managing downy mildew in basil**
**Investigators: Margaret T. McGrath and Karen LaMarsh**
**Location: Long Island Horticultural Research and Extension Center**

Downy mildew is a new disease of basil that has occurred every year on LI since first seen in this area in 2008. This disease can have tremendous impact because affected leaves are unmarketable. New and currently registered fungicides for organic and conventional production were evaluated.

An experiment was conducted with field-grown basil at LIHREC. Fertilizer (10-10-10) at 1000 lb/A was broadcast over the bed area and incorporated. Beds were formed with drip tape and covered with black plastic mulch. Weeds between mulch strips were managed by mowing. To provide a source of natural inoculum within the experimental area, basil was transplanted into a spreader row on 19 July before transplanting the plots. The spreader row was on the west side of the experiment with rows of sorghum-sudangrass planted earlier to the west of the spreader row 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 27 June in trays in a greenhouse, put outdoors to harden, then transplanted on 23 July. 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. A randomized complete block design with four replications was used. Each plot had 13 plants in two 10-ft rows on black plastic mulch with 9-in. plant spacing and 9-in. row spacing. The plots were 5-ft apart in the row. Fungicides were applied weekly on a preventive schedule. Applications were made with a backpack $CO_2$-pressurized sprayer and a hand-held boom operated at 55 psi and 2.4 mph. A boom with a single TJ60-8006vs nozzle delivering 50 gal/A was used when basil plants were small. A boom with a nozzle delivering spray over the top of the plant plus two drop nozzles (all TJ60-8006vs) delivering 50 gal/A was used when plants were larger. Treatments were applied on 7, 14, 20, and 27 August and on 7, 13, 20, and 27 September. Downy mildew was assessed in each plot every week beginning on 16 August. The percentage of leaves per plant with symptoms (yellowing of foliage and/or sporulation of the pathogen visible on the underside) was estimated for 10 plants in each plot. The last disease assessment was done on plants removed from plots to be able to obtain a thorough examination of the underside of leaves. Plants were removed on 1 October, assessed, then held in plastic bags at ambient temperature until re-assessed on 3 and 11 October.

Symptoms of downy mildew were first seen on 16 August. Incidence of leaves with downy mildew was assessed rather than severity because affected leaves are unmarketable. Only QGU42 effectively suppressed downy mildew based on incidence of affected leaves on 7 September and AUDPC value. Zampro also was effective based on the assessment on 7 September. While not significant, incidence often was lower than the non-treated control plants for plants treated with the other fungicides. AUDPC values were lower for treated plants except those treated with Previcur Flex. Other conventional fungicides evaluated were Revus, Ranman, Presidio, K-Phite, and ProPhyt. The two phosphorous acid fungicides, K-Phite and Pro-Phyt, were similar in efficacy. Among the products approved for organic production, AUDPC value was lowest for Organocide applied at the highest label rate (2 oz/gal). The other organic products evaluated were Actinovate, Regalia, Organocide lo rate + NuCop HB, and NuCop HB.

*Acknowledgments*: Project funded by USDA Specialty Crops Research Initiative Program.

**Monitoring program for downy mildew occurrence in basil in the USA**
**Investigators: Margaret T. 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, including on Long Island. 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 2012 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://docs.google.com/spreadsheet/ccc?key=0Ak8NCmWCdGPNdEZxSUdxYTNKaUJueU8tTG1Jd2tmTFE#gid=0
Downy mildew was reported in 2012 on basil grown in greenhouses and outdoors, in both commercial crops and gardens, in the field and in containers. A total of 74 reports were logged. Three were from states that had not reported this disease before: MO, OR, and WV. The first reported observation was from FL in early March. Downy mildew was reported in 22 additional states during the year: AL, AR, CA, CO, CT, DE, GA, HI, IN, MA, MD, ME, MI, MN, NC, NH, NY, PA, SC, TX, VT, and WA. It was also reported in Jamaica, British Columbia, 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 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 on Long Island and elsewhere. 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.

*Acknowledgments*: Project funded by USDA Specialty Crops Research Initiative Program.

**Ozone concentration in Riverhead in 2012**
**Investigators: Margaret T. McGrath and Karen LaMarsh**
**Location: Long Island Horticultural Research and Extension Center**

Ozone reached sufficiently high levels to cause acute, visible injury to leaves of sensitive crops in 2012 as usual on Long Island. Ozone also causes sensitive plants to senesce prematurely. During the growing season (1 May – 30 Sep) in 2012 ozone concentration was $\geq$80 ppb for at least 41 hours on 11 days (the ozone monitor was not working on 6 of the 145 days): 20 June (6 hours), 21 June (7), 22 June (3), 28 June (1), 29 June (7), 30 June (2), 1 July (3), 7 July (1), 14 July (1), 18 July (6), and 31 August (4). Ozone was at least 50 ppb on 499 hours on 66 days and at least 60 ppb on 231 hours on 40 days. The highest concentration in 2012 (115 ppb) occurred on 18 July. Ozone was at least 100 ppb for two hours on that date and one hour on 29 June. There was one period of elevated ozone exceeding 90 ppb for at least two consecutive days (29 June – 1 July). It occurred during a period in the growing season when ozone often reaches a high level. Ozone was at least 40 ppb for 50 of 96 hours and at least 70 ppb for 24 hours during the 4-day period of elevated ozone (28 June – 1 July). Typically high concentrations occurred between 1200 and 2200, as in previous years. Ozone was $\geq$80 ppb for 60, 124, 121, 184, 77, at least 67, 94, 40, at least 10, 95, 65, 47, 57, 32, at least 48, at least and 41 hrs in 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2010, 2011, and 2012, respectively.

**Assessment of ambient ozone impact on plant productivity using a snap bean bioindicator System**
**Investigators: Margaret T. McGrath and Karen LaMarsh**
**Location: Long Island Horticultural Research and Extension Center**

Research on ozone-sensitive and ozone-resistant snap bean lines was continued in 2012 on Long Island, NY, 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 (O3) on plant productivity. These lines yield similarly under low ozone concentrations. There were 3 successive field plantings (seeded on 23 May, 18 June, and 11 July) 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. 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 most previous years at the NY location, ozone reached sufficiently high levels in 2012 to cause acute, visible injury to bean leaves, and to affect yield. 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 ozone during daytime (0800-2000) that was at least 40 ppb for 490, 557, and 399 hours, respectively. During these growth periods, ozone exposure expressed as AOT40

(Accumulated Ozone exposure over a Threshold of 40 ppb) was 7,892 ppb.h, 8,747 ppb.h, and 5,157 ppb.h, respectively. These values are similar to previous years. All three 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 (28 June – 1 July) occurred at a typical time for ozone to be high on Long Island. The first and second plantings were present then.

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. There were a lot of leafhoppers in 2012. Their feeding results in browning of leaf tissue (hopper burn) that is difficult to distinguish from ozone injury. This confounded assessing ozone injury. In the first planting, when hopper burn was least, severity of bronzing on leaves was 15% for S156 and 1% for R331 on 11 July, 18% and 4% on 19 July, and 41% and 11% on 26 July. Severely affected leaves had started to defoliate by 26 July; defoliation was 16% for S156 and 2% for R331.

Number and weight of beans picked at the fresh market stage were always numerically greater for the ozone-tolerant snap bean line R331 than the ozone-sensitive line S156 in all three planting; however, these yield parameters often were not statistically significantly different. Total number and weight were 2.5% and 13% lower, respectively, for the first planting; 17% and 28% lower for the second planting; and 37% and 74% lower for the third planting. Ozone had a greater impact on mature bean yield, which also has been affected more by exposure to ambient ozone conditions than fresh market yield in previous experiments. Weight of dry pods was 59%, 46%, and 42% lower for S156 compared to R331 in plantings 1, 2 and 3, respectively. This reduction was partly due to there being 62%, 28%, and 30% fewer pods, respectively. The number of seeds in pods was reduced by 23%, 24%, and 43%, respectively. Average weight of these seeds was reduced 23%, 2%, and 0%.