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POWDERY MILDEW OF PUMPKIN: EVALUATION OF CURRENTLY REGISTERED FUNGICIDES AND NEW FUNGICIDES

Investigator: M. T. McGrath
Location: Long Island Horticultural Research and Extension Center

Application of fungicides continues to be the principal practice for managing powdery mildew in pumpkin. There are very few resistant varieties. It is the most common disease occurring every year throughout Long Island. Two new products tested, Actigard and Milsana bioprotectant, are in a new group of compounds called plant activators which stimulate the natural defense mechanisms of plants so that they become more resistant to diseases. This response is called systemic acquired resistance or SAR. These compounds have no direct toxic effect on pathogens. Actigard has received federal registration; Milsana has not yet. 'Appalachian' pumpkin seeds were planted on 21 June. One Milsana treatment was started about 1 month after planting so that it could stimulate SAR before powdery mildew had started to develop. This treatment was to receive at least 1 more application of Milsana before other treatments were started; this was not possible because of frequent rains 26 July through 4 Aug. All other treatments were initiated on 4 Aug after the IPM threshold of one leaf with symptoms of 50 old leaves examined was reached in all but 1 plot. This threshold was shown previously to be as effective as using a preventive schedule. Fungicides were applied on 22 July; 4, 10, 17, and 25 Aug; and 1 and 9 Sept with a tractor-mounted boom sprayer equipped with D3-45 hollow cone nozzles spaced 11 in. apart that delivered 100 gpa at 200 psi.

All treatments provided some control of powdery mildew on both leaf surfaces. Powdery mildew became severe as usual. Symptoms were found on 9 of 3600 leaves examined on 25 July, 3 days after the early Milsana treatment. Armicarb, Milsana, and Bravo were less effective for controlling powdery mildew on lower leaf surfaces than treatments that included systemic or translaminar fungicides (Nova, Procure, BAS 500, Quadris, and Flint). These differences were evident beginning on 16 Aug. On upper leaf surfaces, Bravo was as effective as some treatments that included systemic fungicides, it was more effective than Armicarb starting on 31 Aug, and it was note more effective than Milsana until the last assessment on 18 Sept. The early application of Milsana did not improve control as there were no significant differences between these two Milsana treatments. Additional research is needed to determine whether disease control could be improved with several applications on a 7-day interval before reaching the IPM threshold.

When tank mixed with the DMI fungicide Nova and applied in alternation with the strobilurin (QoI) fungicide Quadris, the Bravo alternatives (Armicarb, Nutrol, Kocide, and Microthiol Sulfur) were as effective as Bravo. However, Bravo is expected to be more valuable for managing resistance to DMIs and strobilurins because it is more effective than the Bravo alternatives. The role of these fungicides with low risk of developing resistance is to reduce the overall size of the pathogen populations and thus the size of the selectable population.

Milsana applied in alternation with Quadris and Nova was as effective as a similar treatment with Bravo. The fungicide sequence was: Quadris (week 1), Milsana (2), Nova (3), Milsana (4), Quadris (5), and Bravo (6). However, control of powdery mildew on both upper and lower (under) leaf surfaces was due to the highly effective fungicides Quadris and Nova because a similar treatment without Milsana was not significantly different. Powdery mildew on lower surfaces was controlled more effectively when Quadris and Nova were applied in alternation every 7 days; however, this did not result in significantly less defoliation on 28 Sept or in better fruit quality (percentage of fruit with solid handles) on 18 Oct.

Nova + Bravo was more effective than Procure + Bravo for controlling powdery mildew on lower leaf surfaces. Although very effective, Nova + Bravo is not recommended alone because of the high potential for resistance to develop to Nova. Equally good control was obtained by applying Nova + Bravo in alternation with a strobilurin fungicide. The strobilurins Quadris and BAS 500 were equally effective. All isolates collected before treatment tolerated 20 ppm Nova a.i. After treatment with BAS 500 alternated with Nova + Bravo, the highest fungicide concentrations tolerated were 20 ppm Nova a.i., tolerated by 47% of the isolates, and 2 ppm BAS 500 a.i., tolerated by 83% of the isolates. Control was not improved by adding Actigard to an alternation program of Flint and Bravo. A12325, a pre-pack mix of Flint + Actigard, was more effective than a tank-mix of these products based on powdery mildew severity on lower leaf surfaces on 31 Aug; however, these treatments were not significantly different based on assessments made on 7 and 18 Sept or AUDPC values.

As a consequence of differences in powdery mildew control, treatments without a systemic fungicide had more defoliation beginning on 18 Sept and fewer fruit with good solid handles beginning on 12 Oct than all treatments with a systemic fungicide. Yield was highest for treatments with good control of powdery mildew. Weight of mature fruit was 170 to 225 lb/plot for nontreated, Armicarb, Bravo, and Milsana treatments and 323 lb/plot for Quadris alterated with Nova + Bravo. Phytotoxicity was not observed with any treatments.

Efficacy of Nova when challenged by powdery mildew isolates with moderate sensitivity

Investigator: N. Shishkoff and M. McGrath
Location: Long Island Horticultural Research and Extension Center

Control of cucurbit powdery mildew on LI with the new systemic fungicide Nova may be compromised because of the high level of strains resistant to Bayleton, which is in the same chemical class. The goal of this project was to determine whether strains of the cucurbit powdery mildew fungus tolerating 20 ppm of the active ingredient in Nova are controlled by Nova applied at 5 and 10 oz/A (300 and 600 ppm, respectively) under field conditions. Control was compared to that from Quadris, a fungicide in a different chemical class.

Four week-old Summer squash ('Seneca Prolific') were transplanted on 31 May into a field in 8 70-ft rows and divided into 24 6x10-ft plots (10 plants/plot). Some plots were sprayed with Nova (5 oz/A), Nova (10 oz/A) or Quadris (15.4 oz/A) 5 days before inoculation (on 7 Jul), and others were treated with Nova (5 oz/A) or Nova (10 oz/A) 5 days after inoculation (on 17 Jul). Untreated plots served as the control. Plots were sprayed using a CO_2-pressurized backpack sprayer (55 psi) with a single nozzle boom equipped with a TJ-60 11003 nozzle. On 12 Jul, 16 infected squash plants in 4-in. pots were placed between rows in the field for 6 hr to serve as a source of inoculum. Infected plants had been inoculated 3 wk earlier with an isolate of cucurbit powdery mildew able to tolerate 20 ppm of Nova (collected from the LIHREC grounds in the 1998 growing season). The inoculated plots were monitored for powdery mildew colonies and rated for disease on 1 Aug. For each plant, the oldest leaf in the NW quadrant was selected and a 16 cm^2 area on each side of the midvein was chosen; the number of colonies in each area was counted and the diameter of the largest single colony was measured. Analysis of variance indicated no significant difference among treatments for number of colonies. Colony diameter was statistically slightly larger on plants from control (untreated) plots.

Isolates from each plot (24 total) were tested for sensitivity to Nova using a cotyledon disk growth assay (described below in "*In vitro* Tests to Determine Baseline Sensitivity of *Sphaerotheca fusca* on squash to the Fungicides BAS 490 02F and BAS 500"); 3 isolates collected at the same time from a field upwind (and presumably representing native inoculum) were used as controls. Of isolates from the experimental plot, 5 grew at $\leq$ 2 ppm and 19 grew at $\leq$ 20 ppm; all 3 controls grew at $\leq$ 20 ppm. No isolates could grow at 40 ppm. For comparison, of 19 isolates collected later in the growing season from a different field on the LIHREC grounds, 10 grew at $\leq$ 2 ppm and 9 grew at $\leq$ 20 ppm. Of 14 isolates collected from a field of butternut squash in Freeville, NY, 7 grew at $\leq$ 2 ppm, and 7 grew at $\leq$ 20 ppm.

These results are inconclusive, since no treatment controlled disease. In another experiment at the LIHREC where one of the treatments was Nova applied with Bravo (see previous report on "Evaluation of currently registered fungicides and new fungicides "), mildew was controlled. If subsequent experiments demonstrate that tolerant strains are not controlled well by Nova under field conditions, then this information will be used to support requests for Section 18 registration of alternative fungicides in the future.

In vitro Tests to Determine Baseline Sensitivity of *Sphaerotheca fusca* on squash to Flint Fungicide

Investigator: N. Shishkoff and M. McGrath
Location: Long Island Horticultural Research and Extension Center
A baseline sensitivity study of cucurbit powdery mildew isolates from around the US was done to test Flint, a fungicide in the B-methoxyacrylate class of pesticides derived from naturally-occurring strobilurins. Two-week old squash seedlings ('Seneca Prolific') were sprayed with active ingredient dissolved in water at 0-30 ppm; disks were then cut from the cotyledons and placed in Petri dishes containing water agar. Treated disks were then inoculated. After 2 wk, percent leaf disk area colonized by sporulating mildew was recorded for each disk and averaged for each treatment. Thirty six powdery mildew isolates from 7 states (AZ, CA, FL, MD, MI, NY and TX) showed little variation in sensitivity the fungicide. When grown on disks treated with Flint, all isolates tested were able to grow at ≤ 0.3 or 3.0 ppm.

In vitro Tests to Determine Baseline Sensitivity of *Sphaerotheca fusca* on squash to the Fungicides BAS 490 02F and BAS 500 F

Investigator: N. Shishkoff and M. McGrath
Location: Long Island Horticultural Research and Extension Center

A baseline sensitivity study of cucurbit powdery mildew isolates from around the US was done to test two fungicides: BAS 490 02F and BAS 500 F, fungicides in the B-methoxyacrylate class of pesticides derived from naturally-occurring strobilurins. Two-week old squash seedlings ('Seneca Prolific') were sprayed with active ingredient dissolved in water at 0-40 ppm; disks were then cut from the cotyledons and placed in Petri dishes containing water agar. Treated disks were then inoculated. After 2 wk, percent leaf disk area colonized by sporulating mildew was recorded for each disk and averaged for each treatment. Fifty nine powdery mildew isolates from 7 states (AZ, CA, FL, MD, MI, NY and TX) showed little variation in sensitivity to either fungicide. When grown on disks treated with BAS 490 02F, all isolates tested were able to grow at ≤ 0.2 or 2.0 ppm. When grown on disks treated with BAS 500 F, most isolates grew at ≤ 0.2 or 2 ppm, and none grew at higher fungicide concentrations..

In a second study, two infected cucurbit fields were compared for distribution of sensitive isolates; 30 isolates were collected from a pumpkin field at the LIHREC where application of BAS 500 F controlled disease and 15 from a field of butternut squash in Freeville, NY, where BAS 500 did not appear to control disease. Of LIHREC isolates, 5 isolates could grow at 0.2 ppm or less of BAS 500, 12 at 0.2/2 ppm (that is, in one rep they grew at 0.2, in the other at 2.0 ppm) and 13 could grow at ≤ 2.0 ppm. Of Freeville isolates, 3 grew at ≤ 0.2 ppm, 1 at ≤ 0.2/2.0 ppm, and 11 grew at ≤ 2.0 ppm. It was concluded that there was no significant difference in the sensitivity of isolates at the 2 sites. Some other factor must have been responsible for the lack of control at the Freeville site.

POWDERY MILDEW OF CUCURBITS: DETERMINATION OF PATHOGEN RACE

Investigator: M. T. McGrath
Location: Long Island Horticultural Research and Extension Center

Differential melon genotypes were grown near the powdery mildew experiments to determine which races of the pathogen were present. Topmark is susceptible to all races. PMR-45 is resistant to race 1 and PMR-6 is resistant to races 1 and 2.

Based on powdery mildew development in the differential melon genotypes, race 1 was dominant during most of the epidemic. Race 2 appeared late in the epidemic and remained at a low frequency. Few symptoms due to race 2 were observed on PMR-45 on 11 Sept. Symptoms did not develop on PMR-6, therefore race 3 did not occur.

POWDERY MILDEW OF PUMPKIN: ALTERNATIVE FUNGICIDES TO BRAVO EVALUATED ON VARIETIES DIFFERING IN SUSCEPTIBILITY TO POWDERY MILDEW

Investigator: M. T. McGrath
Location: Long Island Horticultural Research and Extension Center

A powdery mildew tolerant/resistant (PMR) variety (Magic Lantern) and a PMR experimental (HMX 6687) from Harris Moran Seed Company were compared with susceptible Wizard. HMX 6687, which has resistance from both parents, was shown previously to be more resistant to powdery mildew than Magic Lantern. There were three fungicide programs plus a nontreated control. The standard fungicide program was Quadris F (15.4 oz/A) applied week 1, 3, and 5 in alternation with Nova 40W (5 oz/A) + Bravo Ultrex (2.7 lb/A) applied week 2, 4, and 6. The Bravo alternatives fungicide program was Armicarb (4 lb/A)(week 1), Quadris (2), Armicarb+Nova (3), Quadris (4), Microthiol Sulfur 80DF (4 lb/A) + Nova (5), and Quadris (6). The biocompatible fungicide program was Sulfur (1), Armicarb (2), Kocide (3), Armicarb (4), Kocide (5), and Armicarb (6). These materials are currently or potentially acceptable for organic production. Applications were made on 4, 10, 17, 25 Aug; and 1 and 9 Sept. Week 1 application was made on 4 Aug to Wizard and on 10 Aug to Magic Lantern and HMX 6687.

Powdery mildew was found on 8 of 800 leaves of Wizard examined on 25 July and on 81 of 800 leaves examined on 3 Aug. Chemical control was more effective than genetic control, especially when compared with the moderately resistant variety Magic Lantern. Wizard treated with either the Bravo alternatives or standard fungicide program was less severely infected than nontreated Magic Lantern beginning on 29 Aug and than nontreated HMX 6687 beginning on 5 Sept, but only on upper leaf surfaces. The fungicide programs reduced powdery mildew severity in Magic Lantern beginning on 23 Aug for upper surfaces and on 29 Aug for lower surfaces. A fungicide benefit was not detected with HMX 6687 until 5 Sept and 14 Sept for upper and lower leaf surfaces, respectively. Control of powdery mildew resulted in less defoliation. The biocompatible fungicide program was not effective with Wizard based on both powdery mildew severity and defoliation. In contrast, this program was as effective as the standard fungicide program with Magic Lantern until 20 Sept for upper leaf surfaces and 5 Sept for lower surfaces. With HMX 6687, the only significant difference between these treatments was severity on lower surfaces on the last assessment date (20 Sept). The Bravo alternatives fungicide program was as effective for controlling powdery mildew as the standard fungicide program for each variety. However, there were significant differences in amount of defoliation with Wizard most likely because severity was higher, although not significantly, with the Bravo alternatives program. Since there was more defoliation with the Bravo alternatives program than with the standard program, and considering the biocompatible fungicide program was not as effective as the Bravo alternatives program although similar protectant fungicides were used (Armicarb and sulfur), it appears the alternatives to Bravo were not as effective as Bravo in this experiment. The systemic fungicides Nova and Quadris likely are responsible for the similar efficacy of the Bravo alternatives and standard fungicide programs. Bravo was more effective than Armicarb in a nearby experiment. Both chemical and genetic control improved fruit quality based on percentage of fruit with good, solid handles. Nontreated Wizard had significantly fewer fruit with solid handles than all others. There were significant differences in average fruit weight due to variety but not due to fungicide treatment for any variety. Weights were 12.7, 15, and 15 lb/fruit for Wizard, Magic Lantern, and HMX 6687, respectively. For each variety, total weight of mature fruit typically was greater for fungicide treatments, but this was not significant. Wizard was more severely affected by bacterial wilt with an average of 29% of the canopy wilted on 24 Aug compared with 10 and 11% wilt for HMX 6687 and Magic Lantern.

In conclusion, varieties such as HMX 6687, with high levels of resistance, are recommended over moderately resistant varieties such as Magic Lantern. The Bravo alternatives program was as effective as the standard fungicide program for managing powdery mildew on the resistant varieties. It was not quite as effective with susceptible Wizard resulting in greater defoliation. It may not be as effective as the standard fungicide program for managing resistance to Nova and Quadris, especially with a susceptible variety. This needs to be examined. The biocompatible fungicide program was almost as effective as the standard fungicide program only with the more resistant variety, HMX 6687.

POWDERY MILDEW OF MUSKMELON: ALTERNATIVE FUNGICIDES TO BRAVO EVALUATED ON VARIETIES DIFFERING IN SUSCEPTIBILITY TO POWDERY MILDEW

Investigator: M. T. McGrath
Location: Long Island Horticultural Research and Extension Center

Eclipse, which has resistance to race 1, and Apollo, which has resistance to race 1 and 2, were compared with susceptible Superstar. There were three fungicide programs plus a nontreated control. The standard fungicide program was Quadris F (15.4 oz/A) applied week 1, 3, and 5 in alternation with Nova 40W (5 oz/A) + Bravo Ultrex (2.7 lb/A) applied week 2, 4, and 6. The Bravo alternatives fungicide program was Armicarb (4 lb/A)(week 1), Quadris (2), Armicarb+Nova (3), Quadris (4), Armicarb+Nova (5), and Quadris (6). The biocompatible fungicide program was Sulfur (1), Armicarb (2), Kocide (3), Armicarb (4), Kocide (5), and Armicarb (6). These materials are currently or potentially acceptable for organic production. Application times were: 1=4 Aug, 2=10 Aug, 3=17 Aug, 4=25 Aug, 5=1 Sept, and 6=9 Sept. Applications were started on 4 Aug for Superstar and on 17 Aug for Eclipse and Apollo.

Powdery mildew was effectively controlled with either resistant varieties or fungicides applied to a susceptible variety. Powdery mildew was first found on Superstar on 3 Aug. Symptoms were observed on Eclipse and Apollo on 23 Aug, but incidence and severity were low with only a few colonies found in only 2 to 3 of the 16 plots of each variety. Few symptoms were observed on Eclipse and Apollo until 11 Sept, and then only on nontreated Eclipse. These observations indicate that race 1 was dominant during most of the epidemic, race 2 appeared late in the epidemic and is responsible for disease on Eclipse, while race 3 did not occur thus Apollo remained disease-free. This confirms the results obtained in an adjacent study with differential melon genotypes.

The fungicide programs reduced powdery mildew severity in Eclipse but not Apollo. With Superstar, the biocompatible fungicide program was not as effective as the Bravo alternatives or the standard fungicide programs based on ratings of powdery mildew severity, however there were no significant differences among the fungicide treatments in defoliation on 11 Sept. The application of Microthiol Sulfur in the biocompatible fungicide program on 4 Aug to Superstar was phytotoxic, although 82F was the highest temperature reached during 4 to 6 Aug; thereby confirming that muskmelon is too sensitive to use sulfur even when temperatures are only moderately high. Anthracnose also developed in this experiment, especially on Apollo. This most likely accounts for the greater defoliation on 11 Sept and lower percent sucrose in fruit of Apollo compared to Eclipse.

In conclusion, resistant muskmelon varieties, especially those with resistance to races 1 and 2, are recommended for managing powdery mildew on Long Island. Fungicides will still be needed if other diseases such as anthracnose develop. The Bravo alternatives or the standard fungicide programs are recommended for susceptible varieties; the biocompatible fungicide program is not recommended.

Susceptibility of watermelon to races of cucurbit powdery mildew

Investigator: N. Shishkoff and M. McGrath
Location: Long Island Horticultural Research and Extension Center

Cucurbit powdery mildew on watermelon is a disease which has been increasing in importance in the Eastern US. It was first observed in Maryland in 1998 and in Georgia in 1999. Some researchers felt that watermelon was being infected by race 2, which has increased in the US since introduction of cucurbit cultivars resistant to race 1. In Georgia, a watermelon field was observed to have severe powdery mildew while none was found in adjacent cantaloupe fields, suggesting that the watermelon PM was a new *forma specialis*. To clarify the characteristics of the mildew attacking watermelon, powdery mildew isolates from 8 states obtained from 4 species of cucurbit (watermelon [*Citrullus lanatus*], pumpkin and squash [*Cucurbita pepo*], muskmelon [*Cucumis melo*], and butternut squash [*Cucurbita moschata*]) were transferred onto leaf disks of the melon cultivars used as race differentials ('Topmark' and 'Hale's Best', susceptible to all races; 'PMR-45', susceptible to races 2 and 3; and 'PMR-6', susceptible to race 3 only) and onto leaf disks of watermelon 'Crimson Sweet'.

Of the 125 isolates tested, 75 were race 1, 37 were race 2, and 8 were race 3; 64 isolates, including representatives of each race, grew on watermelon. All isolates originally collected from watermelon (29) grew on watermelon leaf disks in culture. Thirty-one of 50 isolates from muskmelon, and 2 of 24 isolates from pumpkin and squash grew on watermelon leaf disks. None of the 10 isolates from butternut squash grew on watermelon.

Robinson Provvidenti and Shail (1975) reported that in watermelon, a single recessive gene controls susceptibility to cucurbit powdery mildew.
It doesn't seem unreasonable to suggest that all 3 races acquired the ability to infect watermelon independently.

COLLECTION LOCATION	HOST	NO. ISOLATES	RACE 1	RACE 2	RACE 3	Growth on Watermelon
Michigan, 1999	Pumpkin	6	5	1	0	0
Texas, 1999	muskmelon	17	4	12	1	11

	watermelon	1	0	1	0	1
Maryland, 1999	muskmelon	8	5	3	0	5
	watermelon	3	2	1	0	3
2000	watermelon	3	3	0	0	3
New York, 1999	muskmelon	11	2	6	3	2
2000	muskmelon	4	4	0	0	3
	squash	2	2	0	0	0
	Pumpkin	13	7	3	4	2
	watermelon	5	5	0	0	5
	butternut	10	5	5	0	0
Arizona, 1999	muskmelon	8	8	0	0	8
California, 1999	muskmelon	2	2	0	0	2
	watermelon	9	9	0	0	9
Florida, 1999	squash	4	3	1	0	0
2000	squash	5	1	4	0	0
Georgia, 2000	watermelon	8	8	0	0	8
	TOTAL	**125**	**75**	**37**	**8**	**64**

EVALUATION OF NEW NOZZLES AND AN AIR ASSIST SPRAYER FOR IMPROVING SPRAY COVERAGE ON UNDER SURFACES OF CUCURBIT LEAVES

Investigator: M. T. McGrath and Andrew Landers
Location: Long Island Horticultural Research and Extension Center

Effective control of powdery mildew in a cucurbit crop necessitates controlling the disease on the underside of leaves. Conditions are more favorable for development of powdery mildew on the under compared to upper surface. A protectant fungicide applied with conventional nozzles is deposited almost exclusively on the upper surface of leaves. Leaves die prematurely when powdery mildew is not controlled effectively on the underside. Thus systemic fungicides have been critically important for powdery mildew control. Unfortunately, systemic fungicides are at-risk for resistance development. The powdery mildew fungus has demonstrated high potential for developing resistance.

A means to improve spray deposition on the leaf underside would reduce grower dependence on systemic fungicides. This would be even more valuable for organic growers because there are no systemic fungicides that are approved for organic production. Several novel nozzles have come into the market place for conventional boom sprayers that reportedly improve coverage by delivering more spray to the leaf underside and also by reducing drift. Another approach to improving coverage is to use an air assist sprayer. Air assist sprayers use air as a carrier for the pesticide. A fan is used that moves air at a fast speed thereby pushing the spray into the canopy and also generating turbulence that moves spray to undersides of leaves. Nozzle velocity can be up to 180 mph. This is an expensive means to improving coverage because it entails purchasing a new sprayer rather than just new nozzles. Another benefit of improved deposition is the potential to maintain good control but with lower pesticide rates.

The goals of this project were to identify spray equipment that maximizes spray coverage on the underside of leaves and to determine if powdery mildew can be controlled effectively with nonsystemic fungicides when coverage is maximized. Disease control is the ultimate measure of coverage because it includes the entire canopy, in contrast with water sensitive paper that can only measure a small percentage of the canopy. The sprayer selected for this project is a tractor-drawn air assist sprayer with a second conventional boom that parallels the air assist boom. Unfortunately, it was not possible to evaluate disease control because the sprayer was not working correctly and required extensive modifications to the design that could not be completed before powdery mildew was well-established.

Spray coverage on pumpkin and muskmelon leaves was examined using water sensitive paper. These two cucurbit crops were selected because they have different canopies. Muskmelon leaves are much smaller and shorter than pumpkin leaves. Also, most leaves in the muskmelon canopy are at the same level whereas the pumpkin canopy consists of a few layers of leaves. Coverage was examined twice on both crops (28 Aug and 7 Sept) and a third time on pumpkin (14 Sept). Water sensitive paper cards were attached in pairs to both leaf surfaces using a staple or paper clip. A computer scanning program was used to determine the proportion of each card that changed color due to spray deposit.

Two novel nozzles (air induction and twin jet) and three traditional nozzles (flat fan, hollow cone, and cone jet) were selected for comparison on the conventional boom. All are considered ideal for applying fungicides. <u>Twin-jet flat fan nozzles</u> use forward and rearward pointing flat fans, which in effect gives two opportunities to hit the plant. They apply the same amount of liquid as a conventional flat fan but halve the quantity for each hole, resulting in a small hole producing smaller droplets for a given output. Smaller droplets stick to leaves, therefore the potential for better deposition maybe acceptable. These nozzles were used at 85 psi and 71 gpa. <u>Air induction</u>, air inclusion or venturi nozzles are flat fan nozzles where an internal venturi creates negative pressure inside the nozzle body. Air is drawn into the nozzle through two holes in the nozzle side, mixing with the spray liquid. The emitted spray contains large (300 micron) droplets filled with air bubbles (similar to a candy malt ball) and virtually no fine, drift-prone droplets. Normally these droplets would be large enough to bounce off their target. However, because of the air they explode on impact and spread over the leaf as the air absorbs the impact load. Coverage is similar to conventional, finer sprays. Drift is reduced even at pressures of $\geq$80 psi. These nozzles were used at 92 psi and 74 gpa. <u>Flat fan</u> 110 degree nozzles were chosen for their finer droplet characteristics compared to 80 degree nozzles. They were used at 85 psi and 54 gpa. The <u>hollow cone</u> is a very traditional design comprising a core that creates the swirl (also called a swirl plate) and a ceramic disc that contains the hole. These nozzles were used at 85 psi and 81 gpa. <u>Cone jet</u> nozzles create small droplets in an 80 degree cone. They were used at 100 psi and 42 gpa. In addition, the air assist sprayer was operated at 63 psi and 23 gpa with the fan at maximum speed.

All spray equipment provided much better coverage on upper than on under leaf surfaces with both crops. The air inclusion and twin jet nozzles provided the greatest coverage on under leaf surfaces. For cards on upper leaf surfaces, percent spray coverage averaged over both crops and all 3 dates was 59% for the air assist sprayer, 84-90% for the traditional nozzles, and 91% for the novel nozzles. Percent spray coverage for cards on the underside of leaves was 5% for the air assist sprayer, 1-4% for the traditional nozzles, and 5% for the novel nozzles.

POWDERY MILDEW AND PHYTOPHTHORA FRUIT ROT OF PUMPKIN: EVALUATION OF Plant Growth Enhancers plus a Fungicide

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

The objectives of this study were to examine the benefits of weekly applications of AuxiGro (1 oz/A) or Greenstim (1-2 qt/A) with Bravo Ultrex (2.7 lb/A) for disease control and yield enhancement. A treatment of Bravo alone was included for comparison. AuxiGro, marketed by Auxein Corp., is a 'plant metabolic primer' that has been shown to enhance growth and development of numerous plant species. Active ingredients are gamma aminobutyric acid (GABA) and L-glutamic acid. Greenstim, a 'nutrient induced resistance system' that promotes vigorous plant growth, contains macro and micro nutrients, sea plant extracts, carbohydrates, and a multi-vitamin component. It is marketed by Miller Chemical & Fertilizer Corp. 'Appalachian' pumpkin seeds were planted on 22 June in a field where Phytophthora fruit rot of pumpkin had developed in 1994 and 1996 through 1999. A similar experiment was conducted in this field in 1999. Treatments were applied with a tractor-mounted boom sprayer on 4, 10, 17, and 25 Aug; 1, 9, 18, and 30 Sept; and 12 Oct. Greenstim was used at 1 qt/A, then 2 qt/A for the last three applications. Soil drainage was improved by subsoiling on 19 July between rows before vines grew over. The field was irrigated (approx. 1.0 in.) on 8 July when soil was dry due to inadequate rainfall. The field was irrigated frequently and often excessively (more than 1 in.) beginning in late Aug to create conditions favorable for Phytophthora fruit rot development by saturating the soil. Irrigation dates were 28 Aug, 5 Sept, 11 Sept, 12 Sept, and 2 Oct. A nondestructive procedure was used to estimate fruit weight so that fruit could be left undisturbed for disease development. Weight was estimated from width X length using a linear regression equation derived using fruit from the non-plot areas of this field. Fruit width and length were measured on 25 Sept.

All treatments provided good control of powdery mildew on upper leaf surfaces, but only some control on lower leaf surfaces and only early in the epidemic. Neither AuxiGro or Greenstim applied with Bravo improved control over Bravo alone, based on ratings of powdery mildew severity on leaves; however, only pumpkins treated with these growth enhancers had significantly more fruit with good, solid handles on 25 Sept than nontreated pumpkins. Very few fruit developed symptoms of Phytophthora fruit rot (5.5%). Most symptomatic fruit could not be confirmed as having Phytophthora fruit rot because visible signs of the pathogen (sporangia) did not develop before affected fruit completely rotted. There were no significant differences in percentage of fruit with Phytophthora fruit rot. In sharp contrast, most fruit were affected and had visible sporangia during the previous experiment in this field with the same variety. Environmental conditions in this field in 2000 should have been favorable for disease development as Phytophthora fruit rot with good sporulation occurred in other experiments with this variety. Subsoiling may have affected disease occurrence by improving drainage; however, this practice was used in the other experiments and the low section of the field had standing water after irrigating to enhance disease development. Decline in incidence and severity of Phytophthora fruit rot also occurred in another LIHREC research field during several consecutive years of research on this disease. There were no significant differences among treatments in percent defoliation on 22 Sept, number of fruit, and average fruit weight. Estimated weight of mature fruit per plot was lowest for nontreated pumpkins, however these differences were not significant.

PHYTOPHTHORA FRUIT ROT OF PUMPKIN: EVALUATION ON ACROBAT MZ FUNGICIDE

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

'Appalachian' pumpkin seeds were planted on 22 June in a field where Phytophthora fruit rot of pumpkin had developed in 1994 and 1996 through 1999. A similar experiment was conducted in this field in 1999. Acrobat MZ was applied 9 times (4, 10, 17, and 25 Aug; 1, 9, 18, and 30 Sept; and 12 Oct) with a tractor-mounted boom sprayer equipped with D3-45 hollow cone nozzles spaced 11 in. apart that delivered 100 gpa at 200 psi. The field was irrigated (approx. 1.0 in.) on 8 July when soil was dry due to inadequate rainfall. The field was irrigated frequently and often excessively (more than 1 in.) beginning in late Aug to create conditions favorable for Phytophthora fruit rot development by saturating the soil. Irrigation dates were 28 Aug, 5 Sept, 11 Sept, 12 Sept, and 2 Oct.

A simultaneous observational study with the same variety was conducted to examine the benefit of applying Acrobat MZ weekly as a component of an integrated management program. The field used for this study had been rotated out of pumpkins from 1997 through 1999. Phytophthora fruit rot occurred in 1992 – 1995 where the observational study was conducted and in the adjacent section of the field in 1992 – 1996. Seeding date, fertility, insect and weed control were the same as in the replicated experiment. In addition to rotation, management practices were used to minimize the potential of the soil becoming saturated with water and thus favoring disease onset. Sorghum sudangrass was planted instead of pumpkin in the low portion of the field where water drained poorly after rain in previous years. Drainage throughout the field was improved by subsoiling on 19 July between rows before vines grew over. This field was not irrigated. Acrobat MZ was applied weekly to half of the field (3 200-ft rows). Applications were made just before treating the plots for the replicated experiment.

Very few fruit developed symptoms of Phytophthora fruit rot. Most symptomatic fruit in the replicated experiment could not be confirmed as having Phytophthora fruit rot because visible signs of the pathogen did not develop before these fruit completely rotted. In sharp contrast, during the previous experiment in this field with the same variety, most fruit were infected and had visible growth of the pathogen (sporangia). Also, most affected fruit in the observational study in 2000 had sporangia. Fewer affected fruit were observed where Acrobat MZ was used in 2000; however, these differences were not significant in contrast with 1999 results. There were significantly more healthy fruit where Acrobat MZ was used. Occurrence of Phytophthora fruit rot in the observational study suggests that a rotation of 3 years out of susceptible plants may not be sufficient; however, the pathogen could have moved here from a nearby field where Phytophthora blight occurred on pepper.

In conclusion, Acrobat MZ is clearly not a panacea for managing Phytophthora fruit rot; however, it may prove to be a valuable component of an integrated management program, if registered for this use. The enormous decrease in incidence and severity of Phytophthora fruit rot that occurred in this field from 1998 to 2000 suggests that biological control developed naturally in this field over the 6 years that the disease occurred.

Epidemiology of *Phytophthora capsici* in cucurbits: distribution of mating types, spread during rains and persistence on seeds

Investigator: N. Shishkoff
Location: Long Island Horticultural Research and Extension Center

On Long Island, it is not known how *Phytophthora* persists in infested fields or for how long. Thick-walled persistant oospores form if isolates of opposite mating types are present. While thin-walled mycelium may persist in moist plant tissue for up to 75 days after incorporation in soil, the thick-walled oospores survived over 200 days in laboratory tests. Both mating types have been found in single fields in North Carolina and Massachussetts. However, in fields in Ohio and Canada, sampled isolates were found to be a single mating type. If no oospores are formed, then one might predict that the fungus would not survive for more than a year or two in the absence of a host. In fields where both mating types are present, the opportunity exists for oospore formation, overwintering and genetic recombination to occur and in such fields, crop rotation might have very little effect in reducing disease levels. Even in fields with only one mating type present, there is a danger of introducing the second mating type; although soil-borne pathogens are generally slow to spread, in *P. capsici*, possible mechanisms include movement of the fungus in major storms, infested seed, infected transplants or produce, or by movement of infested soil.

The distribution of mating types of *P. capsici* on Long Island has never been investigated. In an ongoing study, 55 Long Island isolates of *P. capsici* from different hosts (pumpkins, squash, cucumbers, peppers, tomatoes), different locations (5 in Riverhead, 2 in Mattituck, and single sites in Watermill, Bridgehampton, Orient, and Mt. Sinai) and different years (1998- 2000) are being grown in dual culture with isolates of known mating type to get a picture of the distribution of mating types on Long Island. Of the 45 tested so far, 15 belong to mating type A1, 26 belong to mating type A2, and the rest have given inconclusive results and are being retested. Of the ten fields tested so far, most were dominated by isolates of mating type A2, the exception being the field in Bridgehampton consisted only of A1 isolates. Four fields contained isolates of both mating types.

Zoospores, the swimming spores that are formed in hot wet weather, are the spores that cause epidemics, and may be spread long-distance during storms with wind-driven rain,. Phytophthora blight first occurred in GA in 1994 following Hurricane Alberto, which moved north from FL where *P. capsici* was known to occur. An experimental plot was set up to follow the spread of P. capsici within a field during rainstorms, but the disease developed very late in the season, and no major storms occurred after disease development, so no spread was observed.

Little research has been done to determine whether *P. capsici* can overwinter on or in seeds. A study done at the LIHREC during the 1997 season found that *P. capsici* was easily cultured from seed collected from infected pumpkins. It is likely that seeds would persist in the ground longer than fruit tissue; thus, pathogen-infested seed might overwinter. If infested seed are viable, volunteer plants might germinate in the spring and serve as carriers for the pathogen even if crop rotation is being practiced in that field. In an ongoing experiment, dual inoculation of pumpkins with opposite mating types has been done and seed will be collected and tested.

Management guidelines will be refined from the results of this project. If movement of the pathogen during major storms is feasible, then it will be recommended to growers that they harvest before a storm if possible or apply an appropriate fungicide to protect the crop (fungicides are more likely to be effective in this situation than in a field with infested soil). A finding that seed transmission is not only feasible but an important means of dispersal will lead to further research on methods of seed testing and disinfestation. If the pathogen survives well only when oospores form, then an aggressive management program, with appropriate rotations and sanitation practices, implemented when Phytophthora blight first occurs on a farm could eliminate the pathogen.

EVALUATION OF MESSENGER FOR THE CONTROL OF CUCUMBER BEETLES AND BACTERIAL WILT OF PUMPKIN

Investigator: M. T. McGrath and N. Shishkoff
Location: Long Island Horticultural Research and Extension Center

Harpin, the active ingredient in Messenger, is a protein originating from *Erwinia amylovora*. It has been shown to induce the natural defense system of plants (known as systemic acquired resistance or SAR) for several diseases and to reduce insect attractiveness of treated plants. The variety 'Merlin' was selected for this experiment because it was determined to be more susceptible to bacterial wilt than other pumpkins in 1999. Treatments included 1) Messenger applied as a foliar spray on 17, 23, and 30 June; and 8 and 17 July and 2) Messenger applied as a seed soak for 16 hrs just before planting on 1 June plus the 5 foliar applications. Thin sections from stems of severely wilted plants were examined with a microscope for bacteria to confirm that they were succumbing to bacterial wilt.

Cucumber beetles were numerous and bacterial wilt was severe. Striped cucumber beetles were almost the only vector observed during this experiment. Very few spotted cucumber beetles were seen. Beetles and feeding injury were first observed on 17 June, which was 16 days after planting; none were seen 2 days earlier. Extensive feeding damage was observed on 23 June when plants were at the 2- to 3- leaf stage. Early symptoms of bacterial wilt, wilted sections of leaves, were first seen on 30 June, which was 29 days after planting. A few completely wilted plants were seen 1 week later. Bacteria were observed in all stems examined. No significant differences were detected among treatments in number of beetles/plant, percentage of cotyledons or whole plant with damage from cucumber beetle feeding, or incidence of wilt. All plants wilted and died before Sept. There were a total of only 3, 6, and 1 good orange fruit on 23 Aug in all the nontreated plots, Messenger seed plus foliar treatment plots, and the Messenger foliar treatment plots, respectively. In a similar experiment conducted in 1999, incidence of bacterial wilt was slightly lower for plants treated with Messenger.

In conclusion, Messenger is not an effective tool for managing cucumber beetles or bacterial wilt in pumpkin. This product may be effective with other cucurbit crops and perhaps other pumpkin varieties as SAR inducers have shown some variation in activity associated with the plant.

COMPARISON OF CUCURBIT CROPS AND VARIETIES FOR THEIR ATTRACTIVENESS TO CUCUMBER BEETLES AND SUSCEPTIBILITY TO BACTERIAL WILT

Investigator: M. T. McGrath and N. Shishkoff
Location: Long Island Horticultural Research and Extension Center

Seedlings at the cotyledon to one-leaf stage were transplanted into black plastic mulch on 9 June. Transplanting was done when plants were very young so that they would be in the field almost their entire life including the cotyledon stage when cucurbit crops are highly attractive to cucumber beetles. Plants were examined weekly for cucumber beetles, feeding damage, and symptoms of bacterial wilt. Plants were considered severely wilted when they were at least 50% wilted.

Compared to pest and disease pressure in a similar experiment in 1999, cucumber beetles were more numerous and bacterial wilt was more severe in 2000. Striped cucumber beetles were almost the only vector observed during this experiment. Very few spotted cucumber beetles were seen. Beetles and damage from their feeding were first observed on 20 June. No beetles were found on 14 June. An action threshold for foliar insecticide treatment of 1 beetle/plant is sometimes recommended for cucurbits. This threshold was exceeded on almost all varieties on almost all assessment dates (22 June – 11 July). Symptoms of bacterial wilt were first observed on 3 July. The gourd Turk's Turban (*Cucurbita maxima)* was very attractive to beetles and highly susceptible to wilt, differing substantially from Pear Bicolored (*C. pepo*). All Turk's Turban plants were severely wilted by 8 Aug whereas no Pear Bicolored plants were severely wilted until mid-Aug and only 23% wilted by 22 Aug. The pickling cucumber Country Fair, which is reported to be wilt resistant, was substantially less susceptible to wilt than the other two varieties examined (7% wilted versus all Dasher II and Calypso plants wilted by 22 Aug). This was not due to differences in beetle attractiveness as there were no significant differences among cucumber varieties in number of beetles/plant or amount of feeding damage. Similarly, differences in susceptibility to wilt among pumpkin varieties were not related to beetle density or feeding damage. A higher percentage of Merlin and Magic Lantern plants became severely wilted by 22 Aug than Harvest Moon and Howden plants (97-98% versus 53-58%). The more susceptible varieties have powdery mildew resistance (PMR). Fortunately, there does not appear to be a general correlation between wilt susceptibility and PMR as the PMR muskmelon and yellow summer squash varieties examined (Eclipse, Athena, and Sunray) were not more susceptible to wilt than the other varieties examined. Waltham Butternut (*C. moschata*) had fewer beetles and less feeding damage than other winter squash varieties, and it was the last to develop wilt symptoms, which were not seen until 15 Aug. Watermelon was less attractive to beetles and less susceptible to wilt than other cucurbit crops.

EVALUATION OF ADMIRE FOR MANAGING CUCUMBER BEETLES AND BACTERIAL WILT

Investigator: M. T. McGrath and D. Gilrein
Location: Long Island Horticultural Research and Extension Center

The insecticide Admire 2F (imidacloprid, Bayer Corp.) was registered for use on cucurbits beginning with the 2000 growing season. It is an exciting addition to the arsenal for managing cucumber beetles, and thus wilt, because it has a relatively safe toxicological profile and it is labeled for use at planting which enables product to be in leaf tissue when an early invasion of beetles occurs. Most management practices for wilt target the insects that harbor and vector the pathogen, which are the striped and spotted cucumber beetles, because the bacterial pathogen cannot be controlled directly with pesticides. This study was undertaken to obtain data needed to identify an effective insecticide program with Admire for wilt. White flies have been the focus of most previous evaluations of Admire. Experiments with cucumber beetles have not included assessments of bacterial wilt. Controlling wilt is more important than controlling beetles because beetle feeding rarely kills plants and plants can sustain a lot of feeding injury before yield is impacted. It was anticipated that one application of Admire at planting would not provide full-season control in all situations.

Two parallel experiments were conducted with wilt-susceptible 'Dasher II' cucumber and 'Merlin' pumpkin. Plots were direct seeded by hand on 20 June. Treatments included Admire applied in the furrow with the seed and Admire applied in a 2-inch band over the row after closing the furrow on 21 June, just before irrigating the field. The rate was 1.1 fl oz/1000 linear feet of row. Additional treatments were Sevin XLR (1 qt/A) and Avaunt (0.22 lb/A) applied weekly beginning 11 days after seeding (7 applications to cucumber and 9 to pumpkin), and a combination program with Admire applied in the furrow plus Sevin applied weekly beginning 45 days after seeding (2 or 4 applications). Plants were examined weekly. Cucumber beetles were counted and wilt severity was recorded.

Movement of beetles among the small, closely-spaced plots probably interfered with detection of differences among treatments. Despite this, some interesting results were found. Significantly more beetles were observed on nontreated pumpkins and on pumpkins treated with Avaunt than on those treated with Sevin. Feeding damage was significantly greater on nontreated cucumbers and on cucumbers treated with Avaunt than on those treated with Admire in the furrow. There were significantly fewer wilted cucumber plants where Admire was applied in the furrow or Sevin was applied weekly than where Admire was applied over the row after seeding or Avaunt was applied weekly; the latter two treatments did not effectively control wilt. Control of wilt with Admire was not improved by applying Sevin weekly. However, beetle density was low and remained well below the action threshold of 1 beetle/plant even on nontreated plants. Similar trends occurred with pumpkin, but differences were not significant. Disease pressure was high in this experiment. Percentage of plants that became severely wilted (at least 50% wilted) by 23 August was 40% for nontreated pumpkin and 64% for nontreated cucumber. With the in-furrow Admire treatments, incidence was 8% and 24%, respectively.

In conclusion, where susceptible varieties are used and there exists a history of bacterial wilt, Admire applied in-furrow at seeding appears to control wilt by controlling cucumber beetles. Application over the row after closing the furrow may be more effective in other situations. Additional application methods are described on the label. Foliar application of another insecticide to Admire-treated plots may improve control when insect and disease pressure are higher.

Evaluation of Fungicides for Powdery Mildew of Tomato

Investigator: N. Shishkoff and M. McGrath
Location: Long Island Horticultural Research and Extension Center

To study the efficacy of fungicides in controlling tomato powdery mildew, 6-wk-old seedlings were transplanted at 24-in. plant spacing on 19 Jun into five 300-ft rows on raised beds with black plastic mulch. The outer and center rows were left unstaked as guard rows and the remaining 2 rows were staked. Staked rows were divided into 20-ft plots of 10 plants each for 28 plots total, in a blocked design with 7 treatments and 4 replicatios. Treatments were applied starting on 24 Aug. Flint WG50, Flint plus

Actigard 50WG, A12325 (Flint plus Actigard Prepack), Quadris F (with 6 fl oz/A Nu Film P), BAS 500 (0.75 lb/A or 1.0 lb/A) were applied to foliage biweekly on 24 Aug, 7 Sep and 20 Sep using a CO_2-pressurized backpack sprayer that delivered 50 gpa at 55 psi and was equipped with three TJ110-8003 nozzles per row with one nozzle over the row and one drop nozzle on each side. Each treatment was alternated with Bravo Ultrex (1.5 lb/A on 31 Aug and 2.75 lb/A on 14 Sep and 29 Sep). Data were collected from the middle 8 of 10 plants in each plot. Severity of powdery mildew was recorded weekly from 4 Sep to 5 Oct. as percent of green leaf tissue with symptoms(one leaf/plant at a given height rated). Leaf death (% defoliation) was also recorded. Ripe fruit were harvested weekly 12 Sep through 17 Oct. Fruit were categorized by size into five groups, then counted and weighed. Fruit were considered culls when their diameter was less than 2 inches or they had developed rot.

Powdery mildew developed naturally. Symptoms were first observed on 1 Aug in a spreader row and incidence on staked plants was low and fairly uniform on 4 Sep and 11 Sep. From 18 Sep on, however, disease was significantly more severe on untreated plots than on treated plots. Significant defoliation was observed in nontreated plots beginning Sep 29. BAS 500 at the lower rate was somewhat less effective than other treatments. Many of the fruit from nontreated plots were of poor quality (yellowish red color, some sunburning); this was not quantified. Data in the table are for the last two harvest dates (4 and 17 Oct) when powdery mildew significantly affected yield. Total number reported includes small and cull fruit. Treatment with Flint or BAS 500 at the higher rate gave yields higher than those in untreated controls.

	Powdery mildew (%)**								Ripe fruit/plant (#)**	
	Upper leaf surface			Lower leaf surface			Defoliation		Large Fruit	Total Fruit
Treatment*	18 Sep	29 sep	5 Oct	18 Sep	29 Sep	5 Oct	29 Sep	5 Oct	(>3 in)	
Nontreated control ....…	13.80 a	31.10 a	42.10 a	13.90 a	26.40 a	22.00 a	30.5 a	24.0 a	1.62 a	3.53 a
Flint (2.5 oz/A) .... …...	0.23 bc	0.50b	0.20 b	0.38 c	0.07 bc	0.01 b	1.0 b	3.0 bc	5.67 d	8.32 c
Flint(2.5 oz/A) Actigard (1 oz/A)	0.55 bc	1.17 b	0.39b	1.19 bc	0.09 bc	0.05 b	2.5 b	5.5 b	3.91 bc	5.50 ab
Flint + Actigard Prepack (2.66 oz/A)	0.26 c	0.26 b	0.16b	0.18 c	0.33 bc	0.01 b	2.0 b	3.0 bc	4.22 bcd	6.84 bc
Quadris (6.2 fl oz/A)	0.30 bc	1.19 b	0.29b	0.93 bc	0.11 c	0.01 b	3.2 b	2.0 c	3.47 bc	5.00 ab

BAS 500 (0.75 lb/A)	2.28 b	3.50 b	1.70b	3.40 b	2.06 b	0.21 b	4.2 b	4.0 b	3.06 ab	5.31 ab
BAS 500 (1.0 lb/A)	1.03bc	0.60 b	0.33b	0.60 bc	0.49bc	0.18 b	1.5 b	3.0 bc	4.69 cd	6.09 bc
P-value	0.004	0.0001	0.001	0.005	0.005	0.004	0.012	0.004	0.012	0.004

*Treatments were applied in alternation with Bravo Ultrex at 1.5 lb/A (31 Aug), at 2.75 lb/A (14 Sep and 29 Sep).

**Numbers in a column with a letter in common are not significantly different according to Fisher's Protected LSD (P=0.05).

BACTERIAL CANKER OF TOMATO: INVESTIGATION OF ITS OCCURRENCE AND MANAGEMENT ON LONG ISLAND FARMS

Investigator: M. T. McGrath and D. D. Moyer
Location: Suffolk County

Bacterial canker has become one of the most important disease problems on tomatoes grown on LI. Canker is very difficult to control once it develops. Applications of copper have not been adequately effective. Therefore it is critical to control the source. The goal of this project was to determine what are the sources of bacterial canker on LI and to examine the impact on disease development of management practices used in commercial settings. The pathogen could be reintroduced each year in infested seed or it could be surviving in the greenhouse or in fields, in debris or on planting materials such as plug trays or stakes.

Four farms where canker has occurred previously were selected for this study. A checklist was prepared of practices that can increase or decrease the risk of canker occurring. Management practices for canker were discussed with these growers during the spring to determine what practices were being used. In addition, some practices were identified as infeasible, such as having workers wear plastic gloves and routinely dip them in disinfectant while pruning, trellising, and harvesting. Some management changes were made following these meetings. For example, one grower used a better procedure for disinfecting his tomato stakes. Stakes were pressure washed to remove soil and debris, then soaked for at least 10 minutes in a solution of Greenshield. Previously he had only dipped them in clorox.

To determine if the pathogen was present before transplanting, seedlings were examined for symptoms and some plants were collected and sent to Agdia Diagnostic Laboratory. All growers produced their own transplants. None of the plants tested positive for the presence of the pathogen. This does not confirm that the pathogen was not present in these greenhouses; but if it was present, it was not widespread.

Production fields were scouted routinely throughout the growing season. Symptoms of canker were not seen. This suggests that management programs used in 2000 were effective or that seed were not infested in 2000, but perhaps have been an important source in previous years. In contrast, bacterial spot was widespread on LI and also elsewhere in the US, which has not occurred in recent years. Leaf samples were tested thereby confirming that it was spot. Infested seed is a possible source of the bacteria causing spot.

First Occurence of powdery mildew (*Leveillula taurica*) on peppers on Long Island

McGrath, M., Shishkoff, N., and Moyer, D.
Location: Long Island Horticultural Research and Extension Center

Powdery mildew was observed on peppers on a farm on Long Island. It sporulated on the undersurfaces of leaves, causing yellow lesions which led to premature defoliation of plants. Although tomatoes and eggplant were present in adjacent rows, the mildew was not observed on these crops.

The mildew, *Leveillula taurica*, is a species "complex" (its taxonomy is poorly understood) that infects over 1000 plant species in 74 families, including pepper, tomato and eggplant. It is generally a problem in hot, arid regions of the world, although it will infect peppers in cooler, more humid climates. Powdery mildew of pepper was first reported in North America in 1971 when it was observed in southwest Florida. It is a problem on tomatoes and/or peppers in California, Arizona, Utah and Nevada, Powdery mildew of pepper was reported in Puerto Rico in 1992, in Idaho on greenhouse-grown pepper in 1998, in North-Central Mexico in 1998, and in both Canada and Oklahoma on greenhouse-grown pepper in 1999. It has never before been reported in NY state, although an unidentified powdery mildew on pepper was observed in 1999 in Western NY, which could have been *L. taurica* or *Erysiphe orontii* (which infects pepper rarely).

We speculate that *Leveillula taurica* occurring on pepper on Long Island in 2000 originated in Florida where the seedlings were grown. Growers should be aware that plants grown in Florida may have this disease.

OZONE CONCENTRATIONS IN RIVERHEAD IN 2000

Investigator: M. T. McGrath
Location: Long Island Horticultural Research and Extension Center

In contrast with most previous years, ozone was ≥80 ppb for only 77 hrs on 18 days in 2000: 6-9 May; 1-2, 9-11, 17, 24, and 27 June; 2-3 and 18 Jul; and 7-9 Aug. Ozone was ≥80 ppb for 60, 124, 121, and 184 hrs in 1996, 1997, 1998, and 1999, respectively. The highest concentration (145 ppb) was reached on 10 June, which was similar to 1999 but at least 2 weeks earlier than previous years. Ozone was ≥100 ppb only during 9-11 June; it was at this level for 14 hours. Typically high concentrations occurred between 1200 and 2400, as in previous years.

ASSESSMENT OF OZONE CONCENTRATIONS IN RIVERHEAD USING A CLOVER BIOINDICATOR SYSTEM

Investigator: M. T. McGrath
Location: Long Island Horticultural Research and Extension Center

An ozone-sensitive clone and an ozone-resistant clone of the commercial white clover line 'Regal' were used to estimate the concentrations of ambient ozone and its effects on plants. These clones were selected because they have similar growth rates in the absence of ozone stress. This system is being used in other locations throughout the world. Cuttings were planted in 1-liter pots on 13 Apr and then either transplanted to 15-liter pots on 11 May or transplanted into the field on 23 May. Landscape cloth was used for weed control around the plants in the field. Clover was harvested every 4 weeks. Cutting was done at 7 cm above the soil surface. Both wet and dry weights of harvested forage (leaves, stems, and flowers) were measured.

The forage dry weight ratios (sensitive/resistant) were 0.90, 0.86, 1.04, 1.26, and 1.38 for tissue harvested from clover growing in pots on 14 June, 12 July, 10 Aug, 8 Sept, and 16 Oct, respectively. The ratios were 1.26, 0.95, 0.89, 0.75, and 1.07 for tissue harvested from field-grown clover on these dates, respectively. Although the ratios were less than or greater than 1.0 for most harvest periods, the weights of harvested tissue for the two clones differed significantly only on 12 July for pot-grown clover and only on 12 July and 10 Aug for field-grown clover. Thus the ratios were significantly different from 1.0 only for those dates. Reduced growth of the sensitive clone relative to the resistant clone that was detected on 12 July probably reflects the impact of the highest ozone episode in 2000, which occurred on 9-11 June (see previous report for more details). This episode was too close to the first harvest date (14 June) to have had a detectable impact on growth during the first growth period. In previous years, ratios were smaller and they were less than 1.0 for more growth periods, reflecting the higher ozone concentrations.

SUMMARY OF VEGETABLE DISEASE DIAGNOSES

Investigator: M. T. McGrath
Location: Long Island Horticultural Research and Extension Center

Sixty-six samples were submitted to the laboratory for diagnosis. IPM scouts brought in 18 of the samples. Bacterial spot was very common in tomato in 2000. Phytophthora diseases were also widespread affecting pepper and cucurbits. Bacterial leaf spot affecting pumpkin was more widespread than in previous years. Additional diagnosed diseases and nonpathological problems include: Stewart's bacterial wilt of sweet corn, late blight on potato, white mold and tomato spotted wilt virus (TSWV) affecting tomato, water stress and wind injury damage to various crops, black root rot of strawberry, and Rhizoctonia wirestem affecting mature cabbage.