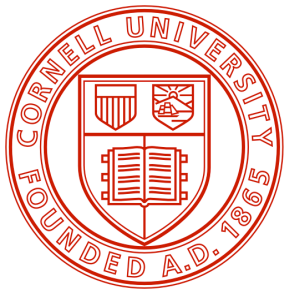

Long Island Vegetable Pathology Program
2009 Annual Research Report

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SENSITIVITY TO FUNGICIDES OF THE CUCURBIT POWDERY MILDEW FUNGUS ON LONG ISLAND IN 2009

Investigators: M. McGrath and G. Fox

Location: Long Island Horticultural Research and Extension Center

Application of fungicides continues to be the principal practice for managing powdery mildew in cucurbit crops, but successful control is challenged by development of resistance to key fungicides. There are varieties with genetic resistant to this disease, but the pathogen has the potential to develop new races to overcome resistance genes, which appears to have occurred, and resistance alone may not provide an adequate degree of suppression. An integrated program is recommended to reduce selection pressure for pathogen strains able to overcome the genetic resistance in the plant as well as fungicide resistance, and to ensure effective control is achieved. The pathogen develops best on the lower surface (underside) of leaves, thus a successful management program necessitates controlling the pathogen on the lower as well as the upper surface. It is difficult to directly deliver fungicide to the lower surface, therefore, an important component of fungicide programs has been fungicides able to move to the lower leaf surface. Unfortunately these mobile fungicides are prone to resistance development because they have single site mode of action.

The goals of this study were to 1) determine fungicide sensitivity of the cucurbit powdery mildew fungal population on LI at the start of disease development and 2) monitor sensitivity during the growing season. This was accomplished by conducting seedling bioassays with fungicide-treated seedlings in squash and pumpkin plantings. This information was used to guide fungicide recommendations. For the assay, pumpkin seedlings were treated with mobile fungicides (Topsin M, Flint, Rally, Procure, Inspire, Tebuzol, Quintec, Endura), then placed with non-treated seedlings for about 4 hours in production and research fields where powdery mildew was developing. The seedlings were kept in a greenhouse until symptoms of powdery mildew were visible, which took about 10 days. Then severity (percent tissue with symptoms) was visually estimated for each leaf. Frequency of resistant pathogen strains in a field was estimated by calculating the ratio of severity on fungicide-treated plants relative to non-treated plants for each group, then determining the field average. Only one representative fungicide in each group is needed because of cross resistance (e.g. an isolate resistant to Flint is also resistant to other QoI fungicides). Only one concentration of Flint and Topsin M were used because resistance to these fungicides is qualitative. Several concentrations of the other fungicides often were used because resistance is known or suspected to be quantitative. Most of the concentrations used were the same as in 2008. Four DMI (FRAC Code 3) fungicides were used to determine if there are differences in inherent activity. Endura (which is not registered for use on cucurbits) was used rather than Pristine (which is registered) because Endura has only one of the active ingredients in Pristine, boscalid (FRAC Code 7). The other active ingredient in Pristine is a QoI fungicide. Additionally, isolates (individuals) of the powdery mildew pathogen were collected in mid-Sep from research and commercial plantings for testing in the laboratory.

The first bioassay was conducted on 30 July in 6 commercial fields and a research field of spring-planted summer squash. This crop was chosen because it is where powdery mildew starts to develop each season. Resistance to Topsin M and to Flint were detected in all squash plantings where the bioassay was conducted. Therefore for managing powdery mildew in 2009 fungicides were not recommended in these chemical classes, which are the MBC (FRAC Code 1) and QoI (Code 11) fungicides, respectively. Proportion of the pathogen population estimated to have resistance varied among the plantings from 28-100% for Topsin M (average of 80%) and 20-100% for Flint (62%). Similar results were obtained in 2008. Strains of the pathogen were detected with low sensitivity to Code 3 and 7 fungicides: 2-36% (18% average) of the pathogen populations were estimated to be able to tolerate 120 ppm myclobutanil (active ingredient in Rally) and 4-48% (19%) tolerated 175 ppm boscalid (a.i. in Endura). The pathogen exhibited similar sensitivity to the four DMI fungicides: average proportion of the pathogen populations tolerating 80 ppm active ingredient was 11% for Inspire, 16% for Tebuzol, 19% for Rally, and 32% for Procure. The pathogen exhibited high sensitivity to Quintec (FRAC Code 13) with an estimated average of only 1% and 8% of the pathogen population tolerating 10 and 1 ppm quinoxyfen, respectively. Based on these results, Quintec was recommended as the main fungicide to use in non-edible-peel cucurbit crops with applications alternated with Pristine and a DMI fungicide.

Another bioassay was conducted on 3 Sept in 7 commercial fields of pumpkin. As for the squash plantings, QoI resistance was detected in all pumpkin fields. Proportion of the pathogen population estimated to have resistance varied among the plantings from 24-100% for Flint and averaged 77%. Resistance to FRAC Code 1 fungicides was not tested. Also, strains of the pathogen were detected with low sensitivity to Code 3 and 7 fungicides, but they were at lower frequencies: average of 0.4% and 11% tolerated 120 ppm myclobutanil and 175 ppm boscalid, respectively. Sensitivity to Quintec also was similar with an estimated average of only 0.5% and 6% of the pathogen population tolerating 10 and 1 ppm quinoxyfen, respectively. These results document the utility of conducting bioassays in spring summer squash crops for predicting pathogen sensitivity in main season crops.

On 24 Sep a bioassay was conducted in two commercial pumpkin fields and in research plots of pumpkin that had been treated every week with the same mobile fungicide or with a recommended fungicide resistance management program consisting of the mobile fungicides applied in alternation and tank-mixed with a protectant fungicide. Results from this bioassay document that sole use of a fungicide with resistance risk can select for tolerant strains during one growing season: proportion of the pathogen population tolerating 500 ppm boscalid was 100% for a plot treated with Pristine, <1% for plots treated with Procure or Quintec, and 17-20% for a plot and the commercial pumpkin fields receiving a fungicide program. Strains able to tolerate this high concentration would be difficult to control with Pristine because this is in the range of what the concentration would be in a spray tank (with Pristine at the highest label rate it would be 411 ppm boscalid when applied at 85 gpa and 698 ppm applied at 50 gpa). Proportion of the pathogen population tolerating 1-10 ppm quinoxyfen or 40 ppm triflumizole (a.i. in Procure) in plots treated with only Quintec or Procure was similar or slightly greater than in the other plots. Efficacy results from the fungicide evaluation conducted in this research field are presented in the following report.

Laboratory testing of pathogen isolates conducted to date on 21 isolates from commercial pumpkin plantings on LI has revealed that three of them were able to tolerate 500 ppm boscalid (e.g. they grew on leaf tissue treated with this concentration). These were from 3 fields on 2 farms. Two of these boscalid insensitive isolates also tolerated 40 ppm myclobutanil and 10 ppm quinoxyfen. Only four additional isolates were able to tolerate at least one of these concentrations.

EVALUATION OF FUNGICIDES FOR MANAGING POWDERY MILDEW ON PUMPKIN AND TREATMENT IMPACT ON PATHOGEN SENSITIVITY TO FUNGICIDES

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

The objectives of this study were to evaluate the efficacy of several individual mobile fungicides and two fungicide programs for the control of cucurbit powdery mildew. Both new and currently registered products were tested. Knowing the efficacy of individual fungicides is important for making fungicide recommendations and for assessing whether fungicide resistance may be impacting efficacy. The cucurbit powdery mildew fungus has demonstrated ability to adapt to fungicides by developing resistance. Mobile fungicides, which are critical for effective control of powdery mildew on the lower surface of leaves, are prone to resistance development due to their single site mode of action. Therefore they are recommended used in combination and alternation with other fungicides to delay resistance developing, and their labels usually have restrictive statements requiring this.

Seeds were planted at approximately 24-in. plant spacing within rows with a vacuum seeder on 16 Jun. The planter applied fertilizer in a band about 2 in. away from the seed. A blend of controlled release fertilizers, consisting of 300 lb/A 15-18-12 and 100 lb/A ESN, was used. The herbicides Strategy (3 pt/A) and Sandea (0.5 oz/A) were applied over the entire plot areas on 17 Jun. Red clover at 10 lb/A was planted with a grain drill to establish spray driveways on 30 Jun. Cucumber beetles were managed by applying Admire Pro at planting and Asana XL to foliage. ProPhyt, Forum and Ranman were applied alternately on a weekly schedule for downy mildew and Phytophthora blight. Plots were three 15-ft rows spaced 68 in apart. The plots were 18 ft apart. Upper and lower leaf surfaces were inspected for powdery mildew symptoms weekly beginning on 23 Jul. Treatments were started on 12 Aug with subsequent applications made weekly through 9 Sep 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. Defoliation, which was mostly due to powdery mildew, was assessed on 17 and 24 Sep. Fruit quality was evaluated in terms of handle (peduncle) condition for mature fruit without rot from 30 Sep to 26 Oct. Handles were considered good if

they were solid. Powdery mildew causes vines to die which results in handles shriveling and rotting as moisture is removed.

Among the fungicides tested that are labeled for controlling cucurbit powdery mildew, Quintec was the most effective providing 99% and 86% control on upper and lower leaf surfaces, respectively, based on AUDPC values (Area Under Disease Progress Curve is a summation of severity over time, typically including all assessments made during an experiment). It was as effective as both formulations of a new experimental fungicide. Quintec has also been the most effective fungicide in efficacy experiments conducted in previous years. However, Quintec was not significantly better than Procure (97.5% and 80% control) and Pristine (96% and 72.5%), the other registered fungicides evaluated that have been recommended used in alternation with Quintec. Performance of Procure and Pristine has oscillated from year to year in previous efficacy experiments on LI. While powdery mildew severity did not differ significantly for these two on any assessment date, severity was numerically higher on lower leaf surfaces of pumpkin treated with Pristine. Procure applied at its highest label rate was more effective for controlling powdery mildew on lower leaf surfaces than two other DMI fungicides (FRAC code 3): the new fungicide Inspire (difference was significant on the last assessment date), and Rally, which at its highest labeled rate contains almost half the rate of active ingredient as Procure. Although the AUDPC values for Rally and Inspire were 37% and 40% lower, respectively, than for the non-treated control, these differences were not significantly different, therefore these fungicides did not provide full season control on lower leaf surfaces. However, they were effective for controlling powdery mildew on upper leaf surfaces. While Rally alone did not provide adequate control, 91% control was obtained on lower leaf surfaces with a fungicide program consisting of Microthiol Disperss applied weekly plus Quintec and Rally applied alternately in blocks of two sprays beginning with Quintec. The fungicide program with Procure plus Microthiol Disperss applied in alternation with Pristine plus Bravo also provided excellent control of powdery mildew (94% on lower leaf surfaces).

Inspire was the only treatment that did not have significantly less defoliation on 24 Sep than the nontreated control.

EVALUATION OF POWDERY MILDEW RESISTANT MELON VARIETIES WITH PERSONAL-SIZED FRUIT

Investigators: M. McGrath, S. Menasha and G. Fox
Location: Long Island Horticultural Research and Extension Center

The objective of this study was to evaluate muskmelon varieties that were released recently with resistance to powdery mildew. Only varieties bred to produce small fruit were examined since these are in demand by organic growers because standard-sized fruit add too much weight to CSA boxes and can damage other produce when they roll. They were compared to Passport, a variety lacking genetic resistance. Fruit type for most of the varieties tested is a cantaloupe; Arava is a galia and Sivan is a charentais.

A blend of 19-10-12 controlled release fertilizer (containing 65% of N as ESN, a controlled release formulation) plus Muriate Potash (0-0-60) was spread on 10 Jun and then incorporated by disking. Black plastic mulch and drip tape were laid on 16 Jun. Seedlings were transplanted into the plastic-covered beds on 23 Jun. No fungicides were applied specifically for powdery mildew control. ProPhyt, Forum and Ranman were applied alternately on a weekly schedule for downy mildew and Phytophthora blight. Plots were three adjacent rows each with three plants spaced 24-in. apart. Rows were spaced 68 in. apart. Within each of the three rows between each plot there was a plant of a susceptible summer squash variety to separate plots and provide a source of inoculum. A randomized complete block design with four replications was used. Upper and lower leaf surfaces of 10 to 20 leaves per plot were assessed for powdery mildew weekly from 15 Jul to 25 Aug. Initially the examined leaves were selected from the oldest third of the foliage based on leaf appearance and position in the canopy. As disease progressed mid-aged to young leaves also were examined. Melon fruit were harvested, weighed, and measured when they reached maturity. Fruit characteristics were also evaluated and rated on a scale of 1 to 9 with 1= poor and 9 = best.

Powdery mildew was first observed on 31 Jul. Severity remained very low through the last assessment on 25 Aug. All resistant varieties were significantly less severely affected by powdery mildew on upper leaf surfaces on 25 Aug than Passport, the susceptible variety, and all except Sivan were less affected on lower leaf surfaces. Average fruit weight ranged from 1.9 lb for Lil' Loupe to 3.2 lb for Arava. Sugar Cube and

Lil' Loupe produced the greatest number of marketable fruit per plant. Other varieties evaluated were Head Start, Pixie, and an experimental from Hollar Seeds.

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

EVALUATION OF POWDERY MILDEW RESISTANT MELON VARIETIES

Investigators: M. McGrath, S. Menasha and G. Fox
Location: Long Island Horticultural Research and Extension Center

The objective of this study was to evaluate varieties of muskmelon with resistance to race 1 or race 1 and 2 of the powdery mildew fungus. Cultural practices and assessments were the same and done at the same time as for another, adjacent experiment with melon described in the previous report.

Powdery mildew was first observed on 31 Jul, three days after first fruit were observed. Severity remained very low in the susceptible variety until the last assessment on 25 Aug. No symptoms were found on leaves of Eclipse or Strike while very few were found on Athena. When evaluated in 2008, Eclipse, which only has resistance to race 1, was more severely affected than Athena. Powdery mildew developed on Athena in another, near-by experiment. Varieties like Athena with resistance to both race 1 and 2 have not been providing adequate suppression of powdery mildew in GA due to presence of a new race (S). There were no significant differences among varieties in number or weight of marketable fruit.

Project funded by the North Central IPM Mini-Grant Program.

POWDERY MILDEW RESISTANT ZUCCHINI VARIETY EVALUATION

Investigators: M. McGrath, S. Menasha and G. Fox
Location: Long Island Horticultural Research and Extension Center

The objective of this study was to evaluate varieties possessing different powdery mildew resistance genes. The main goal was to determine whether varieties with homozygous resistance, e.g. two copies of the powdery mildew resistance gene (PMRR), provide better suppression of powdery mildew than varieties with heterozygous resistance (PMR). This was the case in variety evaluations conducted in 2007 and 2008 but not in 2006 when PMR and PMRR varieties provides similar, excellent suppression. Most commercial resistant squash varieties have PMR. The abilities of the varieties evaluated in 2009 to resist powdery mildew as well as their yields were determined relative to Spineless Beauty, a standard variety lacking powdery mildew resistance.

A blend of 19-10-12 controlled release fertilizer (containing 65% of N as ESN, a controlled release formulation) plus Muriate Potash (0-0-60) was spread on 10 Jun and then incorporated by disking. Black plastic mulch and drip tape were laid on 16 Jun. Seeds were sown on 26 May in the greenhouse. Seedlings were transplanted into the plastic-covered beds on 16 Jun. Weeds were controlled between plastic mulch strips by applying Strategy and Sandea on 17 Jun with a shielded herbicide sprayer and by hand weeding. No fungicides were applied to control powdery mildew. ProPhyt, Forum and Ranman were applied alternately on a weekly schedule for downy mildew and Phytophthora blight. Plots were three adjacent rows each with three plants spaced 24 in. apart. Rows were spaced 68 in. apart. Within each of the three rows between each plot there was a plant of a susceptible summer squash variety to separate plots and provide a source of inoculum. Upper and lower leaf surfaces of 10 to 30 leaves in each plot were assessed for powdery mildew weekly from 13 Jul to 11 Aug. Initially the examined leaves were selected from the oldest third of the foliage based on leaf appearance and position in the canopy. As disease progressed mid-aged and young leaves also were examined. Squash fruit were harvested and weighed from 28 Jul through 25 Aug. Fruit characteristics were also evaluated and overall appearance was rated.

Symptoms of powdery mildew were found on 13 Jul at a low level (1.6% of older leaves examined). Symptoms were found in most plots on 20 Jul and all plots on 31 Jul, 3 days after the first harvest. No significant differences were detected among varieties in powdery mildew severity. This is partly due to the fact that plots were assessed in only three replications on 4 Aug and two on 14 Aug due to poor growth of plants in the other replications, thus there was insufficient data for statistical analysis. Powdery mildew severity was substantially lower on Zucchini #8517, which has resistance genes from both parents (PMRR), than all the other resistant varieties tested, which have only one parent with resistance to powdery mildew (PMR). This experimental variety, developed by Outstanding Seeds, had significantly

less severe powdery mildew than Envy and Payroll in a similar experiment in 2008. Among the PMR varieties evaluated, Golden Glory, a golden zucchini fruit type, had the lowest powdery mildew severity on lower leaf surfaces on 14 Aug (4%). Next lowest was an experimental (SSXP4033), then Payroll, Reward, Envy, and Amatista; average severity on these ranged from 5% to 20% while it was 28% for Spineless Beauty. Based on these results, homozygous resistance (PMRR) is needed to effectively control powdery mildew in zucchini. Heterozygous resistance (PMR) is still a useful tool in an integrated management program with fungicides, which is recommended for managing this pathogen.

All varieties had marketable fruit at the first harvest. There were few significant differences in yield. The highest yielding variety was Golden Glory. Marketable fruit weight was low for Amatista because it is a grey zucchini fruit type which are harvested small. Reward, SSXP4033, and Zucchini #8517 also yielded well.

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POWDERY MILDEW RESISTANT YELLOW SUMMER SQUASH VARIETY EVALUATION

Investigators: M. McGrath, S. Menasha and G. Fox
Location: Long Island Horticultural Research and Extension Center

The objective of this study was the same as for an adjacent experiment with zucchini described in the previous report. Cultural practices and assessments were also the same and done at the same time.

Powdery mildew was found on 13 Jul at a very low level (1.3% of old leaves examined). First fruit just starting to develop were observed around that time (9 Jul). The variety evaluated with resistance from one parent (PMR), Yellow Scallopini, did not suppress powdery mildew: severity values were not significantly less than those of the susceptible variety Gentry at any assessment date. The two varieties with resistance genes from both parents (Sunglo and Sunray) were exhibiting 88% and 96% control on upper leaf surfaces and 77% and 97% control on lower surfaces on 11 Aug, the last assessment date. Yellow Scallopini yielded fewer fruit than the others; however, it produces saucer-shaped fruits with scalloped edges which is a different fruit type from the other varieties and may have impacted yield. Sunray and Gentry produce straightneck fruit while Sunglo has a crookneck type fruit. All varieties had marketable fruit at the first harvest.

Project partly funded by the Friends of Long Island Horticulture Grant Program
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POWDERY MILDEW RESISTANT ACORN SQUASH VARIETY EVALUATION

Investigators: M. McGrath, S. Menasha and G. Fox
Location: Long Island Horticultural Research and Extension Center

The primary goal of this experiment was to determine whether winter squash varieties with homozygous resistance (e.g. two copies of the powdery mildew resistance gene; PMRR) are better protected against powdery mildew than varieties with heterozygous resistance (PMR). This is part of a multi-year project. Ability of these varieties to resist powdery mildew as well as their yields were determined relative to Table Ace, a standard variety lacking powdery mildew resistance that is commonly produced.

A blend of 19-10-12 controlled release fertilizer (containing 65% of N as ESN, a controlled release formulation) plus Muriate Potash (0-0-60) was spread on 10 Jun and then incorporated by disking. Black plastic mulch and drip tape were laid on 15 Jun. Seeds were hand-planted on 16 Jun into holes cut into the plastic. Two seeds were placed and later thinned to one plant where needed. Water was provided as needed through drip irrigation lines located beneath the mulch. Weeds were controlled between plastic mulch strips by applying Strategy and Sandea on 17 Jun with a shielded herbicide sprayer and by hand weeding. No fungicides were applied to control powdery mildew. ProPhyt, Forum and Ranman were applied alternately on a weekly schedule for downy mildew and Phytophthora blight. Plots were three adjacent rows each with three plants spaced 24 in. apart. Rows were spaced 68 in. apart. Within each of the three rows between each plot there was a plant of a susceptible summer squash variety to separate plots and provide a source of inoculum. Upper and lower leaf surfaces of 10 to 30 leaves in each plot

were assessed for powdery mildew weekly from 15 Jul to 1 Sep. Initially the examined leaves were selected from the oldest third of the foliage based on leaf appearance and position in the canopy. As disease progressed mid-aged and young leaves also were examined. Squash fruit were harvested and weighed on 5 Oct. Three representative fruit per plot were selected for measuring fruit width, fruit length, and cavity width and for assessing sugar content, which was done with a hand-held refractometer using fruit samples that were frozen and then thawed. Fruit characteristics were also evaluated and overall appearance was rated on a scale of 1 to 5 with 1= poor and 5 = best.

Symptoms of powdery mildew were first observed on 22 Jul on 1.5% of the older leaves examined. No symptoms were found on 15 Jul. Severity remained low through 14 Aug. On 25 Aug, the susceptible variety Table Ace was substantially more severely affected than the other varieties, which have resistance, in the one replication that could be assessed on that date. Severity increased greatly on the resistant varieties by the next assessment date, 1 Sep. All three varieties with resistance from both parents (Honey Bear, Table Star, and Sweet REBA) were significantly less severely affected by powdery mildew on lower leaf surfaces than the susceptible variety whereas the variety with heterozygous resistance (Tay Belle PM) was not. Average fruit weight was lowest for Honey Bear, which was as expected because this variety was bred to produce a smaller, personal-sized fruit.

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

EVALUATION OF POWDERY MILDEW RESISTANT BUTTERNUT SQUASH VARIETIES

Investigators: M. McGrath, S. Menasha and G. Fox
Location: Long Island Horticultural Research and Extension Center

The goal of this study was to determine whether hybrids with homozygous resistance, e.g. two copies of the powdery mildew resistance gene (PMRR), provide better suppression of powdery mildew than hybrids with heterozygous resistance (PMR).

Cultural practices and assessments were similar to those used for the previous report on acorn squash.

Waltham, the susceptible standard variety, was more severely affected by powdery mildew than the resistant varieties, especially on lower leaf surfaces, but not at the last assessment on 1 Sep. There was no obvious benefit of PMRR compared to PMR. Bugle (PMRR) had the fewest symptoms of powdery mildew through 1 Sep. Next lowest was Betternut 401, then JWS 61107 (PMRR), Metro (PMR), AF 7514 (PMR), Quantum (PMR), JWS 61108 (PMRR), WSXP1037 (PMRR), HMX 7732 (PMR), and Honey Nut (PMR). Severity did not differ significantly among the resistant varieties. Fruit produced by two experimental varieties from Johnny's Seeds, JWS 61107 and JWS 61108, had the highest sucrose content. Bugle, Honey Nut, and JWS 61107 produce small, personal-sized fruit. Fruit of Honey Nut were a darker brown color than the others.

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

EVALUATION OF POWDERY MILDEW RESISTANT PUMPKIN VARIETIES

Investigators: M. McGrath, S. Menasha and G. Fox
Location: Long Island Horticultural Research and Extension Center

Seeds were planted by hand at approximately 24-in. plant spacing within rows on 16 Jun. A seeder was used to open furrows and place fertilizer in a band about 2 in. away from the furrow. A blend of controlled release fertilizers, consisting of 300 lb/A 15-18-12 and 100 lb/A ESN, was used. The herbicides Strategy (3 pt/A) and Sandea (0.5 oz/A) were applied over the entire plot areas on 17 Jun. Red clover at 10 lb/A was planted with a grain drill to establish spray driveways on 30 Jun. No fungicides were applied to control powdery mildew. ProPhyt, Forum and Ranman were applied alternately on a weekly schedule for downy mildew and Phytophthora blight. Plots contained a total of 12 plants in three 13-ft rows spaced 68 in apart. One summer squash was planted between plots in each row for separation and to serve as a source of inoculum. Upper and lower leaf surfaces were inspected for powdery mildew symptoms approximately weekly beginning on 23 Jul.

Powdery mildew severity was low through mid-August, then it increased substantially on all varieties. Trophy was the only resistant pumpkin that was significantly less severely affected by powdery mildew

than Sorcerer, the susceptible standard variety. Other varieties tested included two with PMRR (Magician and Field Trip from Harris Moran), Millionaire (Outstanding Seed), and three from Hollar Seeds (Camaro, Mustang, and HSR 4721) which have a novel resistance gene. Gold Dust and Gold Speck, the two miniature pumpkins tested, both had low powdery mildew severity which did not differ significantly although only Gold Dust has resistance.

Project partly funded by the Friends of Long Island Horticulture Grant Program
and the North Central IPM Mini-Grant Program

EVALUATION OF INTEGRATED MANAGEMENT PROGRAMS WITH BIOPESTICIDES AND A RESISTANT VARIETY FOR POWDERY MILDEW IN PUMPKIN

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

The objective of this experiment was to evaluate on pumpkin integrated programs with two biopesticides, Organocide (5% sesame oil) and Milstop (85% potassium bicarbonate) that effectively controlled powdery mildew in experiments conducted previously with pumpkin. This experiment was part of a study that included two parallel, adjacent field experiments conducted with muskmelon and butternut squash. Biopesticides were evaluated alone and in integrated programs with powdery mildew-resistant varieties and/or conventional, mobile fungicides (Quintec, Pristine, and Procure). The integrated programs evaluated consisted of biopesticides plus conventional fungicides applied on a 7-day spray interval to a susceptible variety and to a variety with resistance to powdery mildew.

Fertilizer (500 lb/A of 10-20-20) was applied on 19 May. Black plastic mulch and drip tape were laid on 27 May. Additional fertilizer (N-P-K 46-0-0) at 30 lb/A was injected through the drip irrigation system on 21 Jul and 11 Aug. Water was provided as needed through drip irrigation. Seeds were hand-planted on 10 Jun into holes cut into the plastic. Plots consisted of 3, 12-ft rows of 5 plants each and were separated by 18 ft in the row. Plants within each plot were at 24-in. in-row spacing and rows were at 68-in. spacing. Weeds were controlled between plastic mulch strips by applying Strategy (3 pt/A) and Sandea (0.5 oz/A) on 3 Jun and hand weeding. Cucumber beetles were managed with Admire 2F applied after plant emergence as a soil drench around seedlings (0.0007 fl oz/plant) on 24 Jun and with Asana XL (9.6 oz/A) applied to foliage on 24 Jun and 1 Jul. Fosphite, Forum and Ranman were applied alternately on a weekly schedule for downy mildew and Phytophthora blight. Treatment applications were made with a tractor-mounted boom sprayer operated at 100 psi and 96 gpa (D5-25 hollow cone nozzles spaced 17 in. apart). Upper and lower surfaces of 10 to 30 leaves in each plot were examined weekly for powdery mildew beginning on 13 Jul. Initially the examined leaves were selected from the oldest third of the foliage based on leaf appearance and position in the canopy. As disease progressed mid-aged and young leaves also were examined. Average severity for the entire canopy was calculated from the individual leaf assessments. Canopy condition including defoliation was assessed on 17 and 24 Sep. Pumpkin fruit quality was evaluated in terms of handle (peduncle) condition for mature fruit without rot on 5, 17, and 20 Sep. Handles were considered good if they were solid and not rotting.

Powdery mildew was found in almost all plots on 30 Jul. No symptoms were found on 20 Jul. The first treatment applications were made on 31 Jul and re-applied on 3 Aug because conditions became windy and rainy on 31 Jul. The resistant variety provided suppression of powdery mildew until the last assessment on 8 Sep, when severity did not differ significantly between the two varieties not treated with fungicides. Both biopesticides effectively controlled powdery mildew on upper leaf surfaces in both varieties. Control was achieved through the last assessment on 8 Sep for the resistant variety but not the susceptible variety. Milstop and Organocide did not differ significantly for most assessments. They provided 39% and 57% control, respectively, based on AUDPC values in the susceptible variety and 93% and 73% control in the resistant variety. Milstop effectively controlled powdery mildew on lower leaf surfaces in the resistant variety based on AUDPC values. Three treatments included mobile fungicides (Quintec, Procure, and Pristine) for controlling powdery mildew on lower leaf surfaces plus Organocide applied weekly. Mobile fungicides did improve control significantly. Two of these treatments with just one application each of Quintec and Procure provided control of powdery mildew through 27 Aug, 17 days after the last application. Disease severity on 8 Sep, however, did not differ significantly from that achieved with Organocide alone. Powdery mildew was controlled more effectively on both leaf surfaces at the last assessment where mobile fungicides were applied every week. Degree of powdery mildew control

influenced canopy condition, expressed as percentage of leaves that died, and fruit quality, expressed as proportion of fruit with good firm handles. Leaves with powdery mildew die prematurely, which leads to desiccation and shriveling of vines and then pumpkin fruit handles.

Project funded by the IR-4 Biopesticide Demonstration Grant Program

EVALUATION OF INTEGRATED MANAGEMENT PROGRAMS WITH BIOPESTICIDES AND A RESISTANT VARIETY FOR POWDERY MILDEW IN MELON

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

The objective of this study was the same as for an adjacent experiment with pumpkin described in the previous report. Cultural practices and assessments were also the same and done at the same time, except that mature fruit were harvested and weighed on 25 Aug and 3 Sep.

Powdery mildew was first seen on 27 Aug; no symptoms were found on 12 Aug. Athena, which has resistance to pathogen races 1 and 2, did not suppress powdery mildew in this experiment, but it was effective in a near-by variety evaluation where it was compared to Superstar. Fungicide applications were started on 31 Jul because powdery mildew was found in the adjacent parallel experiments with pumpkin and butternut squash that were being treated at the same time. Based on powdery mildew severity on 8 Sep, all fungicide treatments were providing effective control on upper leaf surfaces relative to non-treated control plots for both varieties, and all but Organocide applied to the susceptible variety were effective on lower leaf surfaces. The two biopesticides provided high levels of control: 96-100% on upper leaf surfaces and 76-91% on lower surfaces. Tank-mixing Organocide with mobile fungicides improved control significantly only on lower surfaces of leaves on the susceptible variety. Degree of powdery mildew control was related to canopy condition, expressed as percentage of leaves that died.

Project funded by the IR-4 Biopesticide Demonstration Grant Program

EVALUATION OF INTEGRATED MANAGEMENT PROGRAMS WITH BIOPESTICIDES AND A RESISTANT VARIETY FOR POWDERY MILDEW IN BUTTERNUT SQUASH

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

The objective of this study was the same as for two adjacent experiments with pumpkin and melon described in the previous reports. Cultural practices and assessments were also the same and done at the same time, except that mature fruit were harvested and weighed on 30 Sep.

Powdery mildew was first seen on 30 Jul in 11 of the 20 plots planted to the susceptible variety, Butternut Supreme. The resistant variety was not examined then. Fungicide treatments were started the next day and re-applied on 3 Aug due to rain on the first assessment date. The resistant variety suppressed powdery mildew through the last assessment on 8 Sep, when the degree of control was 77% and 43% on upper and lower leaf surfaces, respectively, which was lower than on previous assessment dates. Both biopesticides effectively controlled powdery mildew on both leaf surfaces in both varieties. Milstop and Organocide did not differ significantly. On upper leaf surfaces they provided 64% and 83% control, respectively, based on severity on 8 Sep in the susceptible variety and 95% and 88% control in the resistant variety. Three treatments included mobile fungicides (Quintec, Procure, and Pristine) for controlling powdery mildew on lower leaf surfaces plus Organocide applied weekly. Mobile fungicides did improve control numerically on both leaf surfaces, but only significantly for the susceptible variety treated with mobile fungicides every week, which exhibited 100% and 78% control on upper and lower leaf surfaces, respectively, on 8 Sep. Degree of powdery mildew control influenced canopy condition, expressed as percentage of leaves that died.

Project funded by the IR-4 Biopesticide Demonstration Grant Program

MONITORING CUCURBIT DOWNY MILDEW ON LONG ISLAND

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

A sentinel plot was maintained at LIHREC as part of the national downy mildew forecasting program being conducted in the eastern USA. This plot, along with two others in upstate NY, were among the 85 plots from Florida and Texas to Canada set up to monitor occurrence of downy mildew on the various cucurbit crops. This pathogen exists as different pathotypes that vary in their ability to infect the different cucurbit crop types. A set of differential varieties to distinguish pathotypes was planted at each sentinel plot.

Seedlings of the differential varieties at the 1- to 2-leaf stage were transplanted on 8 Jun and again on 9 Jul into beds covered by black plastic mulch with drip irrigation. Plants were examined routinely for symptoms. Quintec and Procure were applied for powdery mildew. ProPhyt was applied preventively for Phytophthora blight. This fungicide was selected because it is the only fungicide with activity for blight that is considered to have low activity for downy mildew.

Symptoms were first observed on 27 Jul on cucumber in the sentinel plot, which was a month earlier than in 2008. It was not surprising that this cucurbit crop type was affected first because cucumber is susceptible to all pathotypes. Symptoms were found on melon on 6 Aug and on butternut squash and giant pumpkin on 31 Aug. Symptoms were not found on acorn squash in the sentinel plot but they did develop on this crop type in a near by larger research planting. Watermelon also remained asymptomatic in the sentinel plot. It is suspected that ProPhyt affected development of downy mildew on some crop types, notably the butternut and acorn squashes, suggesting that pathotypes of the downy mildew fungus may have differential sensitivity to this fungicide.

Downy mildew was severe in 2009 in commercial plantings of cucumber, pumpkin, zucchini, acorn squash and butternut squash on LI where a recommended fungicide program had not been implemented. Most crops however had few or no symptoms of downy mildew. Fungicides that target the downy mildew fungus (e.g. Ranman, Tanos and Forum) are also effective for the Phytophthora blight pathogen and thus are commonly used

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SUSCEPTIBILITY TO DOWNY MILDEW OF PICKLING-TYPE CUCUMBER VARIETIES

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

The main goal of this study was to evaluate selected cucumber varieties which have exhibited relatively low susceptibility to downy mildew, compared to other varieties, in cucumber evaluations conducted at North Carolina State University since 2005. National Pickling and Straight Eight were included because they are old varieties lacking genetic resistance to downy mildew. The other five varieties evaluated were bred to have resistance for the strains of Pseudoperonospora cubensis that dominated the pathogen population before 2004. The evaluation was conducted as a component of an integrated management program for organically-produced cucumber by regularly applying an OMRI-listed botanical oil plus a copper fungicide. An integrated approach was taken because cucumber varieties bred with resistance to pathogen strains present before 2004 are recognized as no longer providing sufficient suppression of downy mildew to achieve adequate control without the use of fungicides.

Cucumber was seeded on 17 Jul and transplanted on 30 Jul into beds with black plastic mulch and drip irrigation in a field with Haven loam soil at the Long Island Horticultural Research and Extension Center in Riverhead. A late planting date was used to increase the likelihood of downy mildew developing during the experiment. Organic production practices were used. A blend of Pro-Gro 5-3-4 organic fertilizer at 1000 lb/A plus peanut meal at 625 lb/A was spread on 23 Jul over the rows to be planted and then incorporated by disking before laying plastic mulch. Neptune's Harvest hydrolyzed fish emulsion fertilizer (0.094 fl oz in 6 fl oz water) was poured into each transplant hole before planting. Weeds were controlled by hand weeding. Plots consisted of two 12-ft rows spaced 34 in. apart each with 6 plants at 24-in spacing. A randomized complete block design with four replications was used. Organocide at 1 oz/gal plus Kocide 3000 at 1 lb/A were applied on 24 and 31 Aug; and 8, 14, 22, and 30 Sep using a

tractor-mounted boom sprayer operated at 100 psi and 96 gal/A (D5-25 hollow cone nozzles spaced 17 in. apart). It was intended that this treatment be applied on a preventive schedule. Therefore, to obtain some initial suppression of downy mildew, a conventional fungicide with some curative activity but limited residual activity, Curzate (2.75 oz/A), was applied early on 26 Aug to the entire experiment. Downy mildew severity was assessed on 24 and 31 Aug; 8, 15, and 23 Sep; and 8 Oct 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. Marketable fruit and culls were harvested on 10, 22, and 28 Sep.

Downy mildew symptoms were first observed on 24 Aug following over 3 weeks of warm, dry weather. There were only 5 days that rain occurred during Aug before disease onset, and total rainfall was only 0.83 in.: 0.45 in. on 1 Aug, 0.07 in. on 2 Aug, 0.04 in. on 10 Aug, 0.09 in. on 13 Aug. and 0.18 in. on 22 Aug. Conditions were favorable for downy mildew during the experiment. There were four consecutive days of rain, with a total of 1.18 in., starting 3 days after the first treatment application. Subsequently rain fell on 6 Sep (0.01 in.), 9 Sep (0.05 in.), 11-13 Sep (0.66, 0.17, and 0.14 in.), 16 Sep (0.17 in.), 24 Sep (0.06 in.), 27 Sep (0.97 in.), and 29 Sep (0.16 in.). Straight Eight, which has no genes for resistance to downy mildew, was more severely affected initially than the other varieties evaluated (Calypso, National Pickling, Sassy, Jackson Classic, Wainwright Classic, and Feisty). Severity on Straight Eight was numerically the highest through 15 Sep. All varieties were severely affected by downy mildew on 23 Sep. Straight Eight was also more severely affected in a similar experiment conducted in 2008. This further documents that the resistance in modern varieties, which was highly effective for pathogen strains present before 2004, does provide some suppression of strains currently present. Calypso had the lowest severity in 2009 and also in 2008. Calypso and Feisty have generally exhibited better suppression than other varieties in several evaluations conducted at North Carolina State University since 2005.

Project funded by the Friends of Long Island Horticulture Grant Program

SUSCEPTIBILITY TO DOWNY MILDEW OF SLICER-TYPE CUCUMBER VARIETIES

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

An evaluation of slicer-type cucumber varieties was conducted adjacent to the experiment with pickling-type varieties described in the previous report. The same practices and procedures were used.

Straight Eight, which has no genes for resistance to downy mildew, was more severely affected initially than the other varieties. Severity on this variety was numerically the highest until the last assessment on 5 Oct. It was also more severely affected in a similar experiment conducted in 2008. This further documents that the resistance in modern varieties, which was highly effective for pathogen strains present before 2004, does provide some suppression of strains currently present. Poinsett 76, Marketmore 76, and an experimental variety, HMX 7421, were least severely affected based on AUDPC values, which are a measure of severity over all assessment dates. Other varieties evaluated were General Lee, Dasher II, HMZ 4453, and Stonewall.

Project funded by the Friends of Long Island Horticulture Grant Program

EFFICACY OF FUNGICIDES FOR MANAGING DOWNY MILDEW IN ORGANICALLY-PRODUCED CUCUMBER

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

The goals of this study were to evaluate biopesticides and fungicides approved for organic production using a cucumber variety that has exhibited relatively low susceptibility to downy mildew compared to other varieties in cucumber evaluations conducted at North Carolina State University since 2005. This integrated approach was taken because downy mildew is considered a difficult disease to manage organically. K-Phite was the only biopesticide evaluated that is not approved for organic production. The biopesticides were compared to an organic standard treatment, the copper fungicide NuCop, and a conventional fungicide program of Manzate Pro-Stick during the vegetative period followed by Bravo during the harvest period. Only protectant fungicides were used for the conventional fungicide standard

because the organic fungicides also lack targeted activity and mobility. Most biopesticides were tested alone. Organocide was tested at a low label rate tank-mixed with NuCop at a low label rate. The same practices and procedures for the cucumber variety evaluations were used.

Plots consisted of single 27-ft rows spaced 11 or 17 ft apart with 18 plants at 18-in spacing. The plots were 10 ft apart in the row. Fungicides were applied weekly for 7 weeks beginning on 25 Aug, one day after symptoms were first observed, using a backpack CO_2-pressurized sprayer equipped with an 8002E nozzle that delivered 74 gal/A at 50 psi. It was intended that the treatments be applied on a preventive schedule. Therefore, to obtain some initial suppression of downy mildew, a conventional fungicide with some curative activity but limited residual activity, Curzate (2.75 oz/A), was applied early on 26 Aug to the entire experiment.

Symptoms of downy mildew were first observed in this experiment before expected based on environmental conditions; consequently treatment applications had not begun. Conditions in Aug were warm and dry before 24 Aug when symptoms were first seen. There were only 5 days that rain occurred, and total rainfall was only 0.83 in.: 0.45 in. on 1 Aug, 0.07 in. on 2 Aug, 0.04 in. on 10 Aug, 0.09 in. on 13 Aug. and 0.18 in. on 22 Aug. Downy mildew was uniform in the experiment at disease onset as there were no significant differences at the 24 Aug assessment. Conditions were favorable for downy mildew during the experiment. There were four consecutive days of rain, with a total of 1.18 in., starting 2 days after the first treatment application. Subsequently rain fell on 6 Sep (0.01 in.), 9 Sep (0.05 in.), 11-13 Sep (0.66, 0.17, and 0.14 in.), 16 Sep (0.17 in.), 24 Sep (0.06 in.), 27 Sep (0.97 in.), and 29 Sep (0.16 in.). Five biopesticides controlled downy mildew based on both the 8 Sep and the 23 Sep canopy severity values, providing 52-82% and 26-51% control, respectively: Actinovate, K-Phite, Organocide applied with NuCop, Sonata, and Timorex Gold. These were as effective as the organic standard (OMRI-approved copper fungicide NuCop) based on at least one of these assessments. The other four biopesticides (Serenade MAX, Regalia, Sporatec, and Taegro) were effective based on one of these assessments. K-Phite, Organocide + NuCop, and Sporatec had the lowest severity values at the last two assessments. K-Phite was lowest on 8 Sep. K-Phite and Sporatec were as effective as the conventional standard based on the 23 Sep assessment.

Project funded by the IR-4 Biopesticide Demonstration Grant Program

EFFICACY OF BIOPESTICIDES FOR MANAGING FOLIAR DISEASES IN ORGANICALLY-PRODUCED TOMATO

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

Foliar diseases of tomatoes are an important problem of an important crop that need to be controlled to avoid premature leaf death and to maintain fruit quality and yield. An experiment was conducted in a research block at LIHREC that recently has been dedicated to evaluation of products for organic production. Most of the biopesticides tested are OMRI listed for organic production (Actinovate, Companion, Organocide, Regalia, and Sporatec AG) or are being developed for this market (Taegro). One biopesticide not approved for organic production, the phosphorous acid K-Phite, was also tested. They were compared to a copper fungicide and a conventional fungicide program. Non-fungicide-treated tomato seed was planted in an organic soil-less mix on 1 May in a greenhouse. Seedlings grew slowly and poorly suggesting inadequate fertilizer in the mix. Therefore Biolink 5-5-5 Organic fertilizer (2 fl oz per 1 gal water) was applied on 22 May, 10 Jun, and 16 Jun. Seedlings were no-till transplanted on 25 Jun into straw mulch from fall-planted rye. Pro-Grow 5-3-4 organic fertilizer at 1000 lb/A (= 50 lb N/A) was banded across the row at planting. Neptune's Harvest hydrolyzed fish emulsion fertilizer (0.094 fl oz in 6 fl oz water) was poured into the transplant hole before setting the seedlings. Drip tape was laid next to each row. Additional straw mulch was spread around plants. Hand-weeding was also needed to manage weeds. Plants were staked and trellised following standard procedure for fresh-market tomato production. The insecticide Ensure was applied regularly to control worm pests. Fungicides with targeted activity for late blight were applied weekly on a preventive schedule. These were Previcur Flex, Revus, Curzate, and Ranman. Application dates were 15 and 22 Jul; 4, 11, 18, and 26 Aug; and 4, and 15 Sep.

The first application of Taegro was done as a soil drench on 4 Aug. Foliar treatment applications were made using a CO^2-pressurized backpack sprayer with a boom that has a single twin-jet 180-degree nozzle. Each side of the planted row was treated with the boom held sideways to obtain thorough coverage of foliage. Applications were made weekly from 7 Aug through 22 Sep (8 total). It was intended to start

applications before diseases began to develop, but conditions were evidently more favorable than in previous years as symptoms were first observed earlier than expected based on both crop physiology and calendar date. Application dates were 7, 14, 21, and 28 Aug; 1, 8, 15, 22, and 29 Sep; and 5 Oct.

Disease incidence and severity were assessed several times beginning on 6 Aug. Mature fruit were harvested on 23 Sep, 2 Oct, and 14 Oct.

Septoria leaf spot was the main disease. Symptoms were first observed on 3 Aug when plants were trellised and first immature fruit were present, which was earlier than expected based on previous observations. Powdery mildew developed later. Conditions were favorable for Septoria leaf spot. Symptoms became more severe in all treatments, including the conventional fungicide standard, than in a similar experiment conducted in 2008. Based on canopy severity on 29 Sep, the conventional fungicide standard was providing only 77% control. Despite the high disease pressure, three treatments controlled Septoria leaf spot as effectively as the conventional standard: Organocide + Kocide 3000 (both at low label rates), Actinovate alternated with Kocide, and Taegro alternated with Kocide. Neither of these four fungicides was effective used alone. Other biopesticides evaluated were K-Phite, Serenade MAX, Regalia, Sporatec AG, Sonata ASO, and Timorex Gold

Project funded by the USDA IR-4 Biopesticide Grant Program

EVALUATION OF FUNGICIDES FOR DOWNY MILDEW IN BASIL

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

Downy mildew is a new disease of basil. It was first reported in south FL in October 2007 and in Europe in 2001. Both gardens and commercial plantings on LI were affected in 2008 and 2009. It appears to now be established in FL where it occurs year round. Due to the ease with which the pathogen's spores are dispersed by wind, it is anticipated that downy mildew will continue to occur every year in the northeast. It is also anticipated that fungicides will be an important management tool considering there is no tolerance for blemishes on leafy herbs. Few fungicides are presently labeled for this use, but fortunately there are several products with targeted activity for this group of pathogens (oomycetes) and that have been effective in evaluations conducted in FL. The objective of this experiment was to evaluate fungicides under LI conditions. This information will be used by the IR-4 program to obtain their registration.

The experiment was conducted late in the growing season to ensure the pathogen would be present. In 2008 symptoms were first reported in the northeast in late Sep. Seedlings were transplanted into black plastic mulch. Treatments were applied weekly using a backpack CO_2-pressurized sprayer beginning after transplants were established and before symptoms were seen. Disease development was monitored in the field. On 16 Oct an assessment was done with representative plants harvested from each plot to permit a thorough examination of the underside of leaves. Proportion of major, fully expanded leaves with symptoms was determined for each plot. Severity of symptoms was not assessed because any amount of symptoms renders the leaf unmarketable.

Symptoms were severe in the non-treated control plots with an average of 64% of leaves affected. All three fungicides tested were effective. No significant differences were detected among them. There was numerically less downy mildew in plots treated with Revus: affected leaves were only found in one plot and an average of only 1% of leaves were affected. An average of 3% and 11% of leaves were affected on plants treated with Ranman and Presidio, respectively.

The efficacy results obtained on LI are similar to those obtained in several efficacy trials conducted in FL, where Revus and Ranman were among the most effective products tested and Presidio was less effective. Therefore these fungicides perform similarly under different environmental conditions.

Project funded by the USDA IR-4 Program

SUSCEPTIBILITY OF BASIL VARIETIES TO DOWNY MILDEW

Investigators: M. McGrath, S. Menasha, and G. Fox
Location: Long Island Horticultural Research and Extension Center

Severity of downy mildew was assessed for varieties of basil in a variety evaluation conducted in the organic research block at LIHREC. Cultural practices for this experiment are described in a separate report on yield and horticultural assessments, which was the primary focus of this study.

Symptoms of downy mildew were first observed on 1 Sep. They were widespread in some varieties on 9 Sep when the assessment was done. The primary symptom was light to very dark gray sporulation (e.g. spores and the structures holding them) of the pathogen on the underside of leaves. Sporulation tended to be lighter in color and thus harder to see on red-leaved types. There was some yellowing on the top side of leaves opposite where there was sporulation. Symptoms were observed on all 8 varieties. Severity of downy mildew was rated as proportion of leaves with symptoms (incidence) and average severity for affected leaves. Overall or canopy severity was calculated by multiplying the two ratings.

Numerically the varieties differed greatly in amount of symptoms present; however, it was not possible to detect statistically significant differences due to the amount of variability in disease occurrence among plots. Incidence and severity were greatest for Superbo, with an average of 87% of leaves affected and 43% canopy severity. Next was Genovese with 60% and 37%, respectively; Lemon with 67% and 24%; Amethyst with 60% and 22%; Aroma 2 with 30% and 13%; Queenette with 18% and 6%, Cinnamon with 8% and 1 %, and Red Rubin with 5% and 1 %. Varieties with the least downy mildew were generally the spice types, which have flat leaves, in contrast with the traditional Italian types that have downward cupped leaves that likely create a microclimate of higher humidity where conditions would be more favorable for downy mildew development. Spice types were also found to be less susceptible in a variety evaluation conducted in NJ in 2009.

ASSESSMENT OF AMBIENT OZONE IMPACT ON PLANT PRODUCTIVITY USING A SNAP BEAN BIOINDICATOR SYSTEM

Investigators: M. McGrath and G. Fox

Location: Long Island Horticultural Research and Extension Center

Impact on plant productivity of ambient ozone occurring on LI was assessed by growing ozone-sensitive and ozone-tolerant snap bean lines that were developed for use in quantifying ozone impact. Ozone is the most important air pollutant. 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 on plant productivity. These lines yield similarly under low ozone concentrations.

There were 3 successive field plantings on 22 May, 22 June, and 16 July in 2009 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. As they developed, bean pods were harvested repeatedly from some plants when immature and at a size typical for fresh-market consumption. Pods were harvested from the other plants when mature and dry. 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 DEC Air Quality Division. The hourly values were used to calculate ozone exposure expressed as AOT40 (accumulated ozone dose over the threshold of 40 ppb between 7 am and 7 pm). AOT40 is a commonly used measure of ozone exposure.

The ozone-sensitive snap bean line S156 yielded less than the tolerant line R331 when grown under ambient ozone conditions on LI in 2009. Total weight and number of bean pods harvested for fresh-market consumption from planting 1 (22 May) plants was 28% and 19% lower, respectively, for S156 compared to R331 (pods were harvested from 17 July through 21 Aug). There was a 55% and 46% reduction in these yield variables, respectively, for planting 2 (22 June) plants (harvested 10 Aug through 9 Sept). Reduction was 33% and 16%, respectively, for planting 3 (16 July) plants (harvested 4 Sept through 6 Oct). These differences were similar to greater than in previous years. Mature yield data has not yet been collected. Exposure to ozone caused acute foliar injury in all three plantings. The visible symptom was bronzing. Injury was first observed on Planting 1 plants on 19 June. The sensitive line became more severely affected than the tolerant one. Severely affected leaves eventually died and dropped.