Floriculture and Greenhouse Crops

In vitro procedures for the development of new clover varieties
Investigators: Vincent Pennetti and Mark Bridgen
Location: Long Island Horticultural Research and Extension Center

The objectives of this study were to develop protocols for the genetic manipulation of White Clover, *Trifolium repens*, *in vitro*, and for the micropropagation of various other species of *Trifolium in vitro*, including the endangered species of Clover, *Trifolium amoenum*. White Clover plants, as well as other species of *Trifolium*, are natural nitrogen fixers that are widely cultivated cover crops; they possess many essential nutrients as well as unique aesthetic traits. Additionally, White Clover has been observed to positively impact livestock and surrounding plant life, provide erosion control, and supply a highly desirable nectar source for honeybees. In this study two chemical mutagens, Colchicine—a gout medication that causes chromosome doubling—and Surflan—an herbicide which doubles as a cell mutagen—were used successfully to mutate White Clover plants. Plants that were exposed to these two mutagens demonstrated physical mutations, such as increased leaflets per clover. Analysis of shoot production per plantlet exposed to 6-benzylaminopurine exhibited evidence to support that a concentration of 1g/L BAP-6 is most successful in the induction of shoots for micropropagation. Furthermore, other species of *Trifolium* responded similarly to that of White Clover *in vitro*. This observation, coupled with the results from the BAP-6 trials, provided reason to believe that this cytokinin can be used to micropropagate *Trifolium amoenum*, as well as any mutated plants that resulted from exposure to Colchicine or Surflan.

Ultraviolet-C (UV-C) irradiation on ornamental plants for growth regulation
Investigators: Mark Bridgen
Location: Long Island Horticultural Research and Extension Center

Ultraviolet-C irradiation (UV-C) has been successfully used as an environmentally-friendly and safe pre-harvest treatment to increase fresh mass and lateral branching. It has also been shown to affect the flowering time of plants either by increasing the time to flower or delaying the time to flower, depending upon the species.

The objective of this research is to determine the effects of ultraviolet-C irradiation (UV-C) on commercially-valuable greenhouse ornamental plants with specific interest in disease suppression, growth regulation (height/branching/fresh weight), and postharvest longevity. The use of UV-C irradiation is a low-cost technique that is easy to apply to plants. It has already been shown to be a defense-inducible biological elicitor in horticultural products that can extend the postharvest vase life of cut flowers, suppress attack from natural diseases such as *Botrytis cinerea*, *Penicillium expansum*, and other plant pathogens, and act as a natural growth regulator. Under normal growing conditions, effects of UC-C light are not seen on plants because Ultraviolet-C (UV-C) wavelengths (below 280 nm) are highly energetic, absorbed by ozone and are not present in the sunlight at the earth’s surface.

To apply treatments, germicidal low-pressure vapor UV lamps (Osram HNS OFR) were suspended in the LIHREC greenhouses over greenhouse benches. Each lamp has a nominal
power output of 30 W and peak wavelength emission of 253.7 nm. The dosage rate was measured at room temperature (\(\sim 25^\circ C\)). Uniform potted plants of *Impatiens walleriana*, *Zinnia elegans*, *Catharanthus roseus*, *Salvia splendens* and others were subjected to 0, 5, 10, or 15 minute treatments of UV-C every 7 days for 5 weeks. Plants that receive too high a dosage rate are damaged by the UV-C light. Plants that received UV-C were shorter than control plants and more highly branched.

The impact of applying this technology to whole plants would be a breakthrough for the floriculture industry. It will save time and money, and it will have tremendous benefits for the environment by reducing pesticide applications to plants and decreasing the need for plant growth regulators. This is a novel and sophisticated, low-cost technique that can be a sustainable and environmentally-friendly. This project is funded by the American Floral Endowment.

**Breeding downy mildew resistance in *Impatiens walleriana***  
**Investigators:** James Keach and Mark Bridgen  
**Location:** Long Island Horticultural Research and Extension Center and Ithaca

Impatiens downy mildew, *Plasmopara obducens*, is been responsible for the near-total losses of the common impatiens, *Impatiens walleriana*. The advent of this virulent new race of downy mildew has defoliated and decimated impatiens across the United States, as well as worldwide. Often a key crop for small greenhouse growers and nurseries, and a fixture in landscapes and home gardens, susceptibility appears to be near-universal in the common species, *I. walleriana*. While the New Guinea types (*I. hawkeri*) appear resistant, they have drastically different cultivation requirements and methods; unfortunately, these do not form viable hybrids with the common species. Fortunately, preliminary data suggest that other, compatible species may be resistant and useful for breeding new, more diverse forms.

The objective of this project is to evaluate the effect of downy mildew on different impatiens species, and to develop alternative plant options for growers and gardeners. A wide range of impatiens species are being screened for durable, input-independent resistance, and attempts at hybridizing these species with the common species are being made. In addition, the degree of susceptibility in populations of native and naturalized impatiens species, such as the jewelweeds, is being examined and the risk that they might become reservoirs for the disease is being assessed. Concurrently, the potential of other, easy-to-grow species of impatiens to fill the garden niche held by *I. walleriana* is being examined; this will allow the range of species that are cultivated to be diversified.

**California Spring Trials**  
**Investigators:** Mark Bridgen and Neil Mattson  
**Location:** California

A national trip for members of the greenhouse and floriculture industries was organized to the 2014 California Spring Trials (formerly called the Pack Trials) from April 8-10, 2014. Drs. Mark Bridgen and Neil Mattson of Cornell University organized and led this intense, educational trip to several of the key Spring Trial locations. The trip was designed specifically
for members of the greenhouse and floriculture industry and other horticulture professionals. There was a bud-load of attendees including a nice mix of industry and allied trade members and academics. The excursion began in San Jose and traveled south to Los Angeles for 3 days visiting several different locations.

The trip itinerary was packed with horticulture; the days began early and continued at a fast pace late into the evening. Attendees arrived at the San Jose Airport on Monday, April 7, and the journey began the next morning. The first day the group visited Proven Winners and Syngenta Flowers in the morning, followed by Sakata Seed in the afternoon. The second day began with a short drive to San Luis Obispo to see Dümmen, North America including Red Fox and HGTV Home Plant Collection. After another short drive to Santa Paula, our next stop was at Dümmen Part II to see Bartels, Ecke Ranch, Fides, Oglevee, Oro and GreenFuse Botanicals.

The third day began with an intense visit to Ball Horticultural Co. including Ball FloraPlant, Ball Ingenuity, Ball Ornamentals, Darwin Perennials, Kieft Seed, PanAmerican Seed & Selecta. Late in the morning we headed to EuroAmerican Propagators & Suntory in Ventura, and finally to GroLink Plant Co. This stop included Athena Brazil, Flamingo Holland, Florist Holland B.V., Florensis, Hort Couture, PlantHaven International, Inc., Royal Van Zanten, Schoneveld, and Sequoia Group International.

**Breeding and development of winter-hardy, hybrid *Alstroemeria***

**Investigators:** Mark Bridgen, Maria Figueroa, and Nicholas Bates  
**Location:** Long Island Horticultural Research and Extension Center

*Alstroemeria*, the Inca Lily or Lily-of-the-Incas, is popular in the United States because of its colorful and long-lasting cut flowers. Traditional and in vitro breeding techniques are being used to hybridize *Alstroemeria* species with the goal to develop new winter-hardy hybrids for the garden. Multiple crosses were made with *Alstroemeria* species from Brazil and Chile. Hybrid embryos are rescued after pollination via plant tissue culture. Once the embryos germinate in vitro, they are subcultured onto micropropagation medium, grown, rooted, and transferred to the greenhouse until flowering. Cold-hardy (USDA hardiness zone 5) varieties have been introduced by Cornell University and have expanded the interest of this colorful plant as a garden perennial throughout the United States. The objective of this breeding project is to develop and release new garden cultivars to the American market.

**Evaluation of field-grown herbaceous perennial plants**  
**Investigators:** Mark Bridgen and Nicolas Bates  
**Location:** Long Island Horticultural Research and Extension Center

This multi-year project evaluates new herbaceous plants and compares them to other commercially valuable plants when grown under Long Island's climatic conditions. The trial and display gardens at the Long Island Horticultural Research and Extension Center (LIHREC) are also used for educational purposes with more than 300 species and cultivars of winter-hardy herbaceous ornamental plants. The gardens are organized and planted by species in order to effectively evaluate different cultivars of the same genus growing side-by-side.
During the summer of 2013, a new area specifically for shade perennials, was planned and prepared. Trees of the red-flowering crepe myrtle ‘Arapaho Red’ and of the white-flowering ‘Natchez’ were planted to supply shade to future perennials. These trees will bloom with flowers of Cornell colors, red and white. Now that these trees are established and being trained as trees, the herbaceous perennial plants will be planted under them.

The project allows new plants to be evaluated and introduced into the trade and promotes interest in the use of herbaceous plants for the landscape. Each year, these plants are tested and evaluated from a professional landscaper’s perspective. Their maintenance, flower and foliage integrity, bloom period, and insect and disease resistance are recorded and reported to the nursery and greenhouse industries. Winter hardiness is also recorded. Educational programs, such as conferences, all-season demonstrations, open houses, field days, workshops, and symposia keep growers informed and in touch with these research findings.

**2014 Evaluations of dahlias**

**Investigators:** The Cornell Gardeners and Long Island Dahlia Society  
**Location:** Long Island Horticultural Research and Extension Center

The Long Island Dahlia Society trials and displays more than 150 different varieties of dahlias at the LIHREC each summer. The Dahlia Garden is located to the south of the main gardens. This bed is replanted every spring; in the fall the tuberous roots are removed from the ground, cleaned, and stored for the following year. More than 300 guests visited the gardens during 2014 to enjoy the beauty, variety, size, and duration of bloom of the dahlia.

Dahlias are considered one of the most spectacular garden flowers because there is a great variety of form in their flowers. They are available in showy dinner-plate size to the bright, little single ones. Dahlias require some special care for winter storage, however, with minimum care, beautiful dahlia flowers can grace gardens from July until frost. Dahlias should be planted in a sunny location in rich and well-drained soil.

**2014 Long Island annual plant trial**

**Investigator:** Nora Catlin  
**Location:** Long Island Horticultural Research & Extension Center

This year nearly 130 cultivars, including 104 new cultivars, and 6 combinations were included in the Long Island Annual Plant Trial. Plants were submitted by Ball Horticultural Co., Proven Winners, and Syngenta.

Rooted cuttings or plugs were received in April, transplanted to 70mm Ellepots or 3.5-inch pots, and maintained in the greenhouse until planted outdoors. Plants were sub-irrigated and fertilized with a constant feed of 125-150 ppm N of 20-10-20 and pests were managed as needed. During the last week of May, plants were transplanted into containers outside. For each cultivar, three 12-inch containers were planted with three plants each. Containers were drip irrigated and fertilized with constant liquid feed, alternating between 20-10-20 and 15-5-15, 200-250 ppm N. One of the main goals of the trial is to identify low maintenance, top-performing annuals, so once plants are transplanted outdoors pests and diseases were not managed. In addition, plants
are not deadheaded or trimmed with the exception of geraniums and dahlias, which were
deadheaded every few weeks throughout the season.

Plants were evaluated five times from early-July though early September by 3-4 individuals.
Flower display, foliage quality, and overall impact were rated on a scale of 0-5 (5=best; the
flower display rating was omitted for the plants that are regarded as foliage plants such as
ipomoea) and evaluations were averaged to determine the season-long plant rating.

The plants with a season-long rating within the top 25% were:  Angelonia ‘Archangel Dark
Rose’; Begonia ‘Pegasus’; Calibrachoa ‘Callie Apricot’, ‘Callie Yellow Imp.’, ‘Superbells
Cherry Red Imp.’; Cleome ‘Pequena Rosalita’, ‘Senorita Rosalita’; Coleus ‘Colesaurus’;
Cuphea ‘Vermillionaire’; Geranium ‘Caliente Pink’; Impatiens ‘Big Bounce Lilac’, ‘Big
Pennisetum ‘Graceful Grasses Sky Rocket’; Petunia ‘Supertunia Indigo Charm Imp.’,
‘Supertunia Morning Glory Charm’, ‘Whispers Star Rose’; Salvia (S. longispicata) ‘Playin' the
Blues’; Scaevola ‘Pink Wonder’; and Vinca ‘Titan Lilac Imp.’

This trial is supported in part by the participating companies, as well as generous assistance and
donations from Ivy Acres and the Blackmore Company. Many thanks to Caroline Kiang and
Robin Simmen who assisted with plant evaluations, and Adam Hubert who assisted with
evaluations and the maintenance of the trial.

For more information contact Nora Catlin (nora.catlin@cornell.edu or 631-727-7850 x214), or
visit http://ccesuffolk.org/long-island-trial-gardens/ for reports and top performing plants from
previous years’ trials. In addition, trial data has been entered into the National Plant Trials
Database (http://www.planttrials.org), the Long Island Annual Plant Trial is listed as ‘Cornell
Long Island’.

**Evaluation of plant safety of difenconazole+azoxystrobin and benzovindiflupyr+azoxystrobin on columbine**

**Investigator:** Nora Catlin  
**Location:** Long Island Horticultural Research & Extension Center

Plant safety of foliar sprays of three rates (8, 14, and 28 oz/100 gal) of
difenconazole+azoxystrobin (Alibi Flora, A13703G) and three rates (4, 7, and 14 oz/100 gal) of
benzovindiflupyr+azoxystrobin (Mural, A18126B) was evaluated on columbine (Aquilegia
canadensis) ‘Little Lanterns’.

Treatments were applied foliar sprays applied to drip on 2-July 2014, 16-July 2014, and 30-July
2014 using a CO2-powered sprayer fitted with a TeeJet 8003 nozzle at 30psi.  Treatments and an
untreated control were replicated across 11 single-plant replicates.  
Trial plants were evaluated for symptoms of phytotoxicity every 2 weeks, starting 1 week after
the first application.  Any possible symptom of phytotoxicity was evaluated using a 0-10 scale
(0 = no symptoms); fungicide residue was evaluated on a 0-4 scale (0=no residue, 1=very slight residue, 2=residue noticeable, 3=residue apparent and unacceptable, 4=residue very apparent and very unacceptable). Additionally, plant height and width were measured approximately 1 week after the first treatment and at the conclusion of the trial. Where applicable, data were subject to ANOVA and means were separated using Tukey’s HSD (p=0.05).

No symptoms of phytotoxicity or differences in plant size were observed for either product at the tested rates. Unfortunately plants were not in flower at time of trial so no comments can be made about the safety of these products to open blooms or flower timing. No residue was observed on the difenconazole+azoxystrobin-treated plants. However slight residue was observed numerous replicate plants at all three of the tested rates of benzovindiflupyr+azoxystrobin, though all plants were considered saleable and the residue was only observed after the third consecutive application.

Project work supported by the USDA IR4 Program.

**Evaluation of plant safety of fluxapyrosad+pyraclostrobin on columbine, vervain, and zinnia**

**Investigator:** Nora Catlin  
**Location:** Long Island Horticultural Research & Extension Center

Plant safety of foliar sprays of three rates (8, 16, and 32 oz/100 gal) of fluxapyrosad+pyraclostrobin (BAS70301F) was evaluated on columbine (*Aquilegia canadensis* ‘Little Lanterns’), vervain (*Verbena hastata*), and zinnia (*Zinnia elegans* ‘Envy’).

For columbine and vervain, treatments and an untreated control were replicated across 11 single-plant replicates, and for zinnia, treatments and an untreated control were replicated across 4 blocks of 4 single-plant replicates. Treatments for columbine and vervain were applied on 2-July 2014, 16-July 2014, and 30-July 2014 and treatments for zinnia were applied on 12-August, 27-August, 10-September. Foliar sprays were applied to drip using a CO2-powered sprayer fitted with a TeeJet 8003 nozzle at 30psi.

Trial plants were evaluated for symptoms of phytotoxicity every 2 weeks, starting 1 week after the first application. Any possible symptom of phytotoxicity was evaluated using a 0-10 scale (0 = no symptoms); fungicide residue was evaluated on a 0-4 scale (0=no residue, 1=very slight residue, 2=residue noticeable, 3=residue apparent and unacceptable, 4=residue very apparent and very unacceptable). Additionally, plant height and width were measured approximately 1 week after treatment and at the conclusion of the trial. Due to irregular plant shape, zinnia plants were harvested at the soil line and top dry weight data were collected. Where applicable, data were subject to ANOVA and means were separated using Tukey’s HSD (p=0.05).

No symptoms of phytotoxicity or differences in plant size were observed on any of the tested plants at the tested rates. There were also no observed effects of treatments on flower quality or timing for the vervain and zinnia plants; however the columbine plants were not in flower for the duration of the trial. While applications of fluxapyrosad+pyraclostrobin (BAS70301F) did not result in phytotoxicity symptoms, fungicide residue was observed on columbine and zinnia,
particularly at the higher application rates. No residue was observed on the vervain plants. The residue on the columbine and zinnia plants at the 16 oz and 32 oz/100 gal rates was noticeable and many of the plants were unacceptable for sale at the time of evaluation.

Project work supported by the USDA IR4 Program.

**Efficacy of new foliar treatments for the management of Botrytis blight of lily**

**Investigator:** Nora Catlin

**Location:** Long Island Horticultural Research & Extension Center

Various labeled and experimental products were tested for their efficacy in managing Botrytis blight of lily, caused by *Botrytis eliptica*. Tested products included:

- Fluxapyroxad+pyraclostrobin (BAS70301F; 8 oz/100 gal), thyme oil (Proud 3; 4 qt/100 gal),
- mandestrobin (S2200; 7.5 oz/100 gal), tebuconazole (Tourqe; 8 oz/100 gal),
- benzovindiflupyr+azoxystrobin (Mural; 7 oz/100 gal), fenhexamid (Decree; 1.5 lb/100 gal), and
- the three proprietary products: F9110 (24 oz/100 gal), SP2770 (2.66 lb/100 gal), and SP2773 (3.31 lb/100 gal). Also included: an untreated and uninoculated control and an untreated and inoculated control. Treatments were replicated across 8 single plant replicates per treatment.

Lily ‘Vermeer’ planted on 9-June into 4.5-inch pot and kept in greenhouse until after the first treatment. After the first treatment, plants were moved into a hoop house fitted with shade cloth and overhead irrigation in order to provide ideal disease conditions. Containers of symptomatic plants were placed among the plants to serve as inoculation and the untreated-uninoculated control plants were set on the opposite side of the house, in an un-shaded section a distance away from the inoculum.

Treatments were applied every 2 weeks for 6 weeks, starting on 9-July 2014 (30 d after planting), with the exception of F9110, thyme oil, and fenhexamid, which were applied weekly. Foliar sprays were applied to drip using a CO2-powered sprayer fitted with a TeeJet 8003 nozzle at 30psi.

Plants were evaluated weekly, starting one week after treatment. Disease severity was evaluated using a 0-10 scale (0=no symptoms, 10=most) and the number of affected leaves were recorded. Where applicable, data were subject to ANOVA and means were separated using Tukey’s HSD (p=0.05).

At the final evaluation, only the fluxapyroxad+pyraclostrobin (BAS70301F), mandestrobin (S2200), and benzovindiflupyr+azoxystrobin (Mural) treatments resulted in reduced severity ratings and number of affected leaves compared to the inoculated control. No other treatments resulted in significantly reduced disease severity ratings nor significantly fewer leaves affected compared to the inoculated control.
Evaluation of plant safety of fluensulfone on calibrachoa, petunia, and lantana

Investigator: Nora Catlin
Location: Long Island Horticultural Research & Extension Center

Three rates (0.11 ml, 0.22 ml, and 0.44 ml/cu ft potting mix) of fluensulfone (MCW-2) were applied as a one-time drench application to calibrachoa ‘Aloha Tiki Soft Pink’, petunia ‘Carpet Sky Blue’ plants, and lantana ‘Chapel Hill Yellow’ plants. Treatments were applied on 6-December 2014 to calibrachoa, 19-March 2014 to petunia, and 11-July 2014 to lantana. Treatments were replicated across 3 blocks of 4 single-plant replicates for each plant. Each 4-inch pot was drenched with a 65 ml volume; calibrachoa plants were treated 27 days after transplant, petunia plants were treated 10 days after transplant, and lantana plants were treated 8 d after transplant.

Trial plants were evaluated for symptoms of phytotoxicity weekly for approximately 4 weeks after treatment; any possible symptom of phytotoxicity was separately evaluated using a 10-point scale (0 = no symptom/healthy). Additionally, plant height and width were measured approximately 1 week after treatment and at the conclusion of the trial. Due to irregular plant shape, lantanas were harvested at the soil line and top dry weight data were collected. Where applicable, data were subject to ANOVA and means were separated using Tukey’s HSD (p=0.05).

On calibrachoa ‘Aloha Tiki Soft Pink’, no symptoms of phytotoxicity were observed on the foliage. Unfortunately, plants were not flowering at the time of treatment and did not flower for the duration of the trial, so comments cannot be made about the safety of this product on flowers or flower timing.

Results for petunia ‘Carpet Blue Sky’ were less clear. Symptoms which appeared similar to magnesium (Mg) deficiency were observed more often on fluensulfone-treated plants than on untreated plants, though these differences were not significant across all blocks or dates of observation. Due to the somewhat unclear statistics, the observation that the interveinal chlorosis symptoms matched those caused by Mg deficiency, and the fact that symptoms were also observed on untreated plants, it was concluded that the application of fluensulfone is likely not to blame. However, until more experience is gained with this product it would be best to use it cautiously. There were no significant differences in final plant size of treated plants compared to untreated plants, and there were also no observed difference in flowering timing or quantity of flowers.

For lantana, no phytotoxicity symptoms were observed on the foliage. However there was a slight difference in final dry weight and size, with the untreated control plants having a greater dry weight and growth index ([height + width at widest point + width perpendicular to the widest point]/3). This difference was significant for some but not all treatments. Untreated plants had a final average dry weight of 2.64 g compared to 2.23 g, 2.29 g, and 1.19 g for the 0.11 ml, 0.22 ml, and 0.44 ml treatments, respectively. The final growth index for untreated plants was 6.51 in, 5.96 in for the 0.11 ml treatment, 5.72 in for the 0.22 ml treatment, and 5.92 in for the 0.44 ml treatment. These differences in plant size between the treatments were barely discernable visually. No visual difference in root growth was observed, and there were no
significant differences in the days to first flower. While this product may not greatly impact
plant size, a slight size reduction might result.

Project work supported by the USDA IR4 Program.

**Evaluation of plant safety of ametoctradin+dimethomorph on petunia, snapdragon,
geranium, and lantana**

*Investigator: Nora Catlin*

*Location: Long Island Horticultural Research & Extension Center*

Three rates (14, 28, and 56 oz/100 gal) of ametoctradin + dimethomorph (BAS 651F, Orvego) were applied as one-time drench applications to various plants: petunia ‘Carpet Blue Sky’, snapdragon ‘Rocket White’, geranium ‘Orbit White’, and lantana ‘Chapel Hill Sunny Side Up’. For petunia, treatments and an untreated control were replicated across 4 blocks of 4 single-plant replicates and treatments were applied on 19-March 2014; snapdragon treatments were replicated across 10 single-plant replicates and treatments were applied on 12-February 2014; geranium treatments were replicated across 3 blocks of 4 single-plant replicates and treatments were applied on 22-November 2014; and lantana treatments were replicated across 4 blocks of 4 single-plant replicates and treatments were applied on 11-July 2014. Each 4-inch pot was drenched with a 25 ml volume. Petunia plants were treated 27 d after transplant, snapdragon plants were treated 28 d after transplant, geranium plants were treated 18 d after transplant, and lantana plants were treated 8 d after transplant.

Trial plants were evaluated for symptoms of phytotoxicity weekly for approximately 4 weeks after treatment. Any possible symptom of phytotoxicity was evaluated using a 10-point scale (0 = no symptom/healthy). Additionally, plant height and width were measured approximately 1 week after treatment and at the conclusion of the trial. Where applicable, data were subject to ANOVA and means were separated using Tukey’s HSD (p=0.05).

No symptoms of phytotoxicity, differences in plant size, or differences in flower timing or quantity were observed on any of the tested plants at the tested rates.

Project work supported by the USDA IR4 Program.

**Demonstration of commonly suggested shade annual alternatives to garden impatiens – Year 2**

*Investigator: Nora Catlin*

*Location: Long Island Horticultural Research & Extension Center*

This trial is a continuation of a trial established in 2013. The goal was to demonstrate commonly suggested shade annual alternatives to garden impatiens (*Impatiens walleriana*), and serve as a resource for growers, gardeners, and landscapers. A total of 79 cultivars of 29 species were grown in the 2014 demonstration garden.

Plants were planted into the field under a high tunnel fitted with 50% shade cloth during the last week of June. Plants were planted on 12-in centers within the plot, with 24 inches between
plots. Each plot was replicated 3 times to account for varying soil conditions or pests. The majority of the plant material was in 3- to 4-inch containers at planting.

Prior to planting, landscape fabric was laid in between the rows for weed management, and the beds were fertilized with a controlled-release fertilizer (14-14-14, Harrell’s, 3-4 month) at a rate of approximately 2 lb N/1000 sq ft. After planting the beds were mulched to a 2- to 4-inch depth for weed management. Plants were irrigated with trickle tape, which was installed immediately after planting and prior to mulching.

Evaluations of plant performance and observations were recorded throughout the season. During evaluations, flower quality, foliage quality, and overall impact were scored on a 1 to 5 scale, and averaged for an overall season-long score (1=lowest; flower scores were eliminated for the foliage plants Caladium, Helichrysum, Ipomoea, Hypoestes, Iresine, and Plectranthus).


The full list of trialed plants, photographs, and additional observations on plant performance are available up on request (nora.catlin@cornell.edu, 631-727-7850 x214).

Effects of daylength and lime on dahlia culture

Investigators: Nora Catlin, Margery Daughtrey and Lynn Hyatt
Location: Long Island Horticultural Research & Extension Center

Dahlia crops begun in late winter have shown poor performance for some growers: both physiological and disease components appear to be involved. A trial was undertaken to quantify the effects of short days and lime deficiency on dahlia, to develop grower guidelines. Four treatments were tested: short day (SD, 10 hr light), short day plus additional lime (additional 2.5 lb/cu yd dolomitic lime), long day (LD, 14 hr light), long day plus additional lime. Lighting was provided by cool white fluorescent bulbs. Dahlia (XXL series) ‘Durango’ and ‘Alamo’ cuttings were stuck on 15-Oct 2013 and maintained under long-days in a propagation tray until transplant into 6-in. pots filled with either Berger BM-6 growing media or Berger BM-6 media plus additional lime on 5-Dec. After transplant, plants were arranged in a RCBD of 6 blocks, with 3 single plant reps per block. Blocks were arranged perpendicular to the light gradient, which ranged from a high of 130 footcandles to a low of 13 footcandles. Plants were fertilized with a constant feed of 200 ppm N of 13-2-13 fertilizer; the last two weeks of the trial 200 ppm N of 15-5-15 was used. On 19-December flonicamid, 2.1oz/100 gal, was applied to all plants to
manage aphids. Number of flowers (open flowers and cracked buds) and number of buds were recorded for Alamo plants on 11-February 2014 and for Durango plants on 17-February 2014. At the completion of the trial, dahlias were harvested at the soil line and top dry weight data were collected. Roots were evaluated on a scale of 1 to 4 (4=best/healthiest). After overall root evaluation, all roots less than 2.5 mm were trimmed, then tuber fresh weight was recorded. Data were subjected to ANOVA and means were separated using Tukey’s HSD (p=0.05).

The Alamo plants appeared weaker during propagation than the Durango, but no pathogens were isolated from the rooted cuttings: root injury from uneven watering was a possible cause. Eight Alamo plants were removed from the data analysis because of poor root establishment. Overall, plants under the LD treatment flowered approximately 1 week later, but in general dahlias showed more flowers and were much larger, healthier plants under LD. There was no measurable benefit to the 2.5 lb additional lime treatment except in increasing tuber size under SD for Durango. Light had a strong effect on plant growth: there were significant differences between LD and SD treatments in the number of buds, the number of buds and flowers, root quality rating, fresh tuber weight and dry shoot weight for both cultivars. The light effect on tuber mass was impressive: for Durango, tuber mean weight was only 5.9 g (no additional lime) and 6.4 g (additional lime) in LD treatment, but 19.7 g (no additional lime) and 26.1 g (additional lime) in the SD treatment. Under SD conditions, dahlias build tubers at the expense of top growth (leaves, stems and flowers). The reverse correlation was seen with flowering: Durango showed a mean of 9.8 buds + flowers under LD, but only 1.1 under SD; Alamo showed 5.2 buds and flowers under LD, but only 1.2 under SD. Lighting dahlias during late winter production is critical for desirable plant development and flowering.

Management of downy mildew on basil via controlled-release in 4-inch pots
Investigators: Margery Daughtrey and Lynn Hyatt
Location: Long Island Horticultural Research & Extension Center

This trial tested two experimental controlled-released (CRC) formulations of phosphite + fertilizer from Everris for their ability to protect basil grown in 4-in. pots against downy mildew (Peronospora belbahrii). The CRC treatments were compared to other delivery formats for similar chemistry. Basil ‘Genovese’ was seeded 19 June 2014 in Berger germination mix in a 128-cell plug tray and transplanted 21 July into 4-in. pots in ProMix BX. Pots contained approximately 0.5L of mix. Treatments (incorporated in mix unless otherwise indicated) were as follows (given as amount per 6L mix): 1) Aliette 80 WDG (2.8 g) plus Osmocote Exact Mini 15-9-11 +2MgO+TE (16.74 g); 2) Plant Trust 11-6-8 (21.6 g) plus Osmocote (1.92 g); 3. CRC A (23.4 g); 4. CRC B (23.4 g); 5) Potassium phosphite (0.5 g/L) drench at every irrigation plus Osmocote (16.74 g); 6) BioPhos 1% v:v drench 7/18 & 8/25 plus Osmocote (16.74 g); 7) Inoculated control with Osmocote (16.74 g); 8) Non-inoculated control with Osmocote (16.74g) (noninoculated plants were kept in a separate greenhouse, away from any inoculum source). There were 4 replications of 3 plants for each treatment, arranged in a randomized complete block design (except for the noninoculated control). The basil plants remained in the greenhouse for the duration of the trial. Inoculum was provided continually during the experiment by introducing several downy mildew-infected basil plants to the greenhouse and spacing them evenly within the plot, beginning the day after transplant. Plants were hand-watered from overhead, with water or potassium phosphite. Ratings were made starting 4 Aug,
examining every leaf of every plant, recording for each plant the number of leaves showing sporulation of the downy mildew and the presence/absence of phytotoxicity symptoms. The percentage of affected foliage was estimated for each plant that showed downy mildew sporulation. The severity of disease was also rated 1-5, with 5 = a healthy plant, 4 = an attractive plant with some downy mildew sporulation evident and often a few yellowing leaves, 3=a plant with a large quantity of yellow-mottled or curling leaves and 2=a defoliated plant, some leaves remaining, and 1=a dead plant, no remaining leaves. Ratings were made at weekly intervals, on 8/4, 8/12, 8/22 and 9/19.

The first downy mildew symptoms and signs (sporulation) were seen in the plot on 4 Aug. The downy mildew caused patchy yellow leaf lesions. Distortion was apparent by the end of the trial on all plants that were irrigated with potassium phosphite. Some inward leaf rolling was also seen on Biophos-treated basil. Even at the first data collection on 4 Aug, it was apparent that Treatments 2, 3 and 4 had not protected the plants from infection, although Treatments 1, 5 and 6 were symptom-free. Aug 22 there was a downy mildew lesion apparent on one Aliette-treated plant, but Treatments 5 and 6 remained symptom-free. By the last rating, 19 Sept, as many as 50% of the leaves of one of the CRC A treated plants and 80% of one of the CRC B treated plants were infected with downy mildew, while the nontreated controls showed up to 90% infected plants. The Biophos treatment was showing some infection, while the Aliette treated plants and the potassium phosphite drenched plants were symptom-free. The non-inoculated controls remained downy mildew symptom-free during the trial, and did not show the leaf stunting or leaf roll observed in Biophos or phosphite-treated plants. The drenches (Biophos and potassium phosphite) and the incorporated Aliette outperformed the controlled release treatments in this trial. Inoculum of basil downy mildew was available in the greenhouse from the day after transplanting and environmental conditions might have been conducive to infection early in the trial, before CRC formulations had been taken up by the plants.

Management of downy mildew on coleus via controlled-release in 4-inch pots
Investigators: Margery Daughtrey and Lynn Hyatt
Location: Long Island Horticultural Research & Extension Center

This trial tested two experimental controlled-released (CRC) formulations of phosphite + fertilizer from Everris for their ability to protect coleus grown in 4-in. pots against downy mildew (*Peronospora* sp.). The CRC treatments were compared to other delivery formats for similar chemistry. Coleus ‘Limelight’ cuttings were rooted under mist in Promix BX and transplanted on 18 June 2014 into 4-in. pots in ProMix BX. Pots contained approximately 0.5L of mix. Treatments (incorporated in mix unless otherwise indicated) were as follows (given as amount per 6L mix): 1) Aliette 80 WDG (2.8 g) plus Osmocote Exact Mini 15-9-11 +2MgO+TE (16.74 g); 2) Plant Trust 11-6-8 (21.6 g) plus Osmocote (1.92 g); 3. CRC A (23.4 g); 4. CRC B (23.4 g); 5) Potassium phosphite (0.5 g/L) drench at every irrigation plus Osmocote (16.74 g); 6) BioPhos 2% v:v drench (6/18 & 26, 7/18 and 8/25) plus Osmocote (16.74 g); 7) Inoculated control with Osmocote (16.74 g); 8) Non-inoculated control with Osmocote (16.74 g) (noninoculated plants were kept in a separate greenhouse, away from any inoculum source). There were 4 replications of 3 plants for each treatment, arranged in a randomized complete block design (except for the noninoculated controls). The coleus plants remained in the greenhouse for the duration of the trial. Inoculum was provided continually.
during the experiment by introducing several downy mildew-infected coleus plants to the greenhouse and spacing them evenly within the plot, beginning 25 June. Plants were hand-watered from overhead, with water or potassium phosphite. Ratings were made starting 11 July, examining every leaf of every plant, recording for each plant the number of leaves showing sporulation of the downy mildew and the presence/absence of phytotoxicity symptoms. The percentage of affected foliage was estimated for each plant that showed downy mildew sporulation. The severity of disease was also rated 1-5, with 5 = a healthy plant, 4 = an attractive plant with some downy mildew spotting evident, 3 = a plant with a large quantity of spotted leaves and 2 = a defoliated plant, some leaves remaining, and 1 = a dead plant, no remaining leaves. Ratings were made on 11, 21 and 30 July, and 6, 13 and 22 Aug.

The first downy mildew symptoms and signs (sporulation) were seen in the plot on 8 July. The downy mildew caused large, round bruised-looking brown lesions to form on the foliage, with sporulation opposite. The coleus were stunted by the Biophos treatment, and showed downcupped leaves. At the first data collection on 11 July, the treatments had for the most part protected the coleus. The non-treated controls, however, showed fairly uniform but light infection. Some individuals in Treatments 2, 3 and 4 also showed a small number of lesions. The drench treatments appeared somewhat more effective than the incorporated prills. At the end of July, numbers of lesions per infected coleus plant increased, whereas infection did not build in the treated plants. The downy mildew epidemic tapered off at the end of the trial, probably due to high temperatures in the greenhouse. Many of the infected leaves dropped from the plants. The non-inoculated controls remained symptom-free during the trial, and did not show any leaf stunting or curling such as that observed in Biophos-treated coleus. The drenches (Biophos and potassium phosphite) and the Aliette incorporation outperformed the controlled release treatments slightly in this trial in terms of downy mildew control. The CRC treatments showed benefit, but one week may not have been long enough for sufficient uptake prior to challenging plants with the downy mildew inoculum.

Management of downy mildew on impatiens via controlled-release in 4-inch pots

Investigators: Margery Daughtrey and Lynn Hyatt

Location: Long Island Horticultural Research & Extension Center

This trial tested two experimental controlled-released (CRC) formulations of phosphite + fertilizer from Everris for their ability to protect impatiens grown in 4-in. pots against downy mildew (*Plasmopara obducens*). The CRC treatments were compared to other delivery formats for similar chemistry. Impatiens ‘Super Elfin White’ were seeded 5 May 2014 into plug trays and transplanted 25 June into 4-in. pots in ProMix BX. Pots contained approximately 0.5L of mix. Treatments (incorporated in mix unless otherwise indicated) were as follows (given as amount per 6L mix): 1) Aliette 80 WDG (2.8 g) plus Osmocote Exact Mini 15-9-11 +2MgO+TE (16.74 g); 2) Plant Trust 11-6-8 (21.6 g) plus Osmocote (1.92 g); 3. CRC A (23.4 g); 4. CRC B (23.4 g); 5) Potassium phosphite (0.5 g/L) for every irrigation plus Osmocote (16.74 g); 6) BioPhos 2% solution (Jul 18 & Aug 25) plus Osmocote (16.74 g); 7) Inoculated control with Osmocote (16.74 g); 8) Non-inoculated control with Osmocote (16.74 g) (noninoculated plants were kept in a separate greenhouse, away from any inoculum source). There were 4 replications of 3 plants for each treatment, arranged in a randomized complete block design except as noted. Impatiens plugs were potted up in a glass greenhouse on 25 June
and maintained there with hand watering until 25 July. Inoculum was provided by introducing infected impatiens to the greenhouse and spacing them evenly within the plot. Then on July 25 they (all but Treatment 8) were moved outside to a shade-covered (50% shade) hoop house. Inoculum was provided continually during the experiment from downy-mildew-infected plants in the shadehouse area. The impatiens were watered by overhead sprinklers twice a day (6:00 am and 5:00 pm), with the exception of the potassium phosphite watered plants, which were watered by hand and kept under a plastic roof to prevent dilution of the potassium phosphite. Ratings were made starting 29 July, examining every leaf of every plant, recording for each plant the number of leaves showing sporulation of the downy mildew and the presence/absence of phytotoxicity symptoms. The percentage of affected foliage was estimated for each plant that showed downy mildew sporulation. The severity of disease was also rated 1-5, with 5 = a healthy plant, 4 = an attractive plant with some downy mildew sporulation evident and often a few yellowing leaves, 3 = a plant with a large quantity of yellow-mottled or curling leaves and 2 = a defoliated plant, some leaves remaining, and 1 = a dead plant, no remaining leaves. Ratings were made at weekly intervals, on 7/29, 8/7, 8/15, 8/29 and 9/5.

Stunting was apparent early in the trial in the Biophos treatment. Plants continually irrigated with potassium phosphite solution showed stunting over time as well. Other treatments showed no phytotoxicity other than scattered leaf puckering. At the first rating, 29 July, signs of downy mildew were apparent only on the nontreated, inoculated controls, in every plant in all four replications. The number of leaves per plant showing sporulation varied from 4 to 55 in the controls. On 7 Aug, up to 99% of the foliage was showing downy mildew sporulation in the controls and quality ratings in this treatment were 2 (or, rarely, 3), indicating that defoliation had begun. Plants in treatment 6, although stunted, were protected against disease. On 15 Aug, the inoculated control plants were still at an overall quality rating of 2, with up to 100% leaves affected. One leaf on one plant in Treatment 1 showed sporulation in both reps B and C. Plants in all other treatments remained free from downy mildew. On 29 Aug, the disease had progressed markedly in plants in Treatment 1, and had moved into Treatment 2, 3, 4 and 6. Control had tapered off sometime during the Aug. 15-Aug 22 period, when infections would have taken place that resulted in sporulation viewed 29 Aug. The inoculated controls were now rated as 1s, indicating that all the leaves had fallen off. Treatment 5 plants were still not infected, but were stunted and dark green (note that these plants had also been shielded from overhead irrigation so that they could be watered with phosphite solution). On 5 September, the disease was progressing in all treatments other than treatment 5 and the noninoculated control held in the greenhouse. The CRC A and B treatments provided protection from 25 June to 15 August (7 weeks) under very disease-conducive environmental conditions with abundant available inoculum, and sporulation and plant decline began only 9 weeks after treatment. These treatments are promising for post-production protection of impatiens during the spring.

Management of downy mildew on impatiens via controlled-release in hanging basket containers
Investigators: Margery Daughtrey and Lynn Hyatt
Location: Long Island Horticultural Research & Extension Center

Impatiens can be protected with fungicides against downy mildew (*Plasmopara obducens*) during greenhouse production, but homeowners have had no effective protective treatment. In this trial we tested two experimental controlled-release (CRC) formulations of phosphite +
fertilizer chemistry (from Everris) for their ability to protect impatiens against downy mildew post-production. Impatiens ‘Super Elfin White’ were seeded 5 May 2014 into plug trays and transplanted 26 June into 10-in. baskets in ProMix BX with the various incorporation treatments. Each hanging basket contained approximately 5 L of mix. Mix-incorporated treatments (given as the amount added to 46.3 L of mix) included 1) Aliette 80WDG (21.6 g) and Osmocote Exact Mini 15-9-11 +2MgO+TE (129.1 g); 2) Plant Trust 11-6-8 (166.54 g) and Osmocote (14.8 g); 3) CRC A (180.4 g); and 4) CRC B (180.4 g). Mix in inoculated and non-inoculated controls contained Osmocote (167.4 g). There were 9 single-basket replications of each treatment, with 3 plants per basket, arranged in a randomized complete block design. The non-inoculated controls were retained in a separate greenhouse to protect them from inoculum, while the rest were exposed to downy mildew inoculum from infected impatiens brought into the greenhouse and evenly spaced within the plot beginning July 3. On 25 July, all but the non-inoculated controls were moved outdoors to a shaded hoop house (50% shade). In the hoop house, inoculum was available from infected plants spaced within the plot and plants were watered by overhead sprinklers twice a day (6:00 am and 6:00 pm). Ratings were made beginning 29 July, examining every leaf of every plant, recording the number of leaves showing sporulation. The percentage of affected foliage was estimated for each plant. The severity of disease was rated 1-5, with 5 = a healthy plant, 4 = an attractive plant with some downy mildew sporulation evident and often a few yellowing leaves, 3 = a plant with a large quantity of yellow-mottled or curling leaves and 2 = a defoliated plant, some leaves remaining, and 1 = a dead plant, no remaining leaves. Ratings were made at weekly intervals, on 7/29, 8/8, 8/15, 8/22, and 9/5.

No phytotoxicity symptoms were noted in this trial. At the first rating, 29 July, there were signs of downy mildew only in the nontreated, inoculated controls (3-31 leaves per basket). By 8 Aug, up to 100% of the foliage of the inoculated controls showed downy mildew sporulation. Nontreated plants received quality ratings of 1 or 2: defoliation from downy mildew was well advanced. On 15 Aug, although the inoculated control plants showed 99-100% of leaves affected, no other treatments were affected. On 22 Aug, sporulation was evident in Treatments 1, 2 and 3, but plants still received ratings of 4: there was no yellowing or defoliation, and plants continued to bloom. On 5 September, only a plant quality rating was made. All of the treatments scored far better than the nontreated controls, which were at a ranking of 1 (completely defoliated). CRC treatments received ratings of 4 in some reps, 3 in others, 2 less often. The CRC A and CRC B treatments provided protection (prevented sporulation) from 26 June through 15 August (7 weeks) under very disease-conducive environmental conditions, with abundant inoculum supplied. CRC A and CRC B treated plants stayed healthy-looking and attractive for 8 weeks and were still flowering at 9 weeks, whereas inoculated control plants were defoliated in 5 weeks under the same conditions.

Management of impatiens downy mildew with experimental fungicides

Investigators: Margery Daughtrey and Lynn Hyatt
Location: Long Island Horticultural Research and Extension Center

Two experimental fungicides were compared to Heritage and Pageant for their ability to control downy mildew on impatiens using 7- and 14-day spray intervals.
Impatiens ‘Super Elfin White’ were propagated from seed and transplanted to 6-in. azalea pots on 3 July 2014. They were fed 20-10-20 at every watering while in the greenhouse. Fungicide treatments were applied with a CO₂ powered hand sprayer fitted with a hollow cone nozzle, at 35 p.s.i., beginning 10 July in the greenhouse. The plants were set outside on 21 July in a hoop house with 50% shade, fitted with overhead irrigation running twice daily, at 6:00 am and 6:00 pm. Treatments were arranged in a randomized complete block design, in 6 single-plant replications. Inoculum was supplied from infected impatiens spaced evenly within the plot. The 7-day interval spray treatments were made 10, 17, 23 & 30 July and 6 Aug, while the 14-day interval sprays were made 10 & 23 July and 6 Aug. The experimental fungicides A13703G (14.0 fl oz/100 gal) and A18126B (7.0 oz) were compared to Heritage (4.0 oz) and Pageant (18.0 oz) as well as nontreated controls. Capsil at 6.0 fl oz/100 gal was added to all but the Pageant treatment. Leaves were inspected for downy mildew weekly. Data were collected on the number of leaves per plant showing downy mildew sporulation on 29 July and 4 Aug. A final assessment of the percent of the foliage affected by downy mildew was made on 27 Aug. All data were analyzed using Tukey’s HSD, \( P=0.05 \).

Downy mildew sporulation was first seen on 29 July in some nontreated controls, at which time the 14-day interval of the Heritage treatment also showed a little sporulation. The epidemic progressed rapidly: by 4 Aug, the foliage of the controls was almost completely infected (and sporulating) with downy mildew. All of the treatments except for the longer spray interval of Heritage showed some benefit on 4 Aug, with both Pageant treatments and the A13703G (7d) being the most effective. There was a significant difference between the 7- and 14-day treatment for the A13703G and the Heritage, and other fungicides showed the same trend—under the very disease conducive conditions of this trial, the shorter spray interval was important. A13703G treatments showed some stunting and flower reduction. There did not appear to be a long-term benefit to the treatments, as all the impatiens in the trial showed 95-100% infection at a final rating made 3 weeks after the last treatment.

**Control of Phytophthora crown rot on calibrachoa with an experimental fungicide**

**Investigators:** Margery Daughtrey and Lynn Hyatt  
**Location:** Long Island Horticultural Research and Extension Center

Phytophthora crown rot is one of the diseases that has caused crop losses in calibrachoa. In this trial we tested an experimental fungicide, A21008A (0.65 and 3.2 fl oz/100 gal), in contrast to Adorn 4SC (1.0 and 4.0 fl oz), SubdueMAXX 2MEC (1.0 fl oz) and Micora 2.08 SC (8.0 fl oz) for control of Phytophthora crown rot. Cuttings of calibrachoa ‘Lemon Slice’ were rooted under mist beginning 11 June. The rooted cuttings were transplanted on 20 July into ProMix BX in 4.5-in. pots. There were 4 replications of 4 plants for each of the 8 treatments. Drench treatments were applied on 19 Aug, using 3.5 fl oz per 4.5-in. pot. Inoculation was made 7 days after treatment, on 26 Aug. For inoculum, a *Phytophthora nicotianae* culture was used. A slurry was prepared in a Waring blender by blending the agar from 2 wk old cultures with deionized water, using 1 plate/100 mls water. Five mls of inoculum was poured into a hole made with a glass rod halfway between the edge of the plug and the pot rim for all pots except the noninoculated controls, avoiding direct contact with the stem or roots. Plants were arranged in a randomized complete block design on the greenhouse bench, with 4 replications of 4 plants for each treatment. Plants were rated 12, 19 and 28 Sept and 15 Oct for the number of wilted or
dead plants. Plants were harvested at the soil line on 20 Oct, and dry weights were calculated for the four plants (combined) in each rep. All data were analyzed using Tukey’s HSD, \( P=0.05 \).

No phytotoxicity was observed. Plants grew well in the uninoculated control and most of the treatments, while 63\% of the nontreated, inoculated plants wilted by the end of the trial (15 Oct). The Micora drench, however, resulted in a very poor plant stand: symptoms developed at the same rate as seen in the inoculated controls, and dry weights were also similar to the inoculated controls. We suspect that this may have been old or otherwise inactivated material, so Micora should be re-tested. There were no statistical differences between plants given the 2 rates of Adorn or A21008A. With the exception of one dead plant in one of the experimental treatments, wilting and death from the Phytophthora inoculation was entirely prevented by the A21008A, Adorn 4SC, or SubdueMAXX drenches. The experimental fungicide at the rates tested appears to be similarly effective to materials currently used for Phytophthora control in the greenhouse industry.

Effect of fungicide drenches on oospore formation in *Impatiens walleriana* infected by downy mildew

**Investigators:** Margery Daughtrey and Lynn Hyatt  
**Location:** Long Island Horticultural Research & Extension Center

As part of our research on the role of oospores (overwintering spores) in impatiens downy mildew disease, we conducted a trial to learn whether fungicide treatment might affect oospore development in impatiens infected with *Plasmopara obducens*.

Healthy impatiens were transplanted to 6-in. pots filled with ProMix BX on 15 Aug 2014 and kept in the greenhouse until drench treatments were made 20 Aug. Alude was drenched at 10.0 fl oz/100 gal (2 pints/sq ft or 190 ml/6 in. pot), SubdueMAXX at 1.0 fl oz/100 gal (1.5 pint/sq ft or 142.5 ml/6-in. pot) and Micora at 8.0 fl oz/100 gal (180 ml/6-in. pot); non-drenched plants served as a control. The drench treatment was not repeated during the experiment. There were 6 replications of the 4 treatments for harvest on each of 5 dates. The impatiens were held in the greenhouse for a week after treatment. On 27 Aug, all plants were moved outside to a shade house, given overhead irrigation and exposed to natural inoculum from diseased impatiens placed evenly within the plot. Inoculum pressure was high during the trial. Plants were inspected weekly for signs and symptoms of downy mildew, and the number of leaves with sporulation was counted. Plants were also rated for symptoms, with 5=no symptoms, 4=sporulation on leaf undersurface, 3=yellowing, 2=yellowing and defoliation and 1=complete defoliation and dying plant. At each rating, one plant from each replication of each treatment pre-marked for a particular harvest date was brought into the lab and one branch (one showing sporulation if available) was hand-sectioned at top, middle and base and examined microscopically for internal downy mildew structures.

Within 17 days after plants were exposed to inoculum (17 dai), sporulation was evident on many leaves and haustoria were seen inside the stem of nontreated controls. Some plants in Micora and Alude treatments also showed sporulation on this date. Oospores began to appear 13 days after sporulation (26 dai) in nontreated controls. Symptom development and oospore formation was slower in Alude-treated plants than in the controls. At 73 dai, all the nontreated
control and Micora treated plants showed haustoria in top, middle and bottom of stems, while Alude-treated plants showed haustoria and oospores only at the top of the plant—and SubdueMAXX treated plants were still free from symptoms or signs of the pathogen. The protective effect of SubdueMAXX drench at the high labeled rate was very long-lasting on this susceptible strain of *P. obducens*, but resistance to this chemistry has already been reported in the US. Micora appeared to have little effect on *P. obducens* infection in this trial, but treatment did delay oospore formation slightly. (The low effectiveness was surprising, and Micora should be re-tested using a different batch of the fungicide). Symptoms, sporulation, and formation of both haustoria and oospores were slowed by the single Alude treatment. Subdue MAXX and phosphorous acid materials (such as Alude) may interfere with survival of impatiens downy mildew as well as delay symptoms.

**Pythium populations in Long Island mum crops**

**Investigators:** Paulina Rychlik, Lynn Hyatt, Jadwiga Jedrys, Carla Garzon and Margery Daughtrey

**Location:** Long Island Horticultural Research and Extension Center

Three Suffolk County locations were sampled in 2014 to monitor the *Pythium* populations in garden mum crops throughout the production season. A total of 590 soil samples were collected from the containers of healthy or wilting chrysanthemums between 22 July and 14 Oct. Samples were incubated for 24h at room temperature in 4 oz. plastic bags, with added tap water to saturate the sample and 2 pieces of raw potato (each piece about 3cm long, 1 cm wide and 5mm thick) to trap zoospores. The potato chunks were cultured on *Pythium*-selective medium and isolates with a *Pythium*-like colony form were collected and examined further. Over the season 250 *Pythium* isolates were obtained (thus 42% of the samples yielded *Pythium*). Samples from the 3 locations varied in total number of *Pythium* isolates collected (the number ranged from 34-136), and in the identity of the species present. Preliminary identification to the species level was done with the microscope, using morphological characteristics. Of the 250 Pythium isolates, 209 were identified as species that are likely to be pathogens. *Pythium irregulare* was the most abundant at two locations, and almost tied for most abundant at the third location (where *P. myriotylum* was the most frequently recovered species). One or more cryptic species are lumped with *Pythium irregulare* as identified by morphology, so final identification of isolates identified as *P. irregulare* awaits DNA analysis at collaborator Carla Garzon’s lab. *Pythium aphanidermatum* was the second most commonly recovered species across all sites. *Pythium ultimum* was seen at 2 out of 3 sites, but in only a single sample each. The mycelium of the *Pythium* isolates has been forwarded to Oklahoma State University for sequencing. Tests of mefenoxam resistance from isolates at one site showed all of the *P. aphanidermatum* isolates were sensitive, while 12 out of 78 *P. irregulare* isolates collected were insensitive to mefenoxam (the active ingredient in SubdueMAXX). Growers will need integrated management programs including fungicide rotation to maintain healthy roots in garden mums, as the harmful pathogens *P. aphanidermatum, P. myriotylum,* and *P. ultimum*, as well as the opportunistic *P. irregulare*, were present in the Long Island crops we sampled.
Tests of Zonix Biofungicide as a treatment to protect against Pythium root rot in geraniums and poinsettias

Investigators: Margery Daughtrey, Lynn Hyatt and Paulina Rychlik
Location: Long Island Horticultural Research and Extension Center

Zonix is a rhamnolipid surfactant labeled as a treatment against pathogens that form zoospores. We trialed Zonix at a range of rates (300-750 ppm) to explore its use as a drench against Pythium root rot in geraniums, comparing it to Banrot (8 oz/100 gal) as an industry standard. Geraniums ‘Pinto Premium White’ were seeded on 31 July 14 and transplanted 13 Oct to 4-in. pots in MetroMix 360 Sun Coir growing medium. Treatments with Zonix and Banrot were begun 14 Oct and repeated on 22 and 28 Oct, 5 and 12 Nov, applying Zonix every 7 days, and Banrot on a 28-day schedule. Materials were drenched at 1 pint per sq ft. Inoculation was made just after the first treatment, applying 5 ml of a *Pythium cryptoirregulare* slurry into a hole dibbled halfway between root cube and pot rim for each pot to be inoculated. The slurry was made from our cultures WK-1 and G-10, blending a mixture of PDA and CMA agar cultures (100 ml water added per plate) in a Waring blender for 30 seconds. There were 5 replications of 4 plants per treatment, arranged in a randomized complete block design on the greenhouse bench. On 16 and 21 Oct and 6 Nov a NemaShield drench was made for fungus gnat control, and Safari was sprayed at 8 oz/100 gal for aphids on 16 Oct. The geraniums were fertilized with Peters 20-10-20 at 300 ppm. Plant quality was rated on 14 Nov, with 1=entirely yellow leaves, 2=bright interveinal chlorosis, 3=pale interveinal chlorosis, 4=pale green foliage, 5=healthy green color. Root ratings were done 14 Nov on a 5-point scale, with 5 being good roots, and 1 being a completely rotted root system. The geranium top growth was harvested at the soil line on 15 Nov and dry weights were taken on 19 Nov. Data were analyzed using Tukey’s HSD, \( P=0.05 \).

Geraniums in the Zonix treatments that were inoculated became yellow and stunted, whereas the plants treated with the high rate of Zonix alone, without inoculation, remained attractive. Above-ground plant quality ratings did not show a significant effect of inoculation, but root ratings did indicate that *Pythium* inoculation lowered the vigor and health of the roots. Roots treated with Zonix were either similar to those of the inoculated controls or (in the case of the 750 ppm rate) had a lower rating than the inoculated controls. Banrot-treated plants had higher dry weights than those treated with Zonix. In a coir growing medium, Zonix used weekly appeared to be stressful to the plants in the presence of *Pythium cryptoirregulare*. Poinsettias treated with Zonix in a separate trial using *Pythium aphanidermatum* did not show as much sensitivity to the rhamnolipid. Future experiments should examine the benefits of Zonix rates below 300 ppm and also test effects in peat-based media and with different *Pythium* species.

Control of foxglove aphid on greenhouse-grown salvia with foliar and drench insecticides

Investigators: Daniel Gilrein, Faruque Zaman and Lucille Siracusano
Location: Long Island Horticultural Research and Extension Center

Thirteen treatments were compared in a greenhouse trial for control of foxglove aphid (*Aulacorthum solani*) infesting salvia (*Salvia farinacea* ‘Evolution Deep Violet’). Treatments included foliar sprays with an experimental material at two rates in combination with CapSil adjuvant (100% blend of polyether-polyalkylsiloxane copolymer and nonionic surfactant,
Aquatrols), four rates of the experimental material and one rate of Marathon II (imidacloprid 2F, OHP) as media drenches, Endeavor 50WDG ( pymetrozine, Syngenta) as a spray with and without CapSil and also as a drench, and Aria 50WDG (flonicamid, FMC) as a spray. CapSil + water spray and water spray alone were used as controls.

Salvia plants in 5.25” pots infested with foxglove aphids from a laboratory colony were randomly assigned to treatments using eight single-plant replications per treatment. Treatments were applied on 8/16 after pre-treatment counts were taken. Foliar applications were applied to wet using a CO2-powered backpack sprayer fitted with at TeeJet 8006VS twinfan nozzle operating at 30 psi. Drench applications were made in 96 ml water/pot. Experimental product and Endeavor + CapSil sprays were repeated on 8/29 and 9/12. Plants were arranged in a completely randomized design on a greenhouse bench following each application. Post-treatment foxglove aphid counts to evaluate efficacy were taken on 8/22, 8/27, 9/5, and 9/27. Plant quality and phytotoxicity ratings were done on 8/21 (all treatments), 9/19 and 10/10 (all except Endeavor 5 oz spray and Aria); leaf distortion ratings (from foxglove aphid feeding) were done on 10/10 (except Endeavor 5 oz spray and Aria). ANOVA and pairwise comparisons of treatment means using Tukey’s HSD test were performed on raw or transformed data (JMP v. 9, SAS software).

All insecticide treatments as well as CapSil significantly reduced foxglove aphid populations compared with control treatment. The effect of CapSil alone was transient, with aphid levels quickly recovering. There was no phytotoxicity in any treatment with no residue apparent on plants treated with the experimental product. Control plants and those sprayed with CapSil had high levels of distortion from aphid feeding affecting plant quality; no distortion from aphids was noted on other plants.

**Control of sweetpotato whitefly on poinsettia with foliar and drench insecticides**

**Investigators:** Daniel Gilrein, Faruque Zaman and Lucille Siracusano  
**Location:** Long Island Horticultural Research and Extension Center

Eight insecticide treatments were compared as foliar sprays or pot drenches for control of sweetpotato whitefly [*Bemisia tabaci* (Genn.)] infesting poinsettia (*Euphorbia pulcherrima* Willd. ex Klotzsch). Treatments included two rates of Mainspring (cyantraniliprole 200SC/1.67SC, Syngenta) tank mixed with CapSil adjuvant (100% blend of polyether-polymethylsiloxane copolymer and nonionic surfactant, Aquatrols) as foliar sprays, Mainspring alone at two rates as foliar sprays, Mainspring applied as a drench once or twice at a 14-day interval, and Safari 20SG (dinotefuran, Valent Professional Products) applied twice as a foliar spray. Foliar sprays with CapSil +water or water alone were used as controls.

‘Euro Red Glory’ poinsettia were exposed to sweetpotato whiteflies from an untreated laboratory colony in late August. Treatments were applied on 9/26. Foliar sprays were applied using a CO2-powered backpack sprayer fitted with at TeeJet 8006VS twinfan nozzle operating at 30 psi. Drenches were applied in 118 ml water per pot. Foliar sprays and one Mainspring drench were repeated on 10/10 and (except for Safari) on 10/24. Treatments were replicated eight times and arranged in a completely randomized design on a greenhouse bench. Treatments were evaluated by inspecting eight randomly selected middle-aged leaves per plant and tallying
the number of live immature whitefly stages (nymphs and pupae) present in a randomly selected 1-inch square area on the underside of each leaf. Empty pupal case counts were done similarly on 11/13. Spray residue, plant quality, and phytotoxicity ratings were taken on 10/3 and 11/17. ANOVA and pairwise comparison of transformed or untransformed treatment means using Tukey’s HSD test.

Whitefly levels were relatively low and increasing when treatments were initiated. Except for the final sampling date (11/13), CapSil + water appeared to have minimal impact on whitefly populations; at the end of the trial numbers of empty pupal cases on foliage sprayed with CapSil + water were also similar to those on water-sprayed plants. Whitefly levels and numbers of empty pupal cases on plants drenched once with Mainspring were not significantly from those on control plants, which may be related the the relatively large plant size at time of treatment. However, whiteflies were well-controlled with other Mainspring treatments and the Safari spray treatment. A single spray of Mainspring at the 8 fl oz/100 gal. rate significantly suppressed whitefly populations (with similarly low numbers of empty pupal cases) on treated plants, though levels were not quite as low as those on the somewhat more effective treatments. There was slight phytotoxicity noted on plants treated with CapSil and noticeable residue only on plants sprayed with Mainspring alone, which had minimal impact on final marketable quality.

Control of broad mite on English ivy cuttings with dip treatments

Investigators: Daniel Gilrein, Kevin Dichtl and Lucille Siracusano
Location: Long Island Horticultural Research and Extension Center

Six cutting dip treatments were compared in two greenhouse trials for control of broad mite [Polyphagotarsonemus latus (Banks) infesting English ivy (Hedera helix) in two trials. Treatments included Suffoil-X at 1% and 2% rates, M-Pede (2%), Ultra-Pure Oil (2%), water, and undipped. One trial maintained cuttings in rooting blocks after treatment under mist until rooting. The second trial placed cuttings in vases with water without mist until rooting. The second trial placed cuttings under shade cloth in vases with water without mist until rooting.

This work was conducted from March 5 to March 25, 2014 in one greenhouse. English ivy mother plants in a greenhouse showing signs of broad mite infestation (stunted and distorted foliage, bronzing leaves) were used in this trial. Infestation was confirmed by examining foliage under magnification for both mites and characteristic eggs. Cuttings (~12”) with symptoms on newest growth were selected from mother plants on March 5 and randomly assigned to treatments noted above. 10 cuttings were used for each treatment. Cuttings were dipped on March 5 in insecticide preparations or left undipped, then laid out on a bench until dry. One set of cuttings (10 per treatment) were stuck in rockwool blocks (Grow-Cubes, Grodan B.V.) and randomly arranged on a mist bench until rooted. A second set of cuttings (10 per treatment) were stuck in vases of water and placed under shade cloth but without mist on an adjacent bench. Temperatures were maintained at 65-75F under ambient light and humidity. Plants in both trials were checked for symptoms of phytotoxicity (yellowing leaves; brown, necrotic spots on leaves; leaf drop) on March 10 and examined under a microscope for broad mite eggs and adults on March 14 (both trials), March 17 (cuttings in vases only), and March 25 (both trials). Live eggs and adults found were tallied. ANOVA and pairwise comparisons of untransformed treatment means were done using Tukey’s HSD test. In the first trial (mist), no broad mites were
found on cuttings on March 14 or 25 (SuffOil 1% and 2%, Ultra-Pure Oil) or at very low levels (undipped, M-Pede, water dip treatments) and treatments were not significantly different. No broad mite eggs were found on cuttings in this trial on either date. In the second trial (cuttings in water vases under shade cloth, not under mist), mites were found at low levels on cuttings in all treatments on March 14 except for those dipped in 2% SuffOil; there were no significant differences among treatments. Mite eggs on that date were high on undipped cuttings and on those dipped in M-Pede, significantly greater in both cases than the low levels seen in other treatments. On March 17, a moderate number of eggs and very low numbers of mites were found on undipped cuttings and those dipped in water, with few or none in other treatments. By March 25 eggs were at low levels in all treatments with slightly but not significantly more on water-dipped cuttings. Mite numbers were extremely low or absent in oil treatments with low numbers found on others. Slight but significant phytotoxicity was noted in both trials on plants dipped in Ultra-Pure Oil and in the mist trial on cuttings dipped in M-Pede. There was no injury observed in any other treatment. In general, in the absence of mist a cutting dip in horticultural oil provides better control of the egg stage and a dip in any of the tested insecticides appears to reduce mite numbers though not significantly. However, regular mist in propagation appears to have a great impact on mite populations on English ivy cuttings, with only slight, if any, additive effect from a dip in water, M-Pede or horticultural oil.

**Investigating the use of fertilizers and vermicompost extract to manage Fusarium wilt in basil**

**Investigators:** Neil Mattson, Margery Daughtrey and Meg McGrath  
**Location:** Long Island Horticultural Research and Extension Center

Fusarium wilt is a common disease of basil, caused by host-specific strains of *Fusarium oxysporum*. High ammonium-nitrogen fertility tends to promote development of the disease while nitrate-nitrogen may reduce its development. Organic fertilizer and vermicompost extract (VCE) may offer benefits because of reduced ammonium nitrogen, and the VCE may also contribute competitive microorganisms to aid in Fusarium wilt suppression. Two trials in 2014 tested a range of fertilizer treatments to explore the ability to minimize Fusarium wilt of basil via nutrition. Treatments included low, medium and high ammonium rates (15-5-15, Sustane 8-4-4 and 20-20-20), with or without nonaerated VCE. Plants were grown with and without the addition of 6-mm agar discs of *F. oxysporum f. sp. basilicum* in 4-inch (500 cc) containers in a 3:1 (v:v) peat:perlite mix. There were 10 single-plant replications of each treatment, arranged in a randomized split plot design. Height and fresh and dry weight at finish were recorded at the end of both trials, which occurred about 6 weeks after transplanting (on 18 September, 2014 and 12 December, 2014). Basil plants were also rated on a 4-point scale, with 1=dead plant, 2= >50% of plant with symptoms, 3= <50% of plant with symptoms and 4=healthy plant.

At the end of Expt. 1, most noninoculated plants remained healthy. Inoculation led to disease in all treatments. Out of the total of 10, there were 2 dead plants in 15-5-15 without VCE and 4 with VCE; 6 dead plants in 20-20-20 without VCE, 5 dead plants in 20-20-20 with VCE; 4 dead plants in Sustane without VCE, and 4 dead plants in Sustane with VCE. At the end of Expt 2, again most noninoculated plants remained healthy. Inoculation led to disease in all treatments in Experiment 2. Out of the total of 10, there was one dead plant in 15-5-15 without VCE and one with VCE; one in 20-20-20 without VCE, no dead plants in 20-20-20 with VCE; 4 dead plants
in Sustane without VCE, and 4 with VCE. In noninoculated plants, the vermicompost extract resulted in larger plants no matter which fertilizer was used and generally slowed, but did not prevent, disease development in all three fertilizer treatments in both experiments—but this was not always a significant effect. The least disease was seen with 15-5-15 + VCE fertilization in the first trial, and with 20-20-20 + VCE fertilization in the second. Further experimentation with lower inoculum levels is indicated in order to better observe the interactions between fertilizer and Fusarium wilt in basil.

**Grapes and Other Fruit**

**Evaluation of vinifera winegrape varieties and clones**

*Investigators: Alice Wise and Libby Tarleton*

*Location: Long Island Horticultural Research and Extension Center research vineyard*

A 1.5 acre variety and clone trial is located at LIHREC. The goal of this work is to assess viticultural characteristics and fruit quality for 33 red and white vinifera winegrape varieties. For all bearing vines, the following data was taken: crop weight, cluster number, berry number/cluster, and fruit quality assessments (°Brix, titratable acidity, pH). A full report can be viewed on the grape program website: [http://ccesuffolk.org/grape-program](http://ccesuffolk.org/grape-program).

The 2014 season was slightly cooler than 2013, particularly in July and August. From July through September, the weather was very dry. Despite irrigation, young vines in the research vineyard were stressed, likely exacerbated by the presence of weed cover as we practice under-vine mowing. The research vineyard has been largely free from crown gall until the 2014 season. Two year old vines of Arneis, Moscato Giallo and in particular Vermentino all displayed crown gall at the graft. Some vines had galls extending up the trunk. In >20 years, there has been one vine lost to crown gall in this vineyard.

Renovation of varieties continued with the removal of Arandell, a disease tolerant hybrid. All Arandell vines had leaf roll virus. Vine health, yield and fruit quality were all suffering. Thanks to testing services provided by Cornell virologists Marc Fuchs and Keith Perry, leaf roll virus was also confirmed in Merlot and Albariño.

A cold hardy Minnesota hybrid, Petite Pearl, was planted in 2014. It is reportedly resistant to powdery mildew, downy mildew, black rot and bunch rot. Unlike many other hybrid reds, acids are moderate at harvest. It reportedly ripens well even in cool summers.

Thanks to the sunny dry weather, canopy and cluster diseases that are problematic with wet weather were largely absent in 2014. Fruit quality was again excellent in 2014. It is rewarding to have two good seasons in a row.

**Innovative under trellis management in vineyards: under vine mowing**

*Investigators: Alice Wise, Libby Tarleton and Justine Vanden Heuvel, Cornell*

*Location: LIHREC vineyard cv. Merlot*

Conventional viticultural wisdom dictates that significant weed growth in the area under vines provides competition for water and nutrients. Consequently, herbicides have long been used as a cost-effective way to maintain a weed free strip under vines. However, under this regime, excessive vine vigor is often an issue for winegrape varieties. This forces vineyards to repeatedly