MAINTAINING FARM VIABILITY
PRESERVING OPEN SPACES
ENHANCING ENVIRONMENTAL QUALITY
PROVIDING PEST CONTROL ALTERNATIVES
PROTECTING WATER QUALITY
What is IPM?

Integrated pest management (IPM) is a sustainable approach to managing pests. IPM practitioners base decisions on information that is collected systematically as they integrate economic, environmental, and social goals. IPM can be used within the context of both agricultural and urban environments, and is flexible enough to accommodate the changing demands of agriculture, commerce, and society.

IPM emphasizes the integration of many pest suppression technologies:

- **Biological control** - use of beneficial organisms to manage pests.
- **Cultural control** – crop rotation, improved sanitation, and other practices that reduce pest pressure.
- **Mechanical and physical control** – for example, traps and cultivation.
- **Chemical control** – judicious use of selective pesticides.
- **Host plant resistance** – use of pest-resistant varieties.
- **Regulatory control** – state and federal regulations that prevent the spread of pests.

IPM Program Contacts

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For more information on IPM, see the UConn IPM Website at http://www.ipm.uconn.edu
The general public has a right to safe and affordable food and water, and an environment that is free from contamination. Certain chemicals employed in pest control have the potential to adversely affect human health and the quality of natural resources. History has shown that once environmental damage or contamination has occurred, it may be either irreversible or extremely costly to correct. Furthermore, when a single pesticide or other pest control strategy is used repeatedly, it can lose its efficacy in controlling pests as the pests develop resistance. A proactive approach to pest control that integrates diverse control methods is needed to achieve long-lasting pest control that poses minimal threat to human health and natural resources.

The goal of integrated pest management (IPM) is to reduce the dependence of agricultural producers, homeowners and schools on pesticides while maintaining or improving productivity, crop quality and quality of life. Since its inception in 1980, the Connecticut IPM program has made great strides in developing and implementing more sustainable methods for pest control throughout Connecticut. The IPM program has educated growers throughout Connecticut about the judicious use of pesticides and alternative pest control methods.

Each year, IPM training programs are conducted for vegetable, fruit, greenhouse, turfgrass, and nursery production. In 2009, 55 growers participated in full-season IPM training programs. Information is also disseminated to growers through presentations, publications, pest information hotlines, and the IPM website at www.ipm.uconn.edu. In addition, the Connecticut IPM program educates the public and natural area managers on issues related to invasive species. Homeowners, teachers and students benefit from other program offerings such as conferences, web-based materials and the ongoing development of school curricula on IPM. Through such education, the IPM program has significantly increased the economic viability of agriculture and the green industries in Connecticut, while at the same time safeguarding human health and the environment.

Since 1984, IPM personnel at the University of Connecticut have held 922 full-season, one-on-one training programs for individual growers and groundskeepers in Connecticut. This training has vastly reduced pesticide use in Connecticut, resulting in over 93 tons of pesticide active ingredient not being applied to Connecticut crops and landscapes. This reduction included at least 33 tons of chemicals classified as having moderate to severe potential to contaminate groundwater. The Connecticut IPM program training efforts have substantially improved the economic viability of agriculture in Connecticut through both lowering pesticide costs and reducing pest damage to crops.

“I feel the information is very current and helps me stay alert to potential problems that may show up on our crops.”
IPM Funding

The IPM program is the result of a joint effort between the University of Connecticut Cooperative Extension System and the Department of Plant Science & Landscape Architecture. A variety of private, state and federal funding sources support the program. The CT Department of Environmental Protection Non-Point Source Grant Program has funded the Quinebaug River Watershed Reduced Pesticide Loading/Integrated Crop Management Demonstration. State funds and USDA Smith-Lever funds covered the salaries and fringe benefits of several IPM team members. The USDA Natural Resource Conservation Service continued to partner with the IPM program in order to provide IPM training to growers enrolled in the NRCS EQIP program.

Grower donors throughout Connecticut
Multi-state Hatch Project S-1024
New England Vegetable & Berry Growers’ Association
Northeastern IPM Center (USDA)
Sustainable Greenhouse Health Maintenance Program, USDA NE SARE
The Connecticut Department of Agriculture
The University of Connecticut
U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Services (APHIS)
USDA Northeast Sustainable Agriculture Research & Education Program

Other Partners

All America Selections
Audubon Society of Connecticut
Bartlett Arboretum
Bill Syme
Cassidy Hill Vineyards
Connecticut Association of Conservation and Inland Wetland Commissions (CACIWC)
Connecticut Botanical Society
Connecticut Department of Transportation
Connecticut Greenhouse Growers Association
Connecticut Invasive Plant Working Group (CIPWG)
Connecticut River Coastal Conservation District
CT River Coastal, Eastern Connecticut, North Central, Northwest and Southwest Conservation Districts
Connecticut Valley Winery
Cornell Cooperative Extension
Dr. Botond Balogh
Eben Weil, Equipment Consultant, Formerly with Monroe Tractor, Inc
Federated Garden Clubs of Connecticut
Fred & Stacia Monahan
Gary Sweet, Sweet’s Gourmet Sweet Corn, N. Ridgeville, OH
George Ayres, Fresh Ayr Farm, Shortsville, NY
Invasive Plant Atlas of New England (IPANE)
Jonathan Edwards Winery
Jones Winery
Keith Marshall and Jim Wilson, Wilson Farms, Lexington, MA and Litchfield, NH
Mad Gardeners
Maple Lane Farms, Preston, CT
Nature Conservancy, Connecticut Chapter
Nelson Cecarelli, Cecarelli Farm, Northford, CT
New England Center for Invasive Plants
New England Floriculture Inc.
New England Invasive Plant Group
New England Vegetable & Fruit Conference Steering Committee
New England Vegetable Management Guide Editing Committee
Paradise Hill Vineyard & Winery
Several municipalities (biological control release sites)
Steve Bengtson
The Connecticut Agricultural Experiment Station
The Connecticut Horticultural Society
The Nature Conservancy
The University of Connecticut Master Gardener Program
Tom & Karen Scott, Scott’s Yankee Farmers, E. Lyme, CT
University of Connecticut
University of Maine
University of Massachusetts
University of New Hampshire
University of Rhode Island
University of Vermont
Viliam Zvalo, AgraPoint International Inc., Nova Scotia, Canada
Walker Road Vineyards
Program Highlights

Vegetable IPM

The project, Hastening Adoption of Zone-Tillage (DZT) on CT/New England Vegetable Farms, consisted of a soil compaction and OM survey and a sequence of outreach meetings and articles, all with the goal of hastening the adoption of deep zone tillage in CT and New England. Reduced-tillage growers and Extension educators partnered and used workshops, twilight meetings, conferences, discussion groups, newsletter/web site articles and case studies to disseminate zone-tillage information.

- Ten new farms and 3 universities converted to using DZT in 2009.
- Two municipalities added zone tillage requirements to land rental contracts.
- Ten growers adopted BMP
- Five DZT growers surveyed at end of 2009 season indicated
  - Improved yields because they were able to plant wet fields on time with DZT system
  - Increase in organic matter and general soil health
  - Compaction alleviated
  - Better drainage provided

In 2009, 14 growers received weekly IPM training through NRCS EQIP or DEP grants. The objective of this program is to provide Connecticut and New England vegetable farmers with cutting edge, environmentally-sound solutions to their pest management and crop production problems and to help keep them competitive on the local, regional and national level.

- Twelve growers (86%) increased adoption of BMP
- Eleven growers (79%) reduced pesticide usage. However, the 3 who did not had a previous history of no pesticide use.

The Commercial Vegetable Crops Program helps keep Connecticut’s producers current on some of the latest and most innovative ideas and technology, helps keep their farms profitable, and has a positive impact on their farms, families, products and the environment. The objective of this program is to provide Connecticut and New England vegetable farmers with cutting-edge solutions to their pest management and crop production problems and to help keep them competitive on the local, regional and national level.

- Seven farm tours/twilight meetings
- Twelve press articles/interviews
- Two articles in manuals/bulletins
- 210 weekly IPM training sessions with growers were conducted
- Eight presentations were given at conferences.
- ‘Crop Talk’ newsletter for commercial vegetable and fruit growers reached 880 growers/educators quarterly.
- Over 4000 calls/hits to the UConn vegetable phone & internet pest message. Fifteen messages were provided.
- Over 1500 copies of the 2010-2011 New England Vegetable Management Guide were sold.
- 1557 people attended the 2009 New England Vegetable & Fruit Conference and Trade Show. (J. Boucher is on the conference committee)
  - 88% said that the information they obtained at the conference would help them improve cultural farming practices.
- 166 growers and service representatives attended the Annual CT Vegetable and Small Fruit Growers’ Conference in Vernon, CT January, 2010.
  - 70% indicated they would adopt one or more new practices as a result of attending the conference.
- 225 growers attended 2 special topics meetings covering Greenhouse & High Tunnel Tomatoes, and Biological Control in Greenhouses.
- Over 117 growers, researchers, educators and administrators attended 2 farm tours and 2 June twilight meetings.

A grower in Pomfret using pest monitoring traps
Fruit IPM

Stone fruits (peaches, nectarines, plums, apricots, and cherries) are grown on over a thousand acres in New England. Even though production acreage is not that high, stone fruits are very high value crops. Unfortunately, there have been no precise pest management guidelines for stone fruits in this region. The purpose of this multi-year program, Development and On-Farm Training of Biologically Based Methods for Integrated Crop Management of Stone Fruits in New England, is to develop pest management practices for New England stone fruit growers including those that are more sustainable and biologically based. A separate research component to develop biological control of bacterial spot disease is being conducted by the Dr. Robert Marra, Co-Pi, from the Connecticut Agricultural Experiment Station.

- Nine Connecticut growers with 80 acres of stone fruits received one-on-one training in Integrated Pest Management (IPM) practices in 2009
- All 9 of the growers adopted the use of mating disruption for peachtree borer and lesser peachtree borer.
- Mating disruption alone resulted in the reduction of 480 pounds of active ingredient of chlorpyrifos. Additional growers learned about stone fruit IPM through grower meetings during the summer and winter of 2009.

Grape IPM

A series of 10 workshops was organized for growers by Dr. Richard Kiyomoto during the first part of 2009. These workshops included a New Grower program presented by owners and staff of the host vineyard/winery together with Dr. Kiyomoto. Another component of this series was an IPM training session on Organic Methods of Disease Control in Grapes also presented by Dr. Kiyomoto. Grape IPM field training programs were offered again in 2009 with funding from the USDA NRCS Environmental Quality Incentives Program. The Connecticut IPM program website also provided grape pest management information, pest alerts, disease forecasting model predictions, weather data, and growing degree-day records.
Greenhouse IPM

Fourteen businesses participated in the full season sustainable greenhouse IPM hands-on training program directly impacting 14.15 acres (616,428 square feet) of intensive greenhouse production plus 10 acres of outdoor production.
- 50% of the businesses used biological control agents including beneficial nematodes, and/or predatory mites.
- 66% also reduced pesticide use.
- All participants increased adoption of recommended IPM practices.

Educational conferences, workshops and grower meetings were held specifically targeting the increased use of biological controls in a sustainable greenhouse environment. University of Massachusetts, University of Connecticut, and Northeast SARE sponsored Using Biological Control in Greenhouses in Vernon, CT with 61 attendees.
- 76% stated that they would benefit economically as a result of this conference.

“In Great to “see” how things are done.
I feel that this is our future.”

Grower to Grower on Greenhouse Biological Controls at Pioneer Gardens, Deerfield, MA

UCONN and UMASS initiated a series of “Grower to Grower” Meetings on Greenhouse Biological Control. The first was held at Grower Direct Farms, in Somers, CT and the second at Pioneer Gardens in Deerfield, MA. Fifty-two attended.
- 100% rated the program as useful to very useful.

IPM and Nutrient Management Demonstration Project

The objective of the IPM and Nutrient Management Demonstration Project was to provide educational programs in IPM/ICM for Connecticut growers and groundskeepers, as well as the general public. The farms and businesses were located in the lower Thames River Basin, Niantic River watershed, and Coginchaug River watershed. 9 people from 8 different businesses (farms, green industry) with 380.7 acres participated in Integrated Pest Management programs (IPM) or Nutrient Management programs in 2009. The businesses involved in IPM programs included: 2 vegetable farms, 4 fruit farms, 2 nurseries, and 1 greenhouse operation. The training was conducted by J. Boucher (vegetable crops), D. Ellis (nursery crops), L. Los (fruit crops), and L. Pundt (greenhouse crops).
- 94 in-field IPM training sessions were conducted with these cooperators.
- 100% of the participants increased adoption of recommended IPM and Nutrient Management practices.
- 63% of the growers reduced pesticide use.
- 5 educational workshops were conducted.

Invasive Plants

Non-native invasive plants are a problem because they establish easily and grow aggressively, disperse over wide areas, displace native species, and reduce biological diversity. These plants invade not only terrestrial habitats but water bodies as well, where they can grow and proliferate undetected for many years. Some invasive plants are more familiar to the public because of their beauty (purple loosestrife), their poisonous traits (giant hogweed), or homeowner frustrations trying to control them (Oriental bittersweet and Japanese knotweed). The push to control invasive plants is becoming common nationwide.
In response to increasing populations of the invasive plant mile-a-minute vine, outreach efforts increased significantly to inform the public how to identify, report, and control this new invader in Connecticut. Materials continue to be developed on invasive plants, with emphasis on mile-a-minute, including:

- Press materials in collaboration with local news outlets, town newsletters, and conservation departments to better educate the public regarding the problems caused by MAM vine, giant hogweed, and other invasive plants.
- An Online Reporting System, which can be used both by experts and the general public to report the suspected presence of MAM to University staff. The reports can then be individually tracked, and can be verified using digital photos to confirm identification of the species.
- A new 4-panel poster exhibit on invasive plants and native alternatives was developed and has been displayed at many public events and conferences.

Outreach efforts included the distribution of postcards, flyers and posters on Mile-a-minute; articles in magazines, newsletters, newspapers and the Internet; as well as local television and radio stations. More than 238 inquiries and reports of mile-a-minute occurrences in Connecticut were received during 2009. Although the majority of the reports were negative (representing other plants that were mistaken for MAM), the results show the effectiveness of invasive plant public outreach.

**New invasive plant display for the Connecticut Invasive Plant Working Group**

**Beetle Farmers collecting Galerucella beetles for purple loosestrife biological control in Bloomfield, CT**

**Nursery IPM**

Eighteen IPM training and scouting sessions were conducted biweekly with two growers, a wholesale nursery in Waterford, CT and a retail garden center in Salem, CT. Insect, disease, weed and cultural problems were observed and discussed as well as beneficial insect identification. A pre-season survey was completed during the first IPM site visit, and the grower/manager completed a post-season survey after the last IPM visit.

**Two Major IPM Conferences**

The Ornamental Plant Extension Team (Donna Ellis, Leanne Pundt, Richard McAvoy, and Dawn Pettinelli) along with many individuals from the Department of Plant Science and Cooperative Extension, planned and implemented 2 major conferences.

**2010 Perennial Plant Conference**

Four hundred and seventeen professional horticulturists attended the Perennial Plant Conference on March 11, 2010, and they traveled from the New England area, Michigan, New York, and Pennsylvania. Including speakers and staff, the total attendance was 450.

- 96% replied that they are now more prepared to practice sustainable horticulture by attending the conference.
• 90% stated that they are more prepared to make changes to their business operation by attending the conference.

“Excellent selection of topics – you nailed it this year!”

2010 Garden Conference

The Garden Conference on March 12, 2010 was attended by 261 gardening enthusiasts, who also traveled from the New England area and New York. Including speakers and staff, the total attendance was 285.

• 100% of the respondents felt more prepared to make changes relating to sustainability to their home landscape and gardens after attending the conference.

“Topics were relevant to things gardeners are interested in learning about and incorporating into their own gardens/garden practices.”

Landscape & Turf IPM

Several scarab beetle species are important pests in a number of settings in the Northeast region. Ornamental plants, vegetables, field crops, fruits and turfgrass are attacked by a number of scarab beetles such as the Japanese, Oriental and Asiatic garden beetles. The Japanese beetle is an exotic pest that has spread gradually and now it is well established in most states east of the Mississippi River. This beetle is considered to be the most widespread and destructive insect pest of turf and landscape plants in eastern United States. It is estimated that this beetle is responsible for more than $450 million each year in costs for control and renovation or replacement of damaged turf and ornamental plants. Similarly, the Oriental beetle is another invasive scarab that as a larva feeds on roots of turfgrass and is a serious pest. It also causes severe damage to strawberries and nursery stock.

The Spring Tiphia and the Summer Tiphia wasps were imported from Asia for Japanese beetle control. These wasps are parasites of the beetle grubs. The Spring Tiphia wasps attack grubs during spring and the Summer Tiphia attack the grubs that are present in late summer. The Spring Tiphia is not known to parasitize any native scarab species. Since 1950 the occurrence of these parasitic wasps in Connecticut had not been monitored and they had been considered to be rare in occurrence. A recent survey by Ramoutar and Legrand (2007) indicated that the Spring Tiphia wasps were widely distributed in the state with a peak occurrence around the last week of May.
Conservation biological control involves manipulation of the environment to enhance the survival, fecundity, longevity and behavior of natural enemies as to increase their effectiveness for pest management. One approach in conservation biological control is to provide food resources to natural enemies either through food sprays or by incorporating flowering plants habitats that could provide food resources over a period of time. Many parasitoid wasps species visit flowers to obtain nectar and/or pollen that provide essential nutrients. This in turn improves fecundity, longevity and increases rates of parasitism. Thus, the objective of this study was to identify ornamental plants that can serve as a source of nectar for Tiphia wasps in Connecticut.

For Spring Tiphia, ornamental plants were selected based on their production of extrafloral nectar. It was hypothesized that this characteristic will be the best suited to the nectar feeding habits of this wasp given the timing of its occurrence. Plants selected included three cultivars of Paeonia lactiflora, Viburnum dentatum and Sambucus canadensis. For T. popilliavora, plants were selected based on their flower arrangement, flowering phenology and ornamental use. The plants selected included wild carrot D. carota, Achillea filipendulina, three cultivars of A. millefolium, and ornamental goldenrod Solidago cutleri.

Spring Tiphia wasps were observed feeding off the extrafloral nectar on all the plants selected. However, these wasps were observed feeding extensively from the extrafloral nectar of peonies. Feeding damage by the Japanese beetle was also recorded on all plants tested and peonies were also the best in this regard because the beetles lack a preference for these plants. Of the plants selected for summer Tiphia only the wild carrot attracted a significant number of Tiphia wasps.
Vegetable IPM

Hastening Adoption of Zone-Tillage on CT and New England Vegetable Farms

Reduced-tillage systems, such as deep zone tillage (DZT), help to minimize field preparation costs; reduce energy use; eliminate soil, nutrient and pesticide runoff; help restore soil health and fertility; provide farmers access to open space; reduce irrigation demands; and provide the ultimate climate change tool for a region that is forecast to become warmer and wetter. Deep zone tillage helps the soil retain moisture during dry conditions because the soil surface is protected by mulch, and allows plant roots to grow through the plow pan and fully explore the soil profile. In wet conditions, DZT helps prevent soil crusting which improves germination, prevents flooding in low wet areas which minimizes disease problems and increases productive ground, allows crops to be planted on time even in wet fields, and allows growers to avoid standing water when preparing ground for planting.

The extensive tillage practices used on vegetable farms in the Northeast are expensive and result in problems with soil compaction, soil degradation and soil erosion. Our conventional-till vegetable growers continue to compact their soils, break down the soil structure and mine the soil organic matter away every time they till the soil. Most vegetable farmers plow, harrow several times, cultivate or bed the plantings, and may also cultivate many times. Multiple tillage trips across the field are expensive and produce plow- and disc-pan which often prevents root growth beyond 8 to 12 inches deep and lead to soil flooding and erosion. Soil flooding, in turn, leads to crop disease problems, while surface runoff causes soil, pesticides and nutrients to leave the field and enter surface water. Constant tillage oxidizes soil organic matter (OM) away as CO₂ resulting in the loss of soil structure, soil pore space, soil microbial populations and reserve fertility.

This project consisted of a soil compaction and OM survey and a sequence of outreach meetings and articles, all with the goal of hastening the adoption of deep zone tillage in CT and New England. Reduced-tillage growers and Extension educators partnered and used workshops, twilight meetings, conferences, discussion groups, newsletter/web site articles and case studies to disseminate zone-tillage information. In the past year, a total of 10 new farms converted to using DZT, and Extension Educators in all 6 New England states and beyond (i.e. Nova Scotia) helped in promoting the new reduced-till system.

Deep-zone tillage at Nelson Cecarelli’s farm, Northford, CT

- Ten commercial farms and three universities transitioned to deep zone tillage between July 2009 and June 2010, bringing the total number of DZT farms in New England to 15.
- Twenty-two people said they would adopt DZT as a new practice after the CT Vegetable & Small Fruit Growers Conference.

Five DZT growers were surveyed at the end of the 2009 growing season.
- 100% saved field preparation time, fuel, machine hours and maintenance time using DZT and improved their yields.

One grower took the time to plow and harrow one square acre and DZT another, and measured the time it took and the fuel consumed.
• Reduced field preparation time from 1.5 to 0.5 hours (67%)
• Reduced fuel consumption from 4.5 to 1.25 gallons (72%).

The first 5 farmers using DZT described 30 benefits that this technique provides over conventional tillage and we expect new converts to add to the list. These 5 growers identified the following potential benefits of their new tillage system:
• reduced fuel, labor, and machine hours
• reduced chemical/nutrient runoff and soil erosion
• soils that warm faster than conventional or no-till
• elimination of compacted layers (plow pans);
• improved drainage
• deeper, healthier crop roots
• reduced disease incidence (less Phytophthora and black rot)
• fewer planting delays
• better water infiltration (turns wet holes into productive ground)
• can plant wet fields in wet seasons (increased acreage)
• can avoid wet areas when planting (fewer stuck machines)
• less soil surface crusting, conservation of soil moisture in dry spells
• increased organic matter,
• improved soil structure and more beneficial organisms (i.e. earthworms)
• reduced dust and noise
• fewer annual weeds
• fewer rocks to pick
• eliminates dead furrows
• better seed emergence and yields
• improved crop quality (straighter/longer carrots, cleaner pumpkins and butternut, no dry tip on sweet corn)
• and rental of land trust/municipal property which prohibits conventional till.

After positive experiences with one grower, the town of Wallingford, CT added a requirement that farmers must use zone tillage to rent their municipal property. This was enacted to help eliminate the possibility of soil, pesticide and nutrient runoff entering the town water supply. The use of DZT also helped a farmer in Concord, MA win a rental agreement with the town to help prevent erosion damage and runoff. Adopting DZT will also benefit growers in the future by helping them adapt to climate change in the Northeast, where long term forecasts call for conditions to get warmer and wetter.

![Average % Organic Matter](image)

**Sustainable Vegetable Crops Extension Program**

The objective of this program is to provide Connecticut and New England vegetable farmers with cutting-edge solutions to their pest management and crop production problems and to help keep them competitive on the local, regional and national level.

**New England Vegetable & Fruit Conference and Trade Show**, held in Manchester, NH, featured 30 educational sessions with 145 individual presentations over 3 days. There were also 10 farmer-to-farmer discussion groups and 122 commercial and non-profit exhibit booths in the trade show. Total attendance was 1,557 people and 186 (17%) completed post-conference evaluations.

• 88% said that the information they obtained at the conference would help them improve cultural farming practices
• 87% said it would improve pest management
• 80% said it would improve soil and nutrient management
• 75% said it would help improve farm profitability
• 61% said it would improve marketing or business management
• 79% said they would adopt a new practice in the following year as a result of attending the conference.
Annual CT Vegetable & Small Fruit Growers’ Conference, held in Vernon, CT, was attended by 166 growers.

- 100% (84 respondents) indicated that they learned something to improve their crop production and marketing practices.
- 90% indicated the program would help them improve their pest management or crop quality.
- 82% indicated that it would help them improve their farms environmental quality.
- 78% indicated that it would help them improve their farms profitability.
- 70% said they would adopt one or more new practices as a result of attending the conference.

In 2009, 14 growers received weekly IPM training through NRCS EQIP or DEP grants. The objective of this program is to provide Connecticut and New England vegetable farmers with cutting edge, environmentally-sound solutions to their pest management and crop production problems and to help keep them competitive on the local, regional and national level.

- Twelve growers (86%) increased adoption of BMP: adoption of new alternative pest management strategies to reduce crop damage from insects, diseases, weeds and other pests.
- Eleven growers (79%) reduced pesticide usage. However, the 3 who did not had a previous history of no pesticide use.

Sixty growers learned about stone fruit management and guidelines and the bacterial spot research at the Annual Meeting of the Connecticut Pomological Society in December, 2009. In addition, growers learned about specific stone fruit IPM methods at two twilight meetings during the summer of 2009.

L. Los was also the lead scientist in the development of the guidelines for the Eco-Stone Fruit protocol in collaboration with the IPM Institute of North America and Red Tomato. The protocol is followed by growers who cooperate with Red Tomato, a non-profit organization which helps farmers sell their sustainably grown produce to supermarkets, distributors and other buyers. Lorraine Los was also the editor of the stone fruit sections of the 2010 New England Tree Fruit Management Guide. All pesticide recommendations and IPM information were reviewed and revised.

**Fruit IPM**

**Development and On-Farm Training of Biologically Based Methods for Integrated Crop Management of Stone Fruits in New England**

Stone fruits (peaches, nectarines, plums, apricots, and cherries) are grown on over a thousand acres in New England. Even though production acreage is not that high, stone fruits are very high value crops. Unfortunately, there have been no precise pest management guidelines for stone fruits in this region. The purpose of this program is to develop pest management practices for New England stone fruit growers including those that are more sustainable and biologically based.

Nine Connecticut growers with 80 acres of stone fruits received one-on-one training in Integrated Pest Management (IPM) practices in 2009.

- All 9 growers adopted at least one new practice; specifically the use of mating disruption for peachtree borer and lesser peachtree borer.
- The use of mating disruption alone resulted in the reduction of 480 pounds of active ingredient of chlorpyrifos, which is typically applied on an annual basis for borer control.

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L. Los was also the lead scientist in the development of the guidelines for the Eco-Stone Fruit protocol in collaboration with the IPM Institute of North America and Red Tomato. The protocol is followed by growers who cooperate with Red Tomato, a non-profit organization which helps farmers sell their sustainably grown produce to supermarkets, distributors and other buyers. Lorraine Los was also the editor of the stone fruit sections of the 2010 New England Tree Fruit Management Guide. All pesticide recommendations and IPM information were reviewed and revised.

**Fruit IPM**

**Development and On-Farm Training of Biologically Based Methods for Integrated Crop Management of Stone Fruits in New England**

Stone fruits (peaches, nectarines, plums, apricots, and cherries) are grown on over a thousand acres in New England. Even though production acreage is not that high, stone fruits are very high value crops. Unfortunately, there have been no precise pest management guidelines for stone fruits in this region. The purpose of this program is to develop pest management practices for New England stone fruit growers including those that are more sustainable and biologically based.

Nine Connecticut growers with 80 acres of stone fruits received one-on-one training in Integrated Pest Management (IPM) practices in 2009.

- All 9 growers adopted at least one new practice; specifically the use of mating disruption for peachtree borer and lesser peachtree borer.
- The use of mating disruption alone resulted in the reduction of 480 pounds of active ingredient of chlorpyrifos, which is typically applied on an annual basis for borer control.

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Mating Disruption of the Currant Borer (Synanthedon tipuliformis) in Connecticut

The currant borer has been identified as the most serious pest of black currants in Connecticut. There are few pesticides registered for this crop and chemical controls are not known to be particularly effective. Mating disruption with insect pheromones is an alternative control that is being explored at Maple Lane Farm in Preston, CT. This is the largest black currant farm in North America.

A total of 12.5 acres were treated with mating disruption in 2006 and 2007. In 2008 and 2009, a total of 25 acres were treated with mating disruption pheromones. Treatments included fields with one half treated and one half used as a control; fields that were mowed, then treated with mating disruption; and fields treated with half rates (100 pheromone dispensers per acre). Results show a reduction in borer infestation level of at least 50% after two years of use. Results from fields that were mowed and subsequently treated with mating disruption showed complete control of borers after the first year. Reduced rates of pheromones did not result in any increased borer infestation.

A grant proposal was submitted to the USDA IR-4 program during the fall of 2008. The grant was funded to continue the research in 2009 and 2010. As part of this grant, the IR-4 program will work with Pacific Biocontrol Corporation to register the pheromone product in the United States.

Grape IPM

A series of 10 workshops was organized for growers by Dr. Richard Kiyomoto during the first part of 2009. These workshops included a New Grower program presented by owners and staff of the host vineyard/winery together with Dr. Kiyomoto. Another component of this series was an IPM training session on Organic Methods of Disease Control in Grapes also presented by Dr. Kiyomoto. Grape IPM field training programs were offered again in 2009 with funding from the USDA NRCS Environmental Quality Incentives Program. Mr. Arthur Tuttle worked with three vineyard operations. Vineyards were scouted weekly or bi-weekly and IPM training was provided on-site for each vineyard. In addition to on-site IPM training and scouting, a weather station was provided to each trainee to record temperature, humidity, leaf wetness and rainfall parameters all used for disease forecasting models. The use of disease forecasting models allowed the vineyard operators to make informed decisions about disease management actions. Several weather stations were also maintained at other locations around the state and used for disease forecasting. The Connecticut IPM program website also provided grape pest management information, pest alerts, disease forecasting model predictions, weather data, and growing degree-day records. The Connecticut IPM program with the help of Arthur Tuttle also collaborated in the ‘Combining A Disease And Weather Monitoring Network With Measurements Of Inoculum Potential For Disease Forecasting In Vineyard IPM For Southern New England’ project led by Dr. Francis Ferrandino of the Connecticut Agricultural Experiment Station.
**Sustainable Greenhouse IPM**

Connecticut farmers employ greenhouses to grow potted herbs, vegetable bedding plants, tomatoes, annual and perennial flowering plants (from both seed and cuttings), and potted holiday crops. Greenhouse-grown plants are sold to consumers for planting in gardens or landscapes and for use in mixed planters, hanging baskets or for indoor use. Greenhouse vegetables and herbs are sold retail at farmers markets and roadside stand, and wholesale to restaurants and through other markets.

Many farmers in southern New England have added greenhouse crops to their businesses to increase income. In Connecticut, the greenhouse industry is a significant part of the environmental horticulture industry (production, retail & landscape services) which is a major sector of Connecticut agriculture. The environmental horticulture industry provides many jobs (over 48,000 employed in CT), with plant sales generating over $583 million. It also helps keep more than 46,000 acres in agriculture of which 23% is open space. (New England Nursery Association, Feb 2009).

Critical issues for farmers wishing to adopt sustainable greenhouse production are prevention of cultural and pest problems (which are increasing due to industry globalization and pest invasion), early diagnosis, and early intervention. More growers are interested in employing biological controls because chemical resistance is making it hard to control many common greenhouse pests. But, it is a very different strategy than conventional control with a different set of skills and knowledge needed.

The Greenhouse IPM program targets wholesale & retail greenhouse growers, and retail garden centers. Educational programming consisted of multi-state NESARE sponsored conferences, workshops (in conjunction with the Connecticut Greenhouse Growers Association), multi-state Grower to Grower meetings on Greenhouse Biological Control, plus meetings held in multiple locations to update growers on pest issues. Full season IPM hands on training sessions were held at participating growers’ greenhouses. During visits, farmers learned how to use tools for early diagnosis, cultural practices to reduce pests and how to use low-risk pesticides and biological controls.

**Full Season Intensive Hands-On IPM Training in Connecticut Greenhouses**

Full season IPM hands on training sessions were held at the individual grower greenhouses. Fourteen businesses participated in the program directly impacting 14.15 acres (616,428 square feet) of intensive greenhouse production plus 10 acres of outdoor production. A total of 131 infield IPM training sessions were conducted. This sustainable greenhouse health maintenance program was able to provide unbiased information that helped growers to prevent problems and grow their greenhouse crops using sustainable practices and products.

- 100% of participants increased their adoption of Integrated Pest Management (IPM) practices.
- For the 14 participating businesses, insecticide use decreased as 14.7 pounds of insecticide active ingredient was saved from application.
- Crop losses were reduced, cultural practices were improved, and crop quality increased.
- 50% of the businesses used biological control agents including beneficial nematodes, and/or predatory mites.
- 66% also reduced pesticide use.

Aphid mummies on herb plants (after host specific parasitic wasps have been released)
Greenhouse Educational Conferences

Using Biological Control in Greenhouses was held in Vernon, CT (sponsored by University of Massachusetts, University of Connecticut, and Northeast SARE). 61 attended and 38 completed evaluation forms.

- 100% rated the conference as useful or very useful.
- 63% were currently using some biological control agents.
- 76% stated that they would benefit economically as a result of this conference.

New England Greenhouse Update Website

The New England Greenhouse Update website (www.negreenhouse.org) is a joint effort of University of Massachusetts and University of Connecticut Extension educators and faculty (UCONN – L. Pundt, R. McAvoy, and J. Bartok) and University of Massachusetts (T. Smith, P. Lopes, D. Cox, R. van Driesche, R. Wick) where information from site visits are posted as messages on a blog. The blog allows participation from Extension educators in different geographic areas to easily post messages into a pre-formatted webpage. The website also includes a searchable photo library.

Weekly email updates were sent to 500 growers in southern New England with short abstracts, photos and links to additional information via the website (New England Greenhouse Update (www.negreenhouseupdate.info)

“Very useful information, professionally presented in a timely fashion. I have learned a lot from NE Greenhouse Update. The fact that it is focusing on our region makes it very useful to me. I feel the info is very current and helps me stay alert to potential problems that may show up on our crops due to discoveries or problems occurring here in New England”

Attendees take a closer look at cyclamen mites and their associated damage on Aconitum at Plant Diagnostic Clinic sponsored by UConn & CT Greenhouse Growers Association.

With the increased interest in biological control among growers, UCONN and UMASS initiated a series of “Grower to Grower” Meetings on Greenhouse Biological Control. The first meeting was held at Grower Direct Farms, in Somers, CT that has 18 acres of indoor greenhouse production and 20 acres of outdoor growing area. They have been using biological controls for 3 years. 52 attended. The second meeting was held at Pioneer Gardens in Deerfield, MA, a wholesale perennial producer with 2 acres of greenhouse production and 40 acres of field production. They have been using biological controls for 5 years.

“Great session. Continue to have further updates”.

Habitat plants provide food (pollen and nectar) and shelter for natural enemies in the greenhouse.
IPM and Nutrient Management Demonstration Project

L. Los, J. Boucher, D. Ellis and L. Pundt

A total of 9 people from 8 different businesses (farms, green industry) with 380.7 acres participated in Integrated Pest Management programs (IPM) or Nutrient Management programs in 2009. The farms and businesses were located in the lower Thames River Basin (114.0 acres), Niantic River watershed (75.5 acres), and Coginchaug River watershed (191.2 acres). Some were involved in more than one program. The businesses involved in IPM programs included: 2 vegetable farms, 4 fruit farms (orchards and/or small fruits), 2 nurseries, and 1 greenhouse operation. The frequency of the IPM training sessions varied by commodity, from weekly to as needed throughout the growing season. The training was conducted by J. Boucher (vegetable crops), D. Ellis (nursery crops), L. Los (fruit crops), and L. Pundt (greenhouse crops).

- A total of 94 in-field IPM training sessions were conducted with these cooperators during this reporting period.
- The Connecticut River Coastal Conservation District was sub-contracted to sample 185 acres of field corn for the Presidedress Soil Nitrate Test and the End-of-Season Cornstalk Test for the nutrient management portion of this project.
- Pre- and post-season surveys were conducted to determine changes in pesticide and nutrient loading at participating farms and green industry businesses. The results are being analyzed.

On-site demonstration plots with participating growers in these watersheds included

- the use of weather stations in three orchards to forecast fruit disease infection periods for apple scab, fire blight, sooty blotch and flyspeck as well as degree days for insect pests
- the use of deep zone-tillage on an entire 25+ acre vegetable farm
- a comparison of scouting for early blight on tomatoes vs. a computer generated forecasting model called TomCast

All participants increased adoption of recommended IPM and Nutrient Management practices and 63% of the growers reduced pesticide use.

Presentations took place at locations in the targeted watersheds.

- Quinebaug Valley Fruit Growers’ Annual Summer Meeting and Farm Tour. Holmberg Orchards, Gales Ferry, CT. June 29, 2009. 25 attendees. The presentations by Lorraine Los included: Tree Fruit Integrated Pest Management (IPM) Program Mid-season Update, Use of Weather Data for Disease Management, Asian Longhorned Beetle
IPM School Curriculum

The Connecticut Curriculum for Integrated Pest Management (IPM), begun in 2001, is a science-based curriculum that teaches the concepts and methods of IPM to school children and 4-H youth. Invasive plant issues, including purple loosestrife biological control, the volunteer Beetle Farmers, MAM, and giant hogweed are topics that have been included in IPM curriculum materials for grades K-8 developed by area teachers, Donna Ellis, and the late Richard Ashley for the University of Connecticut.

Invasive Plant IPM

Non-native invasive plants are a problem because they establish easily and grow aggressively, disperse over wide areas, displace native species, and reduce biological diversity. These plants invade not only terrestrial habitats but water bodies as well, where they can grow and proliferate undetected for many years. Some invasive plants are more familiar to the public because of their beauty (purple loosestrife), their poisonous traits (giant hogweed), or homeowner frustrations trying to control them (Oriental bittersweet and Japanese knotweed). The push to control invasive plants is becoming common nationwide. The estimated cost of environmental and economic impacts by invasive plants and efforts directed at their control surpassed $122 billion in the U.S. Integrated Pest Management (IPM) methods can be used to control invasive plants in backyards, communities, and in natural landscapes. IPM technologies include the use of biological, mechanical, and chemical controls.

Mile-a-minute vine (Persicaria perfoliata; abbreviated MAM) is a highly invasive, non-native annual vine first recorded in Connecticut in 1997. The vine, which is capable of growing up to six inches per day under ideal conditions, outcompetes and outgrows other vegetation, crowding out native species and interfering with seedling establishment in forest regeneration. Since its original introduction in southwestern Connecticut, the species has spread to at least 18 towns in the state.


The Connecticut General Statutes now include regulations on invasive plants. The Connecticut Invasive Plants Council was established in 2003 to address invasive plant issues. The Council published the *Connecticut Invasive Plant List* in January 2004, which was updated in 2009. Many of the plants on the official state list are prohibited from sale, purchase, movement (except for the purposes of research, education, or eradication), import, cultivation, distribution, or transplanting. Increasing educational awareness of invasive plants through identification, control, and the use of alternative, non-invasive plants is the focus of this program. The Connecticut Invasive Plant Working Group (CIPWG), a statewide ad hoc group organized in 1997, addresses invasive plant issues in Connecticut and the region.
Materials continue to be developed on invasive plants, with emphasis on mile-a-minute, including:

- Press materials in collaboration with local news outlets, town newsletters, and conservation departments to better educate the public regarding the problems caused by MAM vine, giant hogweed, and other invasive plants.
- An Online Reporting System, which can be used both by experts and the general public to report the suspected presence of MAM to University staff. The reports can then be individually tracked, and can be verified using digital photos to confirm identification of the species. The combination of programs described above resulted in multiple reports of MAM during 2009.
- A new 4-panel poster exhibit on invasive plants and native alternatives was developed and has been displayed at many public events and conferences.

In addition the following was also accomplished:

- 8,200 postcards, 430 flyers, and 250 posters on MAM were distributed to the public, municipalities, and organizations during 2009.
- Seven magazine and newsletter articles, and 34 newspaper and Internet articles on MAM, purple loosestrife, and other invasive plants were published.
- Stories on MAM and purple loosestrife appeared on six local television and radio stations.
- More than 238 inquiries and reports of mile-a-minute occurrences in Connecticut were received during 2009. Although the majority of the reports were negative (representing other plants that were mistaken for MAM), the results show the effectiveness of invasive plant public outreach.
- A total of 655 inquiries via telephone, email, and on-site visits were received and responded to from the public, nursery growers, garden center staff, and landscapers regarding weeds and other invasive plants, insects, and pathogens.
- More than 1.5 million beneficial beetles have been reared and released into 120 wetlands to control the invasive plant purple loosestrife through the dedicated efforts of more than 735 volunteer Beetle Farmers in Connecticut.

D. Ellis serves as:

- Co-chair of CIPWG, a consortium of individuals, organizations, and agencies that provide educational outreach on invasive plant issues. Partners involved with CIPWG include affiliates of approximately 100 agencies and organizations such as the CT Department of Environmental Protection (CT DEP), The Connecticut Agricultural Experiment Station (CAES), the Connecticut Department of Transportation (CT DOT), USDA Natural Resources Conservation Service (NRCS), The Nature Conservancy, Invasive Plant Atlas of New England (IPANE), Audubon Society, and the Federated Garden Clubs of Connecticut.
- Program Coordinator for the statewide Purple Loosestrife Biological Control Program, which includes the training of volunteers to become Beetle Farmers, rearing and releasing beneficial insects for biological control of the invasive plant purple loosestrife
- Principal Investigator on a USDA APHIS Cooperative Agreement to conduct biological control of MAM
- Principal Investigator on a USDA APHIS Cooperative Agreement to conduct giant hogweed surveys and provide management recommendations for this Federal Noxious Weed
• Instructor for the topic of invasive plant identification, control, and alternatives for the Master Gardener Program, which is conducted in 5 locations throughout the state each year.
• Ms. Ellis supervises Logan Senack, who was hired in 2008 as the Connecticut Invasive Plant Coordinator through a Cooperative Agreement between the University of Connecticut and the CT DEP.

Two Major IPM Conferences

The Ornamental Plant Extension Team (Donna Ellis, Leanne Pundt, Richard McAvoy, and Dawn Pettinelli) along with many individuals from the Department of Plant Science and Cooperative Extension, planned and implemented 2 major conferences.

2010 Perennial Plant Conference

Four hundred and seventeen professional horticulturists attended the Perennial Plant Conference on March 11, 2010, and they traveled from the New England area, Michigan, New York, and Pennsylvania. Including speakers and staff, the total attendance was 450. Of those, 205 completed an evaluation.
• 98% rated the Perennial Plant Conference as good to excellent.
• 84% thought they would benefit economically as a result of the conference.
• 99% stated that the conference was the same or better than other professional conferences they attended recently.
• 100% responded that they would recommend this conference to others.
• 99% learned information by attending the conference.
• 96% replied that they are now more prepared to practice sustainable horticultural by attending the conference. The practices listed included using more native plants, less lawn, and increasing biological diversity, using edible plants in the landscape, and changing products or practices to be more sustainable.
• 90% stated that they are more prepared to make changes to their business operation by attending the conference. The business operation changes listed included increasing social media (Internet, websites, blogs, emails) and increasing the amount of native plants and edible plants for sale at their place of business.

“Outstanding conference!”
“Very, very informative as well as being entertaining.”

Plant sales during Garden Conference
2010 Garden Conference

The Garden Conference on March 12, 2010 was attended by 261 gardening enthusiasts, who also traveled from the New England area and New York. Including speakers and staff, the total attendance was 285. Of those, 147 attendees completed the evaluation form. Evaluation results included the following:

- 100% rated the Garden Conference as good to excellent.
- When asked how much they typically spend on their gardens annually, approximately half of the respondents indicated that they spend between $200 and $500, and 30% spend between $500 and $1,000.
- 100% stated that they thought the conference compared as favorably or more favorably than other conferences they had attended.
- 100% stated they would recommend this conference to others.
- 100% stated that they learned information at the conference.
- 100% of the respondents felt more prepared to make changes relating to sustainability to their home landscape and gardens after attending the conference.

Landscape & Turf IPM

The objectives of the Landscape & Turf IPM program are to develop improved methods of controlling ornamental plant and turfgrass pests and to provide continuing education to the green industry and consumers. Ana Legrand, IPM Program Coordinator, works in this area together with Stephen Rackliffe, Turfgrass Extension Educator. S. Rackliffe works to support turf managers around the state and also has been involved in teaching for the Master Gardener Program. A. Legrand has presented results from the research described below at several conferences and was invited to present on the topic of ‘Biological control of Scarabaeid Beetles’ at the Eighty Years of Biological Control in the Northeastern U.S. Symposium during the Entomological Society of America EB Annual Meeting. In addition, A. Legrand has presented information on general IPM and turf IPM at several public events and also provided presentations in Spanish on the same topics.

The focus of recent applied research efforts has been on turfgrass IPM and in particular dealing with scarab beetles such as the Japanese beetle, Oriental beetle, Asiatic garden beetle, and European chafer. These insects in their immature stages, known as white grubs, are considered the most damaging pests of turf. Moreover, they are also considered important pests of many of our common landscape plants. Conventional insecticides continue to be the major tool to manage these turfgrass pests in sod production areas, recreational areas and private settings. However, distress about the use of pesticides in urban areas, particularly where children are likely to come into contact with pesticide materials has energized the demand for pest management programs that rely less on chemical insecticides. An example of such public concerns is the recent legislation that bans the use of lawn care pesticides on the grounds of any public or private school with students in grade eight or lower. Thus, this research effort seeks to advance the use of biologically-based alternatives that will be easy to implement by sod-producers, managers and homeowners.
Currently, studies are carried out on two species of parasitic wasps that attack the Japanese and the Oriental beetles. These parasitic wasps are the Spring *Tiphia* or *Tiphia vernalis* and the Summer *Tiphia* or *T. popilliavora*. During 1920’s and early 1930’s USDA entomologists imported *Tiphia vernalis* Rohwer from Korea and *Tiphia popilliavora* Rohwer. (Hymenoptera Tippiidae) from Japan for Japanese beetle control. Numerous wasp releases were made throughout the northeastern U.S. Releases of *T. vernalis* were made between 1936 and 1949 in six of Connecticut’s eight counties and *T. popilliavora* was released in 5 counties between 1921-1940. The primary target of these releases was the Japanese beetle. However, *T. vernalis* and *T. popilliavora* are parasitoids of the Oriental beetle as well. These parasitoids feed on the larvae with *T. vernalis* attacking the 3rd instars during spring and *T. popilliavora* attacking 2nd or 3rd instars during late summer. Many parasitoid wasps species visit flowers to obtain nectar and/or pollen that provide essential nutrients. This in turn improves fecundity, longevity and increases rates of parasitism. Thus, one approach in conservation biological control is to provide food resources to natural enemies either through food sprays or by incorporating flowering plants habitats that could provide food resources over a period of time. The following projects that address *Tiphia* wasp conservation were done with support from a Northeastern IPM Center grant.

**Evaluation of ornamental plants as sources of nectar for the Spring *Tiphia***

Ornamental plants were selected for this evaluation based on their production of extrafloral nectar. It was hypothesized that this characteristic will be the best suited to the nectar feeding habits of this wasp given the timing of its occurrence. For the first evaluation, plants selected included *Paeonia lactiflora*, *Viburnum dentatum* ‘Blue Muffin’ and and *Sambucus canadensis* ‘York’. *P. lactiflora* cultivars used in this study were ‘Big Ben’, ‘Bowl of Beauty’ and ‘Festiva’. These three peonies were selected to identify locally available cultivars that could attract *Tiphia* wasps. Peonies secrete extrafloral nectar through the calyx of unopened flower buds, in the selectected viburnum the extrafloral nectaries are located on the leaf margin close to the petiole and in *S. canadensis* the extrafloral nectaries are found on the stems or as modified leaflets along the rachis. A second set of plants was evaluated and this included: *V. dentatum* ‘Blue Muffin’, *V. opulus nanum*, *V. opulus sterile*, *S. canadensis* ‘York’, wild *S. canadensis* and *S. nigra* ‘Blacklace’.

All of the plants selected for the first evaluation attracted the Spring *Tiphia*. No significant differences were found in the mean cumulative number of wasps counted during hourly observations on the peonies, *V. dentatum* ‘Blue Muffin’ and *S. canadensis* ‘York’. *Tiphia* wasps were observed feeding off the extrafloral nectar on all the plants selected. A second set of plants composed of various elderberries and viburnums was evaluated. Significant differences were found in the mean cumulative number of wasps found on the plants. *V. dentatum* ‘Blue Muffin’ attracted the most wasps followed by *S. canadensis* ‘York’. The other elderberries or viburnums tested did not attract many wasps.

The peonies ‘Big Ben’, ‘Bowl of Beauty’ and ‘Festiva’ could be good selections as part of a landscape design that included plants to attract and feed the Spring *Tiphia*. The evaluation of Japanese beetle damage, as described in the following section, suggests that peonies are the best choice for this purpose over the elderberry and viburnum.
Evaluation of ornamental plants as host plants for pest scarab beetles

The presence of Japanese beetles and their degree of feeding injury were evaluated on plants that attracted Spring *Tiphia* wasps. These evaluations were done in July to August 2009. Peonies ‘Big Ben’, ‘Bowl of Beauty’ and ‘Festiva’ together with elderberry ‘York’ and viburnum ‘Blue Muffin’ were evaluated. Groups of four potted plants for each type were arranged in a completely randomized block design with 3 replications for each plant type. During July and first two weeks of August, weekly counts were done of the number of Japanese beetles found on the plants. In addition, on August 14th, three observers rated the percent feeding injury visible on each group of plants. An average for each replicate was obtained from the 3 observers’ data. Along with the evaluation of naturally occurring feeding injury on plants, a test was done where 100 Japanese beetles were caged with a set of plants that included all the aforementioned plants. Five replicates of the caged sets were done and this was set up as a choice experiment. At weekly intervals, 3 observers rated the percent feeding injury observed on each plant type. An average for each plant within the cage was obtained from the 3 observers’ data. In addition to Japanese beetle adult feeding, the selected plants could attract scarab beetles to oviposit nearby them. The area nearby the selected ornamental plants was sampled to quantify the presence of scarab beetle larvae.

Very few Japanese beetles were observed on the selected ornamental plants during the field evaluation. Most of the beetles were observed on *V. dentatum* ‘Blue Muffin’ which received most of the feeding injuries. Nevertheless, the degree of injury on this viburnum was very small relative to other ornamentals that could have more than 60% of leaves with feeding injuries. The evaluation within the cages confirmed this result. The viburnum received the most feeding injury within the cages followed by the elderberry ‘York’. This increased level of injury is likely due to the higher pest pressure placed on the plant (100 beetles per cage). The peonies were free of feeding injuries both in the open field and caged experiments. The grub samples obtained around the plants indicated the presence of Oriental and Asiatic Garden beetle grubs only. Other species were not found. The numbers of Oriental beetle and Asiatic Garden beetle grubs were not significantly different.

Evaluation of ornamental plants as sources of nectar for Summer *Tiphia* spp.

Plants were selected for this evaluation based on their flower arrangement, flowering phenology and ornamental use. One of the plants selected was wild carrot *D. carota*, member of the umbelliferae, because of previous accounts noting that the Summer *Tiphia* feeds on these flowers. The other plants selected included members of the asteraceae such as yarrow *Achillea filipendulina* ‘Moonshine’, *A. millefolium* ‘Pink Grapefruit’, *A. millefolium* ‘Pomegranate’, and *A. millefolium* ‘Sunny Seduction’ and ornamental goldenrod *Solidago cutleri* ‘Goldrush’. For all evaluations, single potted plants were arranged in a completely randomized block design with three replications for each plant type and wasp observations were conducted during August and the first two weeks of September. Wild carrot plants were set out as bouquets of cut flowers. The number of *Tiphia* spp. wasps

![Tiphia wasps on wild carrot](image)
observed nectaring on flowers were recorded during each plant census. *Tiphia* wasps were collected for identification. Data were also collected on the number of other insects (by species and family level) visiting the flowers and were collectively summarized by insect order for each location.

Of the plants selected only the wild carrot attracted a significant number of *Tiphia* spp. individuals in either location. The yarrow selections and the ornamental goldenrod did not attract *Tiphia* wasps except for two times at each location when one wasp was observed on one of the yarrows. In spite of not attracting *Tiphia* spp., the ornamental plants selected did attract a variety of beneficial insects including several types of syrphid flies, bees and bumble bees. The orders most often represented in the data collected were the hymenoptera and diptera. In conclusion, the wild carrot attracted a high number of *Tiphia* wasps often as high or higher in number compared to all of the other hymenoptera observed visiting all of the other flowers. Field observations indicate that *Tiphia* spp. are commonly found on wild carrot plants and occasionally on wild goldenrods. In this experiment, the ornamental goldenrod *S. cutleri* did not attract any *Tiphia* wasps. For now, wild carrot is the only plant identified as a nectar source for *Tiphia* wasps active in late summer. Wild carrot is considered a weed so its usefulness for conservation biocontrol in settings like golf courses or public landscapes might be limited. However, it is an aesthetically pleasing plant (its popular name is Queen Anne’s Lace) that some homeowners or other private entities might find useful. Future work will assess if other members of the Apiaceae could attract these wasps.
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