Washington Report

2014 NCERA-224 State Report
September 28-29, 2014
Hendersonville, NC

WSU Puyallup Ornamental, Christmas Tree and Nursery Stock Program
Personnel, Cooperators and Sources of Support

Project leaders and Staff

Dr. Gary Chastagner, Plant Pathologist (chastag@wsu.edu)
Dr. Marianne Elliott, Research Associate and Sudden Oak Death Education Coordinator
Katie Coats, Research Associate
Andree DeBauw, Ag. Res. Tech. III
Andy McReynolds, Plant Technician II
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David McLoughlin, Technical Asst. I
Jenne Ford, Technical Asst. II
Mark Kurkov, Technical Asst. II

Carly Thompson, Professional Worker I
Anna Gibson, Technical Asst. II

Graduate Students
Andrea Garfinkel, Plant Pathology Ph.D. Degree
Katie McKeever, Plant Pathology Ph.D. Degree
Anna Leon, Plant Pathology Ph.D. Degree
Lucy Rollins, Plant Pathology MS Degree

2014 Student Intern
Zackery Zobrist, CAHNRS Internship

Location of Cooperators
Oregon State University
Michigan State University
Ohio State University
Pennsylvania State University
University of California Davis
University of Alaska Fairbanks
North Carolina State University
Danish Forest and Landscape Research Institute
Norwegian Crop Research Institute
University of Hawaii, Hilo

Major Sources of External Support
USDA NIFA Specialty Crop Research Initiative
USDA Floriculture and Nursery Research Initiative
USDA APHIS
USDA IR-4 Ornamental Program
WSDA Specialty Crop Block Grant Program
WSDA Nursery Research Program
WSDA Christmas Tree License Program
Pacific Northwest Christmas Tree Associations
Washington State Bulb Commission
Northwest Agriculture Research Foundation
Alaska Peony Grower Association
PNW Christmas tree and ornamental bulb and cut flower growers

Outline of Current Ongoing Project.

Christmas Trees and Conifer Nursery Stock Research
Biology and management of the silver fir woolly adelgid [Adelges (Dreyfusia) nordmannianae] on Nordmann fir Christmas trees in western Washington: A series of trials were initiated in 2013 to obtain information on the distribution of this adelgid, its rate of spread, its life cycle in western Washington, the susceptibility of different North American and European species of true firs to this pest, and the effectiveness of insecticide applications in controlling this pest.

Genomic Project: A five-year NIFA supported SCRI project was initiated in 2012 by Christmas tree researchers from Washington State University, North Carolina State University, University of California at Davis, Michigan State University, and Pennsylvania State University to identify and develop genetic markers to identify *Abies* Christmas trees that have superior needle retention and resistance to Phytophthora root rot.

Phytophthora root rot component of genomic project at WSU (Katie McKeever, WSU Plant Pathology Ph.D. Graduate Student): This project is developing information on the *Phytophthora* species that are causing root rot on *Abies* spp. in the major Christmas tree production regions of the U.S. Isolates from this collection will be used to study host susceptibility and host-parasite interactions between true fir and *Phytophthora* species.

Neonectria branch dieback on true firs in the PNW (In collaborated with Dr. Venche Talgø at the Bioforsk, Norwegian Institute for Agricultural and Environmental Research, Plant Health and Plant Protection Division in Ås, Norway): Fir Bark Canker (*Neonectria neomacrospora*) is a newly recognized disease that is causing major damage to true firs (*Abies* spp) in Scandinavia. Since *Neonectria* has been shown to be seedborne, in August 2013 we did a survey natural stands of this species, as well as locations where various firs are grown in these states. Fir bark canker was not found in natural stands of subalpine fir, but it was observed on subalpine fir and 15 other fir species in various cultivate locations in the lowlands in Oregon and Washington. Hosts included *A. alba* (European silver fir), *A. amabilis* (Pacific silver fir), *A. balsamea* (balsam fir), *A. balsamea* var. *phanerolepis* (Canaan fir), *A. bornmuelleriana* (Turkish fir), *A. cephalonica* (Greek fir), *A. concolor* (white fir), *A. fraseri* (Fraser fir), *A. grandis* (grand fir), *A. koreana* (Korean fir), *A. lasiocarpa* (subalpine fir), *A. magnifica* var. *shastensis* (Shasta red fir), *A. nordmanniana* (Nordmann fir), *A. numidica* (Algerian fir), *A. pinsapo* (Spanish fir), and *A. procera* (noble fir). The diseased trees were found in Christmas tree and landscape plantings.

Growth and postharvest needle retention characteristics of balsam fir: In 2008, a replicated common garden field trail was established at WSU Puyallup. We are evaluating the growth and postharvest characteristics of 26 provenances of balsam fir (*A. balsamea)* and eight progeny collections of 'bracted' balsam fir (*A. balsamea* var. *phanerolepis)* from the northeastern U.S. and Canada.

Overview of other Christmas tree genetic trials: In collaboration with Christmas trees specialists at a number of institutions, a series of genetic trials are underway at WSU Puyallup to identify sources of trees that are adapted for Christmas tree production in the PNW. Traits being measured include growth rates, bud break, sensitivity to frost damage, susceptibility to pests and diseases, and postharvest needle retention. The following species are included in one or more current trials: *Abies balsamea* (balsam fir), *A. balsamea* var. *phanerolepis* (Canaan fir), *A. bornmuelleriana* (Turkish fir), *A. concolor* (white fir), *A. equi-trojani* (Trojan Fir), *A. fraseri* (Fraser fir), *A. grandis* (grand fir), *A. koreana* (Korean fir), *A. magnifica* (California red fir), *A. magnifica* var. *shastensis* (Shasta red fir), *A. nordmanniana* (Nordmann fir), *A. procera* (noble fir), and *Pseudotsuga menziesii* (Douglas-fir).

Quantification of *Fusarium commune* in Douglas-fir nurseries using real-time PCR (Anna L. Leon, WSU Plant Pathology Ph.D. Graduate Student)**:** The goal of this project is to develop an easy, rapid method of quantifying *Fusarium commune* and distinguishing it from populations of *Fusarium oxysporum* in the field in an effort to improve the management of root rot in commercial nurseries.

Potential effectiveness of hot water dips in killing slugs in exported Christmas trees: Live slugs continue to be intercepted in Hawaii from containers of certified manually and mechanically shaken Christmas trees from the PNW. During the past couple of years, the Hawaii Department of Agriculture (HDA) has given importers the option of treating trees in containers with intercepted regulated pests with a hot water shower treatment that was originally developed to treat plants to control the spread of the coqui frog, an invasive pest that is already present on a number of island in Hawaii. In 2013, a project was initiated to determine crop tolerance and the minimum temperature and expose duration needed to kill slug with hot water dips.

Sudden Oak Death

Comparison of five detection and quantification methods for *Phytophthora ramorum* in stream and irrigation water (Lucy Rollins, WSU Plant Pathology M.S. Graduate Student): Propagules of *Phytophthora ramorum*, the causal agent of sudden oak death (SOD) and ramorum blight, can be recovered from infested stream and nursery irrigation runoff using baiting and filtration methods. Five detection methods, including pear and rhododendron leaf baits, Bottle O' Bait (BOB), filtration and qPCR performed on zoospores trapped on a filter were compared simultaneously in laboratory assays using lab or creek water spiked with known quantities of *P. ramorum* zoospores to determine the detection threshold for each method and to verify which methods could be used to quantify inoculum density. In creek water, filtration and qPCR methods had the lowest detection thresholds: between 1 and 10 direct plate colony-forming units per liter (DP CFU/liter); leaves and leaf disks had detection thresholds between 1 and 35 DP CFU/liter while pear baits had the highest detection threshold, between 10 to 35 DP CFU/liter. Filtration, qPCR and leaf disks were able to quantify *P. ramorum* zoospores ranging from 1 to 400 DP CFU/liter; however, precision was lost at higher inoculum concentrations. The ability to detect and quantify *P. ramorum* inoculum in water will assist scientists, regulatory agencies and nursery personnel in assessing the risk of using untreated infested water for irrigation.

Inoculum threshold for *Phytophthora ramorum* in irrigation water required for infection of rhododendron leaves (Lucy Rollins, WSU Plant Pathology M.S. Graduate Student): The concentration of *Phytophthora ramorum* zoospores needed in irrigation water for infection of nursery hosts is not well understood. To determine the inoculum threshold, a novel measured-inoculum spray applicator (MISA) was constructed to apply pressurized zoospore suspensions of *P. ramorum* to wounded detached rhododendron leaves under controlled laboratory conditions. The pressurization and spraying of *P. ramorum* zoospores out of the MISA did not significantly affect zoospore viability or infectivity on wounded detached rhododendron leaves. The inoculum threshold concentration for infection on wounded detached rhododendron leaves was found to be 51 zoospores/ml in the laboratory assays.

Examining fungicide resistance and pathogenicity among clonal lineages in *Phytophthora ramorum*: Mefenoxam (Metalaxyl-M, Subdue MAXX) is one of the most commonly used chemicals for controlling *Phytophthora* species on ornamentals and other crops. It has been shown to be effective when used preventatively against *P. ramorum* and is inhibitory to both mycelial growth and sporulation. Unfortunately, resistance to this chemical can develop in *Phytophthora* species. The objective of this project is to provide information that may lead to a better understanding of why there has been an increase in occurrence of NA2 and EU1 genotypes in Washington nurseries in recent years, as well as detecting whether *P. ramorum* is developing resistance to mefenoxam (Subdue Maxx) in US nurseries. Phenotypic characters evaluated were aggressiveness (lesion area on detached rhododendron leaves), sensitivity to mefenoxam, relative growth at 10, 20, and 30ºC, and sporulation potential (sporangia and chlamydospore production on rhododendron leaf discs). There was a stronger relationship of phenotypic characters among isolates from a given nursery than among isolates from a given clonal lineage. For example, the EU1 isolates from nursery 41 and its trace-forwards all had some tolerance to the fungicide mefenoxam and high sporulation potential (in particular sporangia production). This may explain why *P. ramorum* has persisted at this nursery in spite of mitigation efforts, and the ease with which it has spread from the nursery to a local stream and in trace-forwards. Conversely, many of the NA1 isolates from nursery 35 and its trace-forwards are weakly aggressive and have relatively low sporulation potential. *P. ramorum* has not been detected in nearby streams or soil on this nursery, suggesting that this strain of *P. ramorum* has not been able to establish and persist at this site. The two EU1/NA2 isolates studied in detail behaved very differently, with one isolate being weakly pathogenic (nwt) and growing at 30ºC, and the other being more aggressive and not growing at 30ºC.

Development of biofiltration systems to reduce the spread of *Phytophthora* inoculum in water: We are partnering with the WSDA, APHIS, and the WSU Puyallup Low Impact Development (LID) Research and Education Center to develop a biofiltration demonstration system that could be used at nurseries to limit the spread of *P. ramorum* and other *Phytophthora* spp. in water. The installation of a biofiltration systems is being installed at a *P. ramorum* contaminated nursery site and field testing of some of the most effective biofiltration methods from lab and column trials will be done in 2015.

Steaming as a method of eradicating *Phytophthora ramorum* and associated *Phytophthora* species in nursery field soil: An environmentally acceptable means of eradicating *P. ramorum* from nursery soils would greatly enhance our ability to mitigate the risk of this regulated pathogen from persisting at nurseries. This project is part of a multi-state APHIS-supported project that involves technology transfer from the National Ornamentals Research Site at Dominican University of California (NORS-DUC) to Washington and Oregon. The objectives of this project are to: 1) Demonstrate the effectiveness of steam as a means to eradicate soil-borne *Phytophthora*, including *P. ramorum*, from nursery soils; 2) Analyze soil temperature data, including field soil type and longitudinal soil temperature data, in different nurseries; and 3) Combine soil temperature and type data with the steam data to recommend steam standards for different field soils under nursery conditions.

Research Projects at the National Ornamentals Research Site at Dominican University (NORSDUC) in San Rafael, CA

Risk of root-to-root spread of *Phytophthora ramorum* in ornamental production nurseries (In cooperation with Steve Tjosvold, University of California Cooperative Extension, Watsonville, CA and Nina Shishkoff, USDA-ARS, Fort Detrick, MD): We examined the root-to-root spread of *P. ramorum* on *Viburnum tinus*. Results indicate that *P. ramorum* can persist on root systems of viburnum plants. In cases where the plant dies, other organisms colonize the plant material and *P. ramorum* does not sporulate and spread to other plants nearby. When the inoculated plants survive, *P. ramorum* may continue to sporulate and infect other plants. In later sampling times root growth of some plants was extensive and contact with infected roots was more likely to occur. Sporulation on roots was occurring during all sampling times in this experiment, as verified by positive baiting of runoff water. Thus, infection and subsequent spread of *P. ramorum* could be due both to limited movement of inoculum in soil water and from root contacts between the central inoculated plant and surrounding plants in the crate.

Phytophthora ramorum threshold inoculum levels in irrigation water needed for infection of nursery hosts (Lucy Rollins, WSU Plant Pathology M.S. Graduate Student): The objective of this study was to determine the threshold level of *P. ramorum* inoculum that is necessary in irrigation water for infection of Rhododendron, Camellia, and Viburnum plants and infestation of soil. Four inoculum concentrations were applied using a separate MISA for each concentration: high (1,000 to 10,000 zoospores/ml); medium (100 to 1,000 zoospores/ml); low (1 to 100 zoospores/ml); and none (0 zoospores). Plants were exposed to inoculum twice during the one-week inoculation period. Only one positive infection was found on a camellia plant at the highest inoculum concentration. All other plants were negative for *P. ramorum*. The potting media of each pot was baited after 10 weeks to determine whether *P. ramorum* colonized the roots. Positive baits were seen at only the highest inoculum concentration.

Biological suppression of *Phytophthora ramorum* in potting mixes: In this study we are testing the effectiveness of selected commercially available biocontrol organisms to prevent the spread of *P. ramorum* in and from potting mixes in a nursery environment. *P. ramorum* inoculum was applied to all pots in the form of precolonized, sporulating *Rhododendron* leaves placed on the soil surface. Inoculum of selected commercially available biocontrol agents (Cease (*Bacillus subtilus*) and Plant Helper (*Trichoderma atroviride*)) was applied as a soil drench according to label instructions. Treatment efficacy and longevity was measured monthly using Rhododendron leaf baits to test for the presence of *P. ramorum* in leachate from the containers. Due to low recovery of *P. ramorum* from all treatments during the warm season (June - August 2013), the pots were re-treated with biocontrols and re-inoculated with *P. ramorum* in November 2013. The results from the cool season (Dec-Feb) were compared with the warm season (Jun-Aug). There was an increase in *P. ramorum* positive plants during the cool season, from 18% in December to 69% in February. Preliminary results indicate that while there were fewer plants with symptoms in the two biocontrol treatments when compared to untreated, the number of *P. ramorum* positive plants was similar for all biocontrol treatments.

Ornamental Bulb Crops

Integrated management of *Botrytis* on peony cut flower crops (Andrea Garfinkel, WSU Plant Pathology Ph.D. Graduate Student): The WSU-Puyallup peony project has the following objectives: 1) Identify *Botrytis* species associated with gray mold and postharvest decay of peony cut flowers, 2) Determine the progression of *Botrytis* infection throughout the growing season, 3) Determine if *Botrytis* species can be introduced into peony plantings on infested rootstocks, 4) Determine the source of the host-specific *Botrytis* in AK, and 5) Determine if there are differences in fungicide resistance among *Botrytis* populations from peony fields.

Development of a qPCR assay to detect *Rhizoctonia tuliparum*: Studies are underway to complete the validation of a Rtul qPCR assay developed and validated by this group as a reliable *R. tuliparum* diagnostic qPCR assay and to develop a framework/protocol for using Rtul to detect *R. tuliparum* in bulbs.

Development of a qPCR assay to detect *Fusarium oxysporum* f. sp. *tulipae*: The eighth genomic region studied for F.o.t.-unique nucleotide sequence has yielded a successful qPCR assay. Real-Time qPCR primers and a TaqMan probe were designed to bind to the 5' untranslated region of the pg5 endopolygalacturonase gene on chromosome 9. The "Fotul" assay produced an average C_T value of 25.80 when tested on three known *F. oxysporum* f. sp. *tulipae* isolates and a relatively high or no C_T value in non-*tulipae* isolates. ROC (Receiver Operating Characteristic) analysis was employed to determine a Youden's statistic (J) cut-off value; in other words, a C_T threshold value below which samples are considered positive and above which samples are considered negative, of 33.

Effectiveness of reduced-risk and new biocontrol products in controlling diseases on ornamental bulb crops: Working with the USDA IR-4 program and industry representatives, trials are being conducted to determine the effectiveness of 19 fungicides in controlling leaf spot (*Mycospharella macrospora*) on bulbous iris, fire (*Botrytis tulipae*) on tulips, smoulder (*Botrytis narcissicola*) on daffodils, gray mold (*Botrytis spp.*) on peonies, powdery mildew on dahlias, and fire (*Botrytis elliptica*) on lilies.

Identification of efficacious biopesticides and integration of these products into Botrytis disease management programs on ornamental bulb crops: *Botrytis* species on bulb crops tend to be aggressive, host-specific pathogens that can reduce yields by 60% and have the potential to cause the complete pre- and postharvest destruction of cut flowers. Because of the increased interest among new, small growers, we are initiating a project on field-grown peonies, tulips and lilies to examine the effectiveness of integrating applications of biopesticide products in *Botrytis* disease management programs on these crops. The information obtained from the proposed studies will be used to develop integrated *Botrytis* disease management guides for tulips, lilies and peonies.

Other Projects

Adaptability of Dutch Elm-resistant cultivars of elm to Western Washington: As part of the NECRA 224 National Elm Trial, 17 DED-resistant commercially available elm cultivars were planted at WSU Puyallup. We are: 1) Determining the growth and horticultural performance of the cultivars in western Washington, and 2) Determining the relative disease, insect, and abiotic stress tolerance of these cultivars. To date, the most significant finding has been the damage resulting from an ice storm in January 2012. Cultivars that had no damage on any of the trees were ‘Frontier’ (*U. carpinifolia x U. parvifolia*) and ‘New Horizon’ (*U. pumila x U. japonica*). The most heavily damaged was ‘Pioneer’ (*U. glabra x U. carpinifolia*). Based on this information, it is recommended to cultivars such as ‘Pioneer’ should not be planted in areas prone to ice storms.

Pacific Madrone Project: We are studying genetic variability in a range-wide collection of 105 provenances Pacific madrone that were used to establish five (5) common garden plantings in Washington, Oregon, and California. Data is being collected from these common garden plantings to examine genetic variation in the susceptibility of the seedlings to diseases, growth characteristics, and cold tolerance.

Publications, Presentations, Workshops and Field Tours

Publications Since 2013 NCERA 224 Meeting

☐ Chastagner, G. A., K. Coats and A. DeBauw. 2013. Relationship of inoculum level to the development of gray bulb rots on tulips and iris. Acta Phytopathologica Sinica 43 (supplement): O12.008, p. 186.

☐ Chastagner, Gary, Andy McReynolds, and Kathy Riley. 2014. Mid-rotation growth and postharvest needle retention characteristics of balsam fir grown in western Washington. P. 42. In: MacDonald, M. (Ed). Proceedings IUFRO 11th International Christmas Tree Research and Extension Conference. 74 p. August 10-14, 2014. Truro, Nova Scotia.

☐ Landgren, Chal, Gary Chastagner, Ulrick Nielsen. 2014. Results from common source trials of Nordmann and Turkish fir in Denmark and the PNW, USA. P. 32-34. In: MacDonald, M. (Ed). Proceedings IUFRO 11th International Christmas Tree Research and Extension Conference. 74 p. August 10-14, 2013. Truro, Nova Scotia.

☐ McKeever, Kathleen, and Gary Chastagner. 2014. Screening true fir resistance to Phytophthora root rot and structures of *Phytophthora* communities from Pacific Northwest Christmas tree farms. P. 26. In: MacDonald, M. (Ed). Proceedings IUFRO 11th International Christmas Tree Research and Extension Conference. 74 p. August 10-14, 2013. Truro, Nova Scotia.

☐ Chastagner, Gary, Kathy Riley, Andy McReynolds, and Monica Gallucci. 2014. An emerging adelgid pest on Nordmann fir Christmas trees in western Washington. P. 24. In: MacDonald, M. (Ed). Proceedings IUFRO 11th International Christmas Tree Research and Extension Conference. 74 p. August 10-14, 2013. Truro, Nova Scotia.

☐ Talgø, Venche, Gary Chastagner, Andrew Dobson, Arne Stensvand, and Iben M Thomsen. 2014.

☐ Use of shade netting strongly reduces current season needle necrosis (CSNN). P. 27. In: MacDonald, M. (Ed). Proceedings IUFRO 11th International Christmas Tree Research and Extension Conference. 74 p. August 10-14, 2013. Truro, Nova Scotia.

- Chastagner, Gary, and Annie DeBauw. 2014. The effectiveness of reduced-risk and new biocontrol products in controlling fire on lilies. Acta Horticulturae 1027: 2231-239.
- Copes, W. E., B. Barbeau, and G. A. Chastagner. 2014. Chlorine Dioxide for irrigation water treatment. P 251-266. In: Hong, C., G. W. Moorman, W. Wohanka, and C. Buttner (Eds.) 2014. Biology, detection, and management of plant pathogens in irrigation water. 436 p., APS Press, St. Paul, MN.
- Dugan, F. M., S.L. Lupien, C.M. Vahling-Armstrong, G.A. Chastagner, and B.K. Schroeder. 2014. Host ranges of North American isolates of *Penicillium* causing blue mold of bulb crops. Crop Protection 64: 129-136.

Web sites

- WSU Sudden Oak Death Program (http://www.puyallup.wsu.edu/ppo/sod/)
- Pacific Madrone Research (http://www.puyallup.wsu.edu/ppo/madrone/)
- National Elm Trial (http://www.puyallup.wsu.edu/ppo/elm/)

Workshop/Field Days/Tours Organized or Co-0rganized

- Bulb and Cut Flower Section of the 2014 Wilbur-Ellis University, January 21, 2014. Auburn, WA.
- WSU Bulb Growers Field Day, May 14, 2014, WSU Puyallup. Puyallup, WA
- WSU Puyallup tour for students in PlP 525, June 11, 2014

Presentations since 2013 NCERA 224 meeting.

- Chastagner, G. 2013. Biology of waterborne pathogens and the spread of *Phytophthora ramorum* in Washington. Whatcom County 19th Annual Master Gardener Advanced Training Workshop. Bellingham, WA. October 24, 2013.
- Elliott, M., Chastagner, G., Coats, K.P., Dermott, G., and Rollins, L. 2013. Stream monitoring for early detection of invasive *Phytophthora* spp. in Western Washington. Canadian Phytopathological Society - BC Regional Meeting, Pacific Forestry Centre, Victoria, BC. October 29th and 30th, 2013. (Poster)
- Elliott, M., Chastagner, G., Shamoun, S.F., Sumampong, G., Goheen, E., Kanaskie, A., Orre, E., and Bernheisel, A. 2013. Biological control of tanoak and bay laurel resprouts using *Chondrostereum purpureum*. Canadian Phytopathological Society - BC Regional Meeting, Pacific Forestry Centre, Victoria, BC. October 29th and 30th, 2013.
- Elliott, M., Chastagner, G., and Rollins, L. 2013. Detection and mitigation of *Phytophthora* in nursery irrigation and runoff water in Washington State. "Integrated Management of Zoosporic Pathogens and Irrigation Water Quality for a Sustainable Green Industry" 2013 annual meeting Nov. 13-14 Virginia Beach, VA.
- Chastagner, G., Elliott, M., and Coats, K.P. 2013. An overview of *Phytophthora ramorum* in Washington 2013. SOD annual meeting, US Forest Service, Portland OR Dec. 5 2013.
- Chastagner, G. 2014. Peony Cut Flower Production in Alaska. Wilbur-Ellis University, January 21, 2014. Auburn, WA.
- Chastagner, G., Annie DeBauw, and Katie Coats. 2014. Potential New Tools to Manage Foliar Diseases on Tulips, Iris, Daffodils, Lilies and Peonies. Wilbur-Ellis University, January 21, 2014. Auburn, WA.
- Chastagner, G. Kathy Riley, Andy McReynolds, and Monica Gallucci. 2014. An Emerging Adelgid Pest on Nordmann fir Christmas trees in western Washington. Wilbur-Ellis University, January 21, 2014. Auburn, WA.
- Chastagner, G. 2014. Botrytis and Other Pathogens in Alaska Peony Fields. 2014 Alaska Peony Grower Association Annual Conference. January 31, 2014. Anchorage, AK.
- Chastagner, G. 2014. Washington State University Research Overview. 2014 Pacific Northwest Christmas Tree Association Annual Short Course. March Portland, OR.

- Elliott, M., and G. Chastagner. 2014. Overview of WSU SOD research at NORSCUD. 59th Annual Conference on Soilborne Plant Pathogens. March 11-13, 2014. San Rafael, CA.
- Chastagner, G., and Annie DeBauw. 2014. Effectiveness of Reduced-risk and Biocontrol Products in Controlling Fire on Lilies. ISHS III International Symposium on the Genus Lilium. April 2, 2014. Zhangzhou, Fuijan, China
- Chastagner, G. 2014. Ornamental Disease Management Research at Washington State University. Invited seminar at Huazhong Agricultural University and Henan University of Science and Technology. April 7, 2014. Wuhan, China.
- Chastagner, G. 2014. Ornamental Disease Management Research at Washington State University. Invited seminar at College of Agriculture, Henan University of Science and Technology. April 10, 2014. Luoyang, Henan Province. China.
- Chastagner, G. 2014. Overview of Ornamental and conifer disease research at WSU Puyallup. Plant Pathology 525 Ornamental Plant Pathology Tour. June 11, 2014. Puyallup, WA.
- Chastagner, G., Katie Coats, Annie DeBauw, Andrea Garfinkel, and Pat Holloway. 2014. A Complex of *Botrytis* spp Associated With Gray Mold on Peonies. APS Pacific Division Meeting. July 10, 2014. Bozeman, MT.
- Chastagner, G. 2014. Tree Keepability: A Review of Best Practices to Keep Fresh Cut Trees at Their Best. 2014 Pacific Northwest Christmas Tree Association Annual Tree Fair. September 6, 2014, Portland, OR.
- Chastagner, G. 2014. A Review of Christmas Tree Diseases and Management Practices. 2014 Pacific Northwest Christmas Tree Association Annual Tree Fair. September 6, 2014, Portland, OR.
- McKeever, K., and G. Chastagner. 2014. Regional Variation of *Phytophthora* Species from U.S. Christmas Tree Production Areas. 62nd Western International Forest Disease Work Conference (WIFDWC). September 9, 2014. Cedar City, Utah.

Scientific and Advisory Meetings/Workshops Attended

- 58th Annual Conference on Soilborne Plant Pathogens. March 11-13, 2014. San Rafael, CA.
- ISHS III International Symposium on the Genus Lilium. March 31/April 3, 2014. Zhangzhou, Fuijan, China.
- APS Pacific Division Meeting. July 8-11, 2014. Bozeman, MT.
- Washington State Department of Agriculture Christmas Tree License Program Advisory Meetings. April and September, 2014. Olympia, WA
- IR-4 Food Use and Biopesticide Workshops. September 9-10, 2014. Atlanta, GA

News Releases, Media Interviews and Stories: Information was provided to a number of internal and external media sources relating to the WSU Puyallup Christmas tree research program. Interviews included AP, Capital Press, Chemical and Engineering News, Oregon Public Broadcasting, Northwest Public Radio, Illinois Public Media/NPR, Seattle PI.com, Puyallup Herald, Washington State Magazine, Men’s Health, Wordpress.com, AgInfo.net, Onset Computer Corporation Podcast, and Al Jazeera America TV. Allen G. Breed, an AP National Writer/Video Journalist did a story on Phytophthora root rot. Following the release of this story on December 2nd, there were about 800 posts of the story within 48 hrs in other media outlets such as MSNBC, NBC, CBS, Today, USA News, and Huffington Post.

NCERA 224: Insects and Diseases of Woody Ornamentals

Michigan Report

Dave Smitley, November 7, 2014

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Growing Nursery and Greenhouse Plants Safe for Pollinators in the Yard and Garden.

In 2013 and early 2014 a media campaign organized mostly by Friends of the Earth and the Organic Consumers Organization targeted garden centers as selling 'toxic plants'. The campaign gathered considerable press coverage, and many consumers appear to be worried about the safety of plants that they buy in garden centers. The rationale for the protests apparently arose from the temporary ban of neonicotinoid insecticides in Europe because of the perceived negative impact on honey bees. Extensive research on honey bees indicates that recent bee decline problems are mostly due to varroa mite and several bee diseases, with the role of neonicotinoids in field crops still being uncertain. Plants purchased in garden centers are unlikely to have any impact on managed honey bee colonies, and in fact, probably increase food resources for bees. A team of researchers and educators was assembled by Smitley at MSU to: (1) develop a communications strategy for informing consumers about the safety of garden center plants to bees, (2) identify nursery production practices and landscape maintenance practices that could be harmful to pollinators, (3) develop alternative practices that are safe to bees and other pollinators, and (4) design a set of experiments to determine the hazard of imidacloprid soil drenches to pollinators, using bumble bees as the test species.

Potential Impact on Michigan Nursery/Ornamental Horticulture Industry:

Michigan is a leading state for growing ornamental trees, shrubs and perennials, with annual sales estimated at $291 million. Also, the Michigan landscaping, sod production and lawn care industries contribute $1.2 billion, annually to the Michigan economy (Michigan Specialty Crops 2013). Most of the perennials, trees and shrubs are sold to retail stores and garden centers. Media articles suggesting that garden center plants are “toxic to bees” could affect sales during the peak garden center sales period in the spring and early summer. Even a 10% decrease in sales would cause of loss of $29.1 million per year in sales.

Progress Report

Three nurseries were interviewed to determine the most critical pest control practices where alternatives to a neonicotinoid insecticide is needed. A list of of pest problems was compiled and alternative products recommended. Smitley worked with the regional horticulture agents to develop a new Nursery Insect Management bulletin that gives guidelines on management of the most important nursery pests, including the identification of neonicotinoid products, and alternatives to them. The survey results, list of alternative products and the ne Nursery Insect Management bulletin are given at the end of this report.

Summary of Experimental Results in 2014

An experiment with hanging baskets with flowers attractive to bees was conducted in 2014. Half of the baskets were drenched with imidacloprid at 5 weeks before the finish date. All baskets were placed in one of sixteen screen cages with a bumble bee colony in each cage. Bumble bees were confined to the screen cages with treated or control plants for 3 weeks. No significant impact was observed on the bumble bee colonies.

In another experiment flowers were sprayed with imidacloprid at 1, 2 and 4 weeks prior to shipping. Analysis of dislodgable residues of suggest that sprays applied to flowers at 4 weeks or more before shipping will be safe for pollinators. Sprays applied at 1 week or less before shipping could be harmful to pollinators, and sprays applied at 2 weeks before shipping are mostly safe for pollinators, but it depends on the type of plant being sprayed.

Linden trees maintained at the MSU forestry farm in pot-in-pot containers sunk into the ground were treated with a basal soil drench of imidacloprid immediately after petal fall, or were drenched with water as a control treatment. Next June these trees will be placed in screen tents with colonies of bumble bees.

A National conference on ‘Protecting Pollinators in the Ornamental Landscape’

Smitley worked with three Extension educators in Michigan and Steve Frank in North Carolina to organize a national conference scheduled for October of 2015. Research and education leaders will be giving a series of key note presentations on: (1) the diversity and importance of pollinators in the ornamental landscape, (2) native pollinators, (3) impact of production practices on pollinators in the landscape, and (4) strategies for protecting pollinators during production and in the landscape. An announcement for the conference is attached.

Team Members: Dave Smitley (Professor of Entomology and Landscape Industries Extension Specialist), Erik Runkle (Professor of Horticulture), Brigit Behe (Professor of Horticulture), Zachary Huang (Professor of Entomology), Heidi Wollager (Regional Extension Educator), Kristin Getter (Regional Extension Educator), Tom Dudek (Regional Extension Educator), Mary Wilson (MSUE state-wide coordinator of Master Gardener program), Terrance Davis (Entomology research technician III), Joy Landis (Entomology communications specialist), Holly Whetstone (AgBioResearch Communications), Douglas Brinklow (ANR Communications director), and Beth Steuver (ANR Communications Specialist), the Michigan Floriculture Growers Council and the Michigan Nursery and Landscape Association.

Nursery Insect Management 2014/2015

David Smitley

Michigan State University

September 17, 2014

Scouting

In hoop houses and greenhouses scout for thrips and whiteflies with yellow sticky cards. Change cards once per week. Use at least one card per house or one per 2,000 ft^2. Also check the first plants to flower for thrips. For spider mites and aphids look for shed skins, leaf stippling and leaf curling on the most susceptible plants.

Systemic insecticides

Kontos, Mainspring, Imidacloprid*, Flagship*, and Safari* can all be applied to the soil surface as a drench for uptake by plant roots and systemic movement throughout the plant. The only soil systemic insecticides available at this time that are NOT neonicotinoids are Kontos and Mainspring.

Neonicotinoid insecticides

Insecticide products that contain a neonicotinoid active ingredient are marked in this bulletin by an asterisk (*) immediately after the product name.

Imidacloprid products

Many imidacloprid* products are now available for use in the greenhouse and nursery. Wherever imidacloprid* is mentioned, any of the following products could be used: Bounty*, Discus*, Imidacloprid 2F Nursery & GH*, Lada 2F*, Marathon II*, Amtide Imidacloprid*, Imigold*, Mantra 1G*, or Benefit*. Other imidacloprid products may also be labeled for ornamental plants.

Making sure an insecticide is labeled for use on your nursery plants

EPA requires that the site is listed on the label. For example, if you are spraying burning bush for spider mites, the product label should say that it can be used on burning bush. Some labels have a more general category of woody ornamentals, nursery plant production or ornamentals. In addition all pesticide products used in Michigan must also have a state of Michigan registration. All the products listed in this bulletin have a federal label that includes ornamental plants, and a registration for the state of Michigan. See MDARD for more detailed questions about products labeled for use in greenhouses.

Phytotoxicity

Some insecticides are safe to spray on most plants, but may be toxic to certain groups of plants. A list of sensitive plants or a precautionary statement often appears on the product label. Precautionary statements for most of the products listed in this bulletin are given in the wall chart: ***'Insect Controls for the Greenhouse Industry', MSU Extension Bulletin E-2696***. Phytotoxicity may cause leaf margin necrosis, leaf spots, yellowing, stunting and a variety of symptoms. Diagnosing phytotoxicity is done best by comparing new plant growth after the insecticide was applied with older leaves that were sprayed, and by looking for patterns of damage that match spray patterns. It is always wise to spray a few plants and wait one week to see if there is any plant reaction to the insecticide.

Insecticide products for key nursery pests

Aphids, psyllids and spittlebugs

- ***Soil drench***

Kontos, Imidacloprid*, Flagship*, Safari*, Imidacloprid*, or Mainspring[1]

- ***Foliar spray when aphids are first found***

Aria, azadarachtin[3] (Aza-Direct, AzaGuard, Azatin O), Imidacloprid*, BotaniGard, Distance, Endeavor, Enstar II, Flagship*, Ornazin, Orthene 97, Precision, Safari*, or Tristar*. Talstar, Scimitar, Tame, Decathlon and other pyrethroid insecticides also work well if resistance is not a problem.

Armored scales (Euonymus scale, pine needle scale, Oysterhshell scale, etc.)

- ***Foliar spray***

Distance or a 2% horticultural oil when crawlers begin to emerge.

Black vine weevil

・***Incorporate into the container substrate as instructed on the label***

Talstar

・***Soil drench***

Kontos, Imidacloprid*, Flagship*, Safari*, or Mainspring[1] in July

Broad mites and cyclamen mites

・***Soil drench***

Kontos

・***Foliar spray***

Avid, Akari, Judo, Kontos, Pylon, SanMite, or 2 % horticultural oil. Reduce humidity in greenhouse, hoop house, or holding area to below 80% if possible.

Fungus gnats

・***Soil drench***

Azadarachtin (Aza-Direct, AzaGuard, Azatin O), Adept, Imidacloprid*, Distance, Flagship*, Tristar* or Safari*. Repeat once every 6 weeks, if necessary.

Japanese beetle compliance program

Contact your MDARD inspector for information about soil sampling or to confirm treatments needed for the states where you are shipping. For ornamental grasses Talstar can be incorporated into the growing substrate or applied as a soil drench that wets the entire growing substrate, as specified in the Japanese beetle harmonization plan. See MDARD for details.

Mealybugs:

・ ***Foliar spray***

Aria, Flagship*, Mainspring[1], Orthene 97, Safari*, Talus or Tristar*. Talstar, Astro or Decathlon also work well if resistance is not a problem.

Root aphids:

・***Soil drench***

Kontos, Imidacloprid*, Flagship*, Safari*, or Mainspring[1]

Soft scales (*Lecanium* scale, cottony maple scale, magnolia scale, etc.)

· ***Soil drench***

Kontos, Imidacloprid*, Flagship*, Safari*, Imidacloprid*, or Mainspring[1]

· ***Foliar spray when crawlers emerge***

Aria, Imidacloprid*, Orthene 97, Safari*, Tristar*, Talstar, Astro, or Decathlon.

Spider Mites

· ***Foliar spray***

Akari**,** Avid, Floramite, Hexygon, Judo, Kontos, Ovation, ProMite, Pylon, Sanmite, Shuttle-O, Tetrasan, or Ultiflora

Thrips

· ***Foliar spray***

Mainspring[1], Mesurol, Orthene 97, Overture, Pedestal, Pylon, Rycar, Sanmite, or Tolfenpyrad[2] (also available as HachiHachi[2], and Torac[2])

Whiteflies

· ***Soil drench***

Kontos, Imidacloprid*, Flagship*, Safari*, Imidacloprid*, or Mainspring[1]

· ***Foliar spray when whiteflies are first found***

Aria, azadarachtin (Aza-Direct, AzaGuard, Azatin O), BotaniGard, Distance, Endeavor, Enstar, Kontos, Ornazin, Orthene 97, Pedestal, Precision, Safari, Sanmite, Talus, Judo.

White grubs

· ***Incorporate into the growing substrate as instructed on the label***

Talstar

· ***Soil drench***

Imidacloprid*, Flagship*, Safari*, or Mainspring[1] in July.

***NOTE: More information is available on the Wall Chart, 'Insect Controls for the Greenhouse Industry', MSU Extension Bulletin E-2696.

[1] Mainspring contains cyantraniliprole. It is expected to be available beginning in fall of 2014.

[2]Do not use Tolfenpyrad, HachiHachi, or Torac (all contain tolfenpyrad) on New Guinea Impatiens or Impatiens. Tolfenpyrad is also phytotoxic to to some species of *Ageratum*, *Colocasia*, *Geranium*, *Lobelia*, *Pansy* (flowers), *Verbena*, and *Vinca*.

[3]Note: because of the short residual activity of azadarachtin, sprays may be needed once every three days until whitefly is under control.

Acknowledgements

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State Report

Project: NCERA-224: IPM Strategies for Arthropod Pests and Diseases in Nurseries and Landscapes

State: South Carolina

Report period: 10/1/2013 – 9/30/2014

Principal Investigator:

Juang-Horng "JC" Chong

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OUTPUTS/ACCOMPLISHMENTS:

Objective 1*: New and emerging pests: Investigate detection methods, biology, and management of new and emerging pests*

Study 1. Species diversity and seasonal activity of native and exotic bark and ambrosia beetles in three habitats

Collaborator: John Weaver (USDA-APHIS-PPQ), Laurie Reid (SC Forestry Commission)

A study was initiated in 2011 and currently on-going to determine the species diversity and seasonal activity of the native and exotic bark and ambrosia beetles in ornamental plant nurseries, native forests, and botanical gardens in South Carolina. A total of 82 bark and ambrosia beetle species, as well as 26 roundheaded borer species, 8 flatheaded borer species and 4 wood wasp species, were detected in the three habitats. Adult seasonal activity was also determined for these species and will be used in developing borer management programs in various habitats.

Objective 2*: Pesticide technology development: Evaluate effectiveness of reduced–risk pesticides, biopesticides, new and novel chemistries, and application technologies for control of key disease and arthropod pests of landscapes, nurseries, and Christmas trees*

Study 2: Efficacy of cyflumetofen (Sultan) in outdoor and greenhouse ornamental plant productions

Collaborator: Kathie Kalmowitz (BASF)

Cyflumetofen is a miticide of beta-ketonitrile derivative that inhibits mitochondrial complex II electron transport chain (IRAC MOA # 25). The chemistry was recently introduced as Sultan into the ornamentals market by BASF for the management of spider mites (Tetranychidae). A series of indoor and outdoor experiments were conducted to evaluate the efficacy of cyflumetofen applied at various rates. Results suggested that Sultan applied at the label rate of 13.7 fl oz/100 gal, as well as lower rates of 9 and 7 fl oz/100 gal, was highly effective in eliminating the twospotted spider mite population in both indoor and outdoor productions. The motile population (nymphs and adults) was eliminated within 3 days and the eggs within 7 days. The product appeared to have residual of at least 28 days.

Objective 3*: Pesticide alternatives: develop management strategies for key pests based on classical biological control, host plant resistance and cultural control*

Study 3: Field acute and residual toxicity of cyflumetofen against the predatory mites

Collaborators: James Bethke (University of California Cooperative Extension), Kathie Kalmowitz (BASF), Lance Osborne (University of Florida – Apopka)

This study was initiated in 2013 and is repeated in 2014. The same experimental protocol was developed and implemented by collaborators at three locations in the country to investigate the residual and acute toxicity of cyflumetofen against two of the most frequently used predatory mite species (*Phytoseiulus persimilis* and *Amblyseius swirskii*). The acute toxicity was tested by treating plants with the two predatory mite species 1 day after the release. Toxicity of 1-, 3-, 7- and 14-day residue was also tested by releasing the predatory mites on treated plants at the prescribed intervals. Cyflumetofen applied at 6.5 and 13 fl oz/100 gallons appeared to be compatible with both *P. persimilis* and *A. swirskii* where survival rates of the predatory mites on treated plants were similar to those on the water-treated plants. Future studies will be conducted to determine the effects of the chemistry on predatory reproduction.

Objective 4*: Technology transfer: Develop and deliver science-based educational materials focused on management of key pests through outlets such as mass media, publications and fact sheets, eXtension.org and social media*

Study 4: Development of a handbook of wood boring insects of ornamental trees and shrubs of the eastern US

Collaborators: Karla Addesso (Tennessee State University), Joshua Basham (Tenessee State University), Alicia Bray (Central Connecticut State University), Emily Dobbs (University of Kentucky), Steven Frank

(North Carolina State University), Dan Gilrein (Cornell University Cooperative Extension), Matt Ginzel (Purdue University), Frank Hale (University of Tennessee), Dan Herms (Ohio State University), Bill Klingeman (University of Tennessee), Joseph Lampley (Tennessee State University), Jonathan Larson (University of Kentucky), Deb McCullough (Michigan State University), Venessa Muilenbeurg (Ohio State University), Jason Oliver (Tennessee State University), Randy Ploetz (University of Florida), Dan Potter (University of Kentucky), Christopher Ranger (USDA-ARS), Laurie Reid (SC Forestry Commission), Sarah Vanek (University of Kentucky), Andrew Young (University of Tennessee), Nadeer Youssef (Tennessee State University)

A handbook that will assist growers, landscape care professionals, arborists, ground managers and extension personnel in diagnose, identify, monitor and manage common wood boring insects of ornamental trees and shrubs in the eastern United States is being prepared. About 45 most commonly encountered species and various chapters on IPM, monitoring, pheromone and kairomone communications, disease and invasive species are included in the handbook. Currently, 28 out of the 46 chapters have been prepared. The project was initiated in 2012 and will continue until the handbook is completed and published. The Entomological Society of America has approved the handbook to be published as part of the ESA Handbook series.

OUTCOMES/IMPACTS:

Bark and ambrosia beetles are important pests of ornamental plant and silvicultural productions, as well as in urban forestry. In ornamental plant nursery of South Carolina, damage by the granulate ambrosia beetle can reach as high as 13% of susceptible tree species stocks in some years. Management of the ambrosia beetle relies on well-timed applications of pyrethroid insecticides. Current management recommendation includes monitoring the spring adult flight using an ethanol trap, and weekly or biweekly applications of bifenthrin or permethrin to the trunk of the susceptible trees as soon as adult beetles are captured in the ethanol trap. Preventive application timed to the adult flight in the spring can reduce the damage to 1%. Applications of systemic insecticides have not been effective in numerous trials. A better understand of the species richness and seasonal activity of bark and ambrosia beetle can inform ornamental tree growers, foresters, plant managers and landscape care professionals on potential pest species in the local and the best timing for preventive application of insecticides.

Through studies conducted in South Carolina and else where, cyflumetofen (marketed as Sultan) has been shown to be an effective chemistry against the twospotted spider mite and other mite species in the family Tetranychidae. The product is extremely effective and has 28-day residual when applied at the label rate of 13.7 fl oz/100 gal. Studies also showed that the efficacy did not diminish when the product is used in outdoor nursery plant production. This is a welcome addition to the arsenal of miticides in the ornamentals industry because it is effective against all life stages of spider mite, with long residual and represents a new mode of action that could be easily incorporated in a miticide rotation program.

Cyflumetofen is a compatible chemical for the predatory mites *P. persimilis* and *A. swirskii* in a multi-state project. The results suggested cyflumetofen could be used without significant negative impact on *A. swirskii* and *P. persimilis* when these predatory mites are used in biological control programs against whiteflies, thrips and twospotted spider mite in greenhouses and nurseries. Therefore, cyflumetofen can be safely incorporated into a comprehensive, multiple-target IPM system in ornamental plant production systems.

The handbook on wood boring insects of ornamental trees and shrubs of the eastern US is expected to become an important reference for producers and managers of ornamental plants, as well as extension personnel. There are few, if any, comparable source of information or publication, particularly considering the inclusion of many useful and informative photographs.

PUBLICATIONS:

Refereed:

Chong, J.-H. and E. R. Camacho. 2014. Distribution, host plants and life cycle of *Melanaspis deklei* (Hemiptera: Diaspididae) in South Carolina, U.S.A. Acta Zoologica Bulgarica, Supplement 6: 13-19.

Chong, J.-H., L. F. Aristizabal, and S. P. Arthurs. 201_. Biology and management of *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae) on ornamental plants. Journal of Integrated Pest Management (in review).

Robayo Camacho, E., and J.-H. Chong. 201_. Voltinism and crawler emergence timing in soft scale insects (Hemiptera: Coccidae). Journal of Integrated Pest Management (in review).

Extension:

Robayo Camacho, E. and J.-H. Chong. 2014. Camellia scale, *Lepidosaphes camelliae*. The South Carolina Nurseryman May/June 2014, pp. 18-19.

Chong, J.-H. and E. Robayo Camacho. 2014. Oak lecanium scale, *Parthenolecanium quercifex*. The South Carolina Nurseryman January/February 2014, pp. 18-19.

Chong, J.-H. and E. Robayo Camacho. 2013. Gloomy scale, *Melanaspis tenebricosa*. The South Carolina Nurseryman. November/December 2013, pp. 26-27.

Eric J. Rebek

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NCERA 224 Meeting

September 28-29, 2014

Hendersonville, NC

Annual Report: Pests of Horticultural Crops in Oklahoma

Redbud Leaffolder Outbreak Continued in 2014. Oklahoma has experienced a sustained outbreak of redbud leaffolder, *Fascista cercerisella*, since 2012. This caterpillar pest attacks our state tree, redbud, *Cercis canadensis*. While feeding damage is not detrimental to healthy hosts, leaf folding and subsequent defoliation reduce the aesthetic quality of landscape trees. Normally, I advise landscape managers and homeowners to remove dropped leaves in the fall, thereby reducing the number of overwintering pupae in the landscape. However, pest pressure has been so high in recent years that landscape managers and homeowners have requested insecticide options. At the NCERA 224 meeting, I presented data from an insecticide trial I conducted at Deep Fork Tree Farm in Arcadia, OK in 2009-2010 targeting redbud leaffolder infesting Chinese redbud, *Cercis chinensis* 'Avondale'. This trial investigated the efficacy of anthranilic diamide insecticides (chlorantraniliprole and cyantraniliprole) against caterpillar pests. I won't provide excessive detail from that trial in this report since it was included in my 2012 state report following the NCERA 224 meeting in San Juan, PR. Results of that trial are summarized below.

In 2009, I tested the following foliar-applied insecticide treatments:

Acelepryn (chlorantraniliprole) 1.67 SC at 1 fl. oz. per 100 gal.

Acelepryn 1.67 SC at 2 fl. oz. per 100 gal.

HGW86 (cyantraniliprole) 1.67 SC at 1 fl. oz. per 100 gal.

HGW86 1.67 SC at 2 fl. oz. per 100 gal.

Talstar (bifenthrin) P at 10 fl. oz. per 100 gal.

All treatments were replicated 5 times (i.e., 5 trees) and compared to a non-treated control group in a randomized complete block design. Applications were made on July 23 and evaluations were completed on July 30 (7 DAT). Leaffolder mortality was estimated by opening leaf folds and recording the number of live caterpillars per tree. The second of three generations of redbud leaffolder was present at the time of insecticide application, and a large number of leaffolder webs contained no larvae. Empty webs were formed by first-generation caterpillars that had either completed development or were killed by unknown mortality factors such as predators (e.g., spiders were found in a small number of empty leaffolder webs). On average, Talstar P provided excellent control with 98% reduction in leaffolder numbers compared to the non-treated control (Table 1). Applications of Acelepryn and HGW86 resulted in leaffolder reductions ranging from 62% to 83% compared to non-treated trees (Table 1). For both Acelepryn and HGW86, a higher percentage of caterpillars were controlled when treatments were made at the 2.0 fl. oz./100 gal. rate than the 1.0 fl oz/100 gal rate.

Table 1. Mean number of live redbud leaffolder caterpillars recovered per treatment and percent reduction compared to the non-treated control following foliar application of insecticides.

Treatment/formulation	Rate (fl oz/100 gal)	Mean number of leaffolders (±SE)	Percent reduction
Non-treated check	---	10.4 (3.9)	---
Talstar P 0.67 SC	10.0	0.2 (0.2)	98.1
HGW86-355 1.67 SC	2.0	1.8 (1.6)	82.7
Acelepryn 1.67 SC	2.0	2.6 (2.4)	75.0
Acelepryn 1.67 SC	1.0	3.0 (1.2)	71.2
HGW86-355 1.67 SC	1.0	4.0 (1.6)	61.5

In a separate trial, I investigated the efficacy of soil drench applications against redbud leaffolder and compared fall versus spring drenches of the following treatments:

Acelepryn 1.67 SC at 0.25 fl. oz. per foot shrub height (fall 2009 application)

Acelepryn 1.67 SC at 0.25 fl. oz. per foot shrub height (spring 2010 application)

HGW86 1.67 SC at 0.25 fl. oz. per foot shrub height (fall 2009 application)

HGW86 1.67 SC at 0.25 fl. oz. per foot shrub height (spring 2010 application)

Merit 75 WP (imidacloprid) at 1.9 g per foot shrub height (fall 2009 application)

Merit 75 WP at 1.9 g per foot shrub height (spring 2010 application)

Lepitect (acephate) 97.4 WSP at 5.7 g per foot shrub height (spring 2010 application)

All treatments were replicated 5 times (i.e., 5 trees) and compared to a non-treated control group in a randomized complete block design. All treatments were prepared by mixing the product in a bucket of lukewarm water, yielding a solution volume of 32 fl. oz. per foot of shrub height. Prior to application, I removed all bermudagrass, weeds, and mulch from around the base of each shrub to maximize root uptake of each treatment. Treatment solutions were then applied to the soil around each shrub at the root flare. On August 31, 2010, caterpillar abundance was estimated by counting the number of leaf rolls per tree.

On average, the number of damaged leaves was lowest on shrubs treated with HGW86 and Acelepryn in fall 2009 and spring 2010 (Table 2). Shrubs treated with Merit resulted in 67% and 76% reduction in webs for fall and spring applications, respectively. Lepitect had no effect on redbud leaffolder caterpillars and control was less than 1% (Table 2). A high level of caterpillar control can be achieved with soil applications of anthranilic diamides in the fall or spring, offering the tree care specialist flexibility in timing of treatments. It is not surprising that soil drenches of imidacloprid (Merit) were not very effective since this neonicotinoid insecticide does not have much activity against caterpillar pests. In hindsight, acephate (Lepitect) should have been applied as a soil drench several more times in 2010 since this organophosphate insecticide does not have long residual activity.

Table 2. Mean number of redbud leaffolder webs recovered per treatment and percent reduction compared to the non-treated control following soil drench application of insecticides.

Treatment/formulation	Rate (amt./ft shrub ht.)	Mean number of leaffolder webs (±SE)	Percent reduction
Non-treated check	---	104.0 (40.9)	---
HGW86 1.67 SC (fall)	7.4 ml	3.0 (2.1)	97.1
HGW86 1.67 SC (spring)	7.4 ml	3.8 (2.5)	96.3
Acelepryn 1.67 SC (fall)	7.4 ml	4.5 (4.2)	95.7
Acelepryn 1.67 SC (spring)	7.4 ml	6.3 (8.8)	93.9

Merit 75 WP (spring)	1.9 g	25.5 (17.7)	75.5
Merit 75 WP (fall)	1.9 g	34.3 (32.9)	67.0
Lepitect 97 WSP (spring)	5.7 g	103.3 (102.6)	0.01

IMPACTS: Current management strategies for webworms and leaffolders involve the use of organophosphates, pyrethroids, and carbamates. Landscape and nursery professionals need alternative chemistries to replace and/or rotate with these conventional chemistries. Products containing chlorantraniliprole and cyantraniliprole show promise for control of leafrollers, especially when used as a soil drench. They also show promise as environmentally friendly products that do not harm pollinators that visit flowering ornamental plants. However, products containing these active ingredients are expensive, but the small amount of product needed to be effective may offset the high cost at time of purchase. Nevertheless, recommendations to tree care specialists need to include integrated management strategies for redbud leaffolder, including sanitation, pruning, and the use of microbial insecticides (e.g., Bt).

First State Reports of Arthropod Pests in Oklahoma for 2014. Spotted wing drosophila, *Drosophila suzukii* was first found in a berry orchard near Tulsa in June 2013. This first state record has been modified to June 2012 with a Panhandle pitfall find in Beaver Co. Dr. Jackie Lee and I conducted survey work in 2014 using fermentation traps in vineyards and berry orchards throughout the state. Our work revealed this pest to be widely distributed throughout the state; every vineyard and orchard surveyed had positive finds of spotted wing drosophila (Figure 1). Although not a pest of ornamental plants, this fruit fly poses significant risk to viticulture, berry, and vegetable production in Oklahoma.

IMPACTS: Small fruit and potentially vegetable growers need to know where this direct pest is distributed in Oklahoma and if it will be a threat to their crops. Our work has delineated the distribution of spotted wing drosophila in major grape- and berry-producing counties in Oklahoma. Further investigation will help reveal pest density, behavior, and overwintering habit that can be used for management recommendations.

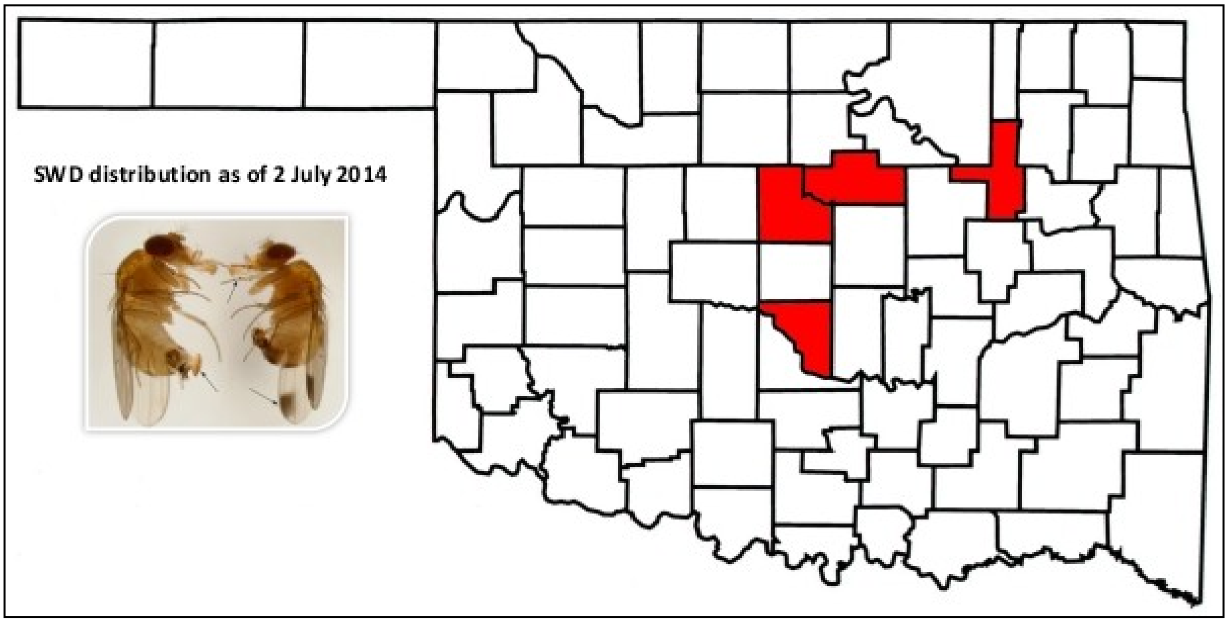

Figure 1. Map of counties where SWD has been detected as of July 2014.

First reports of ornamental insect pests in Oklahoma include daylily leafminer, *Ophiomyia kwansonis*, discovered in August 2013 at a nursery; (Asian) hackberry woolly aphid, *Shivaphis celti*, discovered in August 2013; and European pepper moth, *Duponchelia fovealis*, found in September 2013. USDA-APHIS is monitoring for this pest in Oklahoma greenhouses.

Although emerald ash borer, *Agrilus planipennis*, has not been found in Oklahoma, the Oklahoma Department of Agriculture, Food, and Forestry is continuing to monitor for this destructive woodboring pest using purple panel traps and tree surveys. The encroachment of emerald ash borer into neighboring Arkansas has Oklahoma state officials and entomologists on high alert. As an extension entomologist, I am active in educating the public about this pest. I have produced Oklahoma Cooperative Extension Publication, L-443: Signs and Symptoms of Emerald Ash Borer, which is useful in identification of the beetle and the damage it causes to ash trees. I am working on two other extension publications that pertain to ash tree identification and look-alike insects that are often confused with emerald ash borer. These publications should be available in early 2015.

Activity of Key Arthropod Pests of Ornamental Plants in 2014.

The following is a list of key ornamental/landscape arthropod pests reported to be active in Oklahoma from 2013-2014:

Bordered patch caterpillars (*Chlosyne lacinia*), June thru August 2013 – damage to sunflowers

Boxelder bugs (*Boisea trivittata*), much of 2013 – ornamental and home

Cerambycid woodborers (*Neoclytus scutellaris, N. mucronatus*), July-Aug, 2013 – attacking drought-stressed trees

Chittamwood (Bumelia) borer (*Plinthocoelium suaveolens*), June-August 2013

Clover mites (*Bryobia praetiosa*), March-April, 2013-2014 – yards, houses

Common oak moth (*Phoberia atomaris*), April-May 2013 – N to S central OK

Cotton/melon aphids (*Aphis gossypii*), summer 2013-2014 – home gardens

Crape myrtle aphids (*Tinocallis kahawaluokalani*), late summer 2013-2014 – many reports in 2014

Crape myrtle scale (*Eriococcus lagerstroemia*), May-September, 2013-2014 – moving north, now found in Tulsa area

Elm sawfly larvae (*Cimbex americana*), June 2013, adult May 2014

Fall armyworm (*Spodoptera frugiperda*), late summer 2014 – lawn and pastures

Florida fern moth (*Callopistria floridensis*), August 2014 – fern, possible new state record

Flatheaded appletree borer (*Chrysobothris femorata*), summer 2013-2014 – lingering effects of drought and tree stress

Juniper scale (*Carulaspis juniper*), September 2014 – juniper

Kermes scale (*Nanokermes pubescens*?), summer 2014 – oaks, last outbreak in 2012

Leaf beetle (*Phaedon desotonis*), spring 2013-2014 – *Coreopsis*

Morningglory leaf miner (*Bedellia somnulentella*), July 2013-2014

Oak flake cynipid galls (Neuroterus sp.), spring-summer 2013-2014 – burr, chinkapin oaks

Oak lace bugs (*Corythucha arcuata*), summer 2013-2014 – damage appears to be heavy this year, lingering effects of drought stress?

Periodical cicada (*Magicicada septendecim*), late May-June 2014 – not really a pest *per se*, but we observed new range extension for Brood II, farthest west in the US

Redbud leaffolder (*Fascista cercerisella*), summer 2013-2014 – third consecutive year of heavy infestation

Scentless plant bug (*Niesthrea louisianica*), late summer 2013 – rose-of-sharon

Spotted wing drosophila (*Drosophila suzukii*), June-July 2014 – three new county records

Underwing moth caterpillar (*Catocala* sp.), spring 2013 – coincided with common oak moth outbreak

Vein pocket gall (*Macrodiplosis quercusoruca*), summer 2014 – red oak group, heavier than normal reports in 2014

Walnut caterpillar (*Datana integerrima*), summer 2014 – walnut, pecan, heavier than normal reports in 2014

Wheel bug (*Arilus cristatus*), summer 2013-2014 – not a pest, but large number of egg masses and nymphs in 2014, often confused as "red spiders"

Whitemargined burrower bugs (*Sehirus cincta*), May-June 2013-2014 – yards, porches

NCERA -224: Arthropod Pests & Diseases of Ornamentals: Delaware & SE PA

University of Delaware Co-operative Extension:

Brian Kunkel & Nancy Gregory

Regional Weather:

Total precipitation for each county in Delaware was drier from New Castle County (north) to Sussex County (south) this past year (Table 1).

Table 1. Total precipitation for Delaware over past year (December 2013- November 2014)

County	Precipitation (inches)	Departure from Normal (inches)
New Castle	50.9	+6.8
Kent	46.2	+2.2
Sussex	43.5	-1.4

Temperatures during the winter 2013 – 2014 was much colder than those experienced in the previous two years. Spring temperatures were cooler than 2012, and the growing degree days (GDD_{50}) accumulated this year were the lowest in New Castle County since at least 2006. We begin accumulating GDD_{50} starting on 1 March.

Insect and Disease Highlights:

Insects

This year found greater activity of various Curculionids (Scolytidae) such as *Xylosandrus crassiusculus*, **Granulate Ambrosia beetle**, and *Xylosandrus germanus*. We found female activity in nurseries and landscapes in the spring and in the late summer. Typically, we see frass toothpicks in the spring and little evidence of bark beetle activity later in the year.

Common non-pest caterpillars causing incidental damage to various plants included: *Actias luna* (**Luna moth**), *Acharia stimulea* (**Saddleback moth**), and *Orgyia leucostigma* (**White-marked tussock moth**). Caterpillar pests such as *Malacosoma americanum* (**Eastern tent caterpillars**) were more common this year, but not a source of significant damage to trees. The first generation of *Hyphantria cunea (**F**all* **webworms)** were readily seen this summer; however high populations early did not lead to outbreak populations during the second generation in the late summer and fall. *Podosesia syringae* (**Lilac/Ash borer**) emergence holes continue to be confused as emerald ash borer attacks on ash trees (New Castle and Sussex counties). Furthermore, canopy thinning caused by ash rust in the spring also resulted in erroneous claims of EAB infestations in Wilmington (New Castle County). We still have <u>not found</u> emerald ash borer in Delaware. Monitoring for EAB continues by Delaware Department of Agriculture in all counties. **Bagworms**, *Thyridopteryx ephemeraeformis, and Manduca quinquemaculata (**Five-spotted hawk moth**; larvae called **tomato hornworms**) were commonly found this past growing season in all counties.*

Soft scales such as *Ceroplastes ceriferus* (**Indian wax scale**), *Toumeyella liriodendri* (**Tuliptree scale**), and *Pulvinaria* scales (**Cottony Taxus/Camellia Scale, Cottony Maple Scale**), *Eulecanium cerasorum* (**calico**), *Parthenolecanium corni*, *P. fletcheri*, and *P. quercifex* (**European fruit lecanium**, **Fletcher**, and **oak lecanium** respectively) were sent to the lab for identification this year. Indian wax scale populations were high last fall (2013) and an outbreak this summer was expected; however, the cold winter appeared to have significant impact on their populations. Landscape professionals and nursery professionals found significantly fewer living wax scale in the spring.

Many armored scale samples were diagnosed this summer including *Chionaspis pinifoliae* (**pine needle)**, *Fiorinia externa* (**elongate hemlock**), *Aspidiotus cryptomeriae* (**cryptomeria**), *Carulaspis juniperi* (**juniper**), *Melanaspis obscura* (obscure) and *Lopholeucaspis japonica* (**Japanese maple**) scales. Landscape companies continue to report Japanese maple scale as one of their most common and difficult pests to manage.

Other sucking insect pests such as **lace bugs**, and **aphids** were minor problems reported during the year. Greenhouse managers still encounter high populations of *Frankliniella occidentalis* (**Western flower thrips**). This year, *Miscanthicoccus miscanthi (**miscanthus mealybug**) was found at a nursery in Sussex County, and a research trial was conducted looking at entomopathogenic nematodes as possible biological control agents in cooperation with Stanton Gill at the University Maryland.*

Nurseries in the mid-Atlantic continue to struggle with *Systena frontalis* (**redheaded flea beetle)** control. This year multiple trials were conducted targeting larvae and adults as part of IR-4 research efforts and other contracted insect efficacy trials. Populations of *S. frontalis* were high until October. **Roseslug sawflies** were very common in landscapes this year causing considerable damage on roses. Other minor pests encountered this year include, **boxwood leafminer**, and **carpenter bees**. **Japanese beetle** populations were more abundant this summer and emerged about seven to 10 days earlier than previous years.

Select Invasive species

Scouting for **emerald ash borer** continues in Delaware and none have been found to date. **Brown Marmorated Stink Bug** (*Halyomorpha halys*) were rarely encountered on ornamentals in the lansdacape and on nursery stock the entire growing season.

Diseases

Ornamentals constituted approximately 50 % of the total of approximately 725 samples received from October 2013 through September 2014. Of the 380 ornamental plant samples, **physiological** or **environmental stress** was a factor in many samples. Winter injury was particularly pronounced in Leyland cypress and other evergreens, as well as crape myrtle. Approximately 40 samples were submitted as insect identifications. Many landscape ornamentals newly planted in the past 2 or 3 years suffered from environmental stress, often leading to further issues with disease organisms and insects. Excessive rains in the spring and early summer led to **saturated soils** and problems with **root rot** and **establishment of good root systems**. Holly and juniper with **Phytophthora** root rot were common. **Anthracnose** was common on hardwoods, especially Norway maple, in the spring, but trees leafed out again in a few weeks. **Gymnosporangium** rusts were severe on Rosaceous hosts such as pear, hawthorn and serviceberry. Ash rust was extremely severe this season, leading to leaf drop all season.

New Reports – **Impatiens downy mildew** continued to be a problem on *Impatiens walleriana* and *Impatiens balsamina*. A **downy mildew** was confirmed on *Coreopsis*, caused by a *Plasmopara sp*. ***Rhizosphaera kalkhoffii*** was confirmed on blue atlas cedar (*Cedrus atlantica*), but was most likely an opportunistic pathogen following winter stress. This was a first report of this pathogen on *Cedrus* in the U.S. **Tobacco mosaic virus** was detected on petunias, after being widely shipped in the trade, and INSV and TSWV were detected on *Verbena*. A ***Puccinia*** **rust** was found on *Deschampsia* tufted hair grass. **Fusarium oxysporum bulb rot** on *Narcissus* was diagnosed. **Phytophthora root rot** on *Zelkova* was confirmed. **Exobasidium leaf gall** was found on *Camellia*.

Pathogens of regulatory significance – Plants sampled as a part of the Farm Bill Survey and a trace forward for ***Phytophthora ramorum*** were tested serologically and a few sent forward for PCR testing, but all were negative for *P. ramorum*.

Swiss needlecast has become a predominant problem on Douglas fir in Christmas tree and landscape plantings. **Phytophthora root rots** have been widespread due to excessive rains and saturated soils in the spring and summer. **Rose rosette disease** continues to spread to cultivated and hybrid rose plantings.

Some common turf diseases included **red thread** and **brown patch** during the summer, as well as **take-all**.

2013-2014 Publications & Notables

Kunkel and Gregory contributed weekly columns on insects and diseases to *Ornamentals Hotline*, a grower newsletter published and distributed by University Delaware Cooperative Extension to over 150 subscribers. Kunkel contributed articles about various insects and management practices to the local newspaper. Kunkel worked with Stanton Gill on an article about BMSB feeding preferences on herbaceous perennials in the mid-Atlantic. This article is published in the November 2014 American Nurseryman. Kunkel and Gregory continue to work on updating and creating new fact sheets for professionals in the mid-Atlantic region.

The Ornamentals Task Force at the University of Delaware continues to offer training sessions for green industry professionals at their business. The disease and entomology workshops are provided to Delaware green industry professionals in addition to "pest walk" tours in New Castle and Sussex counties. Kunkel and Gregory continue to work with Delaware Christmas tree growers on a project evaluating new Christmas tree variety susceptibility to insects and diseases of the area. Kunkel provided greenhouse IPM training to Future Farmers of America teachers as a summer workshop.

Master Gardener training was also conducted by Kunkel and Gregory.

Gill, Stanton, Brian Kunkel, Karen Rane, Deborah Smith-Fiola and Suzanne Klick. 2014. How Destructive is the Stink Bug? American Nurseryman

2012 -2013 Research Highlights:

Summary of Brown marmorated stink bug (BMSB; *Halyomorpha halys*) project:

- Populations very low
- Very few egg masses found on woody ornamentals at nurseries in DE, NJ, PA
- A few parasitoids were found from an egg mass and are being identified

Summary of Redheaded flea beetle (RHFB, *Systena frontalis*) project:

- Aloft seems to provide some control of larva when sprenched onto potted plants
- Mainspring, Xxpire, Scimitar, Safari all reduced damage from *S. frontalis* feeding compared to controls during trials; however, amount of overall damage to plants may still be significantly more than tolerated by end-user (customer)

Summary of Miscanthus mealybug (*Miscanthicoccus miscanthi*) project:

- Entomopathogenic nematodes provided virtually no control
- Kontos and Safari were the most effective compounds; however control provided did not exceed 30%. An additional trial is underway.

2014 Impact statements

- Forty-five percent of recent workshop attendees learned something new about pesticides including the use of reduce risk products. Ten percent of attendees stated they learned about the proper timing of pesticide applications, and products work better on some pest groups versus others (e.g., B.t. for caterpillars but not sawflies).

- Sixty percent of attendees at a workshop with the general public claimed they would be more tolerant of insect feeding on their plants, and not try to kill every spider found on their property. Eighty five percent of these same attendees said they learned new things about pesticides such as reduced risk products and proper timing to maximize control.

- Eighty percent of attendees claimed to have learned about host specificity for various diseases and that there are differences between signs and symptoms for plant diseases. Everyone attending this workshop learned of cooperative extension services and expressed interest in sending in samples when they encounter problems.

- Forty three percent of Christmas tree growers attending their workshop have changed their management operations regarding needle cast diseases. They learned maximum control of the diseases is obtained with proper timing of fungicides and there are 3-4 applications needed per growing season.