2018 WERA-1017 Annual Meeting
May 16-17, Portland, Oregon

Attending: Paul Jepson, Katie Murray, Rubella Goswami, Frank Peairs, Laura Lavine, Peter Ellsworth, Al Fournier, Naomi Pier, Mark Wright, Karey Windbiel-Rojas, Dave Crowder, Dawn Gouge, John Connett, Marion Murray, Ashley Bennett, Tunyalee Martin, Jim Farrar, Carrie Foss, Amanda Crump, Mary Burrows, Diane Alston, Ronda Hirnyck, Doug Walsh, Cheryl Wilen, Matt Baur, Len Coop, Hans Lu, Bob Schlub, Kathy DeBellis, Casey Matney

Thursday May 17

1.Welcome

- Moment of silence in remembrance of Rick Melnicoe
- Mentioned was opening up this forum/meeting to others outside the current WERA 1017 group

2. ARDP PROJECT REPORTS

Amanda described the PD workshop requirement, the NIFA format requirements, and the plan to report on the 2016 ARDP awards (5 projects). Two projects will present this year (see below) and three will present in 2019 including John Wagner (Colorado State University) on the Development of Integrated Pest Management Strategies for Commercial Dairies: Formulating Dairy Total Mixed Rations that are Resistant to Bird Depredation, Prashant Jha (Montana State University) on the Ecological Management of Kochia in Irrigated Western Cropping Systems, and Katie Murray (Oregon State University) on IPMSPs: Bringing Integration to Pest Management Strategic Plans.

David Crowder (Washington State University) presented on the first year of Improving integrated pest management of wireworms in cereal crops.

- Project targets three wireworm species including sugarbeet (limonius californicus), western field (L. infuscatus), and great basin (Selatosomus pruininus)
- Seed treatments with neonicotinoids are ineffective at reducing soil populations
- The current work focuses on the use of biologicals including Metarhizium anisoplia, Steinernema carpocapsae, combined with diatomaceous earth, pyrethroids, and neonicotinoids
- Research results: in greenhouse and field artificial infestation experiments, Metarhizium anisoplia, Steinernema carpocapsae, and diatomaceous earth increase plant growth and wireworm mortality significantly. Treatment (M. anisoplia or S. carpocapsae) effect was not significant in the first year of small-plot natural infestation fieldwork.
- Also testing the use of in-furrow bifenthrin treatment in peas for carry-over effect in wheat
- extension of the research information through the web site (smallgrains.wsu.edu), podcasts (wheat beat), Washington Wheat Academy, and field days

Doug Walsh, (Washington State University) presented on the first year of Developing and Delivering IPM Strategies to the Rapidly Expanding U.S. Hop Industry.

- Two research objectives focus on pest (insect and pathogen) outbreaks and pesticide use, nutrient management, and frequency of resistance traits

- Six extension objectives will disseminate information about decision aids, best management practices including the importance of starting with clean plant material, MRLs, and the PNW IPM pocket handbook.

3. USDA NIFA Update from Rubella Goswami

- Discussed personnel changes at NIFA including the new EIP co leader (Tesfa Mengistu), appropriation changes for AFRI and SARE, and the change to virtual technical review panels for all programs.
- Highlighted the importance of the NIFA acknowledgement for funding on all outputs and the Share Your Science effort, the NIFA gateway showing funding levels by congressional district, the 2018 NIFA listening sessions, the Food and Agriculture Cyberinformatics and Tools (FACT) initiative, the State Liason Program, and the Tactical Science Initiative
- Highlighted plant-health related programs including Foundational Knowledge of Agricultural Production (Matheiu Ngouajio), Pests and Beneficial Species in Ag Production Systems (Mary Purcell-Miramontes), Critical Agriculture Research and Extension program (Wesley Dean)
- AFRI Education and Literacy Initiative is now the Education and Workforce Development program
- Among the RFAs currently open, the AFRI Education and Workforce Development, and AFRI Sustainable Agriculture Systems were highlighted.
- Rubella requested information about opportunities to see projects/programs in the west

4. WERA 1017 Member updates

Marion presented for Utah

- Vegetable program
    - Outputs include 25 pest advisories for 10,500 subscribers, production guide update, and the decision aid tool with 12 pest models (climate.usu.edu/traps)
    - Impacts: producer monitoring increased by 23%, 40% increase in use of pheromone traps, degree day model use increased by 10%, increased profits realized by 18% of producers surveyed
- Tree fruit program
    - outputs include 2018 tree fruit production guide for intermountain west with pesticide use feature (intermountain.org), and fall fruit school
    - Impacts: 71% of tree fruit producers use IPM, and 21% are high level IPM practitioners
- Other outputs mentioned include community & small farm workshop (50 participants) and school IPM newsletter
- Other highlighted issues/projects were brown marmorated stinkbug damage on peach, popcorn, apple, and squash, a graduate student project on BMSB natural enemies, downy mildew on greenhouse grown spinach, balsam wooly adelgid, elm seed bug, wild hosts for spotted wing drosophila, western cherry fruit fly, validation of codling moth biofix, and the use of biochar in tomato and melon

Ronda presented for Idaho

- CoPDs on the recent EIP include Mark Schwartzlander, Sanford Eigenbrode, and Ronda
- Community IPM, master gardener and PSEP modules to move to online content through eXtension and moodle

- Discussed was the time and expertise required for content development through Adobe Captivate

Mary presented for Montana

- Highlighted outputs included Montana Pestweb with wheat midge and alfalfa weevil reporting (pestweb.montana.edu), pulse PMSP completed (ipmdata.ipmcenters.org), facebook and twitter presence, real estate agent trainings for invasive species, online urban landscape professional certification program, mobile application for diagnostic lab sample submission, private applicator training workshops, herbicide injury workshops
- Impacts include Ag alerts at 1,000 subscribers, urban alerts at 400 subscribers, MSU Fungicide Decision Tool (www.msuextension.org/econtools/fungicide/) at 200 page views, 98% of participants at Private Applicator Training workshops likely to use IPM
- Highlighted problems included new county records for cudweed, teasil, purple loosestrife and others

Jim presented the California report

- Highlighted outputs included coyote catcher (ucanr.edu/sites/CoyoteCatcher) for crowd sourcing incident reports, bed bug demonstration project, insectary plants web page, and podcasts on honeybees and IPM
- Highlighted problems included the Coyote problem in urban areas and San Jose Scale resurgence in cherry in the northern San Joaquin Valley

Ashley presented for New Mexico

- Highlighted outputs include a new demonstration garden built to evaluate new native plant combinations for attracting pollinators, a survey of Master Gardeners about IPM program impacts, pollinator talks, walks, workshop series, and guides
- Highlighted projects included manipulating flower area to study the effects on ecological services, tree surveys in Las Cruces to help park managers solve pest problems, drones to survey parks for tree pests, Master Gardener backyard monitoring for beneficials, and two undergraduate students working on the iPiPE project focused on open spaces and urban farms in Albuquerque and Santa Fe

John presented for Wyoming

- Highlighted outputs include a IPM practice survey for schools (last survey was November 2009), a certificate program for schools using StopSchoolPests training materials, school IPM website (www.uwyo.edu/wyschool_ipm/), annual training program on landscape IPM, the submitted manuscript entitled "Host-parasite ecology of horn flies on black and white cows in high-elevation rangeland", and a mosquito IPM workshop in conjunction with City of Laramie and the Wyoming Department of Health.
- Highlighted activities include linking tribal school districts and health groups to StopPests program, contributed to the biannual Wind River Tribal Health Fair and annual Native American Education Conference on the Wind River Indian Reservation, preparing school IPM bulletins addressing wasps and voles, providing IPM support to University of Wyoming including trainings and in-classroom instruction, developing IPM based infographics, developing school pest Lucid key mobile application, teaching school IPM at Wyoming Department of Agriculture Pesticide Applicator recertification trainings, organize the Entomology Short Course for pest management professionals, organize the National

Grasshopper Management Board meeting, and research work on chickpea cultivars and forage sorghum hybrids.
- Highlighted outcomes include an increase in the number of school districts calling with pest management questions/issues as a result of school IPM training, five of the largest districts choosing non-pesticide solutions to pest problems such as a recent mouse infestation in an elementary school solved by monitoring and prevention (sanitation and exclusion) outlined in their IPM policy, increasing awareness of IPM through social media efforts in concert with Wyoming land management agencies, over 400 insect samples submitted for diagnostics including a new invasive (elm seed bug), 100% positive feedback that the entomology training is useful and pertinent in the Master Gardener Basic and Advanced Entomology training programs at five locations, and community IPM presentations at regional garden clubs and Wyoming Territorial Park's Spring Expo in Laramie to over 500 people.

Mark presented for Hawaii
- Highlighted research on macadamia felted coccid, coconut rhinoceros beetle, a classical biocontrol efforts against a gall forming wasp on Erythrina (willi willi tree), contol bagrada bug on cole crops with mechanical collection, and thrip control in eggplant using a cover crop to attract beneficials, and control of GF120 resistant melon fly
- Highlighted outputs include an advanced IPM training for Master Gardeners, and demonstration projects and extension materials through mini grants ($5-6k per year)

Peter presented for Arizona
- highlighted outputs include "Impact of CPPM funding for AZ" delivered to lawmakers, 12 comments to EPA from AZ informing pesticide registration decisions, crop-pest losses assessment expanding to hazelnut, cherry, and onion
- Highlighted outcomes included 40 people attending the IPM Evaluation Workshop at IPM Symposium, the ethephon comment to EPA from AZ retained the ability to apply six times per year, 66 people attending the school IPM conference, the crop-pest losses assessment in cotton and lettuce covering greater than 65% of the total acreage in Arizona, the crop-pest losses assessment data used to support a Section 18 for sulfoxaflor, the cotton IPM program has now saved producers more than $0.5 billion,
- Highlighted problem was the iron cross beetle in spinach

Frank presented for Colorado
- Highlighted outputs include the school IPM website and monthly newsletter, crop clinic, and fact sheets on Japanese beetle, biological control, small scale food production, residential pests
- Highlighted research included insects pests on industrial hemp, and baseline weed susceptibility data ahead of clearfield wheat release
- Highlighted outcomes included honey bee hobbyist training program headed up by Arathi Seshadri and in collaboration with the Colorado Department of Agriculture expanded into three Colorado counties, and the Mesa County school district added to the IPM program (this is the last of the large Colorado school districts)

Casey presented for Alaska
- Highlighted pest problems included Lygus and Botrytis on peonies, spruce bark beetle, and spruce aphid and pest problems in high tunnels

- EIP funded program will focus on community IPM, livestock IPM, peonies and cover crops (to reduce Botrytis and increase nutrient retention)

Bob presented for Guam
- Highlighted work on anthracnose on cucurbits, viruses in tomato, little fire ant, coconut rhinoceros beetle, and ironwood decline

Doug presented for Washington agriculture
- Highlighted the new quarterly newsletter (ipm.wsu.edu/newsletter) and the new apiculturist Brandon Hopkins

Carrie presented for Washington urban and community IPM
- Highlighted outputs included videos on Phytophthora ramorum (recently discovered in Washington), eleven courses on IPM training for landscape pesticide applicators
- Highlighted efforts to develop a certification program for sustainable urban landscapes

Paul presented for Oregon
- Highlighted outputs included the iPMSPs and crop pest losses survey tool, and "Fall armyworm in Africa: A guide to IPM"

Western IPM Center Update (Amanda)
- Highlighted outputs include a manuscript on IPM for mosquitoes, new website, and new PMSPs,
- Highlighted current efforts including the common outcome measures for CPPM
- Discussed the idea of the National IPM Communication Office

Planning for 2019 WERA-1017 in Nevada (Joy Newton is chair)
- Decided that we should have a back-up host (in case Joy can't host in 2019) who will serve as 2020 chair (if not hosting in 2019) - Doug volunteered with a likely meeting date in May
- In 2021, Marion, Doug, Ashley, Paul, Mark Wright, Frank, Casey will present their formal EIP reports
- Ashley (tentatively) volunteered as 2021 chair elect

New WERA-1017 projects
- Suggested to add a half day that incorporates a training on topics such as impact assessment, crop pest losses, iPMSPs, communication and messaging, social media efforts, pesticide resistance, pollinator health, or impact evaluation
- Suggested that chair consider applying for SARE PDP money to cover extra half-day of training

6. Laura updated on congressional activity and highlighted the number of funding lines for USDA NIFA and the suggestion of consolidation

7. Conclusion of WERA-1017 meeting

APPENDIX - JOINT WORKGROUP – SENSITIVE SITES

IPM for Sensitive Sites in the Built Environment - Western Region Work Group

Sensitive Sites addressed by this work group include physical areas where vulnerable people exist (schools, childcare facilities, medical facilities, housing, sheltered accommodation, etc.), and locations in which there is a low tolerance of pests (food processing plants, restaurants, clean manufacturing buildings, aircraft, etc.) or chemical use (areas housing persons with multiple chemical sensitivity, certain food processing areas and clean labs).

Purpose: The Work Group was formed to provide a focal point for interactive communication and collaboration of community IPM stakeholders* and change agents throughout the Western Region. Members include state, territory and tribal representatives, university, industry, advocacy organization, and federal agency groups.

Goal: Work to encourage and enhance successful implementation of IPM in community environments in the NIFA Western Region.

* the term “audiences” and “stakeholders” is used to reference a broad number of groups managing, occupying, using, or investing in a sensitive environment.

Stakeholder identified priorities and needs

Research

1. Research the impact pest management practices have on indoor and outdoor home/school/childcare environmental health, e.g., IAQ, well-water, etc.

2. Evaluate building design, construction, renovation, and maintenance criteria with regard to pest opportunities and pest management challenges.

3. Document effective least-risk products, tools, and strategies to manage pests and measure continual IPM improvement.

4. Compile data/information on effects of pesticides and pests on children’s health, (asthma, allergies, absenteeism, grades, ADHA,), academic performance and safety factors, e.g., IPM PRIME for schools.

5. Evaluate outreach methods to determine most effective ways of influencing sensitive environment community audiences, e.g., identification of entry points for implementation of IPM and study of sociological factors affecting adoption of IPM. Conduct a comparative analysis of the effectiveness of different types of change agents such as Extension and advocacy group parents have on IPM adoption. Determine motivational factors involved in establishing higher pest management standards. Documentation of client needs as guidance and/or recommendations.

6. Research effectiveness of pesticides/pest treatments, e.g., turf management options (low impact product identification), organic 25b, reduced-risk options, home remedies, stinging

insect IPM management, microbial drain cleaners, bed bug IPM and head lice treatment options.

7. Investigate commensal rodents for pathogen carrying capacity.

8. Determine any cross-over benefits of school IPM programs that lead to quality of life improvements for the greater community.

9. Survey county, state and Tribal Health Departments for pesticide resistance management practices and needs.

10. Generate unbiased product efficacy data on key pests of the built environment including commensal rodents, bed bugs, and German cockroaches (monitoring and chemical and non-chemical control).

11. Determine rodent related disease risks in urban rat and mouse populations.

Management

1. Develop sustainable state and federal funding for statewide IPM programs to deal with "routine"/"non-novel" ongoing needs that are not funded by grants (e.g. annual IPM coordinator training, maintenance of low-impact pesticide lists, and updating of educational materials).

2. Identify, educate and activate appropriate school-related organizations to embed IPM into the organizational culture, including ongoing continuing education opportunities for members.

3. Develop IPM decision-making tools, e.g., a decision tree with pest-specific steps and/or a pest solution center to help sensitive environments prioritize needs within budgetary constraints, facility/work order management systems such as School Dude, MUNIS, i-PEST, IPM Calculator.

4. Track adoption of IPM practices in sensitive environments and disseminate economic, environmental and/or health impacts of IPM to stakeholder groups, e.g., schools perform annual self-assessments, case studies, utilize state report cards to help determine training needs and goals.

5. Recognize schools/childcare facilities, organizations and pest management providers for practicing verifiable, high-level IPM and provide incentives, e.g., IPM STAR, recognition, positive publicity, reduced liability and insurance, using clear and comprehensive standards.

6. Coordination with state agencies (e.g., posters for schools, packets for teachers).

7. Identify and piggyback with ongoing environmental health efforts and coordinate with partners in promoting IPM to help facility managers to meet health, high performance and safety, economic, and energy efficiency goals, e.g., Environmental Management System, engage environmental health and safety professionals by creating awareness of the need and effective methodology for success, connect school IPM projects with broader pollution prevention initiatives at school district, state and national level.

8. Promote greater inclusion of IPM in certification standards, e.g., USGBC, Green Seal.

9. Establish environment specific practical vector management protocols for stakeholder groups.

Education/Outreach

1. Educate policy makers about the needs and benefits of IPM in terms of dollars, health, environmental and academic performance, e.g., use case studies describing how sensitive environment IPM programs can be initiated and sustained.

2. Create best management practice for schools/childcare facilities to use with vendors of pest management services, design and construction services, custodial services, food and drink product service providers, etc.

3. Promote education on how to read a pesticide label, and the importance of understanding the directions before use.

4. Create Spanish language materials.

5. Provide information on the connection of IPM and improved health and safety to audiences.

6. Develop and utilize educational methods to provide education and practicum training for stakeholder groups.

7. On-site assessment of and training on pesticide storage and disposal practices.

8. Education and training of Environmental Health Specialists (i.e. health inspectors) that inspect schools, restaurants, etc.

9. Educate audiences on commensal rodents and rodenticide laws.

10. Educate on food-safety issues relevant to food preparation and service.

11. Develop infographics for increased public understanding of foundational IPM topics.

12. Educate audiences on vector management and vector-borne diseases.

IPM for Sensitive Sites in the Built Environment - Western Region Work Group

Regulatory

1. Work to incorporate IPM strategies into building codes.

2. Identify and promote interagency cooperation among regulatory, environmental, health, insurance, education, State and Federal, Cooperative Extension and other agencies.

3. Establish IPM policies in school systems to institutionalize the commitment to IPM, e.g., establish and share Parent /Teacher Association (PTA) school IPM models/restrictions; incorporate IPM into school wellness legislation; state school board adoption of IPM policy.

4. Create and mandate minimum standards for school IPM at federal level, e.g., established through high level IPM training/licensing for pest management professionals.

5. Implement and enforce existing IPM laws and policies (regarding verifiable standards) at the highest level of economic and regulatory accountability.

6. Identify opportunities for improving regulations and regulatory and legislative processes to improve IPM adoption, e.g., US Senate and House committees that work on school legislation at the federal level.

7. Develop organizations and strategies for influencing change that will result in state Department of Education, Health and Safety regulations and policies that call for IPM, e.g., seek state legislator champion to present successful legislation at NCSL annual conference.

8. Establish or use existing diverse local stakeholder committees to advocate for policies and procedures that implement proven IPM strategies and practices, e.g., develop and disseminate a protocol for grassroots implementation to increase effectiveness of local advocates, partner with National Pest Management Association, Beyond.

9. Establish minimum students' rights for environmental health standards in schools and include students and teachers in OSHA-like protections.

10. Fund consultant services for IPM compliance assistance to provide schools with access to experts who can identify opportunities for improvements.

APPENDIX: STATE REPORTS

ANNUAL STATE IPM REPORT FOR CALIFORNIA

James Farrar, Director

Summary:

IPM in California addressed new pests and resurgent old pests in communities, agriculture and natural areas in 2017. Worthy of special note is the news around coyote and human interactions, which are happening with increasing frequency especially in Southern California. UC IPM's Urban IPM Program celebrated its 10-year anniversary. UC IPM developed its first podcast. Chris Greer is a new IPM advisor providing plant pathology expertise in strawberry, cole crops, lettuce, and grapes. Maggie Reiter is a new affiliated advisor, providing expertise in grasses and urban turf systems, dealing with concepts of ecology, water conservation, and IPM.

Accomplishments and Impacts (2017)

Urban and Community IPM

Coyote Encounters Collected with the Coyote Cacher: Managing coyotes that have adapted to living in urban areas is everyone's concern. Coyotes thrive in urban areas because food, water, and shelter are abundant. Coyotes feed on household garbage and pet food. Some even prey on house cats and small dogs. Because of this close association with people, coyotes in some areas have become increasingly aggressive towards humans. Better and improved strategies for measuring and managing coyote-human conflicts is needed. Human-Wildlife Interactions Advisor **Niamh Quinn** developed the Coyote Cacher (http://ucanr.edu/sites/CoyoteCacher), a web application that enables people to report encounters with coyotes. Users can submit when and where the encounter occurred and the type of encounter. "We really need the people to tell us what they're seeing and what's happening. We can't be outside all the time to try and see what's happening, so we're relying on the people of California to help us find out what's really going on," says Quinn. People can sign up for alerts to learn about encounters in their zip code, including the type of encounter they'd like to be alerted about. Encounter types range from sightings, to attacked pets, to people being bit. If you see a coyote in California, please use the Coyote Cacher to report your encounter. "We need the information to better manage coyotes. This will help you get the information out there that we need to help us make management decisions," requests Quinn.

Short-term outcomes:

Increased use of the Coyote Cacher by Californians provides much needed information about coyote-human encounters. The data gathered by the Coyote Cacher informs Quinn and other researchers about how coyotes are interacting with humans in urban environments and will inform them to develop best management practices for coyotes. It is anticipated that good management of people (how they may be encouraging coyote presence) and the coyotes themselves will lead to fewer negative coyote-human interactions.

Impacts:

- Increased workforce competency
- Improved community health and wellness
- Improved management of wild animals
- Reduced human health and environmental risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practices and improve local economies

White Grubs in Turf: A common urban pest problem are vertebrates destroying turf and landscapes during late summer or autumn. The vertebrates causing the damage are racoons, skunks, wild pigs, and geese. The real culprit, however, is underground. The skunks and other vertebrates are digging to eat the fat, juicy beetle grubs in the soil, which also directly damage plants and turf by feeding on their roots. Pesticides are often used to kill white grubs, but in urban areas, concerns with pesticide use include surface water, soil, and groundwater contamination; harming human health; disruption of the ecosystem; economic costs; and negative public perception. Urban surface water contamination with pesticides have been recorded at levels two to three times higher than surface water in production agricultural areas. Some of the culprits found in urban surface waters include insecticides and herbicides like

diazinon, chlorpyrifos, pyrethroids, fipronil, 2,4-D, triclopyr, diuron, MCPA, bifenthrin, imidacloprid, and malathion. Area Urban IPM Advisor **Andrew Sutherland** teaches no grubs = no digging = no problem. By managing white grubs, which are the larvae of various scarab beetles, vertebrate damage to turf or landscape is prevented. He suggests prevention first by also planting more tolerant warm season grasses, proper irrigation, and thatch removal. Sutherland tested an insecticide containing a bacteria, *Bacillus thuringiensis galleriae*, and a chemical insecticide containing chlorantraniliprole applied based on monitoring via light traps (during peak adult flight) or on a calendar basis based on cooperating municipalities. All insecticide treatments reduced the number of grubs in the test plots. At both sites, a newly planted site and one with a chronic grub infestation, both pesticides reduced the numbers of grubs compared to an untreated site whether they were applied on a calendar basis or when monitoring indicated a need.

Short-term outcomes:

Sutherland's research will improve knowledge on preventing white grub damage that occurs directly from feeding on roots, as well as by vertebrates searching to feed on the grubs in turf and landscapes. His outreach efforts will improve IPM skills for appropriately identifying grub pests, monitoring for grubs, and making decisions for when an insecticide is needed. It is anticipated that increased knowledge and improved skills will aid in the adoption of an IPM program for white grubs.

Impacts:

- Increased workforce competency
- Improved community health and wellness
- Reduced human health and environmental risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practices and improve local economies

Wilen Tests Alternatives as Cities Limit Glyphosate Use: The announcement that glyphosate is a carcinogen has resulted in new ordinances in some cities in southern California. The new ordinances being considered or adopted are limiting the use of products containing glyphosate on city-owned property. Alternative herbicides are needed. Area IPM Advisor **Cheryl Wilen** tested herbicides—most of them organic or biopesticides—to see if they may be a good replacement for glyphosate for weed management. Wilen applied two treatments to test plots containing hairy fleabane, annual sowthistle, Jerusalem oak, and common purslane. "While I'm still evaluating the data, I can say that some products look pretty good. While the costs are high, at least the cities can narrow down what products would work for them," says Wilen. Several of the products with potential for controlling weeds were organic, although Wilen noted that their signal words indicated they were more hazardous than glyphosate.

Short-term outcomes:

Wilen's research improves knowledge of how well alternative herbicides to glyphosate manage weeds. It is anticipated that cities that adopt ordinances limiting the use of glyphosate and so use the tested alternative herbicides might save money by using the best herbicide for their situation and budget.

Impacts:

- Increased workforce competency
- Improved community health and wellness
- Reduced human health and environmental risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practices and improve local economies

Bed Bugs Demonstration Project: Multi-unit housing exacerbates the challenges of bed bug management due to the ability for bugs to move from one unit to the next, use of secondhand furniture and personal belongings, high number of residents, high turnover, communication barriers, and lack of funding. Surveys and research have identified these problems and possible solutions. Do these research-based solutions work in low-income apartment buildings? Area Urban IPM Advisor **Andrew Sutherland** demonstrated that proactive bed bug management programs with collaborating pest control operators were initially more expensive than reactive, complaint-based, insecticide-reliant programs typical of how bed bugs are currently managed. However, over time, the monthly costs of the proactive program decreased. After one year, the number of bed bugs were reduced compared to the number of bed bugs at the beginning of the trial. Tenants were more satisfied with the proactive program versus the complaint-based program.

Short-term outcomes:
Researchers are increasing their knowledge about what works in multi-unit housing to prevent and manage bed bug infestations. Tenants with bed bug problems have more knowledge of bed bugs and skills to prevent or manage them. It is anticipated that finding a way to work with tenants and pest control operators will lead to the increased incorporation of IPM in multi-unit housing for bed bug management.

Impacts:

- Increased workforce competency
- Improved community health and wellness
- Reduced human health and environmental risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practices and improve local economies

Best Management Practices for Ground Squirrels in Urban Areas and Agriculture: Human-Wildlife Interactions Advisor **Niamh Quinn** updated the Ground Squirrel BMPs website (best management practices; http://www.groundsquirrelbmp.com/biology.html). The website covers biology, identification, management, regulations, resources and frequently asked questions. Management efforts are more effective when directed at the right pest. Ground squirrel biology plays a big role in management because knowing when to expect seasonal changes in ground squirrel activity and food preferences can help make management efforts as efficient as possible.

Short-term outcomes:
More people will find the updated website and the improved organization of information will ensure users find the information they need. Increased knowledge of which ground squirrel is causing problems will enhance the effectiveness of management methods. The website will contribute to the increase in knowledge about ground squirrel management regulations including trapping and pesticide-use regulations.

Impacts:

- Increased workforce competency
- Improved community health and wellness
- Improved management of wild animals
- Reduced human health and environmental risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practices and improve local economies

Agricultural Production IPM

Improving Application Efficiency May Make Ant Bait a Viable Management Option for Vine Mealybug:

Vine mealybug is a destructive pest in California vineyards; it contaminates fruit and reduces vine health and productivity. In coastal vineyards, Argentine ants disrupt IPM programs for vine mealybug because they interfere with the activity of a parasitic wasp that attacks vine mealybug. Liquid ant baits significantly reduce mealybugs in vineyards by contributing to increases in biological control. However, the costs associated with delivering the liquid in bait stations have been prohibitive to widespread adoption. Baits formulated as granular products or polyacrylamide gels that can be broadcast with a fertilizer spreader can be distributed more quickly over a large area making them affordable. Viticulture Advisor **Monica Cooper** and IPM Advisor **Lucia Varela** evaluated broadcast applications of an experimental bait to control Argentine ants in vineyards. The bait solution consists of 0.0006% insecticide in 25% sucrose solution deployed in polyacrylamide water-storing crystals. These crystals absorb water and water-soluble chemicals, and when hydrated present a thin layer of liquid bait solution on the surface for 24 to 72 hours following application. The hydrated crystals were deployed using a tow spreader pulled with an all-terrain vehicle. Two applications of the polyacrylamide bait in early spring reduced ant populations for more than 6 months.

Short-term outcomes:
We anticipate an increase in the use of solid bait formulation, due to the lower cost to broadcast apply these baits compared to liquid bait stations. Ant population reduction allows for effective biological control of vine mealybug. If biological control keeps vine mealybug numbers where it does not interfere with vine health and productivity, then other management tactics, such as pesticides, are not needed or reduced.

Impacts:

- Reduced human health and environmental risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practice and improve local economies

More San Jose Scale Issues After Spotted Wing Drosophila: San Jose scale infestations in cherry are becoming more prevalent in the northern San Joaquin Valley. Some infestations were severe enough to kill trees within one to two years. In addition to tree and limb death, scale feeding damages the fruit surface, making them unmarketable, especially for export. Previous research identified an abundance of parasitic wasps, which may reduce San Jose scale numbers. In 2008, spotted wing drosophila became a pest throughout California and changed pest management practices in cherry. Area IPM Advisor **Jhalendra Rijal** suggests that the management practices for spotted wing drosophila may harm parasitic wasps and reduce their numbers. To determine if this is true, Rijal assessed the occurrence and abundance of San Jose scale parasites in orchards using sticky traps baited with the San Jose scale pheromone. He observed two parasites, *Aphytis* spp. and *Encarsia* spp., in all orchards. Low parasite numbers in May coincide with spotted wing drosophila insecticide applications. Rijal plans to continue monitoring San Jose scale and its parasites.

Short-term outcomes:

This research improves our knowledge of the San Jose scale phenology in the northern San Joaquin Valley. It is anticipated that a better understanding of the phenology can lead to improved application timing if crawler treatments are needed that will not interfere with cherry harvest. Rijal's work will also enhance our understanding of how broadspectrum insecticide applications for spotted winged drosophila affect parasites in cherry orchards.

Impacts:

- Reduced human health and environmental risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practices and improve local economies

New *Insectary Plant* Webpage: Biological control, or the use of natural enemies that feed on pests, is an important component of IPM. Fields and orchards may miss out on this control if they do not offer sufficient habitat for natural enemies to thrive. Insectary plants (or insectaries) can change that—they feed and shelter these important insects and make the environment more favorable to them. For instance, sweet alyssum planted near lettuce fields encourages syrphid flies to lay their eggs on crops. More syrphid eggs means more syrphid larvae eating aphids, and perhaps a reduced need for insecticides. Similarly, planting cover crops like buckwheat within vineyards can attract predatory insects, spiders, and parasitic wasps, ultimately keeping leafhoppers and thrips under control. Flowering insectaries also provide food for bees and other pollinators. There are both greater numbers and more kinds of native bees in fields with an insectary consisting of a row of native shrubs planted along the field edge (called a hedgerow). Native bees also stay in fields with these shrubs longer than they do in fields without them. Therefore, not only do insectaries attract natural enemies, but they can also boost crop pollination and help keep bees healthy. To get the word out about how to use insectary plants, a webpage was developed discussing why insectary plants are important and how to establish and manage them. Visit the *Insectary Plants* webpage (http://ipm.ucanr.edu/mitigation/insectary_plants.html?src=41918) to learn which types of insectaries may suit your needs and situation. Financial assistance is available to establish insectaries on farms, by applying for Conservation Action Plan funds from the Environmental Quality Incentives Program (EQIP) offered by the Natural Resources Conservation Service.

Short-term outcomes:

It is anticipated that improved knowledge about insectaries will increase their use.

Impacts:

- Reduced human health and environmental risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practices and improve local economies

UC IPM's First Podcast on Honey Bee IPM: Each year, honey bees in the USA produce over $300 million of honey, and pollinate an additional $17 billion in fruits, vegetables, and nuts. Pests and diseases harm these honey bees used for pollination or to produce honey. One of the biggest pests of honey bees are Varroa mites. Varroa mites feed on honey bee blood, transmit viruses, and suppress immunity in developing and adult bees.

Varroa mites can kill a honey bee colony if they are not managed properly. The cost of a full-strength colony is about $150 to $180, which does not include the income beekeepers would get from honey or renting the colony out for pollination services. Treating for Varroa mite can cost $8 to $10 per colony. Beekeepers can have thousands of colonies. Treating the colonies for Varroa mite two or three times during the year can add up quickly. UC IPM's podcast (https://soundcloud.com/ucipm/help-honey-bees-cope-with-pests) features an interview with UC Specialist **Elina Niño** who talks about prevention and using IPM to manage pests in honey bee hives. IPM practices include monitoring, cultural methods such as resistant bee stock, and miticides.

Short-term outcomes:

Information about IPM in honey bees will improve the knowledge of commercial and hobby beekeepers about IPM practices to control Varroa mite. It is anticipated that increased knowledge will lead to adoption of IPM practices.

Impacts:

- Increased workforce competency
- Improved community health and wellness
- Reduced human health and environmental risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practices and improve local economies

Pesticide Safety

Pest Control Adviser Licensing Exam Questions Updated: In California, any person who offers a recommendation on any agricultural use of a pest control product or technique, presents himself/herself as an authority on any agricultural use, or solicits services or sales for any agricultural pest control tool is a pest control adviser (PCA). Agricultural use includes use in parks, golf courses, waterways, forests, roadsides, cemeteries and many other situations, as well as the traditional agricultural crops. According to California law, all PCAs must be licensed by the California Department of Pesticide Regulation (DPR). To become a PCA, you must meet specific educational requirements; pass the laws, regulations, and basic principles exam; and pass an exam in the pest control disciplines in which you wish to make recommendations: Insect, Mite and Other Invertebrates; Plant Pathogens; Nematodes; Vertebrate Pests; Weeds; Defoliation; and Plant Growth Regulators. Pesticide Safety Coordinator **Lisa Blecker** and Writer Editor **Shannah Whithaus** are working to ensure PCA exam questions adequately test for the knowledge needed to be a licensed PCA. Exam questions in the seven categories were reviewed or are being reviewed to ensure they link well with the knowledge expectations, the information that PCAs are expected to know to pass the exam. Additionally, Blecker and Whithaus are developing a pool of questions for each exam category, providing the ability for DPR to assemble multiple exams with different questions that test for the same knowledge expectations.

Short-term outcomes:

Updated questions that better test the knowledge needed will result in licensed pest control advisers with increased knowledge about pest management and IPM. Linking knowledge expectations from the study material with licensing exam questions is anticipated to increase PCA knowledge and improve the exam passing rate.

Impacts:

- Increased workforce competency
- Improved community health and wellness
- Reduced human health and environmental risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practices and improve local economies

Publications

2017 Peer-Reviewed Publications

2017. UC IPM Pest Management Guidelines: Alfalfa. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 3430. http://ipm.ucanr.edu/PMG/selectnewpest.alfalfa-hay.html (updated)

2017 Peer-Reviewed Publications

2017. UC IPM Pest Management Guidelines: Almond. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 3431. http://ipm.ucanr.edu/PMG/selectnewpest.almonds.html (revised)

2017. UC IPM Pest Management Guidelines: Apricot. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 3433. http://ipm.ucanr.edu/PMG/selectnewpest.apricots.html (updated)

2017. UC IPM Pest Management Guidelines: Asparagus. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 3435. http://ipm.ucanr.edu/PMG/selectnewpest.asparagus.html (updated)

2017. UC IPM Pest Management Guidelines: Cherry. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 3440. http://ipm.ucanr.edu/PMG/selectnewpest.cherries.html (updated)

2017. UC IPM Pest Management Guidelines: Citrus. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 3441. http://ipm.ucanr.edu/PMG/selectnewpest.citrus.html (updated)

2017. UC IPM Pest Management Guidelines: Grape. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 3448. http://ipm.ucanr.edu/PMG/selectnewpest.grapes.html (updated)

2017. UC IPM Pest Management Guidelines: Lettuce. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 3450. http://ipm.ucanr.edu/PMG/selectnewpest.lettuce.html (revised)

2017. UC IPM Pest Management Guidelines: Pistachio. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 3460. http://ipm.ucanr.edu/PMG/selectnewpest.pistachios.html (updated)

2017. UC IPM Pest Management Guidelines: Plum. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 3462. http://ipm.ucanr.edu/PMG/selectnewpest.plum.html (updated)

2017. UC IPM Pest Management Guidelines: Prune. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 3464. http://ipm.ucanr.edu/PMG/selectnewpest.prune.html (updated)

2017. UC IPM Pest Management Guidelines: Turfgrass. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 3365-T. http://ipm.ucanr.edu/PMG/selectnewpest.turfgrass.html (updated)

2017. UC IPM Pest Management Guidelines: Walnut. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 3471. http://ipm.ucanr.edu/PMG/selectnewpest.walnuts.html (revised)

2017. UC IPM Pest Notes: Dyer's Woad. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 74175. http://ipm.ucanr.edu/PMG/PESTNOTES/pn74175.html (new)

2017. UC IPM Pest Notes: Widow Spiders and Their Relatives. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 74149. http://ipm.ucanr.edu/PMG/PESTNOTES/pn74149.html (revised)

2017. UC IPM Pest Notes: Invasive Plants. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 74139. http://ipm.ucanr.edu/PMG/PESTNOTES/pn74139.html (revised)

2017. UC IPM Pest Notes: Woody Weed Invaders. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 74142. http://ipm.ucanr.edu/PMG/PESTNOTES/pn74142.html (revised)

Achmon Y, Fernández-Bayo JD, Hernandez K, McCurry DG, Harrold DR, Su J, Dahlquist-Willard RM, Stapleton JJ, VanderGheynst JS, Simmons CW. 2017. Weed seed inactivation in soil mesocosms via biosolarization with mature compost and tomato processing waste amendments. Pest Management Science 73:862-873.

Fernández-Bayo JD, Achmon Y, Harrold DR,Claypool JT, Simmons BA, Singer SW, Dahlquist-Willard RM, Stapleton JJ, VanderGheynst JS, Simmons CW. 2017. Comparison of soil biosolarization with mesophilic and thermophilic solid digestates on soil microbial quantity and diversity. Applied Soil Ecology 119:183-191.

Fernández-Bayo JD, Achmon Y, Harrold DR, McCurry DG, Hernandez K, Dahlquist-Willard RM, Stapleton JJ, VanderGheynst JS, Simmons CW. 2017. Assessment of two solid anaerobic digestate soil amendments for effects on soil quality and biosolarization efficacy. Journal of Agricultural and Food Chemistry 65:3434-3442.

Hubble-Wirgler CW, Sutherland AM. 2017. Evaluation of a granular formulation of Bacillus thuringiensis galleriae for use against white grubs within municipal turf. Arthropod Management Tests. 42(1): tsx119. https://doi.org/10.1093/amt/tsx119.

2017 Peer-Reviewed Publications

Joseph SV, Martin T, Steinmann K, Kosina P. 2017. Outlook of Pyrethroid Insecticides for Pest Management in the Salinas Valley of California. Journal of Integrated Pest Management 8(1): 6. doi: 10.1093/jipm/pmx001.

Oldfield T, Achmon Y, Perano KM, Dahlquist-Willard RM, VanderGheynst JS, Stapleton JJ, Holden NM, Simmons CW. 2017. A life cycle assessment of biosolarization as an option for tomato pomace utilization in California. Journal of Cleaner Production 141:146-156.

Reiter M, Friell J, Horgan B, Soldat D, Watkins E. 2017. Drought response of fine fescue mixtures maintained as a golf course fairway. International Turfgrass Society Research Journal 13:65–74.

Rijal JP, Bergh JC. 2017. Grape Root Borer (Lepidoptera: Sesiidae): An economic pest of commercial vineyards in the eastern United States. J. Integr. Pest Manag. Published on 13 December. https://doi.org/10.1093/jipm/pmx027.

Rijal JP, Duncan R. 2017. First report of an established brown marmorated stink bug (Hemiptera: Pentatomidae) population in California agricultural crops. J. Entomol. Sci. 52 (4): 450-454.

Romero A, Sutherland AM, Gouge DH, Spafford H, Nair S, Lewis V, Choe D-H, Li S, Young D. 2017. Pest management strategies for bed bugs in multi-unit housing: a literature review on field studies. Journal of Integrated Pest Management. 8(1): 1-10. https://doi.org/10.1093/jipm/pmx009.

Vargas RI, Souder SK, Morse JG, Grafton-Cardwell EE, Haviland DR, Kabashima JN, Faber BA, Mackey B, Nkomo E, Cook PJ, Stark JD. Chemical Degradation of TMR Multilure Dispensers for Fruit Fly Detection Weathered Under California Climatic Conditions. 2017. Journal of Economic Entomology 110(4):1495-1500. doi:10.1093/jee/tox159

Zalom F, Haviland D, Barlow V. 2017. Obituary: Larry D. Godfrey. American Entomologist 63(3): 122-123.

2017 Extension Bulletins/Newsletter Articles/Technical Reports/Blog Posts

2017. Efficacy and Timing of Fungicides, Bactericides, and Biologicals for Deciduous Tree Fruit, Nut, Strawberry, and Vine Crops. http://ipm.ucanr.edu/PDF/PMG/fungicideefficacytiming.pdf

2017. Retail Nursery and Garden IPM Newsletter. Volume 7: 2. University of California Statewide IPM Program. http://ipm.ucanr.edu/PDF/PUBS/Summer_2017_Retail_Newsletter.pdf

- Sutherland AM. 2017. Do-it-yourself bed bug control? Retail Nursery and Garden Center IPM News. UC IPM. 7(2).

2017. Retail Nursery and Garden IPM Newsletter. Volume 7: 1. University of California Statewide IPM Program. http://ipm.ucanr.edu/PDF/PUBS/retailipmnews.2017.may.pdf

2017. Green Bulletin Newsletter. Volume 7: 2. University of California Statewide IPM Program. http://ipm.ucanr.edu/PDF/PUBS/greenbulletin.2017.winter.pdf

2017. Green Bulletin Newsletter. Volume 7: 1. University of California Statewide IPM Program. http://ipm.ucanr.edu/PDF/PUBS/greenbulletin.2017.may.pdf

- Lacan I, Wilen C, Roncoroni J. 2017. Using Herbicides Safely Around Trees. UCIPM Green Bulletin 4-6.

2017. Quick Tips. University of California Statewide IPM Program.

- Asian Citrus Psyllid and Huanglongbing Disease
- Damping-off of Seedlings
- Ground Squirrel
- Leaf-feeding Caterpillars
- Phytophthora Root and Crown Rot
- Powdery Mildew
- Scales
- Snails and Slugs
- Common Garden Spiders
- Lawn Watering

Achmon Y, Fernández-Bayo J, Hernandez K, McCurry D, Harrold D, Su J, Dahlquist-Willard R, Stapleton J, VanderGheynst J, Simmons C. 2017. Weed seed inactivation using biosolarization with mature greenwaste compost and tomato pomace amendments. In: Proceedings, 2017 Annual Meeting of the California Weed Science Society 69:81.

Baur M, Crump A, Elliott S, Farrar J. 2017. Integrated Pest Management of Mosquitoes: A Case Study of West Nile Virus in California. 23 pages. Western IPM Center.

Burks CS, Symmes EJ, Rijal JP, Higbee BS. 2017. Seasonal and Crop Effects on Reliability of Synthetic Navel Orangeworm Lures. 91st Annual Orchard Pest and Disease Management Conference. January 12, 2017, Portland Oregon.

2017 Extension Bulletins/Newsletter Articles/Technical Reports/Blog Posts

Choe D-H, Sutherland AM. 2017. UC ANR teamed up to investigate effective integrated pest management for bed bugs in low-income, multiple-occupancy housing. UC Delivers. http://ucanr.edu/delivers/?impact=1015&delivers=1.

DeBiase R, Freeman Long R, Orloff S, Goodell PB, Putnam DH. 2017. New Pest Management Guidelines for Alfalfa – Revised & Updated. Posted on 1 blog. http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=24088.

Fernández-Bayo JD, Randall TE, Achmon Y, Hestmark KV, Harrold DR, Su J, Dahlquist-Willard RM, Gordon T, Stapleton JJ, VanderGheynst JS, Simmons CW. 2017. Application of partially stabilized organic amendments to inactivate Brassica nigra (a weed) and Fusarium oxysporum f.sp. lactucae (a fungus) using soil biosolarization. In: Proceedings, 2017 Annual Meeting of the California Weed Science Society 69:15-16.

Goodell PB. 2017. Integrated Pest Management: It's time to revisit and renew a familiar concept. 2017 Conference Proceedings, California Plant and Soil Conference. California Chapter of Am Agronomy Soc. Pp 25-29.

Goodell PB. 2017. Integrated Pest Management: Revitalizing and reinvesting in a proven approach. CAPCA Adviser February 2017: 36–38.

Haviland, D. Evaluation of Sixspotted Thrips, Scolothrips sexmaculatus, for Biological Control of Spider Mites in California Almonds. Proceedings of the 5th International Symposium on Biological Control of Arthropods (eds. P. G. Mason, D. R. Gillespie and C. Vincent), Langkawi, Malaysia, 11-15 Sept, 2017, pp 290-291.

Haviland DR. 2017. Evaluation of Sprayable Pheromone for Vine Mealybug. 2016-17 Research Project Report-Consolidated Central Valley Table Grape Pest and Disease Control District.

Haviland D. Evaluation of Sprayable Pheromone for Vine Mealybug in Grapes. Vit Tips San Joaquin Valley Newsletter, Spring 2017, UCCE p. 1, 4-5.

Haviland DR. Exploration of the Role of Sixspotted Thrips in Spider Mite Biocontrol in California Almonds. In 2017 Orchard Pest and Disease Management Conference, Portland, Oregon, Jan 1–13, 2017, p. 37.

Haviland DR. 2017. Kern County Pierce's Disease Monitoring Program. 2016-17 Research Project Report-Consolidated Central Valley Table Grape Pest and Disease Control District.

Haviland D, Rill S. Field Evaluation of Sixspotted Thrips, Scolothrips sexmaculatus (Pergande), as a Predator of Pacific Spider Mite, Tetranychus pacificus (McGregor), in California Almonds. Book of Abstracts, IOBC Working Group Meeting "Integrated Control of Plant-Feeding Mites", 4–7 Sept 2017, Chania, Greece, p. 26.

Martin TA, Berger L, Goodell P. 2017. UC IPM coordinates a statewide conversation about the role of chlorpyrifos. UC Delivers. ucanr.edu/delivers/?impact=993&delivers=1

Martin TA, Berger L, Goodell P. 2017. UC IPM delivers IPM solutions to Californians. UC Delivers. ucanr.edu/delivers/?impact=992&delivers=1

Milliron L, Hasey J, Symmes EJ, Michailides T. September 2017. Fall Walnut Orchard Considerations. UCCE Sacramento Valley Walnut News.

Morse JG, Phillips PA, Flaherty DL, O'Connell NV, Goodell PB, AA Urena AA, Grafton-Cardwell EE. 2017. Timing of Adult FRB Soil Emergence. Citrograph, Summer 2017: 46–51.

Parreira S. 2017. Blog post and podcast: August 19th is National Honey Bee Day: Dr. Elina Niño reminds us to help honey bees cope with pests. Posted on 6 blogs. http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=24914

Parreira S. 2017. Blog post: Bee knowledgeable: Pollinator Week is June 19–25. Posted on 7 blogs. http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=24426.

Parreira S. 2017. Blog post: National Poison Prevention Week—March 19–25, 2017. Posted on 7 blogs. http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=23602.

Parreira S. 2017. Blog post: National Invasive Species Awareness week: February 27–March 3, 2017. Posted on 10 blogs and 1 website. http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=23418.

Parreira S. 2017. Blog post: National Poison Prevention Week—March 19–25, 2017. Posted on 7 blogs. http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=23602.

Pope KS, Niederholzer FJA, Symmes EJ. March/April 2017. May Orchard Tasks: Prune. California Fresh Fruit, 11.

Pope KS, Niederholzer FJA, Symmes EJ. February 2017. Prune Bloom Orchard Management Considerations. UCCE Sacramento Valley Prune News.

Pourreza A. April 2017. A Practical Solution to Address the Emergence of Citrus Greening Forecasting in California. CAPCA Adviser.

2017 Extension Bulletins/Newsletter Articles/Technical Reports/Blog Posts

Reynolds C. 2017. Blog post: Almond and Walnut Pest Management Guidelines revised just in time for the holidays. Posted on 4 blogs. http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=25911

Reynolds C. 2017. Blog post: It's time for DPR license and certificate holders to renew—get units via online courses from UC IPM. Posted on 10 blogs. http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=25607

Reynolds C. 2017. Blog post: Looking to hire a maintenance gardener? Make sure they are DPR certified. Posted on 4 blogs. http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=24240

Rijal JP. 2017. Effect of Winter Flooding on Spider Mite and Navel Orangeworm Population in Almond Orchard. Technical Report submitted to Almond Board of California.

Rijal JP. 2017. Insect pest monitoring in almonds and walnuts. The IPM Corner (March).

Rijal JP. 2017. Invasion of brown marmorated stink bug (BMSB): Orchard pest update-peach growers beware. California Fresh Fruit. Vol. 34 (September Issue). pp. 8-11.

Rijal JP. 2017. IPM Advisors Report. Annual Progress Report submitted the UC IPM Program, UCANR.

Rijal JP. 2017. Mating disruption: An effective IPM tool for navel orangeworm. Progressive Crop Consultant. Vol. 2, Issue 3 (May-June), pp. 30-34.

Rijal JP. 2017. Monitoring of brown marmorated stink bug (BMSB) in the northern San Joaquin Valley peach orchards. Technical Report submitted to the California Cling Peach Board.

Rijal JP. 2017. New Pest Update: Reports of Brown Marmorated Stink Bug (BMSB) infestation in peach and almond orchards in California. Poster. Almond Board of California Annual Conference, 5-7 December, Sacramento, CA.

Rijal JP. 2017. Oviposition deterrents and insecticides for spotted wing drosophila control in cherries. Technical Report submitted to the California Cherry Board.

Rijal JP. 2017. Seasonal Insect Pest Monitoring Updates in Almonds. The Almond Doctor. 22 March.

Rijal JP. 2017. Updates on Brown Marmorated Stink Bug (BMSB) Monitoring-2017. Field Notes Newsletter (August).

Rijal JP, Caprile J. 2017. San Jose scale and it's biological control activity in North San Joaquin Valley. Field Notes Newsletter (February).

Rijal JP, Duncan R. 2017. Brown marmorated stink bug spread to peach growing areas in the northern San Joaquin Valley. CAPCA Newsletter (August). pp. 32-35.

Rijal JP, Duncan R. 2017. Brown Marmorated Stink Bug Survey in Cling Peach Orchard. The IPM Corner (March).

Rijal JP, Tollerup K. 2017. Developing sampling methods for pre-season mite detection and implementing management decisions in almonds. Technical Report submitted to Almond Board of California.

Rijal JP, Tollerup K. 2017. Developing sampling methods for pre-season mite detection in almonds. Almond Board of California Annual Conference, 5-7 December, Sacramento, CA.

Risorto S, Blecker L. 2017. Blog post: Is your pesticide safety training in compliance with the new Worker Protection Standard? Published on 11 blogs and 2 websites. http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=23116.

Stapleton JJ, Simmons CW, Dahlquist-Willard RM, Achmon Y, Fernandez-Bayo JD, VanderGheynst JS. 2017. Biosolarization for organic vegetable crop production: Where weed management and soil health meet. 2017 Proceedings of the Western Society of Weed Science 70.

Symmes EJ. 17 September 2017. Harvest Damage Evaluation for Walnuts. Sacramento Valley Orchard Source Blog.

Symmes EJ. September 2017. Codling Moth Monitoring Tips in Walnuts. Western Fruit Grower.

Symmes EJ. 23 August 2017. Navel Orangeworm in Walnuts 2017 – Stay Alert. Sacramento Valley Orchard Source Blog.

Symmes EJ. 15 August 2017. Harvest Damage Evaluation for Almonds. Sacramento Valley Orchard Source Blog.

Symmes EJ. August 2017. Almond and Walnut Harvest Evaluation: Identifying Sources of Damage. UCCE Sacramento Valley Almond News Email Extra.

Symmes EJ. August 2017. Almond and Walnut Harvest Evaluation: Identifying Sources of Damage. UCCE Sacramento Valley Walnut News Email Extra.

Symmes EJ. 17 July 2017. 2017 Walnut Insect and Mite Updates. Sacramento Valley Orchard Source Blog.

Symmes EJ. July 2017. IPM Updates and Summer Considerations: Walnuts and Almonds. West Coast Nut, 4-8.

Symmes EJ. June 2017. Monitoring Navel Orangeworm and Codling Moth In and Near Mating Disruption Orchards. CAPCA Adviser, 26-29.

2017 Extension Bulletins/Newsletter Articles/Technical Reports/Blog Posts

Symmes EJ. June 2017. Approaches to Spider Mite Management in Almonds. UCCE Sacramento Valley Almond News.

Symmes EJ. May 2017. Managing Spider Mites in Almonds and Walnuts. West Coast Nut, 17-20.

Symmes EJ. 7 April 2017. Monitoring Codling Moth In and Near Mating Disruption Orchards. Sacramento Valley Orchard Source Blog.

Symmes EJ. April 2017. Monitoring Codling Moth In and Near Mating Disruption Orchards. UCCE Sacramento Valley Walnut News.

Symmes EJ. March/April 2017. Trapping In and Near Mating Disruption Orchards. Progressive Crop Consultant, 32-35.

Symmes EJ. March 2017. Walnut Orchard Tasks. Pacific Nut Producer.

Symmes EJ. February 2017. Almond and Walnut IPM Activities to Start the Season. West Coast Nut, 22-29.

Symmes, E. J. February 2017. Protecting Honey Bees During Bloom. West Coast Nut, 42-43.

Symmes EJ. January/February 2017. Winter Sanitation in Nut Crops. Progressive Crop Consultant, 16-17.

Symmes EJ. 24 January 2017. Protecting Honey Bees During Bloom. The Almond Doctor Blog.

Symmes EJ. 18 January 2017. Protecting Honey Bees During Bloom. Sacramento Valley Orchard Source Blog.

Symmes EJ. 13 January 2017. 2016 Post-Harvest Walnut Navel Orangeworm Update. Sacramento Valley Orchard Source Blog.

Symmes EJ. January 2017. Navel Orangeworm Update. UCCE Sacramento Valley Walnut News.

Symmes EJ. January 2017. Protecting Honey Bees During Bloom. UCCE Sacramento Valley Almond News.

Symmes, EJ, Connell JH, Lightle DM, Niederholzer FJA, Pope KS, Buchner RP. 2017 (continuously updated). Sacramento Valley Almond Production Calendar.

Symmes EJ, Niederholzer FJA. May 2017. Prune Management Considerations: Late Spring through Summer. UCCE Sacramento Valley Prune News.

Taravati S. 2017. Training public housing staff about Integrated Pest Management in Southern California. UC Delivers. http://ucanr.edu/delivers/?impact=1010&a=0

Wilen C. 2017. Crop Safety Fiesta (Fe HEDTA) Herbicide applied over the top at 3 rates and 2 spray volumes IR-4 Biopesticide PR. NO.: B00102.: 22.

Wilen C. 2017. Preemergent Herbicide Crop Safety Protocol #: 17-010 PRnumbers: 28989, 29065, 28981. Technical report to IR-4: 10.

Wilen C. 2017. What is IPM? UC IPM handout brochure. Versions: English, Spanish, Mandarin

2017 Extension Online Trainings/Videos/Website Tools & Pages

Video: Cómo eliminar plagas de alacena. https://www.youtube.com/watch?v=XZcKzFhLEb0&feature=youtu.be

Video: Cómo controlar hierbas usando mulch. https://www.youtube.com/watch?v=W94Pn7DA1fE&feature=youtu.be

Video: Usando una barrera pegajosa para prevenir hormigas en árboles y arbustos. https://www.youtube.com/watch?v=--bevhZtEIw&feature=youtu.be

Webpage: Invasive and Exotic Pests: Italian white snail (white garden snail) links to information. ipm.ucanr.edu/Invasive-and-Exotic-Pests/ (new)

Webpage: Insectary Plants. ipm.ucanr.edu/mitigation/insectary_plants.html (new)

Website: Coyote Cacher. http://ucanr.edu/sites/CoyoteCacher/ (new)

WERA 1017 Report for Washington State 2017-2018

Doug Walsh, Sally O'Neal, Carrie Foss and Extension IPM Team • Washington State University

ANNUAL REPORT

General/Overall

- Developed and launched a new IPM website, http://ipm.wsu.edu
- Developed and disseminated our first quarterly IPM update *(2018 Quarter 1 Newsletter)* featuring activities of the statewide Extension IPM team, https://ipm.wsu.edu/newsletter/
- *2018 Quarter 2 Newsletter* under development at this writing
- Forged a relationship with WSU's Social & Economic Sciences Research Center (SESRC) to develop and implement surveys to formally assess outcomes and impacts of selected activities

IPM in Agronomic Crops

- Integrated pest management in small grains (wheat, barley)
    - ACTIVITY: Outreach to growers
    - OUTPUTS:
        - Launch of completely overhauled Wheat and Small Grains website, http://smallgrains.wsu.edu
        - Nutrient Management & Precision Application Technology webinar, December 4, 2018
        - Wheat Academy, December 12-13, 2017 (sold out audience)
        - Integrated Weed Management & Insect Pests in Dryland Cereal Systems webinar, December 18, 2017
        - Soil Acidity Workshop, January 4, 2018
        - Crop Tours, 39 from May through early July 2018
        - Multiple episodes of *The WSU Wheat Beat Podcast*
    - SHORT-TERM OUTCOMES:
        - Increased knowledge of the role soil pH plays in grain health and pest complex/management
        - Greater understanding of neighboring growers and their crops and management issues and solutions
        - Increased knowledge of disease diagnostics, soil health, and wheat breeding and the impacts of these factors with respect to weed management and production
        - Documented >1,000 growers received IPM information
        - Increased knowledge of weed management in an IPM context
    - IMPACTS: More effective and sustainable pest control in small grains

- Integrated weed management in pulse crops (chickpeas, lentils, dry peas)
    - ACTIVITY: Outreach to growers
    - OUTPUTS:
        - Web-based herbicide mode-of-action tool launched, https://moapulsecrops.cahnrs.wsu.edu
        - Content updated for Dry Pea, Chickpea, and Lentil sections of *Pacific Northwest Weed Management Handbook*
    - SHORT-TERM OUTCOMES:
        - Better understanding of ways to control, in an IPM context:
            - Mayweed chamomile
            - Common lambsquarters
            - Prickly lettuce
            - Italian ryegrass
            - Other weeds
    - IMPACTS: More effective and sustainable weed control in pulse crops

- Integrated pest management and pollinator protection in alfalfa grown for seed

- ACTIVITY:
  - Outreach to growers
  - Outreach to regulators
- OUTPUTS:
  - Updates to "Pests of Alfalfa Grown for Seed" chapter in *Pacific Northwest Insect Pest Management Handbook*
  - Reports presented to state and regional commodity groups
  - Research and analysis conducted on sulfoxaflor (Transform) as an efficacious pest management tool with minimal impact on pollinators
  - Face-to-face meeting on alfalfa seed pest management and pollinator protection issues with members of U.S. Environmental Protection Agency staff
- SHORT-TERM OUTCOMES:
  - Increased knowledge of pollinator protection methods
  - Increased understanding of Lygus (primary pest) biology and control
  - Improved retention of pollinators
  - Enhanced understanding of pollinator and pest interactions and management on the part of USEPA and other regulatory agencies
  - Re-registration of key pest management tool (sulfoxaflor)
- IMPACTS:
  - Enhanced managed pollinator populations
  - Increased yield
  - Reduced pesticide inputs
  - More economical production of alfalfa seed for national and international markets

IPM in Animal Agriculture

- Integrated pest management and best management practices in shellfish
  - ACTIVITY: Outreach to growers
  - OUTPUTS:
    - Conference Presentations
      - National Shellfish Association, March 2018
      - Journal articles
      - Updates to Aquatic Weed Control section in *Pacific Northwest Weed Management Handbook*
  - SHORT-TERM OUTCOMES:
    - Improved knowledge of aquatic weed control
    - Improved communication between growers, regulators, and environmental groups
  - IMPACTS:
    - More profitable and sustainable shellfish farming
    - Helping stabilize economy in two of state's most disadvantaged counties

IPM in Communities

- Hortsense and Pestsense websites
  - ACTIVITY: Updated both websites
  - OUTPUTS:
    - New images
    - New fact sheets
    - New modules on beneficial arthropods
  - SHORT-TERM OUTCOMES:
    - Additional information available on common landscape, garden, and indoor pest problems
    - New information on beneficial beetles, pollinators, and spiders available
  - IMPACTS:
    - Public is better able to handle indoor and outdoor pest problems safely
    - Fewer nuisance pests creating health problems

        - More judicious/appropriate use of home and garden pesticides

IPM in Specialty Crops

- Outreach in hops
    - ACTIVITY: Finished Managed Pollinator Protection Plan (MP3)
    - OUTPUTS: On-line and printed version distributed July 2019
    - SHORT-TERM OUTCOMES:
        - Increased communication between beekeepers and hop growers
        - Awareness of pollinators within and near hopyards
        - Hop growers support of this document shows support of pollinator protection
        - Dissemination of data from 2014-2015 comprehensive pollinator survey in Yakima Valley hopyards
    - IMPACTS:
        - Documentation to support maintenance of pest management tools in hop
        - Protection of pollinators in and around hopyards

- Outreach in vegetable row crops (potato, carrot, onion, corn, other)
    - ACTIVITY: Grower education, student education
    - OUTPUTS:
        - Dozens of presentations on IPM to growers at multiple state, regional, and national industry meetings
        - Classroom presentations at community college
        - Master Gardener presentations
    - SHORT-TERM OUTCOMES
        - Increased awareness for growers of:
            - Management of Lygus, thrips, aphids and other pests in potato
            - Identification and management of carrot diseases
            - Management of thrips and *Iris yellow spot virus* in onions
        - Basic understanding of vegetable production by Master Gardeners
        - Community college students learning about monitoring for insect pests
    - IMPACTS:
        - Reduced pesticide inputs in vegetable row crops
        - More sustainable carrot, potato, onion, and corn production

- Outreach to growers and among researchers on fungicide resistance in grape
    - ACTIVITIES:
        - Presentations throughout Washington (and into Oregon & California)
        - Popular press interviews and articles
    - OUTPUTS:
        - Information on fungicide resistance management, specifically relating to powdery mildew (PM)
        - Articles in *Good Fruit Grower* magazine
        - Researcher summit in Napa Valley (December 2017)
    - SHORT-TERM OUTCOMES
        - Shared knowledge among researchers
        - Increased grower and industry knowledge of resistance management
            - Scouting strategies
            - Relationship to grape prices
            - Why resistance is increasing
    - IMPACTS
        - Increased scouting prior to spraying
        - Decreased fungicide expense
        - More sustainable grape production

- Cranberry IPM outreach

- ACTIVITY: Multi-modal IPM education
- OUTPUTS:
  - 6 workshops organized, publicized, and presented to growers
  - Fact sheets produced
  - Newsletters written and posted electronically
  - Presentations made at regional and national conferences
- SHORT-TERM OUTCOMES: Increased and updated knowledge among cranberry producers on control of insect, weed, and disease pests in sensitive estuarial environments
- IMPACTS:
  - Restoration and improvement of coastal and estuarial habitats
  - Improved sustainability of cranberry farming in disadvantaged coastal counties

- Brown marmorated stink bug (BMSB) tracking and control
  - ACTIVITY:
    - Consumer-direct outreach regarding presence and control of BMSB (expanding program beyond tree fruit growers)
  - OUTPUTS:
    - Identification materials
    - FAQ lists
    - Presence at Farmer's Markets to educate homeowners
  - SHORT-TERM OUTCOMES:
    - Increased general public's knowledge of BMSB ID and control
    - Homeowners (often the first to spot BMSB in a new area) learned to track BMSB sightings on established WSU database website
  - IMPACTS: General public taking an active role in protecting WA tree fruit and other specialty crop producers to forestall BMSB becoming an economic pest in the region

IPM for Pesticide Applicators

- ACTIVITY: Education about pathogen now in Washington forests and urban areas.
- OUTPUTS: 5-minute educational video, *Ramorum Blight: A Washington Story*
- SHORT-TERM OUTCOMES:
  - Increased knowledge among 1,500 professional pesticide applicators about the causal agent of Sudden Oak Death
  - Disseminated control recommendations
  - Started a conversation about mitigating this disease in urban and recreational areas
- IMPACTS:
  - By forestalling the spread of this invasive disease, recreational venues and natural resources will be saved.

PRIMARY LINKAGES (*=WERA member)

- Webinars with University of Idaho*
  - Integrated Weed Management & Insect Pests in Dryland Cereal Systems webinar
  - Nutrient Management & Precision Application Technology
- Cooperation with Oregon cherry growers with respect to *Western X phytoplasma* research
- Technology transfer with Michigan State University for publication of a region-specific hop IPM handbook
- Walsh and Alston (Utah State University*) co-organized a program symposium, *High-Impact Extension Programs and Methodologies in the Western U.S.,* at the Pacific Branch of the Entomological Society of America in Reno, NV in June 2018. https://esa.confex.com/esa/2018pb/meetingapp.cgi/Session/31925
- Wine grape extension coordination between Oregon State University and University of California Davis with respect to powdery mildew management and fungicide resistance education.
- Collaboration with Washington State Department of Agriculture to produce Pollinator Protection Plans for alfalfa seed and hop.

GRANTS
Awarded between 7/1/17 and 6/30/18

USDA NIFA Crop Protection and Pest Management Program
Washington State IPM Extension Implementation Program 2017-2020
PI: Doug Walsh; Co-PIs: Elizabeth H Beers, Carrie Robin Ross, Brandon Kingsley Hopkins, Drew Lyon, Michelle Moyer, Sally D O'Neal, Kim David Patten, Timothy David Waters, and Carol Ann Miles
New, 9/1/17-10/31/18, $272,998

USDA NIFA Special Research Grants (via UC Davis)
IR-4 Magnitude of Pesticide Residue Trials
PI: Doug Walsh
Renewal, 9/1/17-8/31/18, $55,000

USDA FAS Technical Assistance for Specialty Crops (via UC Davis)
IR-4 TASC Magnitude of Pesticide Residue Trials
PI: Doug Walsh
New, 6/29/17-5/31/18, $13,200

US AFRI (via National Alfalfa and Forage Alliance)
Integrated Pest Management and Pollinator Protection on Alfalfa Produced for Seed
PI: Doug Walsh
New, 1/1/18-12/31/18, $35,000

Washington Hop Commission
Hop Entomology Research
PI: Doug Walsh
Renewal, 1/1/18-12/31/18, $72,005

Washington Hop Commission
Fertilization Pest Disease Nutrient Carryover Into Hops
PI: Doug Walsh
New, 5/1/17-9/30/18, $10,000

Renotech
Characterizing Molecular Mechanisms of EcoRaider for Pest Control
PI: Fang Zhu; Co-PIs: Doug Walsh and Laura Sue Lavine
New, 5/1/17-7/31/18, $25,210

USDA ARS Basic and Applied Research Program
Various (14 separate grants): *Acquisition of Good and Services (11); Evaluation and Development of Hop Germplasm for the Washington State Hop Growing Region; Alfalfa Pollinator Research Initiative; Breeding Disease Resistant Hop Cultivars*
PI: Doug Walsh; Co-PIs: Phillip Miklas, Lyndon Porter, Rick Boydston, Long-Xi Yu, George Vandemark, Jungmin Lee
New or Supplemental, various terms, $449,125 total

Washington Hop Commission
Hop Entomology Research
PI: Doug Walsh; Co-PI: Rick Boydston
Renewal, 1/1/18-12/31/18, $7,000

Western Alfalfa Seed Growers Association
Hop Entomology Research
PI: Doug Walsh
New, 10/1/17-9/30/18, $13,963

US Dry Pea and Lentil Council
Evaluation of Combinations of Commercial Inoculants and Root Health Promoters on Nodulation, Root Diseases, Nitrogen and Phosphorous Uptake and Yield of Popular Green Dry Pea Cultivars
PI: Doug Walsh; Co-PI: Lyndon Porter
New, 7/1/16-12/31/19, $32,000

Washington Hop Commission
Bioassay on a Hop Miticide
PI: Doug Walsh
New, 11/1/17-11/30/20, $6,000

Washington Tree Fruit Research Commission
Native hosts of the Western X phytoplasma
PI: Scott Harper; Co-PIs: Doug Walsh and Alice Wright
New, 2/1/18-12/31/21, $28,580

Agricultural Research Foundation (via Oregon Sweet Cherry Commission)
Native hosts of the Western X phytoplasma
PI: Scott Harper; Co-PIs: Doug Walsh and Alice Wright
New, 2/1/18-12/31/21, $9,527

Mint Industry Research Council
Multi-State Weed Research in Mint
PI: Doug Walsh; Co-PI: Rick Boydston
Renewal, 2/1/15-1/31/19, $5,532

Mint Industry Research Council
Monitoring and Management of Mint Root Borer on Mint
PI: Doug Walsh
New, 2/1/18-1/31/19, $16,023

Washington Mint Commission
Weed Research in Mint
PI: Doug Walsh
Renewal, 5/1/18-6/30/20, $9,359

Washington Mint Commission
Monitoring and Management of Mint Root Borer on Mint
PI: Doug Walsh
New, 7/1/18-6/30/20, $16,023

Washington Wine Commission
Quantifying Grape Mealybug's Efficiency as a Vector of Grapevine Leaf Roll Associated Viruses (GVLRaVs)
PI: Doug Walsh
Renewal, 7/1/16-6/30/20, $21.302

PUBLICATIONS

Peer-Reviewed

Adesanya, A.W., M.A. Morales, D.B. Walsh, L.C. Lavine, M.D. Lavine, & F. Zhu, 2017. Mechanisms of resistance to three mite growth inhibitors of *Tetranychus urticae* in hops. doi:10.1017/S0007485317000414.

Vinchesi, A.C., D.B. Walsh, C. Broadhead. 2018. Assessing Transportation Impacts to Alkali Bees (Hymenoptera: Halictidae) and Alfalfa Seed Production in Southeastern Washington State.

American Entomologist, 64:1, pp. 52-58.

O'Hearn, J., & D.B. Walsh. Evaluating the Toxicity of Candidate Organic and Conventional Insecticides on Western Grape Leafhopper (Erythroneura elegantula) and Virginia Creeper Leafhopper (Erythroneura ziczac) (Hemiptera: Cicadellidae) under Vineyard and Laboratory Conditions.

Nakawuka, P., R.T. Peters, S. Kenny, and D. Walsh. 2017. Effect of deficit irrigation on yield quantity and quality, water productivity, and economic returns for four cultivars of hops in the Yakima Valley, Washington State. Industrial Crops and Products. 98(2017) 82-92.

Patten, K., C. O'Casey, & C. Metzger. 2017. Large-Scale Chemical Control of Smooth Cordgrass *(Spartina alterniflora)* in Willapa Bay, WA: Towards Eradication and Ecological Restoration. Invasive Plant Science and Management 10(3): 284- 292.

Extension Publications/Online Trainings/Videos

Foss, C.R. 2018. Ramorum Blight: A Washington Story. Video created for professional pesticide applicators to familiarize them with this causal agent of Sudden Oak Death, now present in Washington State.

Lyon, D.J., I.C. Burke, and J.M. Campbell. 2018. Integrated management of mustard species in wheat production systems. Washington State University Extension Publication PNW703. Pullman, WA.

Lyon, D. 2018. Peas (Dry) *and* Lentils *and* Garbanzo Beans (Chickpeas). In Pacific Northwest Weed Management Handbook. pnwhandbooks.org

Patten, K., J. Madsen, & V.H. Morgan. 2018. Aquatic Weed Control. In Pacific Northwest Weed Management Handbook. pnwhandbooks.org

Patten, K. & C. Daniels. 2017. 2018 Cranberry Pest Management Guide. Washington State University Extension Bulletin EB0845E. 19pp.

Patten, K., C. Bouska, & J. DeFrancesco. 2018. Cranberry Pests. In Pacific Northwest Insect Pest Management Handbook. pnwhandbooks.org

Rinehold, J., N. Bell, & T. Waters. 2018. Common Pests of Vegetable Crops. In Pacific Northwest Insect Pest Management Handbook. pnwhandbooks.org

Rinehold, J., N. Bell, & T. Waters. 2018. Hosts and Pests of Vegetable Crops. In Pacific Northwest Insect Pest Management Handbook. pnwhandbooks.org

Walsh, D. 2018. Pests of Alfalfa Grown for Seed. In Pacific Northwest Insect Pest Management Handbook. pnwhandbooks.org

Conference Papers (selected)

Adesanya, A.W., M.A. Morales, L. Lavine, D. Walsh, F. Zhu. 2017. NADPH-cytochrome P450 reductase is involved in multiple acaricide resistance in the generalist herbivore, Tetranychus urticae Koch. Paper and Presentation, Entomological Society of America Annual Meeting, November 6, 2017, Denver, CO.

Adesanya, A., M. Wu, L. Lavine, D. Walsh, F. Zhu. 2017. Acaricide resistance of the two-spotted spider mite in hop fields. Poster Presentation, Entomological Society of America Annual Meeting, November 6, 2017, Denver, CO.

Badr, G., Hoogenboom, G., Moyer, M. et al. Precision Agric (2018). Spatial Suitability Assessment for Vineyard Site Selection Based on Fuzzy Logic. Precision Agriculture https://doi.org/10.1007/s11119-018-9572-7

Badr, G., Hoogenboom, G., Moyer, M. et al. Precision Agric (2018). Spatial Suitability Assessment for Vineyard Site Selection Based on Fuzzy Logic. Precision Agriculture https://doi.org/10.1007/s11119-018-9572-7

Lyon, D. 2017. Weed Control in Pulse Crops. Pacific Northwest Vegetable Association annual meeting, Pasco, WA.

Lyon, D. 2017. Weed Control in Pulse Crops. Blue Mountain Seed annual meeting, Walla Walla, WA.

Lyon, D., I. Burke, D. Crowder, D. Whaley, T. Murray, & R. Bomberger. 2017. Fallow Weed Management (Burke & Lyon); Identifying and Managing Insect Pests on the Farm (Whaley & Crowder); Effect of Soil pH on Wheat Diseases (Murray); Diseases and Disease Disorders (Bomberger). Wheat Academy, Dec. 12-13, Pullman, WA.

McCoy, M., M. Moyer, G. Hoheisel, & L. Khot. 2018. Assessing Sprayer Technologies in Washington Vineyards. Washington Winegrowers Association presentation, February 7, 2018, Kennewick, WA.

Moyer, M.M., A.N. Boren, and J.M. Tarara. 2017. Dual Fumigant and Herbicide Use Optimizes Replanting Preparation in a Virus and Nematode-Affected Vineyard. Catalyst: Discovery into Practice: 2: 55-61.

O'Neal, S. and D. Walsh. 2018. Integrated Pest Management of Arthropods on Hops: 2017 Report. American Hop Convention, Palm Desert, CA. January.

Patten, K. 2018. Effect of controlled large-scale *Zostera japonica* removal on estuarine megafauna and microfauna. National Shellfish Association annual conference. Seattle, WA, March 2018.

Patten, K., C. Metzger, & D. Bellamy. 2017. Cranberry field rot, storage rot, fresh fruit keeping quality and yield in Washington as a function of variety, type of fungicide(s) applied, and the number and timing of applications. North American Cranberry Researcher and Extension Workers Conference. Amherst, MA, August 2017.

Waters, T. D., (2017). Bayer Crop Science Potato Growers Meeting, "Management of Lygus and Other Important Potato Pests," Cle Elum, WA, United States of America.

Waters, T. D., (2017). Great Lakes Expo, "Common Carrot Pest and Disease Identification and Management," Michigan Vegetable Industry, Grand Rapids, MI, United States of America. Dec. 6.

Waters, T. D., du Toit, L. J., Pappu, H., Wohleb, C. H., (2017). W-2008 Onion Meeting, "Washington State Onion Report," Grand Rapids, MI, United States of America. Dec 4.

Waters, T. D., du Toit, L. J., (2017). Hermiston Farm Fair, "Common Carrot Pest and Disease Identification and Management," Hermiston Farm Fair Committee, Hermiston, OR, United States of America. Nov 29.

Waters, T. D., du Toit, L. J., (2017). Pacific Northwest Vegetable Association Annual Meeting, "Common Carrot Pest and Disease Identification and Management," Pacific Northwest Vegetable Association, Kennewick, WA.

<u>Classroom Education</u>

Miles, C. (2017) Train the Trainer: Vegetable Grafting Workshop. Curriculum for Master Gardeners, WSU staff, and other interested parties.

Moyer, M.M. (2017). Growing Grapes *and* Disease Management. Curricula for WSU Viticulture Certificate Program.

Waters, T.D. (2017). Vegetable Production Basics. Master Gardener Training, Kennewick, WA.

Waters, T.D. (2017). Monitoring for Insect Pests in Vegetable Crops. Entomology 101, Columbia Basin Community College, Pasco, WA.

Guam State Report to WERA-1017
Robert L. Schlub IPM Coordinator
09/2016-06/2017

Faculty within the University of Guam (UOG) Cooperative Extension & Outreach (CE&O) and the Western Pacific Tropical Research Center (WPTRC) are actively engaged in IPM activities. Some of their activities are reported below.

The disease anthracnose, caused by the fungus *Colletotrichum orbiculare*, has likely been on Guam from the start of the cultivation of this popular crop; however, it wasn't until 1979 that is was officially reported. In 2017 California Dept. of Food and Agriculture confirmed the pathogen as *Colletotrichum orbiculare* CBS570.97+Lars73.

Dr. Robert Schlub launched a project in 2017 to reduce the impact of anthracnose on Guam through the identification and promotion of resistant cultivars. Dr. Schlub's approach is to screen for resistance by inoculating seedlings and then rating their disease severity level. The project's objectives include the following: selection of test cultivars, year-one, authoritative identification of Guam's anthracnose pathogen, year-two, and screening of cultivars and relay of findings to Guam farm community, year-three.

Guam tomato virus research

In early 1980's, *Tobacco mosaic virus* (TMV), *Tomato mosaic virus* (ToMV) and *Cucumber mosaic virus* (CMV) were known to occur on Guam. These three viruses plus *Potato virus Y* (PVY) tested positive with ELISA in 2006. In 2013 a unique strain of *Ageratum yellow vein virus* (AYVV) was identified. *Potato virus Y* (PVY), *Southern tomato virus* (STV), *Tobacco streak virus* (TSV), *Tomato bushy stunt virus* (TBSV), and *Tomato spotted wilt virus* (TSWV) were identified during the period of 2013 to 2015.

In 2017, Guam produced a general audience YouTube video on AYVV https://youtu.be/mG67w0bQSuA.

IPM related activities of UOG researcher Dr. Ross Miller (WPTRC) and extension agent Dr. Aubrey Moore (CE&O) are outlined below:

Little fire ant (LFA), *Wasmannia auropunctata* continues to spread throughout Guam, largely by human movement of infested plants, garbage, or equipment. With funding from USDA CAPS and US Forest Service, Miller's team performed surveys at each treatment site to determine the magnitude and range of the infestation. The area is then treated with low toxicity granular bait called Siesta™. A second insecticide that interrupts the growth cycle of the ants is sprayed on tree trunks and leaves. One week later the team conducts a follow-up survey to check the effectiveness of the treatments, and then six weeks later both insecticides are reapplied and the site is again surveyed. Each site received a total of eight repeat treatments over a period of more than a year. "The only complication we have found is getting 12 straight hours without rainfall to apply the insecticides," said Miller. "The treatment is working beautifully, but the ants continue to spread because of the indiscriminate dumping of LFA infested garbage and green waste."

Greater banded hornet (GBH), *Vespa tropica* has spread throughout Guam. It is best controlled by nighttime applications to the nests of over the counter bee and wasp insecticides, followed by removal of the nest.

Coconut rhinoceros beetle (CRB), *Orcytes rhinoceros* is on the move. It has been attacking coconut trees on Guam since it was first discovered in 2007. The CRB was first detected on Oahu in December 2014 at Joint Base Pearl Harbor – Hickam. So far, CRB has not been detected on other islands. The Department of Lands and Natural Resources on Rota has identified 30 coconut trees in October 2017 with coconut rhinoceros beetle damage (Photo below).

Emergence of *Ralstonia solanacearum* as the primary cause of death and decline of *Casuarina equisetifolia* (ironwood) in Guam, China and possibly Hawaii

College of Natural & Applied Sciences
University of Guam | Unibetsedåt Guåhan

Robert L. Schlub

Extension and Outreach, University of Guam, Mangilao, GU

United States Department of Agriculture
National Institute of Food and Agriculture

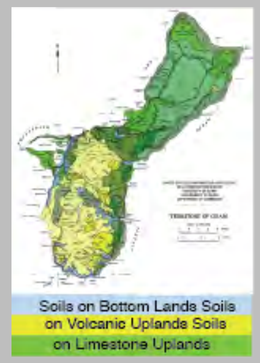
HISTORY

Likely native to the island of Guam, ironwood is considered an integral member of the natural landscape. It is propagated for windbreaks, reforestation, erosion control on beaches and hillsides and for its foliage, which is used as a mulch.

BOTANICAL CHARACTERISTICS

The tree is an evergreen angiosperm, with needle-like jointed branchlets that bear anatomical minute tooth-shaped leaves. Within the Mariana Islands, trees may live to 95 years and obtain height and circumference measurements of 13.7 m and 2.9 m, respectively.

HABITAT AND DISTRIBUTION



In Guam, ironwood grows in low pH volcanic and bottomland soils and high pH limestone and beach soils. Ironwood thickets are a component of Guam's forest surveys, where it is considered a secondary forest species. It grows nearly everywhere with the exception of undisturbed limestone forests.

IMPORTANCE

Casuarina equisetifolia is one of the most common trees occurring on frost-free beaches anywhere in the world and constitutes some 3% of all trees planted in tropical areas. Ironwood's ability to thrive under Guam's harsh conditions of salt spray, typhoon force winds, and drought has been largely responsible for it being one of the dominant trees in the Marianas.

POSITIVE ABIOTIC FACTORS

Trees in sandy shores of Guam respond to water availability by producing a long tap root system when the water level is low and longitudinal roots when the water level is high.

IRONWOOD DECLINE ONSET

Ironwood trees on the island of Guam are in the midst of a decline that was first noticed in 2002. By 2009, there were dozens of stands of dead and dying trees across Guam.

SYMPTOMATOLOGY IN CHINA

Photo provided by Dr. Chonglu, Zhong Chinese Academy of Foresty.

Bacterial wilt in ironwood has been known to occur in China since 1964. Symptoms are more severe than those associated with trees in Guam. In Guam die back generally precedes death, and the formation of bacterial ooze is limited, whereas in China tree death is rapid and copious amounts of ooze often forms.

Photo provided by He Xue-You, Fujian Academy of Forestry.

GUAM IRONWOOD DECLINE CONTRIBUTORS

Biotic factors	Emerging factors	Relevance
Branch dieback	*Pestalotiopsis*	*
Root rot	*Fusarium*	*
Wood rot	*Ganoderma australe*	****
Xylem residing bacteria	*Ralstonia solanacearum*	***
	Wetwood bacteria	**
Nematodes	*Helicotylenchus*	*
Insects	Termites	**
	Selitrichodes casuarinae	*
Abiotic factors	**Emerging factors**	**Relevance**
Weather	Typhoon damage	*
Management	Poor tree care practices	*
Site environment	Poor site selection	**
Host genetics	Lack of genetic diversity	**
Low * to High ***		

SYMPTOMATOLOGY IN GUAM

Symptom progression of ironwood tree decline begins with thinning of foliage (right tree) with little of no internal discoloration progressing to die- back of branches (left tree) and extensive internal discoloration.

Left tree

Right tree

CULTIVAR SELECTION

To increase genetic diversity within Guam's ironwood population, tree seeds from 11 countries were out planted in 2012, and all quickly established. The fastest growing geographically paired provenances were from the Solomon Islands, Vanuatu, Malaysia, and China. The slowest were from Austrailia, Kenya, and Guam.

R. SOLANACEARUM IN HAWAII?

In 2017, symptoms of rapid tree death were reported on a 4-mile stretch of ironwood trees at the Maui Mountains Watershed by Watershed Program Manager, Chris Brosius. Though R. solanacearum has not been reported in Hawaii's ironwood trees, the likelihood of its presence is high considering it has been confirmed in Hawaii on other hosts.

Photo provided by Chris Brosius, Program Manager West Maui Mountains Watershed.

ACKNOWLEDGEMENTS:

Chris Brosius, Chonglu Zhong and He Xue-You.

This work is supported by MacIntire-Stennis FAIN no. NI18MSCFRXXXG061/project accession no. 1005476 from the USDA National Institute of Food and Agriculture.

SELECTED REFERENCES:

Ayin, C.M., Schlub, R.L. Yasuhara-Bell, J., Alvarez, A.M. 2015 Identification and characterization of bacteria associated with decline of ironwood (Casuarina equisetifolia) in Guam. Australasian Plant Pathology (2015) 44:225–234

Fisher, N., Moore A., Brown B., Purcell M., Taylor G., Salle J. 2014. {Two new species of Selitrichodes (Hymenoptera: Eulophidae: Tetrastichinae) inducing galls on Casuarina (Casuarinaceae)}. Zootaxa. 3790:534–542. Schlub, K.A. 2010. Investigating the Ironwood Tree (*Casuarina equisetifolia*) Decline on Guam Using Applied Multinomial Modeling. M.Ap. Stat. thesis, Louisiana State University.

Schlub, R.L., Mendi, R. C., Aiseam, C.C., Mendi, R. C. Davis, J.K. and Aime, M.C. 2012. Survey of wood decay fungi or *Casuarina equisetifolia* (ironwood) on the islands of Guam and Saipan. Phytopathology 102:P416.

1) Cover page

a. Award Number: 2017-70006-27155

b. Project Title: Montana State University's Extension Implementation Plan for Integrated Pest Management

c. Project Director (PD) name: Dr. Mary Burrows

d. Institution name: Montana State University

e. Requested amount: $300,000

2) Review of past accomplishments

Primary Priority 1. Implementation in Agronomic Crops

Objective 1: Real Time monitoring of pests via website and farmer Cooperators

Faculty from five Research Centers participated in monitoring fields in 2017. Seventeen volunteers in 18 counties aided in monitoring for the presence of the orange wheat blossom midge in a total of 88 fields during 2017. A total of 13 counties in Montana reported the presence of the wheat midge in 2017. Wheat midge distribution appears to be concentrated in the northern tier of counties. The website had 378 users, 360 of whom were new with 654 sessions and 4,048 pageviews from 1 May to 1 September, 2017 with the greatest activity in July.

Objective 2: Hands on training for agricultural professionals

The 2018 IPM Entomology Workshop will be held in June of 2018.This is an advanced workshop for 20-25 participants with high quality interaction and hands-on activities. The agenda is online at http://ipm.montana.edu/workshops.html. Certified Crop Advisor Continuing Education units and Pesticide Applicator Credits from Montana Department of Agriculture are offered. The 2017 “Advanced Plant Disease Diagnostics" workshop survey indicated participant’s knowledge was increased. After the workshop, participants were less likely to use pesticides and more likely to set action thresholds and monitor pest levels. In this workshop, 17 participants provide advice for growers in over 31 counties and over 735,800 acres.

Objective 3: Distribute research-based information for pest management

From September of 2017 until May of 2018, 25 Ag Alerts were posted to 1099 email, 130 text, and 13 fax subscribers. Typical outputs for PIs are listed in Table 1 for the calendar year 2017. Specific outputs during the reporting period are also listed below in section 6, additional materials.

Primary Priority 2: IPM Implementation in Communities

Objective 1. Enhance online offerings for urban IPM education

The Urban IPM certification program is an ongoing program. In the spring of 2018 the website was active. Participants could choose to take online classes or participate in a wide variety of in service trainings throughout the state and at annual green industry conferences. Webinars and workshops were announced through the Urban Alert system and through Facebook. Announcements were also sent to state wide green industry professional organizations such as the Association of Montana Turf, Ornamentals and Pest Professionals and the Montana Nursery and Landscape Association. In the reporting period there were 17 Urban Alerts emailed to 370 subscribers and texted to 14 subscribers.

Objective 2. IPM Education in Master Gardener Training

There are currently over 2000 trained Master Gardeners in MT. There are 652 active master gardeners in the state. An online survey conducted December 27, 2017 had 444 respondents. Four hundred and twenty eight participants indicated the average level of understanding of IPM was increased by Master Gardener training. Overall, 98% of respondents are "somewhat likely" to "very likely" to use something they learned from the program. The 2019 IPM Calendar will be distributed in the Fall of 2018. Pictures for the calendar were collected from gardeners from across the state. Each month will have an article on a specific issue facing the urban gardener along with information on identification and management.

Objective 3. Hands on learning opportunities for landscape professionals, Extension faculty and master gardeners, in cooperative in-service trainings with Idaho

In July of 2018 the Horticulture multi-state In-Service will be held in Missoula, Montana in cooperation with Idaho. This two-day workshop will focus on the urban landscape with an emphasis on small urban gardening. Tours, along with seminars, hands on training and demonstrations will be held for in-depth training on issues facing the urban gardener.

Objective 4. Collaborate with Colorado and Utah to update the Intermountain Tree Fruit Guide

MSU included several updates for the latest version of the *Intermountain Tree Fruit Guide* for 2018, including Montana-specific information on irrigation, pesticide information, organic certification, diseases, insects, special programs, and IPM methods. 200 copies will be made available through Montana State University Extension in 2018. The Intermountain Commercial Tree Fruit Production Guide is available as a PDF at http://intermountainfruit.org/IntermountainTFG-2018.pdf

Objective 5. Participate in a webinar series with Utah and Nevada

One hundred and thirty five individuals participated in the Learn at Lunch Webinar "A History and Future of White Pine Blister Rust in North America" on April 24, 2018. Montana State University Extension Integrated Pest Management and Utah State University Forestry Extension co-sponsored the webinar. This webinar examined the biology, disease cycle, and history of white pine blister rust in North America and provided information on cultural control methods and resistance breeding programs for western white pine and whitebark pine. This series is focused on individuals involved in forestry/green industry, such as arborists, foresters, state and federal employees, extension/research professionals and master gardeners. The webinar is available through e-extension at www.youtube.com/watch?v=3OAHkcV-Ffg&feature=youtu.be

Objective 6. Distribute research-based education on pests in urban environments and structures

"Bedbugs and pesticides in the home (MT199406AG)" was revised in April 2018. The newly revised MontGuide includes an updated pesticide table for bedbugs in addition to updated information on treatment options. Typical outputs for PIs are listed in Table 1 for the calendar year 2017. Specific outputs during the reporting period are also listed in section 6, additional materials.

Secondary Priority 1: IPM Support for Pest Diagnostic Facilities

Objective 1. Educate clients of the diagnostic laboratory on IPM-based pest management

Four hundred and eighty one diagnoses were made from September 1, 2017 until May 1, 2018 at the Schutter Diagnostic Lab. Research-based management information was provided upon client request. First reports included the elm seed bug, *Arocatus melanocephalus*, from Ravalli County, damage on a crop (cabbage) by the invasive root weevil, *Cathormiocerus spinosus* in Gallatin County, Fusarium root rot on chia and quinoa from Hill County and Phoma causing on quinoa from Toole county.

In annual year 2017, the major field crops were winter wheat (85 samples, 144 diagnoses), spring wheat (32,51), barley (30,44) chickpea (30,37) and alfalfa (17,27). In alfalfa, spring black stem (*Phoma medicaginis*) was common throughout the season, as well as bacterial stem blight (*Pseudomonas syringae*). Bacterial diseases were also common in barley (11 samples in July). *Wheat streak mosaic virus* was common in spring (15 samples) and winter (32) wheat, although submissions were lower than last year due to drought conditions and successful education in 2017 according to a client survey by Changsoo Song, UNL. Durum wheat (9 samples, 13 diagnoses) were submitted primarily for Fusarium root rot and Fusarium head blight. Chickpeas were primarily submitted for submission of Ascochyta blight (10 samples confirmed), but herbicide injury, drought and root rot were another primary cause for submission. An AgAlert on 6 July

significantly reduced submissions of chickpea, which is a key indicator of the value of this service in helping clients identify crop problems without submitting a sample. Peas and lentils were submitted for leaf spots and root rot, primarily. Chia, quinoa and hemp were interesting minor crop submissions this year. Chia and hemp grown near Big Sandy had Fusarium root rot. Quinoa grown near Shelby had Phoma stem blight. Staff are pursuing greenhouse trials for Koch's postulates and will publish a first report in Plant Disease, pending results.

Following the wet and cool spring in 2017, many trees and shrubs showed symptoms of bacterial diseases. The SDL received a high number of apple and crabapple tree samples with fire blight and bacterial blight as the dominant diseases. Lilac shrubs and trees predominantly showed symptoms of bacterial blight (*Pseudomonas syringae*). Throughout the year, evergreen samples were submitted with symptoms of Cytospora canker and Rhizosphaera needle cast disease. In late summer, Marssonina leaf spot was evident on aspen, poplar and cottonwood trees. Powdery mildew on vegetables, annual/perennial plants, vines, shrubs, and trees was a common occurrence this season. Seven samples were submitted over concern of the potential wood-boring invasive, the Emerald ash borer, *Agrilus planipennis* (no Emerald ash borers were detected). Six bed bug cases were diagnosed, confirming the need for further outreach and prevention for this insect across the state. Leaf-cutting bees (Family Megachilidae) were common around windows and homes (particular those with cedar siding). Eriophyid mites (several species) were diagnosed and causing injury to several woody ornamentals throughout the summer. Outbreaks of spider mites on tree trunks (several species) occurred in several counties, although the spider mite species was not determined. Wheat stem maggots were a common problem in wheat and occurred in one field of triticale.

Accurate plant identification is critical in assessing plant toxicity, and we assisted clients with poisonous plant issues in 2017. For example, several elk died after eating an ornamental shrub, and we confirmed the plant was ornamental yew (Taxus x media), a shrub that can cause sudden death and has also been implicated in wildlife losses in Idaho in residential areas. We are an important resource to accurately identify new plant species in Montana and increase knowledge of our flora. In 2017 we confirmed tumble windmillgrass (*Chloris verticilliata*) for the first time in our state. Our services provide an essential resource for first detectors of high priority pests. For example, in 2017 we identified a suspected sample of common reed (*Phragmites australis* spp. *australis*), a priority 1A plant on Montana's noxious weed list. The sample is currently undergoing genetic testing to confirm our identification. Trends in samples submitted offer opportunities to respond with increased education about emerging agriculture issues. In 2017, we noted a sharp increase in the number of pulse crop samples with symptoms consistent with herbicide carryover. We responded with phone calls, Ag Alerts through email and text, and social media posts to help raise awareness of this issue with growers, consultants, and Extension agents new to pulse crop production.

In June of 2018, a video is being created for sample submission to the Schutter Diagnostic Lab. This video will be posted on the IPM page along with Montana State University affiliated pages such as the IPM eAcademy on YouTube. The video will demonstrate the correct way a sample should be handled in preparation for submission and how not to submit a sample. Two additional videos will be completed during the growing season on "IPM Success Stories" which will highlight producers who have used the services of the SDL and have implemented IPM strategies.

In 2018, we have started accepting digital images for submission through a smartphone app at the request of our stakeholders. Assessment of impacts will be conducted in Fall 2018. This effort was featured in the NIFA 'Fresh From the Field on 17 May, 2018 https://content.govdelivery.com/accounts/USDANIFA/bulletins/1f03a01. Feedback from clients has been very positive.

Objective 2. Extend information on diagnostics services with a focus on local food producers

A one-page resource was created in the Fall of 2017 that lists contact information for MSU specialists http://ipm.montana.edu/documents/2018_IPM_Resources.pdf. This was distributed at MSU Extension field days that were focused on local foods in the Fall of 2017. Additional information will be added in 2018 such as relevant web pages, sample submission and information about IPM.

Objective 3. Provide rapid diagnostic tools to county extension agents

In May of 2018, five extension agents from Ravalli, Pondera, Gallatin, Dawson and Yellowstone counties were supplied with plant disease diagnostic kits for the diagnosis of *Phytophthora* spp., *Erwinia amylovora*, and *Tobacco mosaic virus* (TMV). A log sheet was included in the kit. Data from the log will allow for actual measure of the diagnostic kits' use and impacts.

Secondary Priority 2: IPM Education for Pesticide Applicators

Objective 1. Pest management tour for pesticide applicators

The Montana State University (MSU) Pesticide Education Program offered the Pest Management Tour for pesticide applicators across southcentral Montana. The Private Applicator Training (PAT) District 5, tour ran from October 2nd – 6th Speakers delivered presentations on managing prairie dogs, managing birds, weed management, pulse diseases, pesticide applicator recordkeeping, pesticide drift, herbicide carryover and diagnosing herbicide injury. MSU representatives who spoke on the tour include Dr. Fabian Menalled (MSU Cropland Weed Specialist), Dr. Jane Mangold (MSU Rangeland Weed Specialist), Dr. Jessica Rupp (MSU Potato, Sugarbeet and Pulse Pathologist), Stephen Vantassel (MDA Vertebrate Pest Specialist), Eric Clanton (MDA District Officer) and Dr. Cecil Tharp (MSU Pesticide Education Specialist). The tour covered 10 locations in 5 days. Tour locations were accessible for both the Crow and Northern Cheyenne Reservations. 260 applicators participated in the tour.

Objective 2. Update personal protective equipment kits for hands-on training of pesticide applicators

Fifteen kits will be distributed at the PAT training for new agents in 2019 and 2020.

Objective 3. Interactive training on herbicide carryover and non-target injury for pesticide applicators and educators, private business and the public

During the Fall Pest Management Tour, in October of 2017, a one-hour lecture titled "Understanding how Herbicides Work" and a 1-hour hands-on activity titled "Diagnosing Herbicide Injury" were included in the tour. Participants worked through stations where plants were exhibiting various types of herbicide injury. This was presented at 5 locations with 145 participants.

The publication 'A guide to diagnosing non-target herbicide injury in agricultural and horticultural settings' is in progress. Information and pictures are being gathered during the 2018 growing season. Preventing Herbicide Collateral Damage was the topic of a presentation at the Association of Montana Turf, Ornamental, and Pest Professionals in January of 2017. There were 60 participants.

Objective 4. Delivery of integrated pest management information to pesticide applicators

The MSU Pesticide Education Program coordinates the Montana Private Applicator Program. The Montana private applicator program consists of 5,500 private applicators. The MSU Pesticide Education Specialist provided presentations over 7 core subject areas to 1,803 applicators at 56 pesticide education programs in 2017. In the fall of 2017, 376 participated in workshops by Dr. Tharp.

The MSU Pesticide Education website had 13,552 users from September 1, 2017 until May 9, 2018. There were 16,751 sessions during this time frame.

The Montana IPM Bulletin, a bi-annual publication, is a cooperative effort between Montana State University pesticide education and integrated pest management programs. 300 hard copies of the Spring

2018 IPM Bulletin are distributed to trainers, applicators and other stakeholders. Current and archived additions are available at www.pesticides.montana.edu/news/bulletins.html. There were 218-page views of the Montana IPM Bulletin in 2017. The Montana IPM Bulletin presents critical pest management & pesticide education articles for Montana homeowners, pesticide applicators, farmers and ranchers. These articles are designed to deliver timely updates from an unbiased perspective that are specific to Montana.

3) Prospectus – Plan of Work; no major changes from proposal

Primary Priority 1: IPM Implementation in Agronomic Crops:

Objective 1. Real-time monitoring of pests via a website and farmer cooperators:

In 2018, Orange Wheat Blossom Midge monitoring is underway. Discussions in winter 2018-2019 will determine what pests are targeted in 2019. This program has changed leadership from Bob Stougaard to Jessica Torrion at the Northwestern Agricultural Research Center in Kalispell, MT.

Expected outcomes and impacts: Pestweb website will be maintained, volunteer cooperators will participate in monitoring efforts. Information will be used in educational outreach activities and by growers seeking knowledge about how to manage insect pests. Growers will use the information provided to manage orange wheat blossom midge, leading to economic and quality gains in their crop. A survey of participants will be conducted in fall 2018 to measure impacts of the program and help us assess the existing program and potential improvements.

Objective 2. Hands-on training for agricultural professionals:

Hands on entomology workshop will be held in June 2018; Weed/herbicide damage workshop planned for 2019. Tim Seipel has replaced Fabian Menalled in the role of Extension Crop Weed Scientist.

Expected outcomes and impacts: Participant knowledge about pest management and extension resources will be increased as a result of participation. This knowledge will be used by participants in their consulting activities and misdiagnosis of plant pests will be reduced. A survey of participants at each workshop measures acres participants influence, intention to use the knowledge, and the workshop itself.

Objective 3. Distribute research-based information for pest management:

Efforts will continue including presentations, publications, media, etc.

Expected outcomes and impacts: Participant knowledge about IPM for pest issues is increased by our efforts. PIs reach tens of thousands of participants each year during in-person presentations (2017 data in Table 1), field days, etc. Radio appearances on networks such as the Northern Ag Network reach hundreds of thousands, and a conservative estimate of viewers of Montana PBS 'Montana Ag Live' is 25,000/appearance (http://www.montanapbs.org/MontanaAgLive/).

Primary Priority 2: IPM Implementation in Communities

Objective 1. Online offerings for Urban IPM education:

Additional modules for the online Urban IPM training will be developed during the winter of 2018-2019 including Introductory Entomology, Soil Fertility and Pesticide Safety Education. Existing webinars will be loaded into the system including Marion Murray's 'Abiotic issues in the urban landscape,' Cathy Cripps 'Mushroom ID in Montana,' and others as determined.

Expected outcomes and impacts: Participants' knowledge about established and invasive woody ornamental pests will increase. Participants will also be more likely to change pest management practices through implementation of IPM. Possible measures are the number of urbanipm.org website unique visitors/month as tracked via google analytics, the number of Urban IPM workshops attended, the number

of Urban IPM alert subscribers, the number of subscribers and views of social media platforms, and Urban IPM-trained professional surveys.

Objective 2. IPM education in Master Gardener training:

Efforts will continue; Calendar on pests in the garden will be printed and distributed to Master Gardeners fall 2018; another planned for 2019.

Expected outcomes and impacts: Trained volunteers will have an increased knowledge of yard and garden pests and IPM-based pest management. Pesticide use will be reduced in the yard and garden setting of Master Gardeners.

Objective 3. Hands-on learning opportunities for landscape professionals including cooperative in-service training with Idaho and Utah: The in-service training in 2018 is being hosted by Montana and in 2019 will be hosted by Idaho. Utah could not participate due to budget constraints.

Expected outcomes and impacts: Participant knowledge will be increased by attendance of the workshop. This knowledge will be used in extension education in their communities and with peers to increase pest identification and to utilize IPM practices.

Objective 4. Update the Intermountain Tree Fruit Guide with Colorado and Utah: Completed 2018 and additional revisions will be added as needed; additional printing planned in Y3 of grant.

Expected outcomes and impacts: Grower knowledge of commercial tree fruit pests will increase. Grower demand for IPM-related resources will increase. There will be increased implementation of IPM practices in tree fruits. Possible measures include number of Intermountain Tree Fruit Guides distributed and number of unique website hits for the companion website intermountainfruit.org.

Objective 5. Participate in a webinar series with Utah and Nevada:

Hosted one webinar in 2018, will continue efforts.

Expected outcomes and impacts: Participant knowledge of pests, plant health, weed management, and beneficial insects will increase in the landscape industry. Measures include number of participants and an associated survey of participants.

Objective 6. Distribute research-based education on pests in urban environments and structures:

Efforts will be continued in Y2 including a calendar, color handouts for outreach to local foods, IPM scouting guide, promotional items for sample submission (bookmarks, magnets, hand lenses). A bed bug workshop will be held in September 2018 in conjunction with the director of the Helena Housing Authority, hosted in Helena, MT. The one-day workshop will be held on bed bug biology, prevention, and treatment options.

Expected outcomes and impacts: Urban households and managers of urban spaces (parks, golf courses, hotel owners, landlords, open space operators) will have increased knowledge in pest identification and management. They will be more likely to implement IPM practices and prevention, which will ultimately lead to reduced pesticide use within structural and urban environments. In addition, urban communities will be more familiar with services offered by our team and more likely to seek out research-based information when needed to address urban pests. Possible measures will include number of reported bed bug infestations and surveys to urban households and managers.

Secondary Priority 1: IPM Support for Pest Diagnostic Facilities

Objective 1. Educate clients of the diagnostic laboratory on IPM-based pest management options:

Continuing efforts in diagnostics and IPM-based management.

In June of 2018, a video is being created for sample submission to the Schutter Diagnostic Lab. This video will be posted on the IPM page along with Montana State University affiliated pages. The video will demonstrate the correct way a sample should be handled in preparation for submission and how not to submit a sample. Two additional videos will be completed during the growing season on "IPM Success Stories" which will highlight producers who have used the services of the SDL and have implemented IPM strategies.

Expected outcomes and impacts: Clients will learn how to accurately identify pests and use IPM-based pest management recommendations that are provided as part of our service. This information will be used by clients in their educational efforts. Measures include number of diagnoses and client surveys about management practices.

Objective 2. Extend information on diagnostics services with a focus on local food producers:

IPM team will attend local foods focused field days in 2018, 2019 and distribute informational materials.

Expected Outcomes and impacts: We anticipate that increased outreach about diagnostic lab services will increase sample submission and accurate pest identification by local foods producers. This information will be used to make management decisions increasing the sustainability of their operations. Measures will be increased sample submission from local food producers and local food producer surveys.

Objective 3. Provide rapid diagnostic tools to county extension offices:

Kits have been provided to county offices for the 2018 growing season. In winter 2019 we will assess use of kits, results, and impacts. Project will be continued with adjustments based on stakeholder feedback.

Expected outcomes and impacts: Extension agents will increase their knowledge about plant pathogens. They will also be able to rapidly identify pathogens in the field or their office. This will ultimately reduce disease spread by enabling early identification and therefore increase yield and quality. Possible measures will include annual surveys to measure actual use of the diagnostic kits and economic impacts resulting from the diagnostic services.

Secondary Priority 2: IPM Education for Pesticide Applicators

Objective 1. Pest management tour for pesticide applicators:

Planned for October 2018, 2019.

Expected outcomes and impacts: We estimate the pest management tour will directly target over 600 applicators in the next 3 years, with programs within the Crow, Northern Cheyenne and Flathead tribal boundaries. Knowledge of IPM among participants will be increased.

Objective 2. Update personal protective equipment kits for hands-on training of pesticide applicators:

Kits distributed in 2018, additional kits in 2019.

Expected outcomes and impacts: These kits will be distributed at the 2019 and 2020 PAT Core trainings for new agents. Materials and education will increase the vigilance in applicators following product label requirements; thereby reducing the risk of pesticide poisonings and injuries among agricultural workers and pesticide handlers in Montana.

Objective 3. Interactive training on herbicide carryover and injury for pesticide applicators and educators, private businesses and the general public.

Hands-on trainings have been offered at the Crop and Pest Management School, PSEP update, and the Pest Management Tour. In 2018-2019, the training will be offered at the Horticulture in-service training with Idaho (Priority 2 Objective 3), at the Pest Management Tour (10 locations/year, 2018 and 2019), the

hands-on IPM workship in July 2019, and the 2018 Extension Annual Conference (pending workshop proposal acceptance).

Expected outcomes and impacts: Pesticide applicators and educators, private businesses and the general public will be more knowledgeable about factors contributing to herbicide carryover and injury to non-target plants. This knowledge will transfer to their improved ability to prevent herbicide carryover and non-target injury issues, as well as an improved ability to diagnose non-target injury symptoms and causes. By creating a teaching module for others to use in their pesticide education programs, our reach will be expanded beyond the communities where we give presentations.

Objective 4. Delivery of integrated pest management information to pesticide applicators.

Efforts will continue similar to those summarized above.

Expected outcomes and impacts: Similar participant numbers as detailed above will be reached. The Montana IPM Bulletin will continue to deliver 2 issues per year and a publication (MontGuide) 'Understanding IPM' will lead to an increase in IPM knowledge among readers and significantly benefit trainers across the state.

4) Training

Graduate student Uta Stuhr presented her work on management of Wheat streak mosaic virus at the Northern Agricultural Research Center field day in 2017 and at a grower winter educational meeting in Havre, MT. Post-doctoral research associate Josephine Mgbechi-Ezuri presented an introduction to pulse crop diseases in Havre, MT in Jan 2018. Post-doctoral research associate Tim Seipel presented data on Wheat streak mosaic virus at the Post Farm field day in Bozeman, MT in 2017.

In the remainder of Y1 and Y2, graduate students Ayodeji Owati, Uta Stuhr, Carmen Murphy will participate in field days and IPM related presentations including the hands-on agricultural entomology workshop in July 2018. Graduate student Chance Noffsinger will be performing a one-month internship in the Schutter Diagnostic Laboratory. Tim Seipel, post-doctoral research associate, will be assuming the extension and IPM project duties of Fabian Menalled.

Rapid plant disease diagnostic kits were provided to five agents (Patrick Mangan- Ravalli County, Josh Bilbao-Gallatin, Adriane Good-Pondera, Callie Cooley-Yellowstone and Bruce Smith- Dawson County) in counties representing all regions of the state. Agents will use kits from May of 2018 until September of 2018. They will record the date used, host, test results, client type and whether or not the test was easy to use.

A 1.5 day stakeholder advisory committee and planning retreat was held in November 2017. Most IPM PIs and staff attended a half day Myers-Briggs communication exercise in October 2017.

5) Concluding Statement

The Montana State University IPM Program has created a communication network that allows Montanans to find the resources they require in a style that best suits their needs. Outreach to farmers, green industry professionals and homeowners can be challenging due to distance, access to technology and scarcity of specialists. By not relying on traditional methods of outreach, the IPM Group has been able to reach tens of thousands of stakeholders across the state. We reach participants in many ways including in-person presentations (over 5000 participants per year), via media including press releases, text, radio, television, and print media, farmers markets, calendars, Twitter and Facebook. In a large state with a relatively small population and relatively few specialists in the IPM arena, we work closely with our

stakeholders to identify and prioritize topics for education, the best way to deliver that education and measure impacts of our work. The cornerstone of the IPM program is the Schutter Diagnostic Lab housed at Montana State University in Bozeman, Montana. An average of two thousand samples are submitted annually to the Scutter Diagnostic Lab with an average of $2 mil in economic impact. Our clients have asked for increased digital diagnoses, and we started accepting samples via a smartphone app in 2018 that has been very well received. Diagnostic samples allow us to predict trends in pests, collect samples for research in Montana and other states, and provide first detections for invasive pests. We are increasing our engagement with the local foods movement in urban areas, a growing business opportunity that has a high need for accurate pest identification in high crop diversity situations with a low threshold for crop damage. The annual Pest Management Tour is an educational opportunity provided by the pesticide education program and the IPM program. The 4-day tour focuses on one of five regions each year. An average of 300+ participants take advantage of the tour workshops. In 2017 the tour visited ten locations. The pesticide education program reaches approximately 5,500 private applicators. The Master Gardener Program has trained 2,000 people over the past 4.5 years. Each master gardener donates 20 to 40 hours a year to community service. Agricultural and Urban Alerts are distributed via email, text, and fax. These time sensitive alerts, focus on issues in the fields and urban landscapes. Forty two alerts have been distributed to 1469 email, 144 text and 13 fax subscribers since September of 2017. The MSU Pestweb Project monitors orange wheat blossom midge which attacks spring wheat. The project serves as an early warning system to help producers track wheat midge adult emergence and distribution. Five MSU research stations distribute and monitor pheromone traps. Thirty MSU Extension agents dispense traps to farmers & consultants and have 57 volunteer cooperators. 200 fields in 51 counties were monitored. The foundation of the Montana State University IPM Program is its stakeholders. They provide the input that directs the path in which the program evolves. Farmers, consultants, green industry personnel and homeowners have access to resources that would be scarce if not provided by the IPM Program. We collaborate with other western states including Idaho, Utah, and Nevada as well as regionally with our Western Region IPM Center and relevant committees regionally, nationally, and internationally (Canada). The funding that the MSU IPM program receives is a benefit to the state of Montana and all the communities that make up the Big Sky Country.

6) Additional materials

Table 1. Summary of outputs from each PI on the EIP project during 2017 including number of presentations, number of participants, number of extension documents, books, manuscripts, magazine and other media contributions. This data is considered typical of the team's productivity.

Name	No. presentations	No. participants	No. extension documents	No. books	Published journal manuscripts	Magazine contributions	Other media contributions
Burrows	5	849	2	1	1	1	12
Mangold	16	996	7		5	1	5
Kerzicnik	14	723	1			1	5
Orloff	7	244	2		3		
Tharp	7	376	6		1	3	
Menalled	10	744	3				3
Day	20	1,204				3	8
Grimme	5	385					8
Totals	84	5,521	21	1	10	9	41

Photos and press releases about IPM in Montana

Priority area 1. Agriculture

Garfield County extension agent, Eric Miller, looks at a spring wheat variety infected with Wheat streak mosaic virus at the Post Research Farm in Bozeman, MT during the Advanced Plant Disease Diagnostic Workshop, July 2017

Crop consultants working on a hands-on plant disease epidemiology exercise at the Advanced Plant Disease Diagnostic Workshop, July 2017

A wagon full of attendees of the Northern Agricultural Research Center field day in July, 2017. This was during a severe drought.

Graduate student Uta Stuhr (Germany) presents on Wheat streak mosaic virus in front of her NIFA-funded research trials in Havre, MT during July 2017.

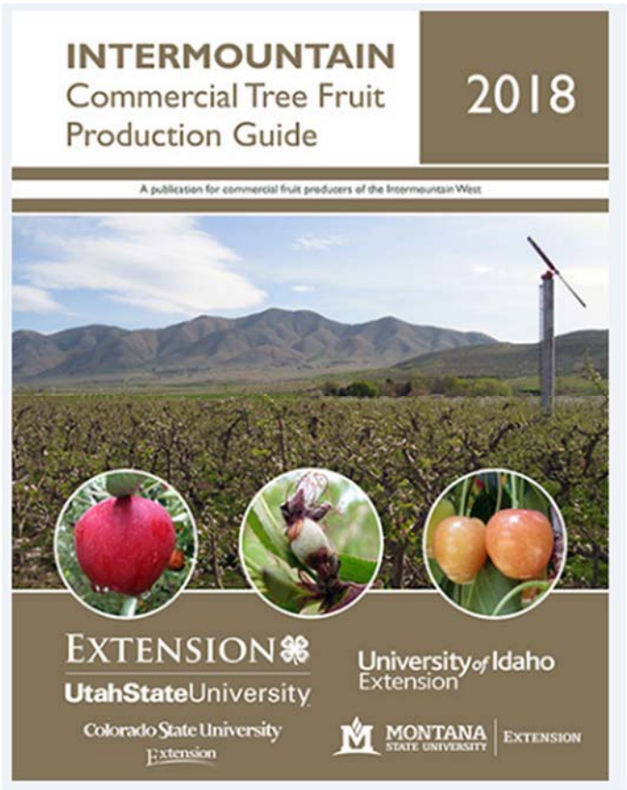
Dr. Jessica Rupp and Dr. Myron Bruce presenting on the use of drones for plant disease detection at the Northern Agricultural Research Center field day in July, 2017.

Priority area 2. Community IPM

Toby Day talks about tree pruning at a Tree Workshop in Havre, MT. March 24, 2017.

Toby Day discussing heritage orchards and apple production in Montana at the Twilight Tour September 8, 2017. Talks and presentations on specialty crops, agricultural production and information on Farm Service Agency loans. The event is slated to educate current and future producers about organic and specialty crops, small scale agriculture, current production trends, best practices and production ag financial management. The event will include local producers, Extension specialists, and Farm Service Agency representatives.

Adam Sigler taste testing cherry tomatoes at the Hort farm Twilight Tour Field Day September 8, 2017.



The Intermountain Tree Fruit Guide was updated in the Spring of 2018

Montana coordinated the Learn at Lunch Webinar with Utah and Nevada. There were 135 attendees at the live presentation and the webinar is posted on eXtension.

Secondary Priority 2 IPM Education for Pesticide Applicators

Montana IPM Bulletin

MONTANA STATE UNIVERSITY | EXTENSION

Spring 2018

Sticky Barriers Protect Urban Trees from Aphids

Ruth O'Neill, Research Associate, MSU Dept. of Plant Sciences and Plant Pathology

In the early spring on a warm day, just as leaf buds are breaking, you may see numerous ants running up tree trunks, investigating twigs and buds. Look closely, and you may see tiny, newly-hatched aphids running along the trunks and twigs as well. If the leaves are already unfolding, you may see aphids, singly or in clusters, feeding on the undersides of new leaves, with ants lingering near them.

What is going on?

The Problem: Aphids are fragile, sap-feeding insects with straw-like mouthparts. They cause serious leaf damage to many garden flowers, vegetables, shrubs, and trees (Figure 1), and they can vector certain plant diseases. Aphids also excrete a large volume of excess plant sap in their waste or "honeydew," which is a nuisance for homeowners when it coats sidewalks, cars, and anything else outside. Plus, honeydew provides a sugary growth medium for black sooty mold, which is unsightly.

However, honeydew is also a valuable food source for many animals. This is particularly true of ants, who collect the droplets of honeydew directly from the aphids' back ends, before it ever hits the ground (Figure 2). Diverse species of ants and aphids (and some of their relatives, like scale insects) have evolved simple or complex mutualistic relationships, with ants herding the aphids, and guarding them from their natural enemies in exchange for the honeydew reward. It's a cooperative relationship, benefitting both sides.

Aphids are prolific reproducers in the spring, even skipping the normal insect egg stage to speed matters up. Instead they give live birth to female clones, who will themselves become aphid-clone-making machines, at a rate of about five births per day in the spring. But aphids have many common and widespread natural enemies that curb their numbers, including damsel

(continued on page 2)

Vernonia. Photo by Inna Smith.

INSIDE:

FIGURE 1. Plum leaf curl aphids, *Brachycaudus helichrysi*, are a common problem on plum trees, causing twisted, stunted leaves. Photo by Whitney Cranshaw, Colorado State University, bugwood.org.

FIGURE 2. Worker ant collecting honeydew from an aphid. The aphid is not harmed by this process. Image: Börsinger Friedrich (licensed under Creative Commons).

Montana IPM Bulletin

MONTANA STATE UNIVERSITY | EXTENSION

Fall 2017

Cercospora Leaf Spot on Sugarbeet

Jessica Rupp, Extension Potato, Sugarbeet, and Pulse Pathology

Cercospora leaf spot (CLS), caused by the fungus, *Cercospora beticola*, is considered the most important foliar disease of sugarbeet in Montana. Yield losses can approach 40% or more under conducive environmental conditions. Losses are attributed to loss of leaf area to the lesions, and the toxins, cercosporin and botricolin produced by the fungus. As the sugarbeet invests more energy to produce more leaves, sugars are unable to be stored in the root.

CLS produces round lesions that are very small, 3-5 mm in diameter. Spot centers appear light brown to brown (Figure 1). As the disease progresses the lesions may coalesce (Figure 2). The toxins cause rapid leaf death. Spots can also be found on petioles, where they may appear more elongated. Full leaf death of these leaves supplying most of the energy for sugar production can occur in serious infections (Figure 3).

The fungus survives between seasons in infected leaves and stems and requires water films, or very high humidity and temperatures ranging from 68°F to 79°F. The disease is most damaging in warm, humid summers. A full disease cycle can take place in as few as 10 days.

Weather models exist to help growers predict the environmental parameters for action, as well as yield loss components. Daily potential infection values (DIV's) are based on the number of hours per day where humidity is greater than 90% and hourly recorded temperatures. These values are then expressed as a number between 0-7 using a model developed by Shane and Teng, 1984. These representative values are then added together for two-day totals to create a DIV of 0-14. Values of 7 or above indicate high risk. In Montana, values between 4-6 are considered conducive for disease development. It is critical to apply a fungicide when conditions first favor disease. Late application of the first spray often leads to difficult season-long control regardless of subsequent fungicide application timings.

When discussing fungicide resistance, it is important to understand that this designation means that the fungus is unaffected by the fungicide that previously gained control in the field. This differs from the term tolerance. In this instance, tolerance means that the fungus growth is reduced under a level of fungicide that previously prevented fungal growth. If tolerant strains are found in the field, growers can expect a reduced level of control. If resistant strains are present in the field, growers will see no control. Resistant isolates of CLS are present in states surrounding Montana, but only tolerant isolates have been found in Montana. It is very critical to rotate fungicide mode of action, both in season, and into the following season. If you suspect either scenario of tolerance or resistance in your field, please contact your local MSU Extension office or Schumer Diagnostic Lab (994-5150).

It is recommended that growers be especially aware of CLS resistance to the benzimidazole class of fungicides; although not found yet in Montana. Because the potential development of fungicide resistance in this class is particularly high in Montana, MSU recommends that a tank mix be used with a benzimidazole (thiophanate methyl) and TPTH (triphenyltin hydroxide). Mix according to label instructions. Labels may be found at www.cdms.net. Research

(continued on page 2)

FIGURE 1. Early infection of sugarbeet with CLS. Lesions are small and round with a dark brown border. Photo: Jessica Rupp

INSIDE:

A Self-Learning Resource From MSU Extension

MONTANA STATE UNIVERSITY EXTENSION

MontGuide

Bed Bugs and Pesticides in the Home

by Lauren Kenzlonik, Associate Extension Specialist, Department of Plant Sciences and Plant Pathology; Cecil Tharp, Pesticide Education Specialist, Department of Animal and Range Sciences; and Amy Bowser, Pesticide Education Technician, Department of Animal and Range Sciences

Bed bugs are blood-feeding pests that are invading human living quarters in increasing numbers.

MT199406AG Revised 04/18

BED BUGS OCCUR REGULARLY IN MONTANA, though at low numbers relative to many other locations in the U.S. As is true elsewhere, infestations of these nocturnal blood-feeders appear primarily in rooms where people sleep, particularly in bedding. Places where there is abundant human traffic arriving from diverse locations (such as apartment complexes, health care facilities, and tourist accommodations) have increased odds of infestation and must be monitored carefully.

Risk Factors

While sanitation helps, even the cleanest indoor environment may harbor bed bugs. An accommodation that has frequent turnover of residents and high-density stays is at higher risk for bed bug infestations. Although smaller cities are not exempt, larger cities tend to have higher instances due to increased cases fitting the above criteria.

Identification, Life Cycle, and Effects on Humans

Bed bugs are reddish-brown, oval, flattened, wingless, blood-feeding insects that are just under one-quarter inch long (Figure 1). Females may live for a year, depositing up to 400 eggs in their lifetimes. This may lead to heavy infestations over short periods of time. Severe infestations can cause anemia in children and the elderly and lead to sleeplessness and stress in the home. Bed bugs have not been found to vector human diseases, yet they are still medically important because many people suffer from unpleasant allergic reactions to the saliva injected with the bite, typically appearing as red circular welts (Figure 2). Once the mouthparts are completely inserted, bed bugs can't get away quickly if disturbed. However, they can move early in the feeding sequence and are quick to move a short distance if disturbed. A very small percentage of people (less than 20%) do not exhibit bite reactions and are not aware of having been bitten.

After feeding, bed bugs move away and lie inactive for several days before depositing a cluster of white eggs. Females seek another opportunity to feed after deposition of eggs, a cycle repeated throughout their lifetime. Because bed bugs hide during the day the first sign of an infestation may be streaks of blood or fecal spots on bedding. Also inspect all crevices and gaps within bedrooms for insects, cast skins, and eggs. High populations have been noted to smell like raspberries.

FIGURE 1. Adult bed bug (photo by Ruth O'Neill). Insect shown actual size.

FIGURE 2. Bite welts.

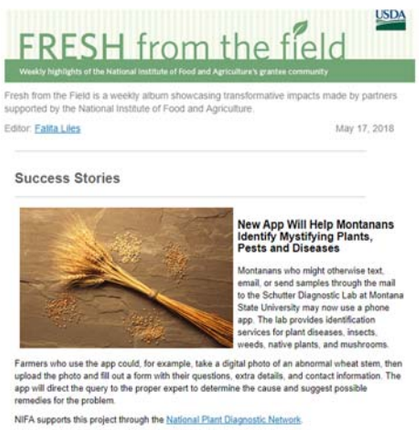
For More Online MontGuides, Visit www.msuextension.org

Primary Priority 2 Objective 6 – Pests in urban environments and structures
The Bed Bugs and Pesticides in the Home MontGuide was updated.

Representative press releases:

New app will help Montanans identify mystifying plants, pests and diseases
http://www.montana.edu/news/17621/new-app-will-help-montanans-identify-mystifying-plants-pests-and-diseases

MSU Extension plant pathologist receives Fulbright to Australia
http://www.montana.edu/news/17623/msu-extension-plant-pathologist-receives-fulbright-to-australia



FRESH from the field

USDA

Weekly highlights of the National Institute of Food and Agriculture's grantee community

Fresh from the Field is a weekly album showcasing transformative impacts made by partners supported by the National Institute of Food and Agriculture.

Editor: Falita Liles May 17, 2018

Success Stories

New App Will Help Montanans Identify Mystifying Plants, Pests and Diseases

Montanans who might otherwise text, email, or send samples through the mail to the Schutter Diagnostic Lab at Montana State University may now use a phone app. The lab provides identification services for plant diseases, insects, weeds, native plants, and mushrooms.

Farmers who use the app could, for example, take a digital photo of an abnormal wheat stem, then upload the photo and fill out a form with their questions, extra details, and contact information. The app will direct the query to the proper expert to determine the cause and suggest possible remedies for the problem.

NIFA supports this project through the National Plant Diagnostic Network.

https://content.govdelivery.com/accounts/USDANIFA/bulletins/1f03a01

MSU Extension horticulture specialist Day honored
http://www.montana.edu/news/17418/msu-extension-horticulture-specialist-day-honored

Western Region IPM Story: IPM in Montana
http://westernipm.org/index.cfm/ipm-in-the-west/agriculture/ipm-in-montana/

Presentations

Burrows

1. The importance of crop rotations for disease prevention and management, December 1, 2017
2. Field Crop Diseases, November 29, 2017
3. Plant diseases Diagnostics, November 17, 2017
4. Wheat streak mosaic virus: a persistent threat to wheat production, October 26, 2017
5. Wheat streak mosaic virus: a persistent threat to wheat production, October 25, 2017

Mangold

1. Invasive grasses, May 16, 2018
2. Cheatgrass management, April 24, 2018
3. New invaders, April 24, 2018
4. Integrated weed management in forages, April 5, 2018
5. Rangeland weed management, March 20, 2018 - March 22, 2018
6. Invasive annual grasses, March 14, 2018
7. Managing weeds during drought, February 16, 2018
8. Current affairs in invasive plants, February 7, 2018
9. Integrated pest management: Weeds, February 2, 2018
10. Invasive plants, the new and the ruthless, January 4, 2018
11. Identifying and managing weeds in Park County, October 28, 2017
12. Weeds from obnoxious to noxious, October 26, 2017
13. Grassland restoration ecology, October 23, 2017
14. Yellow and desert alyssum; managing weeds after wildfire, October 3, 2017 - October 6, 2017
15. Diagnosing herbicide injury, October 2, 2017 - October 5, 2017
16. Online Course, Montana Realtor Noxious Weed Online Training, February 1, 2016 - Present

Kerzicnik

1. *14 Apr 2018_Insect and spider booth Helena MG Celebration",*
2. *14 Apr 2018_Insect friends and foes Helena MG Celebration*
3. *2018_AMTOPP_Insecticide challenges: why isn't this working",*
4. *2018_Tour of Schutter Diagnostic Lab",*

5. *2018_Insect Pests in Montana Orchards",*
6. *2018_Spiders_facts and myths MEEA Conference",*
7. *2018_Tree Care Workshop",*
8. *2017_New Agent Tour with Larry Brence and John Pfister",*
9. *2017_USDA-ARS_update on the Schutter Lab and Cropland Insects",*
10. *2017_MAES Advisory Council plant app training",*
11. *2017_Urban Tree IPM Workshop-24 October 2017*
12. *2017_Lewis and Clark County_Master Gardener Level II Insect Identification"*
13. *2017_Missoula Farmer's Market",*

Orloff

1. Early Detection of Potential New Invaders in Eastern Montana, April 11, 2018
2. Cheatgrass and Other Annual Grasses in Rangeland, April 3, 2018
3. Workshop, Identifying Montana's Residential Trees, March 24, 2018
4. Cheatgrass and Other Annual Grasses in Rangeland, February 6, 2018
5. Preventing Herbicide Collateral Damage, January 30, 2018
6. Urban Trees: Applied Integrated Pest Management, October 24, 2017
7. Noxious Weed Identification, September 20, 2017

Tharp

1. "Pesticide Safety and PPE", November 21, 2017
2. "Forage IPM", MSU Animal and Range Science, Gallatin County, October 11, 2017
3. "New Agent Orientation", MSU Pesticide Education Program September 13, 2017 - October 23, 2017
4. "How to clean pesticide sprayers", MSU Pesticide Education Program, October 2, 2017 - October 6, 2017
5. "Water Quality and Pesticide Performance", October 2, 2017 - October 6, 2017
6. "Pesticide Drift", October 2, 2017 - October 7, 2017
7. "Water Quality and Pesticide Performance", September 19, 2017

Menalled

1. "Cropland Weed Extension December 12, 2017
2. "The Fort Ellis Project December 8, 2017
3. "The Fort Ellis Project December 8, 2017
4. "Climate change 101, October 23, 2017
5. "Understanding how herbicides work October 1, 2017 - October 4, 2017
6. "Identifying herbicide injury, October 4, 2017
7. "Reducing the risk of herbicide carryover, October 5, 2017

Grimme

1. "Common Plant Diseases in Montana, 4/28/2018
2. “Diseases of Trees and Shrubs, 5/10/2018

List of agalerts distributed to email (1099), text (130) and fax (13) subscribers in the reporting period.

Alfalfa blotch leafminer found in MT – a pest to watch for in 2018.	Ruth O'Neill	10/6/2017
New Requirements for Farmers using Dicamba Products on Dicamba Tolerant Soybeans.	Cecil Tharp	10/16/2017
Think about long term disease control when planning rotations with pulse crops	Mary Burrows	10/17/2017
Pulse Education webinars offered by USDPLC	Mary Burrows	10/30/2017
2018 Crop and Pest Management School, Registration Open	Ruth O'Neill	10/31/2017
Register now for the 2018 Crop and Pest Management School, MSU-Bozeman, January 2-4!	Ruth O'Neill	12/9/2017
Regional Pesticide Education Trainings offered across Montana in 2018.	Cecil Tharp	12/19/2017
Schutter Diagnostic Lab samples	Laurie Kerzicnik	7/11/2017
Extended Registration for 2018 Crop and Pest Management School (it's not too late!)	Ruth O'Neill	12/28/2017
Pesticide Applicators should be aware of new WPS Requirements as of January 1st, 2018.	Cecil Tharp	1/2/2018
New RMA statement for chickpea: organic grower's options	Mary Burrows	1/12/2018
Reoccurrence of new pest - pea weevil in Montana	Mary Burrows	1/16/2018
Webinar: "Drones in Ag: The Wild West"	Eva Grimme	1/16/2018
Bat Standards Course Offered by NWCOA	Cecil Tharp	1/19/2018
Fungicide guides for pulse crops	Mary Burrows	2/12/2018
Fungicide guides for pulse crops	Mary Burrows	2/12/2018
Pythium Root Root active ion many crops	Mary Burrows	5/21/2018
Worker Protection Standard Trainings (WPS) across Montana	Cecil Tharp	4/6/2018
Last Chance Private Applicator Opportunities offered in South-Central Montana.	Cecil Tharp	11/8/2017
Wheat fungicide table for 2018	Mary Burrows	4/20/2018
Snow mold in winter wheat this spring	Mary Burrows	4/20/2018
Public comment period, risk assessment for four neonicotinoid insecticides	Ruth O'Neill	1/30/2018
Decreasing Pesticide impacts to pollinators: Best Management Practices and Fieldwatch	Ruth O'Neill	5/08/18
Chickpea Seeding Date	Mary Burrows	5/14/18
Winter Killed Crested Wheat grass and Yellow Alyssium	Leslie Orloff	5/18/18

List of urban alerts distributed to email (370) and text (14) subscribers in the reporting period.

Dirt-colored seed bug	Laurie Kerzicnik	9/8/2017
Elm seed bug	Laurie Kerzicnik	9/7/2017
Seasonal Needle Drop	Eva Grimme	10/10/2017
Survey for Ornamental Plant pests	mary burrows	6/6/2017
Leafcurl ash aphid_9 June 2017_statewide_curling evident in Missoula County	Laurie Kerzicnik	6/9/2017
Webinar on "Identifying and Remedying Abiotic Injury of Certain Fruit, Vegetable, and Ornamental Pla	Eva Grimme	1/23/2018
Webinar on "Conifer Diseases I Have Loved"	Eva Grimme	1/30/2018
Webinar on "Occurrence of Bark Beetles following Wildfire"	Eva Grimme	2/20/2018
Webinar on "Soil Health in Residential Settings"	Eva Grimme	2/13/2018
Webinar on "How should Biopesticides be evaluated and recommended for use in Vegetable Disease Management Programs?"	Eva Grimme	3/5/2018
Snow Molds in Lawns	Eva Grimme	3/27/2018
Tuxedo bug, Raglius alboacuminatus_Gallatin Co. and surrounding areas	Lauren Kerzicnik	4/12/2018
Webinar_A History and Future of White Pine Blister Rust in North America_24 April 2018	Lauren Kerzicnik	4/17/2018
Ticks are out	Lauren Kerzicnik	4/30/2018
Fireblight – Symptoms and New Resources	Eva Grimme	5/15/2018
Codling Moth and Bee-Safe Spraying_statewide	Lauren Kerzicnik	5/22/2018
Sculpured pine borer_Chalcophora sp._statewide	Lauren Kerzicnik	5/30/2018

Timeline for EIP project, Y1-Y3. Hashed lines indicate task is associated with evaluation.

WERA-1017 2017-18 Utah State Report
Marion Murray and Diane Alston, Utah State University (USU)

Accomplishments of IPM in Specialty Crops (fruit, vegetable, nursery)

Activities and Outputs

- IPM Advisories (periodic newsletters with advice on pest activity and IPM recommendations tailored to commercial and home garden producers)
    - Fruits and Vegetables (23 delivered in 2017)
    - Content: weekly scouting by IPM staff plus reports from volunteers and growers
    - Updated advisory format to a blog style to make it more user-friendly (https://pestadvisories.usu.edu/)
    - Subscriptions (as of July 2018): 11,095 for fruit (up 9% over 2016-17), 10,420 for vegetable (up 6% over 2016-17)
    - Over 400 archived advisories
- Utah TRAPs ("Temperature Resource and Alerts for Pests", a web and mobile app pest management tool)
    - Funding: grants, grower support, collaboration with the Utah Climate Center
    - Access to 77 weather stations - added 8 weather station locations
    - 12 insect and disease models – added codling moth "formula biofix" degree-day model
- Utah Pests Quarterly Newsletter
    - 4 issues published in 2017
    - Updated the newsletter format
    - 8,550 newsletter subscribers (up 9% from 2016-17)
- Crop production guides updated in 2018: Intermountain Tree Fruit Production Guide (http://intermountainfruit.org/)--collaborative guide with USU, Colorado State University, University of Idaho, and Montana State University, and Utah Vegetable Production Guide (https://vegetableguide.usu.edu/index)
    - Fruit guide printed in March; 175 copies distributed to growers, Extension offices, garden centers and farm stores
        - Updated website content with new pest biology and management information
        - Updated the customized pesticide search, where results show mode of action and pollinator/beneficial toxicity ratings
    - Vegetable guide printed in June and copies to be distributed
- Other publications on specialty crop pests
    - Wrote and printed full-color guides: Vegetable Pest Identification Guide and Beneficials Identification Guide. Distributed over 400 copies of each at workshops and conferences to producers and Master Gardeners. (Collected emails and impact survey to be disseminated in 2018-19)

    - 5 new or updated fact sheets in 2016-17, and one Spanish translation: vegetable aphids, leafrollers in orchards, European cherry fruit fly, spotted wing drosophila (update), and soil health evaluation; peach leaf curl (Spanish)
- Other
    - Fall Fruit School (38 in attendance; 40-60 streamed live)
    - 12 fruit and vegetable grower meetings and two field days
    - Brown marmorated stink bug and spotted wing drosophila outreach (11 presentations across the state attended by over 300 producers)
- Leveraged grant funding in 2017-18
    - $101,284, including codling moth mating disruption, brown marmorated stink bug management, vegetable pest surveys, and updates to online pest models
    - $30,052 in pending grant funding for future IPM research and extension programming
- Applied Research
    - Survey of potential wild fruit hosts for spotted wing drosophila has found SWD populations can be high in native riparian sites (canyons) of the Intermountain West (collaboration with University of Idaho).
    - Ecology of brown marmorated stink bug (BMSB) in the landscape, and native natural enemies has found urban landscapes support early-season build-up of BMSB that can then move into agricultural sites, and identified more than six native parasitoid wasps that will attack BMSB.
    - Evaluation of low-toxicity insecticides for control of western cherry fruit fly has found several anthranilic diamides provide systemic protection of fruit from eggs and maggots, and no harmful non-target effects.
    - Validated a new codling moth biofix-setting option by field-checking phenology in Utah orchards.
    - Evaluated biochar as a soil amendment and inhibitor of root disease of vegetables, and found a 3-year average increase in yield of tomatoes at 15%, and melons at 4%, but no improvement in disease tolerance
    - Survey of vegetable crops for new and emerging pathogen and arthropod pests is assessing expansion and establishment of leafminers, tomato spotted wilt virus and zebra chip disease in Utah commercial vegetable fields.

Short-term Outcomes

- Tree Fruit Industry IPM Survey (funded by WIPM Center)
    - IPM Practices in Use:
        - Use USU or personal degree day calculators for insect pest activity (42%)
        - Use fire blight prediction model for antibiotic decision-making (36%)
        - Spray based on thresholds (57%)
        - Select resistant root stocks (53%)
        - Identify beneficials when scouting (60%)
        - Hotspot treatments (58%)
    - Change in IPM self-label over time

        - 46% of fruit growers in 1996, 65% in 2010, and 71% in 2017.
        - In 2017, 21% considered themselves high-level IPM-users (low-level plus at least four additional practices).
        - For commercial fruit and vegetable advisory subscribers, those that labeled themselves as "no IPM" decreased by 78% (from 14% to 4%), and those that considered themselves "high IPM" practitioners increased by 78% (from 5% to 9%).
    - Pesticide Use: The proportion of farms with decreased and unchanged pesticide use was greater in 2017 than 2010 across all fruit crops. In 2010, pesticide use increased on 22-35% of fruit farms; whereas in 2017, use increased on only 7-13% of farms
- Results of Other Impact Evaluations
    - Applied research results help to reduce pesticide use and save money. For example, growers using biochar for tomato production may be able to increase profits by almost $5,000 per year, per acre from increased yield and plant health.
    - The in-app survey for the Utah TRAPs app shows that the app is helping over 90% of users to improve their pest management practices due to improved timing.
    - The in-app survey for the Fruit PestFinder app shows that almost 95% of users have learned new IPM practices for at least one pest.
    - The Intermountain Fruit Guide pesticide search survey found that 48% of respondents felt that the search feature helped them to save time and make better pesticide decisions.

Accomplishments of IPM in Communities (landscape, market and home garden)
Activities and Outputs

- Pest Guides for Woody Ornamentals and Turf
    - Over 1,000 copies of this guide were distributed to green industry professionals, Master Gardeners, Extension offices, garden centers, schools, and nurseries
- Training for Master Gardeners, community gardens, small acreage and organic farmers, municipal landscapers, and USU Extension agents
    - Over 600 people received training in IPM practices for small-scale farm and garden production
- Updated core IPM website and added 68 pest "briefs"
- Collaboration with Utah Urban and Small Farms Conference, organized by USU Extension and multiple community partners; major funding comes from a USDA NRCS Risk Management Agency grant
    - The Utah IPM Program organized a full-day vegetable track for Master Gardeners and producers
- Presentations and trade show participation with Utah Nursery and Landscape Association, reaching over 500 members of the green industry.
- In collaboration with the Cooperative Agricultural Pest Survey (CAPS) Program, installed invasive species interpretative sign in two USU demonstration garden locations, with visitation at 5,000/year (estimate)

Short-term Outcomes

- Increased knowledge of community members in invasive pests, allowing for reporting of pest activity on the Utah CAPS website.
- Increased knowledge of IPM practices
- Greater awareness of the IPM concept and how it can help improve community horticulture

Accomplishments of IPM in Schools

Activities and Outputs

- Mentorship program for one underserved Utah school district, matching the district and its county health department with successful counterparts
    - For the underserved district, completed training, baseline IPM assessment (27 buildings), and IPM Plan
    - Follow-up assessments and more training
- Targeted IPM workshops
    - Wasp and bat management to 60 school and health department employees
    - IPM training and programs implemented in 4 charter schools
- Delivery of four editions of the Utah School IPM Newsletter to audience of 490
- Developed targeted IPM plans for eight schools

Short-term Outcomes

- Improved health of students and staff due to reduced indoor pesticide exposure
- Reduction of overall pesticide use due to changes in structural design and pest management plans
- Improved knowledge of school custodial staff in IPM techniques and how to explore alternatives to pesticides

PRIMARY LINKAGES INTERNAL TO WERA 1017

- Publication collaborations
    - Intermountain Tree Fruit Production Guide (intermountainfruit.org), collaborative guide with Utah State University, Colorado State University, University of Idaho, and Montana State University (MSU added as new collaborator in 2017-18).
- Applied research collaboration
    - Survey of potential wild fruit hosts for spotted wing drosophila (collaboration with University of Idaho).
    - Brown marmorated stink bug trap and lure testing (collaboration with California, Oregon and Washington).
- Training on pesticide risk reduction collaboration with OSU, WERA-1017 and WIPMC
    - Dr. Paul Jepson and Katie Murray, Oregon State University, are leading a training program on pesticide risk reduction for members of WERA-1017 and the Western IPM Center; Utah IPM personnel participated in conference calls in 2017-18 and

attended the Western Pesticide Risk Reduction Project Workshop held in conjunction with the WERA-1017 meeting in Portland, OR.

PUBLICATIONS

Alston, D., R. Davis, D. McAvoy, L. Spears, D. Malesky, L. Hebertson, and C. Keyes. 2017. Balsam Woolly Adelgid: Basic Fact Sheet. USU Extension Fact Sheet. 4 pp. https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=2853&context=extension_curall

Alston, D., R. Davis, D. McAvoy, L. Spears, D. Malesky, L. Hebertson, and C. Keyes. 2017. Balsam Woolly Adelgid: Advanced Fact Sheet. USU Extension Fact Sheet. 7 pp. https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=2854&context=extension_curall

Alston, D. and M. Murray. 2017. Leafrollers in Fruit Orchards. USU Extension Fact Sheet. 5 pp. https://digitalcommons.usu.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=2794&context=extension_curall

Cannon, C., E. Petrizzo, D. Alston and M. Murray, 2017. Aphid Pests on Vegetables. USU Extension Fact Sheet. 9 pp. https://digitalcommons.usu.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=2796&context=extension_curall

Cannon, C., M. Murray, D. Alston, C. Nischwitz, C. Shaible, T. Beddes. 2018. Vegetable Pests of Utah: disease and arthropod identification guide. USU Extension. 164 pp.

Cannon, C., M. Murray. 2018. Beneficial Insects of Utah. USU Extension. 100 pp.

Cannon, C., M. Murray, D. Drost, D. Alston, B. Bunn, C. Nischwitz, L. Spears. 2018. Utah Vegetable Production and Pest Management Guide. USU Extension. 213 pp.

Davis, R., B. Hunter, C. Nischwitz, R. Ramirez. Common Ornamental Pests of Utah. USU Extension. 160 pp.

Davis, R. and R. Ramirez. 2017. Ticks and Tickborne Diseases of Utah. USU Extension Fact Sheet. 6 pp. https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=2826&context=extension_curall

Holthouse, C., D. Alston, L. Spears, and E. Petrizzo. 2017. Brown marmorated stink bug (*Halyomorpha halys*) (update) ENT-144-17 (8 pp.). Utah State University Extension, Logan, UT, https://digitalcommons.usu.edu/cgi/viewcontent.cgi?referer=http://utahpests.usu.edu/factsheets/insects-treefruit&httpsredir=1&article=2785&context=extension_curall

McAvoy, D., D. Alston, R. Davis, and M. Dettenmaier. 2018. A new Utah forest insect pest: balsam woolly adelgid. Utah Forest Facts NR/FF/035pr (5 pp.), Utah State University Extension, Logan, UT. https://forestry.usu.edu/files-ou/a-new-utah-forest-insect-pest-balsam-woolly-adelgid.pdf

Murray, M., D. Alston, B. Black, G. Cardon, H. Larsen, T. McCammon, L. Kerzicnik. 2018. Intermountain Tree Fruit Production Guide. USU Extension. 194 pp.

Nischwitz, C., B. Black, and M. Pace. 2017. Verrucosis del Duraznero (Peach Leaf Curl in Spanish). USU Extension Fact Sheet. 2 pp.
https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=2825&context=extension_curall

Spears, L. and D. Alston. 2017. European cherry fruit fly. National Pest Alert (2 pp.), USDA-NIFA Regional IPM Centers. http://ncipmc.org/action/alerts/european_cherry_fruit_fly.pdf

Spears, L, C. Cannon, D. Alston, R. Davis, C. Stanley-Stahr, and R. Ramirez. 2017. Spotted wing drosophila (*Drosophila suzukii*) (update). ENT-145-17 (7 pp.), Utah State University Extension, Logan, UT.
https://digitalcommons.usu.edu/cgi/viewcontent.cgi?referer=http://utahpests.usu.edu/factsheets/insects-treefruit&httpsredir=1&article=2805&context=extension_curall

Thomsen, E., J. Reeve, D. Alston, and G. Cardon. 2017. Simple soil tests for onsite evaluation of soil health in orchards. Horticulture/Soils/2017-02pr (5 pp.), Utah State University Extension, Logan, UT.
https://digitalcommons.usu.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=2814&context=extension_curall

WERA 1017 Arizona State Report 2018
July 2017 – June 2018

Areas Addressed: Specialty Crops IPM (vegetables); Agronomic Crops IPM; School & Community IPM; IPM for Pesticide Applicators, Pesticide Safety & IPM Assessment

Area Addressed: Specialty Crops IPM

Our Vegetable IPM Updates, sent out biweekly via smart phone and web, have over 900 followers and are routinely picked up in the ag press and other mass media, reaching well over 10,000 readers. Timely IPM tips, pest management guidelines for key insect, weed and disease pests, data updates from areawide pest sampling, educational videos and more are featured. Extension publications included: Bagrada bug management in the desert, diamondback moth control and resistance management, areawide diamondback moth trapping network, and management guides for thrips, aphids, whitefly and cucurbit yellow staining disorder virus (CYSDV). Extension trainings on specialty crops included Preseason Vegetable Workshop, Citrus & Date Palm Seminar and Lettuce Pest Losses workshops. The Southwest Ag Summit reached about 800 participants, including pest management presentations and field demonstrations.

Based on surveys sent out to recipients of bi-weekly Veg IPM Updates in 2015 and 2016:

- 38% of respondents indicated that 90 to 100% of their farm operation was positively affected by adopting insect, weed and disease management practices that were recommended by the AZ Vegetable IPM Team. Over 85% of respondents indicated that 50 to 100% of their operations were affected.
- 63% of respondents perceive the Vegetable IPM Entomology specialist has improved their economic returns between $60 to $189 dollars per acre. Extrapolating, the increase in returns would range from $480,000 to $1,512,000 for one typically-sized operation. Similar results across insect, weed and disease management would increase these economic outcomes further.
- For all categories of pests, more than 70% of respondents reported economic savings due to reduction in losses due to UA Veg IPM Team recommendations. 19% of respondents indicate that recommendations of the Entomology Specialist have helped prevent more than $250 per acre in insect pest losses in their operation. In addition, 13% indicated the amount of prevented losses was $100 to $119 per acre. 42% of respondents indicated disease loss prevention from $60 to $250 per acre. 53% of respondents indicated weed loss prevention from $60 to $250 per acre.

Area Addressed: Agronomic Crops IPM

In a multi-crop whitefly resistance management project funded in part by an ARDP grant (Ellsworth et al. 2014), we developed and deployed in our Extension programs "Chemical Use Maps." The maps showed the relative use of six different modes of action for whitefly management and stimulated and enabled proactive resistance management practices. 75% of Extension program participants said the maps would definitely or likely influence their insecticide choices. Pier et al presented a poster on the evaluation of this project at the International IPM Symposium. The Fifth Annual New Technologies workshop covered topics such as Hard and Soft Technologies Support Successful Insect Management in Cotton, Precision Cultivation and Mechanical In-Row Weeding Technologies for Cotton and Removing Auxin Herbicides from Commercial Sprayers. EPA pesticide registration reviews was an ongoing topic at Extension meetings across all program areas, including agronomic crops.

- The Arizona Cotton IPM program reduced environmental and human health risks by preventing >21 million pounds of insecticide active ingredient from reaching the environment (since 1996).
- Cotton growers reduced broadly toxic insecticides by 92% and all insecticides by 82%, comparing 2006-2014 to 1991- 1995 levels. On average, about 20% of cotton acres are never sprayed for insect pests.
- The Arizona Cotton IPM program has saved growers more than $542 mil since 1996, based on fewer sprays and improved yields.
- Research on brown stink bug control in cotton showed that not spraying for this insect increased economic returns for growers. After outreach, growers reduced sprays from 39% of acres to 3% of acres, saving over $8 million in just 1 year.

Arizona Cotton IPM: International Impacts:

The Arizona Cotton IPM program, focused on targeted use of selective insecticides for key pests to enhance conservation biological control has been adopted in the Mexicali region of Mexico, an area with over 210,930 ha. of agriculture and about 30,000 ha of cotton. Over 1 million people populate the region, where rural towns and villages are interspersed with agriculture, and about 15,177 are working directly in agriculture. Cotton is a major feature of the agroecosystem of the Mexicali Valley region and has often been subject to the most broadly toxic pesticide use in the region. Since a 2012 Border IPM grant funded by EPA, Peter Ellsworth has maintained an ongoing relationship with growers and "technicos" (professional pest managers) in the region, and through ongoing Extension efforts has seen widescale adoption of selective insecticides, sampling and thresholds for key pests, including whiteflies and Lygus. Initial results comparing previous practices in 2011 to IPM program results in 2012 included an average yield increase of 17% and a 34% reduction in control costs for one major operation, which saved $45/ha. We estimate that we helped growers save >$1.6M in 2012 alone, with more savings accruing and accelerating in 2013, with large reductions in numbers of sprays and in use of broadly toxic insecticides.

In a recent informal interview, a key Mexican contact for the project reflected on the change in pest management culture there, when asked about potential resistance to using an IPM approach for an endemic but increasingly problematic mealybug pest (paraphrased below). “This is exactly what they said prior to 2010 when the entire industry was using generic, ‘cheap’, broad spectrum insecticides here for the control of all insects, including whiteflies and Lygus. No one thought they would ever do the things needed. We had you [Ellsworth] come here and teach them about the proper IPM for our situation, and now there is no one that does not follow the whitefly and Lygus IPM you helped them with here. Everyone knows about and uses the selective materials they did not know about or thought were too expensive previously. They know about sampling both Lygus and whiteflies and about the proper thresholds, and the important role that 'benéficos' play. They will learn again now that mealybug management requires a complete IPM plan. It will take some time, but they will learn it and implement it; they have to."

These comments demonstrate the transferability and resiliency of some of our IPM approaches in cotton and provide evidence of widespread adoption.

Area Addressed: School & Community IPM

Activities & Outputs:

Our Community IPM Team focuses on School IPM (EIP focal area) and Public Health IPM. This term, we continued the Arizona School IPM Inside-Out program in 8 schools (7 districts), delivering expertise from Extension specialists working in indoor pest management, public health, and turf and landscape management. We delivered 1 in-house hands-on training for school nurses at Maricopa Unified School District (Jan 8, 2018). We conducted 6 demonstration workshops/events on turf and landscapes were provided (Native grasses demonstration field day, Tree health workshop, Desert Turf school, Turfgrass field day, Baseball field day, Desert Horticulture Conference). We also organized and delivered the First Annual Statewide School IPM Conference, hosted by Phoenix Union High School, delivering training to over 60 people including school staff from throughout Arizona, structural pest management professionals, turf and landscape professionals and tribal members. We produced 10 School IPM Newsletters which are distributed nationally to over 1,000 recipients. In partnership with the School of Architecture, Shaku Nair developed an IPM plan as part of the overall preservation plan for Casa Grande ruins National Monument. Our team has also collaborated with other UA scientists and Maricopa County on a major CDC project to document impacts of mosquito larviciding and ULV adulticiding on the vectoral capacity of *Aedes aegypti*.

The following bullets were developed for an IPM Impacts piece developed to highlight the important role of USDA-NIFA Crop Protection and Pest Management funding in supporting human health, economic, and environmental outcomes.

- West Nile Virus can be deadly. Arizona has among the highest incidents of this mosquito-transmitted virus. In 2017, 109 confirmed cases resulted in 8 deaths. A

University-County agency (Phoenix metro area) collaboration prompted control of 8 mosquito populations carrying the virus, reducing disease risk.

- About 100 Arizona residents die yearly due to asthma, and 615,000 are afflicted. Bed bugs & cockroach allergens can trigger asthma attacks. Low-income elderly housing residents are particularly vulnerable. Our Community IPM team reduced cockroaches by 87% and bed bugs by 93% on average across 5 Phoenix public housing sites for elderly & disabled.

Area Addressed: Pesticide Safety

Our Pesticide Safety Education Program, now into its fourth year with a dedicated Assistant in Extension and program coordinator, Dr. Mike Wierda, has reached maturity. Mike brings every day interest and relevance through his engaging teaching style and has worked effectively with our IPM Team members across all Priority Areas to integrate IPM training into PSEP, and pesticide safety topics into IPM programs. Through formation of a Stakeholder Advisory Team to develop a more sustainable and robust Pesticide Safety Education program, we have established new relationships with some stakeholder groups and improved collaboration with the state lead agency.

Core training events: With our multi-day core training events we have seen increased comprehension of core topics and increased passing rates for exams. In 2016 for a single day training, the passing rate was 59%. In 2017 and 2018 our multi-day programs had passing rates of 82% and 88%, respectively.
Respiratory Safety and Fit Testing Training: Arizona has 45 new certified Respiratory Safety Program Administrators, across agriculture, industry, and institutions.

Area Addressed: IPM Assessment

The Crop Pest Losses and Impact Assessments, supported in part through a Signature Program of the Western IPM Center, explicitly engage stakeholders so that they can establish the current state or condition of their industry, including yield losses to pests, pesticide use, and economic outcomes. While these data are most useful in measuring the economics of IPM, there are opportunities to infer progress in environmental and human health safety as well. Only through routine measurement systems will IPM programs be able to live up to the challenge of the IPM Roadmap. This signature program provides tested, reliable metrics to document the impacts of IPM.

- Cotton Pest Losses workshops. Locally in Arizona and Blythe CA, we held 4 Cotton Pest Losses workshops attended by 29 PCAs; 34 surveys were completed (a new record, 5 submitted by email or mail), representing 64.9% of cotton acres in Arizona (plus some CA acres). 4 AZ and CA CEUs were provided to 34 participants.
- Lettuce Pest Losses. Implemented in Yuma, AZ, 5/15/18 in paper format. 25 responses (a few more yet to come in), covered a total of 77,900 acres of lettuce. Unlike previous

years, participants included pest control advisors (PCAs) exclusively from Imperial Valley of California, and 1 PCA from Maricopa County, Arizona, so the estimates reflect a much broader area than just Yuma/Bard this year. 4 AZ and CA CEUs and 3 Certified Crop Advisor CEUs were provided to 50 participants.

The Crop Pest Losses model has been adopted by crop industries in different states to assess impacts. We have collaborated with Katie Murray, Paul Jepson and others in the Pacific Northwest to conduct CPL surveys for onions (OR/ID), potatoes, cherries (WA/OR) and cranberries (OR/WA), and hazelnut (OR) losses survey. This effort has been supported in partnership with an ARDP-funded Integrated Pest Management Strategic Plan (IPMSP) process, led by OSU and through Western IPM Center Signature Program. As part of the re-envisioned IPMSP process, new sections emphasizing non-chemical control practices have been added to the surveys.

Several Arizona personnel have also participated in the OSU-led Pesticide Risk and Hazard Communication Professional Development work group. This has been a very educational and influential activity. Three Arizona representatives presented at the second annual workshop which took place in Portland on the heels of the WERA meeting this past May. We are working on an Extension bulletin on the general topic of risk, and integration of pesticide risk rankings with efficacy and selectivity information in our cotton insecticide recommendations.

Publications

Journal Articles

Amin Jalali, M. , Mehrnejad, M. R., Ellsworth, P. C., Ranjbar, F. and Ziaaddini, M. 2018. Predator performance: inferring predator switching behaviors based on nutritional indices in a coccinellid-psylla-aphid system. Pest Manag. Sci.. Accepted Author Manuscript. doi:10.1002/ps.5076

Amin Jalali, M., Mehrnejad, M. R., Ellsworth, P.C. Inferring putative habitat preference and biological control potential of adult predatory coccinellids using life history traits. Pest Manag. Sci. (*submitted*)

Anderson, J.A., Ellsworth, P.C., Faria, J.C., Head, G.P., Owen, M.D.K., Pilcher, C.D., Shelton, A.M., Meissle, M. 2018. Genetically engineered crops need to be part of a diversified integrated pest management plan for improved durability and sustainability of agricultural systems. *Frontiers in Bioengineering and Biotechnology* (*submitted*).

Carriere, Y., Degain, B., Liesner, L., Dutilleul, P. and Palumbo, J.C. 2017. Validation of a Landscape-Based Model for Whitefly Spread of the Cucurbit Yellow Stunting Disorder Virus to Fall Melons. J. Econ. Entomol. 2017 Oct. 1. 110(5):2002-2009. doi: 10.1093/jee/tox213.

Castle, S.J., Palumbo, J.P. and Merten, P. 2017. Field evaluation of Cucurbit yellow stunting disorder virus transmission by Bemisia tabaci. Virus Res. 2017 Sep 15; 241: 220-227. doi: 10.1016/j.virusres.2017.03.017. Epub 2017 Mar 23.

Castle, S., Palumbo, J. Merten, P., Cowden, C. and Prabhaker, N. 2017. Effects of foliar and systemic insecticides on whitefly transmission and incidence of Cucurbit yellow stunting disorder virus. Pest Manag Sci. 2017 Jul;73(7):1462-1472. doi: 10.1002/ps.4478. Epub 2017 Feb 7.

Correll, J.C., Feng, C., Matheron, M.E., Porchas, M., and Koike, S.T. 2017. Evaluation of spinach varieties for downy mildew resistance, 2017. Plant Disease Management Reports 11:V122.

Farrar, James J, Peter C Ellsworth, Rebecca Sisco, Matthew E Baur, Amanda Crump, Al J Fournier, M Katie Murray, Paul C Jepson, Cathy M Tarutani, Keith W Dorschner; Assessing Compatibility of a Pesticide in an IPM Program, *Journal of Integrated Pest Management*, Volume 9, Issue 1, 1 January 2018, 3, https://doi.org/10.1093/jipm/pmx032

Gouge D.H., S. Li, S. Nair. 2017. Integrated Pest Management: Simple Solution to Wicked Problem Pests in Elderly and Disabled Public Housing. Award Publication Abstract. Journal of Integrated Pest Management. (*accepted*).

Kou F., H. Li, S. Li, H. Xun, Y. Zhang Z. Sun X. Zhou, W. Cai. 2017. Temporal transcriptomic profiling of the ant-feeding assassin bug *Acanthaspis cincticrus* reveals a biased expression of genes associated with predation in nymphs. Scientific Reports. Vol. 7 No. 1 doi: 10.1038/s41598-017-12978-0 https://www.nature.com/articles/s41598-017-12978-0

Matheron, M.E., and Porchas, M. 2018. Impact of summer flooding on viability of Sclerotinia minor and S. sclerotiorum sclerotia in soil. Plant Health Progress 19: 15-18.

Naranjo S.E., P.C. Ellsworth. 2017. Methodology for developing life tables for sessile insects in the field using the whitefly *Bemisia tabaci* in cotton as a model system. Journal of Visualized Experiments. Vol. 129 No. e56150 doi: 10.3791/56150 https://www.jove.com/video/56150/methodology-for-developing-life-tables-for-sessile-insects-field

Matheron, M.E., Correll, J.C., Porchas, M., and Feng, C. 2017. Assessment of fungicides for managing downy mildew of spinach, 2017. Plant Disease Management Reports 11:V121.

Matheron, M.E., Pryor, B.M., and Porchas, M. 2017. Evaluation of conventional fungicides and biofungicides for managing Fusarium wilt of lettuce, 2016. Plant Disease Management Reports 11:V123.

Matheron, M.E., Pryor, B.M., and Porchas, M. 2017. Evaluation of lettuce varieties for resistance to Fusarium wilt, 2016. Plant Disease Management Reports 11:V124.

Matheron, M.E., and Porchas, M. 2018. Comparison of fungicides for managing powdery mildew of muskmelon, 2017. Plant Disease Management Reports 12:V046.

Matheron, M.E., and Porchas, M. 2018. Evaluation of fungicides for managing Sclerotinia lettuce drop, 2017. Plant Disease Management Reports, 12:V004.

Matheron, M.E., and Porchas, M. 2018. Effectiveness of fungicides for managing downy mildew of lettuce, 2017. Plant Disease Management Reports, 12:V003.

Matheron, M.E., and Porchas, M. 2018. Assessment of fungicides for managing powdery mildew of lettuce, 2017. Plant Disease Management Reports, 12:V002.

Reed, D.A., Ganjisaffar, F., Palumbo, J.C. and Perring, T.M. 2017. Effects of temperatures on immature development and survival of the invasive stink bug (Hemiptera: Pentatomidae). J Econ Entomol. 2017 Dec 5; 110(6): 2497-2503. doi: 10.1093/jee/tox289.

Vandervoet, T.F., P.C. Ellsworth, Y. Carriere, S.E. Naranjo. 2018. Quantifying conservation biological control for management of *Bemisia tabaci* in cotton. J. Econ. Entomol. (*accepted*, *2-7-18*) https://academic.oup.com/jee/advance-article-abstract/doi/10.1093/jee/toy049/4932785

Abstracts

Fournier A. J., A. Crump, P. C. Ellsworth, J. Farrar. 2017. Pesticide use data informs regulatory policies. Managing Pesticide Use and Use Data Symposium American Chemical Society Meeting, Washington, DC. August 21 2017.

Fournier A. J., J. Farrar, P. C. Ellsworth. 2017. Pesticide Use Data to Evaluate the Impact of Integrated Pest Management Programs in Arizona and California. Managing Pesticide Use and Use Data Symposium American Chemical Society Meeting, Washington, DC. August 21 2017.

Ellsworth P.C., A.J. Fournier, G. Frisvold, S.E. Naranjo. 2017. Chronicling the Socioeconomic Impact of Integrating Biological Control Technology and Knowledge over 25 Years of IPM in Arizona. Centre for Agriculture and Biosciences International, Langkawi Malaysia. September 11, 2017.
https://cals.arizona.edu/crops/presentations/2017/17ISBGMOGuadalajaravF1uplo.pdf

Crump, A., M. Halbleib, J.J. Dubois, A.J. Fournier, J. Hurley, N. McRoberts, M. Baur, H. Bolton, T. Martin, Y. Liu, S. Ratcliffe, P. Mitchell, D.S. Carley. 2018. Path to Success: Evaluating IPM Programs from Planning to Data to Impact Statements. 9th International IPM Symposium, Baltimore, MD. March 20, 2018. (Invited Workshop)

Halbleib, M., P. Jepson, N. McRoberts, A.J. Fournier. 2018. Novel Approaches to IPM Extension: Transferring Learning across Contexts. 9th International IPM Symposium, Baltimore, MD. March 22, 2018. (Symposium)

Pier, N., A. Fournier, J. Palumbo, Y. Carrière, W. Dixon, L. Brown, S. J. Castle, N. Prabhaker, P.C. Ellsworth. 2018. Adoption of proactive resistance management practices to control Bemisia tabaci in Arizona and California. Poster presented at the 9th International IPM Symposium, Baltimore, Maryland, March 19-22, 2018.
https://cals.arizona.edu/crops/presentations/2018/IPM_Symposium_Poster_vFinal.pdf

Nair, S. Welcome and Opening Remarks Symposium: School IPM: Sinking Ship or Soaring Success, a Discussion. 9th International IPM Symposium, Baltimore, MD. March 21, 2018. (Symposium).

Nair, S., Green, T., Gouge, D. H., Umeda, K., Fournier, A. J., Li, S., Schuch, U.K. and Kopec, D. 2018. Recognizing Excellence in School Integrated Pest Management. 9th International IPM Symposium, Baltimore, Maryland. March 19-22, 2018. (poster)

Gouge, D.H., Li, S. and Nair, S. 2018. Integrated Pest Management – A Simple Solution to Wicked Problem Pests in Elderly and Disabled Public Housing. 2018. 9th International IPM Symposium, Baltimore, Maryland. March 19-22, 2018.

Li, S., Gouge, D.H., Nair, S. and Fournier, A. Implementation of Integrated Pest Management in Elderly/Disabled Public Housing Facilities. CALS Poster Forum. Agricultural and Life Science Research, University of Arizona. Tucson, AZ. March 23, 2018. (poster)

Nair, S., T.A. Green, D.H. Gouge, K. Umeda, A.J. Fournier, S. Li, U.K. Schuch, D.M. Kopec. Encouraging Schools to Practice Integrated Pest Management. ESA International Branch 1st Virtual Symposium, April 16, 2018. (poster)

Li, S. and Romero, A. Insecticide Resistance in Bed Bugs. NEHA Enhancing Environmental Health Knowledge (EEK): Vectors and Public Health Pests Virtual Conference, May 15-16, 2018.

Nair, S. Li, S. and Gouge, D.H. 2018. Communicating about bed bugs to diverse audiences using diverse tools. NEHA Enhancing Environmental Health Knowledge (EEK): Vectors and Public Health Pests Virtual Conference, May 15-16, 2018.

Li, S., Gouge, D.H., Nair, S. and Fournier, A. Implementation of Integrated Pest Management in Elderly/Disabled Public Housing Facilities. Poster presentation. NEHA Enhancing Environmental Health Knowledge (EEK): Vectors and Public Health Pests Virtual Conference, May 15-16, 2018. (poster)

Nair, S., Shaum, K., Bierer, S. Round Tailed ground Squirrels: Do We Need to "manage" Them and How. NEHA Enhancing Environmental Health Knowledge (EEK): Vectors and Public Health Pests Virtual Conference, May 15-16, 2018. (poster)

Selected Extension Publications

Arizona Pest Management Center (APMC). 2018. National Institute of Food and Agriculture's Crop Protection and Pest Management Program Saves Lives, Dollars & the Environment in Arizona. University of Arizona, Arizona Pest Management Center. https://cals.arizona.edu/apmc/docs/AZPM_Impacts_vf.pdf

Gouge D.H., S. Li, C. Bibbs, S. Nair. 2018. Scorpions of the Desert Southwest United States. Extension Publication. University of Arizona Cooperative Extension. Publication no. AZ1768 https://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1768-2018.pdf

Gouge D.H., S. Li, S. Nair, K.R. Walker, C. Bibbs. 2018. Mosquito and Tick Repellents. Extension Publication. University of Arizona Cooperative Extension. Publication no. AZ1761 https://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1761-2018.pdf

Hu J.(Alex). 2018. Cotton Stem Blight and Boll Rot. Extension Bulletin. University of Arizona Cooperative Extension. Publication no. AZ1770 https://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1770-2018.pdf

Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, M.R. Wierda. 2018. School Preparation Guidance for Summer Management Teams. IPM Newsletter, May 2018. University of Arizona, Arizona Pest Management Center. https://cals.arizona.edu/apmc/docs/2018MayAZschoolandhomeIPMNewletter.pdf

Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, M.R. Wierda. 2018. Spring Preemergence Weed Control in Lawns. IPM Newsletter, March 2018. University of Arizona, Arizona Pest Management Center. https://cals.arizona.edu/apmc/docs/2018MarchAZschoolandhomeIPMNewletter.pdf

Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, M.R. Wierda. 2018. IPM for Microorganisms – Focus on Flu Part 2. IPM Newsletter, February 2018. University of Arizona, Arizona Pest Management Center. https://cals.arizona.edu/apmc/docs/2018FebruaryAZschoolandhomeIPMNewletter.pdf

Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, M.R. Wierda. 2018. IPM for Microorganisms: Cleaning Disinfecting and Sanitizing. IPM Newsletter, January 2018. University of Arizona, Arizona Pest Management Center. https://cals.arizona.edu/apmc/docs/2018JanuaryAZschoolandhomeIPMNewletter.pdf

Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, M.R. Wierda, M.R. Wierda. 2017. Increase in Rabies Cases in Animals School and Home Integrated Pest Management. IPM Newsletter, September 2017. University of Arizona, Arizona Pest Management Center. https://cals.arizona.edu/apmc/docs/2017SeptemberAZschoolandhomeIPMNewletter.pdf

Palumbo J.C. 2017. Insecticide Modes of Action on Desert Vegetable Crops. Arizona Vegetable IPM Updates. University of Arizona Cooperative Extension. Vol. 9 No. 6. https://cals.arizona.edu/crops/vegetables/advisories/docs/180321_insecticide_moa_groups_vegetables_2018.pdf

Palumbo J.C. 2018. Aphid Management in Desert Produce Crops, 2018. Arizona Vegetable IPM Updates. University of Arizona Cooperative Extension. Vol. 9 No. 1. https://cals.arizona.edu/crops/vegetables/advisories/docs/180110_aphid_control_chart_2018.pdf

Palumbo J.C. 2017. Corn Earworm Management on Desert Produce. Arizona Vegetable IPM Updates. University of Arizona Cooperative Extension. Vol. 8 No. 21. https://cals.arizona.edu/crops/vegetables/advisories/docs/171101%20CEW%20%20Management%20on%20Desert%20Produce_2017.pdf

Palumbo J.C. 2017. Bagrada Bug Management Tips, 2017. Arizona Vegetable IPM Updates. University of Arizona Cooperative Extension. Vol. 8 No. 17.

https://cals.arizona.edu/crops/vegetables/advisories/docs/170920%20Bagrada%20Bug%20Management%20Tips_VegIPMUpdate_Fall%202017.pdf

Palumbo J.C. 2017. Guidelines for Diamondback Moth Management in Fall Cole Crops. Arizona Vegetable IPM Updates. University of Arizona Cooperative Extension. Vol. 8 No. 18. https://cals.arizona.edu/crops/vegetables/advisories/docs/170906%20Guidelines%20for%20Diamondback%20Moth%20Management%20in%20Desert%20Cole%20Crops.pdf

Walker K.R., H. Yaglom, D.H. Gouge, M. Brophy, M. Casal, O. Encinas. 2018. The Brown Dog Tick and Epidemic Rocky Mountain spotted fever in Arizona and northwestern Mexico. Extension Bulletin. University of Arizona Cooperative Extension. Publication no. AZ1769 https://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1769-2018.pdf

Wierda M.R., D.H. Gouge. 2017. Tick & Flea Collars Integrated Pest Management and Your Safety. Arizona Pest Management Center IPM Short. University of Arizona Cooperative Extension.
https://cals.arizona.edu/crops/cotton/files/17Flea_Collar_short.pdf

Palumbo J.C. 2016. Insecticide Usage on Desert Lettuce 2016 - 17. Arizona Vegetable IPM Updates. University of Arizona Cooperative Extension. Vol. 8 No. 11
https://cals.arizona.edu/crops/vegetables/advisories/docs/170531%20Insecticide%20Usage%20Summary%20in%20Lettuce%202017.pdf

Palumbo J.C. 2017. Impact of Bagrada Bug on Desert Cole Crops: Seven Years After the Outbreak. Arizona Vegetable IPM Updates. University of Arizona Cooperative Extension. Vol. 8 No. 10.
https://cals.arizona.edu/crops/vegetables/advisories/docs/170517%20Bagrada%20Bug%20Survey_2016_%20Seven%20years%20after%20outbreak_report.pdf

Proceedings

Ellsworth, P.C., A.J. Fournier, G. Frisvold, S.E. Naranjo. 2017. Chronicling the Socio-economic Impact of Integrating Biological Control, Technology, and Knowledge over 25 Years of IPM in Arizona. Proceedings of the Fifth International Symposium on Biological Control of Arthropods. P.G. Mason, D.R. Gillespie and C. Vincent, eds. CABI, Langkawi, Malaysia. September 11–15, 2017. pp. 214–216. http://www.isbca-2017.org/download/ISBCA-Proceedings.web.pdf

Ellsworth, P.C., A.J. Fournier, G. Frisvold, S.E. Naranjo. 2017. Chronicling the Socio-economic Impact of Integrating Biological Control, Technology, and Knowledge over 25 Years of IPM in Arizona. Proceedings of the Fifth International Symposium on Biological Control of Arthropods. P.G. Mason, D.R. Gillespie and C. Vincent, eds. CABI, Langkawi, Malaysia. September 11–15, 2017. pp. 214–216. http://www.isbca-2017.org/download/ISBCA-Proceedings.web.pdf

Horowitz, A. Rami, P.C. Ellsworth, R. Mensah and I. Ishaaya. 2018. Integrated Management of Whiteflies in Cotton. In "Cotton and Other Fibre Crops", Eds. M.S. Chauhan & R.S. Sangwan. Cotton Research and Development Association, CCS Haryana Agricultural University, Hisar – 125 004, India, pp. 155–168, http://crdaindia.com/downloads/files/n5aa773bae6cab.pdf

Expert Testimony including Responses to Pesticide Registration Open Comment Periods

Ellsworth, P.C. and J. Peterson. 2017. Request for Section 18 emergency use of Sulfoxaflor (Transform® WG Insecticide) to control western tarnished plant bug (*Lygus hesperus*) in cotton fields in the state of Arizona. Arizona Section 18 Specific Exemption Request of the United States Environmental Protection Agency. Approved, 1 June – 31 October 2017. https://cals.arizona.edu/apmc/docs/2017TransformCottonSection18ArizonavF4lo.pdf

Fournier A.J., M. Matheron, W.A. Dixon II, P.C. Ellsworth. 2017. Mefenoxam, Cymoxanil and Dimethomorph Use in Arizona, New Mexico and Southeastern California. University of Arizona, Arizona Pest Management Center. https://cals.arizona.edu/apmc/docs/Mefenoxam-Cymoxanil-Dimethomorph_vf.pdf

Fournier A.J., W.A. Dixon II, P.C. Ellsworth. 2017. Methoxyfenozide Use in Arizona: Maintain Current Label Rates in Corn. University of Arizona, Arizona Pest Management Center. https://cals.arizona.edu/apmc/docs/APMC_Methoxyfenozide_Comments_Corn_VF.pdf

Fournier A.J., P.C. Ellsworth, W.A. Dixon II. 2017. Neonicotinoid Insecticide Use and Pollinator Protection in Several Crops and Recreational Turf in Arizona and New Mexico. University of Arizona, Arizona Pest Management Center. https://cals.arizona.edu/apmc/docs/Neonicotinoids_July-2017_vf.pdf

Fournier A.J., D. Kopec, P.C. Ellsworth. 2017. Ethephon Use on Arizona & California Golf Courses: Comments on EPA Proposed Interim Decision, Case no. 0382. University of Arizona, Arizona Pest Management Center. https://cals.arizona.edu/apmc/docs/APMC_Ethephon-Golf-Turf_AZ-CA_vf.pdf

Fournier A.J., P.C. Ellsworth, R. Norton, W.A. Dixon II. 2017. Mepiquat Chloride and Mepiquat Pentaborate Use in Arizona. University of Arizona, Arizona Pest Management Center. https://cals.arizona.edu/apmc/docs/Mepiquat_Arizona_Cotton_vf.pdf

Fournier A.J., P.C. Ellsworth, W.A. Dixon II. 2017. Oxamyl Use in Arizona and New Mexico Crops. University of Arizona, Arizona Pest Management Center. https://cals.arizona.edu/apmc/docs/Oxamyl_Use_AZ_NM_vf.pdf

Fournier A.J., P.C. Ellsworth, W. McCloskey, W.A. Dixon II. 2017. Pendimethalin Use in Arizona and New Mexico Crops. University of Arizona, Arizona Pest Management Center. https://cals.arizona.edu/apmc/docs/Pendimethalin_Use_AZ_NM_vf.pdf

Fournier A.J., P.C. Ellsworth, W.A. Dixon II. 2017. Prometryn Use in Arizona Crops. University of Arizona, Arizona Pest Management Center.
https://cals.arizona.edu/apmc/docs/Prometryn_Use_AZ.pdf

Fournier A.J., P.C. Ellsworth. 2017. Imidacloprid, EPA Docket ID: EPA-HQ-OPP-2008-0844. University of Arizona, Arizona Pest Management Center.
https://cals.arizona.edu/apmc/docs/Imidacloprid_Nov13_2017.pdf

Fournier A.J., P.C. Ellsworth, M. Matheron, W.A. Dixon II. 2018. Quinoxyfen Use in Arizona and New Mexico Crops. University of Arizona, Arizona Pest Management Center.
https://cals.arizona.edu/apmc/docs/Quinoxyfen_Use_AZ_NM_vf.pdf

Fournier A.J., P.C. Ellsworth, M. Matheron, W.A. Dixon II. 2018. Fludioxonil Use in Arizona Crops. University of Arizona, Arizona Pest Management Center.
https://cals.arizona.edu/apmc/docs/Fludioxonil_Use_AZ_vf.pdf

Fournier A.J., P.C. Ellsworth. 2018. Fluopicolide Use in New Mexico Chile Peppers. University of Arizona, Arizona Pest Management Center.
https://cals.arizona.edu/apmc/docs/Fluopicolide_Use_NM_vf.pdf

Active Grants

Hall et al. USDA-AMS, Arizona Department of Agriculture, Specialty Crops Block Grant Program. Blister Beetle Impact on Specialty Crops. March 2017. $19,870.

Fournier et al. USDA-AMS, Arizona Department of Agriculture, Specialty Crops Block Grant Program. Pesticide Use Data Benefits Specialty Crops. March 2017. $97,402.

Ellsworth & Fournier. USDA-NIFA, Crop Protection and Pest Management, Extension Implementation Program. The Arizona Pest Management Center: Addressing Statewide IPM Priorities with High-Impact Extension Programs. April 2017. $825,000.

Ellsworth, P.C. Crop Pest Losses & Impact Assessment and Regional Comments Coordination for Southwest. Western IPM Center Signature Program (subaward), USDA-NIFA Crop Protection and Pest Management Program. 2015-2018. $324,375

Ellsworth et al. Cotton Incorporated. Designing & Evaluating Sustainable Cotton Systems with Reduced Pest & Pesticide Risks. December 2017. $45,000.

Ellsworth & Naranjo. Arizona Cotton Growers Association. Designing & Evaluating Sustainable Cotton Systems with Reduced Pest & Pesticide Risks. January 2018. $17,000.

Bordini et al. USDA-NIFA, Western IPM Center Grants Program. Enhancing IPM by integration of chemical and biological controls through assessment of selectivity of chemistries and function of biocontrol. December 2017. $30,000.

Bordini et al. USDA, SARE Program: 2018 Graduate Student Grants in Sustainable Agriculture. Promoting sustainable agriculture by integration of chemical and biological controls through assessment of selectivity of chemistries and function of biocontrol. January 2018. $25,000.

Hall et al. USDA-AMS, Arizona Department of Agriculture, Specialty Crops Block Grant Program. Blister Beetle Risks to Specialty Crops. March 2018. $36,239.

Walker et al. USDA-AMS, Center for Disease Control. Impacts of targeted larviciding and ULV adulticiding on the abundance and age structure of *Aedes aegypti* in south-central Arizona. July 2017. $1,250,000.

WERA 1017 – Annual Report for New Mexico Statewide IPM Program

With contributions from IPM extension faculty and staff including:
Dr. Ashley Bennett
Dr. Leslie Beck
Jason French
Dr. Marisa Thompson
Dr. Jane Pierce

New Mexico IPM Impacts: 7-1-2017 to 6-30-2018

Area Addressed: Urban and Community IPM

Activity 1: Master Gardener Training

Outputs:

- Presentations on beneficial insect ID conservation – 7
- Presentations on insect pest insect ID – 7
- Principles of IPM - 7
- Presentations on Weed IPM – 19
- Presentations on plant diseases and the diagnostic process – 9
- Consulting visits on beneficial insect habitat planning – 4
- IPM advanced curriculum - 1
- Demonstration garden – 1
    - Vegetable display – 1
    - Beneficial insect planting – 1
- Grants – 2
    - General Mills Foundation. A. B. Bennett and K. White. Supporting IPM education and outreach through a demonstration garden. 2018. $1,000.
    - Bayer Feed a Bee Grants. K. White and A. B. Bennett. Supporting pollinators and outreach in the NMSU demonstration garden. 2018. $2,500.
- **Extension publication** – 1
    - Bennett, A.B. and T. Grasswitz. 2017. Using Insectary Plants to Attract and Sustain Beneficial Insects for Biological Control, Guide H-169. New Mexico State University Extension.

Outcomes

- 100% of programs reached
- 100% of attendees indicated their knowledge of IPM increased
- 100% of people attending were now aware of an IPM strategy that reduced non-target effects on beneficial insects
- Improved knowledge of IPM practices and increased use of alternative pest control strategies
- Increased knowledge of beneficial insect conservation
- Master Gardener hours committee to the demonstration garden - 170

Activity 2: Gardening and residential landscapes

Outputs:

- ID Walks
    - 5 beneficial insect walks
    - 7 weed ID walks
- Presentations

    - Beneficial Insect Conservation – 5
    - IPM in urban landscapes / small farms - 7
    - Insect Expo – 1
    - Weed Identification and Management – 6
    - Plant Pathology ID and management - 11
- Consultations
    - Residential visits for weed id and management – 7
    - Site visits / Consultations for insect id and management - 10
- Articles – 2
    - Newspaper column on EAB awareness
    - Extension article: Lauriault, L.M. J.B Pierce, B.J. Schutte, L.L. Beck, A.B. Bennett and W.V. Hamilton. In Review. Managing Aceria malherbae gall mites for control of field bindweed. New Mexico State University Extension.
- Social media – Announcement for EAB awareness
- Radio – What is IPM and research updates
- Displays
    - Drawers of pinned specimens: insect pests and beneficial insects
    - Posters: insect pests and beneficial insects, weed identification
    - Potted specimens of common weeds
    - Common weed/plant identification tools and books

Outcomes:

- Increased knowledge of weed identification strategies
- Increased knowledge on weed management IPM strategies
- Indication of a change in past weed management techniques based on presented information
- Post-session surveying of insect IPM training indicated 100% improved their understanding of IPM but only 61% indicated they were currently applying any IPM strategies

Area Addressed: Pollinator IPM

Activity 1: IPM practices for pollinator conservation in urban landscapes

Outputs:

- ID walks – 2
- Presentations – 11
- 4-part workshop series – 2 workshops to date
- Pollinator lectures series with ABQ Botanic Garden
- Articles -2
    - Honey beekeeper Newsletter, with 1,200+ distribution
- Consulting on pollinator habitat – 2
- Demonstration pollinator habitat - 1

Outcomes:

- 100% increased their level of understanding in the area of pollinator IPM tactics
- Post-workshop surveys indicated:
    - 100% after training were able to list 3 native pollinators
    - 100% after training were able to explain why mouthpart structure is important
    - Participants indicated training increased their knowledge from somewhat knowledgeable before the training to very knowledgeable after the training
- Post-lecture surveys indicated:
    - 100% increase in attendees understanding in pollinator ecology
    - 100% learned something new about pollinator conservation and native bees
    - 93% indicated their understanding around the importance of native bees increased
    - 100% said they learned a new native plant they could use to support native pollinators

Area Addressed: IPM for Wide Area Monitoring

Outputs:

- Recruited 20 home gardeners to participate in backyard beneficial insect monitoring
- Workshops on target groups for 2018 monitoring – 3
- Pocket Guide – 1
    - Pics and ID tips for beneficial insects
- Undergraduate training – 2 students
- Student monitoring – 20 additional study sites: urban farms, parks, natural areas

Outcomes:

- Pre and post tests on beneficial insect identification showed the pre-test scores of home gardeners were ~50% correctly identified while post-test scores showed 100% correctly identified.

Area Addressed: IPM Support for Pest Diagnostic Facilities

The Plant Diagnostic Clinic at New Mexico State University received STAR-D accreditation through the National Plant Diagnostic Clinic in 2016. The clinic also serves as a support lab for the National Plant Diagnostic Network and participates in a variety of local, regional and national pest surveys. Beginning in 2013, pest management specialists from the Plant Diagnostic Clinic have been conducting Plant Clinics at grower's markets around New Mexico. There are over 70 grower's markets in the state with over 1,000 producer participants. This industry, with a value of over $8 million, is the largest outlet for locally grown produce in the state. This year, 3 Plant Clinics were conducted, giving small-scale growers and home gardeners the opportunity to meet the specialists and ask questions regarding plant production and pest management. Through the information provided at these clinics, we are helping to sustain this vital, fresh market produce industry.

Activity 1: Pest diagnostics through NMSU for 2017

Outputs:

- Media – Posts to Facebook, Twitter, Instagram and Pinterest reached over 104,000 individuals
- Collectively processed 1,864 insect, weed, and disease samples
    - 518 insect samples were identified and IPM recommendation returned
    - 483 weed samples were identified and IPM recommendation returned
    - 863 plant samples were processed for disease detection and IPM recommendation returned

Short-term Outcomes:

- The NMSU Plant Diagnostic Clinic responds to requests for pest ID and management recommendations in a timely manner – over 99% of samples submitted receive a diagnosis with recommendations within 5 working days
- Accurate identification of pests prevents the use of inappropriate control tactics, particularly pesticides, which can be costly and time consuming, accelerate the development of resistance, and may pose risks to people and the environment
- Between July 1, 2017 and June 30, 2018, 7 new diseases (host-pathogen combinations) were identified in the state of New Mexico

Impacts:

- Increased implementation of IPM practices through accurate pest ID and early detection
- Early pest detection provides an opportunity for eradication of some pests
- Early detection provides a greater opportunity for effective pest management

Activity 2: Pesticide Training to growers

The Pesticide Safety Education Program (PSEP) at New Mexico State University promotes the responsible use of pesticides through educational resources and training. Training covers a broad range of human safety and environmental issues for a statewide target audience of approximately 2,800 private applicators, 2,200 commercial applicators, and 120 pesticide dealers. This is a collaborative effort with the New Mexico Cooperative Extension Service (NMSU—CES), New Mexico Department of Agriculture (NMDA), USDA National Institute of Food and Agriculture (USDA—NIFA), and the U.S. Environmental Protection Agency.

Outputs:

- 4 pesticide applicator workshops across the state
- 11 pesticide applicator trainings for Continuing Education Units (CEUs) across the state

Short-term Outcomes:

- Workshop evaluations indicate that 97% of participants learned a new skill that will assist them when applying pesticides,
- Workshop evaluations indicate 78% of participants learned new information that will help them when applying pesticides
- 70% of attendees indicated they will change a management practice based on the information they received
- 78% responded this training made them aware of IPM practices to increase the efficacy of herbicide applications on target weeds

Impacts:

- Improved health and safety of applicators due to reduced pesticide exposure
- Reduction of overall pesticide use due to changes in structural design
- Improved knowledge of IPM strategies and use of alternative control tactics to pesticides
- Improved awareness of herbicide resistance and management factors to prevent the development and spread of herbicide resistant weeds
- Provided Continuing Education Credits for pesticide applicators.

Area Addressed: IPM on Recreational Lands (parks, golf courses, natural areas)

Activity 1: Training on IPM in parks

Outputs:

- Presentations on plant diseases – 2
- Presentation on IPM practices – 14
- Workshop on pest monitoring using drones – 1
- NM a tree inventory was completed – 1 park
- Student training – 1
    - Student completed tree inventory and map
- Tree map and identification guide created for Las Cruces Park
- Herbicide damage on trees: college campus diagnostic walks - 3

Impacts:

- Greater diagnostic skills by recreational land managers
- Improved ability to identify characteristics of herbicide damage to desirable ornamentals and trees
- Improved management techniques to control pests while protecting offsite ornamentals
- Improved identification of insect and weed pests on recreational lands
- Increased awareness around the use of drone to monitor for pests in city parks

Area Addressed: IPM implementation for Agronomic Crops

Activity 1: IPM Training and Support for Agronomic Crops including alfalfa, cotton, & corn

Outputs:

- Publications – 1
    - Indocochea, A., Gard, C., Hansen, I. A., Pierce, J. B., Romero, A. (2017). Short-Range Responses of the Kissing Bug Triatoma rubida (Hemiptera: Reduviidae) to Carbon Dioxide, Moisture, and Artificial Light. Insects. 8, 90-12pp.
- Extension Publications – 4
    - Sutherland, C. A., **Pierce, J. B**., Lewis, B. E., Heerema, R. (2017). Ana Henke,

Frank Sholdice (Ed.), *Pecan Weevil: Wanted Dead, Not Alive* (pp. 8 pp.). Las Cruces, NM.

- **Pierce, J. B**., and C. Sutherland. (2017). *Guide L-110: Honey Bees in New Mexico*. Las Cruces, NM: NMSU, University Communications, Cooperative Extension Service. ces.nmsu.edu/pubs/_l/L110.pdf.

- **J. Pierce**. *Beet Armyworm in New Mexico Hay.* 2017. Circular A-334. Las Cruces, NM. New Mexico State University Cooperative Extension Service.

- **J. Pierce**. *Variegated Cutworm in New Mexico Hay*. 2017. Circular A-335. Las Cruces, NM. New Mexico State University Cooperative Extension Service.

- Presentations – 11
- Grants – 4
  - Bowling, C. Allen, C. Vyavhare, S, Kerns, D. Pierce, J. Developing pest management strategies for thrips, cotton fleahoppers and boll sucking pests of cotton in the southwest region. Cotton Incorporate, $42,000.

  - Pierce, J. B. (Principal), Sponsored Research. 2017. "Input Optimization and Insect Pest Management in New Mexico", Cotton Incorporated, $37,800.25.

  - Zhang, J. (Co-Principal), Flynn, R. P. (Co-Principal), Zhang, J. (Co-Principal), Pierce, J. B. (Co-Principal), Idowu, O. J. (Principal). 2010-2017."Yield Potential, Fiber Quality and Adaptability of Glandless Cotton in New Mexico". Cotton Incorporated, $270,164.00.

  - Ghimire, R. (Co-Principal), Lehnhoff, E. A. (Co-Principal), Idowu, O. J. (Co-Principal), Sanogo, S. (Co-Principal), Pierce, J. B. (Co-Principal), Schutte, B. J. (Principal). 2016-2017."Teaching Organic Farmers Effective Evaluation Techniques for Soil Fertility and Pest Management through Participation in Cover Crop Trials". USDA/NIFA/Organic Agriculture Research and Extension Initiative, $43,325.00

Outcomes:

- Increased awareness of pest populations in multiple cropping systems
- Greater awareness of IPM strategies in multiple cropping systems
- Improved understanding of agricultural production in NM
- Impacts to multiple cropping systems – Farmers spent ~$14 billion dollars in 2017 on weed control

WERA 1017 2017-2018 Report for Alaska
Casey Matney, University of Alaska Fairbanks (UAF)

ANNUAL REPORT

Accomplishments:

Alaska Citizen Monitoring Portal - Pest Identification and Reporting Portal
https://www.uaf.edu/ces/ipm/cmp/
Since 2010, this online tool allows the public to be first responders and citizen scientists for the identification and location of pests in Alaska. We received over 100 insect and plant submissions to the portal during the last 12 months.

Alaska Spruce Beetle Resource Webpage
http://www.alaskasprucebeetle.org/
In 2018, this state resource was launched for one of the larger IPM areas of concern for forest pests in communities across Alaska. This website is maintained in cooperation with the UAF Cooperative Extension Service, USDA Forest Service, and the Alaska Division of Forestry.

Alaska IPM Facebook Page
https://www.facebook.com/Alaska.IPM/
22 posts during the 12-month period, 312 Facebook Followers

Alaska Weeds ID App
https://toolkit.climate.gov/tool/alaska-weeds-id-mobile-app
Created in 2015, updated in December 2017
A free mobile application for identification and reporting invasive weeds in Alaska. The app works for both IOS and Android devices. It includes an interactive key, and form to report sightings of potential invasive weeds or get identification help. The app development was done in partnership with the University of Georgia and others, with support of the Western Alaska Landscape Conservation Cooperative and funding from the U.S. Geological Survey and U.S. Fish and Wildlife Service.

Alaska Invasive Species Workshop (3 days)
In Fall of 2017, this annual workshop had over 112 participants. The workshop was held in Anchorage from October 23rd through October 25th. The workshop was hosted by the University of Alaska Fairbanks Cooperative Extension Service and the Alaska Committee for Noxious and Invasive Pest Management.

Spruce Bark Beetle Workshops

Four workshops were presented in collaboration with UAF CES and Alaska Division of Forestry.
Fall 2017: Big Lake (28 participants), Talkeetna (80 participants), Kenai (20 participants)
Spring 2018 Big Lake (34 participants)

Alaska Forest Pests Online Learning Modules

https://forestpests.community.uaf.edu
Introduction Module
Wood-boring Insects Module
Bark Beetles Module
Defoliating Moths Module

Alaska IPM Online Learning Modules

http://ces.open.uaf.edu
Bird Vetch
Controlling Invasive Plants on Roadsides in Alaska
Noxious Weeds
Orange Hawkweed
Spruce Beetles
Spruce Aphid
White Sweet Clover

Asian Defoliating Moth Survey

The Asian gypsy, rosy, nun and Siberian moths are all targets of these trapping efforts. During the last 12-month reporting period UAF CES in partnership with the Alaska Division of Agriculture has been deploying and monitoring over 300 trap sites centered around Anchorage, Delta Junction, Kenai Peninsula, Fairbanks, and the Mat-Su Valley. There have been no detections since 2006, and traps are set at locations where the moths are most likely to be found hitchhiking a ride to Alaska, such as RV parks and high-traffic shipping areas. Our goal is to detect the moths being accidentally brought to Alaska before they can establish and spread.

Alaska Spruce Beetle Survey

In 2017, UAF CES in collaboration with the Alaska Division of Forestry has been conducting outreach and surveys to determine prevalence of spruce beetle in southcentral Alaska.

Alaska Integrated Pest Management on YouTube (Outreach Videos)

Submitting Insect Samples for Identification
https://www.youtube.com/watch?v=9UEAW7ar3vo&t=40s
(4 minutes, 75 views)

Submitting Plant Samples for Identification
https://www.youtube.com/watch?v=9UEAW7ar3vo
(4 minutes, 45 views)

Spruce Beetles: What They Are and What to Do About Them
https://www.youtube.com/watch?v=xM-HUuA8Ko0
(4 minutes, 1,202 views)

Prunus padus (Bird Cherry) and Prunus virginiana (Chokecherry) Invasion of Alaska
https://www.youtube.com/watch?v=RJFipjCNkk8
(7 minutes, 331 views)

Tobacco rattle virus in peonies reference guide

4 authors, one author from UAF
available free by PDF - http://pubs.cahnrs.wsu.edu/publications/pubs/fs284e/

Kenai Cooperative Weed Management Area (CWMA)

Collaboration with US Fish and Wildlife Service, Kenai National Wildlife Refuge, UAF Cooperative Extension Service, Kenai Watershed Forum.
Area weed management priority establishment, educational events, and weed control along with weed control cost-sharing.
Janice Chumley, UAF CES IPM, received the 2018 US Fish and Wildlife Service Alaska Regional Director's Excellence Award as an Outstanding Partner for her many years of partnership through the CWMA.

Anchorage, Fairbanks, and Kodiak Weed Management Areas

The UAF Cooperative Extension Service coordinates with several federal, state, local, and non-profit agencies/groups to provide assistance in management and educational events across the state of Alaska.

IPM Implementation in Animal Agriculture Objectives:

Surveilling of parasite levels in food-producing livestock in Alaska continues as animals/samples/consultations are checked by the state extension veterinarian.
As data continues to be collected we are determining livestock resistance to anthelmintics in Alaska.
Groundwork and materials for providing critical education to Alaskan livestock producers and veterinarians has been created.

IPM Implementation in Specialty Crops

Demonstration plots are identified and being setup for the 2018 season in grower fields, using cover crops to suppress weeds and using compost to control Botrytis cinerea in Alaskan peony crops.

Data sheets and methods for the collection of data and observations from demonstration plots for the development of educational materials have been created.

Statewide IPM in Communities Presentations and Consultations

Provided information to Alaskan growers, Master Gardeners, farmers, producers, and communities in the form of field visits and response to IPM inquiries as needed (>2,000 contacts/participants).

Have provided > 10 Alaskan growers, Master Gardeners, farmers, producers, and communities IPM education instructional events across Alaska during the last 12-month period.

Insect IPM Protocols for Fresh Cut Peonies: Protecting a New Alaskan Export Crop

Four peony farms from the Fairbanks area (3) and Mat-Su (1) region participated in monitoring for lygus bugs and thrips. The goal of the project was to determine IPM protocols for detecting and controlling these insects in peony crops. The project was funded by the Western Sustainable Agriculture and Education Professional + Producer Grant. IPM technicians provided supplies and sampling instructions to growers, who then sampled with sticky traps on a weekly basis. Thrips were included in the sampling to contribute to ongoing research at Washington State University.

Two presentations were delivered to peony growers during the last 12 months, with the findings of the project. Grower surveys were conducted after the project and presentations.

IPM Education for Pesticide Applicators

Alaska has been developing audio and video content for IPM education through online courses focused on IPM management of common pests for home gardeners, ranchers, and farmers. IPM and Pesticide Applicator courses were offered during January and April of 2018 at multiple locations (simultaneously via online and face-to-face) across Alaska (>120 participants).

Impacts:

Insect IPM Protocols for Fresh Cut Peonies: Protecting a New Alaskan Export Crop

IPM strategies and two new publications were produced from this project: 1) Managing Lygus Bugs in Peony Crops and 2) Managing Thrips in Peony Crops.

19 farmers responded to a survey following the project. 18 Farmers reported changes in knowledge, attitudes, skills and/or awareness as a result of their participation

Participant Key Changes:

Improved awareness of insect pests in peonies – 89%

New knowledge about potential damage caused by insect pests and hot to recognize those pests – 95%
New skills in insect pest scouting, recognition, and implementing IPM practices – 94%
Changed attitudes towards the issues surrounding insect pests – 59%

Percentage of participants who were likely to implement change within the next year:

Adopt one or more practices shown – 89%
Increase the operations diversification – 50%
Reduce my use of purchased off farm inputs – 27%
Increase my networking with other producers – 88%
Incorporate value-added into some aspect of my operation – 71%

IPM Education for Pesticide Applicators

More than 120 pesticide applicators were certified for Alaska.

Publications:

Moan, J. 2018. Spruce Beetles: A Guide to Tree Management Options for Home and Woodlot Owners. University of Alaska Fairbanks Cooperative Extension Service Fact Sheet PMC-10067.

Garfinkel, A., Steinlage, T., Chumley, J., and Chastagner, G. (2017). Tobacco rattle virus in peonies: a reference guide for cut flower and rootstock producers. Washington State University Fact Sheet FS284E.

Chumley, J. 2017. Slugs. University of Alaska Fairbanks Cooperative Extension Service Fact Sheet PMC-10070.

Moan, J., Chumley, J., Etcheverry, D., and Graziano, G. 2018. Managing Lygus Bugs in Peony Crops. University of Alaska Fairbanks Cooperative Extension Service, Integrated Pest Management Issues Bulletin.

Moan, J., Chumley, J., Etcheverry, D., and Graziano, G. 2018. Managing Thrips in Peony Crops. University of Alaska Fairbanks Cooperative Extension Service, Integrated Pest Management Issues Bulletin.

Grants:

USDA NIFA Crop Protection and Pest Management (CPPM), Extension Implementation Program
Matney, C. and M. Zhang ($150,129)
Sep 2017 – Aug 2018

Farm Bill 10007 - 1st Detector Exotic Plant Pathogen Training
Graziano, G. ($35,000)
Sep 2017 – Aug 2018

UC Davis - Alaska Western Plant Diagnostic Network
Graziano, G. ($ 13,000)
Sep 2017 – Aug 2018

Division of Agriculture - Asian Defoliating Moth Survey and Outreach
Graziano, G. ($30,000)
Jan 2018 – Dec 2018

Division of Forestry - Spruce beetle survey and outreach
Graziano, G. ($35,000)
Aug 2017 – Dec 2019

US Forest Service - Forest Health and IPM outreach
Graziano, G. ($250,000)
Aug 2015 – Dec 2019

US Forest Service - Prunus padus control research
Graziano, G ($36,000)
Aug 2015 – Dec 2019

2017 Statewide Integrated Pest Management

Integrated Pest Management of *Bagrada hilaris*

July 2018

Area addressed

Bagrada hilaris, known as the Bagrada bug, is a native to Africa, India, Pakistan, and other countries. The Bagrada bug has been an agricultural pest in the western United States, including California and Arizona. This stink-bug is a serious pest in the agricultural areas of both Arizona and California, where a survey conducted in Yuma, Arizona revealed that approximately 90% of the broccoli planted in the fall was infested by the Bagrada bug (Palumbo 2014). Feed by this pest causes leaf damage, stunted growth, the formation of multiple heads, and heavy feeding can cause plant death. Severe economic loss has also been reported due to feeding damage in the early development of crops (Shimat 2014). Management of this agricultural pest has relied heavily on the applications of broad-spectrum insecticides (Palumbo, Perring, Millar & Reed 2016).

First discovered on Maui in 2014, the Bagrada bug is a relatively new pest to Hawaii. The Bagrada bug has been also been identified on Hawaii island, Kauai, and Oahu. The potential for statewide crop loss due to *Bagrada hilaris* infestation can be mitigated by further trials in control options and integrated pest management education for farmers.

The primary focus of this project is to provide further management recommendations for organic and non-organic growers.

Activity outputs and short-term outcomes

A host preference trial was installed at the Kula Agricultural Park on Maui on May 24th, 2018. The trial consisted of 4 randomized replications of brassica crops and plants randomized, including:

- Head cabbage
- Chinese cabbage/won bok
- Broccoli
- Mustard cover crop
- Cauliflower
- Kale
- Mizuna
- Arugula
- Pak Choy
- Mustard Cabbage
- Daikon
- Sweet Alyssum

Sweet alyssum was included in this trial based on information from the University of California's Statewide Integrated Pest Management Program

(http://ipm.ucanr.edu/PMG/PESTNOTES/pn74166.html). In their recommendations for cultural control, it is suggested that sweet alyssum (lobularia maritima) is a very attractive host plant of Bagrada bug and can be used as a bait in pyramid traps. Sweet alyssum was included in this trial to investigate the host attractiveness for Hawai'i.

Due to the cooler temperatures transitioning from spring to summer, a border crop of sweet alyssum was planted in effort to attract the pest to the trial area.

Six weekly surveys were conducted after planting. Bagrada were not observed until the third week at very low numbers. Bagrada were only found on mizuna, a specialty crop in Hawai'i. Average counts of Bagrada on mizuna were 1.33, and 0 on all other hosts across the 6 week period.

Ideally, this trial should be conducted again to assess host preference, including both the recommended sweet alyssum and mizuna which the Bagrada appeared to prefer, observationally.

Fortunately for farmers, it seems the Bagrada population is lower this year than the year prior. Evidence of this has been shown in the host preference trial, as well as a lack of farmer complaints of this pest. Unfortunately, the low Bagrada bug has caused a challenge in completing project activities, which also included pesticide, mechanical removal, and trap efficacy trials.

Past and Upcoming Educational Output Activities:

- Maui IPM Workshop May 23, 2018, Maui Cooperative Extension Office
- CTAHR Ground Support: Research-based Support for O'ahu's Fast-Paced Edible Crop Industry August 1, 2018, Leeward Community College

Impacts

While the population of Bagrada bugs was not ideal for the sake of this project, it seems that those pests that were present in the trial field, preferred mizuna over the 11 potential hosts. Although the pests counts were low in this host preference trial, these observations and results may indicate that mizuna can be effective host for use as a trap crop in Bagrada bug management, offering both organic and non-organic growers another treatment option. Furthermore, a trial conducted by Extension Agent Robin Shimabuku and Dr. Ronald Mau also indicated that Mizuna was one of the preferred hosts for Bagrada bug.

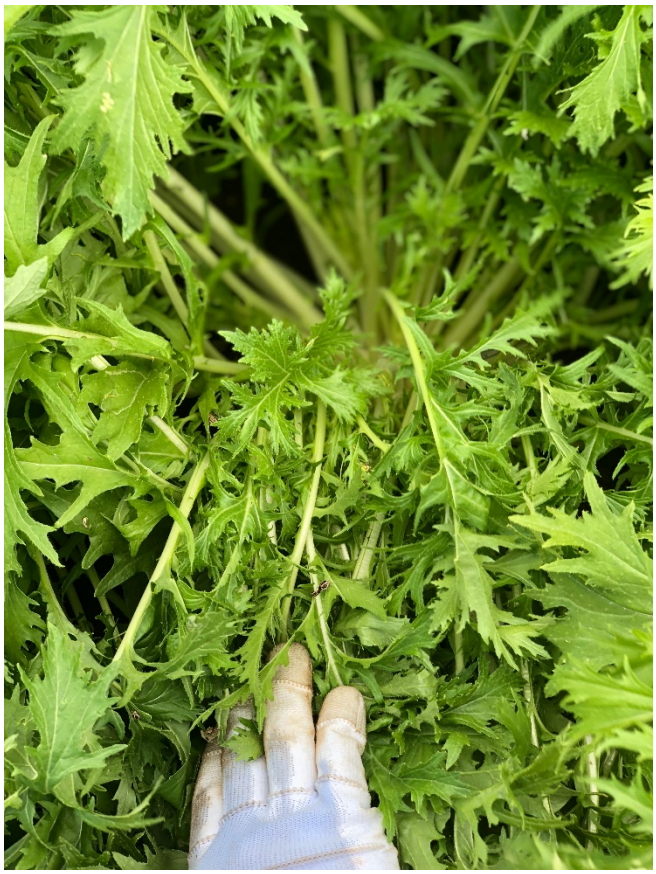
Primary linkages to external groups

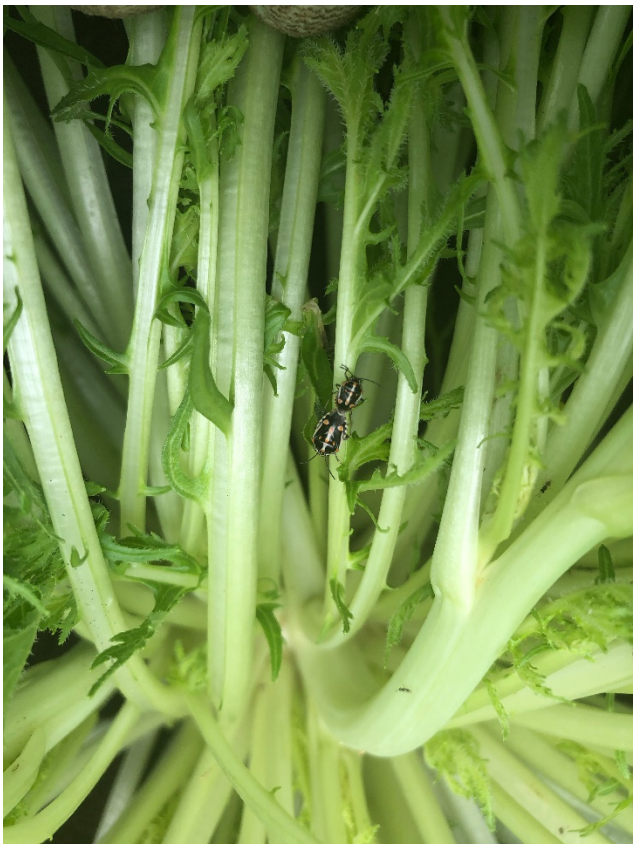
Information about this pest has delivered to commercial vegetable crop growers. This project will continue to build external linkages are additional information from this project becomes available, working with CTAHR faculty and industry organizations to disseminate this information. Efforts to replicate work on other islands will be explored.

Publications

None at this time.

Photos





July 2017 Statewide IPM Report
Updated Melon Fly Resistance and Control Programs for Hawaii
J. Silva, J. Uyeda, J. Sugano, R. Mau, R. Shimabuku, C. Nazario-Leary, K. Wong, A. Kawabata, S. Wages, and E. Kirk

Areas Addressed

Melon fly (*Bactrocera cucurbitae*) is a critical economic pest to Hawaii agriculture, resulting in annual $300 million of crop damage and loss according to 2001 estimates. Successful management efforts were made in the early 2000's with the Hawaii Fruit Fly Area-Wide Pest Management program, with an effective management practice including the use of GF-120 bait spray (protein bait and spinosad insecticide). However, given its widespread use and melon fly biological cycles, resistances to GF-120 in Hawaii melon populations were first observed in 2012.

Amulet is an alternative product to GF-120 that could serve as another means to control melon fly populations. Amulet consists of a molded paper fiber dispenser that is soaked with fipronil, a contact or ingestion-type insecticide, and Cue-Lure, a male-attracting pheromone (Vargas et al. 2005). Amulet is a great potential melon fly control due to its control of both males and females via horizontal transfer of the fipronil pesticide (Spafford et al. 2012). However, Amulet can be expensive, with a pack of 16 traps needed for 1 acre costing approximately $180. Given the high cost of this product, information that would allow for the use of fewer traps per area with adequate melon fly control would be ideal.

The objective of this study was to evaluate Amulet trap densities in controlling melon fly populations at a zucchini farm on O`ahu.

Activity Outputs

A replicated trial of three Amulet treatments was conducted at a cooperating zucchini farmer in `Ewa, O`ahu during April 2018. Within zucchini fields, 1-acre plots were established for monitoring melon fly populations, and traps were placed in sudex grass (sorghum x sudangrass hybrid) border rows, a known roosting host for melon fly (Nishida 1953). Initially six 1-acre plots were established for duplicate replications, but due to unanticipated field practices (e.g. field abandonment, trap destruction), only three plots were utilized for data collection (Fig. 1). The Amulet treatments included 2 Amulet baits per plot, 4 baits, and 10 baits. Two soda bottle traps baited with one Cue Lure were placed at opposite ends centered within each plot to monitor male fly populations. One Torula Yeast station with yellow bottom (Iscatech Technologies), which visually attracts female and possibly male fruit flies (Pinero et al. 2017), was placed on one end of each plot to monitor female populations. Fly populations were monitored weekly.

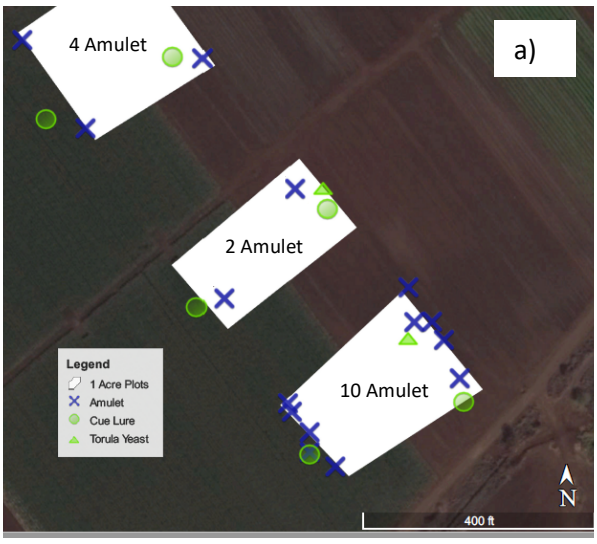


Fig. 1. Plot layout for Amulet, Cue Lure, and Torula Yeast stations

Both male and female melon fly populations were exceptionally high in all three plots throughout the 3-week study period. For Cue Lure stations, male populations were initially low during the first week (5-12 flies per week) but exploded during the second week to as much as 60 flies (Fig. 2a). For the 2- and 4-Amulet trap plots, populations decreased by 33 and nearly 50%, respectively, during the third week of monitoring, but the 10-Amulet plot population remained at the same level.

Female populations measured in the Torula Yeast stations exhibited greater decreases possibly with the addition of Amulet. Similar to the Cue Lure data, female populations were high during the first 2-weeks of monitoring (Fig. 2b), with female levels as high as 500-1000 flies per week for all Amulet rates. At the third week of monitoring, female fly levels decreased drastically in all plots. The 2-, 4-, and 10-Amulet plot fly populations decreased by 61%, 50%, 67%, respectively, between the second and third weeks.

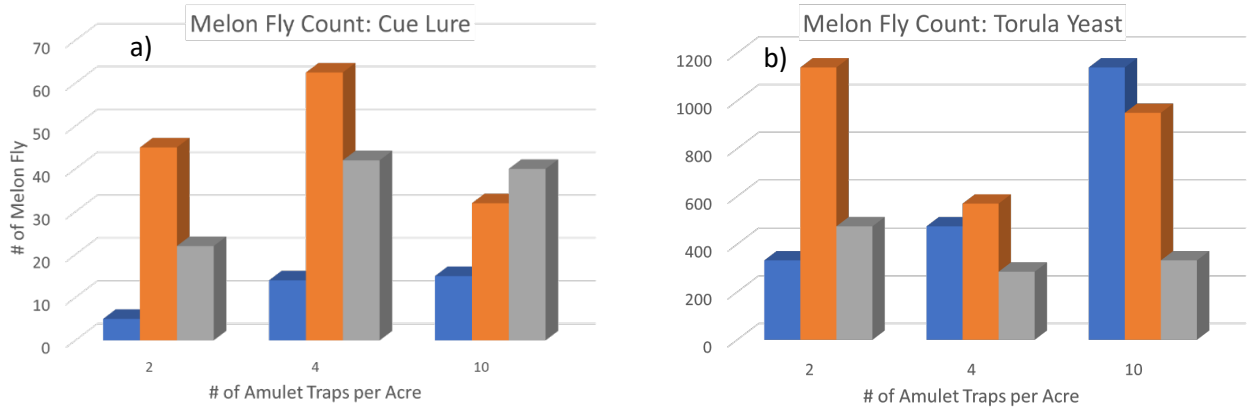


Fig. 2. Melon fly populations for a) Cue Lure and male flies and b) Torula Yeast and female flies

In addition to the study, which is being reconducted, we will be presenting information on melon fly management at an upcoming agricultural conference on August 1 (CTAHR Ground Support: Researched-based Support for Oahu's Fast-Paced Edible Crop Industry. August 1, 2018. Leeward Community College).

Short-term Outcomes, Impacts

Study results suggested that Amulet traps can lower both male and female melon fly populations when targeted in roosting hosts like sudex. However, given additional monitoring since April, the study area and design are too small to capture the effect of Amulet on melon fly populations as flies can travel large distances from roosting hosts to reproductive fruit hosts. The study is being reconducted and expanded to include the larger farm lands. Regardless, from this initial work, the farm gained knowledge on proper Amulet trap construction and use to assist with their other melon and cucurbit production areas.

Primary linkages to external groups

The project team actively collaborates with cooperating farmers and agricultural professional groups to develop and disseminate applied research information to other farmers across the state.

Publications

None currently available

Background

This report covers the accomplishments in the 2017-2020 Colorado Extension Implementation Program (EIP), which address the following priority areas and objectives:

1. IPM Implementation in Agronomic Crops

    Objective 1. Demonstrate harvest weed seed control (HWSC) as a nonchemical alternative for management of winter annual grasses and herbicide resistant weeds, primarily kochia, in winter wheat.

2. IPM Implementation in Communities

    Objective 1. Extending IPM techniques and plant troubleshooting methods to homeowners, non-profit garden leaders and small market farmers.

3. IPM Implementation in Specialty Crops

    Objective 1. Develop educational materials and workshops addressing insect pest management in small fruits, vegetables, and herbs produced in small market farms, community gardens, and Community Supported Agriculture.

4. IPM for Pollinator Health

    Objective 1. Develop curriculum, novel experiential learning, peer-to-peer mentoring and online educational resources to promote honey bee health

    Objective 2. Disseminate best management practices for honeybee hive management

    Objective 3. Develop and extend an IPM framework for honey bee health.

5. IPM Support for Pest Diagnostic Facilities

    Objective 1. Provide accurate and timely diagnosis, technical assistance and recommendations for the application of IPM practices.

6. IPM Training and Implementation in Schools

    Objective 1. Educate school communities about School IPM and pest identification

    Objective 2. Reducing pest problems, pesticide exposures and pesticide applications.

While accomplishments are limited to the period after receipt of 2017-2020 Colorado EIP funding, Extension presentations, scientific presentations and grants received relevant to the Colorado EIP objectives are based on the calendar year. The list of publications is drawn from the larger Colorado IPM community and includes work outside the scope of the Colorado EIP

program.

Progress by priority area

IPM Implementation in Agronomic Crops

Accomplishments

The harvest weed seed control (HWSC) concept was introduced at two meetings with crop consultants and other decision makers, with the purpose of recruiting cooperators and gathering preliminary data.

Fifty-one samples of downy brome, feral rye and jointed goatgrass were tested for resistance to quizalofop-p-ethyl and imazamox. These herbicides are of greatest concern for resistance development because they are available in herbicide-tolerant wheat systems in Colorado. Two stewardship publications have been developed for the newer CoAxium system.

Extension Presentations

PPO herbicides (3)

Molecular biology and herbicide resistance (6)

ACCase herbicides in wheat (2)

Weed management updates (2)

Scientific Presentations

Barker, Abigail Lynn, Todd, Olivia Elizabeth, Dayan, Franck E, Gaines, Todd, Weed Science Society of America, "A Study of Cytochrome P450 Mediated Metabolic Resistance in Kochia scoparia," Tucson, AZ, United States. (2017).

Gaines, Todd, American Society of Agronomy, "Using molecular tools to understand and combat herbicide resistance," Tampa, FL, United States. (October 23, 2017).

Gaines, Todd, Patterson, Eric, Westra, Philip, Sloan, D, Tranel, P, Saski, C, North Central Weed Science Society, "Genome-wide analysis of copy number variation in kochia," St. Louis, MO, United States. (2017).

Gaines, Todd, Patterson, Eric, Pettinga, Dean Jacob, Ravet, Karl, Sloan, Daniel Benjamin, Tranel, P, Westra, Philip, Saski, C, Western Society of Weed Science, "A Draft Genome for Kochia scoparia," Coeur D'Alene, ID, United States. (2017).

Hildebrandt, Curtis Martin, Westra, Philip, Haley, Scott D, Shelton, C, Gaines, Todd, Global Herbicide Resistance Challenge, "Crop safety and winter annual grass weed control in mutagenesis-derived ACCase-resistant winter wheat lines," Denver, CO, United States. (2017).

Hildebrandt, Curtis Martin, Patterson, Eric, Gaines, Todd, Plant and Animal Genome, "Quick Genotyping for an ACCase Herbicide Resistance Gene in Wheat Using KASP Assay," San Diego, CA, United States. (2017).

Hildebrandt, Curtis Martin, Haley, Scott D, Westra, Philip, Gaines, Todd, Western Society of Weed Science, "Viability Assessment of Mutagenesis-derived ACCase Resistant Wheat Lines as a New System for Control of Winter Annual Grasses," Coeur D'Alene, ID, United States. (2017).

Ou, J, Pettinga, Dean Jacob, Stahlman, P, Westra, Philip, Gaines, Todd, Jugulam, M, Global Herbicide Resistance Challenge, "Distinct mechanisms contribute to dicamba resistance in Kochia scoparia from Kansas and Colorado," Denver, CO, United States. (2017).

Ou, J, Pettinga, Dean Jacob, Stahlman, P, Westra, Philip, Gaines, Todd, Jugulam, M, Western Society of Weed Science, "Control Dicamba-Resistance in Kochia from Colorado and Kansas," Coeur D'Alene, ID, United States. (2017).

Patterson, Eric, Ravet, Karl, Pettinga, Dean Jacob, Westra, Philip, Sloan, D, Tranel, P, Saski, C, Gaines, Todd, Plant and Animal Genome, "The Draft Genome of Kochia scoparia : A Foundation for Studying Adaptive Evolution and Its Impacts on Genome Architecture," San Diego, CA, United States. (2017).

Patterson, Eric, Ravet, Karl, Tranel, P, Sloan, D, Westra, Philip, Saski, C, Gaines, Todd, Global Herbicide Resistance Challenge, "Genome sequencing and assembly for Kochia scoparia," Denver, CO, United States. (2017).

Powles, S, Gaines, Todd, Weed Science Society of America, "Exploring the Potential for a Regulatory Change to Encourage Diversity in Herbicide Use," Tucson, AZ, United States. (2017).

Quicke, A, Gaines, Todd, Westra, Philip, Western Society of Weed Science, "Use of SSR Markers to Track the Evolutionary Trajectory of Glyphosate Resistant Kochia in North America," Coeur D'Alene, ID, United States. (2017).

Soni-Castillo, Neeta, Ravet, Karl, Fleming, M, Dayan, Franck E, Nissen, Scott J, Westra, Philip, Gaines, Todd, Global Herbicide Resistance Challenge, "A novel mechanism that confers reduced glyphosate sensitivity in Kochia scoparia," Denver, CO, United States. (2017).

Soni-Castillo, Neeta, Nissen, Scott J, Westra, Philip, Walsh, M, Norsworthy, J, Gaines, Todd, Western Society of Weed Science, "Integrated Weed Management of Winter Annual Grasses in Wheat using Harvest Weed Seed Control," Coeur D'Alene, ID, United States. (2017).

Todd, Olivia Elizabeth, Barker, A, Dayan, Franck E, Gaines, Todd, Global Herbicide Resistance Challenge, "Characterizing the phenotypic response to Fluroxypyr in Putative Resistant Kochia scoparia," Denver, CO, United States. (2017).

Todd, Olivia Elizabeth, Pettinga, Dean Jacob, Westra, Eric Philip, Westra, Philip, Gaines, Todd, Western Society of Weed Science, "Characterizing the Phenotypic Response to Fluroxypyr in Kochia scoparia," Coeur D'Alene, ID, United States. (2017).

Westra, Philip, Gaines, Todd, Dayan, Franck E, Weed Science Society of America, "Using the genome of Kochia scoparia to inform crop improvement research," Tucson, AZ, United States. (February 2017).

Westra, Philip, Gaines, Todd, Pettinga, Dean Jacob, Jugulam, M, Stahlman, P, Global Herbicide Resistance Challenge, "Kochia scoparia Resistance to Auxin Herbicides," Denver, CO, United States. (2017).

Grants

Gaines, Todd A (PI), Westra, Philip (CoPI), "Evaluate Dicamba Formulations for Control of Multiple Kochia Accessions from the Central Great Plains and Canada," Sponsored by BASF Corporation, $103,925.00. (May 1, 2014 - December 31, 2019).

Gaines, Todd A (PI), "Weed Science Herbicide Resistant Weed Management in Winter Wheat," Sponsored by Colorado Wheat Administrative Committee, $90,000.00. (July 1, 2015 - June 30, 2018).

IPM Implementation in Communities

Accomplishments

Several meetings with priority clientele groups have been scheduled and will be held in the near future.

IPM Implementation in Specialty Crops

Accomplishments

Emphasis on Japanese beetle has been increased due to its emerging importance along the Front Range. Accomplishments include a new fact sheet and FAQ. The relative susceptibility of locally adapted rose cultivars has been evaluated, and two biological control agents have been released at several study sites.

A hemp insects website has been established and management guidelines for some of the more important pests have been developed.

Extension Presentations

Emerald ash borer (2)

Garden insects (6)

Landscape insects (3)

Abiotic tree diseases

Master gardener (14)

Hemp insects

Invasive species

Peach diseases (2)

Scientific Presentations

Alakeel, Rasha, Cranshaw, Whitney, Entomological Society of America Annual Conference, "Investigations into some potential risks to non-target species from emerald ash borer applied insecticides.," Denver, Colorado, United States. (November 2017).

Cranshaw, Whitney, NCERA 224, "Update on Colorado Insect Extension/Research Activities," Key Largo, Florida, Key Largo, Florida, United States. (December 2017).

Cranshaw, Whitney S, Entomological Society of America, "Hemp insect pest management: Needs and challenges," Denver, Colorado, United States. (November 2017).

Cranshaw, Whitney S, American Phytopathological Society, "Cannabis pest management: A perspective from Colorado," Above, San Antonio, Texas, United States. (August 2017).

Longtine, Zachary, Cranshaw, Whitney, Kondratieff, Boris, Uchanski, Mark, Shreiner, Melissa, Burns, Wendlin, Entomological Society of America National Meeting, "Insect faunal survey of three non-native mustards as overwintering habitat for cruciferous insects.," Denver, Colorado, United States. (November 2017).

Miller, Stephan Tomas , Otto, Kristen , Sterle, David Gabriel, Minas, Ioannis , Stewart, Jane E , American Phytopathological Society Annual Meeting 2017, "Cytospora Canker: Managing A Major Limiting Factor for Colorado Peach Production," APS, San Antonio, TX, United States. (August 5, 2017).

Miller, Stephan Tomas , Otto, Kristen , Sterle, David Gabriel , Minas, Ioannis , Stewart, Jane E , 9th International Peach Symposium, Bucharest, Romania, "Developing strategies for managing Cytospora canker in peach orchards in Colorado," Bucharest, N/A, Romania. (July 2, 2017).

Peirce, Erika, Sitz, Rachael, Melissa, Shreiner, Burns, Wendlin, Cranshaw, Whitney, Entomological Society of America National Meeting, "The natural enemy complex associated with European elm scale in Colorado, with emphasis on associated parasitoids.," Denver, Colorado, United States. (November 2017).
Shreiner, Melissa, Burns, Wendlin, Peirce, Erika, Hurd, Larry, Cranshaw, Whitney, Entomological Society of American National Meeting, Identifying rose cultivars for the post-Japanese beetle landscape.," Denver, Colorado, United States. (November 2017).

Sitz, Rachael, Stewart, Jane, Cranshaw, Whitney, Entomological Society of America National Meeting, "An Overview of Drippy Blight: An Emergent Insect Associated Disease of Red Oaks.," Denver, Colorado, United States. (November 2017).

Grants

Cranshaw, Whitney S (PI), "Establishing Insect Pest Management Needs for Hemp Grown in the High Plains/Rocky Mountain Region," Sponsored by University of California, Davis, $28,749.00. (March 1, 2017 - August 31, 2018).

Cranshaw, Whitney S (PI), "Disease Description of Drippy Blight: A Unique Association Between a Scale Insect and a Plant Pathogenic Bacteria," Sponsored by Tree Research and Education Endowment Fund, $10,000.00. (January 1, 2016 - June 30, 2017).

Stewart, Jane E (PI), Minas, Ioannis (CoPI), "Cytospora management in peach orchards through cultural practices, cultivar selection, and stress mitigation," Sponsored by Colorado Department of Agriculture, State of Colorado, $91,966.00. (November 15, 2017 - November 1, 2019).

Jahn, Courtney Elaine (PI), Stewart, Jane E (CoPI), "Managing Potato Soil Health Through Crop Rotation Length and Diversity for Increased Economic Gain in Colorado," Sponsored by Colorado Potato Administrative Committee, $111,476.00. (January 1, 2017 - October 15, 2018).

IPM for Pollinator Health

Accomplishments

Three counties have been recruited to participate in the pilot Colorado Beekeeper Mentorship Program. Recruitment materials and curricula are being developed, and mentor training is scheduled to start in the near future.

Grants

Cranshaw, Whitney S (PI), "Disease Description of Drippy Blight: A Unique Association Between a Scale Insect and a Plant Pathogenic Bacteria," Sponsored by Tree Research and Education Endowment Fund, Domestic Non-Profit (other than Domestic Foundations), $10,000.00. (January 1, 2016 - June 30, 2017).

IPM Support for Pest Diagnostic Facilities

Accomplishments

The Colorado State University Plant Diagnostic Clinic has been reorganized to improve timeliness and accuracy of services to clientele.

IPM Training and Implementation in Schools

Accomplishments

The Colorado School IPM website has been developed and made available for users at: http://schoolipm.colostate.edu. The Colorado School IPM Newsletter is now consistently published and distributed electronically to Colorado school districts on a monthly basis. School

inspections and baseline assessments of three schools were conducted in Mesa Valley School District. This district joined the Colorado School IPM Coalition which now includes 16 major school districts comprising 60% of the state's student population.

Coordination

The 2017-2020 Colorado Extension Implementation Program has been in place only a short time, so outcomes and impacts have yet to be realized. Plans are in place for each objective and progress towards our goals is ongoing.

Publications

Broders, K. 2017. The Biovigilante: Monitoring threats to plant health in an era of globalization and climate change. CANADIAN JOURNAL OF PLANT PATHOLOGY 39: 90 - 91.

Busi, R, Gaines, TA, and Powles, S. 2017. Phorate can reverse P450 metabolism-based herbicide resistance in *Lolium rigidum*. PEST MANAGEMENT SCIENCE 73: 410 - 417.

Cockrell, DM, Griffin-Nolan, RJ, Rand, TA, Altilmisani, N, Ode, PJ and Peairs, F. 2017. Plants of the Wheat Stem Sawfly (Hymenoptera: Cephidae). ENVIRONMENTAL ENTOMOLOGY 46: 847 - 854.

Dille, JA, Stahlman, PW, Du, J, Geier, PW, Riffel, JD, Currie, RS, Wilson, RG, Sbatella, GM, Westra, P, Kniss, AR, Moechnig, MJ and Cole, RM. 2017. Kochia (*Kochia scoparia*) Emergence Profiles and Seed Persistence across the Central Great Plains. WEED SCIENCE 65: 614 - 625.

Fernandez-Escalada, M, Zulet-Gonzalez, A, Gil-Monreal, M, Zabalza, A, Ravel, K, Gaines, T and Royuela, M. 2017. Effects of EPSPS Copy Number Variation (CNV) and Glyphosate Application on the Aromatic and Branched Chain Amino Acid Synthesis Pathways in *Amaranthus palmeri*. FRONTIERS IN PLANT SCIENCE 8: 1970.

Glab, L, Sowinski, J, Bough, R and Dayan, FE. 2017. Allelopathic Potential of Sorghum (Sorghum bicolor (L.) Moench) in Weed Control: A Comprehensive Review. ADVANCES IN AGRONOMY 145: 43 - 95.

Haley, SD, Johnson, JJ, Peairs, FB, Stromberger, JA, Hudson-Arns, EE, Seifert, SA, Anderson, VA, Bai, GH, Chen, XM, Bowden, RL, Jin, Y, Kolmer, JA, Chen, MS and Seabourn, BW. 2017. Registration of 'Sunshine' Hard White Winter Wheat. JOURNAL OF PLANT REGISTRATIONS 11: 289 - 294.

Iriarte, G, Hale, I and Broders, K. 2017. Mining the microbiomes of crop wild progenitors for co-evolved beneficial microbes. CANADIAN JOURNAL OF PLANT PATHOLOGY 39: 99 - 100.

Klopfenstein, NB, Stewart, JE, et al. 2017. Insights into the phylogeny of Northern Hemisphere Armillaria: Neighbor-net and Bayesian analyses of translation elongation factor 1-alpha gene sequences. MYCOLOGIA 109: 75 - 91.

Kupper, A, Borgato, EA, Patterson, EL, Netto, AG, Nicolai, M, de Carvalho, SJP, Nissen, SJ, Gaines, TA, and Christoffoleti, PJ. 2017. Multiple Resistance to Glyphosate and Acetolactate Synthase Inhibitors in Palmer Amaranth (*Amaranthus palmeri*) Identified in Brazil. WEED SCIENCE 65: 317 - 326.

Lang, JM, DuCharme, E, Caballero, JI, Luna, E, Hartman, T, Ortiz-Castro, M, Korus, K, Rascoe, J, Jackson-Ziems, TA, Broders, K and Leach, JE. 2017. Detection and Characterization of *Xanthomonas vasicola pv. vasculorum* (Cobb 1894) comb. nov Causing Bacterial Leaf Streak of Corn in the United States. PHYTOPATHOLOGY 107: 1312 - 1321.

Merrill, SC and Peairs, FB. 2017. Temperature variability is a key component in accurately forecasting the effects of climate change on pest phenology. PEST MANAGEMENT SCIENCE 73: 380 - 388.

Monaco, TA, Mangold, JM, Mealor, BA, Mealor, RD and Brown, CS. 2017. Downy Brome Control and Impacts on Perennial Grass Abundance: A Systematic Review Spanning 64 Years. RANGELAND ECOLOGY & MANAGEMENT 70: 396 - 404.

Oliveira, MC, Jhala, AJ, Gaines, T, Irmak, S, Amundsen, K, Scott, JE and Knezevic, SZ. 2017. Confirmation and Control of HPPD-Inhibiting Herbicide-Resistant Waterhemp (*Amaranthus tuberculatus*) in Nebraska. WEED TECHNOLOGY 31: 67 - 79.

Patterson, EL, Fleming, MB, Kessler, KC, Nissen, SJ and Gaines, TA. 2017. A KASP Genotyping Method to Identify Northern Watermilfoil, Eurasian Watermilfoil, and Their Interspecific Hybrids. FRONTIERS IN PLANT SCIENCE 8: 752.

Ritter, SM, Hoffman, CM, Ex, SA, and Stewart, JE. 2017. Impacts of lodgepole pine dwarf mistletoe (*Arceuthobium americanum*) infestation on stand structure and fuel load in lodgepole pine dominated forests in central Colorado. BOTANY 95: 307 - 321.

Sarangi, D, Tyre, AJ, Patterson, EL, Gaines, TA, Irmak, S, Knezevic, SZ, Lindquist, JL and Jhala, AJ. 2017. Pollen-mediated gene flow from glyphosate-resistant common waterhemp (*Amaranthus rudis* Sauer): consequences for the dispersal of resistance genes. SCIENTIFIC REPORTS 7: 44913.

Schuelke, TA, Wu, GX, Westbrook, A, Woeste, K, Plachetzki, DC, Broders, K and MacManes, MD. 2017. Comparative Genomics of Pathogenic and Nonpathogenic Beetle-Vectored Fungi in the Genus Geosmithia. GENOME BIOLOGY AND EVOLUTION 9: 3312 - 3327.

Sebastian, DJ, Nissen, SJ, Sebastian, JR and Beck, KG. 2017. Seed Bank Depletion: The Key to Long-Term Downy Brome (*Bromus tectorum* L.) Management 70: 477 - 483.

Sebastian, DJ, Nissen, SJ, Sebastian, JR, Meiman, PJ and Beck, KG. 2017. Preemergence Control of Nine Invasive Weeds with Aminocyclopyrachlor, Aminopyralid, and Indaziflam. INVASIVE PLANT SCIENCE AND MANAGEMENT 10: 99 - 109.

Sitz, RA, Luna, EK, Caballero, JI, Tisserat, NA, Cranshaw, WS and Stewart, JE. 2017. Virulence of Genetically Distinct Geosmithia morbida Isolates to Black Walnut and Their Response to Coinoculation with Fusarium solani SO PLANT DISEASE 101: 116 - 120.

Sitz, R, Utley, C, Hall, A, Tisserat, N and Cranshaw, W. 2017. Trapping the Walnut Twig Beetle(1) to Determine Flight Patterns in Colorado. SOUTHWESTERN ENTOMOLOGIST 42: 347 - 355.

Wyka, SA, Smith, C, Munck, IA, Rock, BN, Ziniti, BL and Broders, K. 2017. Emergence of white pine needle damage in the northeastern United States is associated with changes in pathogen pressure in response to climate change. GLOBAL CHANGE BIOLOGY 23: 394 - 405.