

**WERA 1017 Arizona State Report 2017
July 2016 – June 2017**

Area Addressed: Specialty Crops IPM (vegetables); Agronomic Crops IPM; School & Community IPM; IPM for Pesticide Applicators & Pesticide Safety.

Program Outcomes Summary:

Across all IPM program areas, we reached over 2,000 participants at over 30 Cooperative Extension meetings and at industry conferences and university events, delivering over 109 AZ CEUs, 42.5 CA CEUs, 24 Certified Crop Advisor CEUs, as well as CEUs from Office of Pest Management for urban pest management. These included several field days and research demonstrations for agricultural crops, pesticide safety, turf and school IPM.

Area Addressed: Specialty Crops IPM

Activities & Outputs:

The Vegetable IPM Team continued biweekly insect, weed and disease management Veg IPM Update advisories, delivering 24 IPM updates to 879 people via web, email, smart phone and in audio file format. Updates were re-distributed by Western Farm Press and other mass media, reaching well over 10,000 readers. The team conducted a survey of the impact of diamondback moth on Arizona cole crops, which found that many pest managers are not able to manage populations using the diamide insecticides any longer. Extension publications included: Bagnrada bug management in the desert, diamondback moth control and resistance management, areawide diamondback moth trapping network, and management guides for thrips, aphids, and whitefly. (Selected examples under Products.) 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.

Outcomes:

Last year, we reported on a Vegetable IPM Team survey that measured adoption and impact of Veg IPM Updates and other team outreach activities. Below, we report from a follow-up questionnaire sent Dec 2016 intended to capture economic impacts of our programs. Here are some highlights from the results (n = 55)

- 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

Activities & Outputs:

We continued to develop and deploy Chemical Use Maps for whitefly resistance management, putting pesticide use maps for 6 modes of action into the hands of pest managers and conducting intense outreach on the “first principles” of resistance management. This effort is leveraged by USDA-NIFA-ARDP, Monsanto, the Specialty Crop Block Grant program and Cotton Inc. Research and outreach on the economics of brown stink

bug management continued this term, leveraged by a Western IPM Center grant, and research results were shared, leading to drastic reductions in the use of pyrethroids and dicotophos for stink bug control. A research project in guayule, a desert shrub used to produce high quality latex products, is developing information on insect management and stand establishment. Recently, concerns have arisen over the apparent resistance of Southwest Corn Borer to at least one variety of Bt corn. We worked with Arizona Department of Agriculture to develop two section 18s, both approved, for use of Transform (sulfoxaflor) to control sugar cane aphid in sorghum (a new invasive pest) and for use in cotton to manage Lygus bug. An IPM Short on Auxin herbicides was published, outlining herbicide label requirements and best practices to prevent drift of auxin herbicides. (Off target movement of 2,4-D and dicamba can cause substantial injury to downwind sensitive plants, a potential liability issue for applicators.) The Fourth Annual New Technologies workshop covered topics such as variable-rate nozzle design for pest management, proactive resistance management of whiteflies using chemical use maps, and new growth regulator technologies in cotton.

Outcomes:

Chemical Use Maps for Whitefly Resistance Management

In 2016, we conducted a telephone survey with PCAs who accessed 2014 Chemical Use Maps, to determine how access to maps impacted 2015 management practices. Key findings included:

- 53% of respondents indicated that the maps provided a large improvement on their knowledge about the previous year's insecticide use in areas around their fields.
- 29% indicated a moderate improvement and 18% a small improvement.
- 41% of respondents indicated they always consider the previous year's chemical use in areas surrounding their fields when making insecticide decisions for whitefly control (irrespective of maps).
- Another 41% indicated they consider this information in 51 to 99% of their decisions.
- About 70% of respondents said they specifically considered information provided in 2014 Chemical Use Maps at least in some cases, with 18% indicating they always considered the maps when making whitefly management decisions.
- When asked to what degree Chemical Use Maps improved their confidence in whitefly management decisions, 27% indicated a large improvement, 33% a moderate improvement, and 40% a small improvement in confidence.
- More extensive analytical work to evaluate use and of the maps and adoption of resistance management principles is underway.

Brown Stink Bug research and outreach

- Our preliminary analysis suggests that the economic savings to growers resulting from this change in behavior easily exceed \$8 million.

Area Addressed: Community IPM

Activities & Outputs:

School IPM. This past year, the Maricopa Unified School District was awarded third-party IPM STAR certification by the IPM Institute of North America. Our team also engaged with County Agents to implement hands-on workshops in outlying school districts and established a proof of concept and template for expanding our program's reach to more AZ schools. In the last year, we reached a much larger tribal audience, conducting 10 events exclusively for tribal audiences and reaching 20 tribal communities (11 in AZ & 9 from other states) with IPM, pesticide safety and public health pest information.

Public Health. Dr. Dawn Gouge and her team are wrapping up an ARDP grant focused on bed bug and cockroach management in public housing. They have started a new project funded by Center for Disease Control (CDC), sampling mosquito populations over a large region spanning two central AZ counties. They are testing the impacts of targeted larvicidal and ULV treatments for adult control and examining the vectoral capacity of *Aedes Egypti*.

Outcomes:

- Stakeholders indicate that our Community IPM Program resources and events are highly valued and help to support IPM adoption. In a 2016 survey about our team's activities and resources, 94% indicated we helped them address pest problems and 96% indicated improved knowledge of IPM.

Area Addressed: Pesticide Safety

Activities & Outputs:

Dr. Mike Wierda, Assistant in Extension for Pesticide Safety Education, has focused on identification of pesticide safety training priorities and working with a stakeholder advisory team to find paths to sustainably for an ongoing PSEP (leveraged through a PSEP-IMI grant). In partnership with the state lead agency, Arizona Department of Agriculture, priority training resources have been identified and we are pursuing possible ongoing funding mechanisms to accomplish these goals. This term, Dr. Wierda presented at more than 10 meetings on topics related to IPM and pesticide safety, reaching over 377 stakeholders. In addition, an information booth at the Yuma Heritage Festival potentially reached 3,000 participants with information about pesticide safety.

Outcomes:

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.

Publications

7/1/16 – 6/30/17

Journal Articles

Gouge D.H. 2016. Working in a World of Bed Bugs. *Journal of Environmental Management Arizona*. Vol. 56, Jun/Jul.

Gouge D.H., S. Li, S. Nair, N. Pier, C. Sumner. 2016. Mosquitoes and the Great Outdoors. *Journal of Environmental Management Arizona*. Vol. 56, Aug/Sept.

Abstracts

Ellsworth P.C., A.J. Fournier, J.C. Palumbo, S.E. Naranjo, G.B. Frisvold. 2016. Chronicling Successful Integration of Technology and Knowledge Over 25 Years of IPM in Arizona. Presented in symposium Economics of IPM in the 21st Century: Multiple Perspectives from Around the World. International Congress of Entomology, Orlando, FL. September 26, 2016. (Symposium Presentation)

Pier N., P.C. Ellsworth, J.C. Palumbo, Y. Carrière, A.J. Fournier, W.A. Dixon II, L.M. Brown, S.J. Castle, N. Prabhaker. 2016. Proactive Resistance Management of *Bemisia tabaci* in the Cross Commodity Systems of Arizona and California. International Congress of Entomology, Orlando, FL. September 28, 2016. (Poster)

Fournier A.J., P. Jepson, M. Guzy, W.A. Dixon II, J.C. Palumbo, P.C. Ellsworth. 2016. Documenting Reductions in Pesticide Risk: Two Decades of Change in Lettuce Pest Management. International Congress of Entomology, Orlando, FL. September 25, 2016. (Presentation)

Li S., D.H. Gouge, A.J. Fournier, T. Stock, A. Romero, S. Nair, C. Foss, R. Kerzee, D. Stone, M. Dunn, D.J. Young, D. Spurgeon, R. LaMorte. 2016. Life quality impacts of bed bug *Cimex lectularius* infestations. International Congress of Entomology, Orlando, FL. September 26, 2016. (Poster)

Gouge D.H., S. Li, S. Nair, M.R. Wierda, K. Drake, T. Stock, A.J. Fournier. 2016. Extreme pesticide use in response to bed bugs and German cockroach infestations. International Congress of Entomology. International Congress of Entomology, Orlando, FL. September 26, 2016. (Presentation)

Selected Extension Publications

Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, P.L. Warren, M.R. Wierda. 2017. Stop School Pests School and Home Integrated Pest Management. IPM Newsletter February 2017. Newsletter. University of Arizona, Arizona Pest Management Center.
<https://cals.arizona.edu/apmc/docs/2017FebruaryAZschoolandhomeIPMNewsletter.pdf>

Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, P.L. Warren, M.R. Wierda. 2017. CDC Online Classes. School and Home Integrated Pest Management IPM Newsletter January 2017. Newsletter. University of Arizona, Arizona Pest Management Center.
<https://cals.arizona.edu/apmc/docs/2017JanuaryAZschoolandhomeIPMNewsletter.pdf>

Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, P.L. Warren, M.R. Wierda. 2016. Ants. School and Home Integrated Pest Management IPM Newsletter September 2016. Newsletter. University of Arizona, Arizona Pest Management Center.
<https://cals.arizona.edu/apmc/docs/2016SeptemberAZschoolandhomeIPMNewsletter.pdf>

Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, P.L. Warren, M.R. Wierda. 2016. Mosquitoes. School and Home Integrated Pest Management IPM Newsletter August 2016. Newsletter. University of Arizona, Arizona Pest Management Center.
<https://cals.arizona.edu/apmc/docs/2016AugustAZschoolandhomeIPMNewsletter.pdf>

Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, P.L. Warren, M.R. Wierda. 2016. Annual Great Arizona Mosquito Hunt and Fight the Bite. School and Home Integrated Pest Management IPM Newsletter July 2016. Newsletter. University of Arizona, Arizona Pest Management Center.
<https://cals.arizona.edu/apmc/docs/2016JulyAZschoolandhomeIPMNewsletter.pdf>

McCloskey W.B., P.C. Ellsworth, K. Umeda. 2017. Auxin Herbicides in Arizona Cotton: Avoiding Off-target Movement. IPM Short. University of Arizona, Arizona Pest Management Center.
<https://cals.arizona.edu/crops/cotton/files/AuxinDrift.pdf>

Mostafa A.M., P.C. Ellsworth. 2016. Sugarcane Aphid: A New Threat to Sorghum in Arizona. Blog entry. University of Arizona Cooperative Extension.
<https://arizonaag.com/2016/08/30/sugarcane-aphid-a-new-threat-to-sorghum-in-arizona/>

Palumbo J.C. 2017. Areawide Diamondback Moth Trapping Network. Arizona Vegetable IPM Update. University of Arizona Cooperative Extension. Vol. 8 No. 1.
https://cals.arizona.edu/crops/vegetables/advisories/docs/DBM%20Trap%20Network%20Data_Jan%202017%202017.pdf

Palumbo J.C. 2017. Aphid Management in Desert Produce Crops - 2017. Arizona Vegetable IPM Update. University of Arizona Cooperative Extension. Vol. 8 No. 2.
https://cals.arizona.edu/crops/vegetables/advisories/docs/Aphid%20Control%20Chart_2017.pdf

Palumbo J.C. 2017. Impact of Diamondback Moth Outbreaks on Arizona Cole Crops in 2016-17. Arizona Vegetable IPM Update. University of Arizona Cooperative Extension. Vol. 8 No. 13.
<https://cals.arizona.edu/crops/vegetables/advisories/docs/170628%20Impact%20of%20DBM%20on%20AZ%20Cole%20Crops%20%20Survey%202017.pdf>

Wierda M.R., A.J. Fournier, W.B. McCloskey, K. Umeda. 2017. Water Soluble Packaging WSP: Mixer/Loader Exposures Best Practices and Labeling Changes. IPM Short. <https://cals.arizona.edu/apmc/docs/wsp.pdf>

Reports

Fournier A.J., P.C. Ellsworth, W.B. McCloskey, W.A. Dixon II. 2016. Glufosinate Use in Arizona., University of Arizona, Arizona Pest Management Center.

Fournier A.J., P.C. Ellsworth, B.R. Tickes, W.A. Dixon II. 2016. Sulfonylurea Herbicides: Importance and Use in the Southwest., University of Arizona, Arizona Pest Management Center.

Fournier A.J., J.C. Palumbo, P.C. Ellsworth. 2016. Spinosyn Use and Importance in Arizona Agriculture., University of Arizona, Arizona Pest Management Center.

Fournier A.J., A.M. Mostafa, J. Sherman, W.A. Dixon II, P.C. Ellsworth. 2017. Chlorpyrifos Use in Arizona and New Mexico., University of Arizona, Arizona Pest Management Center.
https://cals.arizona.edu/apmc/docs/Chlorpyrifos_1-17-17_vf.pdf

Fournier A.J., B.R. Tickes, W.B. McCloskey, W.A. Dixon II, P.C. Ellsworth. 2017. Linuron Use in Arizona. University of Arizona, Arizona Pest Management Center.

Grants (Selected)

Ellsworth, P.C. 2015-2018. \$324,375 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.

Ellsworth, P.C., J. Palumbo, Y. Carriere, A. Fournier, W. Dixon, L. Brown., S. Castle, N. Prabhaker. "Prospective" Resistance Management: Empowering Growers to Understand and Exploit Refugia. 2015-2017. \$424,325 Monsanto Insect Knowledge Management Program.

Ellsworth, P.C., N. Prabhaker, S. Castle, J. Palumbo, Y. Carriere, A. Fournier, W. Dixon, L. Brown. "Prospective" Resistance Management: Empowering Growers to Partition Chemistry in Space and Time. 2014-2017. \$250,000 USDA-NIFA, Crop Protection and Pest Management (CPPM) Applied Research and Development Program (ARDP).

Fournier, A., P.C. Ellsworth, W. Dixon, J. Palumbo & L. Brown. 2015-2017. Grower Tools to Manage Pesticide Resistance. \$112,901. USDA-AMS, Arizona Department of Agriculture, Specialty Crops Block Grant.

Gouge, D. H., S. Li, A. Fournier. 2014-2017. National assessment of bed bug impacts and demonstration of IPM in high-risk elder/disabled housing facility, \$124,999. USDA-NIFA, Crop Protection and Pest Management (CPPM) Applied Research and Development Program (ARDP).

Murray, K., P. Jepson, A. Fournier. 2016-2020. IPMSPs: Bringing "Integration" to Pest Management Strategic Plans. \$215,460. USDA-NIFA, Crop Protection and Pest Management (CPPM) Applied Research and Development Program (ARDP).

ANNUAL STATE IPM REPORT FOR CALIFORNIA

Submitted by: James Farrar, Director

Submitted: July 25, 2017

Accomplishments and Impacts (2016)

Area addressed: Urban and Community IPM

Activity: Human-Coyote Conflict Resolution

Output: At the 27th Vertebrate Pest Conference, Affiliated IPM Advisor and Human-Wildlife Interactions Advisor **Niamh Quinn** co-organized a special symposium on urban coyotes where she discussed the issue with wildlife experts and talked with them about solutions.

Short-term outcomes:

- With so few researchers testing ways to minimize or prevent negative wildlife-human interactions, experts sharing what they have learned, helps the University of California learn how to work with the public and determine research needs.
- The Vertebrate Pest Conference is a forum where experts, pest management professionals, and wildlife managers increase their knowledge about current research and gain a better understanding of knowledge gaps, including public fears regarding wildlife interactions or wildlife management.
- It is anticipated that increasing communication among the wildlife management community about interactions that are occurring will lead to best management practices for handling these situations, including ideal ways to communicate science-based information to the public.

Impacts:

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

Area addressed: Urban and Community IPM

Activity: IPM Publications/Tools

Output: The comprehensive and authoritative *Pests of Landscape Trees and Shrubs: An Integrated Pest Management Guide* is an indispensable resource for landscapers, home gardeners, and parks and grounds managers. This integrated pest management (IPM) guide is easy to use and covers hundreds of insects, mites, nematodes, plant diseases, weeds, and other problems damaging to California landscapes.

Short-term outcome:

- Improved knowledge of IPM for landscape plants.

Impacts:

- Improved community health and wellness
- Improved management of pests
- Improved air quality
- Protected and conserved soil quality
- Improved management and use of water resources
- Reduced human health risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practice and improve local economies

Area addressed: Urban and Community IPM

Activity: IPM Publications/Tools

Output: Users can diagnose 650 arthropod, disease, and abiotic problems on over 300 plants using the *Plant Problem Diagnostic Tool* (ipm.ucanr.edu/diagnostics)

Short-term outcomes:

- Users gain confidence that they correctly identified their pest or problem, making it easier to find the most effective management information.

- Assisting people to better diagnose their pest problems leads to improved integrated pest management decisions.

Impacts:

- Improved community health and wellness
- Improved management of pests
- Improved air quality
- Protected and conserved soil quality
- Improved management and use of water resources
- Reduced human health risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practice and improve local economies

Area addressed: Urban and Community IPM

Activity: IPM Publications/Tools

Output: The online course, *Providing IPM Services in Schools and Child Care Settings* (ipm.ucanr.edu/training), was updated to meet the training requirement of the Healthy Schools Act that went into effect July 1, 2016.

Short-term outcomes:

- Improved knowledge of IPM in schools and child care centers.
- Increased number of school and child care center staff trained in IPM.

Impacts:

- Improved community health and wellness
- Improved management of pests
- Improved air quality
- Improved management and use of water resources
- Reduced human health risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practice and improve local economies

Area addressed: Urban and Community IPM

Activity: Training

Output: From June to September 2016, UC IPM's Urban and Community Program conducted four statewide advanced IPM train-the-trainer workshops for UC Master Gardeners. A total of 272 UC Master Gardener volunteers from 30 counties attended.

Short-term outcomes:

- Forty-five UC Master Gardener volunteers from thirty counties shared information from the workshops through both formal and informal trainings, helpline interactions, booths, newsletter articles, and one-on-one interactions.
- Participants indicated that more than 3,000 people were reached directly, with likely thousands more through radio, social media, and newsletter/newspaper articles.

Impacts:

- Increased workforce retention and competency
- Improved community health and wellness
- Improved management of pests
- Improved air quality
- Protected and conserved soil quality
- Improved management and use of water resources
- Reduced human health risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practice and improve local economies

Area addressed: Urban and Community IPM

Activity: Invasive Pests

Outputs: Area IPM Advisor **Andrew Sutherland** is investigating the incidence of brown marmorated stink bug in urban San Jose. He educates pest management professionals and UC Master Gardeners about brown

marmorated stink bug identification, prevention and exclusion practices that keep overwintering brown marmorated stink bugs out of structures. Area IPM Advisor **Karey Windbiel-Rojas** is working to prevent brown marmorated stink bug as a pest in structures and landscapes in Sacramento. She is engaged in outreach to homeowners and pest managers on management around structures and a webpage that allows the public to submit findings and see the distribution of brown marmorated stink bug in Yolo County.

Short-term outcome:

- Improved knowledge of brown marmorated stink bug location, impact, identification, prevention and management.

Impacts:

- Improved community health and wellness
- Improved management of pests
- Improved air quality
- Protected and conserved soil quality
- Improved management and use of water resources
- Reduced human health risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practice and improve local economies

Area addressed: Agricultural Production IPM

Activity: Invasive Pests

Output: UC scientists responded rapidly—working with public and private partners and international scientists—to develop a pest management program for European grapevine moth. The developed program gave excellent control without disrupting the natural biological controls for other grapevine pests, avoiding secondary pest outbreaks. This allowed grape growers to continue to produce a competitive crop under quarantine restrictions.

Short-term outcomes:

- Over the span of seven years, a dual pest management approach that relied on deploying pheromone dispensers to disrupt mating and application of carefully-timed insecticide was implemented and European grapevine moth detections declined from over 100,000 moths in 2010, to one moth in 2014, and none in 2015 or 2016.
- Subsequently, all previous 10 California infested counties have been deregulated and European grapevine moth declared eradicated from California and United States.
- Policymakers incorporated information generated from trials and observations into European grapevine moth regulations.
- This multi-agency collaboration contributed to a successful science-based response plan to a serious pest threat.

Impacts:

- Improved management of pests
- Improved air quality
- Protected and conserved soil quality
- Improved management and use of water resources
- Reduced human health risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practice and improve local economies
- Protected sustainability and viability of agriculture

Area addressed: Agricultural Production IPM

Activity: Invasive Pests

Outputs: Area IPM Advisor **Jhalendra Rijal** is working on detection and monitoring. Brown marmorated stink bug has been reported in Stanislaus County and it is only a matter of time before it becomes established in the cling peach growing areas of the northern San Joaquin Valley. Rijal monitored nine peach orchards, a preferred host, in Stanislaus and Merced counties. Twenty-four brown marmorated stink bugs were caught in one of the nine orchards. Area IPM Advisor **Emily Symmes** managed trapping locations, confirming reproducing populations in Butte County. Symmes has used her information to update distribution maps for the UC Center for Invasive Species Research (cissr.ucr.edu/brown_marmorated_stinkbug.html) and

StopBMSB.org. Symmes is part of a multi-year, multi-state, multi-institution collaboration funded by NIFA SCRI to monitor, evaluate natural enemies, determine monitoring practices and thresholds, evaluate insecticides, determine alternate management practices to pesticides, and extend this information to pest control advisers and growers. Area IPM Advisor **Lucia Varela**'s goal is to develop a public awareness program and evaluate sampling methods for early interception in North Coast grape and pear growing areas. Varela developed articles, a bilingual Pest Alert and a YouTube video. She trained local UC Master Gardeners as first detectors. Varela is conducting trapping and monitoring surveys on key host plants in high traffic areas surrounding pear orchards for early detection.

Short-term outcome:

- Improved knowledge of brown marmorated stink bug location, impact, identification, prevention and management.

Impacts:

- Improved management of pests
- Improved air quality
- Protected and conserved soil quality
- Improved management and use of water resources
- Reduced human health risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practice and improve local economies
- Protected sustainability and viability of agriculture

Area addressed: Agricultural Production IPM

Activity: New Aphid Pest Identified in Organic Celery

Output: Strawberry and Vegetable Crops Advisor and Affiliated IPM Advisor **Surendra Dara** responded by working with the California Department of Food and Agriculture to identify the aphid. He also tested several organic microbial and botanical insecticides.

Short-term outcomes:

- Two of the insecticides alone, *Beauveria bassiana* and azadirachtin, did not reduce aphid numbers, but when combined did reduce aphid numbers.
- Growers and pest control advisers now know of two new aphids that they need to be aware of and the damage they can cause to celery stands.
- Dara tested organic insecticides and combinations of insecticides, providing an option for growers to manage these new pests.
- Since the initial outbreaks, growers have been using *Beauveria bassiana* and azadirachtin, and no longer have outbreaks of aphids.

Impacts:

- Increased workforce competency
- Improved management of pests
- Improved air quality
- Protected and conserved soil quality
- Improved management and use of water resources
- Reduced human health risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practice and improve local economies
- Protected sustainability and viability of agriculture

Area addressed: Agricultural Production IPM

Activity: Ants

Output: Area IPM Advisor **Kris Tollerup** is raising awareness about the importance of knowing if the ants in almond orchards are pest ants to prevent unnecessary pesticide applications. Nonpest ants that often occur in almond orchards are the native gray ant, pyramid ant, and California harvester ant. In addition to differences in how the ant looks, foraging activity and behavior, nest location, and ant mound structure provide useful information for identification. Tollerup has been gathering this information, including photos, to help growers and pest control advisers learn to quickly recognize pest ants while in the field.

Short-term outcomes:

- Tollerup anticipates an increase in the ability to identify pest from nonpest ants. He is training growers and pest control advisers to increase their knowledge about IPM and to monitor and identify before applying an insecticide.
- Tollerup's work could potentially reduce insecticide applications for ants.

Impacts:

- Increased workforce competency
- Improved management of pests
- Improved air quality
- Protected and conserved soil quality
- Improved management and use of water resources
- Reduced human health risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practice and improve local economies
- Protected sustainability and viability of agriculture

Area addressed: Agricultural Production IPM

Activity: Brown Stink Bug:

Output: Affiliated IPM and Entomology Advisor **Vonny Barlow** monitored commercial cotton fields to determine the extent of damage brown stink bug was causing. He did not observe a relationship between internal boll warts from feeding bugs and cotton boll rot. Barlow concluded that in Southern California, boll rot from brown stink bug feeding may not be an issue for cotton.

Short-term outcomes:

- Insecticide applications for brown stink bug may not be needed in cotton, saving growers the cost of unnecessary insecticide applications.
- By not applying an insecticide for brown stink bugs, secondary pest outbreaks of spider mites and aphids are prevented.
- Growers in the Palo Verde Valley are not applying pesticides and damage from boll rot was extremely low. "Once we figured out brown stink bug was not doing serious damage, we stopped spraying," says a local pest control adviser.

Impacts:

- Increased workforce competency
- Improved management of pests
- Improved air quality
- Protected and conserved soil quality
- Improved management and use of water resources
- Reduced human health risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practice and improve local economies
- Protected sustainability and viability of agriculture

Area addressed: Agricultural Production IPM

Activity: Springtails:

Output: IPM Advisor **Shimat Joseph** examined the use of potato slices for capturing springtails, like how they are used for garden symphylans. Beet slices were also tested because light colored springtails might be easier to see on them than on off-white potato slices and their high sugar levels might make them a more attractive bait. Joseph compared the number of springtails found on potato and beet slices with springtails extracted from the soil using the Berlese funnel. Results suggest that both potato and beet slices are attractive to springtails, with beet slices consistently capturing greater numbers of springtails.

Short-term outcomes:

- Growers and pest control advisers have a tool to monitor lettuce fields for the presence of springtails.
- Joseph has since observed that many growers are using beets instead of potatoes to indicate whether springtails or symphylans are active before or at planting.
- Rather than applying pesticides preventively, pesticide applications can be made based on whether springtails are in the field, reducing the amount of pesticide applied and saving the grower the application cost.

Impacts:

- Increased workforce competency
- Improved management of pests
- Improved air quality
- Protected and conserved soil quality
- Improved management and use of water resources
- Reduced human health risks associated with pests and managing pests
- IPM practitioners gain increased economic benefits by adopting IPM practice and improve local economies
- Protected sustainability and viability of agriculture

Area addressed: Pesticide Safety**Activity: Pesticide Safety Publications/Tools**

Output: There are many new additions to the *The Safe and Effective Use of Pesticides, 3rd Edition* that make this book an indispensable resource for both new and experienced pest control professionals. Technical Editor **Lisa Blecker** and Editor **Shannah Whithaus** have updated and expanded coverage in pest management, offsite movement/environmental hazards of pesticides, and compliance assistance for new and updated state and federal regulations. <http://anrcatalog.ucanr.edu/Details.aspx?itemNo=3324>

Short-term outcome:

- Improved knowledge of the safe use of pesticides.

Impacts:

- Increased workforce retention and competency
- Improved community health and wellness
- Improved management of pests
- Improved air quality
- Protected and conserved soil quality
- Improved management and use of water resources
- Reduced human health risks associated with pests and managing pests
- Protected sustainability and viability of agriculture

Area addressed: Pesticide Safety**Activity: Pesticide Safety Publications/Tools**

Output: Understanding and following label instructions is the focus of a new online course, *Proper Pesticide Use to Avoid Illegal Residues*, developed by Pesticide Safety and Education Coordinator **Lisa Blecker**, Interactive Learning Developer **Cheryl Reynolds** and Content Development Supervisor **Petr Kosina**. The online course is targeted to those who apply pesticides or make pesticide recommendations. It explains what pesticide residues are, how they are monitored, and highlights important residue-related information from several sections of pesticide labels. In addition, the course identifies the following as the most important factors leading to illegal residues: using a pesticide on a crop for which it is not registered; applying pesticides at an incorrect rate; and ignoring preharvest intervals, re-treatment intervals, or plantback restrictions. (Free version: www.youtube.com/playlist?list=PLo3rG4iqv4gEHrtixdZnOipGoR-pBWvzG | For continuing education units: ipm.ucanr.edu/training)

Short-term outcomes:

- Improved knowledge of proper pesticide use to avoid illegal residues.
- Reduced incidences of illegal residues in California-grown crops.

Impacts:

- Increased workforce competency
- Improved air quality
- Protected and conserved soil quality
- Improved management and use of water resources
- Reduced human health risks associated with pests and managing pests
- Protected sustainability and viability of agriculture

Publications

2016 Peer-Reviewed Publications

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2016. *UC IPM Pest Management Guidelines: Eggplant*. University of California Statewide Integrated Pest Management Program. Oakland: UC ANR Publication 3475.
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<http://ipm.ucanr.edu/PMG/selectnewpest.cilantro-parsley.html> (new)
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- Gophers
 - Peach Leaf Curl
 - Termites
 - Thrips
 - Keep Our Water Clean
 - Less Toxic Insecticides
 - Parasites of Insect Pests
 - What is IPM?
 - Las Arañas (Spiders)
 - Muérdago (Mistletoe)
 - Mosquitos (Mosquitoes)
 - Depredadores Benéficos (Beneficial Predators)
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 - Blog: Citrus Bugs (617 views)
 - Blog: Kearney News Updates (883 views)
 - Blog: Southern IPM Activities (732 views)
 - Blog: Topics in Subtropics (529 views)
 - Blog: UCCE Riverside (241 views)
 - Blog: Weed Science (351 views)
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 Blog: Kearney News Update (1054 views)
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 Blog: Salinas Valley Ag (398 views)
 Blog: South Coast REC (438 views)
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2016 Extension Online Trainings/Videos/Website Tools & Pages

Video: Aphid Identification and Monitoring in Alfalfa. <https://www.youtube.com/watch?v=K1a355J079c> (237 views)

Video: Bee Precaution Pesticide Ratings. <https://www.youtube.com/watch?v=6Yufc7ajnFc> (147 views)

Video: Cómo Arrancar Los Dientes de León. <https://www.youtube.com/watch?v=PlzkwN6vAlg> (741 views)

Video: Cómo Atrapar Tijeretas. <https://www.youtube.com/watch?v=MA9jAPEKIuo> (3009 views)

Video: Controlling Weeds Using Mulch. <https://www.youtube.com/watch?v=ixshTaeqHz0&feature=youtu.be> (345 views)

Video: How to Get Rid of Pantry Pests. https://www.youtube.com/watch?v=8Zibw_m7hj8&feature=youtu.be (644 views)

Video: Setting a Gophinator Trap. <https://www.youtube.com/watch?v=aqMzKAty5Lw&feature=youtu.be> (1024 views)

Video: Using a Sticky Barrier to Prevent Ants on Trees and Shrubs. <https://www.youtube.com/watch?v=Wd-nl6Exs18&feature=youtu.be> (413 views)

Website: Brown Marmorated Stink Bug Provisional Guidelines for Apple. <http://ipm.ucanr.edu/PMG/r4302711.html> (new)

Website: Brown Marmorated Stink Bug Provisional Guidelines for Pear. <http://ipm.ucanr.edu/PMG/r603302411.html> (new)

Website: Brown Marmorated Stink Bug Provisional Guidelines for Peach. <http://ipm.ucanr.edu/PMG/r602301711.html> (new)

Website: Campbell K, Sutherland A, Lewis V, Choe, D-H. 2016. California multi-unit housing managers answer bedbug survey. <https://caanet.org/bed-bug-survey-results/>

Website: Quinn N, Baldwin RA, Dimson M. 2016. Ground Squirrel BMPs. www.groundsquirrelbmp.com. (peer reviewed)

Website: Plant Problem Diagnostic Tool. <http://www.ipm.ucanr.edu/diagnostics/> (new)

Website: UCSF California Childcare Health Program, University of California Statewide Integrated Pest Management Program, and California Department of Pesticide Regulation. 2016. Integrated Pest Management Toolkit for Family Child Care Homes. San Francisco: UCSF School of Nursing. <http://cchp.ucsf.edu/content/family-child-care-homes>

Abbreviations and Acronyms:

CE	Cooperative Extension
CSU	California State University
DPR	California Department of Pesticide Regulation
IPM	integrated pest management
MUH	multi-unit housing
NIFA	National Institute of Food and Agriculture
NRCS	Natural Resources Conservation Service
PMP	pest management professional
REI	re-entry interval
UC	University of California
UCCE	University of California Cooperative Extension
UCSF	University of California San Francisco
UC IPM	University of California Statewide Integrated Pest Management Program
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service

**WERA 1017 Report of Accomplishments
GUAM**

Area addressed: IPM Implementation in Communities

Activity 1: IPM Workshop for Home Gardeners (55 participants).

Outputs: Four Powerpoint presentations on IPM developed for home gardeners.

Short-term Outcomes: The pre-test average score was 40%, the post-test average score was 85%.

Impacts: Reduced exposure to pesticides through application of IPM practices.

Acceptance of the importance of contacting agricultural professionals when dealing with pests.

Greater awareness of vegetable cultivars that grow well and have the least pest problems.

Activity 2: IPM Interactive display at University of Guam Charter Day activities (255 participants).

Outputs: 10 fact sheets.

Short-term Outcomes: Participants increased their awareness of insects and fungal pests.

Impacts: Increased awareness of the services provided by Cooperative Extension Service.

Participants gained skills in the use of a microscope.

Participants gained a general understanding of the differentiate between plant damage caused by insects and that caused by diseases.

Area addressed: IPM Support for Pest Diagnostic Facilities (Diagnostician .25 FTE)

Activity 1: Perform plant pest diagnostics.

Outputs: One hundred six plant samples processed.

Short-term Outcomes: Diagnostician received a raise.

Impacts: Application of pest identification to the IPM decision-making process.

Taking social responsibility for bring new pests and diseases to the attention of agriculture professionals.

Activity 2: Ship pest/plant samples to off island laboratories for pest identification to species.

Outputs: Thirty-two pest/plant samples were sent to off island laboratories.

Short-term Outcomes: Plant pests were identified.

Impacts: Increased knowledge of pests and diseases that may pose a threat to Guam's Environments.

Gain in knowledge essential to IPM pest control decision-making.

List any grants, contracts, and/or other resources obtained by one or more project members as a result of the project's activities. Include the recipients, funding source, amount awarded and term if applicable:

Principal Investigator 2017-2018. \$25,000: USDA Forest Service grant: Guam Casuarina Project.

Principle Investigator 2017-2018. \$38,200: USDA Farm Bill APHIS grant: Solanaceous/Tomato Commodity Survey – GU

2017-2020 Hatch Proposal (\$10,000/year) Title: Identifying and screening cucumber cultivars in Guam for resistance to the fungal disease anthracnose

Principle Investigator 2016-2017. \$38,200: USDA Farm Bill APHIS grant: Solanaceous/Tomato Commodity Survey – GU

Principle Investigator 2015-2019 \$50,000: McIntire-Stennis: Refinement and mitigation of *Casuarina equisetifolia* decline components responsible for tree loss in Guam.

Principle Investigator 2014-2017. \$97,500: USDA NIFA CPPM-EIP: Extension Implementation Program Area (EIP) For Guam

Principle Investigator 2014-2017. \$49,500: USDA WARE Professional Producer grant: Screening tomato varieties for suitability on Guam in response to the arrival of Tomato leaf curl Guam virus in the Western Region.

Principle Investigator 2014-2017. \$63,900: USDA WSARE Professional Development grant: Plant Disease Diagnostic Training for Agricultural Professionals in Guam and the Northern Mariana Islands.

Publications:

Schlub, R. Plant Diseases of the Western Pacific tropical island of Guam. Poster presented at: American Phytopathological Society- Caribbean Division's 2017 Meeting; 2017 February 27- March 01; San Jose, Costa Rica.

<http://cnas-re.uog.edu/wp-content/uploads/2017/02/Disease-Poster-Version-9.pdf>

Schlub, R. Pathogens linked to the decline of *Casuarina equisetifolia* (ironwood) on the Western Pacific tropical island of Guam. Poster presented at: American Phytopathological Society- Caribbean Division's 2017 Meeting; 2017 February 27- March 01; San Jose, Costa Rica.

<http://cnas-re.uog.edu/wp-content/uploads/2017/02/Pathogens-linked-to-ironwood-Version-6.pdf>

Schlub, R. "Opinion: Look out for tree-killing fungus." *Pacific Daily News* October 2016. Web. 12. Oct. 2016.

<http://www.guampdn.com/story/opinion/2016/10/12/opinion-look-out-tree-killing-fungus/91924634/>

WERA 1017 Report – Colorado

Urban and Housing

Activities

Ten IPM presentations were made to nursery and retail personnel and others associated urban and structural pest management.

Three bilingual Vegetable Troubleshooting Workshops were held in cooperation with the nonprofit Re:Vision. Participants from local neighborhoods receive specialized training to mentor a network of about 400 gardeners in backyard food production in food deserts.

The Colorado School IPM newsletter has been reemphasized and is being published on a regular basis.

The diagnostic clinic processed 1800 samples this year and continues to receive favorable reviews on social media, Facebook, etc.

The diagnostic clinic in Boulder County was enhanced to facilitate effective diagnosis of emerald ash borer samples.

Seven full day entomology workshops for Master Gardeners.

Four out-of-state Master Gardener presentations.

Over 200 rose cultivars were evaluated for susceptibility to Japanese beetle and use by pollinators (particularly honey bees). Japanese beetle has steadily extended its range and increased in severity as a key landscape pest since its establishment in the Denver area ca. 2008.

Evaluations continue to look at establishment of the microsporidian disease produced by *Ovavesicula popilliae*, which was introduced at two sites (Boulder, Pueblo) in 2015.

Present research is on identifying the most effective controls for adult Japanese beetle, particularly for use plants that are also used by pollinators.

Outputs

Scientific presentations

Cranshaw, Whitney, Cannabis Sustainability Workshop, "IPM of Cannabis Insect Pests," City of Denver, Denver, Colorado, United States. (October 26, 2016).

Cranshaw, Whitney (Author & Presenter), Industrial Hemp Conference, "Insect Management in Hemp," Soil and Crop Sciences Society, Denver, Colorado, United States. (July 29, 2016).

See publications.

Short-term Outcomes

Vegetable Troubleshooting workshop evaluations averaged 4.5 out of a possible 5.

Impacts

Publications

Peer reviewed

Extension

A total of 216 additional images, mostly of insects, were provided to IPMImages.org. This outlet provides images to anyone that has educational interests in their use.

Cranshaw, W. S. 2017. Spottedwing Drosophila, Control in Home Plantings. Colorado State University Extension Fact Sheet 5.596.

Cranshaw, W. S. 2017. Mystery Bites and Itches – Arthropod and Non-Arthropod Sources in Colorado. Guidelines for county offices.

Cranshaw, W. S. 2017. Wood Boring Insects of Ash. (unpublished).

Cranshaw, W. S. 2017. Emerald Ash Borer and Colorado Insects of Similar Appearance (unpublished).

IPM-related grants

Cranshaw, W. S. (PI), Grant, "Disease Description of Drippy Blight: A Unique Association Between a Scale Insect and a Plant Pathogenic Bacteria", Tree Research and Education Endowment Fund, Domestic Non-Profit

(other than Domestic Foundations), \$10,000.00, Active. (sub: October 1, 2015, start: January 1, 2016, end: December 31, 2016).

Cranshaw, W. S. (PI), Grant, "Assessing Effects on Non-target Organisms from Pesticides Used in Emerald Ash Borer Management", EPA-Environmental Protection Agency, Federal, \$19,613.00, Active. (sub: June 2, 2015, start: September 1, 2015, end: August 31, 2016).

Agriculture, Rangeland, Forestry

Activities

Survey of insects associated with industrial hemp, allowing establishment of a Hemp Insect Website (<http://hempinsects.agsci.colostate.edu/>).

Continued evaluation of commercial mycorrhizal preparations on plant health in commercial onion production

Evaluated onion varieties for reactions to thrips, IYSV, and pink root fungus

Stripe rust monitoring and advisories throughout eastern Colorado

West Slope IPM workshop with 185 participants

West Slope surveys for spotted wing drosophila, grape leaf skeletonizer, grape bud mite, hedgehog grain aphids, African fig fly

Pheromone traps were used to monitor field corn and sunflower insects pests.

Outputs

Research presentations

Clark, Amy Lavonne, Norton, Andrew P, Jahn, Courtney Elaine, CSU Graduate Student Showcase, "Induced herbivory defense increases Canada thistle susceptibility to fungal pathogens," Fort Collins, CO, United States. (November 15, 2016).

Dayan, Franck E, Herbicide Resistance Methods Workshop, "Biochemical markers and enzyme assays for herbicide resistance diagnostics," Global Herbicide Resistance Challenge 2017, Denver, CO, United States. (May 14, 2017).

Dayan, Franck E (Author & Presenter), Owens, Daniel (Author), Carbonari, Caio (Author), Gomes, Giovanna (Author), Asolkar, Ratnakar (Author), Boddy, Louis (Author), Weed Science Society of America, "A Depsipeptide from the Pathogenic Fungi Burkholderia sp. A396 Targets Plant Histone Deacetylases," Tucson, AZ, United States. (February 2017).

Dayan, Franck E (Author & Presenter), Carbonari, Caio A (Author), Gomes, Giovanna L (Author), Owens, Daniel K (Author), Pan, Zhiqiang (Author), Velini, Edivaldo D (Author), 7th International Weed Science Congress, "Resistance to Glufosinate is Proportional to Phosphinothricin Acetyltransferase Expression and Activity in LibertyLink® and WideStrike® Cotton," Prague, N/A, Czech Republic. (2016).

Dayan, Franck E, Bayer CropScience USA, "Rationale for a Natural Products Approach to Herbicide Discovery," Raleigh, NC, United States. (November 14, 2016).

Dayan, Franck E (Author & Presenter), Bayer CropScience Germany, "Mode of action and resistance to PPO herbicides," Frankfurt, N/A, Germany. (June 2016).

Dayan, Franck E (Author & Presenter), Monsanto, "A Natural Route to the Next Generation of Herbicides," St Louis, MO, United States. (April 2016).

Dayan, Franck E (Author & Presenter), University of Nebraska, "A functional genomic approach to elucidating sorgoleone biosynthesis," Lincoln, NE, United States. (April 2016).

Dayan, Franck E (Author & Presenter), University of Massachusett, "Sorgoleone and Its Role in Sorghum Allelopathy," Amhert, MA, United States. (March 2016).

Dayan, Franck E (Author & Presenter), Carbonari, Caio (Author), Gomes, Giovanna (Author), Owens, Daniel (Author), Pan, Zhiqiang (Author), Velini, Edivaldo D (Author), Weed Science Society of America, "Resistance to Glufosinate is Proportional to Phosphinothricin Acetyltransferase Expression and Activity in LibertyLink® and WideStrike® Cotton," San Juan, N/A, US/Puerto Rico. (February 2016).

Gaines, Todd, Patterson, Eric, Ravet, Karl, Tranel, Patrick, Westra, Philip, Weed Science Society of America, "Developing genomics resources for Kochia scoparia," San Juan, PR, United States. (2016).

Gaines, Todd, Patterson, Eric, Ravet, Karl, Tranel, Patrick, Westra, Philip, Western Society of Weed Science, "Using Multiple Sequencing Platforms to Assemble the Kochia scoparia Genome," Albuquerque, NM, United States. (2016).

Gaines, Todd, Rothamsted Research, Pesticide Resistance Group, "A tale of two weeds: Functional weed genomics, adaptive gene duplication, and the evolution of glyphosate resistance," Rothamsted Research, Harpenden, N/A, United Kingdom. (December 12, 2016).

Gaines, Todd, Patterson, Eric, Ravet, Karl, Tranel, Patrick, Westra, Philip, Western Society of Weed Science, "Using Multiple Sequencing Platforms to Assemble the Kochia scoparia Genome," Albuquerque, NM, United States. (2016).

Gaines, Todd, XXXI Argentine Plant Physiology Congress, "Molecular mechanisms of target-site herbicide resistance: Mutations and gene amplification," Corrientes, Corrientes, Argentina. (November 2016).

Gaines, Todd, Busi, Roberto, WeedSmart Webinar, "Understanding P450s to Better Manage Resistance," WeedSmart, Online, Online, N/A, All. (November 29, 2016).

Gaines, Todd, Tranel, Patrick, American Chemical Society AGRO division Webinar, "Herbicide-resistant weeds: Molecular mechanisms and impacts," American Chemical Society AGRO division, Online, N/A, All. (April 13, 2016).

Iwakami, Satoshi, Gonzalez, Susana, Gaines, Todd, Yu, Qin, Han, Heping, Brabetz, Veronika, Powles, Stephen, Beffa, Roland, Weed Science Society of America, "Detoxification of herbicides in rye-grass. On the way to characterize key molecular elements," San Juan, PR, United States. (2016).

Kniss, Andrew, Gaines, Todd, Barker, Abigail Lynn, Patterson, Eric, Wilson, Robert, Weed Science Society of America, "Relationship between EPSPS copy number and glyphosate resistance level in Kochia scoparia collected from sugarbeet fields," San Juan, PR, United States. (2016).

Kuepper, Anita, Manmathan, Harish Kumarimandhram, McCloskey, W, Patterson, Eric, Nissen, Scott J, Haley, Scott D, Gaines, Todd, Plant and Animal Genome XXIV, "Population genomics of glyphosate-resistant Palmer amaranth (*Amaranthus palmeri*) using genotyping-by-sequencing (GBS)," San Diego, CA, United States. (January 2016).

Kuepper, Anita, Manmathan, Harish Kumarimandhram, McCloskey, W, Patterson, Eric, Nissen, Scott J, Haley, Scott D, Gaines, Todd, Plant and Animal Genome XXIV, "Population genomics of glyphosate-resistant Palmer amaranth (*Amaranthus palmeri*) using genotyping-by-sequencing (GBS)," San Diego, CA, United States.

(January 2016).

Nichols, Robert L, Burton, James, Burgos, Nilda, Culpepper, Stanley, Dotray, Peter, Gaines, Todd, Lawton-Rauh, Amy, Marshall, Michael, Price, A, Steckel, Larry, York, Alan, World Cotton Conference 6, "Biology and management of herbicide-resistant Palmer amaranth in U.S. cotton," Goias, N/A, Brazil. (2016).

Norton, Andrew P, Katz, Gabrielle, Eldeiry, Ahmed Aly, Holtzer, Thomas O, Waskom, Reagan M, Colorado Water Conservation Board, "Effects of the 2013 flood on phreatophytes in the South Platte River system," Colorado Water Conservation Board, Denver, CO, United States. (November 16, 2016).

Norton, Andrew P, Katz, Gabrielle, Eldeiry, Ahmed Aly, Holtzer, Thomas O, Waskom, Reagan M, South Platte Basin Roundtable, "Flood effects on phreatophytes in the South Platte River system," Colorado Water Conservation Board, Firestone, CO, United States. (November 15, 2016).

Norton, Andrew P, Tuttle, Graham Michael, Katz, Gabrielle, 4th Northern Rockies Invasive Plant Council Meeting, "Russian Olive Alters Nutrient Cycling in Riparian Ecosystems," Northern Rockies Invasive Plant Council, Boise, ID, United States. (October 17, 2016).

Norton, Andrew P, Anderson, Aaron Andrew, Ode, Paul James, W3185 Western Biological Control Working Group Annual Meeting, "Trends in insect biocontrol releases - 1980 - present," Glenwood Springs, CO, United States. (October 6, 2016).

Norton, Andrew P, Katz, Gabrielle, Eldeiry, Ahmed Aly, Holtzer, Thomas O, Waskom, Reagan M, Presentation to the Phreatophyte subcommittee of the South Platte Basin Roundtable, "Flood effects on phreatophytes in the South Platte River system," Colorado Water Conservation Board, Fort Collins, CO, United States. (September 16, 2016).

Westra, Philip, Gaines, Todd, Dayan, Franck E, Weed Science Society of America, "Research on herbicide resistant kochia in the Western US and Canada," San Juan, PR, United States. (2016).

Westra, Philip, Gaines, Todd, Dayan, Franck E, Weed Science Society of America, "Research on herbicide resistant kochia in the Western US and Canada," San Juan, PR, United States. (2016).

Westra, Philip, Gaines, Todd, Dayan, Franck E, Weed Science Society of America, "Research on herbicide resistant kochia in the Western US and Canada," San Juan, PR, United States. (2016).

See publications, below

Short-term Outcomes

Timely stripe rust reports allowed wheat producers to apply fungicide at appropriate times and locations.

Impacts

Publications

Book chapters

Atkinson, S. Y. and C. S. Brown. 2016. Attributes That Confer Invasiveness and Impacts Across the Large Genus Bromus: Lessons from the Bromus REenet Database. Pp. 155-191 in: EXOTIC BROME-GRASSES IN ARID AND SEMIARID ECOSYSTEMS OF THE WESTERN US: CAUSES, CONSEQUENCES, AND MANAGEMENT IMPLICATIONS. Springer Series on Environmental Management. SN 0172-6161.

Brooks, M.L., C. S. Brown, J. C. Chambers, C. M. D'Antonio, J. E. Keeley, and J. Belnap. 2016. Exotic Annual Bromus Invasions: Comparisons Among Species and Ecoregions in the Western United States. Pp. 11-60 in: EXOTIC BROME-GRASSES IN ARID AND SEMIARID ECOSYSTEMS OF THE WESTERN US: CAUSES,

CONSEQUENCES, AND MANAGEMENT IMPLICATIONS. Springer Series on Environmental Management. SN 0172-6161.

Chambers, J. C., M. J. Germino, J. Belnap, C. S. Brown, E. W. Schupp, and S. B. St Clair. 2016. Plant Community Resistance to Invasion by Bromus Species: The Roles of Community Attributes, Bromus Interactions with Plant Communities, and Bromus Traits. Pp. 275-304 in: EXOTIC BROME-GRASSES IN ARID AND SEMIARID ECOSYSTEMS OF THE WESTERN US: CAUSES, CONSEQUENCES, AND MANAGEMENT IMPLICATIONS. Springer Series on Environmental Management. SN 0172-6161.

Germino, M. J., J. C. Chambers, and C. S. Brown. Introduction: Exotic Annual Bromus in the Western USA. 2016. Pp 1-7 in: EXOTIC BROME-GRASSES IN ARID AND SEMIARID ECOSYSTEMS OF THE WESTERN US: CAUSES, CONSEQUENCES, AND MANAGEMENT IMPLICATIONS. Springer Series on Environmental Management. SN 0172-6161.

Harris, M. O., K. Anderson, M. El-Bouhssini, F. B. Peairs, G. L. Hein, and S. Xu. 2017. Wheat pests: insects, mites and prospects for the future. Pp 467-544 in P. Langridge (ed.), Achieving sustainable cultivation of wheat. Volume 1: Breeding, quality traits, pests and diseases. Burleigh Dodds Science Publishing, Cambridge, UK. ISBN: 978 1 78676 016 6.

Monaco, T. A., S. P. Hardegree, M. Pellant, and C. S. Brown. 2016. Assessing Restoration and Management Needs for Ecosystems Invaded by Exotic Annual Bromus Species. Pp. 339-370 in: EXOTIC BROME-GRASSES IN ARID AND SEMIARID ECOSYSTEMS OF THE WESTERN US: CAUSES, CONSEQUENCES, AND MANAGEMENT IMPLICATIONS. Springer Series on Environmental Management. SN 0172-6161.

Monaco, T.A., J. M. Mangold, B. A. Meador, R. D. Meador, and C. S. Brown. 2017. Downy Brome Control and Impacts on Perennial Grass Abundance: A Systematic Review Spanning 64 Years. RANGELAND ECOLOGY & MANAGEMENT 70: 396-404.

Refereed journal articles

Acimovic, S.G., C. L. Harmon, S. Bec, S. Wyka, K. Broders, and J. J. Docola. 2016. First Report of Diplodia corticola Causing Decline of Red Oak (*Quercus rubra*) Trees in Maine. PLANT DISEASE 100: 649-650.

Boraks, A., and K. Broders. 2016. Population genetic diversity of the rare hardwood butternut (*Juglans cinerea*) in the northeastern USA. TREE GENETICS & GENOMES 12: 43.

Broders, K. 2016. The Biovigilante: Monitoring threats to plant health in an era of globalization and climate change. CANADIAN JOURNAL OF PLANT PATHOLOGY 39: 90-91.

Brunharo, C., E. Patterson, D. Carrijo, M. de Melo, M. Nicolai, T. Gaines, S. Nissen, and P. Christoffoleti. 2016. Confirmation and mechanism of glyphosate resistance in tall windmill grass (*Chloris elata*) from Brazil. PEST MANAGEMENT SCIENCE 72: 1758-1764.

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

Carbonari, C., D. Latorre, G. Gomes, E. Velini, D. Owens, Z. Q. Pan, and F. Dayan. Resistance to glufosinate is proportional to phosphinothricin acetyltransferase expression and activity in LibertyLink (R) and WideStrike (R) cotton. PLANTA 243: 925-933.

Charkowski, A. 2016. Opportunistic Pathogens of Terrestrial Plants. Rasputin Effect: When Commensals and Symbionts Become Parasitic. Advances in Environmental Microbiology 3: 147-168.

Cockrell, D. M., R. J. Griffin-Nolan, T. A. Rand, N. Altilmisani, P. J. Ode and F. B. Peairs. 2017. Host plants of the wheat stem sawfly (Hymenoptera: Cephidae). Environmental Entomology 46: 847-854.

- Correa, E., F. Dayan, D. Owens, A. Rimando, and S. Duke. 2016. Glyphosate-Resistant and Conventional Canola (*Brassica napus* L.) Responses to Glyphosate and Aminomethylphosphonic Acid (AMPA) Treatment. *JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY* 64: 3508-3513.
- Douglass, C., S. Nissen, and A. Kniss. 2016. Efficacy and environmental fate of imazapyr from directed helicopter applications targeting *Tamarix* species infestations in Colorado. *PEST MANAGEMENT SCIENCE* 72: 379-387.
- Douglass, C., S. Nissen, P. Meiman, and A. Kniss. 2016. Impacts of Imazapyr and Triclopyr Soil Residues on the Growth of Several Restoration Species. *RANGELAND ECOLOGY & MANAGEMENT* 69: 199-205.
- Fulladolsa, A., S. Jansky, D. Halterman, and A. Charkowski. 2016. Development of molecular markers tightly linked to Potato virus Y resistance gene *Ryhc* in a diploid potato population. *PHYTOPATHOLOGY* 106 (12): 14.
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- Glenn, A., C. Davis, M. Gao, S. Gold, T. Mitchell, R. Proctor, J. Stewart, and M. Snook. 2016. Two Horizontally Transferred Xenobiotic Resistance Gene Clusters Associated with Detoxification of Benzoxazolinones by *Fusarium* Species. *PLOS ONE* 11: e0147486.
- Harvey J, P. Ode, M. Malcicka, and R. Gols. 2016. Short-term seasonal habitat facilitation by an insect herbivore. *Basic and Applied Ecology*. <http://dx.doi.org/doi:10.1016/j.baae.2016.03.005>
- Iriarte, G., I. Hale, K. Broders. 2017. Mining the microbiomes of crop wild progenitors for co-evolved beneficial microbes. *CANADIAN JOURNAL OF PLANT PATHOLOGY* 39: 99-100.
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- Jessup, J., P. Ode, and M. Balgopal. 2016. Competition for limiting resources: quantitative reasoning in evolutionary ecology. *American Biology Teacher* 78: 300-309.
- Kaplan I. J. Carrillo, M. Garvey, and P. Ode. 2016. Indirect plant-parasitoid interactions mediated by changes in herbivore physiology. *Current Opinion in Insect Science* 14: 112-119.
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Lesieur, V., J-F. Martin, D. K. Weaver, K. A. Hoelmer, D. R. Smith, W. L. Morrill, N. Kadiri, F. B. Peairs, D. M. Cockrell, T. L. Randolph, D. K. Waters, and M-C. Bon. 2016. Phylogeography of the wheat stem sawfly, *Cephus cinctus* Norton (Hymenoptera: Cephidae): Implications for pest management. *PLoS ONE* 11(12): e0168370. doi:10.1371/journal.pone.0168370.

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Ode P., J. Harvey, M. Reichelt, J. Gershenson, and R. Gols. 2016. Differential induction of plant chemical defenses by parasitized and unparasitized herbivores: consequences for reciprocal, multitrophic interactions. *Oikos*. <http://dx.doi.org/doi:10.1111/oik.03076>

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Peairs, F. B., J. B. Rudolph, T. L. Randolph, and D. Cockrell. 2016. 2015 Colorado field crop insect management research and demonstration trials. Colorado State Univ. Agric. Exp. Sta. Tech. Rep. TR16-13, 28 pp.

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Extension

Peairs, F. B. 2017. Development of integrated pest management approaches for Russian wheat aphid in Colorado, USA. Pp. 243-248 in: GRDC Grains Research Update, Adelaide, Australia. February 7-8, 2017.

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Press releases on grasshoppers in range, alfalfa weevil, Russian wheat aphid, stripe rust, European corn borer, western bean cutworm and sunflower head pests.

IPM related grants and contracts

Broders, K. D. (PI), Contract, "Development of Integrated Management of Silver Scurf - Area II", Colorado Potato Administrative Committee, Domestic Non-Profit (other than Domestic Foundations), \$10,000.00

Broders, K. D. (PI), Contract, "Investigations into the Ecology and Epidemiology of Barley Pathogens in the Central Plains", American Malting Barley Association, Inc., \$2,000.00,

Broders, K. D. (PI), Contract, "Survey to Determine Diversity, Incidence and Severity of Corn Pathogens in Colorado", Colorado Corn Administrative Committee, \$31,500.00

Broders, K. D. (PI), Grant, "A Predictive Model to Increase Adoption of IPM of a Mite-Virus Disease Complex in Wheat", University of Nebraska, \$117,792.00

Broders, K. D. (PI), Contract, "Comparative Genomics of Mint Pathogenic *Verticillium Dahliae* Isolates", Agricultural Research Foundation, \$5,500.00

Broders, K. D. (PI), Contract, "Plant Pathology - Wheat Plant Pathology Research and Extension Program", Colorado Wheat Administrative Committee, \$17,860.00,

Broders, K. D. (PI), Contract, "Plant Pathology - Wheat Plant Pathology Research and Extension Program", Colorado Wheat Administrative Committee, \$89,300.00

Byrne, P. F., Broders, K. D., Grant, "Exploring the microbiome of root, rhizosphere, and leaf of wheat and its relatives", Colorado Wheat Research Foundation, Colorado State University, \$13,020.00

Dayan, F. E. (PI), Grant, "Analysis of Pesticide Residues and their Metabolites in Sugar Beet, Relevant Weeds and Soils", Western Sugar Cooperative, \$5,000.00, Active. (start: January 1, 2016, end: December 31, 2016).

Dayan, F. and S. Nissen. January 1, 2016 - December 31, 2016. Aquatic Weed Management Program. SePRO Corporation. \$10,000.

Gaines, T. A. (PI), Dayan, F. E. (CoPI), Cooperative Agreement, "Genomic Approaches to Study Metabolic Resistance in Dicots", Bayer Company, \$89,451.00, Active. (sub: March 11, 2015, start: November 3, 2015, end: November 2, 2018).

Dayan, F. E. (CoPI), Grant, "Developing a Rapid Marker for a Novel Form of Glyphosate Resistance in Kochia", Western Sugar Cooperative, \$12,000.00, Active. (sub: January 19, 2016, start: January 1, 2016, end: December 31, 2016).

Gaines, T. A. (PI), Contract, "Develop New Over the Top Grass Herbicide Resistance Traits in Sorghum using Mutagenesis", United Sorghum Checkoff Program, \$30,000.00, Active. (sub: February 23, 2016, start: March 15, 2016, end: March 15, 2021).

Gaines, T. A. (PI), Westra, P., Contract, "Evaluate Dicamba Formulations for Control of Multiple Kochia Accessions from the Central Great Plains and Canada", BASF Corporation, \$164,115.00, Active. (sub: June 20, 2014, start: May 1, 2014, end: April 30, 2018).

Gaines, T. (PI), Westra, P. (CoPI), Cooperative Agreement, "Develop Novel Traits in Sunflower Using Mutagenesis", BASF Corporation, \$222,905.00, (sub: June 1, 2014, start: February 1, 2015, end: January 30, 2018).

Gaines, T. and P. Westra. March 15, 2016 - March 15, 2021. Develop New Over the Top Grass Herbicide Resistance Traits in Sorghum using Mutagenesis. Colorado Sorghum Producers & United Sorghum Checkoff Program. \$150000.

Gaines, T. and P. Westra. February 20, 2014 - January, 2017. Addressing Plant Growth Regulator Resistance Risks – Key Species in the Enlist System and Kochia in the Central Great Plains and Western Canada. Dow AgroSciences LLC. \$180,000.

Gaines, T. and P. Westra. June 1, 2015 - May 31, 2016. Use of Mutagenesis to Develop New Sorghum Resistance to Grass and Broadleaf Herbicides to Aid in the Expansion of Sustainable Sorghum Production. Colorado Sorghum Producers. \$15000.

Gaines, T. A. (PI), Westra, P. (CoPI), Cooperative Agreement, "Molecular Basis for Glyphosate Resistance and its Novel Rapid Necrosis Response in Giant Ragweed", Bayer Company, \$186,376.00, Active. (sub: September 4, 2014, start: January 30, 2015, end: January 29, 2018).

Gaines, T. A. (PI), Contract, "Develop Novel Traits in Sunflower Using Mutagenesis", BASF Corporation, \$261,907.00, Active. (sub: July 30, 2014, start: October 1, 2014, end: September 30, 2017).

Gaines, T. A. (PI), Grant, "Developing a Rapid Marker for a Novel Form of Glyphosate Resistance in Kochia", Western Sugar Cooperative, \$12,000.00, Active. (sub: January 19, 2016, start: January 1, 2016, end: December 31, 2016).

Gaines, T. A. (PI), Contract, "Weed Science Herbicide Resistant Weed Management in Winter Wheat", Colorado Wheat Administrative Committee, \$30,000.00, Active. (sub: July 20, 2015, start: July 1, 2015, end: June 30, 2016).

Gaines, T. A. (PI), Westra, P. (CoPI), Nissen, S. J. (CoPI), Kniss, A. R. (CoPI), Grant, "EPSPS Gene Amplification in Controlling Glyphosate Resistant Kochia Research", Western Sugar Cooperative, \$12,000.00, Active. (sub:

February 24, 2015, start: January 1, 2015, end: December 31, 2015).

Gaines, T. A. (CoPI), Grant, "Analysis of Pesticide Residues and their Metabolites in Sugar Beet, Relevant Weeds and Soils", Western Sugar Cooperative, \$5,000.00, Active. (start: January 1, 2016, end: December 31, 2016).

Hoffman, C., M. Falkowski, S. Ex, JE Stewart, McIntire Stennis (2016-2017), "Establishment of a large scale permanent forest dynamics plot to characterize forest health and resiliency in Colorado" \$25,00

Holtzer, T. O. (PI), Jahn, C. E. (CoPI), Norton, A. P. (CoPI), Other, "Developing a Biological Control Strategy for Canada thistle", Ronald W. Miller and Diane Disney Miller Research, Education, and Engagement Project, \$118,917.00, Funded. (start: August 15, 2014, end: August 14, 2017).

Jahn, C. and J. Stewart. USDA - Specialty Crop Block Grant Program Colorado, (2017-2019), "Managing potato soil health through crop rotation length and diversity for increased economic gain in Colorado.", \$90,799

Lang, J., K. Broders and J. Leach. February 1, 2016, January 31, 2017. June 1, 2016 - May 31, 2017. Development of molecular diagnostics for an emerging bacterial disease of maize. USDA-APHIS. \$39247.

Nissen, S. J. (PI), Gaines, T. A. (CoPI), Thum, R. (CoPI), Grant, "Exploring the Physiological Basis of 2, 4-D Tolerance in Northern Watermilfoil x Eurasian Watermilfoil Hybrids", Aquatic Plant Management Society, \$40,000.00, Active. (sub: April 15, 2014, start: January 1, 2015, end: December 31, 2016).

Nissen, S. J. (PI), Contract, "Improving Roadside Weed Management Through Site Specific Re-Vegetation, Training and Intra Agency Cooperation", Colorado Department of Transportation, State of Colorado, \$43,848.00, Active. (sub: March 27, 2015, start: April 8, 2015, end: December 31, 2017)

Nissen, S. J. (PI), Contract, "Evaluation of Weed Control of BAS 820ABH", BASF Corporation, \$4,422.00, Active. (sub: June 10, 2016, start: March 10, 2016, end: December 31, 2016).

Nissen, S. J. (PI), Grant, "Extending the Duration of Annual, Biennial, and Perennial Weed Control with Esplanade Tank Mixes", Jefferson County, Colorado, \$15,100.00, Active. (sub: April 29, 2016, start: May 24, 2016, end: December 15, 2016).

Nissen, S. J. (PI), Contract, "2015-2016 Weed Seedling Identification Booklet and Associated Workshop", Tamarisk Coalition, \$7,375.00, Active. (sub: May 22, 2015, start: June 22, 2015, end: May 31, 2016).

Nissen, S. and T. Holzer. June 1, 2014 - August 20, 2017. Weed Management at the Blue Creek Ranch. Ronald W. Miller and Diane Disney Miller Research, Education, and Engagement Project. \$357,776.

Nissen, S. July 01, 2016 - June 30, 2017. High-Throughput Genotyping of Myriophyllum spp. Using a KASP Assay. \$48,413.

Norton, A. P. (PI), "Developing Mass Rearing Strategies for Rhinusa Linariae and Mecinus Janthinus", USDA-USFS-Forest Research, Federal, \$24,800.00, Active. (sub: November 6, 2015, start: April 1, 2016, end: March 30, 2017).

Norton, A. P. (PI), "South Platte Phreatophyte Survey", Colorado Water Conservation Board, State of Colorado, \$99,733.00, Active. (sub: March 19, 2015, start: April 2, 2015, end: December 31, 2016).

Norton, A. P. (PI), Cooperative Agreement, "Development of a Database: Biocontrol Agents of Insect Pests

Released in the US", USDA-APHIS-Animal Plant Health Insp Srvc, Federal, \$55,998.00, Active. (sub: June 25, 2015, start: September 30, 2015, end: September 29, 2016).

Norton, A. P. (PI), Contract, "CAPS: Collection and Redistribution of Biological Control Insects for the Control of Invasive Toadflax Species (*Linaria* spp.)", Colorado Department of Agriculture, State of Colorado, \$15,962.00, Active. (sub: July 10, 2015, start: March 1, 2015, end: February 29, 2016).

Norton, A. P. (CoPI), Jamieson, M. (PI), Bowers, D. (CoPI), Grant, "Impacts of Herbaceous Bioenergy Production Systems on Bee Communities: Implications for Pollinator Declines and Pollinator Conservation", USDA-NIFA-National Institute of Food and Agriculture, Federal, \$499,998.00, Funded. (start: March 1, 2013, end: February 28, 2016).

Ode, P. and G. Heimpel. March 1, 2014, April 30, 2017. Causes and consequences of competitive displacement in *Cotesia* parasitoids. USDA AFRI Foundational. \$453,177.

Stewart, J. Specialty Crop Block Grant Program Colorado, Reallocated Funds (2016), "Developing Chemical Strategies for Managing *Cytospora* Canker in Peach Orchards in Colorado", \$18,201.

Stewart, J. and K. Burns. USDA FHP. Evaluation Monitoring (2016-2017), PI Stewart, coPI Burns, K. "Monitoring limber pine health in the Rocky Mountains" \$90,464

Westra, P. (PI), Grant, "Agronomic Practices and Genetic Mechanisms Leading to Evolution and Spread of Glyphosate Resistance in *Kochia*", USDA-NIFA-National Institute of Food and Agriculture, Federal, \$500,000.00, Active. (sub: June 8, 2011, start: March 1, 2012, end: December 31, 2016).

WERA 1017 – Annual report for Hawaii Statewide IPM project

**Mark G. Wright, Department of Plant and Environmental Protection Sciences, University of Hawaii at
Manoa
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With contributions from IPM extension faculty as listed below

August 2017

Andrea Kawabata (University of Hawaii CTAHR)

ANNUAL REPORT – 7/1/16-6/30/17

IPM in Specialty Crop (coffee, tropical fruit and macadamia nut) Production Agriculture

Activity Outputs and Short-term Outcomes:

- 28 outreach events with coffee berry borer IPM information (workshops, seminars, field days, conferences, expos, etc.)
- 2 outreach events for IPM of bee pests and bee-keeping (workshop)
- 1 outreach event for IPM of fruit flies in an orchard setting (workshop)
- IPM Advisories (free e-mail and mail newsletters with advice on pest activity and IPM recommendations)
 - Coffee, Tropical Fruits and Macadamia Nut (12 delivered in 2016-2017)
 - Average about 1,160 subscriptions each
 - Content: IPM educational events, agricultural announcements, farm and cultural practice advisories (pest, disease, propagation, fertilization, etc.)
 - 37 archived advisories
- Online sources of information
 - <http://hawaiicoffee.weebly.com/>
 - Content: CBB IPM, agricultural events and announcements, predators of CBB, coffee pests and diseases, publications and presentations
 - 600 views per week
 - <http://ctahrmacadamia.weebly.com/>
 - 100 views per week
 - Content: Crop cultural information, pests and diseases, crop research, food safety
- Strong collaboration with USDA ARS DKI PBARC and HDOA; major funding from a USDA ARS, HDOA and CTAHR
- Applied Research
 - Floating Out the Trash – an investigation into the post-harvest treatment of floating harvested coffee to reduce CBB damaged berries and beans
 - The Long-term Responses of Coffee Rootstocks to Root-knot Nematode in Kona – an investigation into the effect of rootstocks on nematode resistance, yield, and tree health of ‘Typica’ scion grafted onto 8 rootstocks. Year one study.

Impacts:

CBB and Coffee

- 604 coffee growers directly educated
- 4,000 coffee growers and community indirectly educated via educational booths
- 2016 coffee berry borer survey (n=80)
 - 81% of growers have adopted field sanitation to control CBB in the field; an increase from 71% in 2014-15
 - 77% of growers use a sampling method based on the 30 Trees Sampling Method for CBB Monitoring
 - 95% of growers have adopted spraying *Beauveria bassiana* spray every 2-4 weeks to control CBB in the field
 - 68% of growers receive CBB IPM information from UH CTAHR, including the hawaiicoffee.weebly.com website.
- Coffee event evaluations (n=422)

- 93% of respondents increased their knowledge and understanding of CBB IPM and other topics presented
- 92% of respondents learned at least one thing that was applicable to their operation or work.
- Bee and Bee-keeping event evaluations (n=19)
 - 92% of participants felt the presentation increased their knowledge and understanding of the topics presented and felt more informed.
 - 92% of participants felt they would likely start their own apiary following the workshops.
 - 85% of participants learned at least 3 things from the workshop.

Honors, Awards and Skills

- National Association for County Agricultural Agents (NACAA) National Finalist for Website/Online Content Communications Award – Plaque and \$250
 - For hawaiicoffee.weebly.com
- Hawaii Association for County Agricultural Agents selection for NACAA (national) Communications Award for Website/Online Content (2017)
 - For hawaiicoffee.weebly.com

Grants

Cho, A.H., M. Wright, and A.M. Kawabata. Canopy modification for macadamia felted coccid management in macadamia nut orchards in Hawaii. Western Integrated Pest Management Center. (03/01/2016 - 02/28/2017). \$27,282.

Kawabata, A.M. and A.H. Cho. Hands-on training for tropical fruit, nut and orchard crop producers on sustainable farming techniques and practices. UH CTAHR Extension Supplemental. (10/01/2016 - 09/30/2017). \$25,000.

Leung, P.S., A.M. Kawabata and S.T Nakamoto. Area-wide mitigation and management for coffee berry borer control - economic analysis. USDA-ARS Pacific Basin Agricultural Research Center. (09/01/2016 - 08/31/2017). \$50,000.

Kawabata, A.M. Area-wide mitigation and management for coffee berry borer control - outreach and education. USDA-ARS Pacific Basin Agricultural Research Center. (09/01/2016 - 08/31/2017). \$53,021.

PUBLICATIONS

Peer-reviewed Extension Publications

- Kawabata, A.M., S.T. Nakamoto, and R.T. Curtiss. 2017. Recomendaciones para el manejo integrado de plaga de la broca del café en Hawái 2016. Honolulu (HI): University of Hawaii. 25p. (Insect Pests Series; IP-41_Spanish).
- Kawabata A.M., S.T. Nakamoto, and R.T. Curtiss. 2017. Recommendations for coffee berry borer integrated pest management in Hawaii 2016. Honolulu (HI): University of Hawaii. 24p. (Insect Pests Series; IP-41).
- Kawabata, A.M., S.T. Nakamoto, R.T. Curtiss and R.I. Carruthers (editors). 2016. Proceedings: 2016 coffee berry borer summit and conference. Honolulu (HI): University of Hawaii. 23p. (Insect Pests Series).
- Kawabata, A.M., P. Follett, M. Wright, E. Brill and R.T. Curtiss. 2016. An introduction to the square-necked grain beetle as a predator of coffee berry borer in Hawaii. Honolulu (HI): University of Hawaii. 4p. (Insect Pests Series; IP-40).

Conference Papers and Presentations

- Kawabata, A., E. Brill and P. Follett. 2016. “Augmenting field populations of flat bark beetles: An additional tool for CBB IPM in Hawai’i” presented by Brill at 2016 NACAA Western Region

Annual Meeting and Professional Improvement Conference, Kona, Hawaii. 27 October 2016 (Poster Presentation).

Follett, P.A., A.M. Kawabata and E. Brill. 2016. "Flat bark beetle predators of the scolytine pest coffee berry borer in Hawaii coffee" presented by Follett at XXV International Congress of Entomology, Orlando, Florida. 27 September 2016 (Poster Presentation).

Report Period: July 1, 2016 to June 30, 2017

Project: Western Integrated Pest Management Center Regional Comments Coordinator for the American-affiliated Pacific Islands

Project summary: The Regional Comments Coordinator (RCC) serves as the point of contact for regulatory and other federal information requests to the Pacific island territories and Hawai'i. The RCC contacts pertinent stakeholders in Hawai'i and these territories and assembles requested information delivers it to the Western Integrated Pest Management Center (WIPMC) and/or other requestors in the US Department of Agriculture (USDA), the US Environmental Protection Agency (EPA) and other federal agencies as directed by the WIPMC Director. Responsibilities of the RCC will include: contact pertinent stakeholders within the API about pending regulatory actions on pesticides; collect and compile input from stakeholders and submit a response to the requesting agency (e.g., USDA, EPA, etc.); work with and keep the WIPMC apprised of the RCC's activities; and cooperate with other RCCs within the Western Region as appropriate.

Area Addressed: Production Agriculture IPM

Activity1: Comment Coordination for the American Pacific

Outputs:

Comments submitted to docket at Regulations.gov for the registration reviews of:

- Sulfonylurea herbicides

Comments provided to USDA Office of Pest Management Policy requests for information for registration reviews:

- use and benefits of carbaryl

- ethoprop. Feedback indicated ethoprop is no longer needed by banana growers

Potential Outcomes:

- Carbaryl will remain as a useful pest management tool for vegetable growers and golf course turf managers.

- The sulfonylurea herbicides used in turf and landscapes and pasture and rangeland in Hawai'i will remain as useful tools for pest managers of these sites.

Activity2: Assisting and cooperating with the work of the Center in the American Pacific Islands.

Outputs:

Contributed information on the fitness to an IPM program for IR-4 project requests:

- glufosinate for weed control for banana, coffee, papaya and tropical fruit (inedible peel)

- fluopyram for control of black sigatoka disease in banana

Potential Outcomes:

- Growers of coffee and tropical fruits will have alternative to paraquat to control glyphosate-resistant weeds.

- Registration of a fungicide for control of black sigatoka disease for banana growers

Contact:

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Area Addressed: Turfgrass and Landscape Pest Management (Z. Cheng Lab)
(July 01, 2016 to June 30, 2017)

Activity 1: Extension education to green industry in Hawaii

Outputs:

8 extension seminars and/or workshop/field day to various stakeholder groups reaching over 220 people
List:

Cheng, Z. Management of coconut rhinoceros beetle and lobate lac scale, two new invasive landscape pests in Hawaii. 2017 Crop Production Services Annual Seminar and Trade Show. May 12, 2017. Honolulu, HI.

Cheng, Z. Turf/Ornamental Pests and Control in Hawaii. 2017 Department of Defense (DoD) Pesticide Applicator Training Program. May 01, 2017. Honolulu, HI.

Cheng, Z. and N. Nagata. An emerging landscape pest on Maui – lobate lac scale: state-wide survey and control. 2017 Maui Landscape Pest/Management Seminar and Field Day. March 30, 2017. Kahului, HI.

Cheng, Z. Management of several new invasive landscape pests in Hawaii: Ficus stem and leaf gall wasps and coconut rhinoceros beetle. 2017 Maui Landscape Pest/Management Seminar and Field Day. March 30, 2017. Kahului, HI.

Cheng, Z. Management of coconut rhinoceros beetle and lobate lac scale, two new landscape pests in Hawaii. 14th Annual Landscape Industry Council of Hawaii (LICH) Green Industry Conference and Trade Show. October 06, 2016. Honolulu, HI.

Cheng, Z. Management of some important landscape and turfgrass pests in Hawaii. 2016 Department of Defense (DoD) Pesticide Applicator Training Program. August 15, 2016. Honolulu, HI.

Cheng, Z. Management of new invasive landscape pests in Hawaii. 2016 Kauai Landscape Conference. July 14, 2016. Lihue, HI.

Cheng, Z. Turfgrass maintenance and pest management. 2016 Kauai Landscape Conference. July 14, 2016. Lihue, HI.

- Coordinate “Turfgrass Column” of Landscape Hawaii, a professional magazine published by LICH
- Site visits for pest evaluations and control recommendations at golf courses, landscape sites, gardens, private residences, etc.
- Applied field trials
- Diagnosis of turf and landscape pest samples for stakeholders.

Short-term Outcomes:

- Evaluations of my seminars/workshop/field day demonstrate a substantial increase in skills and knowledge in pests and their control covered
- ~136 people received HDOA Pesticide CEUs through my seminars

Impacts:

- Many trees are saved from being cut down
- Arborists are using my recommendations (low risk method) to treat and protect trees in Hawaii’s urban landscapes
- Improved knowledge of pest control operators to explore alternatives to pesticides, such as potential biological control agents

Activity 2: Master Gardener Training Program

Outputs: 4 training courses on lawns and turfgrass management across 4 major islands in Hawaii reaching over 100 Master Gardener trainees

List:

Cheng, Z. Turfgrass Lawns and Management. 2017 Kauai Master Gardener Training Program. May 03, 2017. Distantly presented to attendees in Lihue, HI.

Cheng, Z. Turfgrass Lawns and Management. 2017 Oahu Master Gardener Training Program. April 28, 2017. Waimanalo, HI.

Cheng, Z. Turfgrass Lawns and Management. 2017 Maui Master Gardener Training Program. April 12, 2017. Kahului, HI.

Cheng, Z. Turfgrass Lawns and Management. 2017 East Hawaii Master Gardener Training Program. February 27, 2017. Hilo, HI.

Short-term Outcomes:

- Evaluations of training courses demonstrate a substantial increase in skills and knowledge in turfgrass and lawns.

Impacts:

- Many trainees are using the turf management practices I taught in their own gardens, including deep watering and thatch control

Activity 3. Hosted WERA011 (Western Regional Turfgrass Research group) meeting in July 2016 in Honolulu (Multistate Activity)

Outputs: WERA011 meeting and annual report

Short-term Outcomes:

- exchange of information and knowledge on turfgrass research/extension/education among western states/territory
- potential multi-state collaboration projects on turfgrass.

Publications

Peer-reviewed:

Bhandari, B.P., and **Z. Cheng**. 2017. Lobate lac scale, *Paratachardina pseudolobata* Kundo and Gullan, in Hawaii's urban landscape: hosts and management. International Journal of Tropical Insect Science. *In Press*.

Li, J., Y.-C. Zhao, G.-D. Ren, and **Z. Cheng**. 2017. Taxonomic study on specimens of the genus *Micrencaustes* deposited in the Bernice P. Bishop Museum (Coleoptera, Erotylidae). ZooKeys, 645: 27-35.

Moore, A., R. Quitugua, I. Iriarte, M. Melzer, S. Watanabe, **Z. Cheng**, and J.M. Barnes. 2016. Movement of Packaged Soil Products as a Dispersal Pathway for Coconut Rhinoceros Beetle, *Oryctes rhinoceros* (Coleoptera: Scarabaeidae) and Other Invasive Species. Proceedings of the Hawaiian Entomological Society, 48: 21-22.

Extension:

Cheng, Z. 2017. Current and recent research projects in Turfgrass and Landscape pest management Lab at University of Hawaii at Manoa. Landscape Hawaii, July/August 2017: 24-26.

DeFrank, J., **Z. Cheng**, and A.J. Lindsey. 2017. Research update on Bermuda grass treatment. Landscape Hawaii, May/June 2017: 16-17.

Cheng, Z. 2017. Frit fly: A challenging turfgrass pest in Hawaii. Landscape Hawaii, March/April 2017: 28.

Cheng, Z., and J. DeFrank. 2016. Suppressing bermudagrass in seashore paspalum turf. Landscape Hawaii, September/October 2016: 30.

Area Addressed: Production agriculture: Tropical fruit and nut IPM (Mark G. Wright)

Activity 1: Applied research – macadamia nuts, macadamia felted coccid

Outputs:

1. Described biology of *Eriococcus ironsidei*, macadamia felted coccid. MFC.
2. Conducted field trials on insect growth regulators for management MFC
3. Investigate effects of canopy management in orchards on MFC and natural enemies.
4. Identified effective predators present within orchards.
5. Conducted research on economic injury level for MFC.
6. Investigated soil nutrient and moisture effects on MFC severity.
7. Presented findings on MFC biology and management at industry meetings (2)
8. Developed an information pamphlet on MFC for dissemination to the industry.

Short-term Outcomes

- approximately 45 attendees of meetings obtained updates on MFC sampling, biology, natural enemies and management.

Activity 2: Coffee – coffee berry borer management.

Outputs:

1. Conducted state-wide surveys for coffee berry borer (CBB), *Hypothenemus hampei*.
2. Developed reduced-effort sampling procedure for field monitoring, including sampling intensity, and a potential improved means of assessing actual beetle density by agitation to cause them to exit coffee berries.
3. Presented findings at coffee industry meetings (2) and regular CBB area-wide management meetings, which include industry representatives.
4. Extension agents led my Andrea Kawabata presented multiple workshops to coffee growers.

Short-term Outcomes:

Published data on sampling intensity reduction options, showing how equally accurate sampling can be conducted with reduced labor, compared with the current procedure.

Improved understanding of CBB biology and management among coffee growers.

Activity 3: Invasive species – general.

Outputs:

1. Published papers on biocontrol risk assessment and biocontrol agent evolution.
2. Continued biocontrol impact monitoring on *Erythrina* gall wasp natural enemies.
3. Continued monitoring naio thrips on endemic *Myoprum*.
4. Conducted pesticide trials for naio thrips on *Myoprum*, and screened germ-plasm accessions for resistance to the thrips.
5. Presented finding at Statewide invasive species workshop and other land-manager meetings in Hawaii.

Impacts:

Demonstrated effective biological control of *Erythrina* gall wasp

Identified potentially effective insecticides for naio thrips management.

Improved communication and collaboration among IPM researchers, Cooperative Extension personnel and partner organizations in Hawaii.

Surveyed new infestations of CBB statewide – provided updated information on distribution and made inputs on state rules for quarantine of coffee for movement among islands.

Recent publications:

1. Guitierrez, R., Zarders, D., Pulakkatu-Thodi, I., Mollenido, J., Yalamar, J., Wright, M.G., Cho, A. 2017. *Macadamia feltd coccid Eriococcus ironsidei* (Hemiptera; Eriococcidae) description, monitoring and control. CTAHR-CES pamphlet.
2. Pulakkatu-thodi, I., Guitierrez, R. & Wright, M.G. 2017. Comparison of sampling intensity to estimate infestations of coffee berry borer on Hawaii island. (In press: *Proceedings of the Hawaiian Entomological Society*).
3. Wright, M.G. & Bennett, G.B. 2017. Evolution of biological control agents following introduction to new environments. *BioControl*, DOI 10.1007/s10526-017-9830-z (invited.)
4. Kaufman, L.V. & Wright, M.G. 2017. Assessing probabilistic risk assessment approaches for insect biological control introductions. *Insects* (In press, Special Issue *Biological Control of Invertebrate Pests.*)
5. Zarders, D.R. & Wright, M.G. 2016. *Macadamia feltd coccid, Eriococcus ironsidei*: biology and life cycle in Hawaii. *Proceedings of the Hawaiian Entomological Society* 48: 51-55.

Randall T. Hamasaki

CTAHR: PEPS: County Extension Agent

Area addressed: Production Agriculture

Activities: Organized/Reported under my Extension Plan of Work titled "Commercial Edible Crops Extension"

Obj. Diamondback Moth Insecticide Resistance Management Program:

Background: The diamondback moth (DBM) is a major pest of crucifers (crops such as head cabbage, Chinese cabbage, broccoli, bokchoy and watercress). The crucifer industry was valued at \$7 million in Hawaii (Hawaii Agricultural Statistics Service, 2011). This pest is notorious worldwide for its resistance to many classes of pesticides. Past experience has shown that when insecticides are not used in a sound insecticide rotation schedule, resistant DBM are selected and control failures result, causing massive crop losses. What was once an effective insecticide for DBM is rendered useless until it not used for months, and the DBM is repopulated by susceptible individuals. Hence, the DBM Insecticide Resistance Management Program was developed at the CTAHR in order to enable growers to manage the DBM effectively by rotating insecticide chemistries on an areawide basis.

Outputs:

- Annual workshop
- Areawide insecticide rotation schedule
- Twice/year insecticide resistance screening

Short-term outcomes:

- Educational workshop: participants learned about the basics of the diamondback moth: how to identify the various insect stages, its life cycle, distribution, host-plants, and the damage it does to crops. They also learned about the integrated pest management of the diamondback moth, including host-plant resistance, pesticides, insecticide resistance management, how spray concentration can affect control and resistance management, the importance of spray coverage.
- 2016 Diamondback moth management plan for the Big Island: The crucifer crop growers applied environmentally friendly pesticides in a coordinated, area-wide basis. The program rotated insecticides from 6 mode of action groups in order to help manage the risk of selecting for resistance in the diamondback moth.
- Insecticide resistance screening: conducted in June and November 2016 showed no evidence for insecticide resistance selection—a good sign that the program was working!

Impacts:

- Helped to preserve the effectiveness of insecticides and enabled growers to achieve their yield goals in 2016

- Waimea crucifer growers were able to produce safe, healthy crops, while preserving the effectiveness of important environmentally friendly insecticides
- There were 7 farms that followed the resistance management program.

Obj. "Farm Doctor":

Background: The basis of the "Farm Doctor" program is to help growers when they are in need and have asked for assistance. Although this is often a reactive, one-on-one approach, there is a good chance of learning and adoption because a client in dire need is at a very "teachable moment." New pests and diseases can be detected early by having a professional responding to these calls for help by farmers encountering something out of the ordinary. The agent worked closely with the Agricultural Diagnostic Service Center for the laboratory testing of samples. Occasionally other personnel from CTAHR, Hawaii Department of Agriculture and the USDA may be required.

Outputs:

- The "Farm Doctor" program reached a varied audience ranging from highly experienced growers to beginning farmers with little experience and often times no agricultural background or training.
- Established farmers frequently requested assistance with pest identification and management while beginning farmers often inquired about general crop culture, sources of information, sources of services such as soil testing, ag credit, etc.
- A total of 120 direct (face to face) interactions such as through farm/office visit consultations and 392 indirect interactions such as through email and telephone consultations were conducted.

Short-term outcomes:

- Sod-Busting Caterpillars: The article "Management of Caterpillar Pests in Hawaii Pastures" by Mark S. Thorne and Randall T. Hamasaki was published in August 2016 in response to severe outbreaks of lawn armyworm and grass webworms in pastures on the Big Island and other islands. CTAHR's Mealani Research Station was not spared from the destruction. Nearly a third of the station's paddocks were affected in September 2015. History shows that these outbreaks have been occurring for some time and they have had devastating consequences for pasture productivity. The intent of the document was to provide information about the caterpillar pests, including what you should do if you find these pests causing damage in your pastures. The article discusses pest identification, pest biology, pasture assessment and monitoring, integrated pest management options, natural enemies, insecticide treatment, and grazing management. The article can be accessed online at the CTAHR publication website.
- A colorful assortment of kale problems: Kale has gained much popularity as a health food in recent times. Would you believe that the known farmgate value of Hawaii grown kale exceeds \$1 million per year? Kale usually grows well but sometimes problems have occurred and producers sought "Farm Doctor" assistance to help them identify and find out about management options for the following: black spot (*Alternaria brassicae*), black rot (*Xanthomonas campestris*), white leaf spot (*Mycosphaerella* sp.), powdery mildew (*Erysiphe* sp.), downy mildew (*Hyaloperonospora parasitica*), *Alternaria brassicicola*, *Leptosphaerulina* probably *maculans*, *Rhizoctonia solani*, green garden looper (*Chrysodeixis eriosoma*), cabbage aphid (*Brevicoryne brassicae*) and garden fleahopper (*Halticus bractatus*).

Impacts:

- There was a high degree of learning and adoption through these close interactions. In some instances, the grower being able to identify and manage a production prevented losses in the thousands of dollars.
- New State Record: Downy mildew *Peronospora mesembryanthemi* was found on hearts and flower plants on the Island of Hawaii.
- Identification pending: Powdery mildew of mulberry (probable new state record).
- New State and US Record: *Asterococcus* sp. prob. *yunnanensis* Borchsenius (Hemiptera: Ceroccidae) on Indian hawthorn in Waimea, Island of Hawaii.

Obj. Outreach Program for Fruit Fly Pest Management:**Outputs:**

- Individualized cooperator training
- Cooperator survey
- Easy As 1,2,3 Starter Kit

Short-term outcomes:

- There were 34 cooperating program participants with a total area of 132.5 acres.
- As a result of training, the participants were able to make informed decisions for managing fruit flies in their farm or garden. These practices resulted in decreased pest infestation and crop damage levels. Many participants have using these practices over many years.

Impacts:

- Cooperators were able to produce apples, avocado, banana, cantaloupe, cherry, coffee, cucumber, eggplant, fig, grape, grapefruit, gourd, jaborcaba, lemon, lychee, mango, mountain apple, nectarine, orange, papaya, peach, pepper, persimmon, pomegranate, plum, pumpkin, sapote, starfruit, soursop, squash, tangelo, tangerine, tomato and watermelon.

Obj. Use of Biofungicide (*Bacillus subtilis*) to Suppress Clubroot on Cabbage:

Background: Head cabbage was the top volume producing vegetable crop in Hawaii in 2014, yielding 6.67 million pounds, and having a farm gate value of \$3.4 million dollars. Increased production of Chinese cabbage and mustard cabbage were also observed (NASS, 2015). A major disease affecting the production of head cabbage as well as other cruciferous crops is Clubroot, caused by the soil borne plasmosiophorid (fungus-like) pathogen, *Plasmodiophora brassicae*. Plant root hairs and cortex become infected with the pathogen which leads to the characteristic clubbing symptom and subsequent wilting. The overall objective of this project is to improve the economic and environmental sustainability of cabbage production in Waimea, Hawaii. Specifically, we propose to: 1) conduct an on-farm trial to evaluate the effectiveness of the biofungicide, *Bacillus subtilis* (Serenade® AZO) and 2) to educate and inform growers about the disease and its management.

Outputs:

- Demonstration field trial
- Workshop for growers

Short-term outcomes:

- Pending.

Impacts:

- Pending.

2017 Publications:

Green, K., M. Chikh-Ali, R. Hamasaki, M.J. Melzer, A. Karasev. 2017. Potato virus Y (PVY) isolates from *Physalis peruviana* are unable to systemically infect potato or pepper and form a distinct new lineage within the PVYc strain group. *Phytopathology*, (ja).

Hamasaki, Randall T., Andrea M. Kawabata and Stuart T. Nakamoto. 2017. Insect and Mite Pests of Blueberries in Hawaii. IP-42. College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa. <https://www.ctahr.hawaii.edu/oc/freepubs/pdf/IP-42.pdf>

Miyasaka, Susan C., Randall T. Hamasaki, and Russell T. Nagata. 2017. Reflective Guide to Growing Olives for Oil Production in Hawai'i. NPH-16. College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa. <https://www.ctahr.hawaii.edu/oc/freepubs/pdf/NPH-16.pdf>

WERA 1017 – Annual Report for New Mexico Statewide IPM Program

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With contributions from IPM extension faculty and staff including:

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August 2017

New Mexico IPM Impacts: 7-1-2016 to 6-30-2017

Area Addressed: Urban and Community IPM

Activity 1: Master Gardener Training

Outputs:

- Presentations on beneficial insect conservation – 19
- Presentations on beneficial and pest insect ID – 19
- Presentations on insect pest ID – 20
- Presentations on Weed IPM – 9
- Presentations on backyard vegetable production – 19
- Presentations on plant diseases and the diagnostic process - 15

Short-term Outcomes

- 100% of programs reached
- 100% of attendees indicated their knowledge of IPM increased
- 100% of people attending presentations reported they learned an IPM practice they could implement
- 100% of people learned an IPM practice that would reduce non-target effects on beneficial insects
- Publications:
 - Extension publications
 - IPM for home gardeners
 - Lawn Care for Disease Control
 - Tomato Spotted Wilt Virus
 - Iron Chlorosis
 - Rhizosphaera Needle Cast of Spruce
 - Extension online
 - The NMSU Plant Diagnostic Clinic is using social media (blog, Facebook, Twitter, Instagram and Pinterest) to disseminate timely information on pest diagnostics to the public. Analytics for only Facebook indicate that our materials reached over 189,000 individuals in 2016.

Impacts:

- Improved knowledge of IPM practices and increased use of alternative pest control strategies
- Increased knowledge of beneficial insect conservation

- The Master Gardener program provides 55,067 volunteer hours each year to community projects totaling \$2,832,862 each year to the state of New Mexico

Activity 2: Gardening and residential landscapes

Outputs:

- ID Walks
 - 7 beneficial insect walks
 - 5 insect pest ID walks
 - 6 weed ID walks
- ID workshops
 - 5 plant clinics were conducted at farmer markets
 - 1 insect pest clinic at a field day
- Presentations
 - Pollinator Conservation – 6
 - Insect Expo – 1
 - Weed Identification and Management - 4
- Consultations
 - Residential visits for weed id and management - 5
- Displays
 - Drawers of pinned specimens: insect pests and beneficial insects
 - Posters: insect pests and beneficial insects
 - Potted specimens of common weeds
 - Common weed/plant identification tools and books

Short-term Outcomes:

- 100% of people attending presentation on pollinator conservation reported they learned at least one new practice they could implement
- 100% of people report learning benefits from interactive displays
- 100% of people report increased knowledge from displays
- 100% of people report increased knowledge on pest id
- Grants: A pocket guide to New Mexico's Tree Pests

Impacts:

- Improved knowledge of pollinator IPM strategies
- Increased knowledge of habitat and nesting needs for pollinator conservation
- 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

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. In June 2016, clinic personnel conducted a joint NPDN Certified First Detector Training and field diagnostic troubleshooting workshop. Fifty-one new "first detectors" were certified through this training.

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. On average, 5 Plant Clinics have been conducted each year with over 1,200 clientele contacts made. These clinics provide an opportunity for small-scale growers and home gardeners 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 2016

Outputs:

- Collectively processed 1,541 insect, weed, and disease samples
 - 787 insect samples were identified and IPM recommendation returned
 - 212 weed samples were identified and IPM recommendation returned
 - 542 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, and may pose risks to people and the environment
- Between July 1, 2016 and June 30, 2017, 12 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
- Early detection and steps toward eradication of stem and bulb nematode on garlic will protect New Mexico's \$48 million onion industry
- The identification of a new bacterial pathogen in pecans, which can result in up to 16% crop loss, and the subsequent education of producers may help protect New Mexico's over \$200 million pecan industry from a potential loss of up to \$32 million.

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:

- 21 pesticide training workshops across the state
- 11 CEU workshops across the state.

Short-term Outcomes:

- Workshop evaluations indicate that 98% of participants learned a new skill that will assist them when applying pesticides,
- Workshop evaluations indicate 75% of participants learned a new pest or plant management practice that will decrease pesticide use.
- 83% of attendees indicated they learned a new IPM tactic they could implement
- 70% responded this training made them aware IPM practices to protect pollinators
- 70% responded this training made them aware of IPM practices to increase the efficacy of herbicide applications on target weeds

Impacts:

- Through recertifying 350 current pesticide applicators and training 150 new license holders with an average annual salary of \$34,570, this program added or maintained over \$17,000,000 to New Mexico's economy.
- 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 in Specialty Crops

Activity 1: Vegetable production and IPM training

Outputs:

- Presentations on plant diseases – 2
- Presentations on organic production – 3
- Field walks in grower fields – 3
- 2 Field days
- 2 conferences organized and support by NMSU Extension
 - Chile Conference
 - Sustainable Ag Conference

Short-term Outcomes:

- 100% of attendees requested more field ID and field walks
- 100% of attendees report increase in weed identification
- 100% of attendees report increase in IPM management strategies for weeds

Impacts:

- Improved knowledge of pest identification in grower fields
- Improved knowledge of management strategies based on pest identification and biology
- Improved knowledge of crop management to aide in pest management

Activity 2: Pecan IPM

Outputs:

- Presentations on pecan IPM – 3
- Site visits in commercial orchards – 5
- Publication – 1

Impacts:

- Biological control of Pecan Nut Casebearer could save up to \$1.6 Million/year

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

Activity 1: Training on IPM in parks

Outputs:

- Presentations on plant diseases – 1
- Presentation on IPM practices – 12
- Workshops on IPM for trees and turf – 9
- Workshop on mosquito IPM – 1

- Pest of Trees: college campus diagnostic walk - 5

Outcomes:

- Tree care plan was drafted for two college campuses
- Adjustments were made to pest management practices to help protect trees and other desirable ornamental plants
- 7 new county records for new insect pests resulting from workshops and walks

Impacts:

- Increased use of IPM to control mosquitos
- 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
- Improved understanding of how property management can impact pest infestations and injury

Area Addressed: IPM implementation for Agronomic Crops

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

Outputs:

- Publications – 9
- Presentations – 25
- Field walks in grower fields - 5
- Site visit to pistachio orchards and chile fields for pest ID and IPM recommendation -22

Short-term 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
- Publications
 - Effects on climate change on pistachio production in NM
 - Managing weeds in alfalfa

Impacts:

Cotton

- Seed treatments save \$2.7 Million/year in losses from thrips

Alfalfa Hay

- Biological control of alfalfa weevil by reintroduction of parasitoids can save over \$1.2 Million/year

Sorghum

- Sugarcane aphid biocontrol and plant resistance can save up to \$4.6 Million/year in New Mexico and \$20 Million in adjacent Texas Counties.

- Impacts to multiple cropping systems – Farmers spent \$14 billion dollars in 2016 on weed control alone

Area Addressed: IPM Implementation for Animal Agriculture

Activity 1: IPM for saltcedar on rangelands

Outputs:

- Site visits to locate saltcedar and assess populations of *Diorhabda* spp. = 11
- Presentation – 5
- Displays:
 - Posters – 2
 - Insect specimens - 2

Outcomes

- 80% of site visits resulted in confirming *Diorhabda* populations

Impacts:

- Improved understanding of IPM strategies using the biological control agent, *Diorhabda*
- Increased acceptance of using a biocontrol agent to control saltcedar

WERA 1017 Nevada Integrated Pest Management Programs

IPM in Urban Communities

Activity 1: IPM training for the Green Industry

- Green Industry Training, 8 classes, all discuss IPM. Average attendance of each class was 40 people; 323 participants attended the 8 classes; 5 classes also offered Pesticide Applicators CEUs. These are the people who work in nurseries and with landscape services. They increase our ability to get IPM messages out into the Urban Communities. In post program evaluations, the participants feel they increased their knowledge level and that they learned something they can pass on to their clients.
- Webinars with Utah State University.
 - Avoiding and remedying Abiotic Injury of Trees, Marion Murray, USU, 225 people viewing initial webinar, posted on YouTube.
 - Managing Trees during Drought Conditions, Heidi Kratsch, UNR Cooperative Extension, 237 people viewing initial webinar, posted on YouTube.

Activity 2: IPM training for Master Gardeners.

- Master Gardener classes, 18 - 3 hour classes, 30 new participants, 5-10 per class existing MGs also participated in each class. Post series surveys indicated 75% of participants felt they learned “a lot” or “a great deal” from the classes on pesticide safety and IPM, lower risk pesticide products, insect pests and plant diseases.
- Advanced Master Gardener Trainings, 11 trainings offered, all discussed IPM, 160 participants.
- Master Gardeners answer questions from the general public in our Horticultural Office, from walk-ins, phone calls and emails. They also answer questions and provide information to the general public at home shows, field day and at other community events. Educating our Master Gardeners increases our ability to get IPM messages out into the Urban Communities.

Activity 3: IPM Training for General Public.

- Gardening in Nevada Lecture Series, Bartley Ranch, 8 lectures, 430 participants.
- Grow Your Own Nevada fall lecture series, live in Reno, offered via video to 9 other sites, 8 total lectures, only 5 discussed IPM, 1 offered CEUs, 230 IPM-related participants (42 participants on the program that offered CEUs).
- Grow Your Own Nevada Spring 2017 lecture series, 8 classes, all discussed IPM, 610 participants.
- Newspaper articles in 3 newspapers in Western Nevada. Over 20 articles were published, for a combined potential readership of over 1,500,000 people.

Activity 4: IPM Publications.

- A Green Industry Professional’s Guide to Integrated Pest management (IPM), in press.
- A Homeowner’s Guide to Integrated Pest Management (IPM), in press.

- Nevada Nuisance Weed Field Guide, in press.
- Heidi Kratsch, JoAnne Skelly, George Hill, & Susan Donaldson. (2017). Using Cluster Analysis to Target Educational Messages to Consumers. Journal of Extension 55(1) Article 1FEA1. Available at: <https://www.joe.org/joe/2017february/a1.php>.
- Heidi Kratsch, Wendy Hanson Mazet, & Marcel Fernando Schaerer (2016). Como Podar los ARBOLES (How to Prune TREES). University of Nevada Cooperative Extension Fact Sheet-16-06. <http://www.unce.unr.edu/publications/files/sl/2016/fs1606.pdf>
- Heidi Kratsch, Wendy Hanson Mazet, & Marcel Fernando Schaerer (2016). Como Plantar ARBOLES (How to Plant Trees). University of Nevada Cooperative Extension Fact Sheet016-05. <http://www.unce.unr.edu/publications/files/ho/2016/fs1605.pdf>
- Heidi Kratsch, Wendy Hanson Mazet, & Marcel Schaerer. (2017). Como Mantener Saludable el CESPED (How to Maintain Healthy LAWNS). University of Nevada Cooperative Extension Fact Sheet-17-03. (not up on the web yet)
- Previous publications distributed to 12 nurseries in 5 counties, Washoe County Public Libraries and 7 University of Nevada Cooperative Extension offices

Activity 5: IPM Public Service Announcements.

- TV Public Service Announcements, June and July, 1152 spots.
- Radio Public Service Announcements on KUNR, June and July, 133 spots.
- Hits to our website, www.manageNVpests.info, DOUBLED in 2015 and 2016 when the PSA were running.

Activity 6: IPM Website

- Hits to the website, www.manageNVpests.info, from July 1, 2016 to June 30, 2017 were 338,559, with total visitor count of 32,938.
- Site is augmented and updated as needed. Newspaper articles are added to the site as an archive and for use by those visiting the website.

Activity 7: IPM retrospective survey

- The survey does not close until the end of July. The survey consisted of a number of questions regarding IPM practices in the home landscape and questions designed to see if our educational campaign is reaching the community. The survey was sent to home gardeners, Master Gardeners, Green Industry professionals, Pesticide Applicators, 4-H program parents and other people who have attended a UNCE program in the last 2-3 years.
- When asked “which of the following practices do you follow in your yard (select all that apply)”, the following breakdown occurred (491 respondents):

○ I Read the label before purchasing or using a pesticide	71%	
○ I set my lawn mower to mow at 3 inches	57%	
○ I adjust the timing of pesticide sprays to protect pollinators and beneficial insects	36%	
○ I apply pest control product only when pests are causing significant damage	59%	
○ I monitor regularly for pests in my landscape	59%	
○ I try to prevent pest problems in my landscape by keeping my plants healthy	77%	
○ I only use pesticides on my landscape when other strategies have not worked	60%	
- In one question, we ask about the different media campaign messages we have been broadcasting. 85 to 95 percent of those responding (533 at this writing) indicated they had heard our five messages. When queried where they heard the messages, the responses fell into the following breakdown (participants could choose more than one):

○ On the radio	18%
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- On television 19%
- From a class I attended 64%
- On a website 60%
- On Facebook or other social media 7%
- On You Tube 4%
- In a webinar 7%
- In a newspaper or magazine 34%
- From a Master Gardener 31%
- I don't remember 12%
- Other 14%

IPM for Pesticide Applicators

Activity 1: IPM for Pesticide Applicators

- 2 Statewide trainings offered for Pesticide Applicator, 90 participants (3 and 4 CEUs offered, respectively)
- 1 Cultivator Workshop, Reno and Las Vegas, 56 participants, 7 CEUs
- Nevada Landscape Association Conference, Pesticide-IPM track, 337 participants, 8 CEUs
- Elko Weed Summit, 55 participants, 8 CEUs
- Weed Warrior Training, 3 sites, 45 participants, 9 CEUs. Participants averaged a 5 weed increase in the ability to identify weeds from the 20 discussed before and after attending the training.
- Green Industry training, 8 classes, 220 participants, 4 classes offered PSEP CEUs, all discussed IPM

IPM in Agriculture

Outputs

- Fact sheets
 - Orange sulphur butterfly
 - Monarch butterfly
 - Tomato hornworm
- Eight workshops or presentations throughout the state on Alfalfa IPM
- Four workshops or presentations on irrigation and how to utilize it in an IPM program
- One presentation on alternative crop options for Nevada, Nevada's IR-4 program, using crested wheatgrass as an IPM strategy, IPM strategies to protect pollinators and low water use/ high value cropping in Nevada.
- Summary publication of 2012 and 2014 Integrated Pest Management stakeholder surveys
- Publication on small scale production of cool weather crops in unheated greenhouses

Short-term Outcomes

- Improved knowledge of the best practices for IPM techniques in Nevada
- Improved understanding of stakeholder IPM knowledge gaps, typically used techniques, and needs
- Shift in stakeholder IPM techniques, including increased used of certain preventative and physical pest control techniques, and a broader range of cultural techniques, between 2012 and 2014
- Acceptance of IPM techniques due to continued trust between producers and our program
- Beginning to develop an IPM program for armyworms in Teff

Impacts

- Change in agricultural land management techniques with more common use and easier acceptance of IPM techniques

IPM on Recreational Lands

Outputs

- Revision of Nevada Weed Management Plan and associated literature

- Two presentations, a booth and on the planning committee for the 2015 Nevada Weed Management Conference and assisted annually with two other smaller noxious weed workshops the Elko Weed Extravaganza and Tri-county Weeds annual conference
- Seventeen other workshops or presentations on noxious weeds statewide during the last funding cycle
- Member on Nevada Weed Management Association Board
- Assisted with planning the 2017 Nevada Weed Management Conference in conjunction with NIASMA to be held in Reno in fall of 2017
- Weed verifications for EDDMapS and Nevada Department of Agriculture

Short-term Outcomes

- Improved knowledge of recreational lands managers about IPM techniques, equipment and pesticide use, noxious weed identification and reporting and newly invading weeds
- Improved understanding of stakeholder IPM knowledge gaps, typically used techniques, and needs
- Shift in stakeholder IPM techniques, including increased used of certain preventative and physical pest control techniques, and a broader range of cultural techniques, between 2012 and 2014
- Identification of needs beyond educational outreach that slow or prevent IPM techniques from being effective in Nevada
- Revised Nevada State Noxious Weed Plan with outreach flyer

Impacts

- Targeting newly invading weed species sooner and raising awareness of IPM and early detection and rapid response strategies
- Adoption of higher-level IPM strategies by recreational land managers
- Updated a critical document for changing noxious weed management in Nevada
- Serving as the primary educational source for noxious weed identification

WERA 1017 – 2017 brief report, Oregon Selected highlights from EIP 2016

Area addressed: IPM and pesticide risk management in specialty crops

Activities: Middle Rogue pesticide stewardship partnership

Outputs: 3 workshops for farmers and agricultural professionals, and an “IPM festival” with morning conference and a tour of a small grain farm, a pear farm and a vineyard. Numerous outputs were developed: a local climate guide that reported the categories of drift occurring in different seasons; a pesticide risk analysis for compounds of concern in the Middle Rogue watershed, including seasonal use patterns; an IPM guideline that connected IPM practices with water quality management goals.

Short-term Outcomes: Increased understanding of pesticide use profile and sources of compounds of concern for Middle Rogue hay and forage crops, pome fruit and wine-grape farmers, and right of way and municipal pesticide users; peer to peer exchange of information on pesticide application practices, IPM implementation and pesticide risk mitigation.

Impacts: Over 24,145 acres of agricultural land, 62% of farmers took risk into account in pesticide selection, 59% changed application practices to reduce the risk of pesticide entry into surface waters, 65% used weather forecasting to determine the timing and location of pesticide applications.

Area addressed: Agro-ecology and conservation biological control

Activities: Christmas tree farmer conservation biological control, Eastern Oregon training of trainers course, functional agro-biodiversity summit

Outputs: Guides to insectary plant selection and planting configurations on Christmas Tree farms and for Eastern Oregon agriculture; biologically-based IPM guidelines for Christmas tree aphids and Douglas Fir Needle Midge; video interviews associated with Christmas Tree workshop and summit
<https://www.youtube.com/watch?v=Cm85boLJLkA&t=7s> and <http://westernipm.org/index.cfm/ipm-in-the-west/agriculture/embracing-functional-agricultural-biodiversity-to-tap-into-nature-s-services/>

Short-term Outcomes: Significant knowledge and skill increases in CBC practices, the ecological services provided by beneficial insects, the selection of appropriate insectary plants, and increased awareness of the location of local resources to support agro-ecology in E and W Oregon

Impacts: For Low Risk Christmas Tree IPM Adoption: 50% of Christmas Tree farmers used on-line weather forecasts to determine spray timing; 79% adjusted spray timing based upon the weather; 58% adjusted applications to protect sensitive sites; 83% of farmers increased scouting for pests; 30% of farmers used less chlorpyrifos; and 48% of farmers reduced aphicide use.

Area addressed: IPM in Schools

Activity: Build School IPM Coordinators' and Grounds Staff's Capacity to Implement IPM and Train School Staff by 1) *Conducting one demonstration plot on school grounds to support annual turf and landscape IPM training and 2) Train IPM Coordinators (IPMCs) from K-12 public school districts and grounds leads at annual turf and landscape workshops.*

Outputs: Key school IPM coordinator/grounds leads were surveyed to determine the 10 plant types to be used in the demonstration plot. Survey respondents were educated about characteristics of 16 plants, which included a discussion and Q&A, then asked to pick their favorite 5. Respondents were given the opportunity to add plants to the list. It was decided to establish two demonstration plots on OSU property that have characteristics similar to typical school grounds. Factors being evaluated include the establishment rate, drought tolerance, weed suppression, mowing tolerance, and visual quality of various ground covers and grasses in a low maintenance situation. Visual quality and uniformity ratings are being done by grounds staff, at least biannually.

The workshop took place in August, 2016. There were 55 participants from 23 school districts and two community colleges. Participants assessed the factors mentioned above and received training on sustainable IPM for school grounds and IPM for annual bluegrass within sports fields from the OSU Turf team.

Short-term Outcomes: The 10 plants chosen were: Creeping red fescue (*Festuca rubra L. ssp rubra*), Chewings fescue (*Festuca rubra L. spp. commutata*), Colonial bentgrass (*Agrostis tenuis Sibth*), Dwarf periwinkle (*Vinca minor*), Bearberry cotoneaster (*Cotoneaster dammeri*), Wintercreeper (*Euonymus fortunei*), Creeping juniper (*Juniperus horizontalis*), Green carpet (*Herniaria glabra*), Caucasian stonecrop (*Sedum spurium*), and Point reyes ceanothus (*Ceanothus gloriosus*). After data analysis from demonstration plots, differences in percent plant coverage and weed cover were observed. From May 2015 to January 2016, colonial bentgrass, chewings fescue, and strong red fescue had the highest percent of plant coverage among all ground covers (83%, 76% and 74%, respectively). The next closest ground cover was *Sedum spurium* which provided 51.8% ground cover. From there the plants drop off in plant coverage, and increase in weed coverage.

At workshop event evaluation results: 38 of the participants responded. 100% learned new things they will put into practice at their schools.

Impacts: to reported at conclusion of grant

List any grants, contracts, and/or other resources obtained by one or more project members as a result of the project's activities. Include the recipients, funding source, amount awarded and term if applicable:

2014- 2016	Pesticide Stewardship Program Technical Assistance Program, Halbleib, M.L., Jepson, P.C.	<i>Enabling IPM transitions in Christmas Trees</i>	49,278
2016- 2018	Western SARE, Halbleib, M., Jepson, P.C., & 7 others	<i>Redefining learner-centered education to build high impact IPM partnerships</i>	67,802
2016- 2017	Pesticide Stewardship Program Technical Assistance Program, Hilton, R., Jepson, P.C., Halbleib, M., Coop, L.	<i>Pesticide management decision support education</i>	40,854
2016- 2017	Pesticide Stewardship Program Technical Assistance Program, Ellen G., Jepson, P.C., Halbleib, M	<i>Biological Christmas tree pest management</i>	25,170

Publications:

Donald, C.E., Scott, R.P., Blaustein, K., Halbleib, M.L., Sarr, M., Jepson, P.C., Anderson, K.A. (2016) Silicone wristbands detect individual pesticide exposures in West Africa. *Royal Society Open Science*, Published 17th August, 2016: DOI: 10.1098/rsos.160433

Gould, M., A. Kowalewski, J. Lambrinos and T. Stock. 2016. "Low-maintenance ground covers for Oregon schools". *Digger magazine* July 2016.

Gould, M., A. Kowalewski, T. Stock, and J. Lambrinos. 2016. 2016. Low Maintenance Ground Covers for Pacific Northwest Municipalities. Peer-reviewed abstract. ASA-CSSA-SSSA International Meeting. Phoenix, AZ. November 7, 2016. Phoenix, AZ.

Halbleib, M.L., Jepson, P.C. (2016) Adaptive, learner-centered education: a toolkit for extension. EM 9144, Oregon State Extension Service.

WERA-1017 2016-17 Utah State Report

Marion Murray and Diane Alston, Utah State University (USU)

ANNUAL REPORT

1st Area Addressed: **IPM in Specialty Crops (fruit, vegetable, nursery)**

Activity Outputs and Short-term Outcomes:

- IPM Advisories (free e-mail newsletters with advice on pest activity and IPM recommendations tailored to commercial and home garden producers)
 - Fruits, Vegetables, Landscape Ornamentals, Turf (25 advisories delivered in 2016)
 - Subscriptions (as of July 2017): 10,210 for fruit, 9,630 for vegetable, 6,680 for landscape, and 6,560 for turf
 - Subscription rates are up from July 2016 by 23 and 20% for fruit and vegetable advisories, respectively
 - Content: scouting by IPM staff and volunteers; reports from growers
 - 375 archived advisories (since 2003)

- Updated advisory format to a blog style to make it more user-friendly (<https://pestadvisories.usu.edu/>)
- Utah TRAPs (Temperature Resource and Alerts for Pests, a web and mobile app pest management tool)
 - Access to 77 weather stations (added 1 new orchard weather station in 2016)
 - 12 insect and disease models (fruit, ornamental, field crops; added 1 new pest model in 2016)
 - Funding: grants, grower support, collaboration with the Utah Climate Center
- Utah Pests Quarterly Newsletter
 - 4 issues published in 2016
 - Updated the newsletter format
 - 7,800 newsletter subscribers
 - Content includes current pest management information for specialty and field crops, commercial and home landscapes, and community and home gardens; invasive pest updates, guest-authored articles, quarterly photos, and national IPM updates
- 2016 Vegetable Production Guide
 - 9 USU authors in 4 disciplines
 - 11 chapters: Cucurbits, Brassicas, Solanaceous, Sweet corn, Onion, covering production issues, soil/nutrient/water management, IPM, and pesticide safety
 - Funding: Specialty Crop Block Grant and USU Extension
 - 450 copies distributed to growers, plus free PDF available on IPM website
 - Interactive guide website developed in 2016 (<http://vegetableguide.usu.edu/>)
- Invasive Fruit Pest Guide
 - 5 authors from USU and Utah Department of Agriculture and Food covering brown rot, plum pox virus, spotted wing drosophila, brown marmorated stink bug, plum curculio, velvet longhorned beetle, and Japanese beetle
 - Funding: Specialty Crop Block Grant
 - 700 copies distributed to growers and for sale on USU Extension website, plus free PDF available on IPM website
- Intermountain Tree Fruit Production Guide (<http://intermountainfruit.org/>), collaborative guide with USU, Colorado State University, and University of Idaho
 - New pesticide recommendation tables tied to database to allow for automatic updates
 - Added customized pesticide search where results show mode of action and pollinator/beneficial toxicity ratings
- Fruit PestFinder Mobile App (free app for fruit Pest identification and IPM recommendations; Android and Apple platforms)
 - Updates include addition of conventional and organic product listings for both commercial and residential users
- Greenhouse Biocontrol Guide
 - A greenhouse guide to beneficial arthropods and the pests they target was developed in 2016-17 (<https://utahpests.usu.edu/files/pubs/greenhousebio-USU.pdf>)
 - Funding: Utah Department of Agriculture USDA Specialty Crop Block Grant
- New Fact Sheets on Specialty Crop Pests
 - 3 new fact sheets in 2016-17: brown marmorated stink bug in Utah, spider mites in raspberry, and caterpillar pests of brassica vegetables
- Refereed Research Publications
 - 4 research articles in 2016-17 on fruit and vegetable IPM

- Leveraged Grant Funding
 - \$292,805 in leveraged grant funding on specialty crop pest management
 - \$473,636 in pending grant funding for future IPM research and extension programming
- New and Emerging Pests
 - Pear sawfly, *Hoplocampa brevis* found in commercial and backyard sites south of Salt Lake City, native to Iran and Europe
 - Sequoia pitch moth, *Synanthedon sequoiae*: killing pines in Salt Lake City area, more severe of a pest than in the past
- 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)
 - Evaluating low-toxicity insecticides (diamides) for control of western cherry fruit fly
 - Testing a new codling moth biofix option based on site latitude and elevation vs. first trap capture of the season by field-checking this insects' phenology in Utah
 - Evaluation of the influence of potassium fertilizer sources and rates in bulb onion on attraction of plants to onion thrips and spread of Iris yellow spot virus
 - Evaluation of biochar for enhanced vegetable production (tomato and melon) and protection from root-rotting pathogens
 - Survey of vegetable crops for new and emerging pathogen and arthropod pests

Impacts:

- Utah TRAPs website and Advisories (fall 2016 survey with 18% response rate; next survey scheduled for fall 2018)
 - 100% plan to continue subscription
 - 87% use Utah TRAPs and advisories as main pest management resources
 - Changes in IPM practices since 2014:
 - the number of people that carefully monitor for pests increased by 23%
 - the number that hang pheromone traps increased by 40%
 - the use of degree day tools increased by 10%
 - the number of people that spray during bloom decreased by 18%
 - the number of people reporting greater yields by following the advisory recommendations increased by 3%
 - the number of people reporting that they use *fewer* broad-spectrum pesticides increased by 7%
 - IPM self-assessment since 2014:
 - For commercial fruit and vegetable 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%).
 - Economic impact:
 - Although pesticide costs are increasing, 18% of commercial specialty crop growers in the 2016 IPM advisories survey reported an increase in profits (78% reported no change) Utah TRAPs app:
 - A survey of app users shows that the app is helping 93% of users to improve their pest management practices due to improved timing.

2nd Area Addressed: **IPM in Communities (landscape, market and home garden)**

Activity Outputs and Short-term Outcomes:

- Community gardens, small acreage farms, organic farms, municipal landscapes

- 15 presentations to community stakeholders
- Over 75 organic producers, 25 extension agents, and 500 community stakeholders received training in IPM practices for small-scale farm and garden production
- Conducted 4 workshops to train Master Gardeners in IPM and early detection of invasive pests (First Detector Training)
- 19 call-in radio programs included IPM and sustainable pest management information
- 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 provides extensive input into conference planning and implementation; four IPM presentations were delivered reaching nearly 100 small acreage stakeholders; a hands-on IPM training session in February 2017 targeted beginning and organic small farm producers
- Interpretative IPM signage
 - Two interpretative IPM signs were deployed at key public garden facilities in 2016: Utah State University Botanical Center in Kaysville, and Wheeler Historic Farm in Salt Lake City
 - Signs were positioned near gardens demonstrating IPM techniques
 - Official visitation numbers are not available, but each site receives an estimated 50-200 visitors per weekend during the growing season
 - In collaboration with the Cooperative Agricultural Pest Survey Program, a new interpretative sign is under development that teaches about how humans help spread invasive species
 - The invasive species interpretative sign will be placed in the same two garden locations as the IPM sign by fall 2017, and perhaps in an additional community garden site

Impacts:

- For the commercial green industry subscribers, those that described themselves as “no IPM” decreased by 63% from 2014 to 2016 (11% to 4%). Those that considered themselves “high IPM” practitioners increased by 33% (6% to 8%).
- Reduction in overall pesticide use due to education on IPM alternatives to prevent and reduce pest pressure
- Change in selection of broad-spectrum, higher toxicity pesticides to those with narrower-spectrum, lower toxicity
- Conservation of beneficial arthropods that assist with biological control
- Education of organic producers in IPM techniques, e.g., preventive pest tactics to reduce application of organic pesticides
- Education of youth and novice stakeholders in IPM practices
- Greater awareness of the IPM concept and how it can help improve community horticulture

3rd Area Addressed: **School IPM**

Activity Outputs and Short-term Outcomes:

- Helping public and private schools transition to IPM to meet Utah’s “IPM in Schools” state law
- Pest ID Handbook (print and website) in collaboration with Colorado State University (<http://utahpests.usu.edu/schoolipm/pest-id-guide/index>)
- 9 hands-on IPM training sessions for school personnel, applicators, and Utah Department of Health inspectors were conducted during 2016
- 16 Utah Pest Press fact sheets on indoor and structural pests are now available in English and Spanish languages for use in School IPM training (<http://utahpests.usu.edu/schoolipm/fact-sheets>)

Impacts:

- 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

4th Area Addressed: **IPM in Agricultural Crops (field and forage crops)**

- IPM Tools to Manage Townsend's Ground Squirrels (*Spermophilus townsendii mollis*) in Irrigated Crop Ground was a 3-year project funded jointly by USU IPM Program and Western Sustainable Agriculture and Education (WSARE). The award recipient was agriculture agent in Beaver County, Utah.
 - Results showed that tube traps were most effective in reducing populations; treating ground squirrel burrows earlier than conventional methods was more successful; early treatment with cabbage + zinc phosphide was most effective
 - Presented results at the 2017 Beaver County crop school (90 participants); 2016 Pesticide Training in Richfield, Utah (120 participants); 2017 IFA Crop School in Cedar City (54 participants); plans to present at the 2018 Vertebrate Pest Conference in Northern California.
- Impacts:
 - Commercial producers were trained in effective trapping practices for a tenacious pest of alfalfa, the Townsend's ground squirrel
 - Education of novice stakeholders in IPM practices

PRIMARY LINKAGES INTERNAL TO WERA 1017

- Publication collaborations
 - Intermountain Tree Fruit Production Guide (intermountainfruit.org), collaborative guide with Utah State University, Colorado State University, and University of Idaho
 - School IPM Pest ID Handbook (print and website), collaboration with Colorado State University
- Applied research collaboration
 - Survey of potential wild fruit hosts for spotted wing drosophila (collaboration with University of Idaho)
- 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 monthly conference calls in 2016-17 and will attend the Western Pesticide Risk Reduction Project Workshop held in conjunction with the WERA-1017 meeting in July, 2017, in Irvine, CA

PRIMARY LINKAGES TO EXTERNAL GROUPS

- Community IPM:
 - Strong collaborations with multiple county-based extension faculty in Cache, Davis and Salt Lake Counties (organic stakeholder trainings, IPM and invasive pest interpretative signs in public gardens, biochar research project)
 - Non-profit community garden organizations (staff and public training, pest monitoring sites)
- School IPM:
 - The USU School IPM Associate coordinates and collaborates with the Utah School IPM Coalition, school district administrators, and the Utah Department of Health to provide

training and outreach education products to stimulate implementation of IPM in Utah's schools

- Invasive pest survey: strong collaborations between the Utah IPM Program and the Utah Cooperative Agricultural Pest Survey Program, responsible for surveillance of invasive pests in the state; we co-organize extension in-service and public stakeholder trainings and co-produce outreach publications (e.g., Utah Fruit Invasive Pest Guide, invasive pest interpretative sign)
- Utah Plant Pest Diagnostic Lab (UPPDL): the IPM Program coordinates with the UPPDL on diagnostics, trainings, development of IPM recommendations, and outreach publications (many fact sheets, the quarterly Utah Pests newsletter, and other extension publications and online content are co-produced by staff from the IPM Program and UPPDL)
- Utah Department of Agriculture and Food: the Utah IPM Program coordinates and collaborates on numerous diagnostic and training activities each year, e.g., accurate identification of Sequoia pitch moth, pesticide applicator training workshops, etc.
- USDA Natural Resources Conservation Service (NRCS): the Utah IPM Program coordinates and collaborates with Utah NRCS field agronomists on outreach training sessions, such as vegetable grower twilight meetings and the Utah Tree Fruit Tour

GRANTS

USDA NIFA Specialty Crop Research Initiative (PD: Jim Walgenbach, North Carolina State University)
Alston, D. (PI) and L. Spears (\$122,380 for USU)
Management of brown marmorated stink bug in U.S. specialty crops
Sep 2016 – Aug 2021

Utah Department of Agriculture and Food – Utah Specialty Crop Block Grant Program
Alston, D. (PI) and M. Murray (\$25,425)
Improving codling moth management by getting a better Biofix
Jan 2016 – Jun 2018

USU Extension Grant Program
Murray, M. (\$10,000)
Improving delivery of pest management recommendations for Utah fruit growers
June 30, 2016 – July 1, 2017.

Utah Agricultural Experiment Station Seed Grant Program
Alston, D. (PI) and L. Spears (\$55,000)
Brown marmorated stink bug: plant host utilization in diverse urban-agricultural landscapes and promoting biological control
May 2016 – May 2018

USDA iPIPE
Spears, L., C. Nischwitz, and D. Alston (\$80,000)
Utah iPIPE vegetable pest program
April 1, 2017 – February 29, 2019

USDA NIFA CPPM EIP
Murray, M (PI) and D. Alston (\$439,489)
Coordinating IPM successes in Utah's crops, communities and schools
October 1, 2017 – September 30, 2020 (Pending)

Utah Department of Agriculture and Food – Utah Specialty Crop Block Grant Program
Alston, D. (PI) and L. Spears (\$34,137)
Brown marmorated stink bug: new invasive pest in Utah’s fruit industry
October 1, 2017 – September 30, 2020 (Pending)

PUBLICATIONS

Journal Articles (Peer-reviewed)

Tebeau, A. S., D. G. Alston, C. Ransom, J. Reeve, and C. M. Culumber. 2017. Effects of floor vegetation and fertility management on weed biomass and diversity in organic peach orchards. *Weed Technology* 31(3):404-415.

Buckland, K. R., D. G. Alston, J. R. Reeve, C. Nischwitz and D. Drost. 2017. Trap crops in onion to reduce onion thrips and *Iris yellow spot virus*. *Southwestern Entomologist* 42(1): 73-90.

Hunter, B., G. Cardon, S. Olsen, D. Alston and D McAvoy. 2017. Preliminary screening of the effect of biochar properties and soil incorporation rate on lettuce growth to guide research and educate the public through extension. *Journal of Agricultural Extension and Rural Development* 9(1): 1-4.

Reeve, J., M. Culumber, B. Black, C. Ransom, A. Tebeau and D. Alston. 2017. Establishing organic and integrated peach orchards in Utah. *Scientia Horticulturae* 214: 242-251.

Extension Book (Peer-reviewed)

Murray, M. 2017. Greenhouse biocontrol in Utah: beneficial insects and the pests they target. Utah State University Extension IPM Program, Logan UT (94 pp.)
<https://utahpests.usu.edu/files/pubs/greenhousebio-USU.pdf>

Extension Fact Sheets (<http://utahpests.usu.edu/factsheets/index>)

Holthouse, M. C., D. G. Alston, L. R. Spears, and E. Petrizzo. 2017. Brown marmorated stink bug in Utah. ENT-144-17. Utah State University Extension and Utah Plant Pest Diagnostic Laboratory, Logan, UT (8 pp.).
http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=2785&context=extension_curall

Alston, D. 2017. Spider mites in raspberry. ENT-183-17. Utah State University Extension and Utah Plant Pest Diagnostic Laboratory, Logan, UT (3 pp.).
http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=2769&context=extension_curall

Cannon, C., B. Bunn, D. Alston, and M. Murray. 2016. Caterpillar pests of brassica vegetables. ENT-181-16. Utah State University Extension and Utah Plant Pest Diagnostic Laboratory, Logan, UT (6 pp.).
http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=2617&context=extension_curall

Extension Newsletters (<http://utahpests.usu.edu/utah-pest-news/index>)

Utah Pests News quarterly newsletter, M. Murray and C. Cannon, editors

- Four issues annually (fall, summer, spring, winter)
- Articles on timely pest management topics with great emphasis on the practice of IPM
- The newsletter has 7,800 subscribers (as of July 2017), and is distributed to the national USDA pest managers listserv

WERA report 2017 Wyoming WERA-1017 IPM Accomplishments Report

Scott Schell
Community and Production IPM

University of Wyoming Extension Entomology Accomplishments (also known as “Outputs”) by calendar date and type for the requested period of 1July2016 – 30Jun2017 (Area Addressed in Bold)

Production Agriculture IPM Helped organize and also presented at the 13th annual Entomology Public Health IPM Organized, promoted, and presented a larval mosquito IPM Training course in conjunction with City of Laramie and the Wyoming Department of Health for mosquito abatement personnel on May 24-25, 2016 in Laramie for 18 attendees.

Community IPM Presented a FE Warren AFB kids program 19JUL2016 over 40 children attended. Cheyenne, WY.

Community IPM “Mothing Event” event for the Biodiversity Institute held 25JUL2016. Laramie Train Depot Park. Over 100 people attended.

Community IPM Advanced Master Gardener training for Leroy Jons on 10AUG2016 for 8 students in Wheatland, Wyoming.

Community IPM Presented at the USDA-APHIS_PPQ CAPS’ D.A.R.T. meeting 25AUG2016 for 22 people. Pinedale, WY.

Community IPM Provided entomology station at Laramie Rivers Conservation District Program (LRCD) at Curt Gowdy State Park September 7th and 8th 2016 for approximately 120 children –(5th through 8th grade) All day, both days.

Community IPM LRCD Program September 13th, 2016 at Table of the Wilderness above Centennial for a Insects (3rd and 4th graders) approximately 140 children - all day). outside of Centennial, WY.

Community IPM LRCD Program September 22nd, 2016 at Curt Gowdy SP for Insect Habitat (1st graders, approximately 30).

Public Health IPM Attended and presented at the Wyoming Mosquito Management Meeting 27 and 28 Sep2016 on “Zika Virus, the Known and Unknown” for 50 people. Thermopolis, Wyoming.

Production Agriculture IPM Cattle Parasite IPM meeting Albany County Extension Office in Laramie, 2 to 4PM, WY 29Sep2016 for 11 people. Albany Co. Fairgrounds bldg.

Production Agriculture IPM Extension Entomology Update at the Weed & Pest fall conference Cody WY Nov. 1 –Nov. 3, 2016 for approximately 60 people. Cody, WY.

Production Agriculture IPM SE Wyoming Beef Production Convention November 22, 2016 Torrington, Wyoming Cattle Lice IPM - 15 people. Torrington, WY.

Production Agriculture IPM Progressive Rancher Forum presentation in Casper, WY 5 DEC2016 “Cattle Parasite Issues” for 12 people in the audience. Casper, WY.

Public Health IPM Commercial Pesticide Applicators Certification Course, Household and Institutional Pests subject matter, December 13th, 2016 3:45-5:15 PM. Albany County Fairgrounds for approx. 60 people in Laramie, WY.

Production Agriculture IPM Attended and chaired the National Grasshopper Management Board meeting held on Feb. 6-8, 2017 Denver, CO

Community IPM Presented Master Gardener program basic 3 hour introduction to entomology trainings at: Cheyenne, WY 15Feb2017 for 14 people; 18Feb2017 in Laramie, WY for 9 people; 4Apr2017 in Wheatland, WY for 12 people; 6Apr2017 in Gillette, WY for 14 people.

Production Agriculture IPM Presented at Commercial Pesticide applicator license training course in Farson, WY on insect identification resources for 30 people on 6Jun2017

Community Events: Community IPM

Attended a booth and presented at the Lander Valley Garden Expo in Lander WY 8Apr2017, approximately 30 people attended 45 minute presentation on garden pest IPM. Estimated 1000 people attended the event in total.

Attended a display table at the Laramie Rivers Conservation District Expo held in Laramie, WY on 15Apr2017. Estimated 200 people attended the event.

Manned an information and display table at the WY Territorial Park, Laramie, on Apr. 22, 2017 (Over 600 people attended the event, I had an estimated 300 people stop by my exhibits

Entomology activity for a Cub Scout day camp held Burlington, WY for approx. 120 youth on 17Jun2017

Webinar: Community IPM

Plants, Pests and Pathogens webinar for Wyoming Master Gardener programs. Laramie, WY. July 27, August 24, and September 14, 2016 with Hilgert, C, K. Panter, W. Stump, and A. Latchininsky

Outcomes for our “Outputs”

With some activities there is no opportunity to measure “Outcomes”. However, one can safely assume that exposure to IPM training will result in some increase in knowledge versus no exposure at all. This is a positive result. With the Master Gardener basic training activities there is post course evaluation and there is universal positive feedback that our entomology training is useful and pertinent to the students. Community and youth activities provide a way to reach an audience that may not know anything about insects and help provide them with fact based basis to form their future outlook on insects and pest management.

Publications:

Schell, S.P., 2016. Large-Scale Grasshopper Infestations on North American Rangeland and Crops. In: Shroder, J.F., Sivanpillai, R. (Eds.), Biological and Environmental Hazards, Risks, and Disasters. Elsevier, pp. 45–61. 2016.

“Promoting Pollinators on Your Place – A Wyoming Guide” by Jennifer S. Thompson; Scott P. Schell; Jacelyn Downey; and Jeffrey Michael Edwards University of Wyoming Extension Publication, 2017.

Integrated Pest Management Helps Control Cattle Lice. Scott Schell and Dr.Derek Scasta. Wyoming Livestock Roundup Vol. 28, No. 32 Dec. 10, 2016 Page 4 2016.

“Don’t let parasites vex your chickens” Scott Schell Barnyards & Backyards Feb. 19, 2017

Jeff Edwards

Pesticide applicator training

Date	Event	Location
12/15/2016	Initial Training For Commercial Applicators	Laramie
January-March 2017	Private Applicator Training	8 Educators running training programs at approximately 20 locations statewide
31-May-17	Weed and Pest Seasonal Worker Training	Gillette
31-May-17	Weed and Pest Seasonal Worker Training	Wheatland
6-Jun-17	Weed and Pest Seasonal Worker Training	Farson
7-Jun-17	Weed and Pest Seasonal Worker Training	Riverton

Integrated pest management is included in all core training material for the Pesticide applicator training program

John Connett

Wyoming school IPM

Web <http://www.uwyo.edu/IPM>

- Conducted School Integrated Pest Management (IPM) and pest prevention training workshops and seminars for school facilities operators, county and state employees, groundskeepers, and pesticide applicators
- Presented School IPM training portion of the UW Entomology Short Course
- Cooperated with national and regional IPM coordinators, Colorado IPM Coalition, WDA, and EPA to establish IPM in and around facilities
- Wrote technical bulletins for IPM around schools pertaining to mice, bedbugs, turf management, filth flies that include only safe options that are focused on prevention
- Conducted integrated pest management inspections and evaluations of school facilities
- Contributed to the biannual Wind River Tribal Health Fair
- Assisted with IPM program grant writing and budgeting
- Redesigned and maintained robust website for Wyoming School IPM material
- Taught the use of PICOL (Pesticide Information Center Online) for schools
- Continued to develop chapters for a Wyoming School IPM Handbook
- Edited new training material for the core manual for Wyoming State Pesticide Applicators manual
- Provided phone and email IPM support for various school district, pest control contractor, and Wyoming health department personnel
- Vetted training materials for the “IPestManager” School IPM resource database
- Cooperating on a grant with Dawn Gouge University of Arizona and Janet Hurley of Texas A&M and will assist in developing national SIPM rodent control training if the grant is funded

- Participating in the School IPM 2020 Steering Committee and the Western School IPM Working Group
- Wyoming designate for the WERA1017 (Western Region Multi-state IPM team) meetings
- Strategizing with Western School IPM Working Group to implement and assist with the statewide distance delivery in Wyoming of “Stop School Pests” - A National IPM Standard Training and Certificate Program for learning lessons for all school community stakeholder groups including: school administrators, facility managers, pest management professionals/school IPM coordinators, landscape and grounds staff, custodians, maintenance staff, nurses, food service staff and teachers
- Working with local school district personnel on ways to improve their IPM practices
- The ongoing mouse IPM program that we established in UW, College of Agriculture, Plant Science department has been successful and very well received for over one year
- Working with the Wyoming Athletics Landscaping and Facilities to develop an IPM program for their fields and areas adjacent to facilities including, safe, legal, cost saving, and sustainable solutions for weed and pest management
- Training bulletins relating IPM strategies at schools for yellow jackets, paper wasps, and voles are in progress
- Several schools have expressed interest in me providing some training to the custodian and school nurses and I plan to utilize the Stop School Pests IPM training materials and PowerPoints.
Link to Stop School Pests <https://cals.arizona.edu/apmc/StopSchoolPests.html>
- Wyoming school IPM outreach, training and acceptance is still moving in a positive direction. We have districts adopting more IPM practices. Five of the largest districts endeavor to not use any pesticides when there are non-pesticide alternative solutions. A recent mouse infestation in an elementary school problem was solved by following the basics of clean up, reducing clutter and exclusion. The district followed their IPM policy and the student’s health was at the top of priorities when the problem was discovered. As with most issues, we trained the maintenance staff and teachers how to prevent and monitor more successfully.
- There is an increase in the number of districts calling to find out the safest way to deal with issues. The increase in calls is partly due to school IPM training that has recently been incorporated into training for pesticide applicators, teachers, and extension personnel. There also seems to be an increasing awareness of IPM through synergy with social media of Wyoming land management agencies.
- Two key points to current pest management in Wyoming are our school setting and budget. The setting for our schools is generally less pests, and cleaner schools than in the more populated areas of the United States.
The budget for the state is in a crisis. This is another reason that school personnel reach out for help with pest issues. School and municipal budgets have been cut drastically. Wyoming state school districts had their budget reduced by \$34 million. The budgets for maintenance are also running out. Link to budget news <http://wyomingpublicmedia.org/term/budget-cuts>
The University budget (only one university in WY) is also hit hard with \$40 million less this year and 369 less jobs. <https://www.insidehighered.com/quicktakes/2017/05/15/37-jobs-will-be-eliminated-university-wyoming>
After a recent visits with a school districts about bedbugs we were able to share the StopPests program with them to solve issues at public assisted housing. <http://www.stoppests.org/>
In our future school IPM workshops, We will continue to make sure participants are aware of the Stop School Pests program that has free IPM certification for all school community stakeholder groups including school administrators, facility managers, pest management professionals/school IPM coordinators, landscape and grounds staff, custodians, maintenance staff, nurses, food service staff, and teachers.
<http://articles.extension.org/pages/73468/self-paced-learning-page-for-urban-ipm>
We are planning a survey of all districts that will elucidate how well IPM has been taught, received and implemented around the state since our first survey in November 2009.
We are also planning to design IPM infographics for use in training and content development.
Potential Infographic IPM Topics include:
IPM & Sanitation, IPM reducing pesticide exposure, IPM & what it is, Benefits of IPM, Steps to IPM, Key components of IPM, Pest Identification, IPM & prevention, Types of Monitoring in IPM & importance of Monitoring, Control Options with IPM, Preventative Control, Mechanical Control, Cultural Control, Chemical Control, Biological Control, Repellants in IPM, Weed life cycles and biology in IPM, Insect life cycles and

biology in IPM, Disease life cycles and biology in IPM, Pesticide formulations in IPM, Least toxic applications explained, Exclusion of Pests, Sealing, Perimeter strategies, Inspection, Maintenance, Plants at 2 feet from buildings, Grow turf varieties that are very competitive, Irrigation or mowing for the most competitive turf, Keep all structural wood at least 12 inches above the soil, Repairing water leaks in plumbing and gutters, Vacuums big & small in IPM, Clutter and pest harborage, Prevent weeds and weed seeds, Check incoming product to avoid introducing pests and eggs, Store boxes off the floor and away from wall, Lighting around facilities, Education of building occupants, Action thresholds, Importance of recordkeeping in IPM, Trapping, Maps, Notification, Signs, Evaluation of IPM, IPM forms, IPM resources.

Brian Mealor

Area addressed: Rangelands and Natural Ecosystems

Activities: Wyoming Restoration Challenge (Educational demonstration of integrated management and restoration of cheatgrass)

Outputs:

- 1 poster at the International Society for Range Management Annual Meeting
- Ongoing Facebook posts to 130+ followers
- 3 popular press media articles
- 1 Ag Experiment Station bulletin
- 4 presentations regarding integrated management and restoration around WY

Short-term Outcomes: Increased awareness of the issue of invasive annual grass management, managers responsible for 5 counties in WY gained hands-on experience attempting to restore cheatgrass-dominated rangeland with multiple methods

Impacts: additional outreach materials being developed currently that will broaden the reach of the project

Area addressed: Rangelands and Natural Ecosystems

Activities: Northeast Wyoming Invasive Grasses Working Group (fill a primary role in the organization dedicated to Early Detection/Rapid Response program for 2 new invasive grasses in the region (medusahead and ventenata))

Outputs:

- 13 presentations in a variety of venues with >400 people reached directly
- Developed invasive grass field identification guide and distributed >400 hard copies and unknown number online
- Developed fact sheet about species impacts and how to report infestations, which was distributed to >1000 people including ALL BLM grazing permittees in Buffalo Field Office and ALL recipients of multiple conservation district newsletters
- Developed educational materials for "boot brush stations" on high-traffic, publicly-accessible state lands in the target area
- Contributed to, or was interviewed for, news and popular press publications (8)
- Hosted a medusahead and ventenata field tour and workshop with 90+ attendees from 5 states

Outcomes:

- Increased awareness of both species in the state and region, with multiple new reports of populations from landowners in the area responding to our outreach program
- Implementation of survey and mapping program in focus geography
- Targeted areas were treated with herbicide fall 2016 and monitored for efficacy in 2017

Impacts:

- Strong collaborative group in place to develop strategy for these problematic invasive species
- Increased diligence in search and survey for these species in NE Wyoming and surrounding areas
- Outreach program contributing to an increased understanding of the distribution and severity of these species that will directly inform a management plan

Wyoming Agricultural Experiment Station 2017

http://www.uwyo.edu/uwexpstn/_files/docs/2017-field-days-bulletin.pdf

Derek Scasta

Cattle Lice IPM

Cattle Parasite Speciation, Prevalence, and Economic Loss Survey to Direct the Development of IPM Plan for Wyoming and Regional producers

Dan Tekiela

Cheatgrass IPM

IPM Implementation in Agronomic Crops - A Primary Priority-

Proper Integration of Bioherbicides Into an Invasive Annual Grass IPM Program

Randa Jabour

Promoting Pollinators and Alfalfa Weevil IPM

<https://academic.oup.com/jipm/article/3064074/Ecology-and-Management-of-the-Alfalfa-Weevil>