

Western IPM Center Project Report Form

How to submit: Please submit this completed form electronically, as an attached Microsoft Word file, to Frank Zalom at fgzalom@ucdavis.edu. **Content:** Complete each section below, and include responses to as many of the questions listed in Attachment A as are relevant to your project. *These are guidelines.* Provide your readers with enough detail that someone who is not familiar with your project can understand what you were trying to achieve, how you went about it, and what you accomplished, but please keep it concise.

A. Report Data

Date: November 2, 2009

Reporting Period: October 2008 to October 2009

Report Type (please check one):

Progress Report Final Report

B. Grant Data

- Grant Agreement #: 2007-34103-18579
- Title: Integrated Management of Mite Pests and Powdery Mildew Diseases on Perennial Hosts
- Grant Type: UNITED STATES DEPARTMENT OF AGRICULTURE
- COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE; Western Region IPM.
- Lead investigator:
 - Name: Dr. Glenn C. Fisher
 - Title: Extension Entomologist and Professor
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- Team members (name, title, institution):
- Amy J. Dreves, Faculty Research Associate-Entomologist, Oregon State University,
- David H. Gent, USDA-ARS, Forage Seed and Cereal Research Unit; Plant Pathologist
- Vaughn M. Walton, Assistant Professor, Oregon State University,
- and David G. James, Associate Professor, Washington State University
- State(s) involved: Oregon and Washington

C. Nontechnical Summary. An overview of the project, briefly outlining the problem(s), how your project addresses them, and your results, *written to a lay audience*. (500 words)

Integration of powdery mildew control on hops and grapevines with biocontrol of spider mite pests (*Tetranychus urticae* and *Eotetranychus willamettei*) on these crops is difficult because sulfur fungicides are toxic to certain predatory mites and may enhance dispersal of spider mites. Developing IPM strategies for these pests is further complicated by the recent discovery of two new eriophyid mites species in Pacific Northwest grapes, the grape leaf rust mite (*Calepitrimerus vitis*) and the grape bud mite (*Colomerus vitis*), that cause leaf and shoot distortions, retarded growth in emerging green tissue, and crop losses, and are described as short shoot syndrome (SSS). This Research and Extension project seeks to improve management of spider mites, eriophyid mite pests and powdery mildew diseases on perennial crops by enhancing our understanding of how sulfur applications for powdery mildew control influence suppression and disruption of conservation biological control of mites, and developing IPM strategies that maximize biological control of mites and powdery mildew control. Two additional treatments were added to the grape trials which included using traps to detect and quantify airborne powdery mildew inoculum to better time fungicide applications. These results will be incorporated into investigations on reducing sulfur use to improve beneficial insect populations in the vineyard.

D. Objectives and Progress. List your objectives and describe your progress for each objective.

This research seeks to advance IPM for hop and grape pests listed above by:

1. Identifying 'beneficials' associated with mite pests on grapevines and hops;
2. Quantifying the effects of direct and indirect exposure to sulfur residues on mortality, fecundity and longevity of beneficial mites that regulate eriophyid and spider mite pests on grapevine and hops;
3. Identifying the phenology of predatory and pest mite population dynamics in vineyards and hop yards in relation to the number and timing of sulfur applications; and
4. Transferring knowledge and IPM systems developed in this project to stakeholders through established public-private partnerships by extension bulletins, electronic formats, trade publications, and annual meetings.

Progress:

- Monitored and characterized pest and predatory mite abundance and diversity in six commercial hop yards and experimental plots and two grape vineyards. Dominant species in hop yards appear to be *Anystis* spp., *Neoseiulus fallacies*, and *Galendroms occidentalis*. Dominant species in grape vineyards appear to be *Anystis* spp. and *Typhlodromus pyri*. A complex of other predators (e.g., Coccinellids, predatory bugs, and spiders) appear to have a major role in spider mite regulation in hop yards and pest reduction in grape vineyards.
- Initiated lab bioassays to quantify the effects of direct and indirect exposure to sulfur on spider mites, and documented that fecundity is affected by the spider mite developmental stage exposed to sulfur.
- Conducted Year 3 of sulfur timing studies in Oregon and Washington, verifying that sulfur timing is critical for maintaining predatory mites and maximizing conservation biological control of spider mites. In six location years of evaluation, sulfur applications made early in the season consistently were least disruptive to conservation biological control of spider mites. These results indicate that it is possible to integrate cost-effective powdery mildew management with biological control of spider mites.
- The phenology and population dynamics of arthropod pests and beneficial organisms were identified and quantified in hop yards and grape vineyards in relation to the timing of sulfur applications. During years 1 to 3, fungicide programs that exacerbate and suppress spider mite and eriophyid mites were identified. Indirect effects of sulfur on spider mite dispersal and fecundity were identified and quantified, and strategies were developed to integrate control of mite pests, powdery mildew, and maintain natural enemies to maximize conservation biological control. Also, the direct and indirect effects of fungicides were studied and mortality, fecundity, and longevity of beneficial phytoseiid mites were identified and quantified. Fungicide bioassay trials on the predatory mite, *Typhlodromus pyri*, are complete. Data on lethal and sub-lethal impact of six fungicides, at three concentrations (label rate, 1x and 2x) were collected. Data analysis is currently in progress. Strategies are being designed to integrate control of mite pests, powdery mildew, and maintain natural enemies to optimize conservation biological control.

• In addition, we clearly described the ‘syndrome’ known to grape growers in Oregon as Short Shoot Syndrome (SSS). By correct description and diagnosis, we were able to link *C. vitis* and *Col. vitis* to ‘Restricted Shoot Growth’ symptoms as described in other countries. Similar symptoms referred to as Short Shoot Syndrome are for the first time linked to *C. vitis* incidence in the sampled Oregon vineyards and confirm the relationship between SSS and *C. vitis* incidence first reported in Australian vineyards. Damage caused by feeding of *C. vitis* on young developing tissue appears to be responsible for SSS and its season-long consequences in Oregon vineyards. Through this work we now better understand the seasonal phenology of *C. vitis* on grapevines by observing mite development and fecundity under controlled and field conditions. Seasonal observations of grapevine phenology, mite pest populations, symptoms due to leaf infestations, and seasonal crop loss data was used to determine periods during the season when damage occurs and when mite populations are more susceptible to control. This information helps growers to more adequately time sprays and dramatically reduce crop losses due to mite infection. It is believed that optimal mite control is dependent on two factors. First, pest mite populations must come in contact with pesticides and this is enabled when bud tissue becomes less tightly packed during the wooly bud stage allowing for movement of mites out of the bud area and pesticides into these areas. Second, mite activity and movement to exposed plant parts start to take place during early spring.

E. Outputs. List your project’s outputs, which might include publications, information, data, meetings held, attendance at meetings held, etc.

Extensive extension activities were conducted during 2009 to continue transferring knowledge and IPM recommendations to stakeholders. Publications, presentations, reports, and other outreach activities are detailed below.

- Presentation: Gent, D. H. 2009. Interactions of fungicide programs and spider mite outbreaks. Oregon Hop Commission, Woodburn, Oregon, February 19, 2009. Approximately 30 in attendance.
- Survey data: Distributed and analyzed survey data on knowledge, awareness, and adoption of IPM practices by Pacific Northwest hop and grape producers.
- Field guide: D. Gent, J. Barbour, A.J. Dreves, D. James, R. Parker, and D. Walsh. First Edition, August 2009. Field Guide for Integrated Pest Management in Hops. Oregon State University, University of Idaho, USDA Agricultural Research Service, and Wash. State University.
- Refereed journal article: Walton, V.P., A.J. Dreves, L.B. Coop, G.V. Jones and P.A. Skinkis. Submitted July 2009. Developmental parameters and seasonal phenology of *Calepitrimerus vitis* (Nalepa 1905) (Acari: Eriophyidae) in wine grapes of Western Oregon. Environmental Entomology. In review.
- Refereed journal article: Gent, D.H., D.G. James, L.C. Wright, J.D. Barbour, A.J. Dreves, G.C. Fisher, and V.M. Walton. 2009. Effects of powdery mildew fungicide programs on twospotted spider mite (Acari: Tetranychidae), hop aphid (Homoptera: Aphididae), and their natural enemies in hop yards. J. Econ. Entomol.102(1): 274-286.
- Refereed Extension Bulletin: Walton V., P Skinkis, A. Dreves, C. Kaiser. March 2009. Grapevine Growth Distortions: A guide to identifying symptoms. Oregon State University Extension Bulletin (EM 8975-E), 7 pages, available online only:
<http://extension.oregonstate.edu/catalog/pdf/EM/EM8975-E.pdf>
- Poster presentation: April 2009. Gadino, A., V. Walton, and A.J. Dreves. Pacific Branch Entomology Society of America annual meeting (San Diego, CA), Impacts of six fungicides on the lethal and sub-lethal effects on *Typhlodromus pyri*.
- Field day workshop: July 2009. OSU Extension Vineyard Workshop (Vineyard, Willamette Valley, OR); A. Gadino oral presentation on, Initial results of fungicide bioassays on *T. pyri* and the implications of this information for vineyard spray programs. Over 100 growers attended.
- Field day workshop: July 2009. Dreves, A.J. and V. Walton. OSU Extension Vineyard Workshop (Vineyard, Willamette Valley, OR), oral presentation on Mite-associated and other factors causing short shoot syndrome in Oregon vineyards. Greater than 100 people attended workshop
- Pest management news: Walton V.M. and A. Dreves., A. Gadino. Vineyard Pest Management News update, 2009 (2 issues/year).

- Reporting meetings: Dreves, A.J. and V.M. Walton. Research updates presented at Willamette Valley Research & Technical Group Meetings to growers, vineyard managers, Oregon wine institute members, Oregon state extension and researchers, etc. (4 times/year).

<http://wine.oregonstate.edu/files/files/OSU%20Vineyard%20Pest%20Management%20Newsletter%20Winter%202009.pdf>

- Educational hands-on module: July 2009. Dreves, A.J. The Good, Bad, and the Ugly (natural enemies) in the vineyard, for OSU Vineyard Sustainability & Mechanization Summer Field Day at King Estate Vineyard, Eugene, OR.

- Educational field modules: August 2009. Dreves, A.J. and V. Walton. Presented educational field modules to growers on Mites, Mealybugs, and Leafhopper Management for Columbia Gorge Vineyard Field Day.

- Presentation: August 2009. Dreves, A.J. Presented talk on Life biology of the smallest of pests and 'beneficials' for a Garden Seminar Series in Eugene, OR. 43 attended talk.

- Presentation: April 2009. Dreves, A.J., V. Walton, G. Fisher, and P. Skinkis. Pacific Branch Entomology Society of America annual meeting (San Diego, CA), Mite-associated short shoot syndrome in Oregon vineyards. 35 attended talk

- Newsletter: October 2009. OSU Viticulture and Enology Newsletter is available to read and download online at <http://wine.oregonstate.edu/newsletter>.

F. Impacts and Potential Impacts. The "impacts" and "potential impacts" sections of your report will help the Western IPM Center highlight the value of IPM research and education by detailing the real-world impacts of Center-funded projects. We will use the information in news articles, reports, and informational brochures to showcase the impacts of projects that our program supports. *See Attachment A at end of form for questions to assist you in describing the impacts of your project.*

1. Impacts. Describe any impacts of your work. *Impacts* are specific changes in condition for those affected by your work. Impacts include adoption of technology, creation of jobs, reduced cost to the consumer, less pesticide exposure to farmers, access to more nutritious food, and a cleaner environment and healthier communities.

- The phenology and population dynamics of arthropod pests and natural enemies were identified and quantified in hop yards and vineyards in relation to the timing of sulfur applications. Multiple hop and grape producers have adopted the management recommendations developed in this work.

-We estimate annual savings of approx. \$500,000 statewide due to improved management techniques in grape vineyards. These figures are obtained by calculating an approx. 0.5% crop savings due to improved monitoring, modeling and control due to increased knowledge and extension activities.

- Numerous observations in grapes and other crops indicate that current guidelines for sulfur use may result in excess product being applied and that the rate can be reduced and the interval between applications can be lengthened. Reduction in the number of sulfur applications and/or rate of application would improve vineyard economics and sustainability without compromising mite or disease control.

-Treatments targeted at exposed and active pest mite populations in spring should result in lower in-season establishment and timed sprays mid-season should decrease potential overwintering populations, hence increasing yields and reducing pesticide use.

-Potential implications of seasonal predatory mite knowledge will be important for the development of fungicide spray regimes in vineyards by optimizing predatory mite populations, enhancing pest biological control, through wise compound choice and application timing.

-We are helping grape producers identify SSS due to eriophyid pest mites and other probable causes of SSS damage such as nutrient deficiencies, frost, thrips, herbicide damage, borers, and mites. Statewide, approximately 1/3 of vineyards have affected acreage from mites. Crop losses of up to 59% were found in 2006. Mites feed on susceptible tissues during the onset of wooly bud to bud break. This causes tissue damage leading to SSS. Two mite treatments timed during this period mitigate damage. Data show that crop losses can be reduced by up to 66%.

-We have been conducting fungicide spray trials for control of powdery mildew and studying the timing and effect of seasonal sprays on mites and beneficial organisms. We estimate that seasonal sulfur application can be reduced by a minimum of 30% if growers adapt fungicide spray protocols in order to enhance survival of biological control agents.

-We have been identifying and recognizing the abundance and diversity of beneficial organisms in the vineyards and their contribution toward reducing pest numbers. Grower awareness of their presence and their roles will ultimately help reduce pesticide use and enhance natural enemies of pests.

-Future work aims to provide guidelines to enhance biological control using attractants and conservation. It is also believed that rescue treatments should be optimized by looking at the best timing and new compounds.

SOCIAL BENEFITS – Growers are being educated with knowledge gained from the project regarding seasonal development of mites and susceptible periods in a mites life cycle, SSS damage, presence of predatory mites and other beneficial organisms which will lead to better management decisions.

ECONOMIC BENEFITS - Identification of fungicide programs that maximize biological control and suppression of mites will lead to greater non-chemical management of these pests, and enhance grower efficiency and profitability due to less intensive miticide use.

ENVIRONMENTAL BENEFITS - Greater reliance on conservation biological control of mite pests should lead to less intensive pesticide use in hops, grapevine, and other perennial crops.

2. Potential impacts. Describe your project’s potential impacts. *Potential impacts* are the ways that your project’s outputs could directly lead to changes in condition that will unfold in the future.

G. Appendices

1. With your report, please attach *at least two (2) photographs* that illustrate your project. Please describe the photo and indicate the name and institution of the person who took the photo. (If you submit more than two photographs, please include those additional descriptions and photo credits under “H. Additional Information,” below.)

Photo #1 description:

SSS: The picture shows mite-associated short shoot syndrome.

Photo #1 credit (photographer's name and institution):

Amy J. Dreves- Oregon State; Crop and Soil Science Dept.

Photo #2 description:

100_9234: A hop yard during vegetative development. David H. Gent, USDA-ARS, Corvallis, Oregon.

Photo #2 credit (photographer's name and institution):

David Gent- Oregon USDA-ARS; Forage Seed and Cereal Research Unit

2. Also attach any printed fact sheets or other publications resulting from your work that will enhance our understanding of your project and its impacts. Please provide a description of each attached publication below.

Document #1 description:

-Extension publication: Walton V.M., P Skinkis, A.J. Dreves, C. Kaiser 2009. Grapevine Growth Distortions: A guide to identifying symptoms. Oregon State University Extension Bulletin EM 8975-E; <http://extension.oregonstate.edu/catalog/pdf/em/em8975-e.pdf>

Document #2 description:

Refereed journal article-Gent, D.H., D.G. James, L.C. Wright, J.D. Barbour, A.J. Dreves, G.C. Fisher, and V.M. Walton. 2009. Effects of powdery mildew fungicide programs on twospotted spider mite (Acari: Tetranychidae), hop aphid (Homoptera: Aphididae), and their natural enemies in hop yards. J. Econ. Entomol.102(1): 274-286. <http://www.bioone.org/doi/pdf/10.1603/029.102.0137>

Document #3 description:

-Hops Field Guide: D. Gent, J. Barbour, A.J. Dreves, D. James, R. Parker, and D. Walsh. First Edition, August 2009. Field Guide for Integrated Pest Management in Hops. Oregon State University, University of Idaho, USDA Agricultural Research Service, and Wash. State University.

H. Additional Information

THIS FORM WAS COMPLETED BY:

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Additional WRIPM Progress Report PICTURES November 2, 2009 submitted by A.J. Dreves

PROJECT NUMBER: 2007-34103-18579

PROJECT TITLE: Integrated Management of Mite Pests and Powdery Mildew Diseases on Perennial Hosts

LEAD PRINCIPAL INVESTIGATOR: Glenn C. Fisher

CO-PIs or OTHER KEY PERSONNEL, and their INSTITUTIONS or AFFILIATIONS: Amy J. Dreves, Oregon State University, David H. Gent, USDA-ARS, Vaughn M. Walton, Oregon State University, David G. James, Washington State University

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Credit: Some of the language about impacts and potential impacts was adapted from a PowerPoint presentation by H. Michael Harrington, Executive Director, Western Association of Agricultural Experiment Station Directors, Colorado State University.

Attachment A

Questions to Help in Reporting Impacts and Potential Impacts

Below are some questions that will guide you in assessing and then describing the impacts and potential impacts of your project. The relevance of each question may vary depending on whether yours is a research or extension project. Please answer as many as you can to the best of your ability, and feel free to describe any additional types of impacts not mentioned below. Remember to identify any potential impacts.

1. Innovations in IPM:

Are there new IPM practices that have been (impacts) or could be (potential impacts) adopted as a direct result of your project? What is the total number of acres (or homes, schools, greenhouses, nurseries) on which these practices could realistically be implemented?

2. Safeguarding human health and the environment:

- a. Has the project reduced risk (or could it potentially do so) by changing the use of pesticides on farms, in homes, in schools, etc.? For example, could it result in fewer sprays per season or a switch to lower-risk pesticides? If possible, quantify the changes in condition. (Since there is no unanimous definition of *high* and *low risk*, investigators selecting this indicator are asked to categorize the pesticides they are reporting on as *high* or *low risk* according to the particular situation [e.g., lower risk to natural enemies]).
- b. Are there any other impacts or potential impacts on human health or the environment as a result of your project?

3. Economic benefits:

- a. What is (or could be) the economic benefit (e.g., dollars saved) for clientele who adopt IPM strategies and systems you studied? Do you envision potential commercialization or mass production of these systems?
- b. How many clients are satisfied with IPM results (such as improved yield, improved quality of yield, reduced pest populations, more effective pest control, greater preservation of nonpest species)?
- c. Are there other financial benefits that might be realized (potential impact) as a result of your project?

4. Implementation of IPM:

- a. How many IPM strategies and systems have been validated through this project (e.g., through on-farm trials, large plot tests, or other methods used to confirm efficacy)?
 - b. How many educational materials were delivered? To whom? And what are the impacts or potential impacts?
 - c. What is the number of growers/personnel trained? And what are the impacts or potential impacts?
 - d. For a Web site, what volume of traffic and type of use has the site experienced? (For example, number of visitors per day or month; number of page views; number of unique user sessions; change in volume during growing season; average viewing time.) And what are the impacts or potential impacts?
 - e. How many more people adopted IPM practices as a direct result of your project, or how many people adopted new IPM practices?
 - f. Are there other ways in which your work will result in improved use or increased implementation of IPM strategies in your region or across the West?
5. Has your project or study increased collaboration among stakeholders interested in the development and implementation of improved IPM strategies and systems?