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: 29 Sept. 2009
Reporting Period: 16 Oct. 2008-15 Oct. 2009
Report Type (please check one):
☒ Progress Report ☐ Final Report

B. Grant Data

- Grant Agreement #: Award no. 2007-34103-18495
- Title: Development of a female-produced pheromone for managing Prionus californicus in hop
- Grant Type:
- Lead investigator:
  - Name: James D. Barbour
  - Title: Associate Professor
  - Institution: University of Idaho
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  - Email: jbarbour@uidaho.edu
- Team members (name, title, institution):
- Jocelyn G. Millar, University of California, Riverside
- Lawrence M. Hanks, University of Illinois at Urbana-Champagne
- State(s) involved: CA, IL, ID

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)

Prionus ca1ifornicus (Coleoptera: Cerambycidae) is a serious root-feeding pest of hop in the Pacific Northwest. At present there are no host-plant resistance or biological control alternatives available to control this pest, and no insecticides have been registered for its control. The only effective methods available for managing P. californicus infestations in hop time are cultural contols (complete removal of hop rootstock from infested fields followed by soil fumigation, or by a 2- to 3-year fallow period) or soil application of a non selectice organophosphate insecticide (ethoprop). All of these alternatives are very expensive and disruptive to hop growers. Our recent research has confirmed that female P. californicus produce a sex pheromone that is highly attractive to males, and we have narrowed the pheromone structure down to one of only eight possible compounds. The primary goals of this proposal are are to confirm the structure of the prionus californicus pheromone and to develop volatile pheromones as a component of an IPM program for managing P. californicus in hop: by reducing populations of insect pests by preventing mating either by eliminating males from the population or by inundating the area with pheromone so that males cannot locate females, and consequently females produce no viable eggs

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

Objective 1: Complete full identification and synthesis of the pheromone.
a) Confirm molecular structure of the major pheromone component by synthesis.
b) Synthesize the possible minor components as required, and scale up syntheses of all required component(s) of the biologically active pheromone blend to provide sufficient material for initial laboratory bioassays, followed by full-scale field experiments in Idaho, Utah, California, Illinois, and Texas (Objectives 2 and 3).

Objective 1 progress: We have completed full identification of the pheromone structure as 3,5 dimethyl dodecanoic acid. The potentially active enantiomers and the all minor components have been synthesized and field tested in California, Utah, Illinois, Texas, and Idaho. Additional tests have been conducted in Georgia, and Washington State.

Objective 2: Verify activity of the pheromone in laboratory and field bioassays.
a) Compare activity of the synthetic pheromone component(s) to that of live females in laboratory olfactometer bioassays.
b) Determine operational parameters for field applications, including optimization of pheromone blend, pheromone dose, release device, and lure longevity.
c) Test mass trapping and male confusion techniques for control of P. californicus.

Objective 2 progress. We identified the active pheromone steroisomer as 3R, 5S-dimethyldodecanoic acid. The non-active stereoiseomers and minor components do not inhibit attraction of the active enantiomer, although two of the minor components show some activity in the absence of the active enantiomer. The synthetic pheromone is highly active at 1-10 ng in laboratory studies and at 0.1 to 10 mg in field studies. The optimum dose for current our release device is about 1 mg, with no decrease in activity at up to 10 mg per lure. At these doses the synthetic pheromone is more attractive than a single P. californicus female in a baited trap. At the 10 mg rate lures are active for at least two weeks under field conditions.

Preliminary fields exeriments show a significant decrease in the capture of males at lure-baited sentinel traps when surrounded by traps baited with senthetic pheromone or by lures not associated with traps, indicating that the pheomone may be useful in an IPM program based on mass trapping and/or mating disruption/confusion.

Objective 3: Test the pheromone of P. californicus, and related homologs and isomers synthesized as part of this project, as attractants for P. californicus in other regions of the western U.S., and for P. imbricornus and P. laticollis in the south-central and eastern U.S.

Objective 3 progress. The synthetic pheromone has been shown to be a strong attractant for P. californicus males in hop in ID and WA, and in Stone fruit in UT. Test in GA demonstrate that th pheromone also is a strong attractant for male P. imbricornis and P. laticollis, important pest of pecan in the southern U.S.

Objective 4: Transfer the pheromone synthesis technology to companies manufacturing pheromone products, and transfer the operational methods to grower clientele.

Objective 4 progress. We are in the process of tranferring this technology to the private sector for development of pheromone-based monitoring/management strategies for P. californicus in hop.

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

Peer reviewed Journal publications

Rodstein, J., J. S. McElfresh, J. D. Barbour, A. M. Ray, L. M. Hanks, & J. G. Millar. 2009. Identification and synthesis of a female-produced sex pheromone for the cerambycid beetle Prionus californicus. J. Chem. Ecol. 35: 590-600.)

Book chapters

Barbour, J. D. 2009. California Priounus Beetle. In: (D. Gent. & S. Prethybridge, Eds.), Compendium of hop diseases, arthropod pests and other disorders. American Phytopathological Society. In Press.

Millar, J. G., L. M. Hanks, J. A. Moreira, J. D. Barbour, and Lacey Barbour, J.D and E. S. Lacey. Pheromone chemistry of Cerambycid beetles. In; (K. Nakamuta, ed.). 2008. Chemical Ecology of Forest Insects. Forestry and Forest Products Research Institute and Asia-Pacific Association of Chemical Ecologist September 10,2007 13:30-17:00 International Congress Center, EPOCHAL TSUKUBA. 98 pp.

Presentations

Jocelyn G. Millar, Lawrence M. Hanks, and James Barbour. 2009. Recent advances in pheromone chemistry of cerambycid beetles only lead to more questions. Research Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry, Key Laboratory of Forest Protection, Beijing. Sept. 18/09.

Jocelyn G. Millar, Lawrence M. Hanks, and James Barbour. 2009. Recent advances in pheromone chemistry of cerambycid beetles only lead to more questions. Institute of Plant Physiology and Ecology, Shanghai Institute for Biological Sciences, Chinese Academy of Sciences, Shanghai, China. Sept. 21/09.

Millar, J. G., L. M. Hanks, and J. D. Barbour. 2009. Semiochemicals for detection and control of cerambycid beetles. Entomological Society of America, Pacific Branch Meeting. SYMPOSIUM: Chemical Ecology Based Pest Management: 50 Years After the First Pheromone Synthesis March 2009. San Diego, CA.

James Barbour, Jocelyn Millar, Joshua Rodstein, Ann Ray, and Lawrence Hanks.. 2009. Evaluation of synthetic female-produced sex pheromone of prionus californicus (Cerambycidae: Prioninae). Entomological Society of America, Pacific Branch Meeting, 1 April 2009 SanDiego, CA.

Millar, J.G., L. M. Hanks, E. Lacey, J. D. Barbour, and S. J. McElfresh. 2008. Advances in the semiochemistry of cerambycid beetles. International Congress of Entomology. Symposium on the impacts of insects on forest landscapes: implications for forest health management. July7, 2008. Durbin, South Africa

Barbour, J. D., J. G. Millar, J. Rodstien & L.M. Hanks. 2008. Response of Prionus californicus Motschulski to synthetic pheromone in laboratory and field studies. Entomological Society of America, National Meeting. Nov. 19, 2008. Reno, NV.

Millar, J. G., S. Mc Elfresh, J. Moreira, L. M. Hanks, A. Ray, & J. D. Barbour. 2008. New chemistry of cerambycid beetle pheromones. Entomological Society of America, National Meeting. Nov. 18. 2008, Reno, NV.

Hanks, L. M., J. G. Millar, J. D. Barbour, E. Lacey, A. M. Ray. 2008. Semiochemicals that signal across trophic boundaries. Entomological Society of America, National Meeting. Nov. 18, 2008, Reno, NV.

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.

This project has resulted in the identification of the first volatile sex pheromone for the cerambycid subfamily Prioninae, and the first female produced sex phereomone for the Cerambycidae. There is intense interest by the hop industry and by several commercial interests in the establishing pheomone-based management of P. californiculs in hops. The pheromone also provides a tool for probing populations of prionine cerambycids for information on distribution, abundance and chemical ecological interactions of importance for managmenat of these beeetles in natural and managed systems.

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.

We anticipate that commercial production of this pheromene will begin in the winter and sparing of 2009-2010 for field tests the will begin in the summer of 2010. With continued good progress volatile pheromone bsed monitoring and /or management of P. californicus in hop might be deployed as early as 2011.

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:

Prionus lecontei (left) and P. californicus males attracted to traps in California baited with 3,5 dimethyldodecanoic acid. Photograph by L. M. Hanks University of Illonois at Urban-Champaign.

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

Male P. californius attracted to 3,5 dimethyldodedanoic acid-baited pitfall traps in a commericial hop yard in southwestern Idaho. Photograph by J. D. Barbour Univeristy of Idaho, Southwestern Idaho Res. & Ext. Center, Parma, ID.

Photo #2 description:

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

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:

Document #2 description:

Document #3 description:

H. Additional Information

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?