Enhancing Biological Control to Stabilize Western Orchard IPM Systems

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Sustainable Pest Management Needs New Approaches

A Teachable Moment

Integrated pest management (IPM) systems in western orchard systems (apple, pear, walnut) are all in a transition because:

- Pesticides used for the past 50+ years are being eliminated by federal legislation
- 23 new pesticides have been registered to take their place
- Mating disruption is allowing us to control our key pest in all three systems with greatly reduced pesticide inputs
- Management programs based on "pesticide replacement therapy" are resulting in more secondary pest outbreaks, and greater costs to the growers.

Our Role

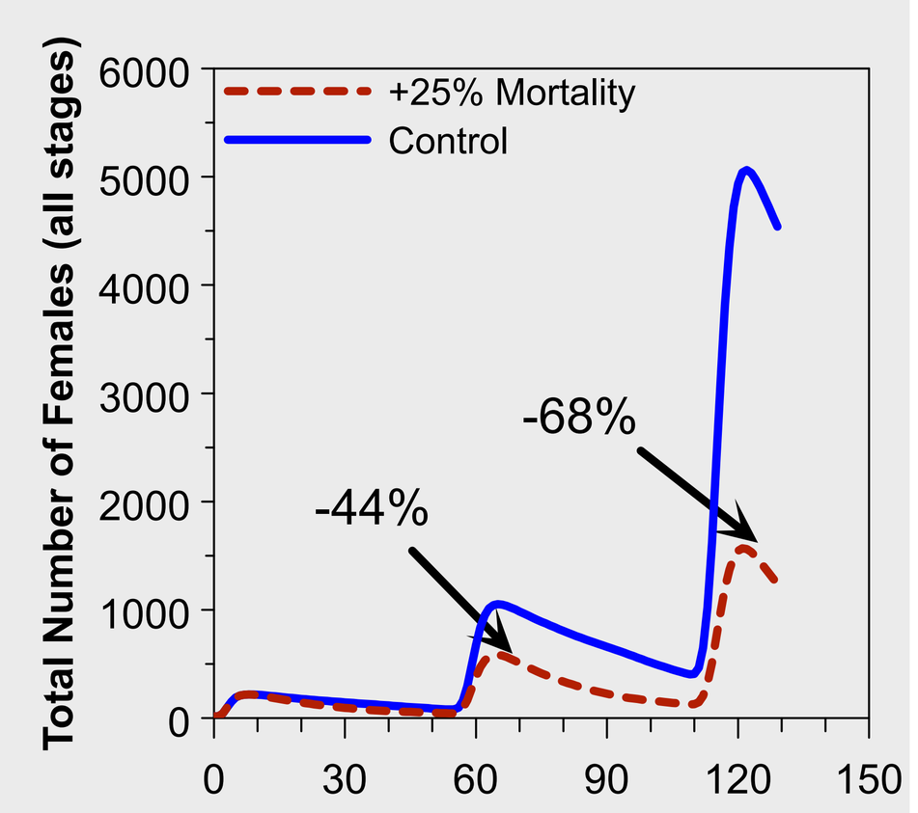
The transition period gives us the chance to design and implement environmentally sound IPM systems that are based on biological control (BC - use of predators, pathogens, and parasitoids). Our team is focusing its efforts in three areas:

- Quantifying natural enemy abundance, diversity, and seasonal occurrence to pinpoint key periods in the season when they need to be conserved
- Evaluating the physiological selectivity of the new pesticides on natural enemies so that we can maximize BC
- Synthesis of new and old information into optimal IPM programs and developing ways to speed educational outreach and adoption

Recognizing the Importance of Biological Control

What you don't recognize can cost you

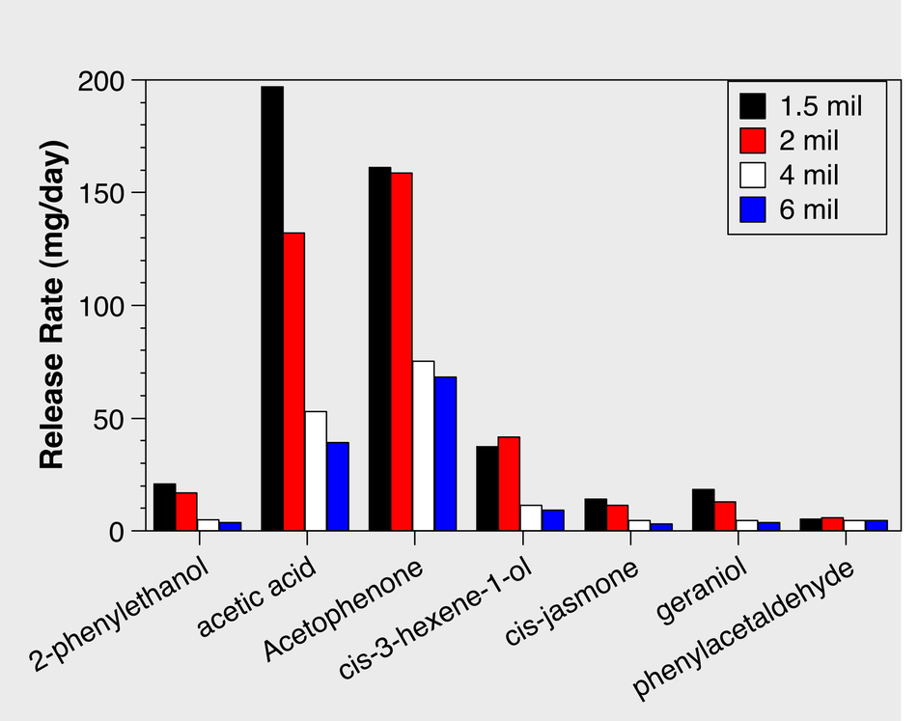
Sampling for natural enemies is difficult and rarely done. Many growers and pest management consultants are not concerned with BC except when it is absent. Using a simple life-table simulation, we have shown how even 25% additional mortality can dramatically change the pest pressures after one or two generations making management programs more effective.



Developing New Sampling Tools

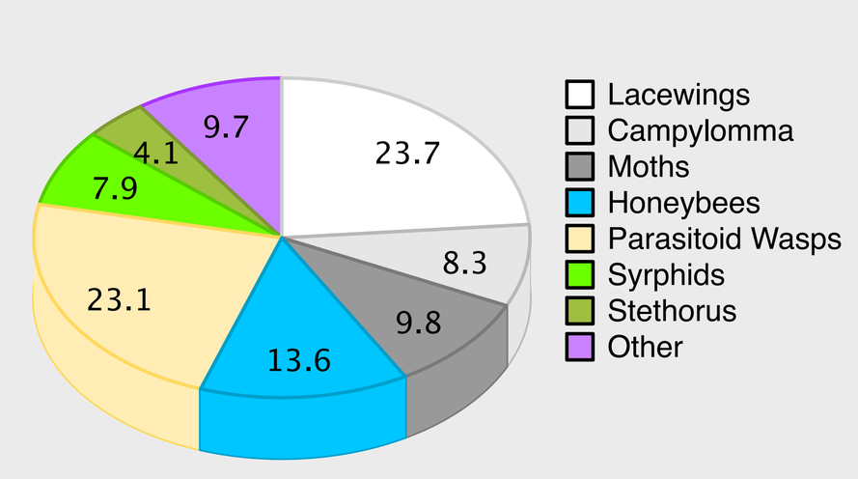
We can improve accuracy and ease of use

We are developing attractant lures to quantify natural enemy abundance, diversity, and importance. However, building a practical lure requires a constant release rate over a long period of time. Our lures are primarily volatiles that the plant releases when damaged by insect feeding and vary in chemical class and volatility. We have developed lures using polyethylene tubing that provide constant release rates >28 days in the field.



Attractants Show Diversity of Natural Enemies

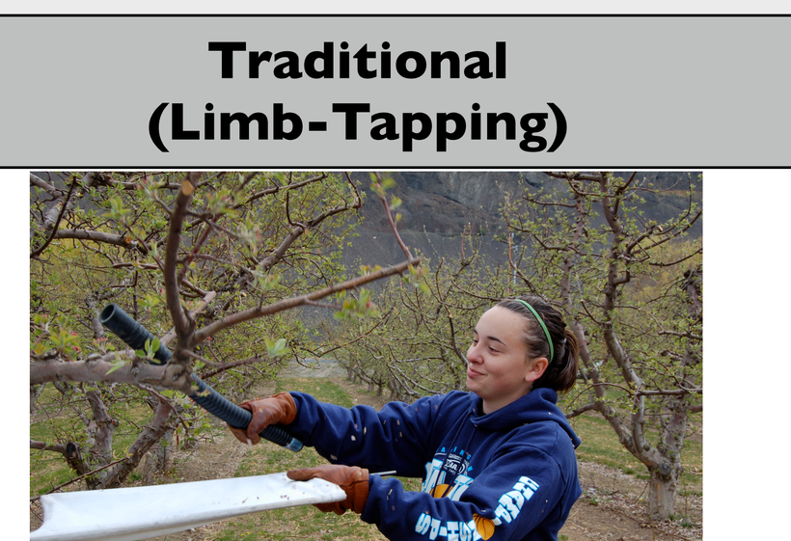
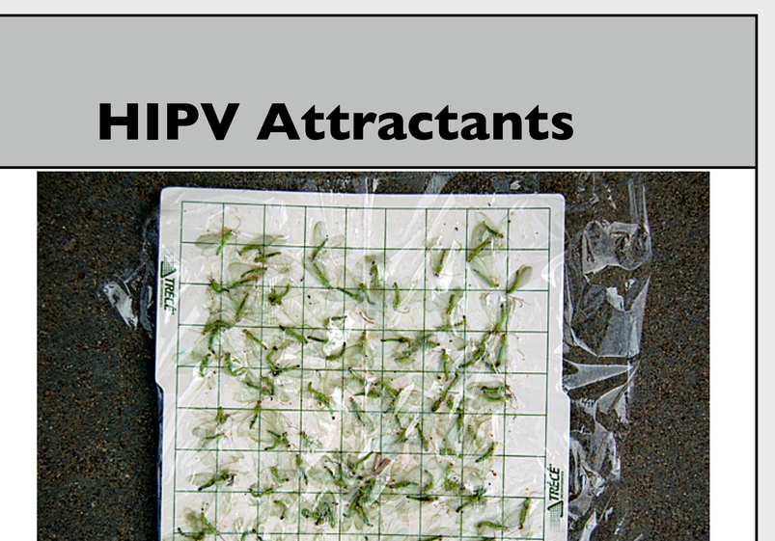
The different lures we have allow us to capture a wide range of natural enemies. There are certain groups that are better represented, but overall, we can use the different lures to evaluate the complex of natural enemies occurring in a particular orchard.



Sampling Results Can Color Reality

One of our lures is highly attractive to the lacewing, *Chrysopa nigricornis*. The data below show how the traditional sampling method and our lure affects our perception of the importance of BC. Not knowing the true population levels results in discounting the importance of BC and poor management decisions.

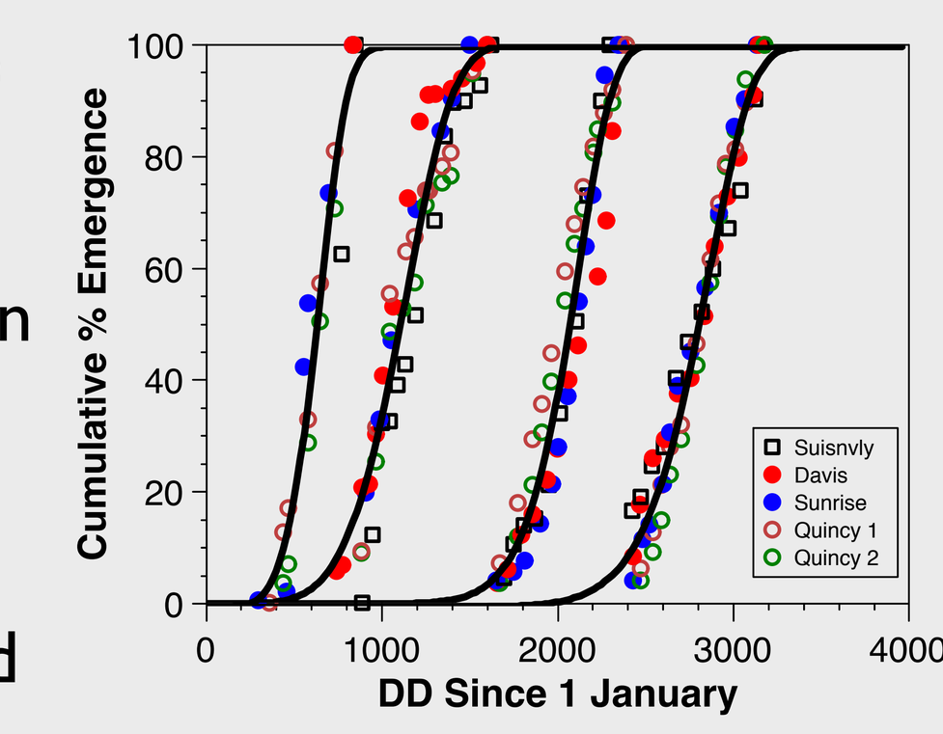
Comparison of use of traditional sampling methods and HIPV attractants developed in this project. Numbers come from five different apple orchards sampled 2-3 times a week from March – October using limb-tapping from 50 trees per orchard. Four attractant traps were in the same blocks and sampled once a week during the same period.

Comparisons	Traditional (Limb-Tapping)	HIPV Attractants
		
Sample Characteristics	Only collects insects on the branch at the time of sampling. Results dependent on time of day	Accumulates insects over time. Samples over a larger area.
Total Number Caught	12	25,604
Average Length of Collection Period	35 days	146 days
Management Conclusions	Rarely found and only during a short part of the season. Not important for BC, focus on other natural enemies.	One of the most abundant predators in the orchard and found season-long. Management needs to focus on conserving this natural enemy

Predicting When Natural Enemies Occur is Key to Management

Proper Timing Mitigates Pesticide Effects

The attractant lures not only tell us what is in the orchard, but also when. We can use this information to develop heat-driven models to determine natural enemy phenology. The graph on the right shows such a model for the lacewing *C. nigricornis* in three Washington apple and two California walnut orchards. As additional data are available, we will refine and validate the model and then use it modify our management programs to conserve this key natural enemy.



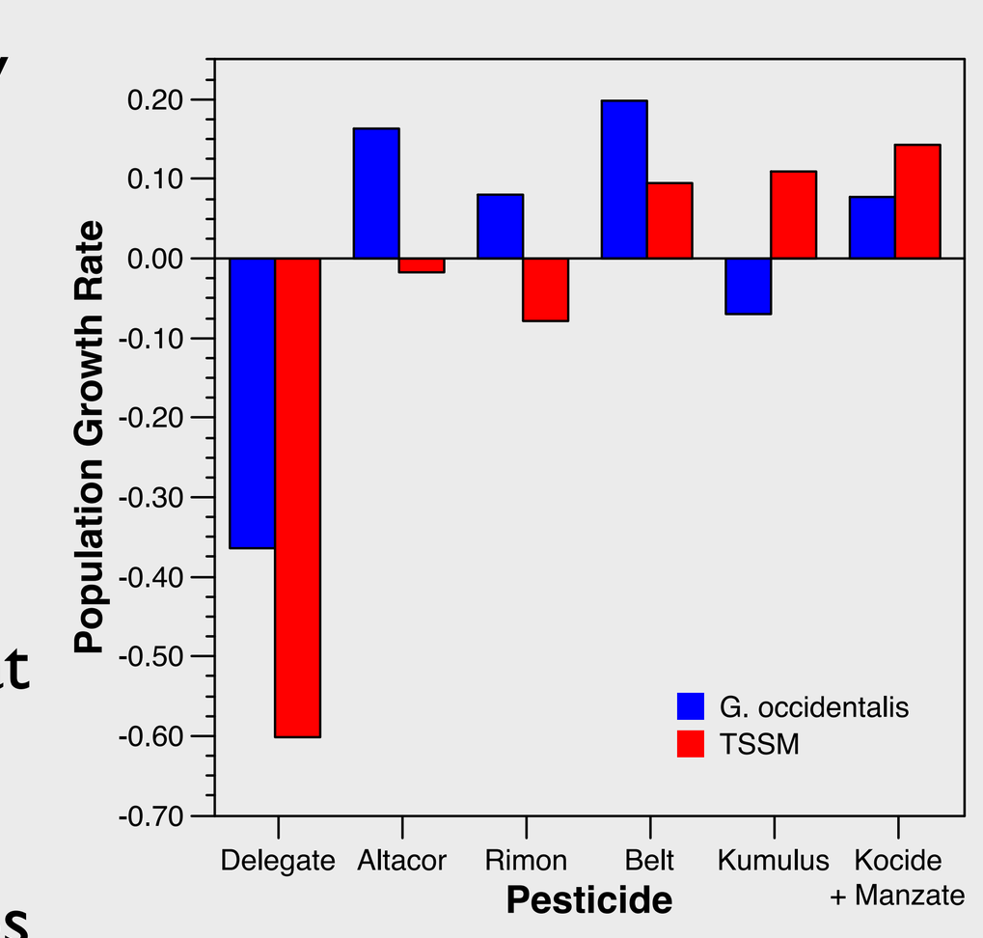
New Pesticides Require New Evaluation Methods

Sublethal Effects on Natural Enemies are Now the Rule

The new pesticide chemistries often have sublethal effects that cannot be characterized by simply increased mortality. Instead, they often cause sterility, altered sex ratios, or affect natural enemy behavior. As such, our laboratory assays are now focused on how pesticides affect population growth.

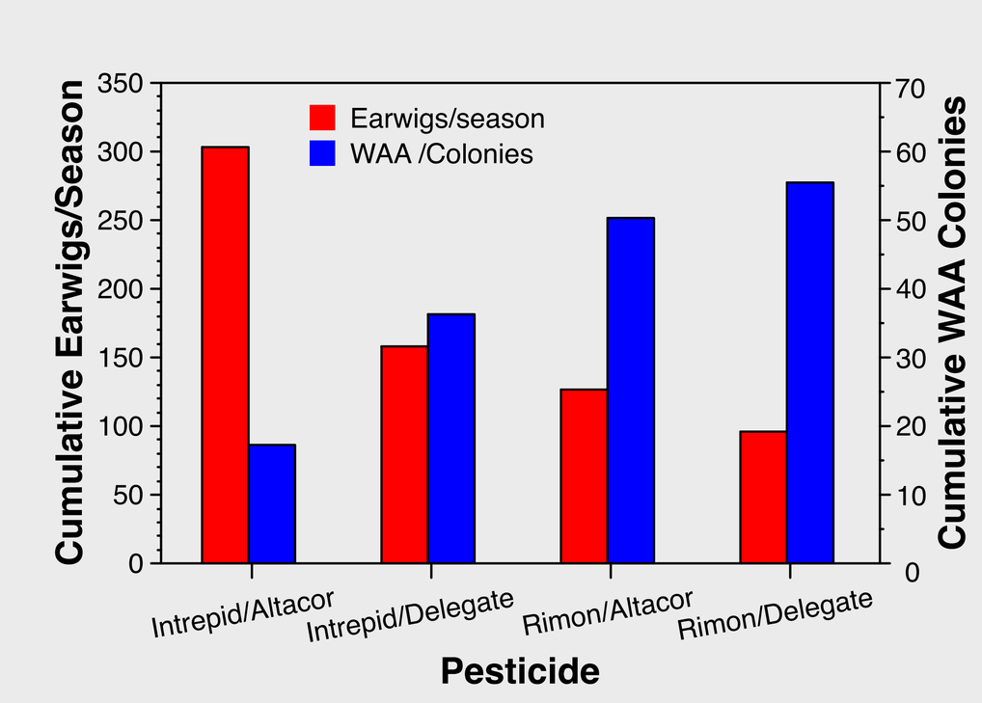
Using Laboratory Mesocosms to Mimic Reality

The predator *Galendromus occidentalis* is the key predator of two-spotted spider mite (TSSM) in Western orchards. The chart on the right shows how different pesticides affect the population growth rates of both the predator and its prey. Materials that suppress *G. occidentalis* need to be avoided to prevent the need for sprays targeted at TSSM. Materials that allow *G. occidentalis* to survive while reducing TSSM levels are selective and can be used to "correct" imbalances in the predator/prey ratios in the field.



Field Studies Verify Lab Data and Reveal New Relationships

Woolly apple aphid is increasing in pest status with the new pesticide management programs. In a large field test last year, we found that the first spray of the season "sets the tone" for BC, although a disruptive spray applied later can eliminate the advantage of using a "softer" first treatment. Our results also showed the number of WAA colonies increased in plots where earwigs were inhibited by the pesticide treatments.



Cost of Implementing Enhanced BC

A Broad Perspective on Cost-Benefit Analysis is Needed

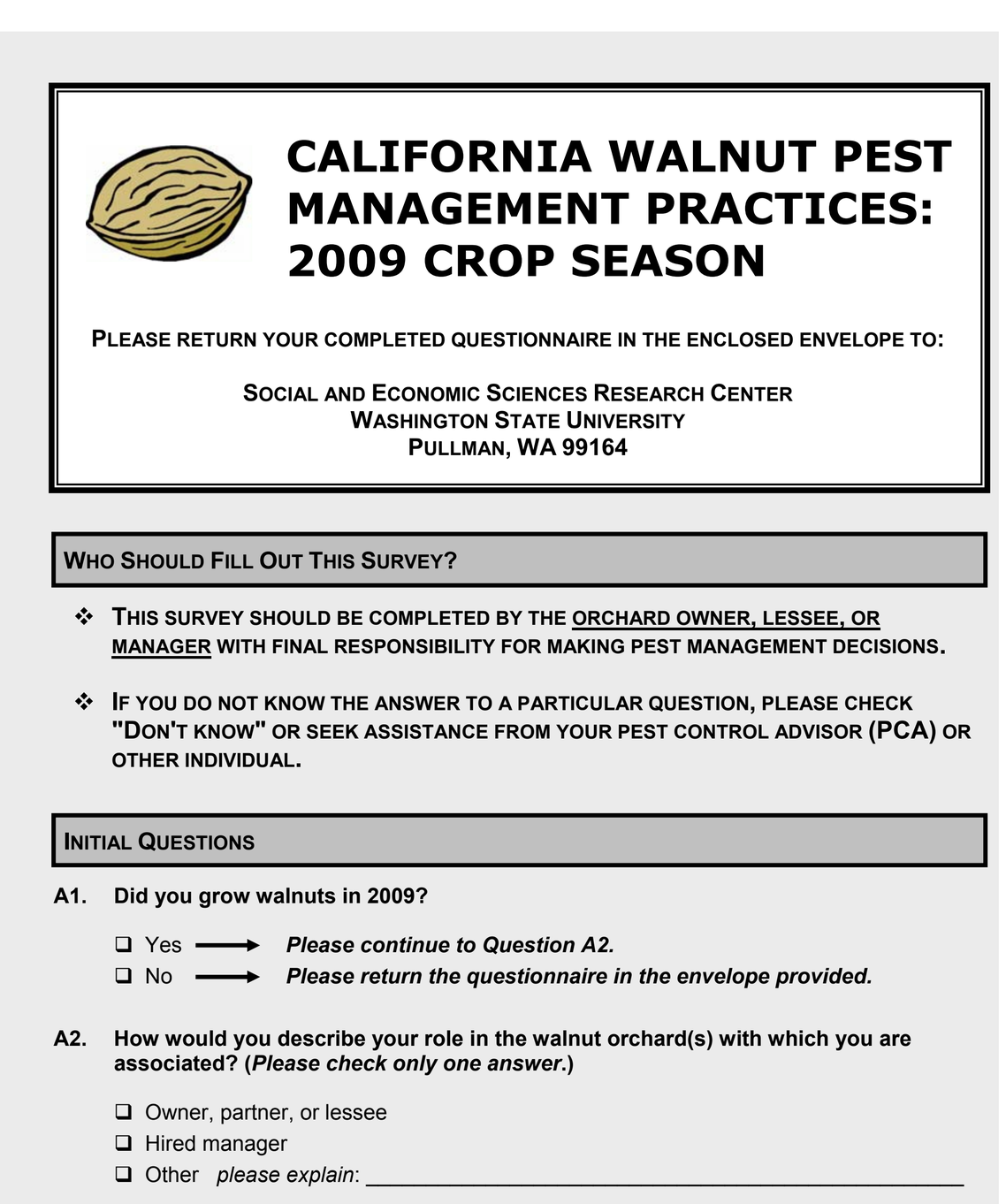
Typical economic studies on the use of biological control focus solely on the number of pesticides reduced or the value of the commodity saved. However, costs associated with just reduced numbers of sprays ignore environmental impacts, worker safety, and markets opened by eliminating pesticide residues. Project members are starting the analysis by evaluating nine hypothetical pesticide management scenarios which differ in their initial pest pressures and levels of biocontrol.

Preliminary results show that scenarios relying more on the new pesticides plus BC at all initial pest pressures present lower costs for labor and machinery application when compared with other scenarios. We are currently performing additional analyses that will help quantify biocontrol cost-benefits in the long run.

Speeding Up Adoption of BC

We Can't wait Seven Years for Adoption

Understanding where growers and IPM consultants obtain information and the breadth of their current knowledge is crucial to allocation of resources for our future educational efforts. We are currently surveying the California walnut growers and will be extending the survey to Washington and Oregon Pear growers in 2011, and Washington apple growers in 2012. The outreach part of the grant will be based heavily on the results of these surveys.


CALIFORNIA WALNUT PEST MANAGEMENT PRACTICES: 2009 CROP SEASON

PLEASE RETURN YOUR COMPLETED QUESTIONNAIRE IN THE ENCLOSED ENVELOPE TO:

SOCIAL AND ECONOMIC SCIENCES RESEARCH CENTER
WASHINGTON STATE UNIVERSITY
PULLMAN, WA 99164

WHO SHOULD FILL OUT THIS SURVEY?

- THIS SURVEY SHOULD BE COMPLETED BY THE ORCHARD OWNER, LESSEE, OR MANAGER WITH FINAL RESPONSIBILITY FOR MAKING PEST MANAGEMENT DECISIONS.
- IF YOU DO NOT KNOW THE ANSWER TO A PARTICULAR QUESTION, PLEASE CHECK "DON'T KNOW" OR SEEK ASSISTANCE FROM YOUR PEST CONTROL ADVISOR (PCA) OR OTHER INDIVIDUAL.

INITIAL QUESTIONS

A1. Did you grow walnuts in 2009?
- ❑ Yes → *Please continue to Question A2.*
- ❑ No → *Please return the questionnaire in the envelope provided.*

A2. How would you describe your role in the walnut orchard(s) with which you are associated? (*Please check only one answer.*)
- ❑ Owner, partner, or lessee
- ❑ Hired manager
- ❑ Other *please explain*: ______

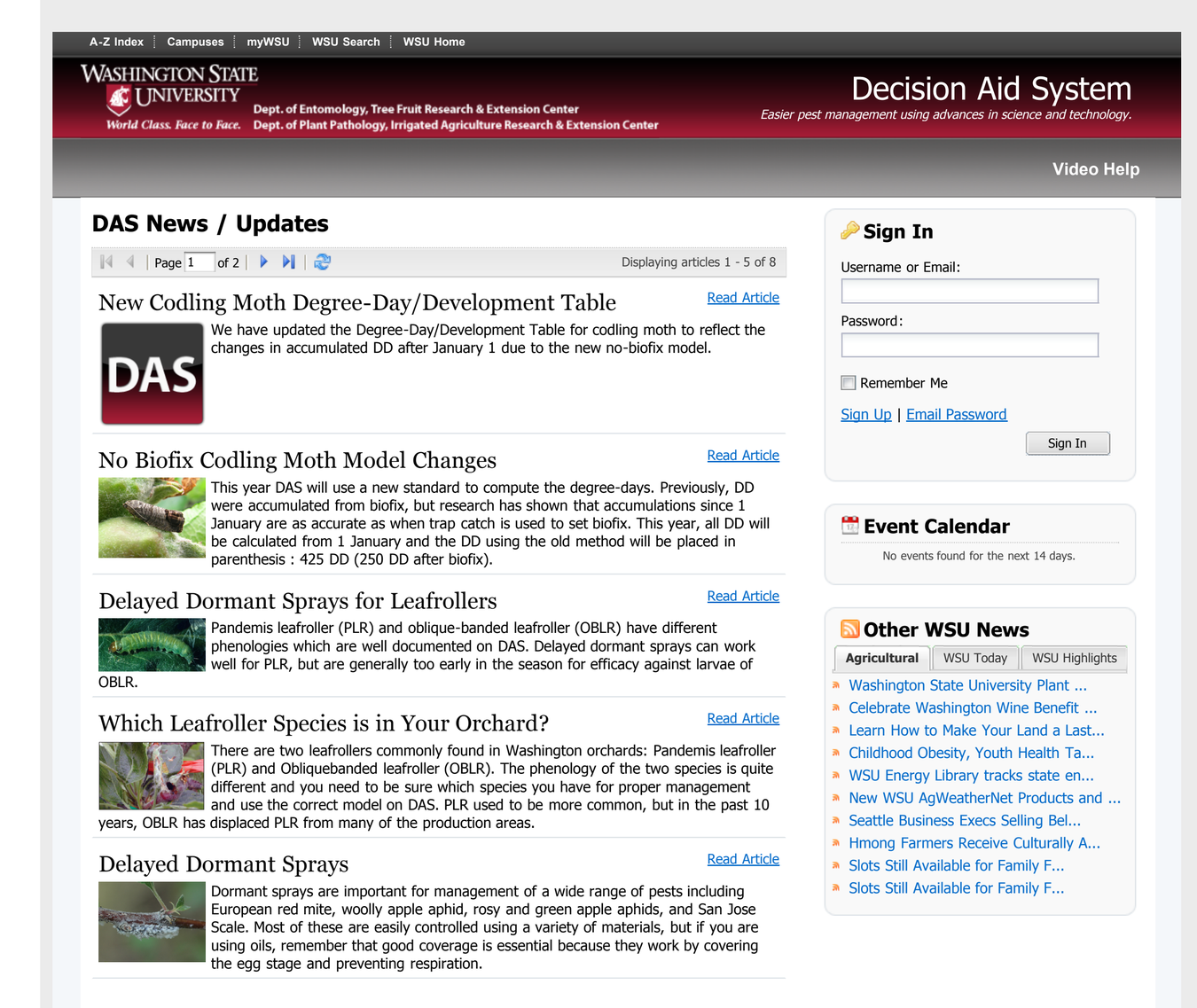
Short-Circuiting the Educational Process

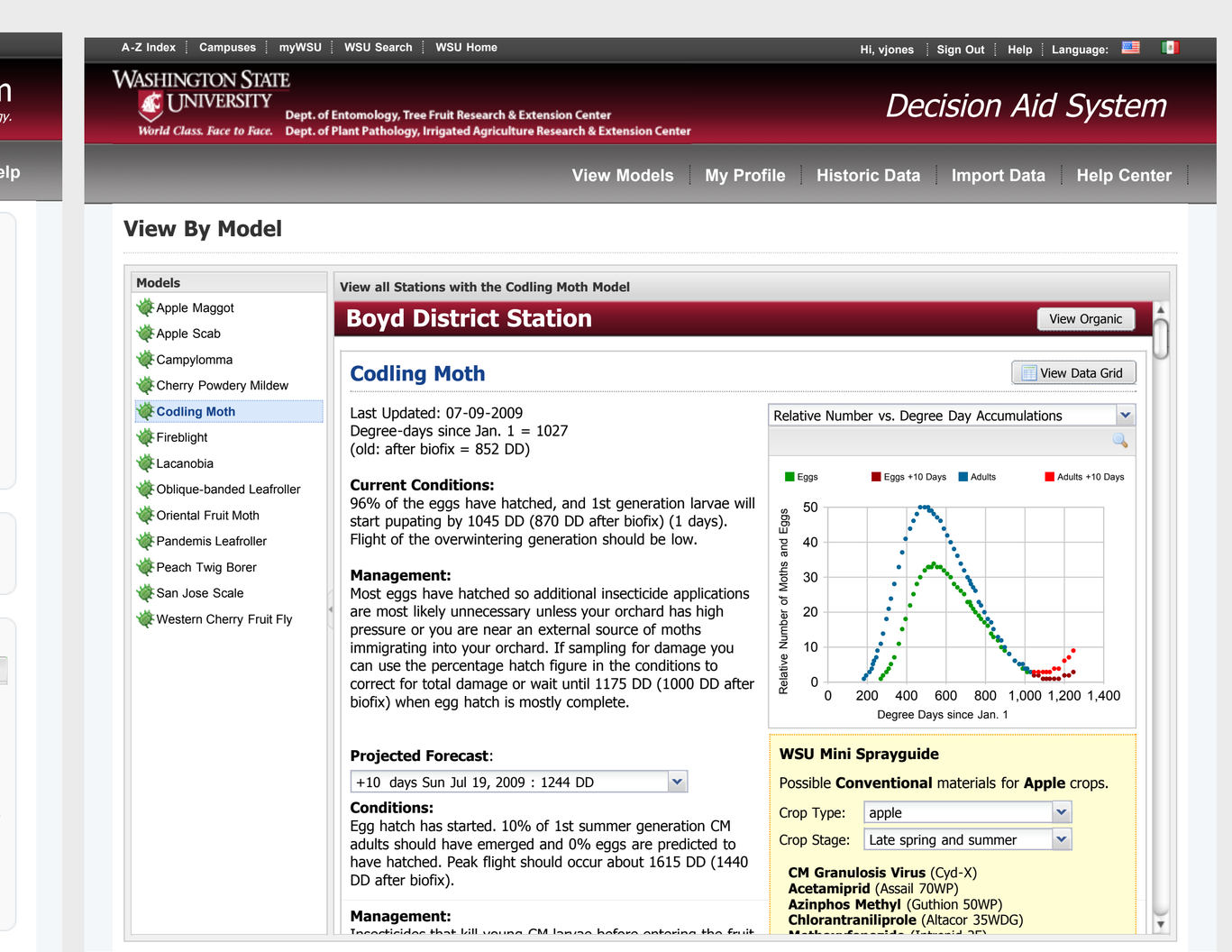
Making the Complex Simpler, Cheaper, and More Efficient

The complexity of the new management programs and the time-sensitive nature of IPM information requires a new look at how educational programs are delivered. The WSU-Decision Aid System is a key aspect of how we need to give IPM practitioners access to IPM information in a timely fashion. WSU-DAS integrates in one location:

- Weather data from WSU-AgWeather Net
- Site-specific weather forecasts from NOAA
- 10 insect models
- 3 disease models
- 1 horticultural model
- Time specific management recommendations
- Pesticide recommendation databases
- Seasonally appropriate learning modules to provide a users information on key management issues and needs.

Our survey in 2008 showed that DAS was valued by the users at ≈$17M/year and covered nearly the entire fruit industry. Using DAS allows us to make changes that are propagated to the users each time they log on to the system. This year we will also have the ability to automatically switch between English and Spanish versions of the system.





Outreach to Stakeholders and Peers

The Job's Not Done Until the Technology is Adopted

The project has nearly 25% of its funding earmarked for outreach and education. Our job is to develop the new management programs using the research occurring within the first three years of the project, package that into the most useful format, and deliver it to our stakeholders and peers. As part of the grant, we are developing a web site (enhancedbc.wsu.edu) with updates on the project, and information on research in progress and preliminary results. Field days will also be held in all three participating states and we will work as a team to integrate the new knowledge into our management programs for all three crops.

Acknowledgements:

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Oregon: Rich Gavin, Bruce Decker, Phil Van Buskirk
Washington: Dan Flick, Nick Stephens, Karen Lewis

and our three outside scientists:

Dr. Marshall Johnson (UC Riverside)
Dr. Doug Walsh (WSU- Prosser)
Dr. Gary Judd (Agriculture and Agri-Food Canada, Summerland, BC)