Web-based Outreach for Orchard Management Decision-Makers

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Abstract

The traditional role of extension has been to provide the bridge between research-generated knowledge and technology to stakeholders through instruction, practical demonstrations, and developing applications of existing, improved or novel practices and technology. However, the number of educators and extension specialists has been decreasing and their roles changing, while stakeholder groups have become more dependent on timely information to cope with rapid changes in management programs. These circumstances necessitate a change in the way information delivery occurs. A key component of the outreach objective in this project was to develop web-based tools to speed the dissemination of research information to decision-makers. Web-based outreach is intended to supplement, but not replace, extension personnel. Hands-on training and direct interaction with the stakeholders is still necessary to insure that relevant information is not just delivered but understood. Here we discuss how our web-based outreach integrates with traditional training as well as other digital information sources available into the future.

Keywords

biological control, online outreach, orchard management, pesticide effects, social media, decision support tools

1. Introduction

Cooperative Extension has undergone a significant broadening of its programs and client base since its inception in 1914 and especially since the later part of the 20th century

(Vine et al., 1963; Ratchford, 1984; Urbanowitz and Wilcox, 2013). Whereas the initial focus was on agriculture, 4H, and rural development, it now includes additional areas such as urban family and community development, consumer science and youth development (Diekmann, et al., 2012; Warner et al., 1998). The increased activity in new program areas and with more diverse clientele has paralleled a decrease in federal and state funding for extension. In the past, the primary focus of Cooperative Extension in agriculture was to provide farmers with research-based information through a network of county-based agents and university-based specialists. As the number of extension personnel has declined, service areas have increased along with an increasing demand for a broader knowledge base. The traditional information transfer model used by extension was to have researchers share results with university-based specialists who then interpreted, summarized and delivered the information to county-based agents for wider public dissemination through vehicles such as demonstration projects, stakeholder meetings and newsletters. A drawback with this model is its high cost in terms of personnel time and travel, especially when extension budgets and the workforce are shrinking. One way to address the loss of funding is to include outreach objectives within research grants. This is only a short-term solution because once the grant has completed, Extension in most cases does not have the capacity to sustain programming that was developed during the grant. Another problem is that the traditional model is estimated to take seven years to go from information transfer to implementation of new technology or practices in agriculture (Alston et al., 1995). This lag time is too long to respond to problems such as invasive pests or diseases that require fast turn-around on knowledge delivery. With the Internet being more accessible even in rural communities (Bonlender, 2013; Horrigan, 2010), the use of web-based programs provides an effective solution to help speed the delivery of research-based knowledge, educational materials, training, and decision support systems (Jones et al., 2009). While face-to-face meetings and on-site instruction are the long-time favorites of both Extension and the agricultural community, in reality they are too costly to be the primary form of outreach in the current funding climate. Electronic forms of information make outreach more cost effective and more responsive to emerging issues (Jones et al., 2009; Schneider et al., 2011; Trede and Whitaker, 1998). Therefore, one objective of our Specialty Crop Research Initiative

(SCRI) project focused much of its outreach programming on the development of web-based components containing new information generated by the researchers, such as visual guides, multi-media and interactive information tools requiring little or no maintenance that would be useful well beyond the completion of the project. A more complete explanation about all project objectives and their execution can be found in the introductory article of this issue (Jones et al., 2016, this issue).

2. Stakeholders and Information Transfer

At the project onset, Pacific Northwest growers, orchard managers and crop consultants with responsibilities in apple, pear and walnut were surveyed to determine how they preferred to receive information and if they accessed the Internet looking for this information. The majority of pear growers (93% in Oregon and 82% in Washington) indicated that they use computers for farm business and 75% regularly access the Internet to acquire farming information (Goldberger and Lehrer, 2016, this issue). These results meet or exceed state and national means from concurrent NASS surveys on farm computer usage and ownership (NASS, 2009, 2013). Washington apple growers and crop consultants had a difference of opinion about their preferences in receiving farm management information. Although the majority of both groups preferred face-to-face delivery methods, nearly 60% of the consultants also accessed web resources compared to about 36% of growers (Gadino, 2012). A similar pattern of correlation was seen for NASS data on California farmers and our survey data from California walnut growers (Goldberger and Lehrer, 2016, this issue).

Based on participant preferences from our surveys (Gadino, 2012; Goldberger and Lehrer, 2016, this issue) and suggestions from the literature (Kallioranta et al., 2006; Kinsey, 2010; Ray, 2007), we launched a broad spectrum of Internet resources including a dedicated project website, a blog, and several forms of social media. The purpose of the website was to inform stakeholders about the project and keep them updated about its progress and new information that was being generated. The blog and other social media sites were employed for a more direct interaction with stakeholders and to promote latest research findings and outreach events with links to more detailed information on the project website.

3. The Project Website

3.1. Website Content

The content of the project's website was geared towards stakeholders (growers and crop consultants) and the scientific community by delivering basic, newly generated and synthesized information on enhancing biological control in orchards (<http://enhancedbiocontrol.org>). Upon entering the website, visitors were presented with a short synopsis about the project, spotlights of featured content and a revolving slideshow of project related events and information. The website was easily navigated using the menu at the top of the page (Figure 1). The majority of the project output fell under the Features heading. From there, visitors could get more detailed information about the project members and objectives or follow the project's progress by browsing through or downloading annual reports, survey results, lists of presentations, posters, and articles published in scientific journals and trade magazines. Synthesized results from the pesticide effects studies were also located under this heading (see Section 3.2 below), as well as a section with downloadable resources for identifying natural enemies. The remainder of the content fell under the separate menu headings Galleries (natural enemies image galleries) and Videos (topic sortable video gallery) making access to these resources more visible.

The website also served as a hub for advertisement and registration for the two-day interactive short course on orchard biological control offered in 2012 (Gadino et al., 2016, this issue). After the short course was completed the advertisement page was converted to a resource page hosting downloadable course materials and viewable presentations (http://enhancedbiocontrol.org/BC_SC.html).

3.2. Pesticide Effects Information and OPENED

A major focus of the project website was to educate stakeholders about the newly discovered sublethal effects of certain pesticides on natural enemies (Mills et al., 2016, this issue) and to deliver this information in a fashion that would help them in their pest management decision-making process. Visitors to the website learn about sublethal effects of pesticides through the lens of limitations on population growth. The research

results were summarized in an interactive table showing impacts on overall population growth for each pesticide-natural enemy combination (<http://enhancedbiocontrol.org/PE.html>). The table was color-coded for better visualization of the effect ratings (Figure 2). Visitors mouse-click (desktop or laptop browser) or touch (tablet or smartphone browser) a table cell to view more detailed information, such as acute toxicity or individual sublethal effects for a specific pesticide on a specific natural enemy.

The initial idea to compare project information of sublethal pesticide effects on natural enemies with other similar available data led to the development of the Orchard Pesticide Effects on Natural Enemies Database (OPENED; <http://enhancedbiocontrol.org/opened/>). In OPENED, pesticide toxicity ratings for selected pesticides and natural enemies relevant in orchards in the Pacific Northwest region were compiled from various sources¹. Details on how the data on sublethal pesticide effects was derived during the course of this project can be found in accompanying articles in the this issue (Amarasekare et al., 2016; Beers et al., 2016a, 2016b; Mills et al., 2016; Shearer et al., 2016; all this issue).

OPENED can be searched by individual pesticide or by crop and target pest, which then lists all recommended pesticides, for example, to control codling moth in apple (Figure 3). The search result shows a color gradient for each pesticide representing the range of known pesticide effects on all natural enemies included in the database (green = no or low, yellow = moderate, and red = high negative effects). The number within the color gradient (n = ##) indicates how many data points (natural enemies and/or source entries) were included in the gradient and whether the effects were based on population growth or acute toxicity ratings. In OPENED, population growth effects override any data based solely on acute toxicity, as population growth provided a more complete representation of a pesticide's risk of negative impacts on a particular natural enemy. The population growth effects are labeled with a star to clearly indicate the difference. Search results can be further filtered to separate out effects on natural enemies that consume a particular type of secondary pest such as aphids or mites. This filter allows growers and stakeholders to specify which secondary pests have been or are the current problem in their orchards. The table then returns additional columns with pesticide effects for these

groups of natural enemies that contribute to the biological control of those secondary pests. With this approach users are not required to have detailed knowledge about specific natural enemy species. For easy comparison, users can sort the list by pesticide effects ratings or any other parameter in the table.

OPENED data has been incorporated into the WSU Crop Protection Guide for Tree Fruit (Beers et al., 2015) as well as the Washington State University Decision Aid System's (WSU-DAS; <https://das.wsu.edu>) pest control database, thus delivering pesticide effects information to virtually the entire Washington state tree fruit industry. Currently, OPENED mainly contains registered pesticides that are recommended by WSU Extension for tree fruit. However, the OPENED database could be set up to accommodate other states if desired and, as funding becomes available, for updating or adding new information.

3.3. Social Media Companions to the Website

In addition to the more traditional routes of information transfer, we turned to social media, such as YouTube for video hosting, Facebook and Twitter for networking, and Blogger for blogging. An increasing number of extension programs around the country have successfully enlisted the use of social media to connect with clientele when frequent face-to-face interactions are not feasible (Cornelisse et al., 2011). In many situations, social media has been used to help promote educational events, give quick links to in-depth resources, and quickly respond to immediate problems or questions (Cornelisse et al., 2011; Kinsey, 2010; Schneider et al., 2011). With the short turn-around time associated with grant funded projects, we wanted to take advantage of the large popularity of social media outlets to boost the quick dissemination of our research results and help advertise learning opportunities with our stakeholders.

With over 3,000 viewings of the project videos as of December 2015, hosting all videos on YouTube has been a very successful strategy. YouTube is rated by eBiz (2014) to be the most versatile tool with a strong overall popularity. Our videos are publicly accessible in a project-dedicated channel entitled "Enhanced Biocontrol" as well as being embedded within our website's video gallery page and on the project blog. This gives the public

multiple ways to find and view the videos, subscribe to our YouTube channel, search by title or keyword, or visit our website video page. Having a dedicated YouTube channel allowed us to add relevant videos posted by others, thereby catering to the broader interest of our clientele and increasing the impact of our research. For example, we included a video interview of the project director Dr. Vince Jones produced by the University of California College of Agriculture and Natural Resources, describing the future outlook of IPM and biocontrol in orchard systems (<http://www.youtube.com/watch?v=ILxGlf3HioA>).

We also set up both a Facebook page (<http://facebook.com/Western-Orchard-Biocontrol>) and a Facebook Profile (<https://www.facebook.org/EnhancedBC>) to test which would be easier to manage and attract “friends”. Although both ended up with the same number of friends (25), the page version was easier to manage. We also set up a Twitter feed (<https://twitter.com/EnhancedBC>). Both the Facebook page and Twitter feed were set up to inform the apple, pear and walnut communities about project related activities, including the release of new videos, recent articles published in trade magazines, to post relevant stories, and to advertise events and new features on the project web site. Links to both the Facebook page and Twitter feed were located in the footer section on all project website pages for easy access. However, a disadvantage for both media types was the limitation on the amount and format of content that could be posted. Twitter posts were limited to 140 characters, which was useful for posting a brief headline and a shortened page link for more information. And although Facebook posts can be long, short posts are more common and may contain an image or link to another page or posting. To overcome this obstacle we created a blog (<http://ewobc.blogspot.com>). Blogs, short for web logs, are not in themselves as quick a mode of information dissemination as the other methods, but do allow for nearly unlimited story length with an appearance that can mirror that of the main project website. However, blogs can be set up to link to Facebook and/or Twitter to instantly post an announcement that a new story has been added to the blog including a direct link. Blogs have the added ability to allow (and later turn off) open or reviewed commenting on the articles where the blog author can reply back to the comments or delete any inappropriate comments. To help increase the popularity of the blog we linked it to both the Facebook page and Twitter feed so that whenever a new

article was posted a notification would appear on each. We also included a link to help drive viewer traffic back to the main website.

3.4. Stakeholders' Web Use and Technical Considerations

For Internet resources to be utilized, they need to be accessible, relevant and meet a need of the target audience (Zickuhr and Smith, 2012). According to NASS surveys regarding on-farm computer and Internet usage, 70% of US farms reported having access to computers and 67% had Internet access in 2013, a 6% and 8% increase from 2009, respectively (NASS, 2009, 2013). Both computer use and Internet access in California, Oregon, and Washington exceeded the national values (Table 1). This indicates that the stakeholders targeted by this project should be able to readily access the project's web resources. By the end of the first year (November 2009), the project website, which then mainly contained information about project goals, research objectives and personnel involved, received about 1,600 total page views. Over time, page views gradually increased and reached a total of over 22,000 by August 2014 when the project had finalized. The project videos were very popular with over 3,000 views as of December 2015. OPENED has become the most popular page (15% of page views by December 2015) outside of the homepage on the site, even though it was only added in January 2014. Website visitor data was collected initially using Statcounter.com then switched to Google Analytics beginning in November 2012 for its enhanced interface and unlimited free data storage. Regardless of the collection method, there was a limitation to the depth of data metrics. Since the website was open access, i.e., did not require a login and user profile, no demographic data could be collected. We were limited to information gleaned from Internet service provider data. Unique website visitors were defined through a combination of information about location (closest city), operating system, device type and monitor resolution. Looking at a breakdown of the website user metrics, we determined that of the 7278 users within the United States, 33.9% were from Washington, 11.8% were from Oregon and 10.2% were from California, and were ranked the top three states, respectively. This aligned favorably with the locations of our target audience. To determine success of website engagement we looked to the information gathered from the grower surveys conducted at the beginning of the project (Gadino, 2012; Goldberger et al,

2013; Goldberger and Lehrer 2016, this issue). Table 2 summarizes information from the surveys and shows the total number of growers in each grower group with the percent responding to the survey and the number of individuals stating that they used university web resources for management information. The number of website users exceeds the number of growers using this type of resource indicating the possibility of engaging our primary audience. The excess users may reflect engagement by our secondary audience comprised of crop consultants, extension personnel and researchers, as well as by non-target viewers.

The increase in website visits over the years can be attributed to the website becoming more relevant and also more “visible” to search engines as more content was added. Intensive promotion of the website at stakeholder meetings and in trade magazine articles was also a likely contributor to the increased website traffic. The importance of adding relevant content and advertisement is reflected in the annual and monthly page views (Figure 4). The spikes in monthly page views corresponded with (1) a major website update including improved mobile browsing and the addition of the 2010 annual report and survey results; (2) stakeholders looking for information about the two-day biological control short course held in February 2012 (Gadino et al, 2016, this issue); and (3) the launch and promotion of OPENED. Even though the research portion of the project was completed in August 2013, the monthly page views have remained high indicating that the material continues to be relevant as a basic resource for orchard biological control information.

Social media like blogs, Facebook or Twitter, on the other hand, represent more novel and specialized ways of interacting with stakeholders. According to a Pew Research Center report, 72% of online adults used some form of social media in 2012 (Brenner and Smith, 2013). Although younger adults were thought to be the most likely users, the number of older adult users had strongly trended upwards since 2009. However, the Pew Internet survey did not address the type of work engaged in by those surveyed, therefore, no conclusions could be drawn for our particular target audience. When California, Oregon and Washington growers and consultants were asked how they preferred to receive information about biological control, social media ranked below all other forms

of communication (Gadino, 2012; Goldberger and Lehrer, 2016, this issue). This low ranking was reflected in the rather disappointing numbers of Facebook friends (25) and Twitter followers (27) that connected with the project through these outlets. Our blog was more popular with over 2860 views as of December 2015.

The challenge with all three social media outlets was to obtain relevant news stories or images from project members for publishing online. If social media pages are not updated on a regular basis, viewers lose interest and stop following. Many could interpret this dilemma as a chicken-and-egg problem: “why invest in social media when there is no interest from the stakeholders to use it?” versus “stakeholders would visit more if there was relevant information or interesting updates.” In fact, a shift in researcher or extension personnel attitude (and also their rewards system) is needed to encourage frequent postings of short and attention grabbing items, with links to more detailed articles if suitable. Only then will stakeholders on social media grow in numbers and keep coming back for more news (Cornelisse, et al., 2011).

Representing the multi-institutional aspect of the project was a technical challenge requiring the development of a unique design layout that highlighted the content over any specific organization’s identity. The website address (URL) was also selected to reflect this intent necessitating the purchase of descriptive and non-institutional domain names, <http://enhancedbiocontrol.org> and <http://enhancedbiocontrol.com>, with both linked to the underlying URL (<http://enhancedbc.tfrec.wsu.edu>) hosted at WSU. Adopting the descriptive address names had the added advantage of being easier for visitors and project members to remember.

Another consideration while developing the website was to make it fully compatible with mobile and touch enabled devices such as smartphones and tablets. The project’s website was designed to recognize the type and size of the visitor’s viewing device and render output accordingly. On smartphones, for example, the navigation menu converts into a single interactive drop-down item that remains closed until touched by the viewer thus giving more screen space to the actual page content.

4. Decision Support Tools

The Washington State University Decision Aid System (WSU-DAS) was another important repository for the project's research results. The WSU-DAS serves virtually the entire Washington State tree fruit industry (close to 240,000 acres; NASS, 2014) with pest model predictions and management recommendations (Jones et al., 2010). Users responded in surveys that the WSU-DAS helped with spray timing, lead to better general understanding of IPM and had an estimated value to the industry of approximately \$18.7 M per year in 2014 (Jones and Chambers, 2014).

Within the WSU-DAS, the pesticide effects data from OPENED is blended with information from the WSU Crop Protection Guide for Tree Fruit. As in OPENED, pesticide effects on natural enemies in the WSU-DAS are summarized within color gradient bars by pesticide. The intent of this information is that users are able to directly compare the risk of various pesticides to natural enemies, thus helping them make pesticide choices to conserve natural enemies in their orchard.

Newly generated natural enemy phenology models for green lacewings and other natural enemies (Jones et al., 2016, this issue) will be incorporated into the WSU-DAS after validation is completed. Users will then be able to see when certain natural enemies are predicted to be present in their orchards, which will help them moderate spray programs during critical parts of the natural enemy life cycle. In conjunction with other information on the WSU-DAS, users will be able to identify pesticides that present the least risk to biological control agents of important secondary pests. An emerging feature of the WSU-DAS will allow users to create logs of sampled pest or natural enemy numbers as well as applied pesticide applications. In the near future, visualization and synthesis of the user-entered data can help the user get a better feel for the presence of biological control agents and potential interactions with pesticides and observed secondary pest outbreaks. Ultimately, these integrated features will serve as a self-assessment tool for past, present and future management programs.

The functionality of the WSU-DAS is limited to Washington state users due to the state-specific pesticide recommendations and also because there may be regional differences in emergence patterns of both pests and natural enemies. However, there are other decision support resources available to Oregon and California clientele. These include Oregon

State University's Integrated Plant Protection Center website (<http://USPEST.org>) and the University of California's Integrate Pest Management (UC IPM) website (<http://ipm.ucdavis.edu>). The USPEST website integrates degree-day calculators for major pests and diseases and allows users to select their location from a visual map similar to the WSU-DAS. However, there are no management recommendations beyond the general suggestion that sprays need to correspond with pest phenology; nor does it include any models for natural enemies found in tree fruit. The UC IPM website contains a wealth of information about both pests and natural enemies and includes both spray recommendations and a table of pesticide effects on natural enemies. Of the three websites, WSU-DAS has the more complete interface for integrating insect phenology models directly with management recommendations at a location-specific level.

5. Future directions – online courses and mobile apps

Further avenues are being pursued to continue outreach efforts for this project that are intended to provide information and training tools to enhance and stabilize conservation biological control in orchards. Funding leveraged from this project's success is being used to transform the hands-on biocontrol workshops into an interactive online course and to develop a mobile app for identification of common orchard pests and their natural enemies. While stakeholders did not rate online courses as their preferred method of receiving biocontrol information, it is quite possible their response was because they have had no, or very little, experience with dynamic online courses. We believe that a well-developed online course represents a timely and efficient outreach strategy. Making information accessible, intuitive, user-friendly, and engaging is essential for the online course and mobile app to be useful and a success. However, the greatest value of these tools will be stakeholder access to information and training whenever needed and at a time of their choosing, in other words, on-demand.

The interactive online course currently under development will be an amalgam of narrated and interactive slides with images, videos and animations. It will also include self-assessment quizzes and self-exploration activities that let the user delve into the many aspects of conservation biological control. As an additional incentive for participating in the online course, users will be able to receive Washington State

Department of Agriculture pesticide applicator re-certification credits upon completing the course. In a broader perspective, the online course could be incorporated into a future IPM certification course or degree program in orchard management. This multi-purpose use of online resources could further optimize the use of valuable Extension resources (time and money) by reducing redundancy in the educational process.

An orchard pest and natural enemy identification app is a logical transition from printed field guides to smartphones and tablet computers that most stakeholders already use and carry with them in the orchard. This app would include pictures of common orchard pests and natural enemies showing different life stages currently found in the printed guides. Unlike the printed versions, users will be able to search using an identification key or browsing through the images by type of insect or its characteristics or even by prey or host. The app would also include information about the biology of the natural enemies, their host or prey, their phenology and how certain pesticides affect them. Although there are a few mobile apps for insect identification, including the University of Florida iPest 1-3 for urban pests, FMC's Ag PhD Guide for field crop pests and a few general field guides for North American insect and spider identifications (<https://itunes.apple.com/us/app/ipest2/id398420454?mt=8;> <http://www.agphd.com/resources/ag-phd-mobile-apps/ag-phd-field-guide/>), this will be the first mobile field guide specific to pests and natural enemies in orchard ecosystems for the Pacific Northwest.

6. Conclusions

In the face of ever-decreasing resources available for Extension services there is a clear need for supplementing educational programs with easily accessible and low-maintenance resources. Digital resources in the form of web pages, videos, downloadable materials, online courses, and mobile apps are needed to fill the gaps when extension personnel are unavailable to supply information directly. It is important to note that the existence of digital resources does not replace the need for Extension educators, but rather compliments their outreach activities and multiplies their influence. There are also stakeholders that are either unable or resistant to adapting to new technologies such as the Internet, smartphones and tablet use. For these reasons, workshops and other live

interactions are still necessary to insure that the information is understood and used appropriately, as well as to reach the technological holdouts. With the completion of our extension program, this project leaves a legacy of digital resources that will continue to provide information transfer in the years to come.

Footnotes

¹ Data from several pesticide effects databases and studies were compiled and added to OPENED. These sources include: USDA-NIFRA SCRI Project “Enhancing Biological Control in Western Orchards”, USDA-IFAFS & USDA-RAMP Projects “Areawide Codling Moth Control Program II, Washington State University Crop Protection Guide, Koppert Biological Systems, International Organization for Biological Control (IOBC), University of California Extension, Cornell University, Ohio State University and Pennsylvania State University.

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533

534

Figure 1. Project website navigation structure. Major categories are shown as white text on black; subcategories are shown as black text on green; subpages are shown as black text on grey under their respective subcategories. The actual appearance and behavior of the navigation menu is dependent on the type of browser used by the site visitor.

Figure 2. Screen shot of the interactive visual table on pesticide effects on natural enemies. Moving a mouse cursor over or touching on the natural enemy images or the words “Acute” and “Sublethal” activates an information pop-up box. Shown here is an example of the information box for the acute effects of Delegate on *Chrysoperla carnea* (<http://enhancedbiocontrol.org/PE.html>).

Figure 3. Screen shot of the Orchard Pesticide Effects on Natural Enemies Database (OPENED) with apple, codling moth and leafroller selected as crop, target pest and secondary pest, respectively.

Figure 4. The trend in website usage based on total and monthly page views. The numbered monthly peaks correspond to known activities discussed in the article (1- website updates, 2 – visits prior to short course, 3 – launch of OPENED).

Table 1. Comparison of percent computer usage and Internet access by farms during 2009 (beginning of project) and 2013 (final project year) between targeted states and national averages.

Table 2. Comparison between of the total number of growers and percentage of survey respondents reporting use of university websites as a source of management information.

Enhancing Western Orchard Biological Control

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Welcome to the Enhancing Western Orchard Biological Control

A USDA-NIFA Specialty Crops Research Initiative Project

A collaborative project between Washington State University, University of California, and USDA-NIFA, and the apple, pear and walnut industries in California, Oregon, and Washington.

Sunrise Orchard NE ID-Workshop

Hands-on natural enemies identification workshops are just part of our Outreach effort. Watch by A. Redmond, WSU-PR201.

1 Who We Are

Enhancing Western Orchard Biological Control

2 About Our Research

Our research objectives are multi-

3 Our Outreach Mission

We are working to identify optimal ways

Table 1

Table 1. Comparison of percent computer usage and Internet access by farms during 2009 (beginning of project) and 2013 (final project year) between targeted states and national averages.

	% Farms with computer access		% Farms owning or leasing computers		% Farms using computers for farm business		% Farms with internet access	
State	2009 ^a	2013 ^b	2009 ^a	2013 ^b	2009 ^a	2013	2009 ^a	2013 ^b
California	69	75	68	72	44	44	66	72
Oregon	79	84	75	81	44	48	69	80
Washington	81	84	74	81	50	44	77	80
United States	64	70	61	68	36	40	59	67

^a 2009 data were used to predict usage at the start of the project.

^b 2013 data were used to evaluate final website reach.

Table 2. Comparison between of the total number of growers and percentage of survey respondents reporting use of university websites as a source of management information.

Audience group	Total #	% Survey	# Using Web
	Growers	Returns	Resources
California walnut growers ^a	2688	21	210
Pacific Northwest pear growers ^b	1001	36	214
Washington apple growers ^c	2155	25	199
Totals	5844		623

^a CA walnut grower numbers extracted from Goldberger and Lehrer, 2016, this issue.

^b Combined WA and OR pear grower numbers extracted from Goldberger and Lehrer, 2016, this issue.

^c WA apple grower numbers extracted from Goldberger et al., 2013.

Figure1

HOME	FEATURES ▼	GALLERY ▼	VIDEOS	BLOG	CONTACT
	About Us	Spiders			
	objectives	Parasitoids			
	our team	Predators			
	Pesticide Effects				
	OPENED				
	BC Short Course				
	Reports				
	2013				
	2012				
	2011				
	2010				
	2009				
	Surveys				
	CA walnut				
	OR/WA pear				
	WA apple				
	Resources				
	ID guides				
	articles				
	posters & talks				
	Events				

Figure2

If viewed on a mobile device, use landscape for best results

Note: "Exirel" is the new registered name for Cyazypyr

	Altacor	Exirel	Delegate	Rimon	Warrior	Kumulus	Kocide/ Manzate
Avg. Disruptive Value:	-43	-55	-73	-62	-88	-54	-28
-12	-36	-96	-74	-99	-91	-77
	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal
-100	-100	-96	-94	-100	-39	-39
	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal
+5	+10	-100	-100	-100	-66	-32
	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal
-87	-84	-100	-100	-100	-44	-11
	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal
-3	-32	-43	-16	-39	+3	+12
	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal
-59	-88	-83	-7	-91	-89	-23
	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal	Acute Sublethal

Delegate Acute Effects
on *C. carnea*

Adult Corrected Mortality
at 10% fr: 0.0%
at 100% fr: 44.0%

Juvenile Corrected Mortality
at 10% fr: 0.0%
at 100% fr: 2.8%

Figure3

Figure4