

**The Arizona Pest Management Center:
Implementing IPM in Diverse Environments of Arizona**
Interim Report on an Extension IPM grant
April 5, 2011

Date awarded: 8/1/09
Status: Extended

FRS# 317770
CRIS# 0218605
Project # ARZT-317770-E-30-500

Participants

Principle Investigators:

Dr. Peter C. Ellsworth, IPM Specialist & State IPM Coordinator, convenes the IPM Coordinating Committee that directs Extension IPM programming. He is team leader for the Cotton / Agronomic Crops IPM program and conducts an active research and extension program. He conducts cotton pest losses workshops, collecting data (important for evaluation) from pest control advisors on pest-specific cotton yield losses, pest management practices and economic impacts.

Dr. Al Fournier, IPM Program Manager, handles daily management of the Arizona Pest Management Center that provides coordination, leadership and support to all IPM program areas. This includes support for IPM needs assessment and program evaluation, grant writing, and collaborations with in-state and out-of-state partner organizations. He develops tools to quantify outcomes and impacts of IPM programs.

Other Individuals [paid more than 160 hours on grant]:

Marco Peña – Coordinates Extension efforts of the Vegetable IPM Team.

Theresa Smith – Develops and manages websites for internal communication of the APMC, collaborative efforts and agricultural IPM outreach.

Richard Farmer – Developed pesticide use database used for program evaluation.

Tilak Mahato – Works with the Urban / Community IPM Team to develop Extension outputs.

Partner Organizations, Collaborators and Contacts:

John Palumbo, High Value Vegetable IPM Team Leader, Department of Entomology, UA

Rick Gibson, Agronomic IPM Team Leader, Pinal County Cooperative Extension, UA

Mary Olsen, Diagnostics Team Leader, School of Plant Sciences, UA

Dawn Gouge, IPM in Schools Team Leader, Department of Entomology, UA

Kai Umeda, IPM on Recreational Lands Team Leader (Turf), Maricopa County Cooperative Extension, UA

Ursula Schuch, Consumer / Urban IPM Team Leader, School of Plant Sciences, UA

William McCloskey, Extension Weed Scientist, School of Plant Sciences, UA

Rick Melnicoe, Director, Western IPM Center and member, IPM Coordinating Committee

Pat Clay, FMD Specialist, Valent USA Corporation and member, IPM Coordinating Committee

Tess Grasswitz, Extension Integrated Pest Management Specialist, New Mexico State University

Eric Natwick, Farm Advisor, University of California Cooperative Extension

Jay Davison, Area Specialist, University of Nevada Reno
Jack Peterson, Arizona Department of Agriculture, Environmental Services Division
Gary Christian, Arizona Department of Agriculture, Environmental Services Division

Training or Professional Development:

Across all program areas, presented training opportunities to over 1,500 end-users at over 78 meetings, conferences and workshops, delivering over 110 continuing education credits.

Published Study Manual for Professional Pest Control Advisors: Fournier, A., J. Peterson & J. Reding, eds. 2010. Arizona Pest Control Advisor Study Manual: Preparatory Materials for the Arizona Pest Control Advisors License. Arizona Crop Protection Association. (Peer Reviewed)

Developed and published Program Planning and Evaluation Website as a professional development resource for faculty in collaboration with College of Agricultural and Life Sciences colleagues, launched January 2010.

Target Audiences & Efforts:

Target Audiences:

Agronomic and High-Value Crops: Pest Control Advisors (PCAs), growers, agricultural industry representatives, pesticide applicators, State and Federal agencies and pesticide regulators, Gila River Indian Community, Ak-chin Indian Community, Colorado River Indian Reservation, racial and ethnic minorities that work in agriculture.

Consumer / Urban / School IPM: Nursery and landscape industry, Master Gardeners, homeowners, public school facility managers and staff, state agencies, non-governmental organizations, pest management professionals, representatives from the Navajo Nation, Hopi Nation, Gila River Indian Community, Pascua Yaqui Indian Tribe, Tohono O'odham Nation, Cheyenne River Sioux Tribe, Cocopah Indian Tribe, Yakama, Winnebago, Salt River Pima Maricopa Indian Community, racial and ethnic minorities that work in the urban sector.

Efforts:

Workshops, field days, on-farm research demonstrations, on-site school IPM demonstrations, golf course and other turf demonstrations, cooperative extension meetings, educational presentations, informal education, training manuals, websites, online videos, smart phone updates, radio broadcasts, newspaper articles, newsletters, trade publications, extension publications, reports, stakeholder dialog sessions, needs assessments, crop pest losses surveys, informal discussion groups, one-on-one consultations, scientific publications, presentations and symposia, Master Gardener training and volunteer program, short courses, Desert Turf School.

Outputs

1. Coordination

- **Developed a strategic 4-year vision for Extension IPM** through discussions with the stakeholder IPM Coordinating Committee. Expanded committee to better represent the diversity of and transdisciplinary nature of IPM in the state.
- **Improved and integrated coordination of the Pesticide Safety Education Program** by managing it through the APMC and initiating a mini-grant program (\$24,700 in the first year).
- **Implemented a new peer-review process for Extension IPM publications.** From 12 publications submitted by faculty, one is still in process, 10 were accepted with various levels of revision, and one was rejected and later resubmitted and accepted after substantial revisions.
- **Improved communication and coordination of UA IPM programs.** For example, we currently host 12 working group or extension team pages on the APMC website, many corresponding to specific areas of EIPM emphasis (e.g., Agronomic IPM Team). Pages facilitate team communication and host links to team notes and outputs.
- **Program Planning and Evaluation Website.** Developed and published resource website for faculty in collaboration with College colleagues, launched January 2010. University of Arizona, Cooperative Extension. <http://extension.arizona.edu/evaluation/>

2. Collaboration

- **Arid Southwest IPM Network (ASIPMNet).** During the 2009-2010 grant term, collaborated on the development of 8 multi-state stakeholder responses to federal pesticide information requests and posted these to the ASIPMNet website: http://ag.arizona.edu/apmc/Arid_SWPMC_Info_Requests.html. These included critical analyses of stakeholder use and concerns regarding pesticide registration issues (e.g., endosulfan, spirotetramat). Improved communication and response rates from collaborating states as a result of EIPM collaboration.
- **Collaboration with Arizona Dept. of Agriculture on pesticide use database.** In 2010, completed a 20-yr statewide pesticide use database. This involved hiring a database specialist, coordinating a partnership with the Arizona Department of Agriculture, and integrating, evaluating and correcting data from diverse sources. Used database to respond to federal pesticide information requests and to document extension program outcomes and impacts, including adoption of reduced risk pesticides. Reduction of economic, environmental and human health risks can be inferred from these data.

3. Agronomic IPM

- **Implemented a statewide IPM needs assessment for agronomic crops** (70 responses), compiled data and developed a report on needs and priorities to facilitate program planning. http://cals.arizona.edu/apmc/agronomic_ipm.html.

4. High-Value Crops IPM:

4a. Vegetable IPM:

- Engaged Vegetable IPM stakeholders to identify needs and priorities and to solicit feedback on recent activities and outputs.
- Developed and implemented new “Veg IPM Updates”, delivering timely information to end-users via web, email and smart phone. Delivered 29 biweekly updates since January 2010 on insect, disease and weed management topics. These reached over 450 Arizona and California stakeholders by email list, and at least 300 stakeholders via the Arizona Crop Information Site. <http://ag.arizona.edu/crops/vegetables/advisories/advisories.html>. Some of these updates have been distributed by Western Farm Press and the Western Agri-Radio Network, reaching over 1,000 subscribers.
- Produced and posted 14 vegetable IPM videos to date (4 on insects, 8 on weed control and 2 on diseases) and created video archive webpage. <http://ag.arizona.edu/crops/vegetables/videos.html>
- Organized on-farm research demonstrations with grower cooperators, including 4 herbicide trial demos for melons and broccoli, 2 large translational research projects on aphid control and on monitoring the use of reduced risk insecticides.
- Held (1) Lettuce and (1) Melon Pest Losses workshop each year (2009-2010) to collect baseline data on sampling, thresholds, pest specific yield losses and pesticide use and profitability. These data will be used to measure future changes in grower IPM behaviors and the impacts of our educational efforts.
- Presented educational information at Desert Vegetable Workshop in August 2010 (150 in attendance).

4b. Cotton IPM:

- In 2009-2010, delivered over 30 educational Extension IPM presentations / meetings to growers, pest control advisors, industry representatives, county extension agents, regulators and other agricultural stakeholders. Provided 36.25 continuing education credits (CEUs).
- In 2009, delivered 19 presentations at scientific and industry conferences on cotton IPM.
- Held 3 Cotton Pest Losses workshops (Yuma, Poston, Maricopa) and engaged pest control advisors to develop statewide data on crop losses, pest damage, economic returns and pesticide use. Historical Cotton Pest Losses data are available at <http://ag.arizona.edu/crops/cotton/insects/cil/cil.html>.
- Held Cotton Pest Management Field Tour focusing on whitefly, lygus bug and mite management and control product performance. This was part of the Small Grains & Late Season Cotton Field Day, Maricopa Agricultural Center, Maricopa, AZ. September 29, 2009. About 50 people attended. Research summary available at <http://ag.arizona.edu/crops/presentations/09CottonFieldDaySummary105.pdf>.
- Media Outputs: Maintain regular contributions to ag press (e.g., Western Farm Press, Cotton Grower, etc.), newspapers, press releases, television and radio, producing or contributing to 6–10 stories per year. Recent stories (2010) covered sampling and identifying natural enemies in cotton fields (Western Farm Press), whitefly and Lygus management (Western Farm Press), the impact of our IPM programs (UA News), sustainable agriculture (Project SAGE), mirid outbreaks in Chinese Bt cottons in contrast to Arizona’s successful cotton IPM programs (Greenwire, NY Times, LA Times) and successful adoption of Bt cotton technologies in Arizona (PBS).

5. Consumer / Urban IPM

- 3 new and 4 revised Extension publications for homeowners and landscape professionals. Topics included IPM for home gardens; selecting, planting and staking trees; verticillium wilt; and diagnosing problems on roses.
- More than 6 extension presentations were given to commercial audiences around the state. Participants included arborists, landscape maintenance personnel, nursery personnel and designers.
- More than 21 presentations were given to over 650 Master Gardeners around the state including new volunteers and advanced training for current certified Master Gardeners. Topics included entomology 101, specific IPM practices, organic pest control and sound horticultural management of plants in the home garden and landscapes.
- One article was published on the importance of Mulch in the landscape in Southwest Trees and Turf in 2010.
- 2 presentations and 1 poster presentation to in-state and national cooperative extension colleagues on whitefly management and related IPM topics.

6. Pest Diagnostics (unfunded)

- Conducted 12 workshops and presentations statewide on plant disease diagnostic topics, targeting commercial and residential clientele. Topics included diagnostic methods, best management practices for urban desert landscapes, diseases in landscape ornamentals, turf, grapes, cotton, and plant pathogens of economic concern. Over 500 attendees.
- The Extension Plant Pathology web site contains descriptions of plant diseases that occur in Arizona, pictures of symptoms and signs of diseases, and prevention and control methods. The site has expanded to over 50 crops or plants and over 195 diseases.
<http://cals.arizona.edu/PLP/plpext/diseases/disease.htm>
- From August 2009 through December 2010, processed more than 450 physical samples (free of charge) and handled over 1,000 email and phone inquiries.
- Leveraged funds provided technical support to enter plant diagnostic data into 2 databases (UA Extension Plant Pathology Database and National Plant Diagnostic Network).

7. IPM in Schools (unfunded)

- National Tribal School IPM Training Program, Phoenix, AZ, July 20-21, 2010, Phoenix, AZ. 52 attended. 20 ADA CEUs and 54 OPM CEUs were awarded. Participants included representatives from Navajo, Hopi, Gila River Indian Community, Pascua Yaqui Indian Tribe, Tohono O'odham Nation, Cheyenne River Sioux Tribe, Cocopah Indian Tribe, Yakama, Winnebago, Salt River Pima Maricopa Indian Community; 7 universities, 3 state agencies, 4 pest control companies and 4 non-governmental organizations.
- 1 workshop on Bed bugs/Mosquitoes/West Nile Virus, Phoenix, AZ, November 12, 2010. 50 attended. Awarded AZ Office of Pest Management CEUs to 20 participants.
- Developed and published 4 IPM Newsletters for schools personnel. Available online.
<http://cals.arizona.edu/apmc/westernschoolIPM.html>

8. IPM on Recreational Lands (Turf, unfunded)

- 16th Annual Maricopa County Short Course, “Pesticide exposures and risky behavior” by S. McDonald, former Colorado State University Specialist. Phoenix, AZ, 8/27/09. 40 attendees.
- Implemented educational IPM seminar for Cactus and Pine Golf Course Superintendents Association. Payson, AZ, Oct 2009.
- 4th Desert Turf School. Tucson, AZ, Jan 4-8, 2010. Taught turf management principles to 60 participants.
- Annual Spring Turf Management Seminar. Phoenix, AZ, April 8, 2010. 15 attendees. Included IPM topics.
- Spring Turf Transition Demonstration. Desert Mountain, Geronimo Course, Scottsdale, AZ. 14 attendees. The demonstration attracted golf superintendents and sports turf managers to view experimental test plots and enabled exchange and sharing of actual practices and ideas among attendees.
- 17th Annual Maricopa County Short Course, “Advances in Spray Drift Technology” by R. Wolf, Kansas St. University Extension Specialist. Maricopa, AZ, Sept 1, 2010 (session 1, 12 attendees); Phoenix, AZ, Sept 2, 2010 (session 2, 30 attendees).

Outcomes and Impacts

1. Coordination

- **Significantly leveraged EIPM resources to accomplish program goals.** The APMC helps faculty to identify funding opportunities, reviews and collaborates on proposals and documents program outcomes. For FY 2010 alone we secured about \$1.1 million in competitive grants and other resources directly related to IPM research and outreach. This included over \$900,000 in federal grants plus \$37,200 in Western IPM Center grants, over \$98,000 in state grants, and nearly \$60,000 in other resources.
- **Improved coordination of the Pesticide Safety Education Program** by managing it through the APMC and initiating a mini-grant program (\$24,700 in the first year). We trained about 220 diverse clientele, many in remote parts of the state. 50 people received initial pesticide certification training based on the new National Core exam; 39 (78%) passed the exam, a significant increase over previous years. 55 people earned continuing education credits to maintain licenses.
- **New peer-review process for Extension IPM publications** has increased the quality of Extension IPM outputs. 11 out of 12 publications submitted by faculty since its inception have been published.

2. Collaboration

- **Pesticide use database.** These data have been used to respond to federal pesticide information requests and to document extension program outcomes and impacts, including adoption of reduced risk pesticides as presented elsewhere in this report (e.g., cotton IPM impacts).
- **Arid Southwest IPM Network (ASIPMNet).** Collaborative responses to federal information requests this term included critical analyses of stakeholder use and concerns regarding pesticide registration issues (e.g., dimethoate, endosulfan, spirotetramat) and

stakeholder input on EPA priorities. Data we developed influenced the extended phase out of endosulfan in certain crops.

3. Agronomic IPM

- **Identified key priorities for agronomic IPM:** The results of this needs assessment are being used by the new Agronomic IPM Team to plan IPM research and outreach to address priority needs in Arizona. These programs will be implemented by the team with assistance from the newly hired Assistant in Extension, Agronomic Crops. Alfalfa, seed alfalfa, wheat and silage corn are the top crops in need of IPM research and outreach. Key needs include: weed management in wheat, concerns about herbicide efficacy and the need for new technologies; Insect and weed management in alfalfa and seed alfalfa with research /education needed on aphids, leaf hoppers, Egyptian alfalfa weevil, Lepidoptera, and broadleaf and grassy weeds.

4. High-Value Crops IPM:

4a. Vegetable IPM: We have seen a steady increase in attendance at educational meeting and a 2-fold increase in listserv membership for Veg IPM updates. Stakeholders have had many positive comments about the quality and relevancy of our outputs. Two regional agricultural publications, Western Farm Press, and Western Agri-Radio Network have requested to use and further distribute our “updates” to larger audiences. These publications reach well over 1000 subscribers. Economic impacts will be quantified once we have collected 3 years worth of survey data from end users at Pest Losses workshops.

4b. Cotton IPM:

- Reached over 200 PCAs, growers and others with Lygus & whitefly management information. Influenced over 100 scientists worldwide regarding Lygus & whitefly management through series of invited seminars & symposia. Published papers, proceedings, and abstracts.
- Conducted an analysis and developed a report at the request of the Arizona Cotton Growers Association on pink bollworm control costs and the value of Bt technologies to the Arizona cotton industry. The report was reprinted in the ACGA newsletter and submitted to Monsanto Company. As a result, technology fees for Bt cotton were reduced for Arizona growers in 2011 with an estimated value gained by growers of \$1.1M in 2011 alone.
- We have seen a rapid adoption of a new reduced-risk insecticide (Carbine) and simultaneous reduction in broad-spectrum sprays for management of Lygus, a key pest of cotton (Figure 1, below). In 2005, 0% all Lygus-targeted insecticides were Carbine. This grew to ca. 52% in 2007, ca. 75% in 2008, ca. 81% in 2009. Clients credit the cotton IPM research & outreach program for this rapid change over. This has resulted in significant reductions in the use of less expensive broad-spectrum alternatives (e.g., acephate, oxamyl or endosulfan), which are damaging to natural enemy populations and can lead to secondary pest outbreaks. The result is improved control with fewer and less damaging insecticides. One grower reported adopting Carbine on 1200 acres resulting in 0% loss to Lygus in 2007 and again in 2010.

- The last 5 years have shown the lowest insecticide use in cotton on record (32 years), at just 1.5 sprays season-long, reducing insecticide loads on the environment by more than 1.6 million pounds of active ingredient annually and saving growers over \$10 million annually in combined control costs and yield savings (Figure 2, below).
- The Compared to 10 years ago, the types of insecticides used now are much safer, with high selectivity and safety for natural enemy populations. Specifically, there has been a 95 percent reduction in organophosphate use, comparing the last 5 years to an all-time high in 1995; a 98 percent reduction in pyrethroids; 80 percent reduction in endosulfan; and 92 percent reduction in carbamates; with an 85 percent reduction overall in cotton insecticide use (Figure 1, below). By 2010, 88 percent of all cotton insecticides used were either fully (61 percent) or partially (27 percent) selective, meaning they are safer to use and safer for the natural enemies in the cotton system. The total number of sprays made in cotton has been reduced by 85 percent.

5. Consumer / Urban IPM

- Surveys following instruction indicated that participants increased knowledge. Oral feedback from participants indicated that they learned new information and were eager to put it into practice. Many comments included “I didn’t know that I was doing this wrong, but now I know what to do and what not to do to have healthy plants.”

6. Pest Diagnostics (unfunded)

- From August 2009 through December 2010, we processed more than 450 physical samples and responded to numerous email and phone inquiries, helping clientele to make informed pest management decisions in urban and agricultural settings.

7. IPM in Schools (unfunded)

- Re-engaged Phoenix metro and Tucson school districts, educated and advised on bed bug monitoring and remediation practices. Prevented school fumigation for bed bugs saving one site over \$15,000.

8. IPM on Recreational Lands (Turf, unfunded)

- Through evaluations conducted at our workshops, we measured increases in clientele knowledge of IPM and turf management principles as a result of training. Typically, over 90% of participants indicated that they would adopt at least one new practice as a result of Extension education programs.

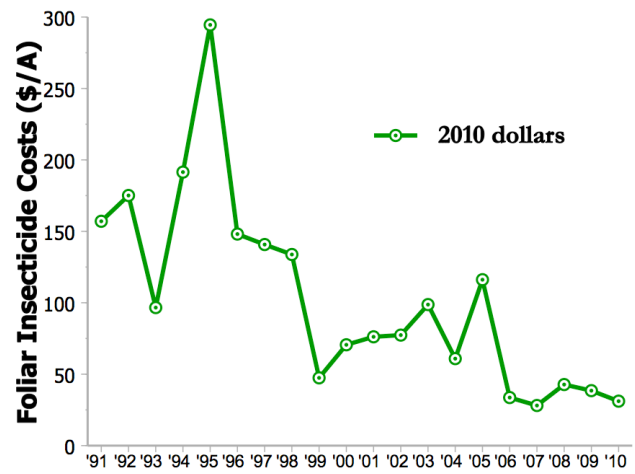
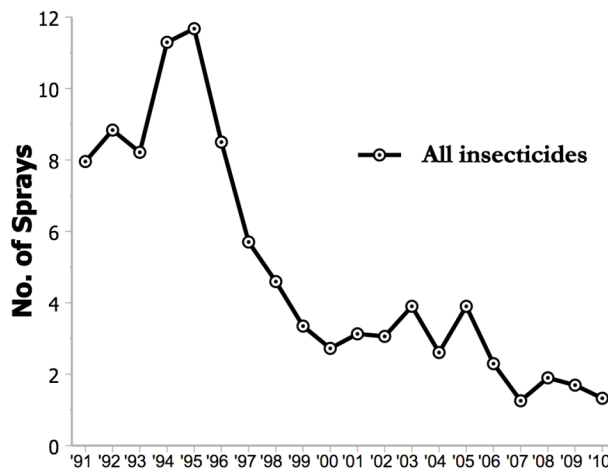
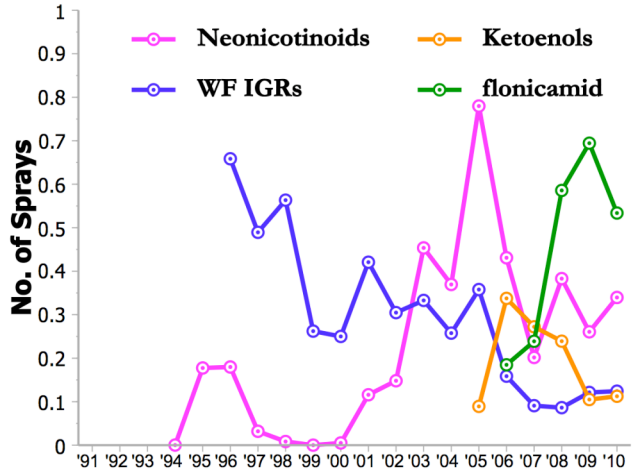
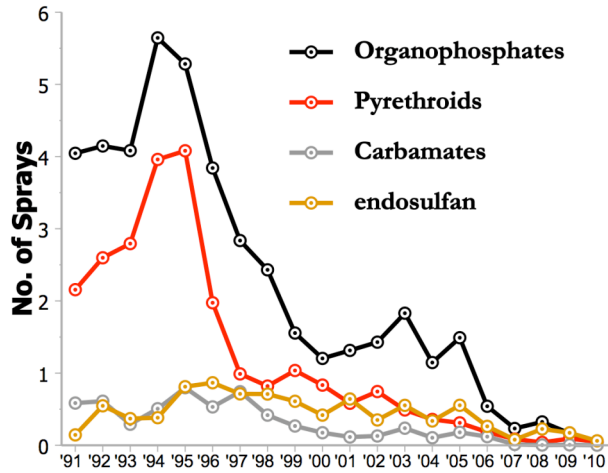


Figure 1. Statewide average cotton insecticide use patterns in Arizona, 1991–2010. Broad spectrum & reduced-risk insecticides (upper left & right) in use during this period. All insecticides & their costs (including application costs) (lower left & right). Insecticide use reached a 30-yr low over the last 5 years; costs reached an all-time low in the last 4 years. *Source: Pesticide Use Reporting Data, Arizona Pest Management Center, Ellsworth & Fournier, unpubl.*

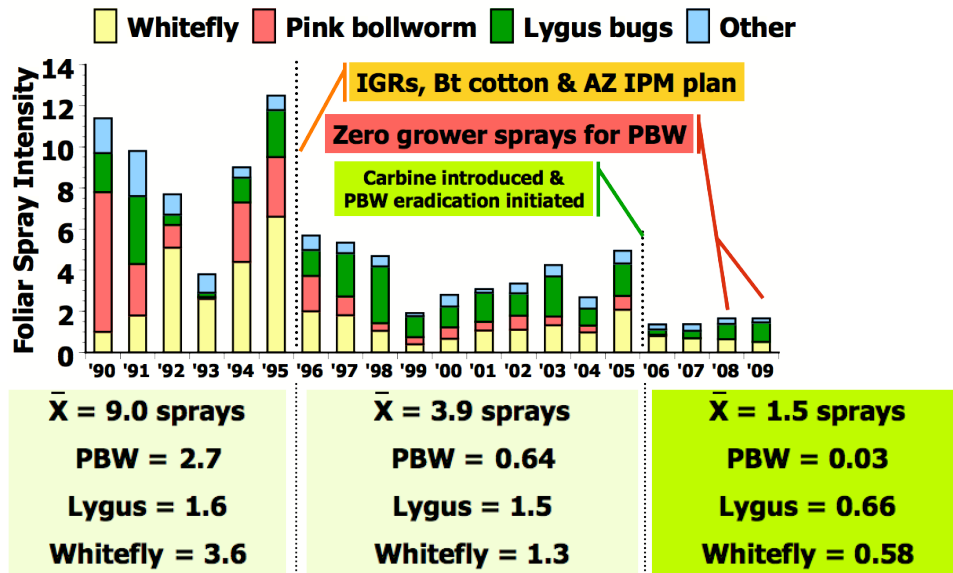


Figure 2. Statewide average cotton insecticide use patterns in Arizona, 1990–2009, by key pest. Over 1.6 million lbs a.i. annual reduction in the last 4 yrs compared to the 32-yr high in 1995; estimated savings in control costs & yield in excess of \$220M. *Source: Cotton Insect Losses Database, Arizona Pest Management Center, Ellsworth et al. 2009.*

Publications (all emphasis areas)

Bealmear, S. R. 2010. Whitefly Pest Control Survey of Homeowners and Ornamental Plants. In Proceedings, 2010 American Society for Horticultural Science, 143:139. Palm Desert, CA. August, 2010.

Bealmear, S. R. 2010. Fungus Gnat Integrated Pest Management. Fact Sheet. University of University of Arizona Cooperative Extension, Publication AZ1531. <http://cals.arizona.edu/pubs/insects/az1531.pdf>

Bealmear, S.R. 2010. IPM for the Home Gardener. University of Arizona Cooperative Extension, Publication AZ1521 <http://cals.arizona.edu/pubs/insects/az1521.pdf>

Brown, P.W., P.C. Ellsworth, M. Olsen, J. Silvertooth, R. Tronstad. 2010. Stub Cotton Production in Arizona. A Review and Feasibility Study. An invited analysis by the Arizona Cotton Growers Association. 29 pp.

Call, R. 2010. Section ID, CORE Information and Concepts: Equipment & Calibration (pp. ID1–ID26). In Arizona PCA Study Manual. Preparatory materials for the Arizona Pest Control Advisor License, ed. by Fournier A., Peterson J. & Reding J., Arizona Crop Protection Association, 574 pp.

Dillard, A. 2010. Mulch Matters. Southwest Trees and Turf. Vol 17(8):1, 10.

Ellsworth, P.C. 2009 Cotton Pest Management Field Tour - Whitefly, Lygus & Mite Control Product Performance. Small Grains & Late Season Cotton Field Day, MAC. Maricopa, AZ. 9/29/09. (Published, annotated presentation.)
<http://ag.arizona.edu/crops/presentations/09CottonFieldDaySummarylo5.pdf>

Ellsworth, P.C. 2009 Cotton Insect Management. Presented at the 2010 Desert Agricultural Conference. Casa Grande, AZ. 5/13/10. (Published, annotated presentation.)
http://cals.arizona.edu/crops/presentations/10DAC_Cotton_mgt_v3plo.pdf

Ellsworth, P.C. When is “Done is done?” Making late season insect control decisions. 2010. Presented at Late Season Production Meeting, Parker, AZ. 8/13/10. (Published, annotated presentation.) http://ag.arizona.edu/crops/presentations/10Parker_LT_decisionsvF2lo.pdf

Ellsworth, P.C. 2010. Section IIA, Invertebrates: Insect Management on Cotton (pp. IIA1–IIA69). In Arizona PCA Study Manual. Preparatory materials for the Arizona Pest Control Advisor License, ed. by Fournier A., Peterson J. & Reding J., Arizona Crop Protection Association, 574 pp.

Ellsworth, P.C. and K. Rice 2010. Section IIE, Invertebrates: Insect and Mite Management in Alfalfa (pp. IIE1–IIE31). In Arizona PCA Study Manual. Preparatory materials for the Arizona Pest Control Advisor License, ed. by Fournier A., Peterson J. & Reding J., Arizona Crop Protection Association, 574 pp.

Ellsworth, P.C. 2010. Lygus in Cotton No. 4: Chemical Control Termination Guidelines (Draft). University of Arizona Cooperative Extension Circular (peer reviewed), 2 pp. Available at: http://ag.arizona.edu/crops/presentations/DRAFT_LT_guide2-pg.pdf

Ellsworth, P.C. Pink Bollworm Control Costs & Value of Bt Technologies to AZ Cotton Growers. Report to AZ Cotton Growers Association & reprinted in ACGA newsletter, and submitted to Monsanto Company, 4 pp.

Ellsworth, P.C. & A. Fournier. 2009. Pesticide Use and User Surveys, North American Pesticide Applicator Certification & Safety Education Workshop, Impact Measurement Tools Seminar, Charleston, SC. 8/11/09. (Published, annotated presentation.)
http://ag.arizona.edu/crops/presentations/09PSEP_Charlestonv5Flo.pdf

Ellsworth, P.C., A. Fournier, P. Goodell, D. Kerns, M. Parajulee, Y. Carrière. 2010. The influence of landscape on Lygus Management: What can growers do about it? P-IE Symposium, “Transcending Geography with Regional Cotton IPM Projects”, Entomological Society of America, San Diego, CA. 12/14/10 (invited). (Published, annotated presentation.)

Ellsworth, P.C., S. Li, B. Tabashnik, J. Holloway, R. Humphries. 2011. Pink bollworm efficacy dynamics in Twinlink™ cotton. Beltwide Cotton Conference Proceedings, National Cotton Council, in press.

Ellsworth, P. & S. Naranjo. 2009. 50 Years of the Integrated Control Concept: Moving the Concept and Implementation Forward in Arizona. Fifth International Bemisia Workshop, Guangzhou, China. 11/10/09. (Published, annotated presentation.)

http://ag.arizona.edu/crops/presentations/09China_Bemisia_50-yrsvF23Flo.pdf

Ellsworth, P.C. & S.E. Naranjo. 2009. 50 years of the Integrated Control Concept: Moving the Concept and Implementation forward in Arizona, North Carolina State Univ., Dept. Entomology, Raleigh, NC. 4/13/09. (Published, annotated presentation.)

http://ag.arizona.edu/crops/presentations/09IPM_NCSU_50-yrsvF16lo.pdf

Ellsworth, P.C. & S.E. Naranjo. 2009. IPM in Arizona Cotton: Successful adoption of selective controls for multiple key insect pests, 6th International IPM Symposium, Portland, OR. 3/26/09. (Published, annotated presentation.)

<http://ag.arizona.edu/crops/presentations/09IPMPortlandBiorationalvF7lo.pdf>

Ellsworth, P.C., J.C. Palumbo, A. Fournier & Y. Carriere. 2009. Measuring Adoption of Cross-Commodity IPM Guidelines for Whitefly (*Bemisia Tabaci*) Control. 5th International Bemisia Conference, Guangzhou, China. November 8-12, 2009. (Abstract)

Ellsworth, P.C., J. Palumbo, A. Fournier, X. Li, S. Naranjo. 2010. Whitefly Management: Multi-Crop Systems. IRAC Symposium, “Understanding and Capitalizing on Agricultural Biodiversity in IPM/IRM”, Entomological Society of America, San Diego, CA. 12/14/10 (invited).

(Published, annotated presentation.)

http://ag.arizona.edu/crops/presentations/10ESA_IRAC_Bemisia7Flo.pdf

Fonseca, J. 2010. Section IC, CORE Information and Concepts: Produce Safety from Field to Table (pp. IC1–IC14). In Arizona PCA Study Manual. Preparatory materials for the Arizona Pest Control Advisor License, ed. by Fournier A., Peterson J. & Reding J., Arizona Crop Protection Association, 574 pp.

Fournier, A., P.C. Ellsworth, J. Palumbo. 2010. Arid Southwest IPM Network website. University of Arizona Cooperative Extension, Arizona Pest Management Center.

http://ag.arizona.edu/apmc/Arid_SWPMC_Info_Requests.html.

Fournier, A., P.C. Ellsworth, R. Gibson, R. Norton, K. Nolte, S. Wang, E. Taylor and L. Masters. 2010. Agronomic Crops IPM Needs Assessment, Preliminary Data and Report. University of Arizona Cooperative Extension, Arizona Pest Management Center.

http://cals.arizona.edu/apmc/agronomic_ipm.html.

Fournier, A., S. Merrigan, B. Hutchinson and D. McDonald. 2010. Program Planning and Evaluation website. University of Arizona Cooperative Extension.
<http://extension.arizona.edu/evaluation/>

Fournier, A., J. Peterson & J. Reding, eds. 2010. Arizona Pest Control Advisor Study Manual: Preparatory Materials for the Arizona Pest Control Advisors License. Arizona Crop Protection Association. (Peer Reviewed)

Gibson, R. 2010. Section V, Vertebrate Pest Management in Agricultural Systems (pp. V1–V64). In Arizona PCA Study Manual. Preparatory materials for the Arizona Pest Control Advisor License, ed. by Fournier A., Peterson J. & Reding J., Arizona Crop Protection Association, 574 pp.

Godfrey, L.D., P.C. Ellsworth, P.B. Goodell, D. Haviland. 2009. Landscape Implications for Control of Spider Mites. Beltwide Cotton Conference Proceedings, National Cotton Council. pp. 1536–1537.

Gouge, D.H. 2010. School Pest Press: August 2010 Issue, featuring Head Lice, in English and in Spanish. University of Arizona Cooperative Extension. (IPM Newsletter for School Personnel).
<http://ag.arizona.edu/apmc/docs/Septemberbedbugs.pdf>
http://ag.arizona.edu/apmc/docs/AZ_August_HeadLice_2010_Spanish.pdf

Gouge, D.H. 2010. School Pest Press: September 2010 Issue, featuring Bed Bugs, in English. University of Arizona Cooperative Extension. (IPM Newsletter for School Personnel).
<http://ag.arizona.edu/apmc/docs/Septemberbedbugs.pdf>

Gouge, D.H. 2010. School Pest Press: October 2010 Issue, featuring Mice and Rats, in English. University of Arizona Cooperative Extension. (IPM Newsletter for School Personnel).
http://ag.arizona.edu/apmc/docs/October_mice_and_rats.pdf

Gouge, D.H. 2010. School Pest Press: December 2010 Issue, featuring Pigeons in English. University of Arizona Cooperative Extension. (IPM Newsletter for School Personnel).
http://ag.arizona.edu/apmc/docs/Pigeons_at_School.pdf

Harrington, J., P.F. Byrne, F.B. Peairs, S.J. Nissen, P. Westra, P.C. Ellsworth, A. Fournier, C.A. Mallory-Smith, R.S. Zemetra, & W.B. Henry. 2009. Perceived Consequences of Herbicide-tolerant and Insect-resistant Crops on Integrated Pest Management Strategies in the Western United States: Results of an Online Survey. *AgBioForum*, 12(3&4), 412-421.
<http://www.agbioforum.org/v12n34/v12n34a16-byrne.htm>

Kelly, J. 2010. Diagnosing Problems of Roses in the Landscape. University of Arizona Cooperative Extension, Publication AZ1528 <http://cals.arizona.edu/pubs/garden/az1528.pdf>

Kerns, D., G. Wright and J. Loghry. 2010. Section IIC, Invertebrates: Insect and Mite Management in Arizona Citrus (pp. IIC1–IIC30). In Arizona PCA Study Manual. Preparatory

materials for the Arizona Pest Control Advisor License, ed. by Fournier A., Peterson J. & Reding J., Arizona Crop Protection Association, 574 pp.

Matheron, M. and M. Olsen. 2010. Section III, Plant Pathology and Disease Management (pp. III1–III38). In Arizona PCA Study Manual. Preparatory materials for the Arizona Pest Control Advisor License, ed. by Fournier A., Peterson J. & Reding J., Arizona Crop Protection Association, 574 pp.

McClure, M.A. 2010. Section IV, Nematology (pp. IV1–III24). In Arizona PCA Study Manual. Preparatory materials for the Arizona Pest Control Advisor License, ed. by Fournier A., Peterson J. & Reding J., Arizona Crop Protection Association, 574 pp.

Naranjo, S.E. and P.C. Ellsworth. 2009. 50 years of the Integrated Control Concept: Moving the model and implementation forward in Arizona. *Pest Management Science* 65:12, pp. 1267-1286. <http://www3.interscience.wiley.com/journal/117935712/group/home/home.html>

Naranjo, S.E. and P.C. Ellsworth. 2009. The contribution of conservation biological control to integrated control of *Bemisia tabaci* in cotton. *Biol. Control*. 51: 458-470.

Naranjo, S.E. and P. C. Ellsworth. 2010. Fourteen years of Bt cotton advances IPM in Arizona. *Southwest. Entomol.* 35: 437-444.

Norton, R., M. Ottman, J. Fonseca and R. Call. 2010. Section VIII, Plant Growth Regulators (pp. III1–III28). In Arizona PCA Study Manual. Preparatory materials for the Arizona Pest Control Advisor License, ed. by Fournier A., Peterson J. & Reding J., Arizona Crop Protection Association, 574 pp.

Olsen, M.W. 2011. True Mistletoes. University of Arizona Cooperative Extension, Publication AZ1308 (revised). <http://cals.arizona.edu/pubs/diseases/az1308.pdf>

Olsen, M.W. 2011. Verticillium Wilt. University of Arizona Cooperative Extension, Publication AZ1034 (revised). <http://cals.arizona.edu/pubs/crops/az1034.pdf>

Palumbo J.C. 2010. Section IIB, Invertebrates: Insect Management on Desert Vegetables and Melons (pp. IIB1–IIB127). In Arizona PCA Study Manual. Preparatory materials for the Arizona Pest Control Advisor License, ed. by Fournier A., Peterson J. & Reding J., Arizona Crop Protection Association, 574 pp.

Palumbo J.C. and Castle S.J. 2009. IPM for fresh-market lettuce production in the desert southwest: the produce paradox. *Pest Manag Sci* 65: 1311-1320.

Pena, M., J.C. Palumbo, M. Matheron, B. Tickes, K. Nolte. 2010. Vegetable IPM Updates. University of Arizona Cooperative Extension. (Biweekly IPM advisories.) <http://ag.arizona.edu/crops/vegetables/advisories/advisories.html>

Peterson, J. and G. Christian. 2010. Section IA, CORE Information and Concepts: Pesticide Laws and Rules (pp. IA1–IA22). In Arizona PCA Study Manual. Preparatory materials for the Arizona Pest Control Advisor License, ed. by Fournier A., Peterson J. & Reding J., Arizona Crop Protection Association, 574 pp.

Richards, T. J., P. C. Ellsworth, R. Tronstad and S. E. Naranjo. 2010. Market-based instruments for the optimal control of invasive species: *Bemisia tabaci* in Arizona. *J. Agric. Resource Econ.* 35: 349-367.

Richardson, J.M., B.A. Castro, J.D. Thomas, P.C. Ellsworth, L.D. Godfrey, D.L. Kerns, 2010. Control of Western Tarnished Plant Bug, *Lygus hesperus*, with Dow AgroSciences Sulfoxaflor Insecticide in Cotton. Beltwide Cotton Conference Proceedings, National Cotton Council. p. 1205.

Richardson, J.M., B.A. Castro, J.D. Thomas, P.C. Ellsworth, L.D. Godfrey & D.L. Kerns. 2011. TransformTM: field performance against *Lygus Hesperus* in cotton. Beltwide Cotton Conference Proceedings, National Cotton Council, in press.

Schuch, U.K. and J. J. Kelly. 2011. Selecting, Planting, and Staking Trees. University of Arizona Cooperative Extension Publication AZ1402 (CD of 36 slides with notes, revised)
<http://cals.arizona.edu/pubs/summary/az1402ndx.html>

Silvertooth, J.C. 2010. Section IB, CORE Information and Concepts: Integrated Crop Management (pp. IB1–IB20). In Arizona PCA Study Manual. Preparatory materials for the Arizona Pest Control Advisor License, ed. by Fournier A., Peterson J. & Reding J., Arizona Crop Protection Association, 574 pp.

Tabashnik, B. E., M. S. Sisterson, P. C. Ellsworth, T. J. Dennehy, L. Antilla, L. Liesner, M. Whitlow, R. T. Staten, J. A. Fabrick, G. C. Unnithan, A. J. Yelich, C. Ellers-Kirk, V. S. Harpold, X. Li and Y. Carrière. 2010. Suppressing resistance to Bt cotton with sterile insect releases. *Nature Biotechnology*: 28(12): 1304-1307 (+ online methods & supplementary information, 10 pp.).

Taylor, E. 2010. Section VII, Harvest Aids (pp. VII1–VII28). In Arizona PCA Study Manual. Preparatory materials for the Arizona Pest Control Advisor License, ed. by Fournier A., Peterson J. & Reding J., Arizona Crop Protection Association, 574 pp.

Tickes, B. 2010. Section VI, Weed Management (pp. VI1–VI52). In Arizona PCA Study Manual. Preparatory materials for the Arizona Pest Control Advisor License, ed. by Fournier A., Peterson J. & Reding J., Arizona Crop Protection Association, 574 pp.

Walworth J. 2010. Section IID, Invertebrates: Insect Control in Arizona Pecans (pp. IID1–IID8). In Arizona PCA Study Manual. Preparatory materials for the Arizona Pest Control Advisor License, ed. by Fournier A., Peterson J. & Reding J., Arizona Crop Protection Association, 574 pp.

Project Modifications

Although three areas of emphasis were “zeroed out” in our approved EIPM budget, the IPM Coordinating Committee reallocated minimal resources to support important statewide Extension IPM efforts in School IPM, Recreational IPM (turf) and Pest Diagnostics. We heavily leveraged EIPM funding with other sources to exceed committed expected outputs and outcomes in most areas of emphasis.