

**Developing and Implementing Field and Landscape Level Reduced-Risk Management
Strategies for Lygus in Western Cropping Systems**

Interim Report on a Risk Avoidance and Mitigation Program grant

February 17, 2009

Date awarded: 9/1/06

FRS# 358320

CRIS# 0207436

Project # ARZT-358320-G-30-505

Principle Investigators:

Peter C. Ellsworth, IPM Specialist & State IPM Coordinator, University of Arizona, Maricopa, AZ

Pete Goodell, IPM Advisor & State IPM Coordinator, University of California, Parlier, CA

Megha Parajulee, Assistant Professor, Texas A&M University, Lubbock, TX

Scott Bundy, Assistant Professor, New Mexico State University, Las Cruces, NM

Steve Naranjo, Research Entomologist, USDA-ARS, ALARC, Maricopa, AZ

Jay Bancroft, Ecologist, USDA-ARS, Shafter, CA

Yves Carriere, Associate Professor, University of Arizona, Tucson, AZ

Al Fournier, IPM Program Manager, University of Arizona, Maricopa, AZ

Larry Godfrey, Extension Entomologist, University of California – Davis, CA

James Hagler, Research Entomologist, USDA-ARS, ALARC, Maricopa, AZ

John Palumbo, Research Scientist, University of Arizona, Yuma, AZ

Jay Rosenheim, Professor, University of California – Davis, Davis, CA

Collaborators: Andrew Corbett (Veterinary Information Network), Pierre Dutilleul (McGill University), Bob Hutmacher (UC-Davis), M.J. Jimenez (UC-IPM), David Kerns (Texas A&M), R. Molinar (UC-IPM), Shannon Mueller (UC), Dale Spurgeon (USDA), Russ Tronstad (UA)

Partner Organizations:

Arizona Cotton Research and Protection Council

Arizona Pest Management Center

BASF

Chemtura

Cotton Incorporated Core Funding Program

Cotton Incorporated Texas State Support Committee

Cotton Incorporated California State Support Committee

Dupont Corporation

FMC Corporation

New Mexico State University IPM Laboratory

University of Arizona Cooperative Extension

University of Arizona Maricopa Agricultural Center

University of California Davis, Dept. of Entomology

University of California Statewide IPM Program

UC Davis Agronomy Farm

UC Kearny Agricultural Center Geospatial Laboratory
UC Shafter Research and Extension Center
UC West Side Research and Extension Center
USDA Agricultural Research Service
USDA ARS Arid Lands Agricultural Research Center
Valent Corp, USA
Yulex Corporation
Yuma Agricultural Center, University of Arizona
USDA National Research Initiative program

Target Audiences:

Professional Pest Control Advisors (PCAs), growers, agricultural industry representatives, Cooperative Extension, pesticide regulatory agencies, entomologists, IPM practitioners, Land Grant & USDA colleagues.

Outputs

* Conducted at least 18 field and lab experiments related to field-level Lygus damage to crops (cotton, seed broccoli, dry beans, chiles, eggplant, lesquerella, guayule) in CA, AZ, NM and TX. Experimental data are being analyzed with 4-years of Lygus control data in cotton from prior studies.

* Conducted 8 series of field experiments related to determining insecticide efficacy, timing, and effect on natural enemies in cotton and dry beans in AZ, CA and TX. This included experiments to determine deployment options for selective reduced-risk Lygus control compounds and impact of control strategies on natural enemies.

* About 12 landscape level studies were conducted over large regions in 3 states (AZ, CA, TX), covering about 2,600 sq. miles, to determine Lygus presence and movement among crops and non-crop areas, including cotton, alfalfa, guayule, weeds and native plant communities. Conducted preliminary analyses on 2007 data.

* Developed preliminary model to predict boll susceptibility based on heat units.

* Developed model and graphical interface for predicting impact of landscape factors on Lygus populations in host crops. This model will be further developed based on additional data from landscape-level research and will later serve as the basis for a Lygus management gaming simulation.

* Developed web-served GIS mapping program and made available on the web. This program is currently being revised.

* Analyzed lab studies on the impact of wind speed on Lygus movement.

- * Conducted a series of 5 capture-release studies to examine Lygus movement between crops in a cotton, lesquerella, guayule, and alfalfa agroecosystem. Assayed over 25,760 insect samples for 3 separate protein markers (n=77,280 ELISAs).
- * Researchers presented results of various studies at about 30 growers meetings, 8 field days, and 2 grower demonstrations reaching about 700 clientele in CA, AZ, NM and TX.
- * Team members presented over 20 research presentations to hundreds of scientific colleagues at various conferences and professional meetings in late 2007 and 2008 (since last reporting).
- * Weekly updates on Lygus status were produced by UC Extension throughout the field season and distributed to ca. 150 growers and PCAs via MiteFax.
- * Research info distributed to over 1,400 subscribers via electronic newsletter in TX.
- * Updated Lygus & RAMP information on home page for Lygus RAMP project (<http://cals.arizona.edu/apmc/RAMP.html>) and 2 other related sites.
- * Used RAMP listserv for ongoing communication among project partners.
- * Evaluation team developed overall approach to measuring behavior change throughout this project and conducted 3 conference calls. Collected Lygus Management Survey data at 9 mtgs in AZ, NM, CA and TZ with 116 responses. This will provide baseline for evaluation of overall project impact.
- * Published at least 3 news articles, one Cotton Beltwides Proceedings paper and 13 abstracts in the Journal of Insect Science, now available online at <http://www.insectscience.org/8.49/>.
- * Revised UC Pest Management Guidelines for Dry Beans based on RAMP research.

Outcomes and Impacts

- * Seed growers in Arizona have adopted a simple sampling methodology for detecting Lygus and FCB in *Brassica* seed crops.
- * Close association with farmer cooperator has allowed insight into the organic eggplant production system in California, and the importance of risk aversion by the farmer.
- * Selective experimental insecticides tests for Lygus control in California dry beans reduced Lygus populations (particularly nymphs) while having less impact on natural enemies than pyrethroid insecticides.
- * Carbine, as recommended by University of Arizona guidelines, continued to be used by the majority of Arizona PCAs to manage Lygus in 2008, replacing the standard (non-selective)

Lygus control, acephate. Secondary outbreaks were rare as a result. Growers have sprayed less than twice for all insect pests of cotton over the last 3 seasons, averaging just 0.56 sprays against Lygus, less than 45% of the 13-yr average. In 2008, growers reported much untreated acreage.

* As a result of Extension education including on-farm demos, more Arizona growers became aware of and elected to use flonicamid as the reduced-risk alternative to acephate, endosulfan, or other broad spectrum chemistries for Lygus control in cotton.

* Data generated in various field studies in Arizona on chemical efficacy and non-target effects will likely play a large role in the registration of metaflumizone in cotton for Lygus control, and will provide Arizona with a second selective agent for the control of Lygus, minimizing risks of resistance, secondary pest outbreaks and pest resurgence.

* On a college farm setting in California, alfalfa was completely cut in June causing massive movement of Lygus into cotton. Farm managers are now leave some alfalfa habitat to mitigate movement and have used this approach for the remainder of the 2008 season.

* Working with a community to develop a response to the changing landscape allowed California farmers to focus on the problem. Working with crop protection companies, we explored possible remedies for requesting new classes of insecticides for management of Lygus in safflower. The discussions and overview of the community provided interactions in which the complexity of the problem was widely appreciated and recognized.

* On August 5 and 6 in Portland, NAFA held a Strategy Meeting for a Lygus Bug Initiative for the Pacific Northwest and California. The purpose of this new multi-crop initiative is to identify a long-term IPM strategy that would develop and deliver science-based information and technologies to reduce Lygus bug pest pressure and severity for these crops. The largest, and in some cases, the only geographic growing area in the U.S. for these crops is the PNW states and California. This Strategy Meeting serves as the foundation for this new collaborative, cross-crop approach and the group will be applying for a RAMP grant early next year. This activity was stimulated by interaction with Peter Ellsworth.

* Leveraged an estimated \$338,500 in grants and gifts in 2008, about \$891,000 cumulatively throughout the project term. (Full report at <http://cals.arizona.edu/apmc/RAMP.html>)

Publications

Anonymous, 2008. Multi-state Effort Aimed at Suppressing Lygus in Cotton. Western Farm Press, December 30, 2008. Available online: <http://westernfarmpress.com/cotton/lygus-control-1230/index.html>.

Anonymous, 2008. Fully selective insecticides preferred for lygus, whitefly control in low desert cotton. Western Farm Press, November 5, 2008. Available online: <http://westernfarmpress.com/cotton/insecticides-lygus-1105/index.html>.

Bancroft, J. & Goodell, P.B., 2008. Landscape Modeling of *Lygus hesperus* Populations. Presentation Abstract, Second International Lygus Symposium, Pacific Grove, CA, April 15-19, 2007. In Goodell P.B. & Ellsworth, P.C. 2008. Second International Lygus Symposium. *Journal of Insect Science* 8:49, available online: <http://www.insectscience.org/8.49/ref/abstract2.html>.

Bancroft, J. & Goodell, P.B., 2008. Intercept Traps for Monitoring Lygus Flux Between Fields. Presentation Abstract, Second International Lygus Symposium, Pacific Grove, CA, April 15-19, 2007. In Goodell P.B. & Ellsworth, P.C. 2008. Second International Lygus Symposium. *Journal of Insect Science* 8:49, available online: <http://www.insectscience.org/8.49/ref/abstract4.html>.

Blackmer, J.L., Byers, J.A., & Rodriguez-Saona, C., 2008. Evaluation of color traps for monitoring Lygus spp.: design, placement, height, time of day, and non-target effects. Presentation Abstract, Second International Lygus Symposium, Pacific Grove, CA, April 15-19, 2007. In Goodell P.B. & Ellsworth, P.C. 2008. Second International Lygus Symposium. *Journal of Insect Science* 8:49, available online: <http://www.insectscience.org/8.49/ref/abstract9.html>.

Carriere, Y., Ellsworth, P.C., Dutilleul, P., Eilers-Kirk, C., Barkley, V. & Antilla, L., 2008. Area-wide pest management of *Lygus hesperus*. Presentation Abstract, Second International Lygus Symposium, Pacific Grove, CA, April 15-19, 2007. In Goodell P.B. & Ellsworth, P.C. 2008. Second International Lygus Symposium. *Journal of Insect Science* 8:49, available online: <http://www.insectscience.org/8.49/ref/abstract13.html>.

Cline, H., 2008. Lygus likely to come from neighboring crops in 2008. Western Farm Press, June 10, 2008. Available online: <http://westernfarmpress.com/cotton/lygus-bugs-0610/index.html>.

Ellsworth, P.C., 2008. Lygus Management: A Western Perspective. Presented by invitation at the Open Forum: Management of the Sucking Bug Complex across the Cotton Belt, 2008 Beltwide Cotton Conferences, Nashville, Tennessee. January 9, 2008. Available online: http://cals.arizona.edu/crops/presentations/08Nashville_Western_Lygus_vFlo.pdf.

Ellsworth, P.C. and Naranjo, S.E., 2008. Action thresholds and selective insecticides for management of Lygus in Arizona cotton. Presentation Abstract, Second International Lygus Symposium, Pacific Grove, CA, April 15-19, 2007. In Goodell P.B. & Ellsworth, P.C. 2008. Second International Lygus Symposium. *Journal of Insect Science* 8:49, available online: <http://www.insectscience.org/8.49/ref/abstract20.html>.

Fournier, A., Ellsworth P.C. & Barkley, V., 2008. Economic Impact of Lygus in Arizona Cotton: A Comparative Approach. Presentation Abstract, Second International Lygus Symposium, Pacific Grove, CA, April 15-19, 2007. In Goodell P.B. & Ellsworth, P.C. 2008. Second International Lygus Symposium. *Journal of Insect Science* 8:49, available online: <http://www.insectscience.org/8.49/ref/abstract22.html>.

Godfrey, L.D., Canevari, W.M., Wright, S.D, Pierce, T.L. & Lewis, R.R., 2008. Western tarnished plant bug management in California field crops - insecticide efficacy in cotton and dry beans. Presentation Abstract, Second International Lygus Symposium, Pacific Grove, CA, April

15-19, 2007. In Goodell P.B. & Ellsworth, P.C. 2008. Second International Lygus Symposium. *Journal of Insect Science* 8:49, available online: <http://www.insectscience.org/8.49/ref/abstract23.html>.

Goodell, P.B., 2008. Measuring localized movement of Lygus into cotton. Presentation Abstract, Second International Lygus Symposium, Pacific Grove, CA, April 15-19, 2007. In Goodell P.B. & Ellsworth, P.C. 2008. Second International Lygus Symposium. *Journal of Insect Science* 8:49, available online: <http://www.insectscience.org/8.49/ref/abstract24.html>.

Goodell P.B. & Ellsworth, P.C. 2008. Second International Lygus Symposium. *Journal of Insect Science* 8:49, available online: [insectscience.org/8.49](http://www.insectscience.org/8.49).

Hagler, J.R., 2008. A molecular approach to quantify predation rates on Lygus hesperus. Presentation Abstract, Second International Lygus Symposium, Pacific Grove, CA, April 15-19, 2007. In Goodell P.B. & Ellsworth, P.C. 2008. Second International Lygus Symposium. *Journal of Insect Science* 8:49, available online: <http://www.insectscience.org/8.49/ref/abstract28.html>.

Hagler, J.R., Blackmer, J. & Naranjo, S., 2008. Quantifying movement of Lygus hesperus and its natural enemies using a protein mark-capture technique. Presentation Abstract, Second International Lygus Symposium, Pacific Grove, CA, April 15-19, 2007. In Goodell P.B. & Ellsworth, P.C. 2008. Second International Lygus Symposium. *Journal of Insect Science* 8:49, available online: <http://www.insectscience.org/8.49/ref/abstract29.html>.

Katz, M., 2008. San Joaquin Valley cotton growers offered survival strategies for 2009. Western Farm Press, December 2, 2008. Available online: <http://westernfarmpress.com/cotton/survival-strategies-1202/index.html>.

McGinley, S. 2008. RAMPing Up Against Lygus. 2007 Arizona Agricultural Experiment Station Report, University of Arizona, College of Agriculture and Life Sciences, Tucson, AZ. Available online: <http://ag.arizona.edu/crops/cotton/insects/RampingupagainstLygus.pdf>.

Mueller, S.C. & Goodell, P.B., 2007. Managing Lygus in seed alfalfa. Presentation Abstract, Second International Lygus Symposium, Pacific Grove, CA, April 15-19, 2007. In Goodell P.B. & Ellsworth, P.C. 2008. Second International Lygus Symposium. *Journal of Insect Science* 8:49, available online: <http://www.insectscience.org/8.49/ref/abstract38.html>.

Naranjo, S.E., 2008. Integrating insect-resistant GM crops in pest management systems. IOBC/WPRS Bull. 33: 15-22.

Naranjo, S.E., Dierig, D., & Ellsworth, P.C., 2008. Survey and evaluation of Lygus bugs on lesquerella and guayule, two new desert crops in the western USA. Presentation Abstract, Second International Lygus Symposium, Pacific Grove, CA, April 15-19, 2007. In Goodell P.B. & Ellsworth, P.C. 2008. Second International Lygus Symposium. *Journal of Insect Science* 8:49, available online: <http://www.insectscience.org/8.49/ref/abstract40.html>.

Naranjo, S.E. & Ellsworth, P.C. 2008. Population dynamics and impact of potential pests and natural enemies in two new industrial crops in the western US. Poster presentation, Entomological Society of America, Reno, NV.

Naranjo, S.E. & Luttrell, R.G., 2009. Cotton Arthropod IPM. P. 341-353. *In* Integrated Pest Management: Concepts, Tactics, Strategies & Case Studies, E. B. Radcliff & W. D. Hutchison (eds.). Cambridge University Press, Cambridge, UK.

Naranjo, S.E., Ruberson, J.R., Sharma, H.C., Wilson, L. & Wu, K.M., 2008. The Present and Future Role of Insect-Resistant GM Cotton in IPM. P. 159-194. *In* Integration of Insect-Resistant Genetically Modified Crops within IPM Programs, J. Romeis, A. M. Shelton & G. G. Kennedy (eds.). Springer, New York

Parajulee, M.N., Shrestha, R.B. & Carroll, S.C., 2008. Intercrop movement of *Lygus hesperus* in the Texas High Plains: Potential for landscape level management. Presentation Abstract, Second International Lygus Symposium, Pacific Grove, CA, April 15-19, 2007. In Goodell P.B. & Ellsworth, P.C. 2008. Second International Lygus Symposium. *Journal of Insect Science* 8:49, available online: <http://www.insectscience.org/8.49/ref/abstract44.html>.

Sheller, F.J., Rosenheim, J.A., & Hagler, J.R., 2008. Examining the dispersal capabilities of *Lygus hesperus* and its natural enemy *Geocoris pallens* in California's San Joaquin Valley. Presentation Abstract, Second International Lygus Symposium, Pacific Grove, CA, April 15-19, 2007. In Goodell P.B. & Ellsworth, P.C. 2008. Second International Lygus Symposium. *Journal of Insect Science* 8:49, available online: <http://www.insectscience.org/8.49/ref/abstract50.html>.

Project Modifications

McGuire changed positions after the grant application was submitted and will not be participating in this project. This has resulted in plans to drop one (unfunded) project: the development of a selective biopesticide for *Lygus*.

David Kerns was added as a Principle Investigator in place of Vice-Leser at Texas A&M University.

Jay Bancroft is no longer with USDA and will no longer participate in RAMP related projects.

Jackie Blackmer of USDA-ARS, stationed at the Arid Lands Research Center in Maricopa, Arizona, passed away this year. Jackie's expertise, and her research on factors affecting *Lygus* movement have contributed greatly to this project. It is unclear whether some of the unaddressed objectives of her research can be completed by other PIs on this project.