Project Agreement

THIS AGREEMENT is made on the date last below written between the Insecticide Resistance Action Committee (IRAC) and the Party named below.

The University of Florida Board of Trustees, a public corporation of the State of Florida (University of Florida or the"Party"), 219 Grinter Hall, Gainesville, FL 32611

WHEREAS

IRAC wishes to collaborate and or sponsor work to be carried out as detailed below:
(1) Sampling and identification. Suspected bifenthrin-resistant populations of *Blissuis insularis*;
(2) Resistance testing of confirmed *B. insularis* populations will be subjected to laboratory bioassays to assess resistance ratios (S:R ratios) to bifenthrin (Talstar).;
(3) Laboratory simulation of resistance development of three B. Insularis colonies with different phenotypes;
(4) Laboratory evaluation of management strategies.
(5) Deliverables - At the end of this 2-year project, we expect to have identified a suitable management strategy with reduced risk of insecticide resistance for application against chinch bug populations.

NOW THEREFORE IT IS HEREBY AGREED AS FOLLOWS:

Article 1

In this Agreement the following words and expressions have the meaning hereby assigned to them unless the context otherwise requires:

"IRAC"	means	the Insecticides Resistance Action Committee
"the Project Document"	means	the document entitled: Assessment of Southern Chinch Bug Insecticide Resistance Prevention
"the Project"	means	the project details in the Project Document
"the IRAC Project Leader"	means	Graham P. Head, leader of the relevant IRAC Committee/Team/Working Group or appointed representative
"the Party"	means	University of Florida

Article 2 – Reports

The University of Florida will present to IRAC interim progress reports at 6 months interval after the start of the project and a comprehensive final report at project termination.

Article 3 – Communication

Communications written or oral (other than regarding the payment of the contribution specified in Article 4) between IRAC and The University of Florida shall normally be through the IRAC Project Leader who shall keep all parties to this Agreement informed for such communications.

Article 4 – Compensation

IRAC will pay to University of Florida for the service rendered in two installments, with the second installment pending outcome of results from Year 1. IRAC will pay to University of Florida for the first installment of $21,780.00 at the start of the project in Year 1 (July 2012). Prior to commencement of work at the start of Year 2 (July 2013), a progress report summarizing results and outcomes will be submitted to IRAC for review. Upon receipt of the progress report, IRAC will have 30 days to review the progress report and determine if the project results are meeting the objectives and if funding will continue for Year 2.

- First installment at the start of the project $21,780.00 (July 2012).
- Second installment of $22,334.40 on completion of the work and review of the final report.

Changes in the context of the work or compensation should be agreed in writing between the IRAC Project Leader and University of Florida, the details of which are included as an appendix to this agreement.

Article 5 – Results

All rights and entitlement to the information obtained by the University of Florida during work carried out shall belong jointly to the University of Florida and IRAC, except insofar as such information is already known in public domain.

IRAC recognizes that UF as a public and land grant institution of higher education must have the ability to publish research results or otherwise publicly present (non-proprietary) information gained in the course of research at symposia, professional meetings, in journals, student theses and dissertations or other forums not so mentioned.

However, in order to give IRAC an opportunity to review and comment regarding loss of intellectual property and/or to identify any inadvertent disclosure of IRAC proprietary information UF will submit to IRAC copies of the proposed publication or presentation material at least sixty (60) days in advance of the submission date for publication or planned presentation date.

IRAC recognizes that timing is of the essence and the review of such materials shall be completed within that 60-days from the receipt of the planned publication. UF agrees to delete identified IRAC proprietary information from any proposed publication or presentation material unless IRAC agrees to allow its release.

At the request of IRAC, UF will agree to delay publication of materials submitted by up to another 60-days (or longer if mutually agreed upon) to allow for preparation and filling of a patent application which IRAC has right to file or to have UF file at IRAC's request

.Article 6 – Improvements

All rights and title to University Intellectual Property under Project shall belong to University and shall be subject to the terms and conditions of this Agreement. Rights to inventions, improvements and/or discoveries, whether patentable or copyrightable or not, relating to Project made solely by employees of IRAC shall belong to IRAC. Such inventions, improvements, and/or discoveries shall not be subject to the terms and conditions of this Agreement.University will promptly notify IRAC of any University Intellectual Property conceived and/or made during the Contract Period under Project. If IRAC directs that a patent application or application for other intellectual property protection be filed, University shall promptly prepare, file, and prosecute such U.S. and foreign application in University's name. IRAC shall bear all costs incurred in connection with such preparation, filing, prosecution, and maintenance of U.S. and foreign application(s) directed to said University Intellectual Property. IRAC shall cooperate with University to assure that such application(s) will cover, to the best of IRAC's knowledge, all items of commercial interest and importance. While University shall be responsible for making decisions regarding scope and content of application(s) to be filed and prosecution thereof,IRAC shall be given an opportunity to review and provide input thereto. University shall keep IRAC advised as to all developments with respect to such application(s) and shall promptly supply to IRAC copies of all papers received and filed in connection with the prosecution thereof in sufficient time for IRAC to comment thereon.

If IRAC elects not to exercise its option or decides to discontinue the financial support of the prosecution or maintenance of the protection, University shall be free to file or continue prosecution or maintain any such application(s), and to maintain any protection issuing thereon in the U.S. and in any foreign country at University's sole expense and with no further obligation to IRAC.

University grants IRAC the first option, for consideration, a non-exclusive license or an exclusive license with a right to sublicense, on terms and conditions to be mutually agreed upon. The option shall extend for a time period of 90 days from the date of disclosure to IRAC.

The University of Florida's Office of Technology Licensing (OTL) will be the point of contact for disclosures and Intellectual Property Licensing agreements.

Article 7 – Circumstances beyond Control

The University of Florida shall not be made responsible for failure to carry out the work in whole or in part due to circumstances whatever beyond his control. In the event of unforeseen circumstances, The University of Florida retains

the right to make minor changes to the program or protocol without prior consultation with IRAC so as to allow work to progress.

Article 8 – Governing Law

This Agreement shall be governed by the Laws of the state of Florida

Article 9 – Arbitration

Any dispute arising out of or in connection with this Agreement shall be finally settled under the American Arbitration Association (AAA) at a mutually agreed upon time and place.

Article 10 – Effective Date

This Agreement shall come into effect upon July 1, 2012

and remain in place until December 31, 2014

Insecticide Resistance Action Committee (IRAC)

6/21/12

U.S. Chairman Date
Graham Head of Monsanto

University of Florida

6/20/12

Brian Prindle Date
Associate Director of Research, Authorized Official

Appendix 1.

Mitigation of Southern Chinch Bug Insecticide Resistance

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The southern chinch bug (*Blissus insularis* Barber) is the most damaging insect pest of St. Augustinegrass in the Southeastern United States. Aggregations of nymphs and adults feed within leaf sheaths at the crown and stolons. This feeding causes turf growth to decline, plant color to turn yellowish then brown with a reddish or burnt appearance, and the lawn to appear drought-stressed as it dies. Tolerance to turf damage is low, especially in deed-restricted communities that require high quality landscapes. Any damage to St. Augustinegrass often is misdiagnosed as irrigation system problems, scalping injury, animal urine, or even herbicide damage. Preventive insecticide applications are the norm, and monitoring by lawn care operators is limited. Host plant resistance has been overcome (*e.g.*, populations thrive on the cultivars 'Floratam' and 'Captiva') and biological control agents are present but ineffective at preventing damage in untreated lawns and are absent in intensively managed lawns.

Blissus insularis has developed resistance to nearly every chemical class used since the 1950s (*e.g.*, cyclodienes, organophosphates, carbamates, pyrethroids). Several variables contribute to this pest's tendency to develop resistance to insecticides: it's host plant is widespread (St. Augustinegrass comprises three-fourths of turfgrass grown in Florida), it has multiple generations (≤10 in South Florida) with overlapping life stages each year, and development from egg to adult takes 4-6 wk while adults live another 2 mo. Hence, this species will likely continue developing resistance to new products, unless new management strategies are adopted by turfgrass managers. Where resistance to pyrethroids (*i.e.*, bifenthrin, active ingredient in Talstar 7.9 P) has been documented, only the neonicotinoids [e.g., clothianidin (Arena 50 WDG) and thiamethoxam (Meridian)], and the premixes of bifenthrin with either clothianidin (Aloft SC) or imidacloprid (Allectus), have satisfactorily knocked down chinch bug populations. However, with apparently no new insecticidal compounds in development for this market, we need to delay resistance development to the neonicotinoids and regain or stabilize the use of pyrethroids in the urban marketplace.

Combining insecticidal compounds is controversial among entomologists, and is largely discouraged in turfgrass pest management. Yet, theoretically, mixtures could be used to broaden the spectrum of product activity (*ie.*, kill more pest species), increase product efficacy against one target pest that has not yet developed resistance, and in a resistance management strategy by potentially overwhelming the insect's nervous system. However, information is lacking on whether or not mixtures are viable tools when one active ingredient (*e.g.*, bifenthrin) in the mixture has resistance problems when used alone. Thus, this project will determine if rotating between single active ingredient products with different modes of action and/or using mixtures may provide better resistance management against *Blissus insularis*.

Materials and Methods

Sampling and Identification. Populations of *B. insularis* (at least five) will be vacuum-collected with a modified leaf blower from multiple St. Augustinegrass lawns in Florida during the summer of 2012. Sites will be identified in collaboration with County Extension agents, university colleagues, and product manufacturer Sales or Research & Development representatives. Treatment histories will be obtained, if possible. *Blissus insularis* nymphs and adults will be removed from any debris and placed into colony (Vázquez et al. 2010) at the University of Florida Landscape Entomology laboratory in Gainesville, FL (Alachua Co.).

St. Augustinegrass Maintenance. Commercially-obtained plugs of 'Palmetto' St. Augustinegrass will be established in 15.2 cm plastic pots containing Farfard potting soil (Conrad Farfard Inc., Agawam, Massachusetts). Plants will be maintained in a University of Florida greenhouse in Gainesville, Florida, under a 14L:10D photoperiod with day and night temperatures of ~27 and 24°C, respectively. Plants will be fertilized weekly, watered as needed, and cut to a height of ~7.6 cm.

Initial Bifenthrin Resistance Assay. Tests will be conducted using an airbrush bioassay on plugs of St. Augustinegrass (Vázquez 2009). A bifenthrin-susceptible laboratory population will be used as a standard in this test. Serial dilutions (based on preliminary lab tests) will be made with formulated bifenthrin (TalstarOne®); prepared fresh on each test date. Eight or 9 concentrations will be tested for each population so the mortality ranges from 5 to 95%. The number of dead *B. insularis* will be assessed at 72 h using a 10× dissecting microscope. Insects will be scored as dead if they are on their backs or unable to walk. This will indicate what the resistance ratios (S:R ratios) of each population are to bifenthrin.

Additional Insecticide Testing. Each insecticide (Talstar, Aloft, Arena) will then be tested at a dose that translates into the recommended label rate per acre (29.7 fl oz of Talstar = 0.15 lbs of bifenthrin). Parallel bioassays will measure resistance to comparable doses of Aloft LC SC (17.5 fl oz per acre = 0.15 lbs of bifenthrin + 0.3 lbs of clothianidin per acre), Arena 50 WDG (9.6 fl oz = 0.3 lbs of clothianidin), and control mortality (water). Results from these assays will determine S:R ratios of each population and possible cross-resistance to alternative products currently available for chinch bug control.

Laboratory Simulation of Resistance Development. From the sampled and evaluated populations, three laboratory chinch bug colonies with different phenotypes (high, intermediate, and no/minimal resistance to bifenthrin) will be

established. Each of these colonies initially will be divided into two groups (A and B). Colonies from group A will be released from selection pressure and reared without bifenthrin exposure, while colonies from group B will be reared under sublethal exposure to bifenthrin (to attempt to obtain purely bifenthrin-resistant populations). For 9 generations (1 generation develops from egg to adult in 5-6 weeks; adults live another 2 mo), every third generation of chinch bugs will be subjected to resistance testing as described above. It should be noted that potential pitfalls may include colony collapses or colony contamination with natural enemies, and additional sampling from sites with known S:R ratios may be required to establish new chinch bug colonies. To be prepared for the worst case scenario (sequential collapses), suitable sites with known bifenthrin treatment regimes will be identified during the initial phase of this project for repeated collections.

Laboratory Evaluation of Management Strategies. Rearing of bifenthrin-resistant and -susceptible chinch bug colonies will allow us to evaluate the effect of different treatment plans on resistance development. Additional groups of selected colonies will be exposed to the following pesticide application plans with switches made between generations: group C (rotating between Talstar and Arena); group D (rotating between Talstar and Aloft); group E (rotating between Aloft and Arena). Each third generation will be subjected to resistance testing as described before. By comparing the rate of shift in S:R ratios between groups A through F, we expect to be able to outline a management strategy that will minimize the development of insecticide resistance by chinch bugs.

Statistical Analyses. Differences in susceptibility to the insecticides between populations will be tested by the 95% confidence limits (CL) of lethal concentration ratios (LCRs) at LC50 (Robertson and Priesler 1992, Robertson et al. 2007).

Deliverables

At the end of this 2-year project, we expect to have identified a suitable management strategy with reduced risk of insecticide resistance for application against chinch bug populations. Study results will be published in peer-reviewed entomological journals and in the Florida Turf Digest. An extension article summarizing the results and incorporating resistance management strategies will be published in the Florida Pest Pro trade journal.

In addition, a hands-on training program for certified pesticide applicators in the Lawn and Ornamental category (Florida Statutes, Chapter 482) will be developed in collaboration with an advisory group (includes county extension agents, managers/owners of lawn care companies, UF faculty, and Florida Dept. of Agric. and Consumer Services [FDACS]), pilot-tested, and formally delivered through the UF/IFAS "Pest Management University". Topics for this program will include how to read /understand a label, how to determine a compound's mode of action, pesticide compatibility, proper mixing/application procedures, pesticide safety, and how to delay or mitigate pesticide resistance. Participants will receive a binder with educational materials, including copies of any PowerPoint slides, handouts, and the IRAC mode of action booklet. The program will be videotaped and video clips of different techniques/topics will be developed and posted online.

Proposed Budget

Anticipated Expenses (2 yrs)	**2012 (Year 1)**	**2013 (Year 2)**
Personnel: Graduate Student + 3% raise in Y2 ($16,800 in Y1, $17,304 in Y2)	$16,800.00	$17,304.00
Travel: Mileage, gas, per diem, lodging	$750.00	$750.00
Supplies	$2,250.00	$2,250.00
Total direct costs	$19,800.00	$20,304.00
Indirect costs (10%)	$1,980.00	$2,030.40
Total	**$21,780.00**	**$22,334.40**

References

Robertson, J.R., and H. K. Priesler. 1992. Pesticide bioassays with arthropods. CRC Press, Boca Raton, Florida.
Robertson, J.R. et al. 2007.

Vázquez, J. C. 2009. Initial steps for developing a resistance management program for the southern chinch bug, *Blissus insularis* Barber. University of Florida, Department of Entomology and Nematology Dissertation. Gainesville, FL. 171 pp.

Vázquez, J. C., M. A. Hoy, R. N. Royalty, and E. A. Buss. 2010. A synchronous rearing method for *Blissus insularis* (Hemiptera: Blissidae). J. Econ. Entomol. 103(3): 726-734.

Vázquez, J. C., R. N. Royalty, and E. A. Buss. 2011. Susceptibility of *Blissus insularis* (Heteroptera: Hemiptera: Blissidae) populations in Florida to bifenthrin and permethrin. Florida Entomol. 94(3): 571-581.