The Next Five Years of IPM Research and Implementation: *Inspect, Reduce, Remove*

Robert G. Hollingsworth, Research Entomologist
US Pacific Basin Agricultural Research Center, Hilo, Hawaii
Project on Areawide IPM of Coffee Berry Borer in Hawaii and Puerto Rico

Funded through National Program staff at the USDA Agricultural Research Service

5-year program at about $1 million/yr
Approximately 15 scientists and extension workers have written proposals and are receiving money
We meet each year to give project updates and share information with the growers
Does coffee berry borer need an Areawide?

• Yes, to prevent pest spread to other islands
• Yes, to prevent mass emigration
• Yes, because different tactics are needed in different areas due to differences in climate and pest pressure
ARS may receive 5 years of new Areawide Funding

• There have been three previous years of funding under the Areawide. Not all of the money have been spent. Specific Cooperative Agreements are in place for many of the researchers through mid-2018.

• However, new money is needed to beef-up research programs for those researchers, to provide money for new researchers, and to fund new initiatives.

• Dr. James gave us the choice of putting together a one-year plan now and a more comprehensive plan in 2017, or putting together a comprehensive 5 year plan now. We did a little of both.
Proposal received this year for a demonstration of Frequent Harvesting Technique:

**Reducing Coffee Berry Borer Populations and Increasing the Quality of Coffee Production by Improving Cultural Control Practices in Coffee Farms from Hawaii**

**Investigators:**
Luis F. Aristizábal, IPM-CBB Consultant
Suzanne Shriner, CBB Grant Administrator, Synergistic Hawaii Ag Council
Robert Hollingsworth, USDA/ARS, Research Entomology

**Collaborators:**
Rondall Stevens, General Manager Ka’u coffee farm, Pahala, HI
Bod Nelson, Owner Lehuula coffee farm, Kona, HI

**Contact information:**
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Mid-Florida Research & Center
University of Florida
2725 S. Binion Rd
Apopka, FL, 32703
Cell:813-863-4995
laristizabal721@gmail; larist@ufl.edu
Have all the pathogens of CBB been found?

There may be protozoa (neogregarines), microsporidia, baculoviruses, could be discovered both in Hawaii and other areas of world that could be used in a classical biological control or inoculative technique to add stress, illness, mortality to the CBB population.
“The microsporidian *Mattesia* sp. was observed only once, while examining the adult borer’s intestines coming from a population of laboratory-reared insects, kept at Cenicafé. Individuals of this host, affected by these protozoa, are relatively inactive and their reproduction is reduced or show inability to breed.”
Nosema:
a genus of microsporidian parasites. The genus, circumscribed by Swiss botanist Karl Wilhelm von Nägeli in 1857, contains 81 species. Most parasitise insects and other arthropods, and the best-known Nosema species parasitise honeybees, where they are considered a significant disease by beekeepers, often causing a colony to fail to thrive in the spring as they come out of their overwintering period.

Kingdom: **Fungi**
Division: **Microsporidia**
Class: **Dihaplophasea**
Order: **Dissociodihaplophasesida**
Family: **Nosematidae**
Name: Donald C. Steinkraus <steinkr@uark.edu>
Dept. of Entomology, 319 AGRI
Univ. of Arkansas, Fayetteville, AR 72701

Academic Record:
- Ph.D. Cornell University 1987
- M.S. University of Connecticut 1979
- B.A. Cornell University 1975

Primary Research Area: Biological control with pathogens & apiculture

Current Appointment: 55-85% Research, 0-35% Teaching, 15% Service

Professional Experience:

<table>
<thead>
<tr>
<th>Rank/Position</th>
<th>Institution</th>
<th>Date</th>
<th>Research Areas</th>
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<tbody>
<tr>
<td>Full Professor</td>
<td>University of Arkansas</td>
<td>1999-date</td>
<td>Biocontrol &amp; Apiculture</td>
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<tr>
<td>Associate Professor</td>
<td>University of Arkansas</td>
<td>1994-98</td>
<td>IPM &amp; Insect Pathology</td>
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<tr>
<td>Assistant Professor</td>
<td>University of Arkansas</td>
<td>1989-99</td>
<td>Row Crop IPM</td>
</tr>
<tr>
<td>Research Associate</td>
<td>Cornell University</td>
<td>1987-89</td>
<td>Dairy/Poultry IPM</td>
</tr>
</tbody>
</table>
Predator Thrips

*Karnyothrips flavipes*, a predator thrips, is a biological control agent for Coffee Berry Borer in Kenya.

*Karnyothrips* lay eggs inside infested coffee beans. Adults and larva thrips feed on CBB eggs and larvae.
Infected juveniles of *Steinernema feltiae* from within *Galleria*.
An ambusher, it waits for a host to come by.
Nematodes could be ideal for killing CBB in rocky soil
Honey bees and CBB
Wild bees are disappearing

- In Hawaii Island......
- Varroa mite detected in 2008
- Small hive beetles found in 2010

- Old-timers (anyone who was farming coffee 8 or more years ago) reminisce about the hum that used to be.
Neelendra K. Joshi
Department of Entomology, 319 Agriculture Building, University of Arkansas, Fayetteville, AR.
Email: nkjoshi@uark.edu, Cell 814 380 4541

Education

2011  Ph.D. (Dual Degree) – Entomology and Comparative & International Education
The Pennsylvania State University, University Park, PA, USA
2001  Master of Science Agriculture - Entomology
G.B. Pant University of Agriculture & Technology, Pantnagar, India
1999  Bachelor of Science - (Major: Zoology, Botany, & Chemistry)
Kumaun University, Nainital, India

Research Focus

- Pollinator biology, ecology and ecosystem services, Pollinator and non-target arthropods’ ecotoxicology and pesticide risk assessment, Pollinator conservation and management in economically important crops and other ecosystems. Integration of pollinator health into existing IPM programs and crop production.
- Ecologically-based IPM in various crops, Insect ecology, Modeling insect phenology, Monitoring and sampling, Insecticide resistance, Development and implementation of IPM programs.

Professional Experience

2015 - Present  Assistant Professor, University of Arkansas (Entomology), Fayetteville, AR
2011 - 2015  Postdoc. Research Scholar, Penn State University (Entomology), University Park, PA
2005 - 2011  Doctoral/Grad. Research Assistant, Penn State University (Entomology), PA
2004 - 2004  Senior Research Fellow, G.B. Pant University of Agriculture & Technology (Dept. of Entomology) - Hill Campus, UK, India
2002 - 2003  Junior Research Fellow, H.N.B.G. University, (Dept. of Zoology), Tehri, UK, India
2001 - 2002  Assistant Manager, Manjushree Plantations Limited (Coffee, Tea, Cardamom), New Hope, TN, India.
Excerpt from proposal of Neel Joshi and Donald Steinkraus received this year

- Although there are a few species of coffee that are self-fertile, recent studies convincingly suggest that the yield of coffee (both self-fertile as well as self-sterile species) is significantly increased by flower visitation by honey bees (Klein et al. 2003b, Roubik 2002b) and different species of wild bees (Klein et al. 2003a). For instance, in case of the highland coffee (*Coffea arabica*) grown in Indonesia, the fruit-set had been reported to be increased by over 12 % when flowers were pollinated by bees (Klein et al. 2003b). In Panama, Roubik (2002b) found a 25 % increase in the mass of ripe berries when African honey bees dominated flower visitation in *C. arabica* plants. Roubik (2002b) also found a significant increase (49 %) in the abundance of ripe berries per flower in plants under open pollination. This research reveals that the bees not only significantly contribute to *C. arabica* fruit-set, but also consistently improve production (over 36%) in coffee farms (Roubik 2002b).
Reducing pest populations through good sanitation and harvesting methods (strip picking, harvesting frequency, techniques to prevent coffee berries from ending up on the ground, mitigation measures for CBB in berries already on the ground)

5 target areas of IPM research/implementation
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- Efficient use of *Beauveria* and other environmentally acceptable chemicals, including improved application and pest sampling methods
5 target areas of IPM research/implementation

Basic biological studies of the pest and natural enemies under Hawaii conditions (life history, life table or other demographic studies, infestation biology, emigration from feral coffee, seasonal mass immigrations, survival during periods when coffee berries are not available on trees)
Infestation biology and life history of CBB: New discoveries
(Desperate Times Require Desperate Measures)

Robert G. Hollingsworth, Research Entomologist
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Fate of CBB in Berries with and without ground cover
# Results After 4 weeks

<table>
<thead>
<tr>
<th>Bob Nelson's Farm</th>
<th>Number of Adult Females per 10 berries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Set up October 8, 2015</strong></td>
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<tr>
<td><strong>Adult Beetles</strong></td>
<td><strong>15-Oct</strong></td>
</tr>
<tr>
<td>Plot 1 Bare</td>
<td>15</td>
</tr>
<tr>
<td>Plot 2 Grass</td>
<td>74</td>
</tr>
<tr>
<td>Plot 3 Bare</td>
<td>15</td>
</tr>
<tr>
<td>Plot 4 Grass</td>
<td>40</td>
</tr>
</tbody>
</table>

6 of 10 "rotten"
## Results from Bare vs. Groundcover

**Bob Nelson's Farm**  
**Number of Adult Females per 10 berries**  
**Set up October 8, 2015**

<table>
<thead>
<tr>
<th>Adult Beetles</th>
<th>15-Oct</th>
<th>23-Oct</th>
<th>29-Oct</th>
<th>4-Nov</th>
<th>SUBTOTAL</th>
<th>Beetles/Berry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plot 1 Bare</td>
<td>15</td>
<td>39</td>
<td>24</td>
<td>26</td>
<td>104</td>
<td>2.6</td>
</tr>
<tr>
<td>Plot 2 Grass</td>
<td>74</td>
<td>11</td>
<td>27</td>
<td>7</td>
<td>119</td>
<td>3.0</td>
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<tr>
<td>Plot 3 Bare</td>
<td>15</td>
<td>20</td>
<td>13</td>
<td>27</td>
<td>75</td>
<td>1.9</td>
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<tr>
<td>Plot 4 Grass</td>
<td>40</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>50</td>
<td>1.3</td>
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</table>

6 of 10 "rotten"

<table>
<thead>
<tr>
<th>Date</th>
<th>12-Nov</th>
<th>18-Nov</th>
<th>25-Nov</th>
<th>2-Dec</th>
<th>8-Dec</th>
<th>16-Dec</th>
<th>SUBTOTAL</th>
<th>Beetles/Berry</th>
<th>TOTALS</th>
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</thead>
<tbody>
<tr>
<td>20</td>
<td>22</td>
<td>28</td>
<td>37</td>
<td>76</td>
<td>35</td>
<td>218</td>
<td>3.6</td>
<td>322 Bare</td>
<td></td>
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<tr>
<td>16</td>
<td>7</td>
<td>0</td>
<td>3</td>
<td>27</td>
<td>9</td>
<td>62</td>
<td>1.0</td>
<td>181 Grass</td>
<td></td>
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<tr>
<td>21</td>
<td>12</td>
<td>2</td>
<td>18</td>
<td>47</td>
<td>16</td>
<td>116</td>
<td>1.9</td>
<td>191 Bare</td>
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</tr>
<tr>
<td>0</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>23</td>
<td>0</td>
<td>30</td>
<td>0.5</td>
<td>80 Grass</td>
<td></td>
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</table>

4 berries
• Upon emergence, F1 or F2 females may bore into berries of the same coffee plant (common), or colonize trees some distance away (rarely up to 500 meters away). Males never leave the fruit.

• There can be three to five generations per season. Up to a hundred beetles can be found in a single fruit.

• The insect is very sensitive to desiccation and waits for the rains to leave the fruit. The most affected areas in the crops are the shady and moist ones.
average number of adults per raisin

Seven different farms in the Kona District Sampled in late February
Development and demonstration of farming systems which document the cost, efficiency, and practicality of individual IPM components and include information on yield, quality, and profit.

5 target areas of IPM research/implementation
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• Cultural methods to reduce pest incidence or facilitate IPM (planting density, pruning methods, shade, irrigation, windbreaks, ground covers and other inter-crops, techniques for synchronizing flowering)
Tactics for IPM implementation in Hawaii

**Inspect:** Use traps to detect movement, use infestation counts (% berries with holes, positions of beetles in berries)

**Reduce:** Well-timed Beauveria, sprays, pyronyl, Surround, pruning techniques, physical barriers, predators, **repellents**

**Remove:** frequent and thorough harvesting, strip picking, stumping, plant growth hormones for uniform flowering, **ground covers**

Square-Necked Grain Beetle, *Cathartus quadricollis*

Ethanol/methanol trap used for timing of *Beauveria* sprays

Ethanol/methanol trap used for timing of *Beauveria* sprays