

CBB Response Manual

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I. Introduction

The coffee berry borer (CBB), *Hypothenemus hampei* (Ferrari), is the most serious insect pest of coffee worldwide, causing severe economic damage in nearly every region where commercial coffee is grown. For many years, Hawaii coffee growers had developed successful horticultural and pest management programs in the absence of this pest.

However, the invasion of the beetle into coffee farms on the Big Island in 2010 threatened to seriously impact the entire coffee industry throughout the Hawaiian Islands. This industry comprises approximately 7,000 acres, with total production value of about 50 million dollars, which makes it the third largest crop in the state (<https://www.nass.usda.gov>). Although the means by which CBB made its way to the remote Hawaiian Islands remain unknown, genetic analyses of Hawaii's CBB compared to other CBB populations world-wide suggest the most likely route of invasion was from Kenya to Uganda to Latin America to Hawaii (Chapman et al. 2015). It is thought that CBB was accidentally transported to the Big Island by farm workers or other travelers from Latin America who accidentally carried borer-infested seeds in their clothing or luggage, or else by small quantities of illegally imported beans, although improper fumigation of legal shipments from Latin America remains a possibility.

After its arrival, CBB spread quickly throughout the Kona and subsequently Ka'u coffee growing areas of the Big Island. The beetle moves around quite rapidly, mostly (it is thought) by vehicles and people inadvertently transporting infested coffee beans and berries, harvest bags, equipment, etc.

In 2014, CBB made the jump from Hawaii Island to Oahu, where it was found infesting hundreds of acres at Dole's Waialua Coffee Estate. A quick response delimitation survey (see details below) determined that it was too late to attempt eradication at Waialua, and Integrated Pest Management options were presented to the grower.

In Nov. 2016, two specimens of CBB were found infesting a backyard coffee planting in Hana, Maui. The trees were stripped and the ground around the trees raked to remove all cherry and raisins. Traps were then placed to monitor for any remaining CBB in the area. As of this writing (December 2016), CBB has still not been found in the commercial coffee growing areas of west Maui, nor on the islands of Kauai, Molokai, or Lanai.

II. Advance Preparation

Enough is known about CBB biology from decades of experience in other countries, and from the last 5 years in Hawaii, to suggest approaches that may help to delay the time when CBB moves into currently uninfested coffee growing areas of the state. Most research entomologists concede that it is only a matter of time until all islands and areas in the state are invaded, but it may be possible to delay the expansion through the following methods:

A. Good management practices.

1. Field sanitation. The removal of dried coffee berries (i.e, raisins) and other unharvested coffee fruit from the trees and from the ground, to the greatest extent possible, will minimize the host material available for CBB colonization and reproduction.

2. Remove unmanaged coffee trees from the area around the farm. Coffee seeds are often spread by pigs, birds, rats and water runoff to establish stands of unmanaged live coffee plants that can serve as reservoir host material for CBB. Working with neighbors or adjacent property owners to remove any unmanaged coffee (including both feral coffee and abandoned or unmanaged farms) will minimize available host material.

3. Weed control. Excessive weed growth in coffee plantations not only harms plant growth and weakens trees, but can hinder accessibility, both for monitoring purposes, and for delimitation surveys and response treatments should an incipient outbreak be detected. Keeping weeds on the farm well-managed will facilitate both monitoring and action response efforts.

4. Minimize visitors / educate visitors. Most entomologists consider the likeliest means of CBB invasion to be inadvertent carrying of infested coffee seeds (or adult beetles) by humans. Thus, one way to minimize risk of infestation is to minimize visitors, especially those that have recently travelled from CBB infested regions (i.e., Kona or Kau). For some plantations (i.e., on west Maui) this may be feasible, but for others (i.e., Kauai Coffee) the visitor center is an important component of the overall business model. In the latter case, educational materials informing visitors of the risk of transporting (potentially infested seeds) is important to mitigate risk. To this end, we have widely distributed posters (shown below) to help educate coffee-tourists (additional copies of this poster are available from messing@hawaii.edu).

Help Protect Hawaii Coffee

Taste the coffee
Hawaii has it all - from seed to cup, from small farms to large estates, from hand pickers to accomplished baristas.

Tour the farm
Coffee is grown on all the major islands, with 8,000 acres statewide. Enjoy a plantation tour and learn how coffee is grown and prepared.

Don't pick the berries
Please DO NOT pick or touch berries from the trees or off the ground. Never carry berries off the farm. Berries may contain beetles inside the seeds.

Stop the spread
The coffee berry borer is a small beetle attacking coffee worldwide. It is not yet found on Kauai, Maui, or Molokai.

College of Tropical Agriculture and Human Resources
University of Hawaii at Manoa

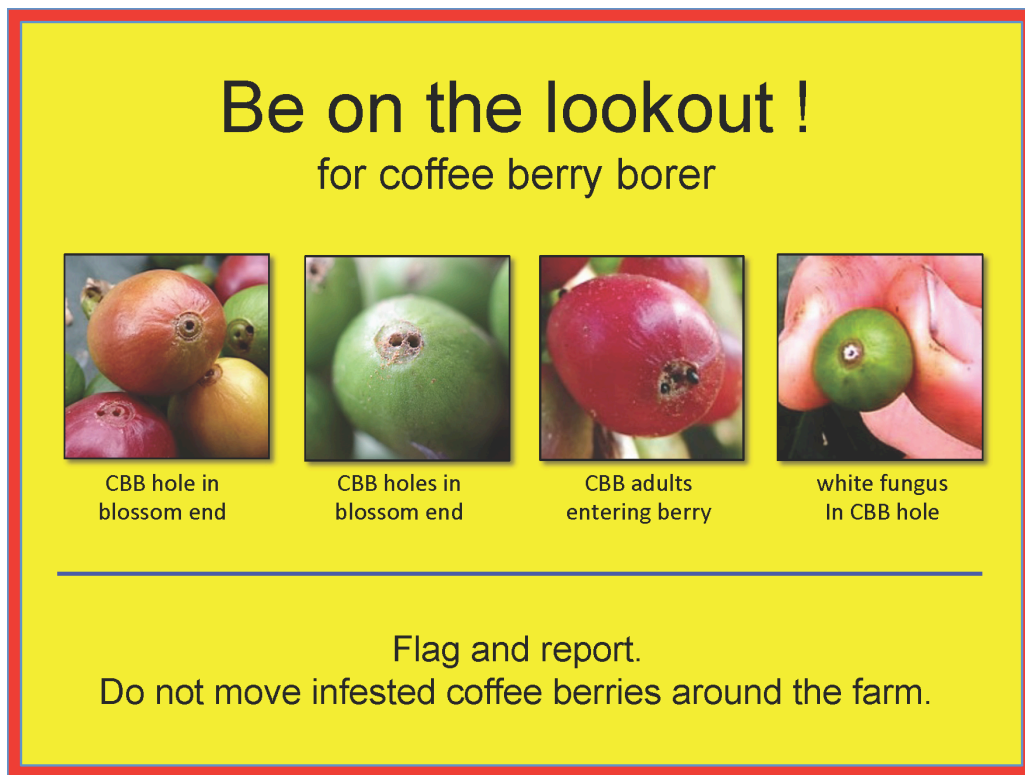
For more information call:
808-822-4984 ext 223

5. Post-harvest sanitation: Coffee farms that have mills, processing and/or storage areas can minimize risk of inadvertently spreading incipient CBB infestations by keeping all areas tightly screened as much as possible. Also, as far as it is practical to do so, growers should transport harvested coffee in covered vehicles, and should use double bags (i.e., plastic and burlap) to transport cherry.

B. Training

1. Fieldworkers. The more eyes in the field that are on the lookout for the telltale signs of CBB infestation, the more likely that a new infestation can be detected at the earliest possible time, when localized eradication may still prove feasible. It is not necessary for farm workers to be able to distinguish CBB from other morphologically similar scolytid beetles that are widespread in Hawaii. Rather, simply by looking for beetle entry holes, which almost always occur at the calyx end of the fruit for CBB, observers have a good chance of finding infestations. Educational placards (as shown below) are a useful tool that can be widely distributed to every field worker, and farm vehicle, and strategic places around the farm (lunchroom, locker room, factory, etc.). Workers should be encouraged and trained to develop a CBB mental search image, and to always be on the lookout every time they are in the field and whenever fruit (including green berries) are on the trees.

Laminated placards on heavy-duty stock, suitable for rough outdoor field usage and rainy conditions, are available upon request from: messing@hawaii.edu



2. Mill workers should also be trained to watch for typical coffee parchment and bean damage caused by CBB (refer to pictures below). On-farm record keeping should be maintained of sufficient quality and detail to be able to track back any detection of damaged beans to the particular field from which they were harvested.



C. Scouting: transects, and the role of traps.

Early detection of an incipient CBB infestation is facilitated by regular and thorough inspection of coffee fruit on the trees in the field, looking for visible adult CBB or CBB entry holes on the calyx end. It is important to include unripe (green) fruit during the inspection, as adult CBB will often attack green berries, bore only partially into the endocarp, and remain visible on the fruit surface until the seed reaches proper maturity for feeding and oviposition.

It is generally not feasible to inspect every tree on a farm, especially those with larger acreage. The question then arises: how many trees (or what percentage of trees) should be surveyed? There is no correct statistical answer to this question. Simply stated, the more trees (and the more berries on each tree) that can be inspected, the higher the likelihood of detecting invasive CBB adults before they become well established and distributed throughout the farm. The extent of inspection is mainly limited by time and labor constraints.

Given an inability to inspect every tree, how should different areas be prioritized? For islands and areas that are currently CBB-free, it is thought that the most likely route of invasion will be inadvertent transfer by human visitors or vehicles. Therefore it is logical to concentrate sampling efforts in those areas of the farm with the most human and vehicular traffic (especially visitor centers, parking areas, and processing areas). In our experience, walking up and down the rows of coffee nearest these areas, perhaps every third or fourth row, visually observing coffee berries that are waist-to-chest-high, provides the most inspection coverage on a farm with the least amount of labor.

CBB traps are an important adjunct to visual sampling. Standard Brocap traps (shown below) baited with a 3:1 mixture of methanol: ethanol; and with a killing agent (i.e., Hercon vaportape) inside the trap, have proven effective at capturing flying adult CBB to some extent. However, the utility of the traps for early detection is limited by several factors:

- traps are non-selective, and capture other closely-related beetles besides CBB. Some of these other beetles are very hard to distinguish morphologically from CBB, and the process requires painstaking examination under a high-powered (and expensive) microscope.
- the plastic traps themselves are manufactured in Mexico, and are somewhat difficult and expensive to obtain. Home-made traps can be constructed from plastic soda bottles or milk containers, but these break down quickly and must be replaced often.
- the “pulling power” of traps is unknown; that is, the distance from which beetles may be attracted to a trap, and the relative attractiveness of the trap compared to actual coffee fruit has not been well studied. Thus a positive identification of a CBB in a trap tells you only that CBB occurs somewhere in the area, but not which direction, nor how far from the trap location.



D. Site-specific action plan

Every coffee farm that is not currently infested by CBB should have an action plan ready to implement immediately upon detection of an incipient invasion. Farm management should maintain an emergency contact list of knowledgeable and responsible Hawaii Dept. of Agriculture (HDOA) and University of Hawaii, College of Tropical Agriculture and Human Resources (CTAHR) personnel, who can assist with and help guide appropriate rapid response measures (see Appendix 1).

Farms should also have an accepted chain-of-command, an internal emergency contact list, and a well-established telephone and/or email network to quickly notify field, mill, and management workers in the event CBB is detected and rapid response is needed.

Supplies for collecting, preserving and shipping insect samples, and for conducting a delimitation survey if any CBB are detected, should be ready in order to save time should a rapid response be required. This includes multiple copies of farm maps, clipboards, vials, small sealable plastic bags (baggies), and perhaps GPS units if the farm is of sufficient size. Cell phone cameras are readily available and may prove useful in recording particular locations, and questionable evidence of damage. Also, if CBB is positively confirmed, it would be useful to have spray equipment readily available, as well as chain saws for stumping or pruning. In some cases state agricultural burning permits should be obtained in advance, if heavy pruning and burning of infested limbs and berries is part of the response plan. Also, while some pesticides (i.e., BotaniGard[®], pyrethroids) may have a limited shelf life, and therefore cannot be stockpiled, it would be prudent to make sure through local suppliers that these CBB control compounds are readily available and can be obtained on short notice should a rapid response be necessary.

III. How to respond to a new CBB invasion

A. Confirmation of beetle identity

If routine scouting or trapping turns up a coffee berry with a hole in the calyx end, or a potential CBB captured in a trap, the beetle(s) should be properly identified by someone with taxonomic expertise before going any further. This is because there are several other beetles that occasionally enter the calyx end of coffee, and frequently enter CBB traps, that are morphologically similar to CBB, and may trigger a false alarm. Tropical nut borers, *Hypothenemus obscurus*, are often found in traps, especially if near macadamia trees, but only rarely if ever enter coffee berries. Black twig borer *Xylosandrus compactus*, readily and frequently enter coffee berries, at times from the calyx end, but do not enter the coffee seed. *Ericryphalus longipilus* is more rarely encountered, but is sometimes found in traps, and quite hard to distinguish from CBB.

If a potential infested berry is found, it is important to handle it carefully to avoid spreading CBB around the farm (or between farms). The first thing that should be done is to flag the location where found, or note the position on a map, by photo, or GPS coordinates. Field workers should then report the find to farm management, or to someone trained in CBB handling. The coffee berry should then be transferred in a sealed plastic bag or vial to a secure location. Immediately contact a local CTAHR Extension Agent or HDOA entomologist (see Appendix 1). The Agent

or entomologist will then transfer the suspected berry (or adult beetle) to trained taxonomists in Honolulu, for positive identification.

While awaiting confirmation of beetle identification (which may take a few days to transfer specimens between islands), it is important to minimize human and vehicular traffic through the area where the suspect beetle was found. If harvest is in progress, farm management will have to make an economic decision whether to avoid the field in which the find occurred, until the beetles can be identified. If the harvest is not postponed, it should proceed from the outermost (non-infested) areas first, to the infested areas last.

B. Conducting a Delimitation Survey

1. Purpose of the delimitation survey. When and if a positive identification of CBB is made by a trained taxonomist, the next step in the response should be a rapid delimitation survey. The goal is to estimate the extent of CBB distribution throughout the farm, and the relative population abundance of the beetles. While more sophisticated sampling methods are used in CBB Integrated Pest Management programs (Kawabata et al. 2015), the delimitation survey has a focus primarily on speed, thus only presence/absence data (or at most rough estimates of population density) are recorded. The sole purpose of the delimitation survey is to provide farm managers with the information necessary to make a decision as to the appropriate response to a new infestation. Generally, this is a binary decision: either move into an Integrated Pest Management approach (as is currently in use throughout coffee growing areas of Kona and Ka'u), or attempt to locally eradicate an incipient infestation before it can become widely (and permanently) established on the farm.

It should be acknowledged that eradication in most situations will be exceedingly difficult or impossible. CBB's small size and protected feeding location inside the coffee berry makes detection problematic and control by pesticides or natural enemies daunting. Nevertheless, if an entire 3,000 acre farm is at risk, it may be worth the expense to at least attempt eradication, if only a few trees or even a few acres are infested.

2. Networking for manpower. A delimitation survey should focus on inspecting as many trees on the farm as possible in the shortest possible time, to provide data for decision making before the beetles have time to reproduce and to spread. To that end, an influx of manpower is needed as soon as possible after detection. In previous delimitation surveys in Hawaii, manpower (and womanpower) was provided by three government agencies (UH-CTAHR, HDOA, and USDA-ARS; see Appendix 1 for contact information); plus employees of the farm in question. Another possible source of manpower is the Invasive Species Committees on the respective islands, whose mandate includes responding to outbreaks of invasive species such as CBB. Invasive Species Committee contact information for Kauai and Maui Counties is also included in Appendix 1.

We have found it useful during delimitation surveys to organize the response crew into two-person teams; one member of each team being an agency employee with some experience and knowledge about CBB habitus and biology, and the other member of the team a farm employee with more knowledge about farm layout, roads, local conditions, and crop status in various fields.

3. Conduct of the survey: The response crew will hopefully have been trained to some extent through previous experience, presentations and visual materials; but in any case, a brief review and re-training on site is useful. The placards (shown on page 3) can be distributed for use on-site. Strict instructions should be given not to move infested (or suspect) fruit around the farm, unless enclosed in impermeable vials or bags, with the precise location recorded.

A leader or organizer should establish a central staging and reporting location, and assign response teams to particular fields or areas throughout the farm. Starting with fields on the perimeter and working inwards towards the infestation point will minimize traffic through the danger zone and reduce chances of spreading beetles inadvertently. Teams should inspect their assigned field by walking up and down the tree rows, examining fruit, and looking for typical CBB entry holes in the calyx end. As an example, in the delimitation survey at Waialua Estate on Oahu, teams were assigned to scout coffee blocks of approximately 2 acres at a time, inspecting every fourth row of trees, visually scanning 3 branches containing coffee berries at 1-2 meters height at 5 meter intervals along the row. Thus about 5% of the trees in each block were scouted.

After completion of scouting, the team should estimate each block (as a whole) as having either: (A) zero CBB symptoms; (B) low CBB infestation (~1 hole in a berry per tree); or (C) high CBB infestation (>5 holes in berries per tree). Data should then be reported back to the staging location, where it should be entered on a master map and a spreadsheet. If counts are very low, it would be useful to record the relative position of any live beetles seen on the cherries (i.e., in the AB position, see Kawabata et al. 2015).

While it also may be useful to inspect feral and abandoned coffee in the area (if time and labor allow), there is no need to examine alternate hosts other than coffee plants. Some alternate hosts for CBB have been reported in the older literature, but this has been seriously questioned and examined recently in Hawaii, where no alternate hosts were found (Messing 2012).

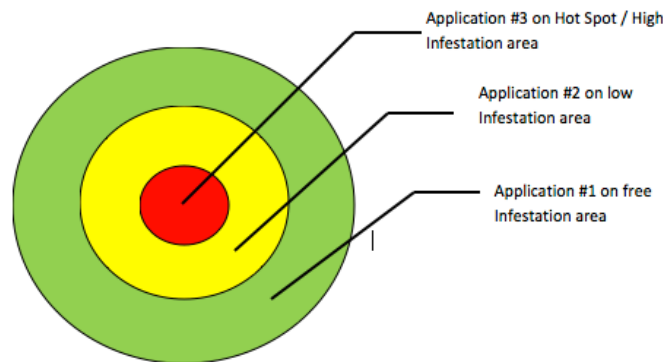
C. Decision-making and action response.

When the delimitation team leader presents the results of the survey to the coffee farm management, a decision must be made in short order as to the appropriate action response. It is the opinion of most trained entomologists that a widespread distribution and high population density of CBB on a farm preclude any realistic possibility for eradicating the beetles from that farm. Chemical, fungal, and biological control methods are only marginally effective for CBB control, as a large percentage of the beetles are well protected for most of their life history within the coffee seeds.

The decision on whether or not to attempt local eradication is based on both ecological and economic factors. While the odds of successfully establishing an entrenched population are small, this must be weighed against the certain very high costs of future CBB management (and lost production) if an incipient population is allowed to further establish and spread. It should be noted that the IPM programs worked out by CTAHR, HDOA, ARS and private growers that are currently used with some success on the Big Island are mostly relevant to relatively smaller farms that use manual labor for harvest (and sanitation). New permutations of IPM will be required for the larger, fully mechanized farms on Kauai, Maui and Molokai (and Oahu); and their efficacy cannot be predicted at this time,

If a decision is made to attempt local eradication, the primary tools available to growers are chemical pesticides, fungal pesticides, and sanitation. Of the chemical pesticides currently registered in coffee in Hawaii, pyrethroids + PBO (i.e., Pyronyl or Evergreen) offer a quick knockdown effect, but dissipate rapidly with no residual impact. The fungal pesticide *Beauveria bassiana* (i.e., BotaniGard) has the advantage of a longer residual, but is more susceptible to fluctuations in humidity, sunlight, etc. Pyronyl and *Beauveria* can be tank-mixed in a single spray; however, both products are very expensive.

The turbulence of driving spray rigs through an infested area, and the activity of the chemicals themselves, may agitate adult beetles and cause them to disperse. Therefore, to have the best chance of containing an incipient infestation, the control effort should start at some distance away from the locus of infestation and move inward.



Sanitation, in the form of removing every single infested coffee berry from the farm, is the most challenging yet most critical part of any attempted eradication. The likelihood of success depends on the population density of the beetles and the geographic spread of the infestation. Other important factors are the visibility and accessibility of dropped coffee fruit on the ground (hence the importance of regular weed control), and proper disposal of collected fruit and seeds (by deep burying, burning, or solarization).

If local eradication fails, growers are advised to move as quickly as possible into intense Integrated Pest Management (see Kawabata et al. 2015).

For additional video and Powerpoint presentations on CBB management, see also: <http://hawaiicoffee.weebly.com/cbb-management.html>

Note: larger coffee farms (such as the 3,000 acre Kauai Coffee Company) are mostly mechanized, and cannot economically support the manual labor required to do thorough sanitation for CBB management. The situation on mechanized farms is exacerbated by the fact that harvest machines routinely drop over 20% of ripe coffee fruit onto the ground. Long-term management of CBB on mechanized coffee farms in Hawaii may require changes in basic farm management practices to enhance sanitation potential. This may include changes to weed control methods and efficacy, placement of irrigation pipe, new pruning methods, active groundcover management, and purchase of new machinery capable of removing downed coffee berries from

the orchard floor. An example of orchard ground conditions that may be amenable to mechanized sanitation of dropped coffee is shown below (from a hazelnut farm in Oregon).



References cited:

- Kawabata, A., S. Nakamoto and R. Curtiss. 2015. Recommendations for Coffee Berry Borer Integrated Pest Management in Hawaii. CTAHR Insect Pests Report IP-33. available online at: <http://www.ctahr.hawaii.edu/oc/freepubs/pdf/IP-33.pdf>
- Messing, R. H. 2012. The coffee berry borer (*Hypothenemus hampei*) invades Hawaii: preliminary investigations on trap response and alternate hosts. *Insects* 3: 640-652.

Appendix 1: Emergency contact information

Hawaii Dept. of Agriculture Toll-Free Pest Hotline Number: 643-PEST (7378)

Dr. Russell Messing
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