



Recommendations for Coffee Berry Borer Integrated Pest Management in Hawai'i 2013

Andrea M. Kawabata¹, Stuart T. Nakamoto², R.T. Curtiss³

¹University of Hawai'i at Mānoa (UHM) College of Tropical Agriculture and Human Resources (CTAHR) Department of Tropical Plant and Soil Sciences,
²UHM CTAHR Department of Human Nutrition, Food and Animal Sciences,
³Hawai'i Department of Agriculture – Plant Pest Control Branch

The following document is a collaborative effort between the University of Hawai'i at Mānoa College of Tropical Agriculture and Human Resources, Hawai'i Department of Agriculture, United States Department of Agriculture PBARC, and coffee grower groups. There is much, and sometimes conflicting, information on how to control the coffee berry borer (CBB). We have synthesized the best available information resulting from the January 2013 CBB Summit. The contents of this document are general recommendations which could change as new information becomes available.

Our goal in drafting these recommendations is to provide farmers with general guidelines to better manage coffee berry borer in Hawai'i. Foreign coffee-producing regions have proven that no single approach will control CBB. Although not all recommendations will necessarily apply to all farmers, we recommend that growers use an integrated pest management approach, using as many of the suggestions as possible and in the order listed for maximum effect. This document starts with field sanitation, the most important step to reducing CBB population. We then follow with recommendations for the rest of the crop cycle, including pruning, field monitoring with traps and sampling, pesticide application, harvesting, and shipping.

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SECTION I: FIELD SANITATION

A. COFFEE CHERRY AND RAISIN

1. *How and when do I strip-pick my coffee?*

Field sanitation and stripping cherry at the end of the harvest season, regardless of CBB infestation level, are the most important CBB-control activities. When all cherry is removed from the field and there is nothing to shelter or feed CBB, the population is immediately reduced. Strip-picking is a proactive approach that all coffee farmers in Hawai'i should apply.

- Every farmer should strip-pick all coffee trees at the end of the harvest season.
 - If you have continuous, year-round harvesting, strip-picking of ripe and over-ripe cherries and raisins should be attempted after the peak harvest season.
- Strip-pick all (green, red, over-ripe, and raisin) cherry prior to flowering and/or pruning.
 - Do not allow cherry to fall to the ground or to remain on pruned branches.
 - Avoid allowing raisins to develop on the trees, as they easily dislodge from branches and end up on the ground.
 - Process or destroy all coffee from this picking.
- To encourage pickers to strip-pick:
 - Pay pickers by the hour.
 - Depending on individual farm conditions, strip-pick when 5–10% of your crop remains so a portion may be sold to help defray the cost of paying for hourly wages (vs. dumping or composting all stripped cherry).

2. *How do I dispose of CBB-infested cherry?*

CBB-infested cherry must be disposed of to prevent re-infestation of your coffee farm. We recommend using either buckets or bags that are left in the sun for at least two weeks. It is not clear if CBB are killed by heat, starvation, other factors, or a combination. If it takes longer for the CBB to die off, keep the cherry bagged or bucketed longer! It has been observed that CBB can chew through plastic bags, so if you are using bags, use thick ones. Elsewhere, burying of infested cherry is recommended, but this may not be a viable option for farms with rocky soil.

- Completely enclose CBB-infested cherry in containers or bags.
 - If using bags, use heavy-duty, industrial-strength black trash bags or double-bag regular black bags.
 - Five-gallon buckets with lids and 55-gallon drums with lids, etc., can be used to contain and kill CBB, and they have the advantage of being reusable. Do not reuse any container that previously contained pesticides, however. This is a federal violation.
 - If using burlap bags, place a trash bag inside and then tie the burlap bag to prevent tearing of the trash bag.
 - Leave bags in direct sunlight for at least 2 weeks.
- You can also bury infested cherries under at least 6 inches of soil, or
- Compost infested cherry with cherry skins.
 - Cover the pile with a tarp, and secure the edges of the tarp with a water-filled hose or similar apparatus.
- Small amounts of infested cherry may be frozen for at least 1 week to kill CBB.
- Once CBB are killed, cherry can be returned to the field, used as compost, or disposed of in an appropriate manner.
- Although not a recommended practice for CBB control, an agricultural burn permit may be obtained from and submitted to the Dept. of Health's Clean Air Branch for "fires for prevention or control of disease or pests."
 - All rules and regulations, including "no-burn" periods, must be followed, or you risk citation.

B. PRUNING

Every farm utilizes pruning methods according to individual style and preference. If using pruning as a CBB-control method, stump-pruning by block is the only viable method for establishing a large area without food or shelter for CBB. Traditional Kona-style or Beaumont-Fukunaga pruning by rows will not remove large CBB-infested areas from your farm. It is important to remember that pruning itself is not necessarily a control method; it does not kill CBB. However, it can help to make other activities easier or more effective (e.g., easier to strip and harvest, better spray coverage,

etc.). Removal of excess branches also helps to improve airflow, thereby reducing high-humidity living spaces, which CBB prefer.

- Prune trees AFTER strip-picking all (green, red, over-ripe, and raisin) cherry.
- Pruning with the Beaumont-Fukunaga method in large blocks or areas may help to better control CBB infestations within an orchard.
 - If not actively farming coffee, consider stump-pruning your coffee trees to control CBB and help neighboring farms with their attempt to control CBB infestation.

SECTION II: FIELD MONITORING

A. TRAPS

1. What are traps used for?

Traps should be used as a monitoring tool to determine when CBB is active and vulnerable to spraying, and to help indicate when to start sampling. When traps are set immediately after the final harvest or pruning, many CBB may be caught in traps, indicating mass movement. However, CBB traps will not control or eradicate CBB from your field and should not be used as the sole method of controlling CBB populations. Trapping can be part of a broader program that includes visual inspection and sampling of coffee cherry on your trees. CBB lures may only work over a limited distance and do not attract CBB from far away. Trap catch does not indicate the level of infestation. Dozens of insects, including several beetles that are virtually identical to CBB in appearance, are attracted to traps. As a result, it is more important to be familiar with your field (i.e., with nearby hosts of other beetles) than to learn to identify CBB. Traps may be useful in detecting mass movements that might be triggered by food search, environmental conditions, chemicals released by trees during pruning, etc.

- Traps may be used to help identify “hot spots” or areas within the field that have relatively high CBB infestation levels in comparison to other areas in the field.
 - Increased trap catch may indicate elevated CBB activity, but remember that other virtually identical beetles are also attracted to the lure.

- An increase in trap catch MAY mean that CBB populations are increasing, but verify this observation by in-field sampling or a visual damage survey before spraying *Beauveria*.
- Traps are useful in monitoring CBB but may not catch CBB until populations are high.
- Visual inspection or sampling (e.g., the Thirty Trees Sampling Method; see Appendix) of cherry in the field is better than trapping for detection, infestation estimates, and finding “hot spots.”
 - Although trapping is a recommended monitoring tool, it is optional if you are using other means of monitoring CBB activity, such as visual cherry inspection and/or the Thirty Trees Sampling Method.
 - Trapping may be used as part of an integrated pest management approach but does not replace sampling and visual monitoring.

2. When do I start trapping in the field?

There may be several times throughout the year when CBB activity is high, so intermittent trapping may miss significant CBB movement. Trapping helps you to focus on the critical period for sampling and spraying, but becoming familiar with your field and CBB in general is essential for controlling the pest. Trapping and servicing your traps also helps you to do that. Year-round monitoring, including trapping, can lead to a better understanding of your operation.

- Trapping is recommended following the end of harvest or after pruning, through flowering, and prior to fruit development. At a minimum, start trapping immediately after the harvest season.
- CBB traps may be set, serviced, and monitored throughout the year to assess beetle activity.
 - Each farm is different, and other beetles can actually inundate and skew numbers in CBB traps (e.g., tropical nut borers from nearby mac nut trees).
 - Use trap catch to detect trends, but verify catch with in-field observations and/or sampling.
- Do not stop trapping unless servicing of traps cannot be maintained.

3. Which trap should I use?

Homemade traps with inward-facing flaps and commercial broca traps are equally effective in catching CBB

for use in monitoring activities. Homemade traps, if not painted, may last less than a year in hot, lower-elevation areas, whereas commercial traps may last as long as 3 years.

- Use traps with a “wall and fall” design.
 - CBB fly towards the trap, hit the flap or cross-baffle (partition), and fall into the kill solution.
- Traps should be cleaned at least yearly to maintain effectiveness.
- Painting the outside of homemade traps may help to extend trap life. Commercial traps can also be painted when the colors fade.
- Trap color does not matter, but visible colors like red aid in locating traps in the field.
- While deployed, traps should have an attractant lure and kill solution at all times.

4. How many traps per acre do I use?

Traps help with monitoring CBB activity. Often, individual trap catch is inconsistent in the field. For example, 2 traps side-by-side may catch vastly different numbers of CBB.

- As few as 5 traps per acre can help as a tool for monitoring CBB activity.
 - More could mean better monitoring.
 - Traps must be correctly located to be most useful.
- Set out the number of traps you can service without having to sacrifice activities like strip-picking, spraying *Beauveria*, and harvesting.

5. Where should I put my traps?

Hanging traps on coffee trees may not be problematic (in terms of attracting CBB to the tree) if active CBB monitoring and *Beauveria* spraying is done. If attracting CBB to the tree is a concern, hang traps on stakes or poles in the field to monitor CBB activity.

- Distribute traps throughout the farm.
- Hang traps between 2 and 5 feet from the ground because most CBB are trapped at this height.
 - These heights also help to make servicing easier.
- Hang traps along the farm border to aid in early detection of non-infested fields.
 - Do not rely solely on traps to catch CBB at the onset of initial infestation; CBB may not be caught in traps until infestation levels are elevated.
 - Once a farm is infested with CBB, hanging traps

only along the border does not help to monitor CBB activity.

- Visual inspections of coffee cherry, parchment, and green bean in the field and mill should be done.

6. What should I use to kill CBB in my traps?

In the past, soapy water, pest strips, and antifreeze were recommended for dispatching CBB in traps. However, antifreeze and ethylene glycol are toxic to humans and animals if ingested; propylene glycol can be detrimental to aquatic life; and all antifreeze/glycol compounds, including “biodegradable” glycols such as 100% Better Glycol, must be disposed of properly through an environmental company, and not dumped on the ground or in the field. Soapy water is recommended as the easiest and cheapest solution to kill CBB in traps, but traps must be serviced as the water evaporates or when it overflows in the event of rain.

- Soapy water
 - Use enough soap (a few drops of dish soap per cup of water) to break surface tension so CBB cannot crawl out of the cup.
- Insecticidal or pest strips (ex: Hercon[®] Vaportape[™] II)
 - Allowed for use as a toxicant in insect traps.
 - Collection cups should have perforations at the bottom for rainwater drainage.
 - Do not allow pest strips to become saturated.
 - Effective for 12 weeks or until effectiveness diminishes.
 - Cutting the strips in half reduces effectiveness to 4 weeks.

7. Which attractant should I use in my traps?

Researchers have found that a mixture of methanol and ethanol attracts CBB. The ratio of methanol to ethanol is important in controlling evaporation rate, as methanol evaporates at a faster rate than ethanol. Additionally, methanol is cheaper than ethanol.

- Use a 1:1 or 3:1 methanol to ethanol solution in a vial with a 2 mm hole, or
- 3:1 methanol to ethanol solution in a disposable pouch.

8. How often should I be servicing my traps?

Because soapy water can become foul, grow algae, and evaporate quickly in hot, dry areas, service traps as often as local conditions dictate.

- Monitor traps for CBB activity at least every 2 weeks.
 - Look in the collection cup for any increases in CBB catch.
 - An increase in trap catch may suggest an increase in CBB activity. Confirm your trap catches with in-field observations and sampling to determine the proper time to spray.
- Service traps every 4 weeks or immediately after heavy rainfall.
 - Excessive rainfall can dilute soapy water. CBB may survive, crawl out of the solution, and re-infest cherry. Additional detergent should be added to the collection cup after excessive rainfall.
- CBB can chew through plastic vials and caps.
 - Inspect attractant vials for holes, as attractants may leak out or evaporate too quickly.
 - Holes also will let in water, so the vial eventually looks full but contains only water.
 - There should only be a single opening 2 mm in diameter on each vial.
 - Change lures every 4–6 weeks or as they evaporate.

B. FLOWERING

Noting major farm events such as your first and main flowerings, 60 and 90 days after flowering, spraying, trapping, harvesting, pruning dates and descriptions, etc. on a calendar or notebook for your individual farm(s) is highly recommended. Recordkeeping of all farm activities makes activities like spraying, fertilizing, trapping, etc. easier to schedule, organize, and accomplish. As a result, the farmer may gain a better understanding of their farm and farm needs and CBB behavior in their orchard.

C. SAMPLING

1. Why, when, and how do I sample and monitor for CBB?

CBB sampling helps you determine when to spray *Beauveria*. Early detection of CBB and well-timed sprays will help to reduce infestations before populations explode. Although sampling is vital to determining spray intervals and locations of “hot spots,” sanitation is by far the most important early control method.

- Follow the revised “Thirty Trees Sampling Method for CBB Monitoring” to determine CBB activity, posi-

tion of CBB in the berries, and infestation percentage.

- Begin sampling and monitoring about 60–90 days after the first flowering or as soon as there is an increase in CBB activity as indicated by trap catch or visual observations.
 - Start date of sampling and monitoring will be dependent on your farm location and the flowering habit of your trees.
 - Year-round flowering may require year-round sampling and monitoring.
- Sample at least every 2 weeks at the beginning of the season and if CBB activity increases.
- Sample at least once a month thereafter.

2. Which sampling protocol and sample size should I use?

In August 2012, Luis Aristizábal presented the “Thirty Trees Method for Monitoring and Control” to Kona and Kāʻū coffee farmers. This method has been revised to more accurately suit the needs of coffee farmers in Hawai'i (revised protocols are included in the Appendix at the end of this document), and to address questions about the specific sample size per area being sampled. Individual farmers may need to make changes to these revised protocols based on their particular situation and needs.

- Follow the revised “Thirty Trees Sampling Method for CBB Monitoring” included with this document.

3. What threshold percent of CBB infestation should I use to determine time of *Beauveria* spraying?

- The Cenicafé threshold is 5% when timing *Beauveria* sprays.
 - Hawai'i growers may need to consider a 2% cherry infestation threshold level due to smaller farm sizes, higher costs, and individual “break-even” points.
 - A “break-even” point may be determined through a cost-of-production analysis for individual farms, which should include such information as current product price and yield losses.
- This threshold includes the AB to CD ratio (this relates to the position of CBB in the cherry; see Appendix) and the percentage of infected green cherry.
- If you have a high CD ratio, spraying and monitoring intervals may be too large.
- Use mortality rates to calculate and track the effectiveness of spraying.

SECTION III: PESTICIDE APPLICATION

A. SPRAYING *BEAUVERIA*

1. *How and at which rate do I apply Beauveria?*

Before spraying *Beauveria* or any other pesticide, read and follow all label instructions. The label is the law! *Beauveria bassiana* Strain GHA is the active fungal ingredient in the following:

- Botanigard® ES (EPA Reg. No. 82074-1) – conventional
- Botanigard® 22 WP (EPA Reg. No. 82074-2) – conventional, NOT FOR SOIL APPLICATION
- Mycotrol® O (EPA Reg. No. 82074-3) – OMRI™ approved

These are the only *Beauveria* products that are approved for use to spray and kill CBB in coffee orchards. For tree applications:

- Spray coffee trees with 32 ounces (1 quart) of *Beauveria* per acre; **plus**
- *Beauveria* (Silwet L-77® Surfactant, Widespread® Max, etc.) at rates according to the label; **plus**
- At least 30 gallons of water per acre.
 - Label rates have a range. Consult and follow the product label for application rates prior to mixing.
 - With good agitation, *Beauveria* spores are easily dispersed at lower surfactant rates.
 - At higher surfactant concentrations, there is a risk of phytotoxicity.
- Use as much water as possible per acre, but use all 32 oz. of Botanigard® ES, Botanigard® 22 WP, or Mycotrol® O.
- Spray the entire tree, including the trunk, base of tree, and underside of leaves.
- Spray to wet, but avoid runoff.
- Type of sprayer will determine how much water is needed per acre.
- Tree size, density, and age will also determine gallons of water needed per acre.

2. *Should I spray the ground and in rock crevices around infested coffee trees?*

While CBB is looking for new host fruits, they often miss their targets, hit the tree, branch, or leaves, and fall

to the ground. They may even hit the side of traps and fall to the ground. In addition, fallen or dropped cherry and parchment on the ground may contain live CBB. Spraying *Beauveria* on the ground may help to kill CBB and inoculate the ground with live fungal spores against subsequent infection. This is especially important when there are no berries on the trees, as dropped fruit will be a major source of infestation.

- Botanigard® 22 WP cannot be used for ground application.
- Ground spraying reinforces the need for sanitation but recognizes the challenges of picking up fruit from the ground.
- Ground spraying is not as critical when there is fruit on the trees, as those are bigger sources of CBB.
- According to the label, Botanigard® ES and Mycotrol® O must be applied as a ground application at a rate of 2–8 fluid ounces per 1,000 square feet. This is equivalent to 87.2–348.4 fluid ounces per acre or 2.8–10.8 quarts per acre.
- Add Botanigard® ES or Mycotrol® O and the surfactant to at least 43.6 gallons of water per acre.

3. *How often should I spray?*

Beauveria spores germinate within 6–9 hours and can penetrate a host within 24 hours. Insects can be killed in 3–10 days depending on the number of spores and insect size. Best *Beauveria* growth occurs at 23–30°C (74–86°F) and will slow above 28°C (83°F).

- Start spraying *Beauveria* when there is mass movement of CBB as indicated by trap catch and verified by visual observations and in-field sampling methods; and
- When the threshold % of CBB infestation is attained with CBB in-field sampling methods.
- Spray at least once a month or as often as monitoring and sampling warrants spraying.

4. *Can I add other solutions to Beauveria sprays?*

Other solutions can be mixed with *Beauveria*, but do not combine any pesticides not labeled for coffee. Fungicides may negatively affect *Beauveria* efficacy. Consult the compatibility chart created by the product's exclusive distributor, BioWorks, Inc., prior to mixing pesticides with Botanigard® ES, Botanigard® 22 WP, or Mycotrol® O. This compatibility chart can be downloaded at <http://www.bioworksinc.com/products/>

shared/botanigard-es-tank-mix-compatibility.pdf, or visit www.bioworksinc.com for additional product information.

Also, test any mixed solutions on a small scale for phytotoxic effects, and avoid combining herbicides like RoundUp with *Beauveria* as current studies show a negative effect on spore growth.

5. *Spraying tips for growers using Beauveria*

- Review and follow all pesticide labels for Botanigard® ES, Botanigard® 22 WP, and Mycotrol® O.
- Spray in the afternoon or evening and on cloudy days, if possible.
 - Beetle activity is most often observed in the afternoon.
 - UV affects spore viability.
 - High humidity helps *Beauveria* activity.
- Avoid spraying during bloom and when bees are actively foraging, as *Beauveria* may affect bees.
 - If spraying must be done during a bloom, spray in the late afternoon.
- Shake Botanigard® ES, Botanigard® 22 WP, and Mycotrol® O bottles vigorously before adding to water to suspend spores.
- Store in a cool, dry place. Avoid storage at temperatures below freezing or above 85°F.
- Use tank mix immediately, and avoid holding spores in water solution for more than 24 hours.
- Provide enough time for leaves to dry after spraying, to avoid rain washing them off.

SECTION IV: HARVESTING

A. PRE-HARVEST

1. *Strip-pick cherry before the main harvest*

Often, the first round of coffee harvested will yield very little marketable coffee and is typically of lesser quality than main-round harvested coffee. If this first round is left on the trees, CBB from the first round may infest developing coffee of subsequent rounds.

- The first round of harvest may have a high level of CBB and may be treated as a sanitation strip-pick to get rid of any color-break, ripe, over-ripe, and raisin cherry on the tree.

- Pick and process or destroy all fruit from this first-round harvest.
- Paying by the hour may help with the hiring process.

B. HARVEST

1. *Picker training*

There is a tradeoff between harvesting red only and allowing green berries to be thrown on the ground, and allowing some green berries to be harvested. Coffee cherry left on the ground could harbor CBB. Coffee farmers should supervise pickers and impress upon them the importance of efficient harvesting and removing all ripe and dropped fruit. Farmers may combine performance goals with an economic incentive such as not hiring the picker again, paying for greens and raisins, and hourly pay.

- Avoid discarding green beans or raisin from the picking basket onto the ground.
 - Leave in the picking basket, or
 - Discard in a separate container.
- An alternative is adding a sorting stage before processing.
 - Hand sort, or
 - Machine sort.
- Pick up dropped cherry from the ground.

2. *Harvest interval or frequency*

Coffee farmers are encouraged to avoid a harvesting interval of more than a month, which will allow CBB in berries to mature and escape. Interrupt the CBB breeding cycle. The tradeoffs between frequent harvesting and the availability of labor are lessened if cherry is harvested when it is at color-break to red as opposed to only red.

- A harvest interval of 2–3 weeks is ideal for CBB control.
- Harvest promptly and as often as possible.
- Avoid an interval length that would allow over-ripe cherry to fall to the ground.
- Harvest color-break to red cherry.

3. *Harvest bags*

Appropriate harvest bags are important because CBB is being concentrated in the bag, and often the heat, movement, etc. causes CBB to leave the cherry. If CBB are allowed to escape from the bag, they are transferred

back to and around the field. From grower observations, CBB are effectively contained by lining a burlap bag with a plastic bag. Temperature does not appear to increase when burlap is on the outside of a plastic bag. Some growers have reported using macadamia nut bags to contain harvested cherry; however, other growers find these bags difficult to move around in the field.

- Options for bags:
 - Synthetic fiber bags (e.g., macadamia bags), or
 - Plastic in burlap (check with your mill on acceptability).
- Tie bags shut at harvest to avoid the escape and re-infestation of CBB in the field.
- Consider using mesh “tents” treated with vegetable oil to cover bags and trap CBB leaving the bags.
- Avoid keeping bags in the field in the sun all day.
 - Take bags to the wet mill as soon as possible.
- Do not move cherry in bags from “hot spots”/infested areas to clean areas within the farm. This includes the location of bags during picking.

C. POST-HARVEST

1. *Containment and kill of CBB in wet mill*

Processors can take several precautions to avoid infesting surrounding coffee.

- Screen the wet mill or portions of the wet mill such as the floatation and fermentation tanks, if feasible, to keep CBB from escaping.
- Traps may be maintained in the wet mill.
 - Traps seem to be more effective in enclosed areas.
- Cover skin, pulp, and mucilage piles with a tarp and secure the edges with a water-filled hose or similar apparatus.
- Boil bags in water for 5 minutes, or
- Soak bags overnight in soapy water.
 - Boiling or soaking bags in soapy water also helps to extend the life of burlap bags.

2. *Transportation of CBB to other fields*

Unless steps such as using burlap bags lined with plastic garbage bags and tied shut are taken to prevent CBB from escaping, CBB may hitchhike and be released back to your or other farms on trucks. Therefore, it may be useful to clean coffee cherry delivery trucks and equipment with soapy water following deliveries and before re-entering the farm.

3. *Containment and kill of CBB at the dry mill*

- Enclose the drying deck with plastic or screening if feasible.
- Parchment should be dried to the 11% (10.7%) moisture level.
 - CBB may still be alive, but they do not reproduce and they do not infest adjacent, uninfested beans.
 - CBB seem to flee the beans during storage in chill rooms.
 - Low humidity (50–60%) helps but is expensive.
- The moisture content of green bean should also be at 11%.
- The mechanical drying process seems to kill CBB, perhaps with a combination of drying out, temperature, and physical crushing.
- GrainPro bags are good for storage, especially for smaller growers.
- Traps and sticky paper may be used in storage rooms to catch CBB escaping from beans in the burlap bags.

SECTION V: SHIPPING

Currently, an intra-island (on-island) quarantine for the Big Island is NOT in effect. However, the Hawai'i Department of Agriculture has placed a quarantine on ALL regulated coffee items, including but not limited to unroasted coffee, coffee plants and plant parts, used coffee bags, and coffee-harvesting equipment shipped from Hawai'i Island to other islands that are not infested with CBB.

- Inspection by HDOA Plant Quarantine Inspectors and certain treatments such as fumigation, freezing, or heating are required prior to shipping. ALL regulated items (plants, parts, green beans, and used equipment, etc.) must have a permit issued by the Plant Quarantine Department before transport is allowed. The permit will state the approved treatments, such as the following:
 - Chemical treatment (fumigation), which must be approved by HDOA and applied by a certified applicator. Ex: ProFume[®], sulfuryl fluoride.
 - Cold treatment, which requires that the shipment be exposed to a temperature of 5°F for 48 hours, during which time it must be monitored by a Plant Quarantine Inspector. The size of the shipment depends on the port office freezer

- capacity. No large shipments are allowed.
- Heat treatment, which consists of removing green beans from the bag, heating them to a temperature of 315°F for at least 5 minutes, and re-containing them in unused bags.
 - Inspectors will attach a tag, label, or stamp to indicate the shipment passed inspection requirements.
 - Transporting coffee plants and plant parts for propagation from Hawai'i Island to a non-infested island requires treatment with an approved pesticide and quarantine and monitoring in a State facility for a period of not less than one year.
 - Failure to comply with quarantine regulations may result in civil penalties or fines and the shipment being confiscated and destroyed.

These recommendations are endorsed by the following groups (listed alphabetically):

CBB Task Force

Hawaii Coffee Association (HCA)

Hawaii Coffee Growers Association (HCGA)

Hawai'i Department of Agriculture (HDOA)

Kā'ū Coffee Growers Cooperative (KCGC)

Kona Coffee Council (KCC)

Kona Coffee Farmers Association (KCFA)

Kona Young Farmers

Maui Coffee Association (MCA)

Palehua Coffee Cooperative

United States Department of Agriculture Pacific Basin

Agricultural Research Center (USDA PBARC)

University of Hawai'i at Mānoa College of Tropical

Agriculture and Human Resources (UHM CTAHR)

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APPENDIX

Thirty Trees Sampling Method for CBB Monitoring

Based on a Presentation by Luis F. Aristizábal (University of Florida)
Revised: January 2013 by CBB Summit Committee

It is not enough to know that your coffee trees are infested with the cherry berry borer; it's also important to understand what the beetle is doing on your farm. This simple sampling method will show you total infestation levels, but more importantly, it will show whether the beetle is vulnerable to being killed by spray or not. Sampling will also help you determine the effectiveness of your spray program, may reveal hot spots, and will show you the best management strategies for CBB control on your farm.

Begin monitoring and sampling about 60–90 days after your initial flowering or as soon as there is an increase in CBB activity, as indicated by trap catch or visual observations. Continue monitoring through the end of the harvest, sampling green berries only. Sample your farm every 2 weeks at the beginning of the season to catch early-season infestations and then monthly thereafter. Sample at least 30 trees per 2.5-acre plot to accord with the Cenicafé method of sampling. For smaller plots, sample a minimum of 12 trees per acre to determine infestation level.

Individual farmers may need to adapt these protocols based on their particular situation and needs. For example, if your farm is situated on a relatively even terrain or microclimate and your trees have similar age, management practices, etc., a single sample size of 30 trees might be sufficient for a 3-acre plot. Conversely, you may need to subdivide your farm into smaller plots to address different varieties, tree ages, topography areas, areas with shade vs. sun, etc.

Materials

- Knife
- Clipboard
- Worksheet
- Pencil/pen
- Permanent marker
- Container with lid or resealable Ziploc bag
- Flagging tape or ribbon
- Hand lens, magnifying glass, reading glasses, or other vision aids
- Counter or tally counter
- Farm map

Step 1: Monitoring the CBB Infestation

1. Begin monitoring and sampling about 60–90 days after your initial flowering.
2. Select and draw a map of the coffee plot* to be sampled.

*Plot can be determined by these factors:

- Location, topography, physical features such as roads or gullies
- Orchard age or pruning stage
- Variety
- Kīpuka or microclimate
- Management practices (e.g., mechanization, organic vs. non-organic, pruning, availability of irrigation)

3. Mark a zigzag pattern on the map to follow as you sample.
 - a. At least 12 trees per acre, or
 - b. 30 trees per 2.5-acre plot.
4. Begin sampling at tree #1 close to a corner of the coffee plot, but avoid sampling trees directly on the border.
5. Randomly select a lateral branch in the middle of the tree with at least 45 berries (more is better).
6. Record the total number of green berries on the branch.
7. Record the number of green berries with visible white *Beauveria* fungus.
8. Record the number of green berries infested by CBB (cherries with a hole) on the branch.
9. Pick all CBB-infested green berries (including those showing fungus) from the branch and place them in the container or bag.
10. Flag any trees with high numbers of CBB.
11. Move to tree #2 and return to steps 5–10.
12. Repeat these steps until all samples are collected.

Now, take the information collected and make calculations to obtain the percentage of infestation by CBB:

$$\% \text{ infestation} = \frac{\text{Total green berries infested}}{\text{Total green berries}} \times 100$$

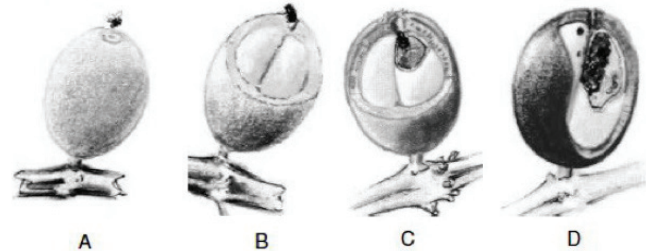
Example: For the 30 coffee branches sampled we have the following information:

Total green berries infested by CBB = 40

Total green berries = 1,500

$\% \text{ infestation} = 40 \div 1,500 \times 100 = 2.66\%$

Step 2: Positions of CBB in Berries Used to Determine Whether to Spray



Randomly select 100 infested green berries from those collected in your container. Carefully cut each berry and determine CBB position (AB or CD). Be careful not to kill the beetle while opening the berry, as determining whether the beetle is alive or dead is very important. Record the information on the worksheet provided.

In AB position, the CBB is entering or boring into the fruit, but the endosperm (coffee seed) has not been affected. You can see the back part of the CBB body. In this position the CBB can be killed by natural enemies, weather, or by application of *Beauveria bassiana* or chemical insecticides. A high percentage of CBB alive in the AB position means they are vulnerable and may be controlled by applications of *B. bassiana*. Spray within a week. A high percentage of dead in the AB position means your spray is effective.

In CD position (inside the endosperm or coffee seed), the CBB is relatively safe. The endosperm (coffee seed) has been damaged by the female and its progeny (larvae). Neither *B. bassiana* nor chemical insecticides can effectively control CBB in this position. In the CD position CBB may only be controlled by manual collection of ripe berries. A high percentage of CBB in the CD position means that your spray program was late or ineffective. Consider employing sanitation techniques to physically remove infested berries from the field.

Step 3: Decision-Making and Timing of Spray

The timing of *Beauveria* sprays may vary greatly from farm to farm. It is better to contain CBB populations early in the season than fight a larger infestation later.

In Colombia, the decision to spray is made when 5% of sampled green berries are infested in the AB position. However, at the value of the Kona crop, this infestation loss far exceeds the cost of spraying. It is more likely that a 2% infestation in the AB position should trigger a decision to spray.

Thirty Trees Sampling Worksheet: Percent Infestation by CBB

Date: _____ Farm: _____

Plot #: _____ Evaluator: _____

Branch	# of Green Berries	# of Infested Berries	# of Berries w/ <i>B. bassiana</i>
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
Total			

$$\% \text{ infestation} = \frac{\text{Total infested berries}}{\text{Total green berries}} \times 100 = \boxed{} \%$$

Positions of CBB in Berries Used to Determine When to Spray

Infested Berries =

Tally of CBB
from infested
berries:

AB Alive =

CD =

AB Dead =

Absent =

$$\% \text{ AB infestation} = \frac{\text{AB Alive} \times \text{Total Infested Berries}}{\# \text{ Infested Berries} \times \text{Total Green Berries}} \times 100 = \boxed{} \%$$

Observations: