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Pre-emptive Management Approach of Coffee Berry Borer (*Hypothenemus hampei* Ferrari) in Arabica Coffee (*Coffea arabica* Linnaeus) in Atok, Benguet

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Abstract

Coffee production in the Cordilleras earned high economic value. However, coffee production also faces inevitable loss due to pest infestation, as such is coffee berry borer (CBB). Thus, a systematic management strategy is needed. The study identified appropriate pre-emptive management approach in combatting coffee berry borer (*Hypothenemus hampei* Ferrari) in Arabica Coffee (*Coffea arabica* Linnaeus) in Atok, Benguet. The coffee plants were maintained for almost 20 years and there were no berries during the conduct of the study. The use of 4 lure trap per 50 coffee trees caught the highest population of CBB with a mean of 272.50. Likewise, the highest peak of female adult CBB population was recorded on the 7th week of monitoring just after the flowering stage of the coffee trees. The source of CBB was from the fallen berries, dried berries, and unripe berries that were present within the coffee plantation. There were 23 different species of other insects collected in the lure traps belonging to six orders and 18 families. From the insects collected, there were no other pests recorded from the coffee beans but pests of grains, vegetables, and various fruits. It is recommended that using 4 lure traps per 50 coffee trees and set it earlier during the months of dearth period to double the effects of the lure trap in mass reduction of CBB. Likewise, all left-over berries on the branches of the coffee trees including the fallen berries on the ground should be removed or collected to prevent source of infestation for the next season.

Introduction

Coffee is one of the most important crops in the Philippines and an important beverage crop in the Cordillera Administrative Region (CAR). It is selected among the regional priority commodities identified by the Regional Development Council (RDC) in the Region (Mangili, Abyado, Laurean, & Maddul, 2015).

The coffee industry in the Philippines is also one of decent sources of livelihood for thousands of coffee growers in the country. Cordillera is one of the top five producers of quality coffee in the Philippines. According to DA-CAR (2017), the Arabica variety thrives and grows better in temperate and mountainous terrain areas like Benguet and Mountain Province while Robusta variety on the other hand, is mostly grown in warmer areas such as Kalinga and Ifugao (DA-CAR, 2017). Coffee is consumed either hot or cold by about one-third of the people in the world, in amounts larger than those of any other drink. Its popularity can be attributed to its energizing effect which is produced by caffeine, an alkaloid present in green coffee in amounts between 0.8 and 1.5 % for the Arabica varieties and 1.6 to 2.5 % for Robusta (Best Toppers of Everything, 2016).

However, among the limiting factors in coffee production is the presence of the insect pest infestations especially the coffee berry borer that affects the yield and quality of green bean. Among the biggest problems is the infestations of coffee berry borer (CBB), *Hypothenemus hampei* Ferrari, which can cause infestation to 90-100% (Da Silva, Mikami, Morales, Uemura-Lima, & Ventura, 2010). CBB damage coffee through the adult females boring a hole into the coffee berry and deposit eggs upon hatching. The larvae feed on the coffee seeds inside the berry; thus, reducing yield and quality of the marketable product. The insect spends most of its life inside the coffee berry; making it extremely difficult to control (Castillo, Infante, Jaramillo, & Vega, 2009).

Messing (2012) stated that multiple control strategies such as chemical, cultural, and other control strategies can be employed. One control strategy used is the employment of lure traps. CBB responds to visual stimuli and interactions between visual and chemical responses. The development and evaluation of trapping systems to each particular target species could be an important approach in an integrated strategy for CBB management. Lure traps containing methanol and ethanol has been used in many countries to monitor flying adult female CBB and can manage these populations by mass-trapping.

Experiments in the laboratory have shown that CBB locates the coffee berry using visual and olfactory cues produced by the coffee berries during maturation. Several authors have demonstrated that vision and olfaction play a role in the CBB's preference (Brun, Frerot, & Mathieu, 1997). In a recent research, Messing (2012) stated that a lure trap with 3:1 ratio of methanol: ethanol outperformed the 1:1 ratio in attracting masses of adult female CBB. It was also found out that red color in the trap is more attractive than the trap with a color of white as, in one study, more CBBs are trapped in the lure trap with red color than in the white one (Brun et al., 1997). Da Silva et al. (2010) found out that 0.5 m captured higher CBB compared to the 1.0 m and 1.5 m but Dufour and Frerot (2008), stated that lure trap set up at 1.2 m from the ground can capture CBB three times better. The best density in reducing populations of CBB was three to five lure traps per 20 coffee trees (Evasco, 2016). On the other hand, Da Silva et al. (2010) found out that 22 traps in one hectare are also effective and efficient in the mass trapping of CBB. The highest collection of the lure traps were reported and observed from January to March (Aristizabal, Arthurs, Bustillo, Jimenez, & Trujillo, 2015).

Due to the increasing infestation of CBB in coffee, which causes to high losses of yields, the study was conducted to provide information to those who are growing and studying coffee production about the effectiveness of lure traps as control of CBB. This study also influences and introduces lure traps to coffee growers and gives chance for the commercialization of this introduced technology.

Specifically, the study found the appropriate number of lure trap per 50 coffee trees, monitored the weekly abundance of female CBB, identified the possible source of the CBB, and identified other species of insects caught in the lure traps.

Materials and Methods

Preparation of the Methanol-Ethanol Lure Trap

The methanol and ethanol were prepared with a ratio of 3:1 based on Messing (2012) was poured out in the vials with 15 ml capacity. The cover of the vials is inserted with a 7 cm bamboo stick (Figure 1). The vials with the methanol-ethanol mixture were integrated inside the lure trap bottle where the methanol-ethanol alcohol acts as an attractant to the coffee berry borer (CBB).

Preparation of Lure Trap

The collection of 60 bottles of containers with 1.75 liter capacity was done and they were used as

Figure 1. a) Preparation of methanol-ethanol ratio; b) Measurement of the bamboo stick in the vial

are grown organically, free from insecticide use, and are dependent on the dried and other organic materials from the Alder trees and various plants. The lure traps were arranged following the Randomized Completely Block Design (RCBD). There were five treatments, each replicated four times. The treatments were the following.

T1= 1 lure trap/50 coffee trees
T2= 2 lure traps/50 coffee trees
T3= 3 lure traps/50 coffee trees
T4= 4 lure traps/50 coffee trees
T5= 5 lure traps/50 coffee trees

All treatments were located in adjacent places surrounded by coffee, Alder trees, chayote, and variety of other trees and plants (Figure 3). In addition, the study was conducted after the harvest period wherein most of the coffee trees were starting to flower and containing several unharvested trapping materials. Each containers were prepared by marking a window shape with a size of 10.16 x 10.16 cm (4x4 square inch) leaving 10 cm above from the bottom of the bottle (Figure 2). The cut window side of the container served as the entrance of the insect. A plastic plate measuring 22.86 cm in diameter was placed on top of the bottle to protect the lure trap dilution from rainwater when it rains and to avoid other contaminations. The whole outer structure of the lure trap bottle including the plastic paper was painted with red using spray paint. A hole was made in the cap of the bottle and a wire was inserted measuring 38.1 cm in length. The lower-end of the wire was used to tie the vials containing the methanol-ethanol mixture. The other tip of the wire was bent in an arc form to carry enough the lure trap to hang in the coffee stem.

Setting of Experimental Units

The study was conducted at Sayet, Caliking, Atok, Benguet with an area of more than 1 ha having more than 1,000 coffee trees. The coffee plantations are owned and have been maintained for almost 20 years by the Atiw and Mayos family. The coffee plants

Figure 2. Modified lure trap

coffee berries. The prepared lure trap was gripped on to coffee branch 1.2 m from the ground (Figure 4). A 75 ml soap solution from the one liter of water mixed with 30 g of powdered soap. The soap solution destroys the surface tension of the water, and the insect attracted on lure trap will not be able to crawl and move out.

Monitoring of the Lure Traps

The collection of trapped CBB and other insects was done once a week from the time it was installed. It is collected with the aid of a screen scoop. Forceps were used for the trapped insects to be fresh and visible for easier identification.

Collection and Counting of Adult Coffee Berry Borer

The CBB that were caught and gathered using the wire scooper and transferred in a petri plate (Figure 5). The collected CBB was brought in the laboratory for proper identification and counting (Figure 6).

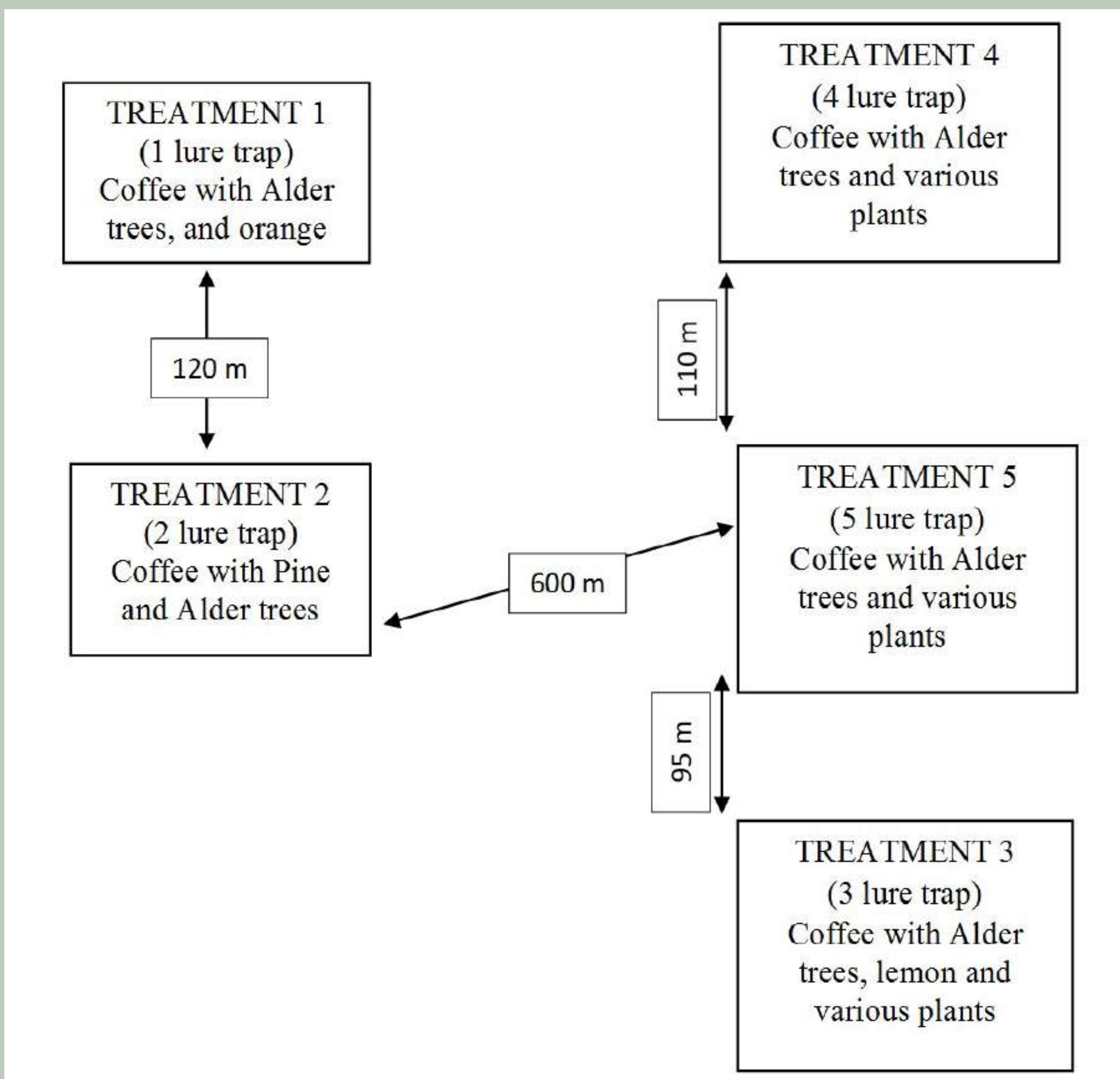

Figure 3. Layout of treatments arranged in Randomized Complete Block Design (RCBD)

Figure 4. a) Setting-up of lure traps; b) Height of lure trap above the ground

Identification of other Species Caught

The collected insects and other arthropods were dried and sorted out according to species. The insects were placed under the microscope for proper identification, and were documented using a digital camera ranging from 10x to 145x magnification. The other species were identified from order to family including the scientific name and its economic importance using entomology books and online references.

Figure 5. Collection of CBB and other insects caught in the lure trap

Figure 6. Identification of CBB and other insects

Possible Sources of Next Generation Coffee Berry Borer

The fallen berries on the ground including the dried, unripe, and ripe berries above and at the bottom of the coffee trees were collected and placed in the plastic container and brought to the entomology laboratory in Mites Predatory Rearing House (MPRH), Benguet State University for further observation for a month for the presence of emerging CBB.

Results and Discussion

Influence on the Density of Lure Traps on Coffee Berry Borer

The efficacy of the different lure traps against female coffee berry borer (CBB). Results show that the use of 4 lure traps per 50 coffee trees garnered the highest number of female CBB with a mean of 272.50 (Table 1). This was followed by a mean of 131.75 from 5 lure traps per 50 coffee trees. The least was from 2 lure traps per 50 coffee trees that was not significantly different from 1 lure trap per 50 coffee trees.

The even distribution characteristics of coffee trees in the experimental area reflected the population of CBB wherein treatments 1 and 2 had the lowest infestation of CBB. Most of the berries were all harvested and all the coffee trees were pruned before setting the trap resulting to the non-survival of the CBB in open field with open sunlight and low numbers of coffee berries on coffee trees. On the other hand, treatments 3 to 5 had high planting density where most of the coffee trees were not pruned and some of the unharvested berries were still intact on the coffee branches. These reasons were supported by Aristizabal et al. (2015) in their research on monitoring the CBB population using the alcohol-baited traps. They found out that the increased in the CBB population was due to warm and wet conditions, higher planting density, reduced harvest worker efficiency, and CBB migration.

In terms of reducing the CBB population, the use of 4 lure traps per 50 coffee trees was the most effective and economical to use compared to the used of 5 lure traps per 50 coffee trees.

Table 1

Mean Population of Caught Adult Female Coffee Berry Borers

Treatment	Mean
T1= 1 lure trap/50 coffee trees	50.25[c]
T2= 2 lure trap/50 coffee trees	44.50[c]
T3= 3 lure trap/50 coffee trees	99.00[b]
T4= 4 lure trap/50 coffee trees	272.50[a]
T5= 5 lure trap/50 coffee trees	131.75[b]

Note: Means with the same letter are not significantly different at 5% level of DMRT.

Weekly Monitoring of Coffee Berry Borer Population

Figure 7 indicates the weekly monitoring of adult female CBB population caught in the lure trap. The highest population of CBB caught in the different treatments were recorded in March until the first week of April when most of the coffee berries were harvested. March and April are the stages of dearth period when no berries are present in most of the coffee trees. Jembere et al. in 2004 found out that female CBB increase steadily just after February and reach its peak in March to July. On the other hand, Das-ilen in 2016 discussed the dearth period where there are no berries in most of the coffee trees in the months of March and April on her study in the age structure of CBB in relation to the phenology of coffee berries.

The first increase in adult female CBB population caught on the lure traps was recorded in the 5th week (April 14, 2018), which coincided with the initial flowering in most of the coffee trees. Damon in 2000 found out that the stimulus which attracts CBB showed that they are not attracted directly towards the leaves or flowers of the coffee berries but flowering stage indicates to have a possible effect to trigger CBB infestation as a sign for the development of the next coffee berries.

There was an increase in CBB population in the 6th week (April 21, 2018) when the flowering stage of the coffee trees was already ending. Further, the population

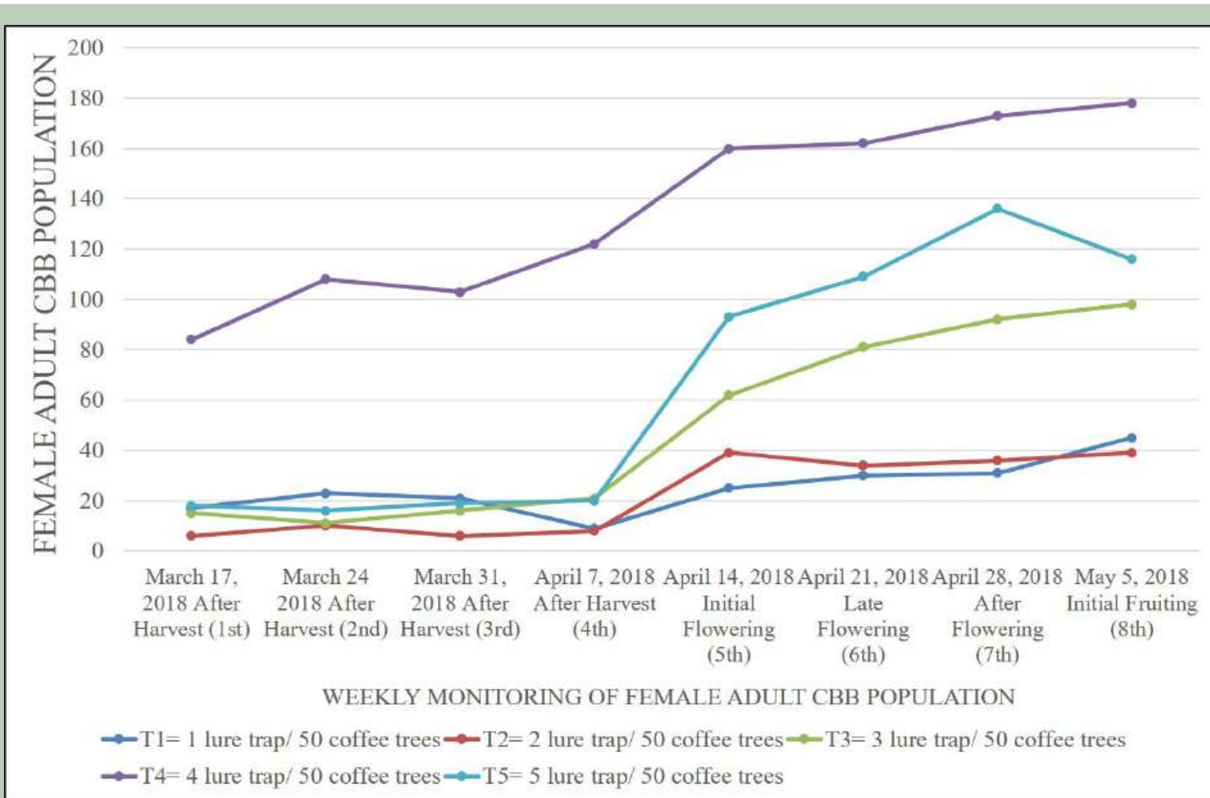

Figure 7. Weekly population of female coffee berry borer caught in the lure trap

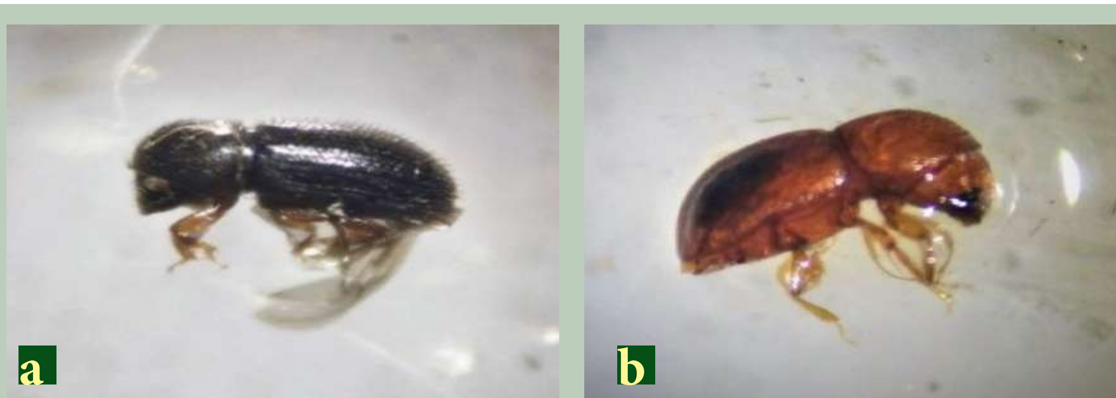

Figure 8. Coffee berry borer (a) Black; (b) Brown, 145x

increased in the 7th week (April 28, 2018) when the highest number of female CBB was collected. Most of the coffee trees in this week have undergone their flowering stage. There was a decline of trapped adult female CBB from the 5 lure traps per 50 coffee trees; however, there was a little increase from the rest of the treatments recorded in the 8th week (May 5, 2018) when initial fruiting of some coffee berries were observed.

The result shows that setting-up of lure traps in March to May when there are no berries (i.e., dearth period) can reduce the population of CBB due to fallen berries and left-over berries found on the coffee trees. For this reason, CBB infestations can be prevented in the remaining months when fruiting season of the coffee trees are starting.

Possible Sources of Coffee Berry Borer Infestation

Number of adult CBB emerged from fallen berries. Table 2 presents the number of collected berries and emerged adult CBB from the fallen berries. The highest mean number of fallen berries collected were from the 5 lure traps per 50 coffee trees with a mean of 352.75 followed by 338.75 from the area with 1 lure trap installed. The area with 2 lure traps per 50 coffee trees got the least collected berries with a mean of 129.25.

Based on the number of emerged adult CBB, the 5 lure traps had the highest mean of 63.75 while the lower mean values of 25.00, 20.25, and 16.75 taken from the 2, 3, and 4 lure traps per 50 coffee trees, respectively, which were not significant from each other.

Number of adult CBB emerged from dried berries. Table 3 presents the number of collected berries and emerged adult CBB from the dried berries collected from the coffee branches. The highest number of dried berries collected was from 4 lure traps per 50 coffee trees with a mean of 303 but was not significant from the 5 and 1 lure traps with mean values of 248.50 and 289.75, respectively. The area with 2 lure traps recorded the least collected berries with a mean of 170.75 but was not significant from the mean of 184.50 at 3 lure traps.

Based on the number of emerged adult CBB, the highest was taken from the area where 5 lure traps are installed with a mean of 18.75. Meanwhile, the number of emerged adult CBB was not significant from the areas where 1, 2, 3, and 4 lure traps are installed with mean values ranging from 4.50 to 8.25. The result shows that there was no direct relationship between the numbers of collected berries per

Table 2

Number of Emerged Coffee Berry Borer from Collected Fallen Berries

Treatment	No. of Collected Berries	Emerged Number of Adult Coffee Berry Borer
1 lure trap/50 coffee trees	338.75^{a}	41.25^{ab}
2 lure trap/50 coffee trees	129.25^{c}	25.00^{b}
3 lure trap/50 coffee trees	228.50^{bc}	20.25^{b}
4 lure trap/50 coffee trees	261.50^{ab}	16.75^{b}
5 lure trap/50 coffee trees	352.75^{a}	63.75^{a}

Note: Means with the same letter are not significantly different at 5% level of DMRT

Table 3

Number of Emerged Coffee Berry Borer from Collected Black/Dried Berries

Treatment	No. of Collected Berries	Emerged Number of Adult Coffee Berry Borer
1 lure trap/50 coffee trees	289.75^{a}	8.25^{b}
2 lure trap/50 coffee trees	170.75^{b}	6.75^{b}
3 lure trap/50 coffee trees	184.50^{b}	5.50^{b}
4 lure trap/50 coffee trees	303.00^{a}	4.50^{b}
5 lure trap/50 coffee trees	248.50^{a}	18.75^{a}

Note: Means with the same letter are not significantly different at 5% level of DMRT treatments to the number of emerged adult CBB.

Number of adult CBB emerged from unripe berries. Table 4 presents the number of collected berries and emerged adult CBB from the unripe berries. The highest mean number of unripe berries collected were from the area where 5 lure traps per 50 coffee plants are installed with a mean of 135.75. In addition, it has the highest number of emerged adult CBB with a mean of 15.50. The rest of the treatments were not significant based on the number of collected berries and emerged adult CBB with respective means of 35.75 (4.50) for 2 lure traps, 76.75 (4.75) for 4 lure traps.

The result shows that there was no correlation between the numbers of collected unripe berries to the emerged number of adult CBB.

Number of adult CBB emerged from ripe berries. Table 5 presents the number of collected berries and emerged adult CBB from the ripe berries. The highest mean number of ripe berries collected was from the area with 5 lure traps installed with a mean of 154. The rest of the treatments were not significant from each other ranging from 37 to 41.75. Moreover, there were no significant differences in the number of emerged adult CBB irrespective to the number of ripe berries collected with means ranging from 2.75 to 6.25.

The results indicate that the number of ripe berries is not correlated to the number of CBB adult that have emerged.

Influences of the Types of Berries on Coffee Berry Borer Emergence

Results showed that the number and type of berries influenced the number of adult CBB emergence

Table 4

Number of Emerged Coffee Berry Borer from Collected Unripe Berries

Treatment	No. of Collected Berries	Emerged Number of Adult Coffee Berry Borer
1 lure trap/50 coffee trees	42.25[b]	7.75[ab]
2 lure trap/50 coffee trees	35.75[b]	4.50[b]
3 lure trap/50 coffee trees	52.25[b]	7.25[ab]
4 lure trap/50 coffee trees	76.75[b]	4.75[b]
5 lure trap/50 coffee trees	135.75[a]	15.50[a]

Note: Means with the same letter are not significantly different at 5% level of DMRT

Table 5

Number of Emerged Coffee Berry Borer from Collected Ripe Berries

Treatment	No. of Collected Berries	Emerged Number of Adult Coffee Berry Borer
1 lure trap/50 coffee trees	41.75[b]	5.00[a]
2 lure trap/50 coffee trees	47.00[b]	6.25[a]
3 lure trap/50 coffee trees	47.00[b]	3.50[a]
4 lure trap/50 coffee trees	37.00[b]	2.75[a]
5 lure trap/50 coffee trees	154.00[a]	4.25[a]

Note: Means with the same letter are not significantly different at 5% level of DMRT

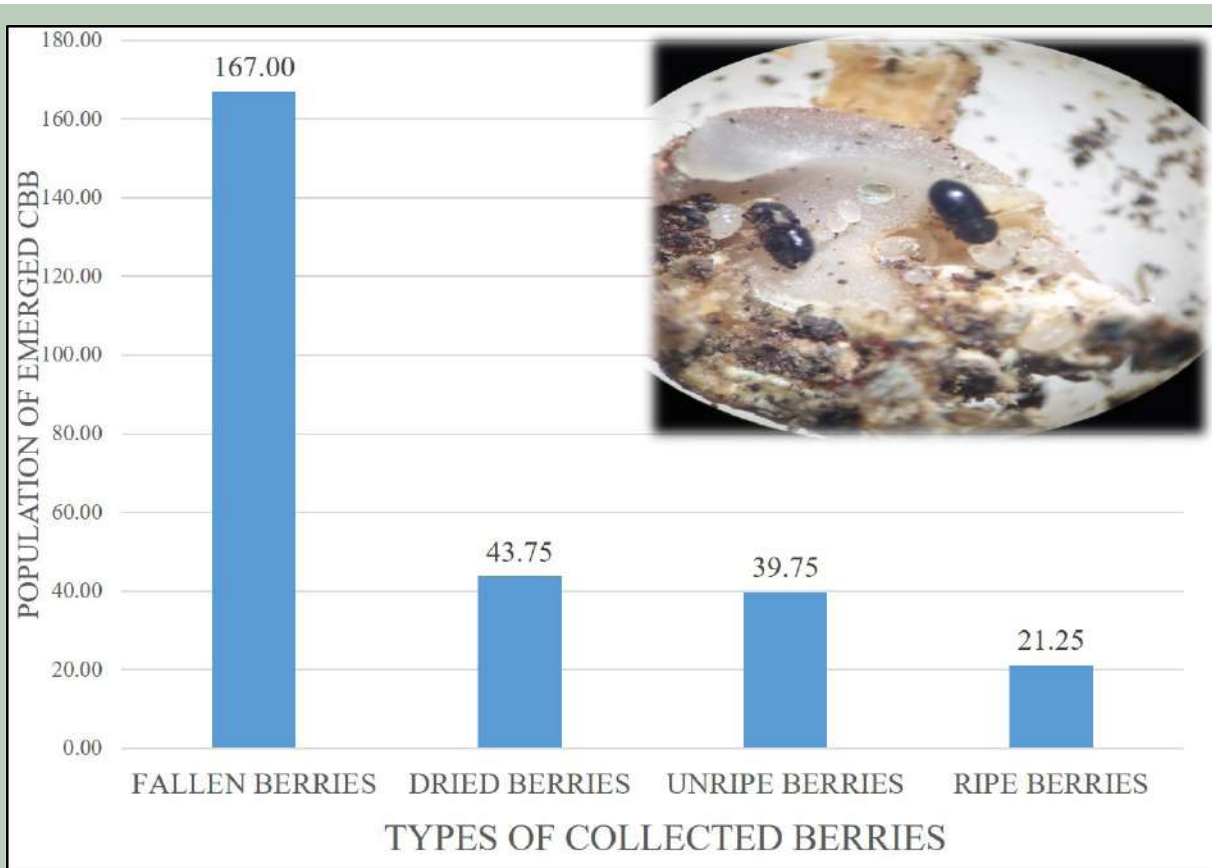

Figure 9. Total number of emerged adult Coffee berry borer (CBB) at different types of berries

(Figure 9). The fallen berries collected on the ground garnered the highest total number of emerged adult CBB with 167, followed by 43.75 from dried berries, unripe berries with 39.75, and the lowest was 21.25 from ripe berries.

The result corroborates to the study of Aristizabal, Arthurs, and Bustillo (2016) stating that adult CBB prefer older berries with greater than 20% dry weight over younger berries less than 90 days old. On the other hand, ripe and over-ripe berries that are left on the trees after harvest and those that fall on the ground serve as a source of new CBB infestations. During dry conditions, infested fallen berries can contribute to a large number of adult CBB that are stimulated to emerge by high relative humidity.

Other Insects Caught in the Lure Trap

There were 23 different species of other insects collected in the lure traps (Table 6, Figures 10-32). The insects that were collected are from the Order *Coleoptera*. These insects are the Click Beetle (*Ampedus sanguineus* Linnaeus), three species of Sap Beetle (*Epuraea corticina* Erichson, *Stelidota coenosa* Erichson, and *Carpophilus Sayi* Parsons), while Grain Weevil (*Sitophilus granaries* Linnaeus), were identified as siblings of the CBB is considered a pest to grains. These insects are all considered pests.

On the other hand, Rove Beetle (*Philonthus tenuicornis* Mulsan and Rey) and Rhizophagid Beetle (*Rhizophagus dimidiatus* Mannerheim) were considered as a general predator. The Bark Beetle (*Placonotus zimmermanni* Leconte) was found to be a potential predator of CBB.

The other insects collected are from the Order *Hymenoptera* that are considered as beneficial insects. The insects are the following: Ichneumon wasp (*Messatoporus discoidalis* Cresson), Diadegma (*Diadegma semiclausum* Helen); and Carpenter ants (*Camponotus pennsylvanicus* DeGeer); and Black Ant (*Dolichoderus pustulatus* Mayr).

Table 6

Classification of Insects Caught in the Lure Traps

Order	Family	Scientific Name	Common Name	Characteristics
Coleoptera	Elateridae	*Ampedus sanguineus* Linnaeus, 1758	Click beetle	General pest of various vegetative crops
	Staphylinidae	*Philonthus tenuicornis* Mulsan and Rey, 1853	Rove beetle	General predator
	Curculionidae	*Sitophilus granaries* Linnaeus, 1758	Grain weevil	Pest of stored grains
	Nitidulidae	*Epuraea corticina* Erichson 1843	Sap beetle	Pest of ripe and dried fruits
	Nitidulidae	*Stelidota coenosa* Erichson, 1843	Sap beetle	Pest of ripe and dried fruits
		Carpophilus Sayi Parsons, 1943	Sap beetle	Pest of ripe and dried fruits
	Monotomidae	*Rhizophagus dimidiatus* Mannerheim, 1843	Rhizophagid beetle	General predator
	Cucujidae	*Placonotus zimmermanni* Leconte, 1854	Bark beetle	Predator of Coffee berry borer
	Coccinellidae	*Cryptolacmus montrouzieri* Mulsant, 1850	Mealybug destroyer	Predator of mealybug
Diptera	Culicidae	*Aedes agypti* Linnaeus, 1762	Mosquito	Human pest
	Drosophilidae	*Drosophila melanogaster* Melgen, 1830	Vinegarfly	Scavenger
	Muscidae	*Musca domestica* Linnaeus, 1758	Housefly	Scavenger
Hemiptera	Cicadellidae	*Agallia constricta* Van Duzee, 1894	Constricted Leafhopper	General pest
	Geocoridae	*Geocoris erythrocephalus* Lepeletier and Serville, 1825	Big-eyed bug	General predator
	Lasiochilidae	*Lasiochilus pallidulus* Reuter, 1871	True bugs	General predator
Hymenoptera	Formicidae	*Camponotus pennsylvanicus* DeGeer, 1773	Carpenter ants	General predator
		Dolichoderus pustulatus Mayr, 1886	Black Ant	General predator
	Ichneumonidae	*Messatoporus discoidalis* Cresson, 1872	Ichneumon wasp	General parasitoids
	Ichneumonidae	*Diadegma semiclausum* Helen	Diadegma	Parasitoids of Diamondback Moth
Lepidoptera	Pyralidae	*Herpetogramma abdominalis* Zeller, 1872	Grass moth	General Pest of vegetative crops

Table 6

Continuation

Order	Family	Scientific Name	Common Name	Characteristics
	Noctuidae	*Erebus acrotaenia* Felder, 1861	Owl moth	Pest of agricultural crops
		Agrotis ipsilon Hufnagel, 1766	Noctuid moth	Pest of agricultural crops
Neuroptera	Hemerobiidae	*Hemerobius humulinus* Linnaeus, 1758	Brown lacewing	General predator

The Order *Diptera* has three types of insects collected: the Vinegarfly (*Drosophila melanogaster* Melgen); and Housefly (*Musca domestica* Linnaeus) that are considered as scavengers and Mosquito (*Aedes agypti* Linnaeus), a known pest to humans.

The Big-eyed Bug (*Geocoris erythrocephalus* Lepeletier and Serville) is considered as a predator, Constricted Leafhopper (*Agallia constricta* Van Duzee) and True Bugs (*Lasiochilus pallidulus* Reuter) that were considered a pest. These insects are all from the Order *Hemiptera*.

The insects collected from the Order *Lepidoptera* are all considered a pest. These are the Grass Moth (*Herpetogramma abdomilalis* Zeller), Owl Moth (*Erebus acrotaenia* Felder) and Noctuid Moth (*Agrotis ipsilon* Hufnagel). One insect species is also collected, *Hemerobius humulinus* Linnaeus, known as the brown lacewing that is one of the general predators of aphids.

Figure 11. Click beetle (*Ampedus sanguineus* Linnaeus), 30x

Figure 10. Grain weevil (*Sitophilus granaries* Linnaeus), 30x

Figure 12. Sap beetle (*Epuraea corticina* Erichson), 135x

Figure 13. Sap beetle (*Stelidota coenosa* Erichson), 90x

Figure 14. Sap beetle (*Carpophilus Sayi* Parsons), 90x

Figure 15. Sap beetle (*Rhizophagus dimidiatus* Mannerheim), 60x

Figure 16. Mosquito (*Aedes agypti* Linnaeus), 30x

Figure 17. Constricted leafhopper (*Agallia constricta* Van Duzee), 15x

Figure 18. True bugs (Lasiochilus pallidulus Reuter), 45x

Figure 19. Owl moth (Erebus acrotaenia Felder), 10x

Figure 20. Noctuid moth (*Agrotis ipsilon* Hufnagel), 10x

Figure 21. Grass moth (*Herpetogramma abdominalis* Zeller), 30x

Figure 22. Rove beetle (*Philonthus tenuicornis* Mulsan and Rey), 45x

Figure 23. Mealybug destroyer (*Cryptolacmus montrouzieri* Mulsant), 60x

Figure 24. Bark beetle (*Placonotus zimmermanni* Leconte), 135x

Figure 25. Ichneumon wasp (*Messatoporus discoidalis* Cresson), 45x

Figure 26. Diadegma (*Diadegma semiclausum* Helen), 90x

Figure 27. Carpenter ants (*Camponotus pennsylvanicus* DeGeer), 60x

Figure 28. Black ant (*Dolichoderus pustulatus* Mayr), 75x

Figure 29. Brown lacewing (*Hemerobius humulinus* Linnaeus), 45x

Figure 30. Big-eyed bug (*Geocoris erythrocephalus* Lepeletier and Serville), 30x

Figure 31. Common housefly (*Musca domestica* Linnaeus), 30x

Figure 32. Vinegarfly (*Drosophila melanogaster* Melgen), 60x

Population of other insects caught in the lure traps. Statistical analysis showed no significant difference in all the treatments because of small differences from one another (Table 7). However, based on its numeric value, the use of 5 lure trap per 50 coffee trees caught the highest mean population while the use of 1 lure trap per 50 coffee trees caught the lowest mean population. This means that as the treatment increases the number of lure trap, the higher the number of insects it can collect. Likewise, the lower the number of lure trap is, the lower the number of insects it can trap.

Table 7

Number of Other Insects Caught in the Lure Traps

Treatment	Mean
T1= 1 lure trap/50 coffee trees	7.921[c]
T2= 2 lure trap/50 coffee trees	11.864[b]
T3= 3 lure trap/50 coffee trees	10.057[bc]
T4= 4 lure trap/50 coffee trees	12.386[ab]
T5= 5 lure trap/50 coffee trees	14.818[a]

Note: Means with the same letter are not significantly different at 5% level of DMRT.

Conclusions

In the mass reduction of female adult coffee berry borer (SBB), the use of 4 lure traps per 50 coffee trees is considered as effective as a means of preventive measures to control CBB infestation. From the data obtained, the dearth period (March to April) of the coffee was observed to be a good time in installing the lure traps to control or reduce CBB populations especially when coffee berries are starting to increase in number, which will create a source of infestations.

Recommendations

It is recommended that using 4 lure traps per 50 coffee trees and setting it earlier during the dearth month period to double the effects of the lure trap in mass reduction of coffee berry borer (CBB). Likewise, all left-over berries on the branches of the coffee trees including the fallen berries on the ground should be removed or collected to prevent source of infestation for the next season.

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