MJSIR
Mountain Journal of Science and Interdisciplinary Research
PRINT ISSN: 2619-7855
ONLINE ISSN: 2651-7744
July-December 2023 • 83 (2) : 36-42

Effective Density of Lure Trap Against Coffee Berry Borer Infesting Arabica Coffee (*Coffea arabica* Linn.) in Benguet, Philippines

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ARTICLE INFO
Date Received: 08-11-2020
Date Last Revised: 11-22-2023
Date Accepted: 12-28-2023

KEYWORDS

Coffee Berry Borer
Lure Traps
Arabica Coffee

Abstract

One major insect pest of Arabica coffee is coffee berry borer (CBB) which was recorded present in Benguet Arabica coffee farms. Previous study revealed that 28 to 47% of these farms were infested with CBB in 2011 to 2014. The management of CBB using lure trap was found effective in other coffee producing countries but yet to be proven locally. This study evaluated the use of lure trap in Arabica coffee farms in Atok and La Trinidad, Benguet in 2018. This study aimed to determine the appropriate number of lure traps per 50 coffee trees. Specifically, to determine the duration of methanol and ethanol lure solution in the traps, population of coffee berry borer trapped, and the effect of lure traps on the percent infestation of coffee berries. Results showed that the duration of the methanol: ethanol lure solution differed in the two locations with the lure solution lasting longer in La Trinidad. The use of 4 lure traps per 50 trees recorded the highest population of adult female CBB trapped in both locations. Meanwhile, the percent infestation was lowest with the use of 4 lure traps per 50 trees in Atok. Therefore, it is recommended to use 4 lure traps per 50 coffee trees to Arabica coffee production areas similar to Atok, Benguet conditions against CBB. Results of the study could serve as basis for further research on the use of methanol: ethanol lure trap in managing CBB in different Arabica coffee production areas.

Introduction

Coffee is one of the most valuable crops over centuries grown in the tropics. In the Philippines, the four coffee varieties including Arabica, Robusta, Excelsa and Liberica can be grown. Arabica is considered to be the best coffee by both local and global market because of its excellent flavor and aroma among the four varieties (Sabio et al., 2012). The Arabica variety thrives and grows better in temperature and mountainous terrain areas like Benguet and Mt. Province, while Robusta variety is mostly grown in warmer areas such as Kalinga and Ifugao (Department of Agriculture-Cordillera Administrative Region [DA-CAR], 2017). Arabica coffee starts flowering one to two years after planting. The plant flowers from March to May and harvesting is done after 9 to 10 months from

flowering (Das-ilen, 2018). Domestic demand of coffee currently stands at 70,000 metric tons while domestic production is forecasted at only 30,000 metric tons in 2010 (Catajan, 2016). The production of the Arabica accounts for only 5-10% of the country's total coffee production (Ferst, 2009). Deficiency in supply could be attributed to occurrence of insect pests and diseases in coffee plants (Evasco, 2016).

The coffee berry borer is the most economically important pest that were recorded in 73 coffee growing countries in the world including Philippines (Centre for Agriculture and Biosciences International [CABI], 2023). First outbreak in the Philippines were recorded in Palomok, Cotabato in 1963 (Gandia & Bocanto, 1964) and 38-97% infestation in Batangas in 1980. In Benguet, infestation of 28-47% were recorded in 2011 to 2014. It is the most destructive and difficult to control insect pest of coffee as most stages of their lifecycles are spent inside the coffee berries (Ligat & Basalong, 2014). It attacks all stages of fruit development once the berries have reached mungo-size to full maturity that directly affects quality coffee production.

The use of traps containing alcohol as an integrated pest management for borers was developed in Central America and has been adopted in Mexico, Brazil, Columbia, and Hawaii (Perez et al., 2014). The methanol: ethanol mixture is commonly used by coffee producing areas in the world since 1991. The mixture has been effectively used as baits for female coffee berry borer (CBB) and prevents the oviposition of females in coffee berries.

Previous studies in other countries recommended 22 lure traps per hectare however, the differences in coffee production practices such as Arabica variety, planting density, shading, elevation and climatic conditions this must be verified locally. The methanol: ethanol lure trap was evaluated in Atok and La Trinidad, Benguet in 2018 to determine the number of lure traps per 50 coffee trees. Specifically, to determine the duration of methanol and ethanol lure solution in the traps, population of coffee berry borer trapped, and the percent infestation of berries caused by adult coffee berry borer.

Materials and Methods

Preparation of the Lure Trap

The method in preparing the lure trap was slightly modified from the College of Tropical Agriculture and Human Resources of University of Hawaii, Manoa (2007). Sixty (60) clear PET bottles with 1.5 liter capacity were used as trapping materials. In each bottle, a window measuring 4 inches by 4 inches was cut out at about 10cm from the bottom. Plastic plate with a diameter of 22.86cm was placed on top of the bottle to serve as roofing to avoid rainwater diluting the lure solution. The outer surfaces of the bottle including the plastic plates were painted with red color for red color was found to be more attractive than other colors (Dufour & Frerot, 2008). A hole was made in the center of the cap and a wire was inserted through the hole and bent into a loop to enable the trap hanging in the coffee branches. On the other end of the wire loop, a 25ml vial containing the mixture of methanol and ethanol with a ratio of 3:1 was tied.

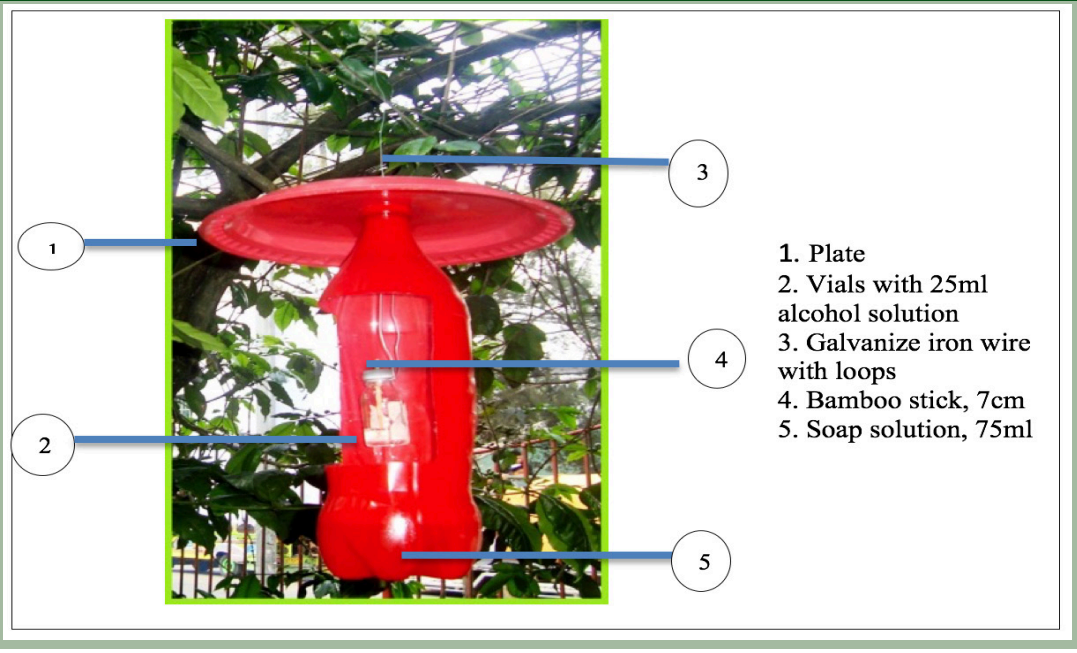
The methanol and ethanol solutions was dispersed by the seven (7) centimeter bamboo stick inserted in the vial cover. One vial per plastic bottle was suspended above the soap solution. Soap solution was prepared by dissolving 25 grams of scentless powder soap that was diluted to one (1) liter water. Three hundred (300) milliliter of the soap solution was poured into the bottom of each plastic bottle in order to disturb the surface tension of water were the trapped insects will not be able to crawl out (Figure 1).

Study Sites

The lure traps were installed in coffee plantations with more than 10 year old Arabica coffee trees planted at 3m between rows and 3m between hills. The study was conducted in the municipalities of Benguet namely Caliking, Atok, and Puguis, La Trinidad, having different agro-ecological characteristics with a minimum of 1000 coffee trees per area. Atok with an elevation of 1,361.6m above sea level (masl) had Alnus sp. as shade trees while La Trinidad is 1,300 masl had Arabica coffee integrated with Benguet pine trees (Table 1). Coffee trees were maintained following the appropriate cultural management by weeding and pruning.

Figure 1

Modified Lure Trap



The coffee trees were organically grown, free from the use of pesticides and synthetic fertilizers based on the interview with the farmers.

Experimental Design

The study was laid out using the Randomized Complete Block Design (RCBD). The lure traps were randomly distributed within the area of 450m² containing 50 coffee trees. The number of lure traps allotted per 50 trees served as treatments (Figure 2). Treatments were replicated four (4) times in each location. Treatments were as follows:

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

Installation of Traps

Lure traps were installed after flowering of Arabica coffee. The prepared lure traps were hanged in coffee branches with a height of 1.2 meters above the ground (Figure 3a).

Duration of the Lure Content

The duration of the lure trap alcohol solution was monitored and recorded from the day the traps were installed until the vial containing methanol: ethanol solution was emptied.

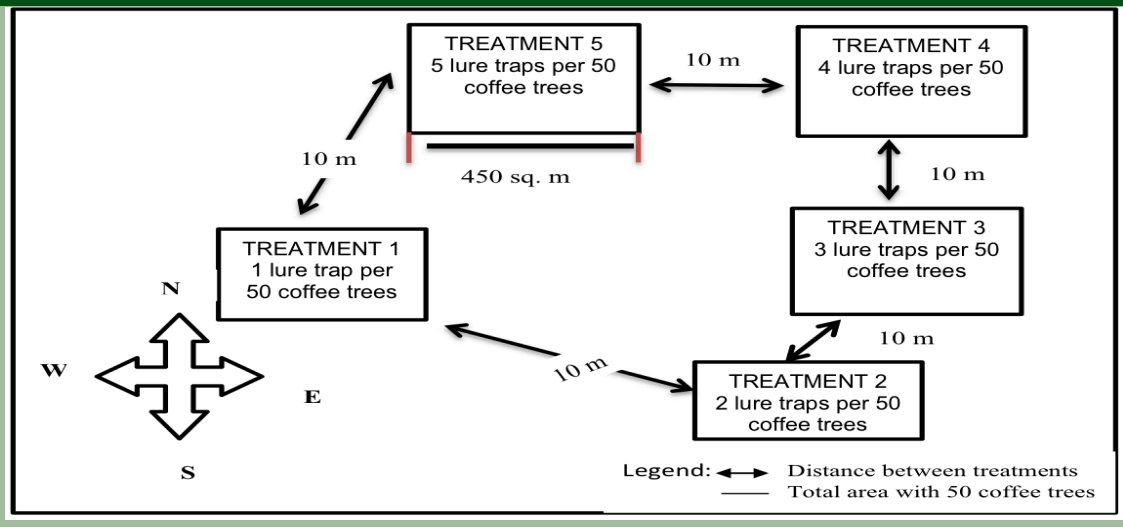
Table 1

Elevation, Temperature, Shade Trees, Shade Tree Density and Light Intensity at the Study Sites.

Municipality	Barangay	Elevation (meters above sea level)	Annual mean temperature	Shade Tree	Shade tree density per 450m²	Light intensity, Klux
Atok	Caliking	1,361.6	18.55°C	Alnus sp.	7	27.6-69.3
La Trinidad	Puguis	1,300.0	26.45°C	Benguet Pine	12	10.3-26.9

Figure 2

Layout of the Area in Each Location with 3m x 3m Coffee Plant Distance



Assessment of CBB Infestation During Harvest

During harvest, sample trees with ripe coffee berries were harvested twice once a month. The third and final harvest was done by using the stripping method. Berries with CBB infestation were counted and proportioned with the total number of berries. Sign of CBB infested coffee berries have pin-sized hole at the tip of the berries.

The percent infestation was computed using the formula by Bustillo et al., 1998:

$$PD = \frac{NIB}{TNB} \times 100$$

Where PD= Percent infestation; NIB= Number of infested Berries; TNB= Total Number of Berries

Collection of Trapped Adult CBB

The collection of the adult trapped coffee berry borer (CBB) and other insect species was done once a week for 4 months. The soap solution containing the trapped insects was strained and were placed in the petri dish (Figure 3b). The trap was refilled with freshly prepared soap solution after collection of the trapped insects. The collected trapped insects were brought in the laboratory for proper identification, counted visually using microscope, and were documented using a digital camera (Figure 3c). The insects were identified following the textbook, the insect of Australia 2nd edition by Chapman (1991).

Figure 3

a) Installation of Traps ; b) Collection of Trapped Insects and; c) Counting of CBB

Data Treatment and Analysis

All quantitative data were collated and analyzed. Analysis of variance (ANOVA) and separation of means by LSD were done using GenStat 15th Edition Software.

Results and Discussion

Duration of Lure Trap Solution

The number of days of the lure trap solution to dissipate varied in the two locations (Table 2). In Atok, the duration of lure did not differ significantly among the treatments which lasted from 18.45 to 20.12 days. Meanwhile, significantly longer duration (29.08 days) of lure traps in La Trinidad was recorded with two (2) lure traps per 50 trees but comparable with the use of one (1) and three (3) lure traps per 50 trees with 28.75 and 23.51 days, respectively. Results in La Trinidad corroborate the study of Copero (2014) that the duration of methanol: ethanol lure lasted for 25.33 to 27 days.

The difference in the duration of the lure trap in the two locations could be due to the effect of different shade tree species, planting density and sunlight intensity. In Atok, coffee trees were planted under Alnus trees planted at wider distance (7 trees/450m²) compared to La Trinidad with Benguet pine as shade trees planted closely at 12 trees/450m² (Table 1). Further, the age of shade trees also affects the sunlight penetration as older trees have wider canopy. Sunlight intensity recorded under Benguet pine shade trees is lower (10.3 to 26.9 Klux) compared to Alnus sp. which ranged from 27.6 to 69.3 Klux. The lure traps under Benguet pine as shade trees were exposed to less sunlight slowing the dissipation of the solution in the traps. These could have resulted in the longer duration of the lure traps in La Trinidad.

Population of Adult CBB Trapped on Lure Traps

The population of CBB trapped from the lure traps significantly varied among the treatments in Atok and La Trinidad (Table 3). The use of 4 lure traps per 50 coffee trees had the highest population of CBB (90.8) trapped in Atok. Similar result was observed in La Trinidad with the use of 4 lure traps recording the highest number of trapped CBB (227.3). The high number of trapped adult CBB could be attributed to the rate of dissipation of the methanol: ethanol solution. The use of 4 lure traps per 50 trees had the shortest duration of lure (Table 3) which indicates that the fume from the lure solution spread quicker to attract female CBB resulting the high number trapped. The results suggest that the installation of 4 lure traps per 50 coffee trees was efficient in trapping coffee berry borer. This is in contrast with the results of Dafour and Frérot (2008) in El Salvador that recommended the use of 44 traps/ha. The variation of the results from their study could be explained by the difference in the farming system specifically Arabica variety, planting density, shading and elevation.

Table 2

Mean Duration (Days) of the Alcohol Solution in Attracting Coffee Berry Borer, 2018

Treatment	Atok	La Trinidad
1 lure trap/50 trees	20.12	28.75[a]
2 lure traps/50 trees	21.25	29.08[a]
3 lure traps/50 trees	19.16	23.51[ab]
4 lure traps/50 trees	18.46	17.44[b]
5 lure traps/50 trees	18.45	21.32[b]

Mean with the same letter are not significantly different at 5% level of LSD

Table 3

Mean Population of Trapped Female Adult Coffee Berry Borers in the Traps, 2018

Treatment	Atok	La Trinidad
1 lure trap/50 trees	16.8[c]	16.4[d]
2 lure traps/50 trees	14.8[c]	125.4[c]
3 lure traps/50 trees	33.0[b]	227.3[b]
4 lure traps/50 trees	90.8[a]	298.0[a]
5 lure traps/50 trees	43.9[b]	150.1[c]

Mean with the same letter are not significantly different at 5% level of LSD

Percent Infestation by Adult CBB on Coffee Berries During Harvest

The percent infestation of the coffee berry borer on harvested berries varied in Atok and La

Trinidad (Table 4). Results shows that the use of four (4) and five (5) lure traps per 50 coffee trees in Atok had the lowest CBB infestation with 1.81% and 1.14%, respectively. The difference in the percent infestation may attributed to the number of lure traps installed. As the number of lure traps increased per unit area, the amount of lure solution released also increased enhanced the attraction of the CBB which explains the decreased of infestation. Results conform with the findings of Kral (2016) that more intense stimuli may elicit a greater insect response. Hence, using 4 lure traps per 50 trees in areas similar to Atok is sufficient to effectively reduced CBB infestation.

Meanwhile in La Trinidad, CBB percent infestation did not differ significantly among the treatments but numerically, the use of three (3) lure traps per 50 coffee trees recorded the lowest percent infestation of 7.50. This would require further study to verify the result.

Table 4

Percent Infestation of Berries During Harvest Caused by CBB, 2018

	Infestation (%) per 100 berries	
Treatment	Atok	La Trinidad
1 lure trap/50 trees	11.32[b]	10.75
2 lure traps/50 trees	7.46[b]	10.50
3 lure traps/50 trees	7.99[b]	7.50
4 lure traps/50 trees	1.81[a]	9.50
5 lure traps/50 trees	1.14[a]	11.00

Mean with the same letter are not significantly different at 5% level of LSD

Conclusions and Recommendations

Based from the results, the duration of the methanol: ethanol lure solution differed in the two locations with the lure solution lasting longer in La Trinidad. The use of 4 lure traps per 50 trees resulted in the highest population of adult female CBB trapped both in Atok and La Trinidad. Meanwhile, the percent infestation was lowest with use of 4 lure traps per 50 trees in Atok.

Thus, the use of 4 lure traps per 50 trees is recommended to Arabica coffee production areas similar to Atok, Benguet conditions. Results of this study could also serve as basis for researchers to further evaluate the use of methanol: ethanol lure solution to manage CBB in different Arabica coffee production areas. Further, similar study could be conducted in La Trinidad to verify the results of this study. Furthermore, promotion of the use of lure traps to manage CBB through Information, Education and Communication (IEC) materials should be done in the locality.

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