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Monitoring coffee berry borer, *Hypothenemus hampei* (Coleoptera: Curculionidae), populations with alcohol-baited funnel traps in coffee farms in Colombia

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The coffee berry borer (CBB), *Hypothenemus hampei* (Ferrari) (Coleoptera: Curculionidae: Scolytinae), is the most important insect pest in coffee (*Coffea arabica* L.) (Gentianales: Rubiaceae) plantations worldwide (Vega et al. 2009). The CBB is a serious pest in Colombia where nearly one million ha of coffee are managed by over half a million growers, with 96% of farms less than 5 ha (FEDERACAFE 2013). Developing larvae feed on the seed, reducing the quality and yield of coffee (Bustillo et al. 1998; Vega et al. 2009). Control is difficult because the CBB spends most of its lifecycle inside berries, limiting the effectiveness of insecticide applications (Baker 1999).

Some newly mated adult females stay and lay eggs in the berry where they were born (Baker et al. 1992). Others leave their native berry in search of new host berries (> 100 days old) (Baker 1999) where they bore a hole, create galleries, and oviposit (Damon 2000). CBB females are attracted to kairomones released by developing berries (Giordanengo et al. 1993; Mathieu et al. 2001; Mendesil et al. 2009; Cruz et al. 2013). Some alcohols, produced in high quantities in ripe berries, are attractive to mated female CBB under field conditions. Traps baited with the synergistic mixture of ethanol and methanol have been used to survey CBB in Mexico (Gutierrez & Ondarza 1996), Central America (Borbón et al. 2002; Dufour & Frérot 2008), Brazil (Silva et al. 2006; Uemura-Lima et al. 2010; Fernandes et al. 2011; Pereira et al. 2012), and Hawaii (Messing 2012). However, results of CBB trapping studies in Colombia have not been reported. Identification of periods with high flight activity of the CBB female can help growers make management decisions and evaluate the efficacy of IPM programs (Aristizábal et al. 2012). Here we used traps to monitor seasonal CBB activity in the central coffee region and compared how trap collection correlated with berry infestation in the field.

Coffee farmers were selected from a participatory research project on integrated CBB management conducted by the National Coffee Research Center, Cenicafé (Aristizábal et al. 2002, 2004). In total, 4 large coffee farms (≥ 20 ha) located in Risaralda municipality, Department of Caldas and 4 small family coffee farms (≤ 3 ha) in Viterbo, Caldas, were selected for trap placement and monitoring between Dec 2003 and Oct 2004. Individual farms were separated by < 2 km, with ≈ 25 km between regions. All farms produced *C. arabica* cv. 'Colombia'. High density production (10,000 trees/ha) occurred in large farms, with coffee in smaller farms grown at lower densities (< 5,000 trees/ha) under shade in association with banana (*Musa acuminaten* Colla) and native trees. Smaller farms were at higher elevations (1,300–1,450 m asl), with cooler, drier conditions (mean 21 °C and 1,121 mm precipitation during the study) compared with larger farms (1,150–1,280 m asl; 23.5 °C and 1,823 mm precipitation) (Cenicafé 2005).

The study was initiated after the main harvest period that occurred from Sep through Dec (when many ripe or overripe berries were present) and continued beyond a second smaller harvest (Mar though May) (Arcila et al. 1993). Management practices for CBB differed among the farms. In small farms, berries were manually harvested by a permanent, skilled farm staff and family members every 2–3 weeks throughout the season (Aristizábal et al. 2011). In large farms, harvesting was conducted at 3–4 week intervals by a limited, less skilled, temporary workforce, while CBB control was supplemented by 3 applications of the insecticides *Beauveria bassiana* (Feb, Apr, and Oct) and endosulfan (Mar and Jun).

Lindgren-type red funnel traps (ChemTica International, Costa Rica) baited with a 3:1 methanol–ethanol mixture enclosed in a semi-permeable plastic membrane (elution rate 186 mg/day; Borbónet al. 2002) (AgBio, Inc., Westminster Colorado, USA) were used to monitor populations of dispersing CBB (Fig. 1). Trap collection cups contained 200 mL soapy water (5% v/v). Traps were placed ≈ 1.2 m high at a density one trap per 500 trees (0.1 ha); i.e. 10 traps per large coffee farm (≈ 1 ha) and 5 per small coffee farm (≈ 0.5 ha). These parameters (color, lure and placement) were optimized for trap effectiveness (Mathieu et al. 1996; Mendoza-Mora 1991; Dufour & Frérot 2008). The number of captured CBB was recorded weekly over 43 and 35 weeks for large and small farms, respectively. Lures were changed at 2 month intervals. Concurrently, CBB infestations in berries were evaluated monthly in the same location by examining all berries for entry holes from a single branch from 30 randomly selected trees using methods described in Bustillo et al. (1998).

In total, 1.65 million CBB were collected from 55 traps during the study. Higher numbers were captured in large coffee farms, peaking in Jan and Feb with an average of 1,650 to 6,120 CBB per trap/week. Highest berry infestation (17–28%) was observed at this time (Fig. 2A). CBB

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Fig. 1. A red funnel trap used to capture CBB (*Hypothenemus hampei*) (A) and the methanol–ethanol lure (3: 1 ratio) enclosed in a semi-permeable membrane (B). CBB were collected in a plastic container containing 200 mL of soapy water. Photo Alex. E. Bustillo.

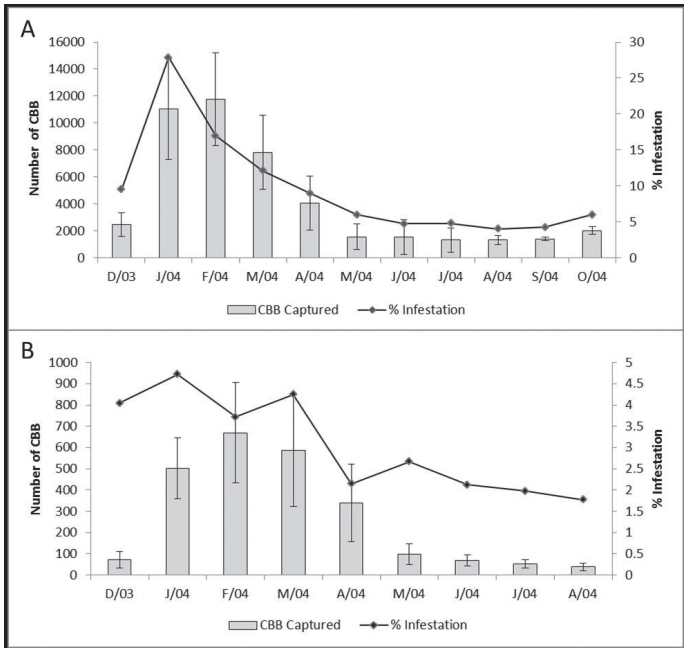


Fig. 2. Number of CBB (*Hypothenemus hampei*) captured per trap per month (mean ± SEM) and corresponding berry infestation (%) on large coffee farms (≥ 20 ha) in Risaralda, Caldas, Colombia (A), and on small coffee farms (≤ 3 ha) in Viterbo, Caldas, Colombia (B) in 2003-2004. Note differences in axis scales.

populations declined through the smaller harvest (Mar–Jun). Fewer CBB were collected in the small coffee farms (Viterbo) (averages of 38 to 105 CBB per trap/week), however, a similar seasonal trend was observed, with captures peaking from Jan–Mar (Fig. 2B). The start of the peak flight activity on smaller farms (Jan) again correlated with higher berry infestation (> 2.5%), and dropped later in the year as flight activity declined. A positive linear correlation (Pearson coefficient) between number of CBB captured and percent berry infestation was observed for both large (r^2 = 0.90) and small (r^2 = 0.68) farms. A similar relationship was reported by Pereira et al. (2012) in Brazil. However, their regression model could not determine an action threshold for CBB, since the intercept indicated that no CBB were caught at a low field infestation (≈3 to 5% berry infestation), which was not observed in our study.

Our data provide information on the seasonal activity of CBB in the Central Coffee region of Colombia. In southern India (with a similar latitude), the greatest collection of CBB by alcohol baited traps was also reported from Jan to Mar (Saravanan & Chozhan 2003). CBB flight periods elsewhere may differ due to climatic differences (Pereira et al. 2012). The lower CBB flight activity and field infestation observed in small farms was significant, given that no insecticides were used. Small farms were managed by more a more efficient work force, which likely contributed to maintaining low berry infestation rates (< 5%). Other factors, such as cooler temperatures, lower planting densities and association with banana may also have played a role in lower CBB populations. The reasons for higher CBB levels in the large farms are unknown, but may reflect warmer and wetter conditions (Baker 1999), higher density plantings, and reduced harvest worker efficiency.

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Summary

We monitored dispersing coffee berry borer (CBB), *Hypothenemus hampei* (Ferrari) (Coleoptera: Curculionidae: Scolytinae), with easily-manufactured, alcohol-baited funnel traps and quantified associated berry infestation on 8 coffee farms in 2 regions in Caldas, Colombia. Flight activity and damage to berries was highest in the 2–3 months after the main harvest (Jan through Mar) and was greater in large farms, where insecticides were used, compared with small farms where efficient and frequent cultural control was implemented. The use of traps and attractants will help farmers track CBB populations and localize efforts to control this pest.

Key Words: coffee berry borer, flight activity, volatiles compounds, integrated pest management, participatory research

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Sumario

La dispersión de la broca del café, *Hypothenemus hampei* (Ferrari) (Coleoptera: Curculionidae: Scolytinae), fue monitoreada con trampas tipo embudo, cebadas a base de alcohol y esta fue asociada con la infestación de la broca en ocho fincas cafeteras de dos regiones de Caldas, Colombia. La actividad de vuelo y el daño a los frutos fue mayor 2–3 meses después de la cosecha principal (de enero hasta marzo) y fue mayor en fincas grandes en donde se aplicaron insecticidas comparado con fincas pequeñas en donde un eficiente y frecuente control cultural fue implementado. El uso de trampas y atrayentes ayudará a los caficultores a seguir las poblaciones de la broca del café y a localizar las concentraciones o focos de la plaga para hacer más eficiente el control.

Palabras Clave: broca del café, actividad de vuelo, compuestos volátiles, manejo integrado de plagas, investigación participativa

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