ICO Coffee Berry Borer Seminar

London, 17 March 2009

Coffee berry borer triple-action integrated pest management

Bernard Pierre Dufour
CIRAD France

Key words

Coffee berry borer, IPM, agronomic control, stripping, trapping.

Summary

In coffee plantations, some of the coffee berry borer (*Hypothenemus hampei* Ferrari) females emerging from residual fruits survive by taking refuge in dry fruits remaining on the branches. They can then colonize new fruits as soon as they become appetizing and continue their development. The control strategy is therefore to capture part of the populations from residual fruits on the ground and eliminate fruit-refuges. CBB control is presented in the form of triple-action Integrated Pest Management: meticulous agronomic control of the coffee plantation, strict branch stripping and trapping. Agronomic control comprises coffee tree pruning, shade tree pruning and rehabilitation of the coffee plantation (cleaning). Branch stripping consists in picking and eliminating all the fruits that remain on coffee trees after harvesting. Trapping enables the capture of CBB during their migratory flights. Triple-action IPM experiments conducted in shaded coffee plantations have shown that it is possible to reduce CBB infestation by over 90% compared to control plots. Of the three IPM operations, only trapping requires any major investment. The advantages of this technique are numerous: efficient basis for control, no risk of contaminating the environment; it is a preventive strategy that is simple to apply, it is compatible with biological control and it does not affect biodiversity.

1. Introduction

The coffee berry borer (CBB), *Hypothenemus hampei* Ferrari, is the most destructive pest in coffee growing on a world scale. It colonizes ripening fruits, multiplies, and soon destroys a large proportion of the harvest. CBB control is based on an INTEGRATED PEST MANAGEMENT (IPM) programme (Decazy, 1990) comprising several control tactics and options: 1.) Cultural control: this involves eliminating berries remaining on the branches (stripping) and collecting berries on the ground, monitoring flowering and removing berries arising from early flowering, and other agronomic practices. 2.) Biological control: this involves releasing different parasitoid species in coffee plantations: *Cephalonomia stephanoderis* Betrem, *Prorops nasuta* Waterston and *Phymastichus coffea* La Salle, and spraying suspensions of the entomopathogenic fungus *Beauveria bassiana* (Bals.) Vuillemin. 3.) Ethological control or trapping: this is the use of attractant traps (kairomones) to capture colonizing CBB females, which cause most of the damage. 4.) Chemical control: this is the application of insecticides intended to kill CBB colonizing young berries. This is a last-ditch solution, when the other methods have not given the expected results.

Through long-standing regional cooperation, and after several years of IPM experiments, the Regional Cooperation Programme for Technological Development and Modernization of Coffee Industry in Central America, Jamaica, the Dominican Republic and Panama (IICA/PROMECAFE), with scientific and technical cooperation from the French Agricultural Research Centre for International Development (CIRAD-France) and the Salvadorian Foundation for Coffee Research (PROCAFE-El Salvador) and financial assistance from the French Ministry of Foreign Affairs, proposes a solution to the CBB problem. It's a simple, efficient and economical IPM strategy comprising three components: meticulous agronomic control of the coffee plantation, strict stripping of branches and rigorous trapping programme.

This simplified IPM applies to geographical zones where there is a single annual harvest, i.e. in the tropical fringe where the climate consists of two clearly distinct seasons, dry and wet. It is more efficient in shaded coffee plantations than in "full sunlight", as trapping responds better to the existence of shade. This programme begins after branch stripping and terminates around the end of June once the major migratory movements of CBB have stopped.

2. How do coffee berry borers survive in a coffee plantation?

After the harvest, CBB develop inside any berries remaining on the coffee tree branches and in berries fallen to the ground during the previous harvest (Fig. 1a). With the first rainfall, adult females, especially those inside berries lying on the ground, fly off to colonize new unripe fruits (Fig. 1b). Usually, the first colonizing females do not find any appetizing fruits. Some of them will therefore die and the rest will take refuge in dry berries remaining on branches (Fig. 1c). As time goes by, young fruits develop and become attractive to CBB. Two distinct populations can then colonize them: on the one hand, the last migrating females from dry berries on the ground; on the other hand,

females existing in berries still attached to the branches (Dufour et al., 2007). In the latter case, the CBB do not need to fly to disperse; they can merely crawl to the nearest appetizing fruits (Fig. 1d).

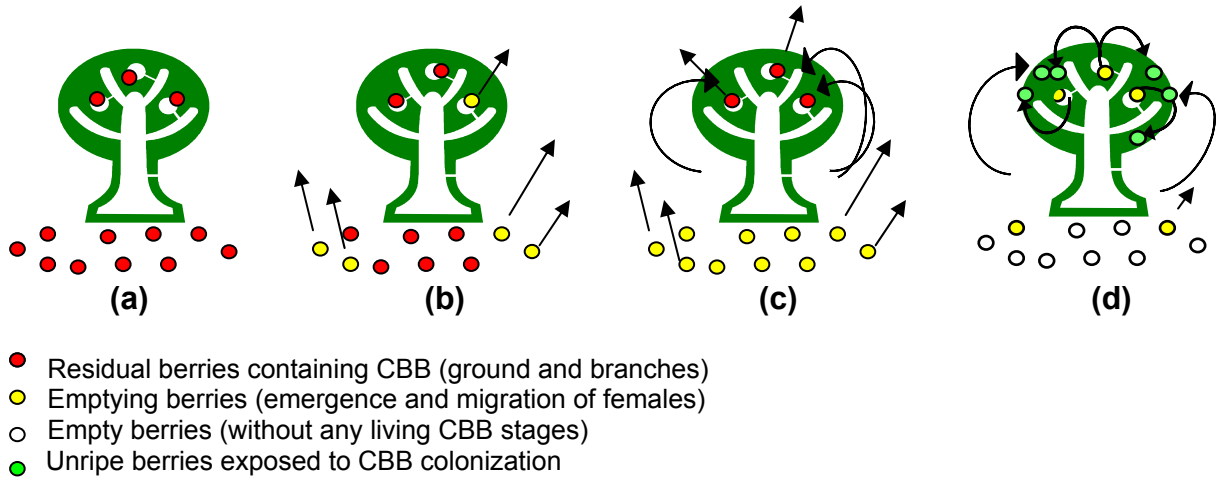

Fig. 1: Diagram showing the process of new fruit colonization by residual CBB populations

3. What strategy should be adopted to prevent CBB survival?

The principle is to interrupt the natural CBB cycle after harvesting:

- by capturing migrating females mostly leaving fruits fallen to the ground. The trapping system therefore remains operative, at least until all the CBB have emerged from those berries.
- by removing residual fruits from branches, since they serve as a refuge for some of the migrating females. This prevents their subsequent re-dispersion, which would lead them to colonize a new generation of berries.

4. Technical aspects of triple-action integrated pest management

4.1. Agronomic control

The activities to be developed as part of agronomic control include: coffee tree pruning, shade tree pruning and rehabilitation of the coffee plantation (cleaning).

- **Coffee tree pruning**: This is done immediately after harvesting. Its aim is to reduce the number of bearing branches to the optimum level and thereby maintain satisfactory production. Removing branches and reducing the foliage ensures good aeration of the coffee tree and boosts sunlight penetration. Consequently, fallen fruits dry out more quickly and the development of CBB populations surviving in those fruits tends to come to a complete halt (Dufour et al., 2007).

- **Shade trees pruning**: this is carried out at the same time as coffee tree pruning or at another time of the year. It produces the same collateral effects.
- **Rehabilitation of the coffee plantation**: this is a task that facilitates stripping and trapping operations. It consists in clearing the coffee tree planting rows, by removing pruning waste from the plots, for use as firewood, and eradicating weeds.

4.2. Branch stripping

Consists in picking and eliminating all unripe, ripe and dry fruits that remain on the coffee trees after harvesting and pruning. In addition, if very young precocious berries arising from early flowering are also picked during this operation, branch stripping achieves its maximum effect.

4.3. Trapping (trap + attractant)

This technique enables the capture of CBB during their migratory flights, which begin with the first rainfall.

Traps are installed at the beginning of March and removed at the end of June (Fig. 2). The recommended minimum number of traps is 18 per hectare (Dufour et al., 2004). Some countries, such as Costa Rica, have adopted 20 per hectare. The traps are inspected every fortnight and captured CBB are removed. The traps are then cleaned and filled with water to their upper limit. It is important to check that the dispensers are working properly and contain enough attractant. The trap recommended by CIRAD is patented under the BROCAP brand name and is manufactured industrially from a strictly designed and tested prototype (Dufour et al., 2002).

It is not necessary to collect fallen fruits off the ground, a practice known as "pepena" or "junta" in Central America. Trapping takes care of capturing and killing any CBB emerging from such berries.

Fig. 2: Trap installation

5. Agronomic aspects to be taken into account

When applying pruning techniques such as cutting back or topping, certain additional measures are necessary.

- **Cutting back**: this type of pruning allows the full regeneration of the coffee trees, but it also offers the opportunity of temporarily removing CBB infestations. However, after two or three years, once the coffee trees start bearing again, they become reinfested. It is therefore necessary to complete cutting back with maintenance pruning, in order to aerate plots and speed up residual berry desiccation.
- **Topping**: this type of pruning is traditionally used in certain countries, such as Jamaica. The zone where the tree is sectioned usually gives rise to several productive branches that form a sort of receptacle in which dry leaves and berries that fall during harvesting can collect. It is essential to remove those fruits when stripping branches.

6. Protection efficiency

Triple-action IPM experiments conducted in shaded coffee plantations, on trees with a tall growth habit, have shown that it is possible to reduce CBB infestation by over 90% compared to control plots (Dufour et al., 2007). Branch stripping and trapping account for more than 70% of that reduction, but it is difficult to determine the contribution made by each of those operations, as they are interdependent. The contribution made by pruning and rehabilitating the coffee plantation may reach 20%.

7. Economic aspects

Of the three IPM operations, only **trapping** requires any major investment. It is essential to have enough traps and dispensers to ensure that the system works effectively for four months per year. During that period, the approximate amount of attractant required is 38 ml, corresponding to two 19 ml dispensers per trap (Dufour et al., 2004). Traps and dispensers vary in cost depending on the type of manufacture and the raw material used. For instance, there exist two types of traps, commercial and "home-made". There are also two types of dispensers, one manufactured in accordance with safety standards and subjected to quality controls, and the other not.
The cost of **agricultural operations** such as pruning and plot rehabilitation forms part of annual plantation upkeep costs. The cost of **branch stripping** corresponds to the wage paid to staff assigned to that task for a given period. This operation is self-funding through sale of the residual berries gathered.

8. Conclusion

CBB triple-action integrated pest management provides a sound, efficient basis for control, without risk of contaminating the environment, which is one up on chemical

control. It is a preventive type strategy, i.e. it controls CBB before they infest the harvest and cause damage. It is simple to apply since only trapping requires specific equipment (the trap). On the other hand, agronomic practices and branch stripping are normal practices in coffee growing, but they must be done with care. CBB IPM is compatible with biological control using parasitoids or entomopathogenic fungi. It does not affect biodiversity.

9. References

Decazy B, 1990. Le scolyte du fruit du caféier *Hypothenemus hampei* Ferr.: considérations sur la lutte intégrée contre ce ravageur. In : Proceedings of the 13th International Conference on Coffee Science, Paipa, Colombia, 21-25 August 1989, ASIC, Paris, 655-665.

Dufour BP, Picasso C, González MO, 2002. Contribution au développement d'un piège pour capturer le scolyte du café *Hypothenemus hampei* Ferr. en El Salvador. In : Proceedings of the 19th International Conference on Coffee Science, Trieste, Italie, 14-18 May 2001 [CD-ROM] ASIC, Paris.

Dufour BP, González MO, Mauricio JJ, Chávez BA, Ramírez Amador R, 2004. Validation of coffee berry borer (CBB) trapping with the BROCAP® trap. Poster in: Proceedings of the 20th International Conference on Coffee Science, Bangalore, India, 11-15 October 2004 [CD-ROM] ASIC, Paris.

Dufour BP, Franco Franco F, Hernández A, 2007. Evaluación del trampeo en el marco del manejo integrado de la broca del café. In: Memoria: La Broca del Café en América Tropical: Hallazgos y Enfoques, Workshop Internacional, Junio 2007, Acapulco, Guerrero, México. Ed. por Barrera JF, García A, Domínguez V, Luna C., ECOSUR y Soc. Mex. Ent., México, 89-99.