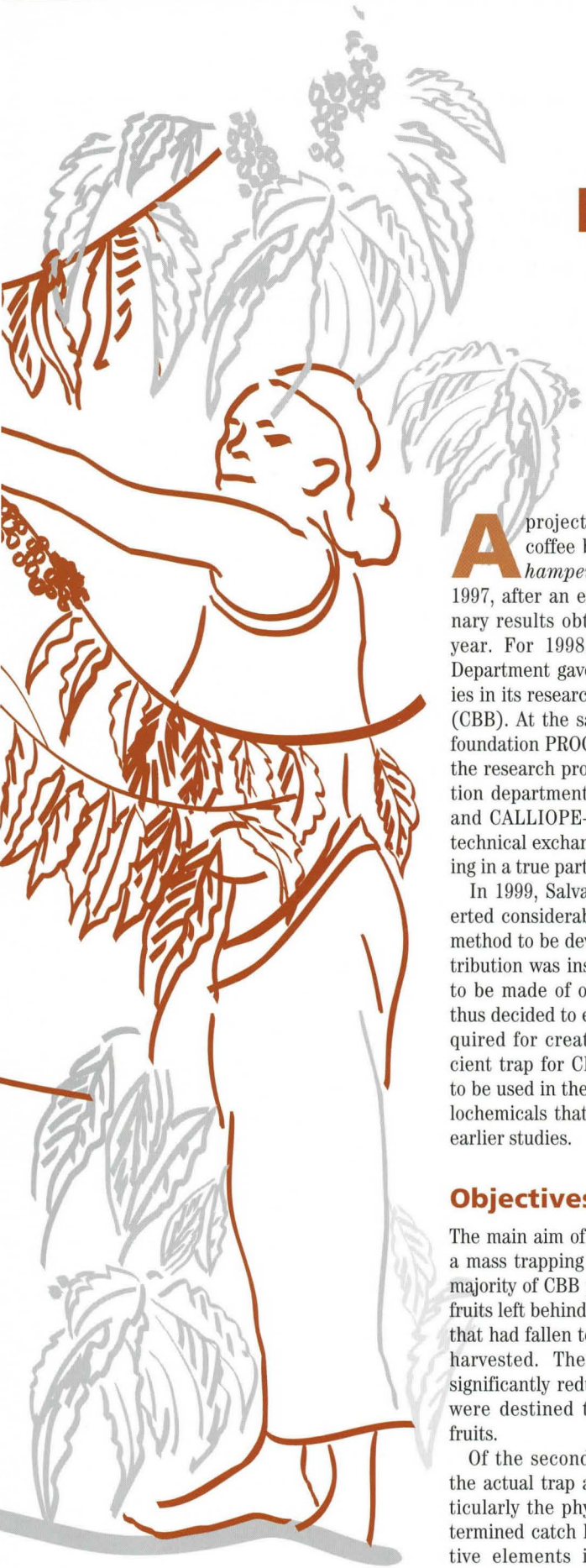

Coffee berry borer trapping

A project to study trapping of the coffee berry borer *Hypothenemus hampei* Ferr. was launched in 1997, after an examination of the preliminary results obtained at the start of that year. For 1998, the CIRAD Tree Crops Department gave priority to trapping studies in its research on the coffee berry borer (CBB). At the same time, the Salvadorean foundation PROCAFE included this topic in the research programme of its crop protection department. Collaboration with INRA and CALLIOPE-NPP led to scientific and technical exchanges, though without resulting in a true partnership.

In 1999, Salvadorean coffee growers exerted considerable pressure for a trapping method to be developed. The scientific contribution was insufficient to enable studies to be made of olfactory attraction. It was thus decided to examine the parameters required for creating a specific highly efficient trap for CBB control. The attractant to be used in the trap was a mixture of allelochemicals that had been amply tested in earlier studies.

Objectives

The main aim of the project was to develop a mass trapping method that captured the majority of CBB populations migrating from fruits left behind after the harvest, i.e. fruits that had fallen to the ground and those not harvested. The idea was therefore to significantly reduce these populations that were destined to infest the new crop of fruits.

Of the secondary objectives, studies of the actual trap are worth mentioning, particularly the physical parameters that determined catch levels, and the study of active elements in the trap, forming the attractant mixture, the dispenser and the diffusion rate. Also of importance is the testing of mass trapping efficiency under natural conditions, along with studies on the different aspects of CBB migration-capture during the post-harvest period, along with the effect of trapping on the ecological balance of coffee plantations and on biodiversity.

Results

The trap

The initial principle of the trap, which consisted of a capture recipient, the dispenser and the capture liquid was kept (photos 1 et 2). The only changes made were to the shape, volume and colour, in order to emphasize the determinant parameters. Firstly, a comparison of five models, three of which were experimental and two commercially available, revealed the importance of size, and the positioning of the trap openings. For instance, CBB enter the trap more quickly if the openings are large and easily accessible. The commercial traps tested, such as Multipher® A and B, which were of a different design, proved to be totally unsuitable. Secondly, the size of the openings was confirmed using new experimental single-aperture models, in the shape of a large-diameter, inverted cone, prototypes A and B. These models also ensured better attractant diffusion and showed that the position of the aperture, in a horizontal plane, made it easier for the insect to land on the trap.

Visual attraction of the CBB, which has been studied by several authors, had always been carried out in the laboratory. In El Salvador, the tests were carried out in coffee plantings, with coloured traps, which revealed that CCB are very strongly attracted to red, with a wavelength of $\lambda = 750$ nm.


B. Dufour

Photo 1.
Initial trap model (1B).

B. Dufour

Photo 2.
Prototype B of the trap, precursor of the Brocap® trap.

Another factor was involved in the size of catches: trap height. The results obtained with traps diffusing at a height of 1.20 m from the ground were three times better than with those diffusing at 0.40 m.

Active trap elements

The attractants comprised an alcohol mixture with different terpenes identified by Mathieu (1998) during chemical analyses on coffee cherries. In a binary or compound mixture, and at low concentrations, terpenes in fact gave results that were similar to or not as good as those obtained with the alcohol mixture alone. The synergy effect of the terpenes seen in earlier trials was not reproduced, despite setting up ten or more comparative trials, at different times and at different sites. Several hypotheses can be put forward to explain the results obtained with terpenes: the attractiveness depends on the particular physiological state of the insect, exceptional ecological conditions, or the effect of chance. The allelochemical attraction of CBB needs to be studied more closely to prove whether terpenes are worthwhile.

Evaporation is the simplest way of diffusing alcohol mixtures. The diffusion rates for the mixture, from 0.12 to 0.35 g/day, in no way changed the capture levels. The Picodrop® system for diffusion of more complex mixtures proved unusable due to trap design. However, although a ceramic wick dispenser did not notably improve diffusion of the alcohol mixture, it could be used for complex mixtures.

Evaluation of mass trapping efficacy under natural conditions

Large catches obtained during migrations of colonizing CBB females did not necessarily mean that trapping significantly reduced infestation on new fruit crops. It was therefore important to carry out an initial study of trapping efficiency and thus assess the potential of the method. Trials were launched in March 1998, just before the first significant migration, and continued up to mid-June, when flights became insignificant. The experimental design was a systematic layout of 16 type 2A traps per manzana (0.7 hectares), i.e. the optimum number defined in the very first trapping tests. It consisted of two treatments with different attractant mixtures and a control.

During trapping, catches occurred in peaks reflecting flight intensity. On the whole, the number of CBB captured only amounted to a small proportion of the initial residual populations. However, efficacy measured in terms of reduced infestation reached 34.8% with the alcohol mixture alone, and 50.7% with the alcohol mixture enriched with terpenes. It needs to be said that the sharp increase in catches obtained with the second mixture did not last.

More recently, a replicate of the efficacy study was carried out with the Brocap® trap and the basic alcohol mixture; it improved the previous results, increasing efficacy to 57%. A trapping effect therefore does exist. It needs to be confirmed by validations currently being carried out.

Study of different aspects of CBB migration-capture during the post-harvest period

This trial was set up in the same plots as those used for mass trapping efficacy. It showed that rainfall played a decisive role in triggering migrations, and therefore in the occurrence of capture peaks. An increase in temperature within coffee plantings also contributes towards CBB activity, encouraging flight. The most intense activity during the day was seen in the afternoon, when warming of the coffee planting reached maximum.

Capture peaks systematically corresponded to the quantities of colonizing females found in the residual fruits, mainly those lying on the ground. Captures of CBB from residual fruits still on the trees did not follow the same rule: migrations were incessantly masked by the comings and goings of CBB of various origins. These fruits were more or less a refuge for migrating CBB that had yet to find a suitable host.

Hence, in order to achieve maximum catches, trapping needs to begin before the first rainfall. Flight intensity can be estimated beforehand from data obtained on the CBB populations, primarily those in residual fruits on the ground.

Examination of the merits of CBB trapping in terms of biodiversity preservation

The attractant used for CBB trapping attracts few other insects apart from the coffee berry borer. Of 68 species identified during the capture period, fewer than ten or so were attracted by the trap, and primarily by the existence of water (capture liquid). *Chrysopa* sp. was the only useful species captured, but in insubstantial numbers.

Trapping is therefore a selective capture method with a good degree of specificity.

Conclusion

Given the results obtained on trapping procedures, the physical characteristics of the trap, its efficacy and its relative neutrality as far as other insects are concerned, studies

can now be continued, primarily to develop a trap that is perfectly adapted to CBB capture.

The prototypes that revealed their trapping efficacy have led on to the first specific CBB trap, registered under the Brocap® brand. A preliminary series was manufactured industrially, in order to have a sufficient number of units for tests. The trap was then validated under natural conditions in 15 coffee plantations in El Salvador, to confirm its efficacy. With the results of these trials it should now be possible to launch the trap on the market.

At the same time as this validation operation, other tests have been set up to gain a clearer idea of how the Brocap® trap performs under true operating conditions: number of units per hectare, CBB capture rates, prevention of accidental plugging of the traps, etc.

Other improvements will follow, primarily the development of a more specific and more powerful attractant. ■

List of publications

DUFOUR B., 2001. Importance du piégeage pour la lutte intégrée contre le scolyte du café *Hypothenemus hampei* Ferr. Plant. Rech. Dév. (in press).

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