

Management strategy of Cacao Frosty Pod Rot caused by *Moniliophthora roreri* (Cif. and Par.) Evans *et al* in Colombia

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ABSTRACT

Frosty Pod Rot has been considered the disease with the greatest impact on the yields and quality of the raw material of the cacao crop in Central and South America. Currently Brazil is considered free of it. Recently was reported in Jamaica, island of the Antilles. In Colombia, its damages have been known for two centuries and losses reach levels of 38-84% without control measures. The Cultural Control is a simple, effective, low-cost, environmentally friendly and sustainable disease management strategy. Reduces infection levels below 1%. It is based on the knowledge of the symptoms, epidemiology, disease cycle, and the rigorous application of the periods and time of removal of diseased fruits, disposition of diseased fruits and pruning of the crop.

Keywords: Cacao; Disease; Control platform

INTRODUCTION

Cacao Frosty Pod Rot (Figure 1), caused by the basidiomycete *Moniliophthora roreri* (Cif. & Par.) Evans *et al* [1], is an endemic and harmful disease responsible for low crop yields and deterioration of the quality of raw material in Colombia for more than two centuries [1,2]. In Spanish is known like Moniliasis, Monilia, polvillo, ceniza and hielo between others.



Figure 1: Cacao fruits with Frosty Pod Rot in sporulation stage

Currently its presence has been reported in Venezuela, Ecuador, Peru, Bolivia and Central America. Jhonson *et al* [3], confirm its recent expansion to Jamaica, an island in the Antilles. It is worrying that in a short time it will spread to the Dominican Republic and other Caribbean islands. Brazil is still considered free of the disease but is at high risk.

Between the years 1970-2000, different studies were carried out on symptomatology, artificial inoculation, disease cycle, epidemiology and control that let it possible to configure an effective and accessible control platform for all producers; it is about Cultural control [4-7].

BACKGROUND OF CROP DAMAGES

In the years 1970-1972, through removal of diseased fruits at intervals of three weeks and buried in the ground, very high losses were confirmed in the crops of farms in Urabá, department of Antioquia, Colombia, with incidence levels of 80% causing the ruin of the producers, as was the case of the “Paraguay” farm, Currulao district, Turbo municipality (Cubillos, unpublished). Barros [8], in the farm “Cacaoteras del Dique”, municipality of Cauca in the department of Antioquia, Colombia, reported incidences of Frosty Pod of the order of 39.3%-52.8% between the ages of 6-8 years of the crop under removals of diseased fruits

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every 2-3 weeks, fruits that were buried in the ground.

In the years 2005-2006, through evaluations carried out in 51 farms in the departments of Norte de Santander, Santander del Sur, Tolima, Huila, Arauca, Meta, Antioquia and Nariño, in Colombia, it was determined that the incidence of the disease fluctuated between 38.6% in Meta department and 84.1% in Norte de Santander department, without applying specific control mechanisms [9].

The above information gives a clear idea of the damage that Frosty Pod Rot has caused to Colombian cacao producers when no control strategy has been used.

CULTURAL CONTROL AS A MANAGEMENT STRATEGY

Cultural control is a method that lets infection levels to be kept below the economic damage threshold. It is effective, simple, low-cost and sustainable over time [10, 15].

It is based on six principles whose knowledge and rigorous application constitute the axis of control. They are: 1. Symptomatology, 2. Epidemiology, 3. Disease cycle, 4. Frequency and time of removal of diseased fruits, 5. Disposal of diseased fruits and 6. Crop pruning.

1. Symptoms

Recognizing when a fruit is sick is the first step to the control of the disease. The symptoms appear on month after infection. Fruits less than three months old show shiny-looking bellies or humps (Figure 2A); fruits older than three months have tiny sub-epidermal oily spots (Figure 2B). A month and a half later in both kinds of fruits, the brown or chocolate-colored stain is observed (Figure 2C). 8-9 days after the brown spot forms, the mycelium appears and sporulation of the pathogen begins (Figure 2D). This last stage constitutes the most critical phase and it is the one that generates new outbreaks of infection.



Figure 2: Fruits with belly or hump symptoms, 2A; with sub-epidermal oily spots, 2B; with brown stain, 2C; with mycelium and sporulation of the fungus, 2D.

2. Epidemiology

It has been estimated that a sporulated fruit is capable of producing 7 billion spores [11] and that the wind is its main means of dissemination. These spores can remain viable for up to nine months on or in fruits attached to stems and branches of trees, conserving their infectivity [12].

Diseased fruits quickly lose their moisture, possibly due to water consumption by the sporulating mycelium; then they become woody or mummified and remain on the tree for up to several years [12]. However, although these fruits follow functioning as sources of infection, they do not have the same power as newly sporulated fruits [13].

Green in the years 1975-1976 [5], showed that with an inoculum density of 3 sporulated fruits per tree, infection levels fluctuate between 55% and 10% in trees 20 m distant from the source of infection (infection gradient).

Then, high densities of diseased fruits within the crop, especially fruits recent sporulated hanging from stems and tree branches, are the determining source of infection responsible of triggering epidemic episodes. The role of external sources of infection is to introduce the disease into the plantations so that the new diseased fruits that are generated become secondary sources of infection aimed at causing strong outbreaks of epidemics. Cubillos [6] and Cubillos and Ardila [14], through monitoring carried out in different places from Colombia, verified that sporulated fruits deposited on the ground with a density of 25-27 fruits per tree are not capable of unleashing Frosty Pod Rot infections in compromised trees.

3. Disease Cycle

The first symptoms appear a month after infection. A month and a half later, the brown (chocolate) stain forms and after 8-9 days the mycelium and sporulation of the pathogen appear. Consequently, the incubation period of the disease (first visible symptoms) is one month and the vegetative period is a little less than three months [7].

4. Frequency and Time of Removal of Diseased Fruits

In crops subject to outbreaks of Cacao Frosty Pod Rot (incidences above 10%), the rounds of removal of diseased fruits must be strictly applied once a week for three consecutive months. After three months, the cycle of the disease has been broken and the levels of infection have been reduced to minimum levels. From this moment on, the weekly rounds are suspended and the removal of diseased fruits is done together with the harvest of ripe fruits to which the producer is accustomed and which corresponds to intervals of 2-3 weeks [2], without risks of the resurgence of new epidemic episodes.

5. Disposition of Diseased Fruits

The diseased fruits that unhang from the stem and branches of cacao trees are left freely on the ground (Figure 3) because they do not constitute sources of infection for the following reasons:



Figure 3: Diseased sporulated fruits removed from trees and left on the ground to prevent them from becoming sources of infection.

1. The spores that remain on fruits lose quickly its germination power.
2. The high humidity that is registered at ground level normally compacts the spores and prevents their detachment from its fruit.
3. The breeze at ground level is very light limiting any spread of spores especially upwards.
4. The leaf litter that comes off the cacao and shade trees progressively covers the diseased fruits obstructing the dissemination of spores.
5. All the biota present in the soil are responsible for rapidly decomposing diseased fruits.

6. Pruning the Crop

Pruning (Figure 4) is a task that harmoniously combines with the control of Cacao Frosty Pod Rot. It is the practice that allows the visualization of diseased fruits in the canopy of the trees and facilitates their removal, especially when a height that does not exceed 4 m is maintained. Pruning should normally be done after the main harvest is over.

The best indicator of the effectiveness of the Cultural control of Cacao Frosty Pod Rot is the absence or minimal presence of sporulated fruits hanging from branches and stems of trees which is equivalent to have none or low density of inoculum within the cacao crop respectively.



Figure 4: Properly pruned trees that allow easy detection of diseased cacao fruits. (Photo by N. Ardila)

RESULTS OF A CASE OF CULTURAL CONTROL

The farm LA ILUSIÓN, located in the municipality of Chigorodó, zone of Urabá, department of Antioquia, Colombia, with a population of 800 trees of different cacao clones and five years of age, by mean the Cultural control of Cacao Frosty Pod Rot had a production of 1,651 kilograms in the year 2019 while is estimated that the production of 2020 will be larger than 2019, with an estimated incidence of Frosty Pod Rot below 1% (Figure 5). These results reflect the efficacy of Cultural control as a management strategy of Cacao Frosty Pod Rot.



Figure 5: Sanitary status of fruits hanged of their trees in advanced development process close to the harvest of 2019. Finca LA ILUSIÓN, municipality of Chigorodó, department of Antioquia, Colombia.

CONCLUSION

The Cultural Control of Cacao Frosty Pod Rot is the proven management mechanism in Colombia for being effective, simple,

low-cost, friendly to the ecosystem and self-sustaining. It basically consists of removing diseased fruits from the stems and branches of cacao trees and leaving them on the ground without moving them from the place of fall for three consecutive months and, later, each time the harvest rounds are made. During the removal of diseased fruits, priority should be given to those that are in a state of sporulation.

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