Microenvironment and air bourne *Moniliophthora roreri* spore number in cocoa plantations shaded by three different leguminous tree species

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Introduction

The fungus diseases of cocoa (*Theobroma cocoa*, L.) are the most important source of yield loss. The fungi *Moniliophthora roreri* (Cif & Par.) Evans *et al.* (Monilia) causes losses of up to 90% of the fruits in the countries of Tropical America where it is present (Galindo, 1984; Enríquez, 1987; Aranzazu, 1982). From 1978, the year when the disease first appeared in Costa Rica, many investigations have been carried out to seek control methods (Campos, 1988).

Chemical combat is not viable alternative due to the high cost. Genetic resistance and antagonistic methods are a still being developing. Cultural practices have been one of the most recommended mechanisms to control Monilia, and different strategies have been evaluated. Some are designed to decrease the sources of fungal spores; others are designed to manipulate the microenvironment of the plantations. Shade regulation is one of the most important recommedations within the strategies for handling the microenvironment for Monilia control. However, it is still not clear how this factor affects the microclimates and how this in turn affects fungal dispersion and infestation (Phillips, 1991).

The growth, shade type and management of the canopies of the trees influences the microenvironment of the cocoa plantations, and probably the development and incidence of Monilia. It is important to study these interactions in order to propose specific recommendations for Monilia control through shade management in agroforestry systems with cocoa. The objetive of this investigation was to determine if under different managed leguminous shade trees there were changes in the microclimate (relative humidity, temperature) and to sample the population of Monilia spores throughout the day below different shade types.

Materials and Methods

The investigation was carried out in the lowland humid Caribbean plains of Costa Rica, between December 1992 to November 1993. The shade species used were: *Gliricidia sepium* (Jacq.) Steud. (Madero), *Inga edulis* Mart. (Guaba) and *Erythrina poepiggiana* (Walpers) O.F. Cook (Poró). The experiment was carried out in Margarita, Talamanca, Costa Rica (12 masl, annual average temperature of 26.5°C, annual precipitation of 2319 mm and a relative humidity of 84%). There is no defined dry period. The soil of the experimental site was classified as a Endisol with an imperfect natural drainage. The original experiment was established in 1988 with the objetive of evaluating the effect of different leguminous shade species on the production of six interclonal crosses of cocoa.

A random block design was used with three repetitions and a split-plot arrangement where the shade species were the main plots and the interclonal cocoa crosses the split-plots. Each plot had 36 shade trees and 100 cocoa trees. The evaluation plot included 16 shade trees and 36 cocoa trees; the interclonal crosses were distributed at random. The shade trees were planted at spacing of 6 x 6 m and the cocoa to 3 x 3 m.

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Shades trees were pruned from 2 years age. In all species a single stem was left and the pruning intensity depended on the growth rate and form of each of the species. Madero produced multiple stems and low branches that were eliminated. In guaba, the forks of the main stem were eliminated; low and branches interlaced with adjacent shade trees were cut. In poró, one stem was left but capped at 7,5 m of height, and low branches were removed.

Fixed cylinder traps were used (Jenkins, 1974), with modified materials to adapt them to the local conditions and to reduce costs. The trap consisted of a tube of plastic of 41,5 cm long x 1 cm wide. In the centre of the tube, an adhesive tape was placed with the adherent part toward the exterior so that the conidios were captured in all conditions. A protector was used against the rain.

Two ways of counting monilia spores in the air, in each one of the established shade treatments, were used:

1. Daily sampling, to evaluate spore dynamics (5 a.m. to 5 p.m.). In a single block of the experiment, 18 traps were placed, six in each shade type. Each trap was placed between four cocoa trees in the central part of the plot. The adhesive tapes were left at five a.m. and removed at eight a.m.; immediately; other tapes were left and these were removed at 11 a.m. This process was repeated until 5 p.m. (three hour intervals). These measurements were carried out every 30 days.
2. Biweekly sampling, to evaluate monthly spore dynamics in each shade type (December 1992 until November 1993). The traps were established every 15 days. The traps remained for eight days in the field. For every sampling period, 45 traps were placed, with five traps/plot, located in fixed points, with a trap in each corner of the main plots and a fifth trap in the center of the plot.

Spore counting methodology was that recommended by Campos (1988). Monilia conidios were tinted with Lactophenol Aniline at 0.1%, in order to count the spores using a microscope. The meteorological variables evaluated were: relative humidity and temperature every two hours (each shade type), using a hygrotermograph (WILH LAMBRECHT), placed at 1.5 m height, between the cocoa and the shade tree in a single block.

Results

The lowest average temperatures were recorded under the poró (24°C); madero's average temperature was 25°C and guaba registered the highest averages (26°C). Relative humidity was lowest under poró. The spore quantity increased significantly during the harvest period. The highest populations were registered below poro shade. The biggest capture of monilia spores ocurred between 8 a.m. and 2 p.m. In the poro treatments and guaba, the biggest quantities were recorded between 11 a.m. and 2 p.m. In the poró and guaba treatments, the biggest quantities were recorded between 11 a.m. and 2 p.m., while in madero, the biggest quantities were recorded between 8-11 a.m.

Conclusions

1. Although not significant, temperature and relative humidity differences were recorded at different times of the day and between the shade types.
2. The relationship between the temperature and the movement of spores indicate that their liberation occurs above 29°C. (10 a.m.)

3. The relationship between relative humidity and the movement of spores indicated that their liberation occurred between 71 and 74% relative humidity that corresponded approximately to 10 a.m – 2 p.m.
4. Monilia spore quantities found under poró shade during the day were greater than under madero and guaba shade.

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