Spatial factors in the epidemiology of black pod rot caused by *Phytophthora* sp.

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Early screening for resistance to* Phytophthora sp. *is efficient, notably using leaf discs. However, a field assessment under natural infection conditions remains necessary to validate results. Infestations display spatial effects on a study plot scale. Spatial heterogeneity therefore has to be taken into account in field assessments.

Study material

The cocoa trees observed in Cameroon were derived from a 6 X 6 complete diallel mating design (without the selfs).

In Vanuatu, the 10 hybrids tested in plot B1-5 at Valeteruru came from crosses between Amelonado and Upper Amazon or Trinitario clones.

Detecting spatial effects

• *Maps*

Plot maps were drawn up. Each tree was represented by a circle whose content depended on the pod rot percentage of the tree (Figure 1).

A gradient appeared, with higher rot rates in the northern and eastern sections.

Smoothing made these gradients clearer (Figure 2).

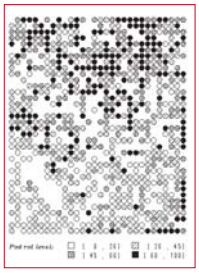

Figure 1. Distribution of pod rot percentages per tree in a diallel plot in Cameroon (Plot A).

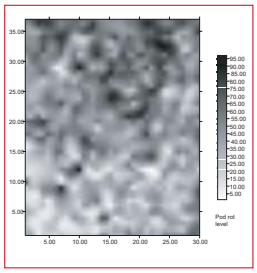

Figure 2. Distribution of pod rot percentages per tree in a diallel plot in Cameroon after data smoothing (Plot A).

• *Semi-variograms*

These are graphs on which mean square errors are represented depending on the distance separating the "observation" points, i.e. the trees. Semi-variograms can be used to characterize spatial heterogeneity.

In the plot in Cameroon, a gradient appeared (Figure 3), consequently division into blocks could be efficient.

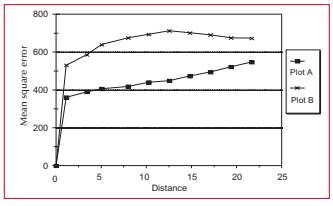

Figure 3. Semi-variogram of the pod rot percentage per tree in the diallel plot in Cameroon.

In the plot in Vanuatu, the semi-variogram rapidly reached its maximum value (Figure 4). Only relations between neighbouring trees were detected.

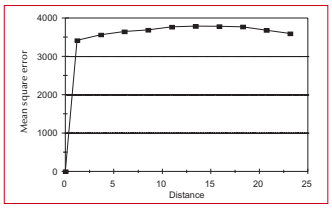

Figure 4. Semi-variogram of the pod rot percentage per tree in the plot in Vanuatu.

Considering spatial effects in analyses

• Micro-blocks

Micro-blocks correspond to *a posteriori* divisions of experimental plots. They make it possible to control some of the heterogeneity. These divisions are useful when a gradient structure appears (diallel in Cameroon).

• Smoothing

Data smoothing is a possible alternative for eliminating environmental effects. The idea is to filter information, so as only to keep variations due to the factors being studied.

The Papadakis method (or nearest neighbours method) is a particular kind of smoothing: the value of each tree is corrected by the values of its neighbours (raw or residual values after an initial analysis of variance). Although this method is empirical, it enables correction of spatial heterogeneity.

• Spatial analysis models

Models can also be used to control the spatial structure of data: spherical model, exponential model, Gaussian model, polynomial model, etc.

Conclusion

Spatial distribution of the disease was not random in the plots. However, spatial correlations were sometimes weak compared to other diseases or insects attacking cocoa trees. Such correlations vary depending on the plots and it is necessary to take them into account in breeding trials.

Gradients can be controlled by dividing plots into blocks, and neighbourhood effects by spatial models or by covariance analyses of the "Papadakis" type.

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