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# DIAGNOSTIC SURVEY IN BANANA PLANTATION

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## INTRODUCTION

The main objective of diagnostic surveys is to determine the influence of ecological conditions (soil, climate), cropping systems, and technical practices on crop yield potentials. In classical experimentation, the effect of one or more factors on crop yield is studied: the variability is experimentally created. In diagnostic surveys, variability of cultivated plots in true situations is used, and cost and duration are considerably reduced relative to multilocal experimentation. Figure 1 presents schematically the various steps followed in diagnostic surveys. Collecting data involves choosing plants at flowering stage and generally includes soil/plant testing, measurement of plant criteria related to crop yields and a general agronomic appraisal (water and mineral nutrition, parasitism, root profiles).

In banana cropping systems, diagnostic surveys have been carried out so far in situations of unsatisfactory yield levels and resulted in the identification, hierarchization, and localization of factors limiting crop potential (Delvaux et al., 1986 and 1990; Dorel and Perrier, 1990).

These diagnostic surveys show that unsatisfactory yield levels have two major origins: 1) obvious agronomic errors without long-term consequences on soil fertility; and 2) soil degradation. In the first case, yield potential of the soil is not affected and fertility is easily restored through adequate management practices such as fertilization, irrigation, and soil tillage. In the second case, yield potential of the soil is affected (uncontrolable soil parasitism, debit balance of organic matter coupled with heavy compaction, etc.) and fertility restoration requires a modification of the cropping system.

## MAIN RESULTS OF DIAGNOSTIC-SURVEY IN GUADELOUPE

Girth of pseudostem is chosen as the indicator of yield crop potential. To identify and hierarchizate factors having an effect upon this indicator, standard multivariate analysis is achieved. Results of this analysis are not submitted here because multiplicity of interactions make interpretation very difficult. Segmentation analysis, able to take these interactions into account, allow more obvious explanations. Through this method, factors having an effect upon girth of pseudostem (Table 1) are hierarchizate as follows (Figure 2).

1) Ecological conditions (Figure 3).

High yield potential in andosol and brown andic soil (annual rainfall (2500-3500 mm).

Figure 1. Various steps followed in diagnostic survey.

1) Preparation/Establishing of Survey Sample

Opinions (farmers, research and development officers)

Ecological and technical parameters

Research data, bibliography

Hypotheses on variations of crop yield

Selection of representative plots

Data to be collected

2) Data Collection

Maximal characterization of each plot (soil, agronomy, management practices, history)

3) Data Analysis and Treatment

Range of variation, binary relationships, multivariate analysis

Interpretation, conclusions

Recommendations, identification of further research

Table 1. Factors having an effect on girth of pseudo-stem.

Ecological zones:

1a: Brown halloysitic soil. Annual rainfall 2000-2500 mm.
1b: Ferralitic soil. Annual rainfall 2000-2500mm.
2a: Brown andic soil and andosol of windward coast. Annual rainfall 2500-3500mm.
2b: Brown andic soil and andosol of leeward coast. Annual rainfall 2500-3500mm.
3a: Perhydrated andosol of windward coast. Annual rainfall >3500mm.
3b: Perhydrated andosol of leeward coast. Annual rainfall > 3500mm.

Corm necrosis

1: absent
2: low
3: medium
4: high

Root necrosis

1: absent
2: low
3: medium
4: high

Cationic Exchange Capacity

1: 3-5.5 meq
2: 5.5-8 meq
3: 8-10.5meq
4: 10.5-13meq
5: 13-15.5meq
6: 15.5-18meq

Nematicide

1: 1 organo-phosphorus/year
2: 0 application
3: 2 organo-phosphorus/year
4: 3 carbamate/year
5: 3 organo-phosphorus/year
6: 3 mixed application

Drainage

1: poor
2: medium
3: good

Preceding crop

1: banana
2: forest
3: fallow

Low yield potential

In perhydrated andosol (annual rainfall >3500 mm)

In brown halloysitic and ferralitic soils (annual rainfall 2000-2500 mm)

2) In high yield potential ecological conditions, variations of yield potential are clearly related to chemical fertility of the soil (CEC; Ca, Mg, P amounts). Variations of chemical properties of the soil depends on two factors:

Components of clay fraction. (Presence of 2:1 lattice clay and absence of gibbsite are related to high CEC and high amounts of Ca, Mg, and P).

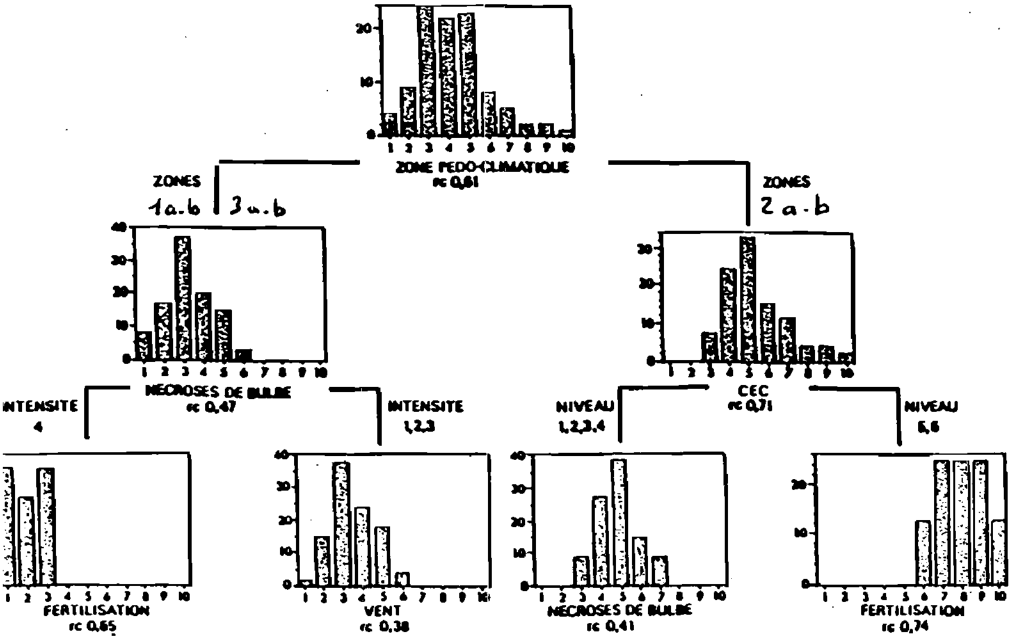
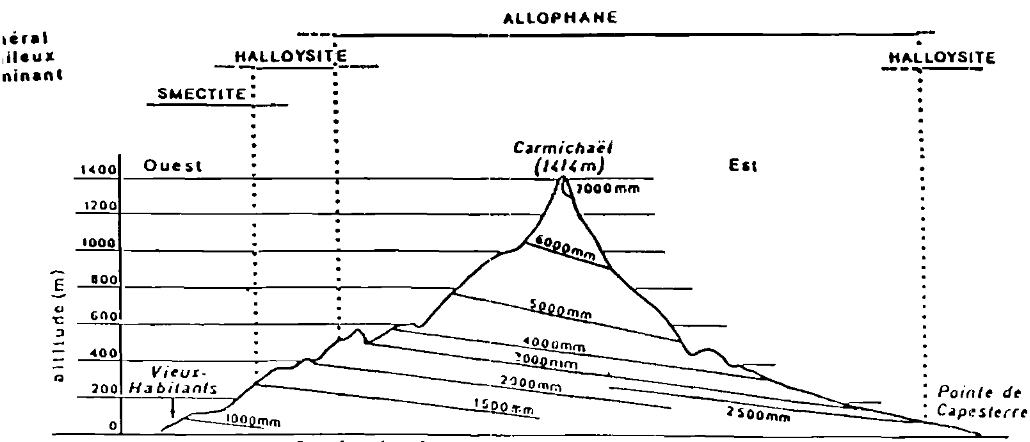



Figure 2. Hierarchy of factors having an effect on girth of pseudo-stem.




*« Coupe pluviométrique », passant par le Carmichaël 16°3'26''*
*(d'après l'ORSTOM, 1985)*

Figure 3. Rainfall, elevation, and dominant clayey minerals.

Cultural practices. All practices leading to a reduction of depth of the humus-bearing layer cause degradation of soil chemical properties (tillage of steep slopes, mechanized land-clearing).

In low-yield-potential ecological conditions, yield potential depends on the severity of rhizome and roots lesions. This factor also arises in high potential ecological conditions if soil CEC is low. Severity of lesions on roots and rhizomes is analyzed by segmentation method (Figs. 4 and 5). In andosol and brown andic soil of leeward coast, lesions are almost absent. In these zones soil-borne pathogens pressure is very weak. In other soils, soil-borne pathogen-pressure, responsible for banana root and rhizome injury, is very high. These pathogens are nematodes (Radopholus similis mainly) and a fungus (Cylindrocladium) recently identified in Martinique and Guadeloupe. Both the fungus and Radopholus similis contributed to roots and rhizome lesions but the following factors reduce the severity of damages: good drainage; application of carbamate 3 times/year; and planting after fallow or forest.

The fertility of the soil (chemical, physical and biological properties of soil) varies in each zone of the Guadeloupean banana plantation and explains for the most part crop potential variations. Technical practices have to take these various conditions into account to improve productivity and profitability of banana-cropping systems. Following the diagnostic survey, adjustment of technical practices is proposed for each ecological zone.

## Adjustment of Technical Practices in Each Ecological Zone.

Andosol and brown andic soil (annual rainfall 2500-3500mm). In this zone, leeward and windward coasts have to be distinguished: leeward-coast soils present good physical and chemical characteristics and low soil-borne, pathogen pressure while windward-coast soils present good physical characteristics but heavy soil-borne pathogen pressure.

In the first situation, constraints on roots are less and allow the maintenance of permanent plantations. This cropping system is the best guarantee against soil fertility degradation caused by tillage under favorable conditions (erosion, compaction). Nematicide application can be reduced (one application each year is enough to control nematodes populations).

In the latter situation, main objectives of technical practices are to reduce parasitic pressure on roots and to maintain (or restore) physical and chemical soil characteristics. Preservation of former characteristics involves reduced planting frequency which is generally achieved on an excessively wet soil (compaction) and leaves bare soil during rainy season (erosion). Planting of disease-free plants (tissue culture plants) on a pathogen-free soil (fallow, crop rotation) permits the increased yield and longevity of the plantation and reduces the frequency of nematicide applications.

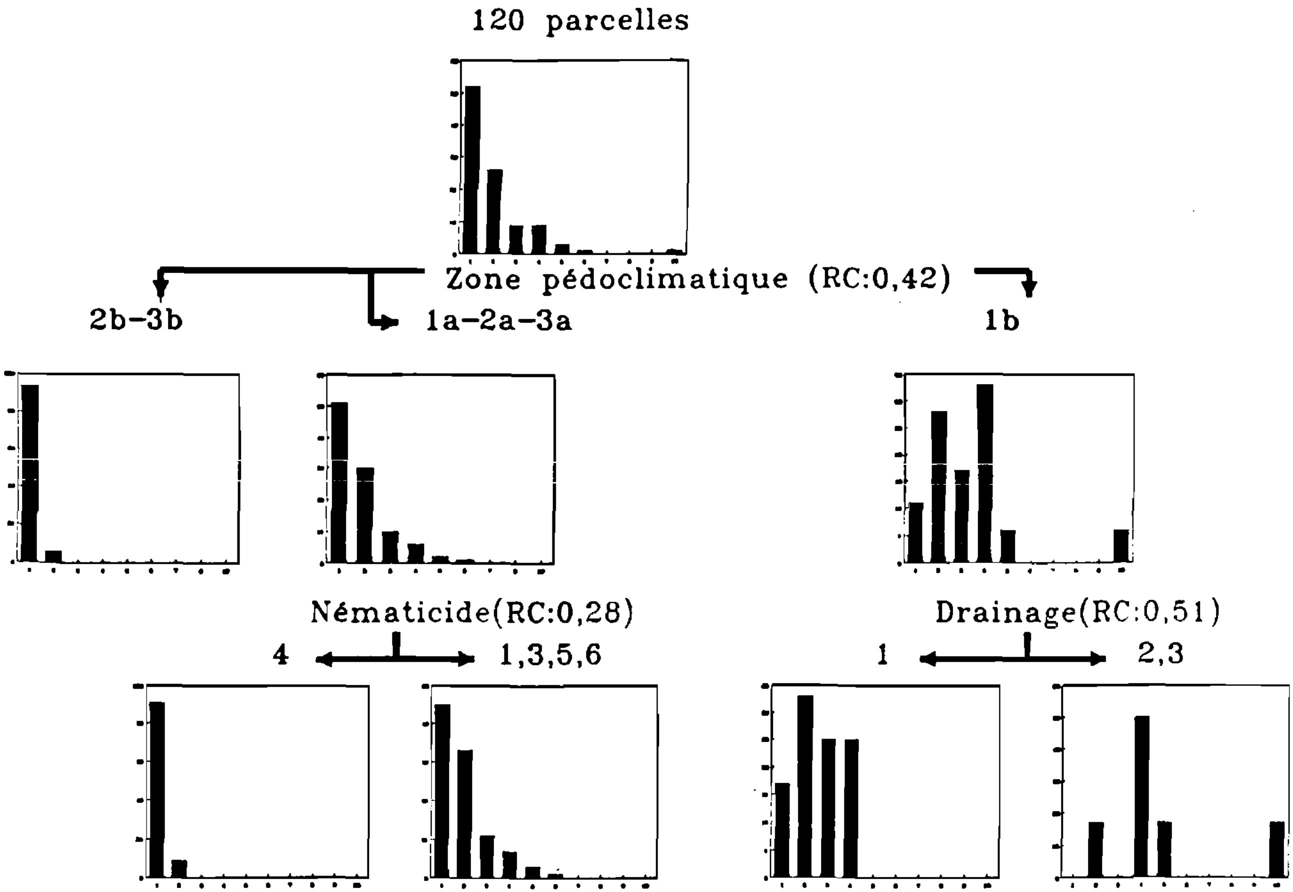



**Figure 4. Incidence of rhizome lesions.**

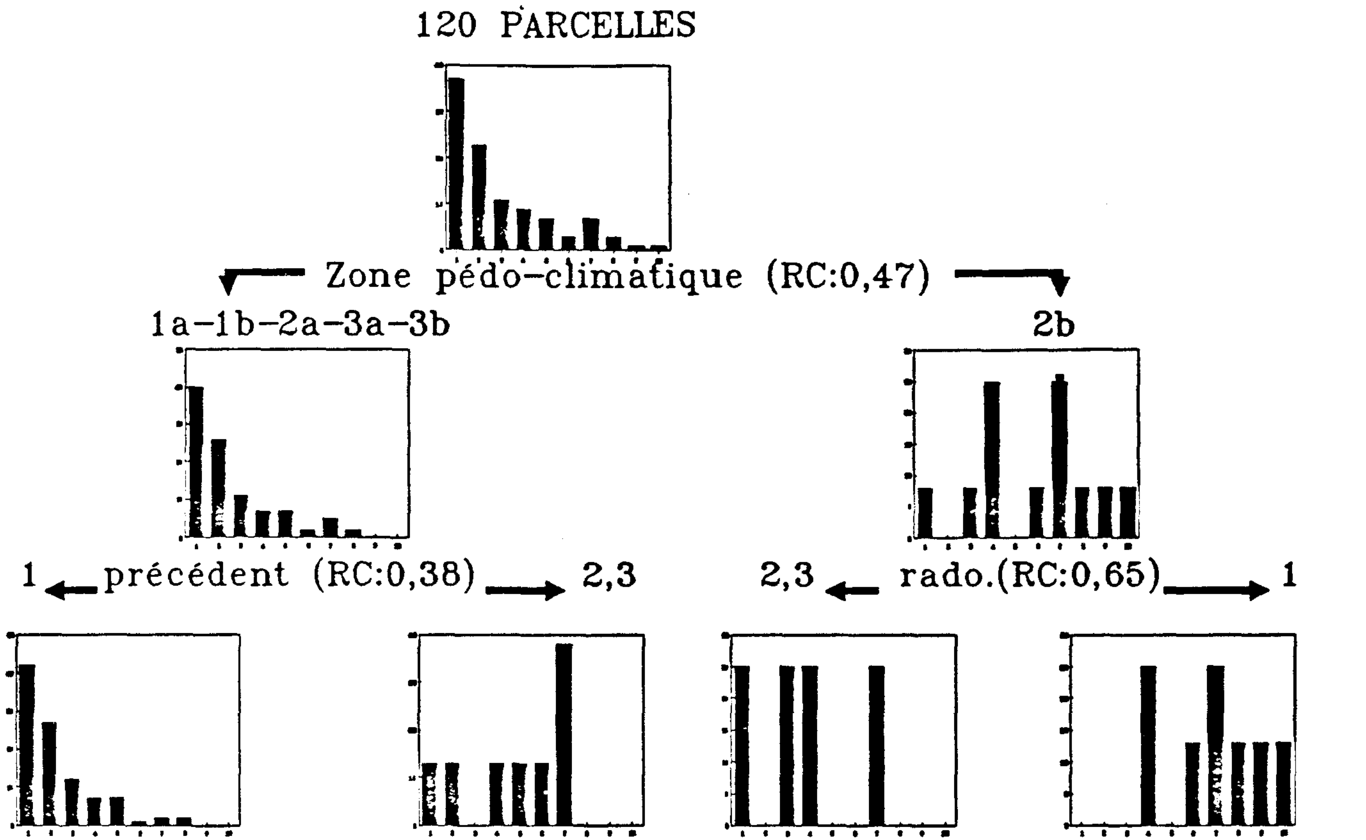



Figure 5. Incidence of root lesions.

Perhydrated Andosol (annual rainfall > 3500mm). Rainfall in excess limits crop potential (excess water in soil, heavy cloud cover, leaching of fertilizers and pesticides).

Because of slopes and rainfall, mechanization is not possible and permanent plantations are the only suitable system. Shallow surface drains are necessary to remove surface water during periods of high rainfall. Hedges around cultived plots should be planted to protect from the wind.

Brown halloysitic and ferralitic soil (annual rainfall 2000-2500mm. Constraints on roots (compacted soil, parasitic pressure) don't allow high yield in monocultural cropping system. Nevertheless high yield can be reached through cropping sequences (fallow/rotation) which lead to reduction of soil-borne-pathogen pressure and improvement of soil structure.

## FURTHER RESEARCH

Although very important constraints have been noted, particularly in clayey soils (physical and parasitical soil constraints, water deficiency), effects of tillage, irrigation or nematicide application don't appear as obvious. In fact, techniques used at present time by farmers are unable to control these constraints. Research needed to perfect new techniques are:

1) Soil-borne pathogen control: Study of new cropping system founded upon control of pathogens through cropping sequences.

2) Improvement of soil structure: study of physical soil properties; tillage experimentation; appraisal of effects of cropping system and cultural practices on structural soil characteristics.

3) Improvement of irrigation technique: study of relationship between physical soil characteristics and water circulation; irrigation experimentation.

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