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FOLIAR DISEASES OF BANANA IN UGANDA: RESULTS FROM A DIAGNOSTIC SURVEY

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ABSTRACT

Data are presented on the incidence and severity of (black and yellow) sigatoka leaf spots and *Cladosporium* freckle in different ecological zones of Uganda. Black sigatoka has become widespread since its arrival in Uganda in 1988. Sigatoka leaf spots were most severe in mid-elevation zones of central Uganda. The disease was absent at altitudes above 1500 m and in drier zones (3–5 wet months per year). *Cladosporium* freckle was present at all survey sites and also most severe in central Uganda.

Key Words: **Banana, *Cladosporium* frekle, Sigatoka leaf spots, Uganda**

RÉSUMÉ

Des données sur l'incidence et la sévérité de la Cercosporiose (Noire et Jaune) et le Cladosporium dans différentes zones écologiques de l'Ouganda sont présentées. La Cercosporiose Noire s'est répandue depuis son arrivée en Ouganda en 1988. Les taches foliaires de Cercosporiose étaient les plus sévères dans les zones d'élévation moyenne de l'Ouganda central. La maladie était absente aux altitudes au-dessus de 1500 m et dans les zones plus sèches (3-5 mois de pluie par an). Le Cladosporium était présent à toutes les sites de l'examen et il était le plus sévère en Ouganda central.

Mots Clés: **Bananaier, *Cladosporium* frekle, les taches foliares de cercosporiose, Ouganda**

INTRODUCTION

The banana *(Musa* spp,) is the most important staple food crop in Uganda, occupying 40% of utilized arable land. Total annual production is estimated at 6.5–7.0 m metric tons with annual per capita consumption of 220–460 kg. East African AAA cultivars, endemic to the region, dominate production (Hartmans, 1989).

Three leaf diseases predominate in Uganda: black sigatoka, yellow sigatoka and *Cladosporium* leaf freckle. Black sigatoka (= black leaf streak) (*Mycosphaerella fijiensis* Morelet) is considered the most important foliar disease of bananas

throughout the world. Its spread, distribution and symptoms have been well described (Meredith and Lawrence, 1961; Rhodes, 1964; Buddenhagen, 1968; Meredith and Firman, 1970; Mourichon and Fullerton, 1990). Black sigatoka appeared in Uganda in 1988 (Stover, 1991; Tushemereirwe and Waller, 1993) and has spread rapidly into most banana growing regions.

Yellow sigatoka (*Mycosphaerella musicola* Leach) is present in all major banana growing regions in the world. The disease was first reported in Uganda in 1938 (Stover, 1962) and is now widespread in the country.

Cladosporium freckle (*Cladosporium musae* Mason) has been reported in most banana growing regions (Stover, 1972). Although the disease is often of minor importance, East African highland bananas appear particularly susceptible; consequently, its importance in Uganda needs to be assessed.

Prior to the arrival of black sigatoka, farmers paid little attention to foliar diseases. Since 1989, farmers have been increasingly concerned about leaf spot symptoms although few understand the nature of the diseases (Gold *et al.*, 1993).

In spite of the importance of banana in Uganda, the distribution, incidence and importance of biotic constraints (including foliar diseases) to banana production have not been ascertained. Therefore, the International Institute of Tropical Agriculture (IITA), in collaboration with the Uganda's Ministry of Agriculture Animal Industry and Fisheries, Banana Programme, is undertaking diagnostic surveys to evaluate the status of pests and diseases in representative banana growing areas of Uganda. This paper provides results on the distribution and importance of sigatoka leaf spots and *Cladosporium* leaf freckle in Uganda.

MATERIALS AND METHODS

Twenty-one villages, representative of banana growing regions of Uganda, were selected using a stratified random sample. Banana production areas in Uganda were classified on the basis of elevation, length of rainy season and population density (land pressure). Sites were then selected according to land area falling within each stratum. Three additional villages showing particular features of interest (e.g. high elevation) were added to the study.

Study farms each contained a minimum of 100 banana mats in a stand at least two years old. Five such farms were selected at each site. On each farm, 25 mats were selected for bimonthly monitoring of banana plant growth, pests and diseases.

In the field, black and yellow sigatoka present indistinguishable symptoms. Therefore, for the purpose of this paper, damage due to the two diseases is treated together and collectively referred to as sigatoka leaf spots.

Sigatoka leaf spots are normally monitored on the basis of streaks on younger leaves reflecting expression of first symptoms. However, in highland bananas, identification of sigatoka streaks is confounded by that due to Cladosporium freckle (Cladosporium freckle does not cause streaking in plantains and sweet bananas). Cladosporium freckle can be distinguished from sigatoka leaf

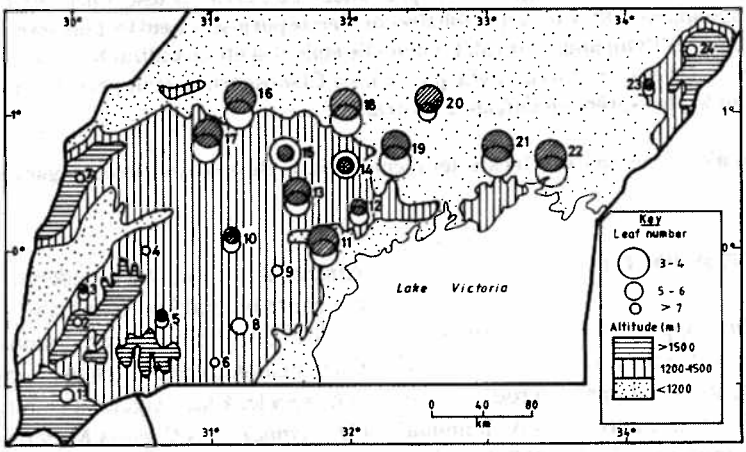

Figure 1. Distribution and intensity of sigatoka leaf spot (φ) in Uganda as indicated by position of youngest leaf showing dry sigatoka spots and *Cladosporium* freckle (O) as indicated by position of youngest leaf showing orange discolouration. The sizes of the circles indicate the relative prevalence of the diseases in each survey location.

spots at a post-streak stage where Cladosporium infection causes orange discolouration of the leaf tissue while black and yellow sigatoka cause dry spots which eventually may fuse to form large brown-black patches. Post-streak leaf damage attributable to sigatoka leaf spots and *Cladosporium* freckle was scored separately using the Gauhl (1989) modification of the Stover (1972) leaf spot scale.

Position of the youngest leaf with infection symptoms has been used to indicate severity of the disease (Stover and Dickson, 1970). This parameter was monitored by recording the youngest leaf with sigatoka dry spots and the youngest leaf with identifiable *Cladosporium* freckle (first leaf showing orange discolouration). The leaves were numbered from the youngest unfurled leaf as number one.

Leaf samples were brought to the laboratory for identification of the various pathogens and other agents of leaf damage. The *Mycosphaerella* species composition was determined by mounting in cotton blue cellotape impressions taken from streaks of fresh samples and examining the slides in the laboratory. For each site 15 slides were made, each from a randomly picked sample.

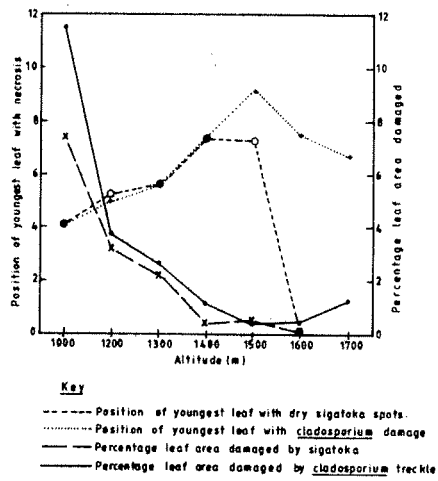

Figure 2. Variation in youngest leaf with dry sigatoka spots (o- - - -o) and *Cladosporium* freckle included orange discolouration (+·····+); and leaf area damaged by the two diseases (x— —x), (• ——•), respectively, in relation to altitude.

RESULTS

All highland banana cultivars at the study sites where black sigatoka leaf spot was severe were susceptible to the disease. In contrast, exotic cultivars, such as Kayinja and Kivuvu (ABB) displayed limited damage and may be resistant to leaf spots. For example, in Iganga district where sigatoka damage was severe, highland cultivars suffered a mean leaf area damaged of 8.3% while the corresponding damage level for Kayinja was 0.4%.

Sigatoka leaf spots were most severe in central Uganda (Fig. 1). These results further indicate that sigatoka leaf spots are widespread throughout central Uganda but notably absent above 1500 m above sea level (masl) as well as from zones with few rainy months (southwestern and eastern Uganda) (Table 1).

Cladosporium speckle was found at all survey sites. Disease incidence and severity tended to be highest at those sites where sigatoka leaf spots were also most prevalent (Fig. 1). Generally, Cladosporium speckle appeared to cause slightly

TABLE 1. Presence of black sigatoka (BS) as affected by elevation and length of rainy season at diagnostic survey sites in Uganda in 1992–1993 (numbers correspond to survey sites).

A. Elevation		
	< 1400 masl	> 1400 masl
BS Present	10 11 12 13 14 15 16 17 18 19 20 21 22 23	
BS Absent	8 9	1 2 4 6 7 24

B. Rainfall			
	3–5 Months	6–8 Months	> 8 Months
BS Present	3 5 10 14	11 12 13 15	17 18
BS Absent	1 2 4 6 7 8 9	18 19 20 21	22 23

more leaf damage than sigatoka leaf spots at lower altitudinal zones. Above 1500 masl, Cladosporium speckle was clearly the predominant defoliator (Fig. 2). Nevertheless, at high elevations, both diseases were restricted to older leaves (Fig. 2) which are often deleafed without noticeable effect on bunch size. Damage caused by the two leaf diseases decreased with increase in elevation (Fig. 2).

Microscopic examinations of leaf samples taken from all study sites revealed that *N. fijiensis* is now widespread throughout Uganda. It was present at all elevations between 1000 and 1500 masl but was absent above 1500 masl; in contrast, *M. musicola* and *C. musae* were both present up to 1850 masl. *M. fijiensis* was the predominant sigatoka pathogen below 1400 masl while *M. musicola* was most important around 1500 masl. Most damage above 1600 masl was due to *C. musae*.

Other banana foliar pathogens encountered in microscopic examinations were; *M. musae (Speg)* Syd., *Veronaea musae* M.B. Ellis, *Periconiella musae* M.B. Ellis, *Cordana musae* (Zimm.) Hohnel, *Phyllostictina musarum* (Cooke) Petrak, *Botryodiplodia theobromae* Pat., *Fusarium* spp. and *Drechslera gigantea* (Heald & Wolf) Ito. They were causing minor damage as previously reported (Jameson, 1970; Waller *et al.*, 1993) apart from *Drechslera* spp. the causal pathogen of eye spot, which was observed at all the survey sites but rarely caused damage to more than 3% of an affected leaf. The disease was most severe on the youngest leaf and became progressively less severe down the older leaves.

Other types of leaf damage observed included marginal drying of the leaves due to water stress, nutrient deficiencies and Cucumber mosaic virus (CMV). CMV was observed at most study sites but it caused minor damage symptoms. The disease incidence was higher in stressed systems of central Uganda; this suggests that reduced plant vigour may affect banana resistance to this virus.

DISCUSSION

Over 100 cultivars (bearing 500 local names) were encountered at survey sites. All east-African highland cultivars at lower elevation sites appeared susceptible to sigatoka leaf spots. Susceptibility of most highland cultivars to sigatoka leaf spots is also supported by preliminary screening trials at the Kabanyolo Field Station outside Kampala (P. R. Rubaihayo, unpubl.). Our observations further suggest that all highland cultivars are susceptible to *Cladosporium* speckle while introduced beer bananas appear resistant.

Black sigatoka was absent and yellow sigatoka infection did not progress beyond streaking at elevations greater than 1500 masl. This suggests the presence of an altitudinal (temperature related) threshold for disease development in Uganda. Altitudinal thresholds have been reported in South and Central America where black sigatoka could not develop above 700 masl (Meredith and Firman, 1970); only *M. musicola* was able to survive at 1000-1500 masl. It is interesting to note that in Uganda such a threshold appears to be twice that of Colombia which shares approximately the same equatorial position.

Yellow sigatoka has been in Uganda since 1938 but has not caused noticeable damage to bananas above 1500 masl. Elsewhere in the world, the yellow sigatoka pathogen has demonstrated greater ability to develop at lower temperatures than that of black sigatoka (Moulion Perfoura and Mourichon, 1990).

The results obtained in this study suggest that black sigatoka may be of little concern in high elevation systems. Alternatively, it is possible that black sigatoka has not yet spread to all regions within Uganda. However, black sigatoka was observed at lower elevations proximal to high elevation sites. The possibility of an altitudinal threshold can be confirmed by continued monitoring of high elevation sites, study of leaf spot incidence along altitudinal clines and by laboratory studies with east-African strains of the pathogen.

Sigatoka leaf spots and *Cladosporium* speckle are part of a banana pest and disease complex. In Uganda, the banana growing regions with the highest leaf spot damage also supported high levels of banana weevils (*Cosmopolites sordidus* Germar) and nematodes (C. Gold and P.R. Speijer, unpubl.). Furthermore, results from cropping systems and soil enhancement trials indicate higher levels of leaf spot damage in nutrient stressed systems (intercrops and controls) than where nutrients are more readily available (e.g. fertilized or mulched plots) (W. Tushemereirwe, unpubl.). These results suggest that stresses (e.g. nutrient

deficiencies or pest attack) which influence plant vigour and leaf production rates may, in turn, exacerbate leaf spot expression and damage.

In summary, the sigatoka leaf spots and *Cladosporium* speckle are widespread throughout Uganda. Damage appears worse at sites where other stresses are present. It is clear that yield loss studies will be necessary to elucidate the importance of leaf spots in farmers fields. Interaction studies to establish how the various host stress factors affect the rates of disease development will also be required.

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