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Fungi associated with banana leaf diseases in South Africa

BY

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For Mum, Dad, Daniel, Aunty Barbara and Uncle Eddie
and in loving memory of my treasure, Blaxie.

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Biological control

Chemical control

SPRINKLE DISEASES

Mycosphaella sp.

Cladosporium sp.

Leaf speckle

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PREFACE

Bananas are classified in the genus *Musa*, named after Musa, physician of Augustus Caesar (Bailey 1900). The origin of banana is not known but it is accepted that primitive man in the tropical regions of South Asia developed the seedless fruit from wild varieties (Graves & Taber 1942). Further selection of seedless varieties lead to the development of the vegetatively propagated edible banana of today, which serves as staple food in over 120 countries world-wide (Jones 2000). The Latin-American-Caribbean, African and Asian-Pacific regions each produce approximately a third of the total global banana crop. Banana is an appealing crop for subsistence farmers in tropical and subtropical regions as it can be produced throughout the year and regenerates after each harvest, ensuring a constant income and food source.

Bananas were first introduced into the KwaZulu-Natal region of South Africa at the turn of the nineteenth century by Indian labourers working on sugarcane farms (Viljoen 2002). Commercial banana production began in this region and gradually expanded to the Limpopo and Mpumalanga lowveld in the 1950's. By 1981, the South African banana industry comprised 9 200 ha, and presently is established on 13 000 ha. During this time banana production has doubled from 120 000 to 240 000 tonnes per annum, with the entire crop being sold on local markets. However, due to the marked increase in production, South African banana growers have, since June 2001, started exporting their produce to countries in the middle East.

Various pathogens, including fungi, bacteria, viruses and nematodes, are known to attack banana plants. Leaf diseases pose a significant threat to banana production globally. Currently, black Sigatoka is considered to be the most threatening, but there are at least 16 other fungal pathogens infecting banana leaves. Infection results in loss of photosynthetic area and, depending on the disease and its severity, loss in yield can be as high as 100 %. Leaves are unable to produce sufficient starches and sugars necessary for optimal crop production, fruit are smaller, ripen unevenly and have an unacceptable appearance and taste. Symptoms of some of the diseases, e.g. black Sigatoka, yellow Sigatoka and eumusae leaf spot, are very similar, rendering diagnosis difficult. Rapid spread of the pathogens occurs through inoculum carried by air currents, in water and on leaf material used during packing and transport. Subsistence farmers cannot afford chemicals for the control of these diseases and more tolerant cultivars are not always acceptable to the consumer.

Very little information has been published on banana foliage diseases in South Africa. Roth (1965) isolated various fungi, including two known pathogens, from symptomatic banana leaves in the Mpumalanga lowveld. Subsequently, Van den Boom & Kuhne (1969) and Brodrick (1973) reported the presence of yellow Sigatoka and *Mycosphaerella* speckle, respectively, from South Africa. However, isolation, identification and molecular characterisation of the causal agents have not been attempted. A need, therefore, exists for more local information on banana leaf diseases, particularly verification of the identity of the causal organisms. This dissertation obliges accordingly by describing the identity, diversity and distribution of fungi associated with lesions on banana leaves in South Africa.

The first chapter comprises a review of fungal pathogens, saprobes and endophytes recorded from banana leaves. A brief overview of the banana plant is given to acquaint the reader with the host. The most economically important diseases are highlighted and a summary is provided of their biology and control. Less threatening diseases are briefly discussed to promote awareness of their presence and the extent of damage they cause. Chapter two describes a survey of pathogenic, saprobic and endophytic fungi isolated from lesions on banana leaves in the various banana-growing regions of South Africa. Chapters three and four report on morphological, molecular and phylogenetic studies to establish the identity of the causal agents of yellow Sigatoka and *Mycosphaerella* speckle, respectively, whereas Chapter five represents a first report of a speckle disease occurring only in the Levubu area.

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RESUMÉ

Leaf diseases are an integral part of banana production. While currently not a cause for major concern in South Africa, many of these diseases can reach epidemic proportions and cause severe crop loss. To determine the present status of leaf diseases in South Africa, a survey was conducted in the five banana-growing regions of the country. The study indicated the following:

Yellow Sigatoka, caused by *Mycosphaerella musicola*, was the most prevalent disease and occurred in all five the regions. *Mycosphaerella* speckle and *Cordana* leaf spot, caused by *M. musae* and *Cordana musae* respectively, were present in four regions. *Cladosporium* speckle, caused by *Cladosporium musae*, was found only in the Levubu area. Various other fungi, mainly

saprobies and endophytes, were also isolated. The most commonly encountered species included *Alternaria alternata*, *Colletotrichum gloeosporioides*, *Nigrospora oryzae*, *N. sacchari*, *N. sphaerica*, *Pestalotiopsis* sp., *Phoma glomerata*, *Selenophoma asterina* and *S. juncea*.

Following morphological identification of the pathogenic species, monoconidial isolates were established from representative isolates of each and their virulence confirmed in artificial inoculation studies. The identity of *M. musciola* and *Cladosporium musae* was verified molecularly by means of species-specific primers and/or sequencing of the ITS region. Validation of the identity of *Cladosporium musae* constitutes the first report of *Cladosporium* speckle on banana in South Africa. Sequence data of the ITS region of isolates from *Mycosphaerella* speckle lesions indicated that the symptoms are caused by two species, *M. musae* and one closely related to *M. colombiensis*, the latter previously described only from lesions on leaves of *Eucalyptus urophylla* in Colombia.

Fungi associated with banana leaf diseases in South Africa

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SAMEVATTING

Blaarsiektes maak 'n integrale deel uit van piesangverbouing. Alhoewel hierdie siektes tans nie groot rede tot kommer bied in Suid-Afrika nie, kan heelwat van hulle epidemiese afmetings aanneem en ernstige oesverliese veroorsaak. 'n Opname om die huidige stand van blaarsiektes in die vyf piesang-produiserende gebiede van Suid-Afrika te bepaal, het die volgende aan die lig gebring:

Geel Sigatoka, veroorsaak deur *Mycosphaerella musicola*, was die algemeenste siekte en het in al vyf die gebiede voorgekom. *Mycosphaerella*-spikkel en *Cordana*-blaarvlek, veroorsaak deur *M. musae* en *Cordana musae* onderskeidelik, was teenwoordig in vier van die gebiede.

Cladosporium-spikkel, veroorsaak deur *Cladosporium musae*, is slegs in die Levubu-gebied aangetref. Verskeie ander swamme, hoofsaaklik sapro- en endofiete, is ook geïsoleer. Die algemeenste spesies was *Alternaria alternata*, *Colletotrichum gloeosporioides*, *Nigrospora oryzae*, *N. sacchari*, *N. sphaerica*, *Pestalotiopsis* sp., *Phoma glomerata*, *Selenophoma asterina* en *S. juncea*.

Na morfologiese identifisering van die patogeniese spesies is enkelspoorisolate berei van verteenwoordigende isolate van elkeen en hulle virulensie bevestig by wyse van kunsmatige infeksiestudies. Die identiteit van *M. musicola* en *Cladosporium musae* is molekulêr bevestig deur gebruik te maak van spesie-spesifieke peilstukke en/of basispaaropeenvolgingbepaling van die ITS-gebied van die rDNA geenkompleks. Bewys van die identiteit van *Cladosporium musae* verteenwoordig die eerste aanmelding van Cladosporium-spikkel op piesang in Suid-Afrika. Basispaaropeenvolgingsdata van die ITS-gebied van isolate vanaf *Mycopshaerella*-spikkel letsels dui daarop dat die symptome veroorsaak word deur twee spesies, *M. musae* en 'n naverwante spesie met *M. colombiensis*, laasgenoemde tot dusver beskryf slegs vanaf letsels op blare van *Eucalyptus urophylla* in Colombia.