

Diseases of plantation *Eucalyptus* in Uganda

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A SURVEY OF DISEASES OF PLANTATION *Eucalyptus* was conducted in southern Uganda during June 1999. The aim was to compile a preliminary list of pathogens in planning future plantations and breeding programmes. Root, stem and leaf samples were collected from trees ranging in age from a few months to approximately 10 years. The most commonly isolated pathogen was *Lasiodiplodia theobromae*, which was frequently associated with stem cankers and die-back. Bacterial wilt, caused by *Ralstonia solanacearum*, was the most common cause of death of trees less than two years old, in the warmer areas around Kampala. In the eastern part of Uganda, the wilt pathogen *Ceratocystis fimbriata* was isolated from dying *E. grandis* and, together with *L. theobromae*, is considered the greatest threat to plantation *Eucalyptus* in Uganda. Other, less important, pathogens isolated during the survey included a species of *Mycosphaerella* from leaf spots and a *Valsa* species associated with stem cankers.

Background

Eucalyptus has been grown in plantations in Uganda since 1912.¹ The predominant species planted is *E. grandis* Hill ex. Maid. Uganda has approximately 19 000 hectares planted to *Eucalyptus*, but this area is expected to increase substantially in the near future. Apart from plantations managed by the Forestry Department, private farmers and tea companies run wood lots that provide timber for fuel and construction. Private individuals, who either collect their own seed or purchase it from the Forestry Department, own most forestry nurseries.² Most of the *E. grandis* trees grown in Uganda are the progeny of seed originally imported from Australia, although a few, smaller introductions have been made from elsewhere in Africa.

There is increasing demand for firewood and construction wood in Uganda. It is estimated that within ten years, all existing native forest resources will be depleted, if their exploitation continues at the current rate. It is hoped that the establishment of plantation forestry using *Eucalyptus* and

Pinus spp. will provide an alternative source of timber.

Many tree health problems have been reported by Ugandan farmers and the Forestry Department, the causes of which are unknown. The only previous investigation of the cause of *Eucalyptus* diseases in Uganda was a survey of pests and diseases in forestry nurseries, which in some nurseries caused up to 50% mortality.² Many of the pathogens were, however, not conclusively identified, with only species of *Cercospora* and *Pestalotiopsis* being recorded.

In our 1999 study, we aimed to identify to most common diseases of plantation *Eucalyptus* in southern Uganda. This knowledge will be used to assist breeding programmes planned for the future expansion of the forestry industry.

Materials and methods

The sampling area was restricted to the southern part of the country. Plantations of private, peri-urban and Forestry Department *Eucalyptus* were sampled in Kabale, Mbarara, Bishenyi, Mpigi, Entebbe, Kampala, Jinja, Tororo and Mbale. Trees sampled ranged in age from a few months to nearly 10 years and were limited to *E. grandis*. Sampling areas varied considerably in climatic and soil conditions (Table 1).

Samples were taken from diseased leaves, stems and roots. Isolation media included malt extract agar (2%, Biolab), a selective medium for the isolation of basidiomycetes (1% malt extract, 1.5% agar, 2 ppm benomyl powder and 100 ppm streptomycin)³ and PARP (17 g/l corn meal agar, 0.1 g/l ampicillin, 0.5 g/l rifampicin, 0.01 g/l pimarinic, 0.1 g/l

PCNB) for the isolation of oomycetes.⁴ Nutrient agar (16 g nutrient broth, 20 g agar) was used for the isolation of phytopathogenic bacteria. Infected tissue was also subjected to detailed microscopic investigation in the laboratories of the Forestry and Agricultural Biotechnology Institute (FABI). Isolates representative of all presumed pathogenic fungi and bacteria are maintained in the culture collection of FABI and will be used in future studies.

Results

Stem cankers

The most common disease symptom was stem cankers. These included cracking of stems, malformation and stunting, kino exudation and the formation of kino pockets in the xylem (Fig. 1), and xylem discoloration. The fungus most commonly associated with stem cankers was *Lasiodiplodia theobromae* (Pat.) Griffon & Maubl. (Teleomorph: *Botryosphaeria rhodina* (Cooke) von Arx.; syn: *Botryodiplodia theobromae* Pat.).

Species of *Valsa* and its anamorph genus, *Cytospora*, were commonly isolated from most branch and stem tissues collected. In many cases these fungi were associated with lesions spreading from machete wounds on the stems of trees (Fig. 1). They were also commonly associated with trees under environmental stress such as drought or that had been planted in wet, swampy areas with poor drainage.

Ceratocystis wilt

A serious wilt disease of mature trees was found in the Tororo area of southeastern Uganda. The disease affected trees ranging from 4–8 years of age, and manifested as extensive blue to brown streaks in the xylem (Fig. 1). *Ceratocystis fimbriata* Ellis & Halst. was commonly isolated from symptomatic wood.

Bacterial wilt

On *E. grandis* less than two years old, in the warmer areas around Entebbe and Kampala, the most common disease was

Table 1. Climatic conditions and altitude of sampling areas.

Sampling area	Average temperature (°C)	Average rainfall (mm yr ⁻¹)	Altitude (m)
Bishenyi	20.2	1464	1463
Entebbe	21.5	1537	1155
Jinja	20.1	1334	1181
Kabale (Mafuga)	15.3	1180	2241
Kampala (Namanve)	21.8	1344	1135
Masaka	21.0	1110	1313
Mbarara (Itojo)	19.8	1154	1524
Mbale	21.2	1311	1494
Tororo	22.5	1427	1170

Source: Meteorological Department, Entebbe.

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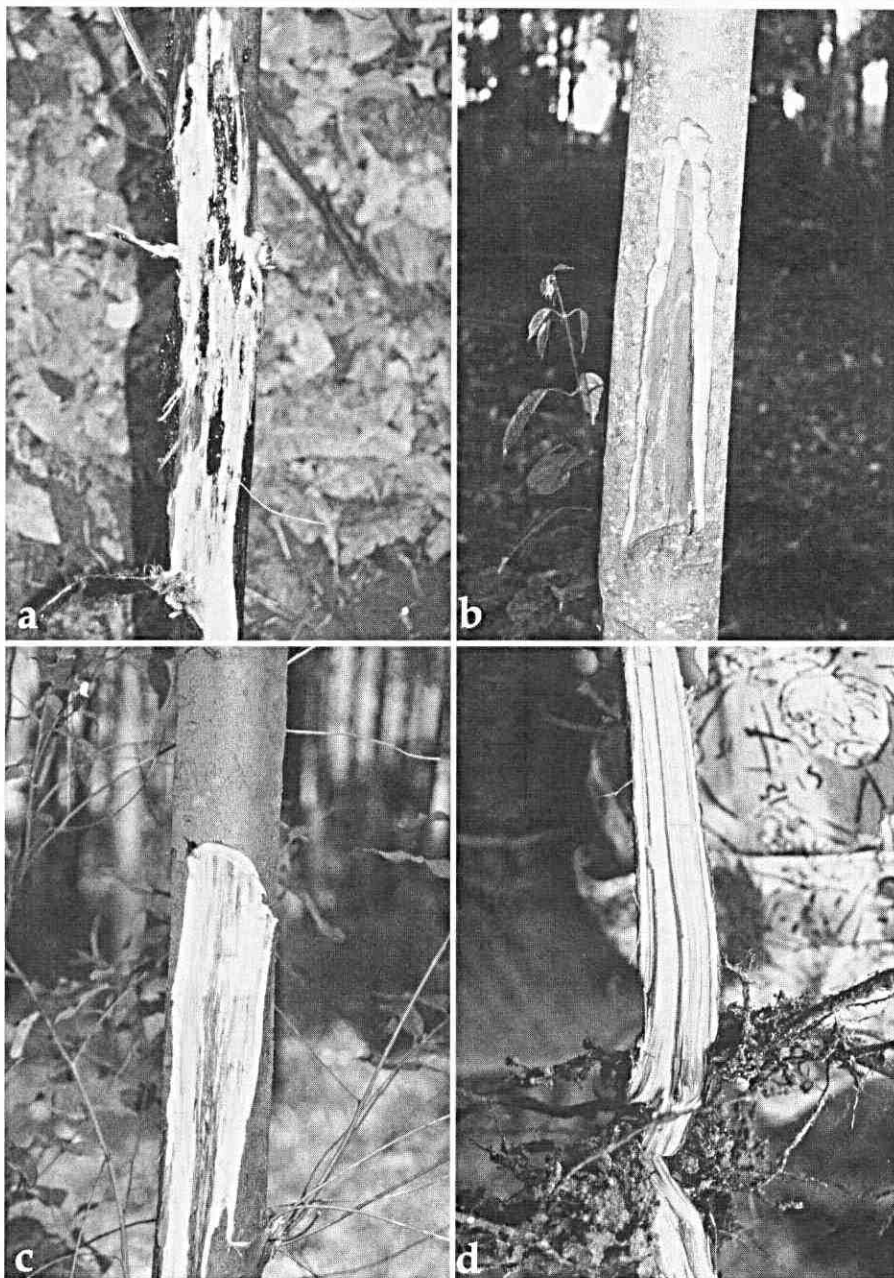


Fig. 1. Disease symptoms on *Eucalyptus grandis* in southern Uganda. a, Kino pockets in the wood associated with *Lasioidiplodia theobromae* infection; b, stem canker spreading from a machete wound in the stem of a tree; c, discolouration of the wood caused by *Ceratocystis fimbriata* infection; d, black discolouration (striations) in the wood of a tree dying of *Ralstonia solanacearum* infection.

caused by the bacterium *Ralstonia solanacearum* (Smith) Yabuuchi *et al.* Characteristic symptoms associated with the disease were wilt, root rot, brown discolouration of the xylem and blue to black streaks in the wood (Fig. 1).

Leaf diseases

Leaf spots were common on trees and three known pathogens were collected from the lesions. Unidentified *Mycosphaerella* spp. were found on the leaves of *E. globulus* and *E. grandis* younger than one year old. Apart from *Mycosphaerella* sp., a *Harknesia* species and *Crypto-*

sporopsis eucalypti Sankaran & Sutton were also isolated from leaves.

Nursery pathogens

In nurseries, powdery mildew and leaf spot caused by *Phacophleospora eucalypti* (Cooke & Massee) Crous, F.A. Ferreira & B. Sutton were common. In some cases, powdery mildew was severe and entire plants were infected. This disease also resulted in malformation of leaves.

Discussion

This survey confirmed that there are many diseases that reduce the productiv-

ity of plantations. Although Uganda does not export or process *Eucalyptus* timber, this tree crop often constitutes the only cash income of private farmers. These diseases result in cracked and distorted stems that reduce their potential value as construction timber, which is the most profitable option for farmers.

In recent years, Ugandan growers have reported the occurrence of dying or stunted trees in their plantations. Various pathogens isolated during the course of this survey could have been responsible for these diseases. *Botryosphaeria* spp. and their anamorphs, such as *L. theobromae*, cause severe stunting and malformation of trees of all ages. These fungi have a cosmopolitan distribution on many different hosts, including plantation *Eucalyptus*⁵⁻⁸ (Wingfield, unpubl.). *L. theobromae* (*B. rhodina*) appears to be one of the most important pathogens of *Eucalyptus* in Uganda.

Lasioidiplodia theobromae (*B. rhodina*) is related to *B. dothidea* and other *Botryosphaeriaceae* fungi,⁹ and has been reported as responsible for root collar disease of *Eucalyptus* in India, where it caused the death of 16-month-old *E. tereticornis* Sm. trees.⁸ In a study by Sharma *et al.*, *E. grandis* was also shown to be susceptible to infection by *L. theobromae*.⁸

Ralstonia solanacearum is well known as a cause of death of young *Eucalyptus* spp.¹⁰⁻¹² Uganda is the third country in Africa from which this pathogen has been reported on eucalypts. Other affected countries are South Africa and the Republic of Congo.^{12,13} Although differences in susceptibility to *R. solanacearum* have been reported for *Eucalyptus* spp. and clones^{14,15}, little is known about its epidemiology in *Eucalyptus* plantations. Given its importance in Uganda, it deserves further study.

Ceratocystis wilt of *Eucalyptus* spp. is a serious and recently recognized disease. It was described for the first time from the Republic of Congo in 1998,¹⁶ followed shortly thereafter by a report on *E. grandis* in Brazil.¹⁷ In the Congo, the causal agent, *C. fimbriata*, led to the death of approximately 80% of a *E. urophylla* hybrid stand. *C. fimbriata* can infect several *Eucalyptus* spp. and hybrids and presents a serious threat to commercial forestry in South America and Africa.

Ceratocystis fimbriata is the cause of many plant diseases worldwide,¹⁸ but appears to be restricted to the hotter, more humid tropics and subtropics. It requires wounds for infection and is closely associated with insects, that facili-

tate its spread.^{19,20} Wounding of trees, which is common in Uganda, should be prevented as much as possible.

Mycosphaerella leaf blotch disease is considered to be one of the most serious foliage diseases of *Eucalyptus* in commercial plantations, with a cosmopolitan distribution. It is especially severe on *E. globulus* Labill. and *E. nitens* (Deane et Maid.) Maid.²¹⁻²³ Mycosphaerella leaf blotch disease has also been found with increasing frequency on *E. grandis*.^{24,25} Species of *Mycosphaerella* are especially important during the first two years of growth, when they infect juvenile leaves and lead to defoliation and stunting of trees.^{23,26-28}

Apart from those discussed here, there are other fungi with the potential to cause losses in combination with stress. Species of *Valsa* and its *Cytospora* anamorphs have regularly been reported from *Eucalyptus* trees.^{29,30} They are closely associated with stress and wounding on many other tree species and may lead to branch die-back of affected trees.³¹⁻³³ In Uganda, *Valsa* spp. are commonly isolated from lesions spreading from stem wounds caused by machetes. These fungi have been isolated from trees infected with *L. theobromae*, *C. fimbriata* and *R. solanacearum*. Although not primary pathogens, *Valsa* spp. can cause serious damage to stressed and wounded trees and this problem must be reduced through careful management.

Fungal and bacterial diseases are responsible for the death of many *Eucalyptus* trees in Uganda. With the envisaged increase in plantation forestry, our survey should assist in the planning of future plantations. It remains to initiate disease screening trials and selections to optimize the performance of *E. grandis*, over the broad range of geographic conditions in the country. Pathogens collected in this survey can be used in population and phylogenetic studies to determine their origin and spread, thus providing information for the improved management of diseases worldwide.

We gratefully acknowledge funding provided by the Norwegian Forestry Society (NORAD) and the Ugandan Forestry Department. We are also grateful to the Forestry and Agricultural Biotechnology Institute, University of Pretoria, for the facilities and equipment used to undertake laboratory analysis of the material collected during the survey. Thanks are also due to staff of the Forestry Department, Kampala, the Forest Research Institute, Kampala, the Norwegian Forestry Society and private farmers, who assisted with the collection of samples.

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