

WILT-LIKE DISORDER OF BANANAS IN UGANDA

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Comprehensive diagnostic surveys carried out in Uganda throughout the 1990s by the Uganda National Banana Research Programme (UNBRP) have shown a number of pests and diseases to be major constraints to banana production. These include Fusarium wilt (*F. oxysporum* f.sp. *cubense*), which is frequently observed in Uganda and is prevalent in many other parts of Africa. In Uganda, Fusarium wilt is prevalent on introduced banana cultivars that are used primarily as dessert bananas and for brewing, e.g. Kayinja. In 1993 symptoms somewhat similar to those of Fusarium wilt were observed¹ on the indigenous and dominant highland cooking bananas (AAA-EA) in the Western Uganda highlands. These have a high starch content and are used on a day-to-day basis for preparation of matooke², the staple food of Ugandans. With an annual production of more than 9 million Mt and average consumption greater than 350 kg per capita per annum, highland bananas represent a major source of income. The problem was therefore considered to be a potentially serious threat to the future production of highland bananas in Uganda and to the livelihood of many smallholder farmers.

The symptoms observed on the highland bananas were initially presumed to be due to a new outbreak of Fusarium wilt, and the problem subsequently therefore referred to as "matooke wilt" to distinguish it from wilt of introduced banana types. However, given current knowledge of symptomology and etiology, it will be referred to in this report as "the disorder". Recent studies by the authors suggest that the disorder is distinct from Fusarium wilt, in terms of etiology and symptoms, and that specific farm management practices are conducive to its development (Kangire *et al.* 2000). For example, occurrence of the disorder appears to be closely linked to areas of the farm where banana refuse or farmyard manure accumulate. Furthermore *F. oxysporum* may not be directly responsible for the disorder, if involved at all. The disorder has also been found to be more widespread than

¹A similar disorder was reported in 1955 by Baldwin (unpublished).

²'matooke' is the local general term for 'highland banana cultivars' (Karamura and Karamura 1995, Karamura 1998) and for the steamed banana dish prepared from highland cooking bananas.

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Plate 1.
Highland cooking
banana severely affected
by the disorder in West Uganda.
Note thin, buckled pseudostem.

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initially suspected. In some villages in Western Uganda more than 70% of farms are affected with up to 25% of plants exhibiting symptoms. It has also now been found to affect non-indigenous as well as indigenous banana types.

Symptoms

External

The external symptoms of the disorder (Plates 1 & 3-8) differ somewhat from those of Fusarium wilt (Plate 2) observed on introduced banana types. From a distance the foliage of affected plants usually appears generally healthy. Although necrosis of leaf margins has been observed on a few occasions (Plate 8), leaves do not yellow but remain green and wilt only slightly in dry conditions. This wilting is usually temporary as the plant recovers as wetter conditions return. Leaves are often smaller than on unaffected plants and tend to undergo early senescence, the latter encouraging their removal by farmers (Plates 3-5). Leaf petioles do not tend to buckle nor is splitting of the lower pseudostem apparent. In pre-flowering plants the lower parts of the outer leaf sheaths usually remain rigid and, externally, appear healthy even where severe discoloration of internal vascular tissues is found. Drying of the leaf sheaths is commonly observed in mature fruiting plants and is particularly pronounced towards the apex of



Plate 2.
Typical external
symptoms of Fusarium
wilt on introduced
dessert banana
(cv. Kayinja),
Bushenyi, West Uganda.

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Plate 3.
A banana farm where all plants have been affected by the disorder. Note thin, dried pseudostems. All plants are Highland clones.

the pseudostem. This is in contrast to Fusarium wilt in Uganda, where petiole buckling is frequently observed and is accompanied by rapid drying and death of the entire leaf sheaths, both symptoms usually being initiated prior to flowering. While plants affected by Fusarium wilt also usually ultimately die, those affected by the disorder continue to produce new suckers that mature to flowering and develop bunches. However, bunches of affected plants do not develop fully and, being small with light, unfilled fingers are unsuitable for consumption and are unmarketable. Affected plants are often unable to support the weight of the bunch, even where these are not fully developed, resulting in the pseudostem bending (Plate 4) or snapping below the canopy (Plates 1, 6a & 6b). A white secretion is often visible on the surface of developing suckers of severely affected mats which, although chalk-like in appearance, is wet to the touch (Plates 7a & 7b).

Internal

The internal symptoms of the disorder are very similar to those of Fusarium wilt. Discoloration of the vascular tissues of the corm and pseudostem is common, sometimes being visible as narrow longitudinal purple/black streaks on the inner surface of the outer leaf-sheaths on removal. Similar discoloration of these tissues is clearly visible within the pseudostem (Plate 9a) and corm (Plate 9b) when transverse or longitudinal cuts are made. Depending on severity of the disorder, the vascular discoloration may extend throughout the entire length of the pseudostem to the emerging leaf axils.

Note: some of the symptoms associated with the disorder have also been observed on banana plants affected by false Panama disease in the Canary Islands and South Africa. For a description of false Panama symptomology, refer to the INIBAP Disease Factsheet No. 9 "False Panama disorder on banana".

Distribution

To date, the disorder has only been observed in the Western highlands of Uganda at altitudes above approximately 1300 masl, and is most commonly found on highland bananas as opposed to introduced types. It has not been reported in Central or Eastern Uganda, areas characterized by higher minimum temperatures. The disorder tends to be restricted to areas of refuse deposition (usually adjacent to homesteads), to areas where animal waste accumulates (i.e. animal kraals) or where such sites have previously been located. On-farm observations, trials and discussions with farmers indicate that the disorder does gradually decline once homesteads and animal kraals are abandoned or relocated, or when disposal of household refuse ceases. This is often

the case where homesteads and animal kraals are relocated to allow farmers to plant on resultant nutrient rich soils, or where farm sizes have gradually been increased by farmers purchasing smaller areas of land from immigrants. Nevertheless, symptomatic plants may still be found 30 years later (Kangire 1998). Conversely, farmers have reported that banana plants growing in the vicinity of newly established animal kraals have developed symptoms within only 2 to 3 years, and that the disorder has developed following relocation of farms to less fertile areas which are subsequently amended with household refuse or animal manure.



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Plate 4.
Bending of pseudostem in fruiting highland banana plant affected by the disorder.

Cultivar susceptibility

While the development of Fusarium wilt is dependent on a number of factors, including cultivar, this disorder appears to indiscriminately affect all *Musa* cultivars grown in Uganda, including plantains, Cavendish and Bluggoe which are not affected by Fusarium wilt (Kangire 1998). The disorder has been observed on both AAA-EA and introduced banana types planted at Mitooma in Western Uganda as part of the INIBAP International *Musa* Testing Programme (IMTP).

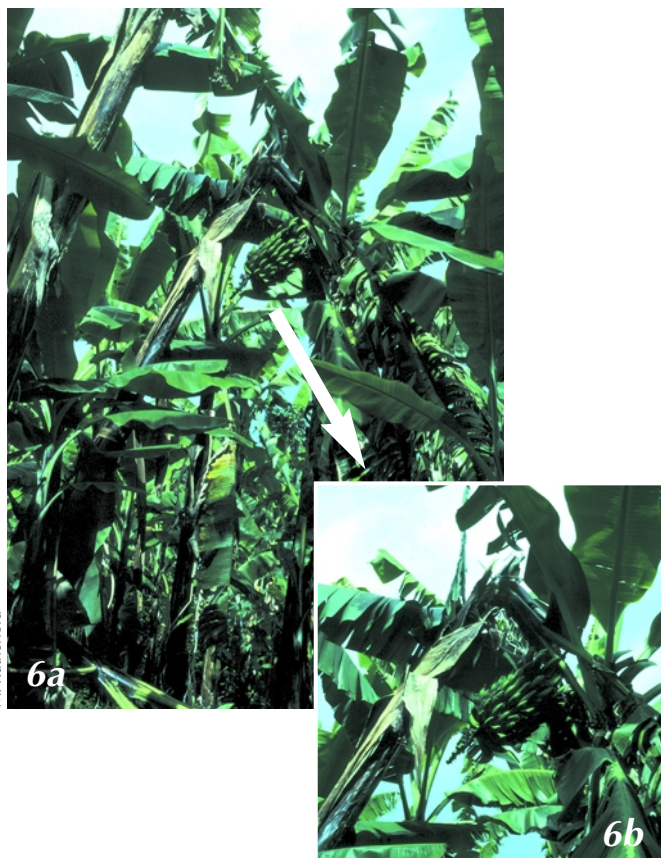
Effect on yield

The disorder causes a marked reduction in plant growth and overall bunch size and weight. Bunch weight has been reduced by as much as 78% in severely affected plants (Kangire 1998), mainly due to poor development of fingers. Several highland cultivars preferred by farmers and among the most important economically have been seriously affected, including Mbwazirume, Nakitembe, Enyeru and Nakabululu.



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Plate 5.
Highland cooking banana affected by the disorder, where upper section of pseudostem has dried and is beginning to break down and leaves are beginning to droop. Leaves undergoing early senescence have already been removed by the farmer.



Plates 6a & 6b.

Highland cooking banana severely affected by the disorder, where weakened pseudostem has snapped (arrowed) under the weight of the developing bunch.

Causal factors

There has been a longstanding and widely held belief in Uganda that this disorder is Fusarium wilt. Unfortunately little research has been undertaken on the disorder in the country and, while this may be due in part to the initial perceptions, it has not helped to confirm or disprove these or, more importantly, to assist in its management. Recent research undertaken by the UNBRP in collaboration with CABI Bioscience and the International Institute of Tropical Agriculture have shed light on the disorder, with a number of observations suggesting that *F. oxysporum* may not be responsible for its development:

- Mixed stands of indigenous highland and introduced banana types are often cultivated in Uganda and, while Fusarium wilt (often severe) has been observed on the introduced types in these stands the highland types have always remained symptomless. This is true in both lowland areas, where the disorder has not been observed, and in the highland areas of Western Uganda where it is prevalent.
- Farmers in many areas have reported observing symptoms on highland bananas prior to the cultivation of introduced types.

³Lukezik and Kaiser (1966) and Greene and Goos (1963) suggested that *F. pallidoroseum* is saprophytic or a secondary invader of damaged or diseased tissues although in the latter case other organisms, including pathogenic fungi, were usually present and found to be the primary cause of symptoms. *F. pallidoroseum* has also been reported to be pathogenic to certain crops such as cantaloupe and cotton (McGovern 1994, Ciegler *et al.* 1981).

- Although levels of production of introduced banana types in Western Uganda are low in comparison with highland banana types, only those plants cultivated in close proximity to affected highland types develop symptoms of the disorder.
- Suckers removed from banana mats affected by the disorder in Western Uganda and replanted in lowland areas of Central Uganda did not develop external or internal symptoms of the disorder through growth to maturity, as would normally occur through replanting on areas already affected by the disorder in Western Uganda.
- Pathogenicity studies undertaken in unaffected areas of the Central lowlands (Kawanda Agricultural Research Institute) and on farms in areas of the Western highlands where the disorder is prevalent have shown that, while inoculation with *F. oxysporum* resulted in development of Fusarium wilt on introduced banana types (cv. Kayinja), symptoms of neither Fusarium wilt nor the disorder developed on highland banana types.
- The authors have repeatedly failed to isolate *F. oxysporum* from tissues of plants affected by the disorder, although this species has been recovered previously (Ploetz *et al.* 1994). While *Fusarium pallidoroseum* (syn. *F. semitectum*) has frequently been isolated from these tissues, pathogenicity tests have suggested that the fungus is not pathogenic³ to either the highland or introduced banana types. Why this fungus is commonly found in affected highland bananas remains unknown.

Preliminary research has shown that soils obtained from affected farms have generally shown higher levels of calcium, potassium, and phosphorus in the vicinity of symptomatic plants in comparison with areas where the disorder is not apparent. Levels of these nutrients have also been found to increase in contained soils to which refuse and farmyard manure are added (Kangire 1998).

Management of the disorder

Investigations undertaken in Uganda to date suggest that the disorder may be alleviated by alteration of farm management practices, such as removal of affected plants, providing adequate drainage and composting household refuse prior to its application to soil.

Plates 7a & 7b. Production of white exudate (arrowed) on suckers of Highland bananas affected by the disorder.





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Plate 8.
Necrosis of leaf margin on Highland banana (cv. Mbwazirume) affected by the disorder.

Current research

Research, funded by UK Department for International Development Crop Protection Programme (DFID CPP), is currently being undertaken in Uganda by NARO in collaboration with CABI Bioscience to investigate the etiology of, and role of factors contributing to, the development of the disorder as a means of identifying mechanisms by which it may be effectively managed.

Acknowledgements

The authors would like to thank the Rockefeller Foundation, the UK Department for International Development Crop Protection Programme (DFID CPP), the International Institute of Tropical Agriculture (IITA) and CABI Bioscience, UK, for supporting research on this disorder and on *Fusarium* wilt of bananas in Uganda.

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Plates 9a & 9b.
Sections through pseudostem (plate 9a) and corm (plate 9b) of Highland banana affected by the disorder, revealing discoloration of vascular tissues. In this case, some weevil damage is also visible in the corm.