

## *Xanthomonas axonopodis* pv. *manihotis*

### Introduction

Cassava is one of the most important food crops, ranking fourth in world production of all tropical crops. It is the most important of the tropical root crops, being the staple for over 500 million people in developing countries. It was not until the late 1960s that serious attention was given to research on cassava, with the establishment of CIAT in Colombia and IITA in Nigeria. Programmes at these two institutions substantially augmented the commendable work that had been done in Brazil and East Africa. The belated attention on cassava sought to exploit its potential for feeding people (especially the poor) in the tropics. Its advantages for the purpose were its wide range of climatic adaptability, tolerance of soils having low nutrient status, resistance to drought, ease of cultivation and potential for achieving high yields.

Cassava bacterial blight (CBB), caused by *Xanthomonas axonopodis* pv. *manihotis*, is considered to be the most important disease of the crop on a world-wide basis. Its ability to cause leaf spotting, wilt, shoot die-back, gumming and vascular necrosis is unique among bacterial plant pathogens. If no management strategies are in place, losses can be as high as over 90%. Total loss of crop yield results in total loss of planting material (Lozano and Sequeira, 1974). The disease can impact negatively in another way: in parts of Zaire, where cassava leaves are eaten as a source of vegetable protein, defoliation caused by CBB resulted in starvation during an epiphytotic from 1970-1975 (Lozano, 1986). Reduced yields vary with the location, variety, weather pattern, time of planting, quality of the planting material, the level of sanitation during cultural operations and the degree of involvement of secondary, weak pathogens.

### Identity

<b>Authority</b>	: (Bondar) Vauterin, Hoste, Kerster & Swings
<b>Classification</b>	
<b>Kingdom</b>	: Procaryotae
<b>Phylum</b>	: Gracilicutes
<b>Class</b>	: Proteobacteria
<b>Family</b>	: Pseudomonadaceae
<b>Genus</b>	: <i>Xanthomonas</i>
<b>Species</b>	: <i>axonopodis</i> pv. <i>manihotis</i>
<b>Synonyms</b>	: <i>Xanthomonas campestris</i> pv. <i>manihotis</i> , <i>Xanthomonas manihotis</i> , <i>Phytomonas manihotis</i> , <i>Bacillus manihotis</i>
<b>Common names</b>	: Bacterial blight, CBB
<b>Role</b>	: Pest

### Note on Classification

See the note on *X. a.* pv. *citri*. *X. axonopodis* pv. *manihotis* is one of the plant pathogens that had been moved to the species, *axonopodis*, by Vauterin et al., (2000), but not supported by Schaad et al., (2000).

## Signs and Symptoms

1. The disease is usually initiated by inoculum in infected planting material which leads to:
  - wilt of new shoots without showing leaf blight, then
  - die-back often accompanied by a gummy exudate on the stems
2. Infections arising from foci of infection associated with infected planting pieces, contaminated tools or rain splash from diseased plants will exhibit:
  - greyish, angular, water-soaked spots, more prominently on the undersides of leaves;
  - brown spots that enlarge and coalesce to form blighted, necrotic areas (Fig. 1.)
  - enlargement of blighted areas which may engulf entire leaves that desiccate and collapse – the blight stage (Fig. 2);
  - systemic infection , spreading into leaf petioles and stems;
  - browning and death of vascular tissue in petioles and stems;
  - leaf wilt and eventual defoliation .

In damp, humid weather (or on cool mornings before sunrise) a yellowish, gummy, bacterial exudate can be found on leaf spots, along the veins and from fissures in petioles and young shoots. In drier conditions, the exudate dries to a shiny, pale scum. Vascular discolouration and rotting is more commonly found in younger shoots, which exhibit typical die-back symptoms that are the culmination of the blight stage.

Seed balls exhibit gradually spreading, water-soaked spots associated with necrotic and deformed seed that are rendered infertile. Apart from rotted spots around necrotic vascular strands, there is no evidence of the disease involving root tissues.

## Morphology

*X. axonopodis* pv. *manihotis* can be identified by standard physiological and biochemical characteristics. Recently, the organism has been identified by RFLP, AFLP and repetitive sequence-based PCR, all of which are employed in measuring the genetic diversity in field populations of the species. *X. a.* pv. *manihotis* is a small Gram-negative bacillus measuring 0.76-2.69 x 0.32-0.49  $\mu\text{m}$ . It has a single, polar flagellum, is non-encapsulated, is non-spore-forming and appears singly or in short chains. The bacterium grows well in media containing sucrose and, unlike most xanthomonads, does not form pigment.

## Biology and Epidemiology

The bacterium perennates in stem pieces used as planting material and in true seed, which are utilized in breeding programmes. These two sources of inoculum are responsible for the long-range dissemination of CBB. Dissemination within individual plots and from one plot to another is primarily by rain splash and contaminated tools. Lozano (1986) noted that the pathogen is spread from unrecognised, infected stems to healthy stems during harvesting operations that are usually conducted jointly with the preparation of planting material. The pathogen enters the host through wounds or the stomata. It breaks down the spongy mesophyll, enters the vascular tissues and moves systemically throughout the plant primarily via the xylem. At the optimal temperatures of 22-26 C, the

bacterium takes 12 hr to reach the xylem and causes symptoms to develop in 11-13 days. It appears unable to penetrate the lignified walls of secondary xylem, which explains the characteristic wilting of shoots only on young stems. CBB is more severe where large day-night temperature fluctuations of 15-30 C occur in the rainy season. Dry weather substantially reduces the development of disease.

## **Dispersal/Vectors**

Long-range dispersal is by means of contaminated vegetative planting material and true seed. Within the crop, rain splash and contaminated tools are the prime agents of dissemination.

## **Management**

### **Quarantine**

As with any disease that is seed borne, an important measure in managing CBB is the imposition of quarantine procedures limiting the importation of planting material to only certified, disease-free sources.

### **Sanitation**

The most reliable method of ensuring clean material is through meristem culture and testing appropriately to determine the pathogen is absent. Another method is by rooting excised buds. The bacterium is eliminated from true seed by treatment with dry heat.

### **Cultural Measures**

These are aimed at reducing the progress of CBB. The recommended procedures are:

- Crop rotation and fallowing - take advantage of the six-month period of survival of *X. a .pv. manihotis* in soil
- Weed destruction - eliminates the possibility of epiphytic survival of the pathogen on leaves.
- Planting near the end of the rainy season - avoids most of the period of high inoculum levels. During the slower growth in the dry season inoculum is low and the plants elaborate pectate, cellulose and lignin which increase the resistance to infection that threatens in the rainy season.
- Use of pathogen-free plants derived through tissue culture procedures.
- Pruning infected shoots (within 3-months after infection) to reduce the inoculum - has been found efficacious only when resistant and moderately resistant varieties are planted or where the prevailing conditions are not ideal for disease development.

### **Resistant varieties**

The development of varieties resistant to CBB is an on-going activity at CIAT and IITA from which several have been released. Many in the MCOL and NMEX series are well known in the Caribbean region. Resistance is multigenic, incomplete and dependent on environment and inoculum level (Kemp et al., 2001). Mechanisms appear to involve copious production of latex that contains various enzymes, e.g., glucanase and lysozyme. Screening methods are broad-based to include assessment of other agents that constrain production. An essential component of the breeding programme is the identification of emerging strains of the bacterium. AFLP analyses offer more precision than RFLP in distinguishing strains (Restrepo et al., 2000). This study demonstrated that Colombian

populations have a high degree of genetic diversity, evidently induced by the range of host genotypes produced in the breeding programme. For about 20 years the breeding strategy has focussed on developing cultivars adapted to specific edaphoclimatic zones (ECZS). Restrepo et al., (2000) showed genotypic differentiation among ECZs, among fields within ECZs and among strains within fields in which a range of cassava genotypes had been planted.

### **Biological measures**

There has been no evidence of the commercial use of bacterial antagonists reported by Hernandez et al., (1987). Strains of *Pseudomonas fluorescens* and *P. putida*, when applied to cassava leaves, were found to significantly reduce the intensity of leaf spotting and of leaf blighting.

**Host Notes:** *Manihot* spp.

### **Distribution**

Initially reported from Brazil (the centre of origin of cassava) in 1912, CBB has spread throughout Latin America and the Caribbean. It was accidentally introduced into Africa on planting material and now occurs in most countries where cassava is grown. The disease is present in the major-producing countries of Nigeria, Cameroon, Benin, Togo, Ghana, Zaire, Congo Republic, Rwanda and Uganda. In Asia, CBB is particularly important in China, Taiwan and Malaysia.



**Fig. 1: Cassava leaves showing typical angular, water-soaked spots on the lower surface.**



**Fig. 2: Cassava plant showing shoots typical of the blight stage of cassava bacterial blight**

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