

## *Fusarium* Wilt of Bananas (Panama Disease)

### *(Fusarium oxysporum f. sp. cubense)*

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#### BACKGROUND

*Fusarium* wilt (Panama disease) is a destructive fungal disease of banana plants. It is caused by *Fusarium oxysporum f. sp. cubense* (*Foc*). It first became epidemic in Panama in 1890 and proceeded to devastate the Central American and Caribbean banana industries that were based on the 'Gros Michel' (AAA) variety in the 1950s and 1960s. Once *Foc* is present in the soil, it cannot be eliminated.

There are four recognised races of the pathogen which are separated based on host susceptibility. Race 1, which was responsible for the epidemics in 'Gros Michel' plantations, also attacks 'Lady Finger' (AAB) and 'Silk' (AAB) varieties. Race 2 affects cooking bananas such as 'Bluggoe' (ABB) and race 4 is capable of attacking 'Cavendish' (AAA) as well as the other varieties of banana affected by races 1 and 2. These three races have been present on the east coast of Australia for many years and race 1 is present in WA. Race 4 is further divided into 'sub-tropical' and 'tropical' strains. 'Tropical' race 4 is a more virulent form of the pathogen and is capable of causing disease in 'Cavendish' growing under any conditions, whereas 'sub-tropical' race 4 generally only causes disease in plants growing sub-optimally (cool temperatures, water stress, poor soil). Race 3 affects *Heliconia* spp., a close relative of banana, and is not considered to be a banana pathogen.

'Tropical' race 4 was discovered in Darwin's rural area in 1997 and has since spread to most banana growing areas of the Top End.

#### DISEASE SYMPTOMS

*Fusarium* wilt of banana can be described as a "classic" vascular wilt disease. It invades the vascular tissue (xylem) through the roots causing discolouration and wilting.

Externally, the first obvious signs of disease in most varieties are wilting and a light yellow colouring of the lower leaves, most prominent around the margins. They eventually turn a bright yellow colour with dead leaf margins (Figure 1). As the disease advances, more of the leaves become yellow and die. A "skirt" of dead leaves often surrounds the pseudo-stem. In the advanced stages of disease, affected plants may have a spiky appearance due to prominent upright apical leaves in contrast to the skirt of dead lower leaves (Figure 2).

Internally, symptoms first become obvious in the xylem (water conducting) vessels of the roots and the rhizome. These turn a reddish-brown to maroon colour as the fungus grows through the tissues (Figure 3). Occasionally, the discolouration first appears yellow in plants showing early stages of infection (Figure 4). When a cross-section is cut, the discolouration appears in a circular pattern around the centre of the rhizome where the infection concentrates due to the arrangement of the vessels (Figure 5). As symptoms progress into the pseudo-stem, continuous lines of discolouration are evident when the plant is cut longitudinally (Figure 3). The infection may travel all the way up to the top of the pseudo-stem. In severe cases it may even enter the leaf petioles and the peduncle (bunch stalk) of bunched plants. However, infection has not been shown to progress into the fruit.





**Figure 1.**



**Figure 2.**



**Figure 3.**



**Figure 4.**



**Figure 5.**

**Figure 1.** Plant showing early symptoms of *Fusarium* wilt

**Figure 2.** Plant showing advanced symptoms of *Fusarium* wilt

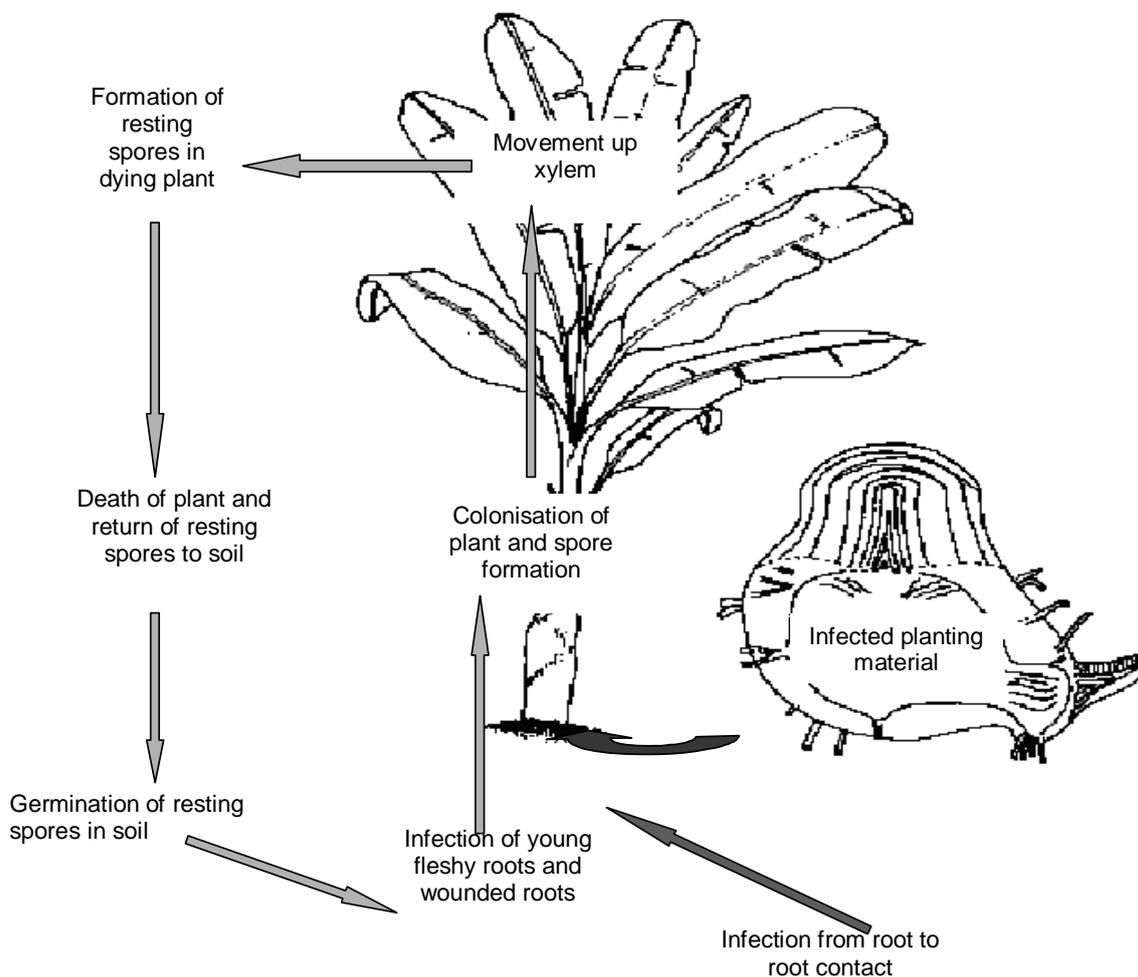
**Figure 3.** Reddish-brown to maroon staining of vessels in the pseudo-stem

**Figure 4.** Yellow staining of xylem vessels in the pseudo-stem

**Figure 5.** Reddish-brown to maroon staining of the vessels in the rhizome

## DISEASE CYCLE

Spores of *Foc* in the soil germinate and grow towards the nearby roots of banana plants in response to chemical compounds exuded from the roots. Infection takes place on the secondary and finer roots and proceeds into the larger, primary roots through the xylem vessels before entering the rhizome. The primary roots and the rhizome do not appear to be infected directly by the pathogen. The xylem network consists of a series of individual vessels with perforated end walls through which the sap flows. Movement of the spores with the sap flow is blocked temporarily when they become lodged at the end walls. The spores then germinate and hyphae grow through the perforations into adjoining vessels where further spores are produced. The plant is often able to prevent infection from successfully travelling to and entering the rhizome by the production of gels and tyloses (a resistance mechanism) to seal off the infection. However, multiple infections occur during the life of a plant and invariably one or more lead to its complete invasion. The virulence of 'tropical' race 4 on 'Cavendish' bananas suggests that the resistance mechanisms employed by the plant against this strain are not as effective as for 'sub-tropical' race 4. This strain generally only causes serious losses in a plantation where the plants are under stress.



**Figure 6.** Disease initiation and life cycle of *Foc* in a banana plant

## PATHOGEN DISPERSAL

*Foc* can be spread unknowingly over long distances onto new plantations when infected rhizome bits and suckers are used for planting material. The use of tissue cultured plantlets from a certified source guarantees planting material free from the disease. Spread can also occur over long distances in infested soil adhering to vehicles and footwear. There is reason to believe that infested soil adhering to the feet of animals is another way by which spread occurs. The fungus can move over short distances within an infected area of a property through the interconnecting network of roots and in surface water.

## DISEASE CONTROL

Once a property becomes contaminated with *Foc*, the only option for continued long-term production is replacement of the susceptible variety with a resistant one. *Foc* cannot be controlled using fungicides and cannot be eradicated from the soil using fumigants. Research conducted in Darwin has identified a number of resistant varieties. However, whilst their resistance genes may be useful in future breeding or gene transfer programs, none are suitable as immediate replacements for the 'Cavendish' variety. Currently, the best option for managing the disease and extending the productive life of a plantation is to minimise spread from known infected areas by restricting movement of people and machinery, animals and water flow within the infected areas. When infected plants are detected, it is best to disturb the area as little as possible and not to cut the plant down. A heat shield, such as corrugated iron, can be erected around the infected and adjacent plants which are then burned. This practice destroys the inoculum in the infected plants (and some in the soil) which would otherwise be released into the soil and add to disease spread as the plant decays. Machinery, tools and footwear that have come in contact with infested soil or diseased plants should be sanitised using a detergent-based product known as Farmcleanse®.

### Better management practices

- Do not allow unauthorised vehicles to be driven around the farm and shed area. Vehicles should be driven to a designated area.
- No vehicles or equipment should be allowed to leave or enter the farm beyond the designated area without inspection and approval by management. Machinery and equipment should be treated with a sanitary solution such as Farmcleanse® which can be obtained from your local agricultural chemical dealer.
- Footwear, which may have contacted banana plants or soil around banana plants elsewhere, should not be worn on the farm.
- No agricultural vehicles, tools (including shovels, knives and ladders) or equipment should be removed from, or brought on to, the farm without prior approval from management.
- When staff show visitors around the farm, it is their responsibility to adhere to all farm procedural guidelines.
- Do not take on to or off the farm any soil or banana material except banana fruit supplied from the packing shed.
- Field staff should make themselves familiar with *Fusarium* wilt information material in order to recognise the disease symptoms and comply with all updated, additional procedural guidelines or regulations.

**In the NT, restrictions are placed on movement of banana material. Know the quarantine requirements for importing planting material into the NT and between the Declared NT Banana Protection Areas.**

## **WHAT TO DO WHEN SUSPECT PLANTS ARE FOUND**

- Cordon off the area containing the suspect plant(s) and the plants immediately adjacent to prevent movement of field staff and machinery through the area. If possible, immobilise any machinery and other equipment that has come in contact with the ground surrounding the affected plant(s).
- Immediately suspend movement of machinery and equipment off the property that has been used in the field.
- Contact the Department of Primary Industry, Fisheries and Mines to arrange an officer to visit to collect samples and advise on decontamination procedures.

## **CONTACT THE DEPARTMENT OF PRIMARY INDUSTRY, FISHERIES AND MINES FOR FURTHER INFORMATION AND ADVICE:**

### **Suspected diseased plants:**

1800 084 881 (Free call)

### **Banana plant import requirements:**

(08) 8999 2088

Please visit us at our website:

**[www.nt.gov.au/dpifm](http://www.nt.gov.au/dpifm)**

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