Status of *Fusarium oxysporum* f.sp. *cubense* Tropical Race 4 (*Foc TR4*) in Australia

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On behalf of the Australian Banana Research and Extension Teams.

DEPARTMENT OF PRIMARY INDUSTRY AND FISHERIES
Australian Banana Production System

• The system
  ▪ Plant and 4 to 5 ratoons

• Reasons why
  ▪ Minimise to build up of pest and diseases.
  ▪ Synchronising harvest periods
  ▪ Labour cost
Some Past Foc Research Activities

Horticulture Australia
FR96013 Banana Tissue Culture for clean sustainable production – M. Smith
FR96018 Banana Plant Improvement – N. Moore
FR98019 Banana Tissue Culture: Plant health Support including nursery development – S. Hamill
FR99009 Plant Protection Extension in the Qld Banana Industry – S. Lindsay
FR99037 Diagnosis of Banana Plant Pathogens - J. Stanton
FR00043 Identification of Banana Varieties with Resistance to Fusarium Wilt Tropical Race 4.- NT – G. Walduck
FR01009 Banana Tissue Culture for Industry development – S. Hamill
FR02021 Fusarium Wilt of bananas: Detection diagnosis and epidemiology – S. Bentley
FR02025 Soil and root health for banana production. – T. Pattison
BA04007 Plant Tissue Culture: providing strategic support for the banana industry. – S. Hamill
BA07001 Strategic banana tissue culture research, industry development and biosecurity activities – S. Hamill

ACIAR
HORT/2005/136 Mitigating the threat of banana Fusarium wilt in Indonesia and Australia- B. Williams
HORT/2008/040 Integrated crop production of bananas in Indonesia and Australia – T. Pattison
Current Extension and Research Foc Projects.

Horticulture Innovation Australia.
BA10020 Banana Plant Protection Program - A. Drenth
BA13004 National Banana Development and Extension project – S. Lindsay

BA14013 Facing Fusarium: Better Banana Biosecurity - S Lindsay
BA14014 Fusarium wilt Tropical Race 4 Research program – T. Pattison

ACIAR
HORT/2012/097 Integrated management of Fusarium wilt of bananas in the Philippines and Australia. – T Pattison
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Grower Driven Questions.

- I don’t have the disease, what do I need to do to prevent getting it?

- I have the disease on one part of the farm, how do I manage the spread?

- I have the disease across the farm, should I continue to farm and if so how?
Key Strategies

- Building science based Farm Biosecurity Systems,
- Improving early detection and response to disease incursion,
- Managing soils and inoculum load in the presence of TR4,
- Resilient production options for industry survival,
- Developing of genetic material suitable for production in TR4 affected areas,
- Tools to facilitate the adoption of biosecurity systems.
Building science based Farm Biosecurity Systems

What disinfectants are best for each situation and how effective are they?
While many disinfectants are very effective against the fungus in laboratory, developing a standard test, showing efficacy in situations where soil or organic matter contamination is present with the most resistant spore type is more appropriate.

How best to minimize the movement of soil?
Reducing the transfer of soil between blocks on machinery and footwear, while not impeding normal farm practices or adding to the costs.

How should waste be managed?
Waste within the biosecurity system may be contaminated with soil and consequently with fungal spores.
Building science based Farm Biosecurity Systems

How should potentially contaminated water be managed?
Contaminated irrigation water is a possible source of new infections as soil washed from infected farms into water courses and dams can in turn contaminate new farms. A protocol for testing survival of Foc spores in water needs to be developed to validate a sampling methodology to ensure irrigation water continues to be safe to use on banana farms.

What can we do with potentially contaminated soil?
Soil treatment options particularly for potentially contaminated soil collected from wash down processes, need to be developed.

How do we deal with contaminated pseudostems?
The Foc pathogen develops and produces the chlamydospores in the banana pseudostem. Treating infected pseudostems may reduce chlamydospore development and suppress the levels of inoculum in the environment.
Improving early detection and response

Rapidly identify abnormal plants.
Plant symptoms of TR4 are easily confused with other soil borne diseases such as Erwinia corm rot, nutritional disorders and water stress. By identifying areas of poor plant growth, diagnostics can be targeted to problem areas, allowing a rapid diagnosis of the presence of TR4.

Streamlining current Foc diagnostics
Current diagnostic techniques consist of a combination of a molecular test support by a VGC. In all a complete diagnostic from field identification to diagnostic outcome can take between 28 to 35 days. If early detection is the forefront of managing the disease this period needs to be reduced.

Early detection of TR4 in soil and water
Soil and water are two main pathways for the movement of Foc. A reliable and consistent technique for detecting Foc in soil and water needs to be developed, with robust procedures for testing the efficacy of the mitigation measures.
Improving early detection and response

Determine effective in-field tools to identify potential Foc infection.
The focus of future diagnostic research needs to move to in-field tools that provided early indications of infection allowing interventions such as chemical injections (synthetic or biological) that are able to attack the more venerable stages of the pathogen life cycle. The current technology can be categorized as:

**Field:** Infra-red thermometer to measure leaf temperature.
Greenseeker
Chlorophyll and phenol monitoring

**Proximal sensing:** Unmanned aerial vehicles (UAV) offer potential for rapid map based crop assessments.

**Remote sensing:** Use of satellite maps to pick out areas of poor plant growth or stress.
Managing soils and inoculum load in the presence of TR4

Infected plants.
The recommended eradication practice for when an infected plant has been identified, however this leaves a significant area of bare soil. Alternative practical techniques for Australian conditions need to be considered.

- Herbicide/fungicide/insecticide injections.
- Microwave treatment of infected pseudostems
- Microbial breakdown of pseudostem material
- Nutrient accelerants to increase microbial decomposition
Resilient production options for industry survival

To gain the knowledge of the pathogen survival, suppression and infection process of banana plants 6 work areas are targeted;

- epidemiology of Fusarium wilt,
  - identify the infection processes of Foc on banana and understand where and when clamydospores are produced in infected plants.

- survival of TR4 on alternate hosts
  - determine how Foc survives in the absence of banana, which plants that co-habit banana plantations (either weeds or groundcovers) and may act as alternative hosts and which plants could be used to reduce survival of Foc (non Hosts).

- rotation crops to reduce TR4 inoculum
  - determine which crops reduce TR4 inoculum in the soil in rotation with bananas.

- microbiome of banana soils leading to TR4 suppression
  - identify keystone soil organisms and genes that suppress or enhance TR4 infection of bananas.

- nutrition management to enhance plant defences and reduce survival of TR4
  - determine how soil nutrient inputs affect Panama disease of bananas.

- physicochemical conditions impacting on the growth and survival of Foc in the soil
  - develop a greater understanding on how soil physicochemical conditions can be manipulated to influence the persistence, growth and infectivity of Foc.
Development and evaluation of genetic material

- Screening germplasm for resistance to TR4.
  - Introduction and evaluation of germplasm from international programs

- Generation of improved banana survival to TR4
  - Mutation breeding from parents with desirable characteristics.

- Marker assisted screening of germplasm for potential resistance to TR4 & STR4
Tools to facilitate the adoption of biosecurity systems

Objectives:
1. to support growers in the redesign of their farms and systems with the provision of expert process and environmental design advice, analyzing systems from an economic and social perspective.
2. to facilitate rapid uptake of improved and scientifically validated practice through a program of communication and training activities linked with the national banana extension project.

Activities:
1. Developing and implementing a new clean planting material system for the Australian banana industry
2. Developing digital tools to assist adoption of best practice farm biosecurity by banana producers
3. TR4 capacity building
Institutions engaged

• Queensland Department of Agriculture & Fisheries
• Queensland University
• Northern Territory Department of Primary Industries & Fisheries
• Queensland University of Technology
• James Cook University
• South Australia Research & Development Institute
• University of New England
Thank you