Can silicon enhance tolerance to Fusarium wilt in banana?

ACPP APPS Darwin 2011 conference

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A Very Broad Overview

- Banana
- Fusarium
- Silicon
Banana

- *Musa* sp.
  - Important domestic and export crop
  - Seedless
  - Limited commercial varieties
Fusarium wilt of banana

- Soil borne fungal disease
  - *Fusarium oxysporum* f. sp. *cubense*

- Infects through roots into vascular tissue

- Distributed globally
  - Spreads slowly
  - But devastating
Fusarium wilt of Banana

- In Australia:
Can you stop Fusarium?

• Fusarium infection is usually a death sentence
  – Good quarantine has slowed the spread

• Genetic resistance

• Limited control in banana
  – Novel control?
The nutrient: Silicon

- **Element** silicon like N, P, K
  - Needed (?) by plants

- **In plants?**
  - Quasi-essential
  - Taken up from the soil; stored mostly in shoots

- **Abundant**
  - But silicon degraded soils are common
The benefits of silicon

• Biotic resistance
  – Increased tolerance to a wide range of pathogens/herbivores

• Abiotic benefits
  – Effects are subtle

• How does silicon induce disease resistance?
  – Physical? (armoured shell)
  – Biochemical (priming)
  – Something else entirely?

• Only presents benefits in presence of negative factor
Objectives

• **Obj1: Show that it works.**
  – Pot trials

• **Obj2: Locate silicon in the roots.**
  – X-ray microanalysis

• **Obj3: Determine what silicon is doing.**
Pot Trial

- Silicon dioxide ($\text{SiO}_2$)
- Inoculate with fusarium infested millet
- Internal symptoms at 14 weeks post inoculation
  - Scale (1 – 6)
Silicon enhances resistance in banana

Results

Disease Rating of *Foc* inoculated Cavendish Banana plants at 14 weeks post inoculation

- **Control**
  - 0% (6, worst disease)
  - 10% (5)
  - 20% (4)
  - 30% (3)
  - 40% (least disease)

- **Silicon**
  - 0% (6, worst disease)
  - 10% (5)
  - 20% (4)
  - 30% (3)
  - 40% (least disease)

Plant Treatment

Percentage of plants fitting disease category
Objectives

• Obj1: Show that it works.
  – Pot trial

• **Obj2: Locate silicon in the roots.**
  – X-ray microanalysis

• Obj3: Determine what silicon is doing.
X-ray mapping

- JEOL 6460 analytical SEM
- From banana plants grown with 10g/kg Si added
- Freeze fractured/freeze dried banana roots

http://www.uq.edu.au/nanoworld
EDS - X-ray Mapping

**Results**

**Banana root silicon content**

Silicon content (%)

- Epidermis
- Hypodermis
- Cortex
- Enodermis
- Stele

- **5**
- **10**
- **15**
- **20**
Objectives

- **Obj1:** Show that it works.
  - Pot trial

- **Obj2:** Locate silicon in the roots.
  - X-ray microanalysis

- **Obj3:** Determine what silicon is doing.
Objectives

Obj3: Determine what silicon is doing.

In Progress!
What does it all mean?

• Silicon in cortical tissues may be resisting fungal penetration.

• Aiding in structural integrity.

• Or priming defences.

• Or something else.
Expected Outcomes

– Does silicon work?
  • Cost?
  • Availability?
  • Effectiveness?

– Greatest applications in tissue culture/horticulture/agriculture?
Summary

- Silicon enhances tolerance to fusarium in banana
- Is located in root cortical tissue (at least)
- Work is ongoing
Acknowledgements

- Dr Elizabeth Aitken
- Dr Bronwen Cribb
- Dr Sharon Hamill
- Dr Leanne Forsyth
- Dr Jennifer Whan

- (soon to be Dr) Sam Fraser-Smith
- (soon to be Dr) Rachel Meldrum

**Funding**
- Horticulture Australia Limited (HAL) and the Australian Banana Growers’ Council (ABGC). Including Mort Johnston Scholarship