Soil health research strategies for managing Fusarium wilt of banana in Brazil

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Banana in Brazil

- 500,000 hectares
- 7 million t/year
- 6% of the world's bananas
- Exports 0.3% of world trade
Introduction

• Fusarium wilt is the major disease of banana in Brazil

• Race 1
  ‘Maça’ (Silk, AAB)
  ‘Pacovan’ (AAB)
  ‘Prata’ and ‘Prata anã’ (Pome, AAB)

• Tropical Race 4
**Introduction**

- Can plant health be impacted by soil health?

*One health* concept: the health of soils, plants, animals, people and the environment is one and indivisible.

*The Soil–Human Health Nexus. R. Lal, 2021*
Soil Management & Fusarium wilt of banana

• Edaphic conditions
  Driving factor to speed up or suppress FWB epidemics

• Almost only the plant's nutritional requirements shape soil management

Soil Management  →  soil health

Soil health  →  plant health
Soil health research strategies for managing Fusarium wilt of banana in Brazil

• Our research approaches

1. Identify potential biotic and abiotic soil predisposing factors associated with FWB

2. Create contrasting environments by managing soil health factors to evaluate FWB
Biotic and abiotic soil predisposing factors associated with FWB

• Identification and description of the main areas affected by FWB in São Paulo, Brazil

  Two surveys in production areas

  Relate plant health to biotic and abiotic factors
Soil attributes & FWB

São Paulo State

- Disease distribution/FOC characterization
- Evaluations
  - Black/Yellow Sigatoka
  - Weevils [density/damages]
  - Nematodes [roots & soil]
  - Physical & chemical soil attributes
  - Plant nutrition
  - Soil microbiota/microbial activity/enzymes
- Management practices description
- Soil & climate classification
Soil attributes & FWB

• Eldorado Farm at Vale do Ribeira

Mosaic of drone images; base map: GoogleEarth. Teixeira, 2022.
Soil attributes & FWB

- Collecting FOC samples → Characterization of isolates
- Collecting rhizospheric soil → DNA extraction
Soil attributes & FWB

- Measuring root penetration resistance
- Collecting soil samples → chemical attributes
Soil & FWB - results

• Cavendish and ‘Prata’
  Ca ↓ → FWB ↑

  pH ↓ (more acid soil) → FWB ↑

  V% (base saturation) ↓ → FWB ↑

  Mn ↓ → FWB ↑
Soil & FWB

• ‘Maçã’ and ‘Prata’

Soil density → FWB

Root penetration resistance → FWB
Soil & FWB

- Soil chemical attributes X FWB
  - Multivariate analysis
    Canonical Discriminant Analysis (CDA)
  - Vale do Ribeira: P, Ca and base saturation (axis 1)
  - São Bento: root penetration resistance (axis 2)

Teixeira et al., 2021
Soil health research strategies for managing Fusarium wilt of banana in Brazil

• Two research approaches

1. Identify potential biotic and abiotic soil predisposing factors associated with FWB
   - Soil pH, Ca, P, base saturation
   - Root penetration resistance, soil density
   - Banana weevil
   - Nematodes
   - ...

2. Create contrasting environments by managing soil health factors to evaluate FWB
Soil management practices

<table>
<thead>
<tr>
<th>Location</th>
<th>Coordinates</th>
<th>Type of farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jaíba, MG</td>
<td>15°S; 43°W; 470m</td>
<td>Plantation</td>
</tr>
<tr>
<td>Aguaí, SP</td>
<td>22°S; 47°W; 660m</td>
<td>Plantation</td>
</tr>
<tr>
<td>Registro, SP</td>
<td>24°S; 47°W; 27m</td>
<td>Small-scale family producer/plantation</td>
</tr>
<tr>
<td>Corupá, SC</td>
<td>26°S; 49°W; 130m</td>
<td>Small-scale family producer</td>
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</tbody>
</table>
Aguaí, SP
Vale do Ribeira, SP
<table>
<thead>
<tr>
<th>Cobertura vegetal</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crotalaria spectabilis no plantio</strong></td>
<td>No</td>
</tr>
<tr>
<td>Fuente de N</td>
<td>Control</td>
</tr>
<tr>
<td>Nitrato de calcio</td>
<td>Ureia</td>
</tr>
<tr>
<td>Fuente de P</td>
<td>Control</td>
</tr>
<tr>
<td>Termo fosfato (18% P₂O₅)</td>
<td>SFT</td>
</tr>
<tr>
<td>Abono orgánico</td>
<td>Control</td>
</tr>
<tr>
<td>2 kg/planta en la siembra + 4 X/año</td>
<td>No</td>
</tr>
<tr>
<td>Trichoderma - inoculación de las vitroplantas</td>
<td>30 y 15 día antes de la siembra</td>
</tr>
<tr>
<td><strong>Trichoderma - inoculación de las plantas en producción</strong></td>
<td>30 y 15 día antes de la siembra</td>
</tr>
<tr>
<td>Silício en la siembra</td>
<td>Control</td>
</tr>
<tr>
<td>1 ton/ha</td>
<td>No</td>
</tr>
</tbody>
</table>
Vale do Ribeira, SP

- Results
Vale do Ribeira, SP

• Results
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• Research approaches

1. Identify potential biotic and abiotic soil predisposing factors associated with FWB

2. Create contrasting environments by managing soil health factors to evaluate FWB

3. There is no silver bullet!

Complex problems require complex solutions
Integrated & site-specific soil management practices

- Site selection
- Plant layout
- Soil analysis
- Soil preparation
- Planting material
- Soil acidity control and its effects
- Soil health oriented fertilization
- Fertilization with soil/plant monitoring
- Application of organic materials
- Cover crop management and green manures
- Crop rotation in orchard renewal
- Beneficial microorganisms
- Knowing and managing physical imitations
- ...
Thanks to all who participate with us in this effort!
¡Gracias!
Thanks!
Merci!