An integrated approach to reduce yield losses caused by Fusarium wilt of banana in São Paulo, Brazil

### The Brazilian banana Industry

<table>
<thead>
<tr>
<th>Type</th>
<th>Estimated %</th>
<th>Resistance Foc R1,2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silk [Maça]</td>
<td>4</td>
<td>HS</td>
</tr>
<tr>
<td>Prata-types</td>
<td>70</td>
<td>S</td>
</tr>
<tr>
<td>Cavendish [Nanica]</td>
<td>20</td>
<td>R</td>
</tr>
</tbody>
</table>

- **BRS Platina**
- **BRS Princesa**
Fusarium wilt in Brazil: Current status
Fusarium wilt in Brazil: Current status
Epidemiological factors and management strategies

- Fusarium wilt management
- Resistant cultivars
- A/B Cycle
- $ Resistant cultivars
- Soil health
  - Microbiome
  - Micro N
  - NO3, NH4
  - Ca+
  - pH
  - Organic Matter
- Seed systems
- Exclusion
- "?" symbols indicating unknown factors in the management strategies.
Two interconnected strategies

A: Pre-existent situations
- In depth characterization of production systems
- Epidemiological factors
- Unveiling biotic and abiotic factors driving FW
- Management practices vs. plant health
- Soil analyses - microbiota
- *Foc* populations

B: Creating contrasting environments
- Testing hypotheses by interventions to transform pre-existent situations
- Integrating tailored management practices
- Multi-site experiments
- Continual Improvement Process
A: Generating knowledge on Foc- Bananas in São Paulo

Management practices
- Foc collection
Evaluation
  • Black /Yellow Sigatoka
  • Weevils [density/damages]
  • Nematodes [roots & soil]
  • Soil chemical
  • Soil physic [Penetration, ]
  • Plant nutrition

Jaguaríúna - Registro = 294 km
Jaguaríúna - São Bento do Sapucaí = 230 km
Jaguaríúna - Penápolis = 451 km
Jaguaríúna - Marinópolis = 555km
A: Generating knowledge on Foc- Bananas in São Paulo

Spatial distribution of Fusarium wilt
A: Generating knowledge on Foc- Bananas in São Paulo

Weevils [C. sordidus; Metamasius]

A: Vale do Ribeira, B: São Bento do Sapucai, C: Penápolis, D: Jales

It is no clear the relation of the number of adults with FW, but damages percentage [still under evaluation] give a better relation
A: Generating knowledge on Foc- Bananas in São Paulo

Soil penetration resistance

Penetration resistance measured at lab with at matric potential of -10kPa (soil humidity similar for all samples) SBS, PN and JA - Foc + higher resistance to root penetration

SE: standard error
B: Transforming environments

Facing the reality: Myth and facts

B: Creating new environments
- Testing hypotheses by interventions on pre-existent situations
- Integrating
- Multi-site experiments
- Continual Improvement process
Disease cycle of Fusarium wilt vs. Disease management

- Crop rotation, cover crops, composts, manures, weed control.
- Application of antagonist microorganisms [antibiosis, parasitism and competition], pH correction.
- Entophytes microorganisms:, *Trichoderma* spp., PGPR,
  - Other rhizo-microorganisms.
  - 2. Control weevils and nematodes.
- Induced resistance
- Nutrition [Zn, N, P, K, Ca]
- Early detection
- Plant eradication
- Reduction of secondary inoculum
- Control of pathogen dissemination

Fungus grows through the cortex to the epidermis

Vascular discoloration in the xylem

Mycelium in vascular tissues

Cornilia rapidly produced in the vascular tissue of host and distributed within plant transportation system

Xylem vessels in healthy stems

Collapsed and distorted vessels in infected stem

Gum in vessels and adjacent cells

Mycelium in vessels

Spores (micro- and macroconidia and chlamydospores) formed by mycelium in the soil

Chlamydospores formed within host tissues returned to soil

Mycthy in vessels

Entophytes microorganisms:,

*Trichoderma* spp., PGPR,

- Other rhizo-microorganisms.
- 2. Control weevils and nematodes.
Integrated approach for disease management and enhancing productivity in Foc-susceptible bananas

- TC plants + target endophytes
- "Biotized"/bio-fortified healthy plants acclimatized – Plant fitness increased
- Use of tailored fertilization based on organic amendments (Biochar, manures, compost) + beneficial soil microbes (Trichoderma & CIA)
- Healthy plants are established on a healthy soil

Use of Beneficial Microbial Diversity Multifunctional isolates

Soil-health oriented practices and crop Integrated management
B: Transforming environments

1\textsuperscript{st} Crop cycle

![Graph showing Fusarium wilt incidence over days after planting for different crop cycles.](image)
• There are many factor associated with FW intensity, but they need a case-by-case considerations. Weevils, Nematodes, Soil parameters here presented are a good example of it. Meta-analyses are under-going

• The role of nutrient [sources and levels] deserves special attention. Their relation with microbial functional diversity need further analyses

• FW reduction observed in the experimental area in SP is not yet conclusive, though the results of the second crop cycle are still showing significant FW reduction. Comprehensive analyses of datasets from additional cropping cycles of this and from other experimental plots already established in different areas in Brazil are in the pipeline.
Obrigado!

Luiz Teixeira: lulaiac@gmail.com
miguel.dita@embrapa.br